RADICAL INNOVATION IN A COORDINATED MARKET ECONOMY: INSTITUTIONAL CAPABILITIES WITHIN GERMANY AND BEYOND

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Diana Schönenberger

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Research and Development Centre
Kent Business School
University of Kent

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Supervisor

Prof. Soo Hee Lee

Professor in Organisation Studies
Head of the People, Management, and Organisation Research Group
Research and Development Centre
Kent Business School
The University of Kent, Canterbury, Kent, CT2 7PE

Second Supervisor

Prof. Dr. Alex Mohr

Professor of Export Management and Internationalization Processes
Institute for Export Management
Department of Global Business and Trade
Vienna University of Economics and Business
Welthandelsplatz 1A-1020 Vienna/Austria Building D1

DECLARATION

The work presented in this thesis is Diana Schönenberger`s own.

Date: 3rd of October, 2017

Signed:

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DEDICATION

This work is dedicated to Aleksandar Frederick and Felice Isabell.

ABSTRACT

This doctoral dissertation illustrates how the typically coordinated market economy of Germany fosters the creation of radical innovation. The findings of this thesis are in sharp contrast with theoretical expectations for the crucial case of Germany. The changes in the German institutional framework, including the labour market, corporate governance, financial institutions and skill creation since re-unification are illustrated. The influence of government policy on institutional change is analysed. Propositions of different approaches to the political and economic theory are discussed in the light of the findings. An enhanced theoretical framework for the support of new and emerging technologies in the coordinated institutional framework of Germany is established.

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ABBREVIATIONS

AD	Automated Driving
BS	Business Systems
BiS	Biotechnology Sector
CC	Comparative Capitalism
CDU	Christlich Demokratische Union Deutschlands
CEA	Comparative Economic Advantage
CG	Corporate Governance
CIA	Comparative Institutional Advantage
D	Germany
DI	Disruptive Innovation
EM	Electro Mobility
FI	Financial Institutions
FDP	Freie Demokraten
FR	France
Gruene	Die Gruenen
J	Japan
LM	Labour Market
LMI	Labour Market Institutions
MNCs	Multi-National Corporations
NIS	National Innovation System
Prop.	Proposition
RQ	Research Question
SC	Skill Creation
SMEs	Small- and Medium-sized Enterprises
SP	Social Policy
SPD	Sozialdemokratische Partei Deutschlands
SS	Software Sector
SW	Sweden
UK	United Kingdom
USA	United States of America
VDA	Association of German Automakers (Verband Deutscher Automobilhersteller)
VoC	Varieties of Capitalism
WPR	Welfare Production Regime

1. CHAPTER ONE: INTRODUCTION

Coordinated market economies hold their comparative economic advantage in incremental trajectories of innovation.

This doctoral dissertation aims to call the underlying proposition of comparative political economy and, specifically, the Varieties of Capitalism (VoC) approach into question. The introductory chapter gives a first impression of the motivation and purpose for writing this doctoral dissertation on *Radical Innovation in a Coordinated Market Economy: Institutional Capabilities within Germany and Beyond.* The four research questions of this thesis, derived from the motivation and purpose, are presented in the Section 1.2, followed by the proposed methodology used in the study. The structure of this thesis is briefly illustrated in Section 1.4. The contributions to knowledge of this study are summarised in Section 1.5.

1.1. Motivation and Purpose

The role of innovation in economic development has been discussed at length in academia, industry, and society. Kestenbaum (2009, 7) states that "Innovation is actually driving business growth […] innovative firms grow twice as fast, both in employment and sales, as companies that fail to innovate". Tellis, Prabhu and Chandy (2009) argue that it is widely acknowledged that in terms of innovations and their impact on both the industry and the firm level, significant differences exist between radical and incremental innovations. In the search for national economic growth, it is not only important to identify *radical innovation*, but also the ways in which it is created. Different authors argue that innovative capabilities and especially

radical innovation "varies substantially in firms across nations (Diamond 1999; Furman, Porter, and Stern 2002; Landes 1999)" (Tellis et al. 2009, 3), and also across different industrial sectors (Hurmelinna-Laukkanen, Sainio, and Jauhiainen 2008). In the search for an answer on how to create radical innovation, and with the economic growth in Western developed nations, some influential approaches have been proposed in political economy. These include the *Business Systems approach* (Whitley 2000; Whitley 1999; Whitley 2005; Carney and Witt 2012), the *National System of Innovation approach* (Nelson 1993; Lundvall 1992; Freeman 1995; Etzkowitz and Leydesdorff 2000), and the *Varieties of Capitalism approach* (Dore 2003; Hall and Soskice 2001; Hancke 1999; Casper, Lehrer and Soskice 1999) which are considered key approaches for this thesis, alongside the literature on Welfare Capitalism (Esping-Anderson 1990a).

Each of these approaches focuses on the search for the source of innovative capabilities, acknowledging the role of the firm in creating innovation within a nation's institutional setting. VoC is a very powerful approach in comparative social science, not only due to its implications for institutional theory or innovation management. In contrast to other approaches, the VoC approach offers a conclusive framework for the concept of comparative economic advantage (CEA) between nations, offering a modern kind of division of work between nations. In *Typologies of Capitalism*, Colin Crouch (2009, 89) describes how social science often tries to construct "rough, tough macho theory that concentrates on the big picture and ignores detail." As a result of simplification, VoC theory continuously dichotomises high-income Western countries into groups such as CMEs and LMEs, ascribing to them the ability to specialise either in incremental or in radical trajectories of innovation.

At the outset, this doctoral dissertation appears to be paradoxical in the face of the VoC approach. The institutional foundations of Germany as a typical CME are not expected to let German firms prosper in radical trajectories of innovation. It is essential for the theory of CEA within the VoC approach, that CMEs specialise their production on so-called incrementally innovative sectors, while LMEs focus their production on radically innovative sectors. The second expectation of previous approaches to comparative capitalism is of a liberalisation of CMEs, at least in times of crisis. Facing the great recession of 2008 and the crisis of the neo-liberal model of capitalism itself (Chorev and Babb 2009; Nesvetailova and Palan 2010), real life undermines this proposition, calling it into question. The simple determinist proposition of liberalism leading to radical innovation, which underlies the VoC argument, is criticised in this thesis.

My key motivation in writing this thesis is to develop an understanding of the complex relationship between national institutions, social and economic policy, and skill creation to support product specialisation by German firms in new technologies. A further development in our understanding of the influence of a national institutional framework upon the nation's ability to create for example, various levels of skill equilibria, which have an effect on innovation, is also of high relevance.

The first purpose of this thesis is to evaluate whether the institutional foundations underlying the German NIS have changed since reunification. The debate on the fit between institutional set-ups and national trajectories towards innovation has been intensified by the pressures for institutional change following the European sovereign debt crisis in 2008 and the ongoing effects of the crisis. Stratfor (2016) publishes a timeline of the ongoing effects of the European crisis since 2008. In *The Crisis of the European Union: Weakening of the EU Social Model*, Vincent Navarro and John Schmitt (2008) argue that a weakening of the

entire European Union social model takes place due to the crisis. It is claimed that outcomes of the EU crisis could lead towards destabilisation of the social model underlying the idea of a European Union. In, *An Introduction to Varieties of Capitalism*, Peter Hall and David Soskice (2001) argue for likely institutional change to coordinated market economies (CME, mainly in continental European countries) in times of crisis. Their approach suggests a liberalisation of CMEs due to external shock. In response to this proposition, the first purpose of this thesis will be to find out whether a change occurred, and, if yes, whether this change took place in the expected direction of liberalisation. A second purpose is to see how government policies and regulation have affected the institutional foundations of the German NIS. To what extent was and is social and economic policy-making in Germany relevant for its development as an NIS? The third purpose of this thesis is to analyse the ability of German firms to produce radical innovation from a comparative perspective. The perception of Germany as being weak in the creation of radical innovation is discussed, and the need to re-think this argument is illustrated. The last purpose is to analyse in what ways the skill formation system in Germany has oppressed or fostered radical trajectories of innovation in the country throughout the past three decades. Following Bob Hancke and Michelle Goyer in *Degrees of freedom: Rethinking the institutional analysis of economic change* (2005), changes in the skill formation system are supposed to be illustrated from a differentiated view, acknowledging various levels of skills. This thesis aims to illustrate the relevance of skill formation for the process of creating innovative capabilities in Germany.

A last but very critical purpose of this dissertation is to rethink the concept of a rational worker underlying political economic theory. Emotional perceptions (e.g. fear) of emerging technologies not only influence policy making, but also a firm's product market choice and individual decision-making regarding skill creation. Not

only is human knowledge restricted, but a human's ability to foresee the possibility of future fields of work is limited. Individual decision-making in skill creation is a non-rational process, likely to follow certain rules. It is the principal purpose of this thesis to establish a picture of the non-rational human beings underlying political economy. In this instance, it is illustrated how social policy, welfare systems and skill creation interplay in Germany and why national innovation management in Germany not only has to be viewed from a political or institutional perspective but other perspectives as well. It is part of national innovation management to foster societal development that is accepting of new technology fields (e.g. biotechnology).

1.2. Research Questions

This thesis asks how the institutional framework of Germany interacts in order to enable firms to create innovation capabilities in so-called radically innovative sectors. This section raises four research questions to discuss this topic.

Three institutional approaches to political economy focus on the production of innovation within the borders of the nation-state: Business Systems (BS), National Systems of Innovation (NIS) and Varieties of Capitalism (VoC). While NIS focuses on the creation of knowledge and innovation in a national context, the latter two approaches categorise country groups depending on their degree of coordination between national actors. They further analyse changes in these institutional spheres and the impact of certain institutional characteristics on a nation's production and innovation behaviour. Within the institutional framework, "[i]n sum, firms have a number of choices in developing innovative competences and selecting innovation strategies that are guided by dominant institutions" (Whitley 2002, 523). In the *Introduction to Varieties of Capitalism*, Hall and Soskice |(2001) argue for the

relative stability of national institutional complementarities, enabling a stable CEA between nations. They do further claim that "[e]conomic shocks and interim attempts to cope with them can unsettle such understandings." Following this perspective, they expect "CMEs (to) deregulate to become more like LMEs" (Hall and Soskice 2001, 63). VoC does imply that external pressures cause institutional transformation e.g. in terms of corporate governance and ownership (Hall and Soskice 2001; Casper 2001; Aguilera and Jackson 2003; Aoki 2011; Goyer 2006). It does also imply a global labour market (Goyer, Reinecke, and Donaghey 2014) and skill formation (Estevez-Abe, Iversen, and Soskice 2001a; Nickel 2011; Brown, Green, and Lauder 2001; Busemeyer and Trampusch 2012). The global crisis of 2008 has led to a societal recap of liberal capitalism's role in the world economy, leaving this proposition about the liberalisation of CMEs in question. The question of institutional non-change within CMEs is not only relevant for institutional change theory, but also for national innovation management. It is of great interest to investigate whether a change in institutions can influence a firm's product market choice as well. Such changes could have implications for CEA approach in VoC, leading to a different image of national economic growth in the face of globalisation. Thus, the first research question is:

Research Question I:

In what ways have the institutional foundations underlying the German NIS changed since reunification?

The second question derives from a lack of theoretical background. As stated by Colin Crouch in *Typologies of Capitalism* (2009), the nation-state is of great importance for the determination of many socio-economic variables. To avoid

discussions about economic and social policy, many macro-level neo-institutionalists‘ postulate virtually hermetically sealed national institutions (Crouch 2009). Research in the area of comparative capitalism does, therefore, mostly focus on the national level (Hall and Soskice 2001; Whitley 1999; Lundvall 1999, 2007). Besides the obvious methodological advantages, e.g. in terms of available data in analysing the issues on the nation state level, instead of certain economic and social policies, comparative capitalists are “eager to play down the implications of globalization” (Crouch 2009, 91). Additionally, as demonstrated in the VoC, BS and NIS approaches, the role of globalization e.g. in the creation of multinational corporations (MNCs) and their own systems of regulation and pressure on national regulation is often abolished. For this doctoral dissertation, it is important not only to view the German case from a macro perspective but to understand HOW institutions and policy interplay in the creation of innovative capabilities, within the case of Germany. It is important to investigate the role of government policy and regulation in the development of radical innovation and comparative economic advantage. Institutional foundations which lead national trajectories of innovation are sensitive to policy change, e.g. regarding labour market policy, skill formation, corporate governance regulation, financial regulation, trade policy, etc. (Lee and Yoo 2007). It is important to identify the effects of regulatory change on national institutions relevant for the production of different kinds of innovation within Germany. Another question is about the possible effects of such intervention. If a government intervenes in labour market flexibility, social protection or the skill formation system, does this lead to general liberalization? This leads to the second research question:

Research Question II:

How do government policies and regulations affect the institutional foundations of the German NIS?

By establishing a conclusive framework for the relationship between a capitalist nation's institutional framework, and its economic performance in the form of innovation behaviour, VoC theory has proved to be a ground-breaking approach in the field of comparative political economy. The VoC approach holds that "variance in political institutions is the primary cause of differences in national innovative behavior" (Taylor 2004, 601). Where the market is allowed to structure itself for the most part, due to flexible labour and loose market relations, the economy is expected to specialise in the production of radical innovation. A high degree of market coordination, due to e.g. labour unions and long-time contracts, as well as stakeholder-oriented corporate governance and internal financing, in turn, is expected to lead to specialization in incremental innovation. This approach matters, because it brings the theory of institutionalism to a point where it explains the Holy Grail of economists – *economic success* (in the form of radical innovation). It provides the reader with a simple and easy to understand answer on how to create this economic success: Liberalism. One proposition underlying the VoC framework is based on the idea that CMEs specialise in the production of incremental innovation. The proposition of the typical CME – which would indicate that Germany is insufficient to produce new and emerging technologies – cries out to be challenged. In the face of Germany's economic performance, especially in the global economic crisis of 2008 and after, it appears to be of high-interest whether German firms' product market choice really follows incremental trajectories of innovation, characterised by old

technology fields at the end of their product lifecycle. A third research question emerges:

Research Question III:

How does German capitalism perform in terms of firm capability to produce radical innovation from a comparative perspective?

The highly institutional framework, which leads to the strategic decisions of German corporations, is frequently discussed in various fields of debate, being referred to as a Neo-Corporatist, Socialist, or Welfare-Production Regime, to mention a few of the terms applied. This discussion appeared to be surprisingly entertaining e.g. in the past U.S. elections. Different concepts were mainly mixed up (answers.yahoo.com 2016; DEBATE.org 2016; QUORA 2016), calling Germany a socialist regime – in direct comparison to Venezuela. Some of the post-WWII images of German institutions seem to have entered a professional stage of confusion by influencing political debates and academic research (Geyer 1984; Iversen 2005; Estevez-Abe, Iversen, and Soskice 2001a; Svallfors 2003). During the 1980s and 1990s, approaches in the field of comparative capitalism that traditionally focused on institutional spheres, such as the financial system, corporate governance, and the labour market, were extended to take into account the perspective of human well-being within the nation. Different concepts of welfare capitalism (Esping-Anderson 1990a; Ronald Dore and Andreff 2002; Van Kersbergen 1995) were developed, based upon the perspective of equality in various capitalist systems (Hicks and Kenworthy 2003; Kenworthy 1999; Kenworthy and Pontusson 2005). This led to the rise of different questions, such as *Do Welfare States lead to better conditions for the poor? Does social policy conquer the principles of capitalism? How does labour*

marked rigidity (due to (un-) employment protection) influence the skill formation system? Is liberal capitalism leading to equality (American dream)? Is it "fair" to help some people (the poor) and does this threaten the chances of "the hard working people" to earn their living? In *Social Protection and Skill Formation*, Estevez-Abe, Iversen and Soskice (2001b, 147) describe inequality regarding issues "based on the academic background of workers, (…) [or] based on gender" only. An obvious shortcoming of their approach is evident in the area of gender equality, in that their premise is based on the assumption that human beings are rational entities. The authors argue that "(…) even women who are willing to invest in skill training will rationally choose trades and professions where there are few men" (Estevez-Abe, Iversen and Soskice 2001b, 159). Thus, discrimination is not talked about except as the *rational choice of women* themselves. This provides a definition of equality limited to an idea that gender issues are a question of choice. The argument is that while women choose educational paths and job positions which lead them into areas of lower pay and less leadership, men choose the opposite. A further implication is that skill creation in women is mainly led by their desire to fulfill the role of a mother. Providing for children does not need a high-skill equilibrium for women. Investing in general skills would, therefore, not constitute a rational choice. The authors do further argue for a linear relationship between social policy and skill formation. National skill equilibria would further lead the nation's firms' product market choice and, with this, innovation.

> "*It is important to note that relative abundance of high levels of general skills (i.e. university and postgraduate qualifications) brings comparative advantages in radical product innovation (...) a flexible labor market with university educated people combining excellent general skills with valuable knowledge about the industry acquiring from switching from one job to another. (...) biotechnology, segments of the telecommunications sector (...) are other examples that fall into this class.*" (Estevez-Abe, Iversen and Soskice 2001b, 149)

While the US is repeatedly used as a major example of the interrelationship between general skills and radical innovation, Germany is downgraded to a country producing firm-specific or, occasionally, industry-specific skill equilibria. The skill creation system which is argued to exist in Germany, as previously described, is due to social policy and labour market rigidity being ruled by a welfare production regime, which leads to incremental product market choices by firms and besides this, it "perpetuates inequality" (Estevez-Abe, Iversen and Soskice 2001b, 155). The VoC approach constructs an overall picture of a Welfare-Skill Formation Nexus in Germany. Underlying all propositions guiding Estevez-Abe, Iversen, Soskice and Hall, but also Mares and Thelen's arguments there is the belief in the existence of a rational worker. The author of this dissertation does not make an assumption of rational workers for the ongoing discussion since neither the existence of a single rational worker nor any rational human being can reasonably be expected. Within the population of mentally healthy human beings, we can find decision-making strategies which follow patterns of e.g. cognitive dissonance reduction, or fairness. Due to a lack of research, many areas of human decision-making have not yet been explored. This is no reason to call the black box of the human brain "rational". The welfare state in VoC is described as an artificial construct of corporations. It only exists due to national firms' influence over the government. These companies desire to specialise their product market strategies through incremental innovation, which is argued to be the comparative economic advantage that these businesses ultimately use in a globalised working order. The complex relationship between corporations, welfare, labour market regulation, skill formation and innovation is of high relevance as a background to the discussion in the German case. The fourth research question emerges.

Research Question IV:

In what ways has the skill formation system of Germany oppressed or fostered radical trajectories of innovation in the country during the past three decades?

In this sense, it is critical to analyse how the social policy and labour market changes of the German political economy, since reunification, may have influenced the national skill formation system and, with this, the skill equilibria available to firms. In a second step, it is important to discuss whether the changes in national skill equilibria might have had an effect on firms' product market choices, and national trajectories of innovation. A discussion of the origin of change in social policy issues is important for the wider context of understanding the action and functioning of the social capitalist. An evaluation of the influence of corporations in policy making is of interest for theory.

1.3. Methodology

It is important to illustrate how this thesis attempts to answer the research questions. This part of the introduction provides a short introduction to the research methodology. For answering the research questions, the typical case of a CME, Germany, is selected. It is illustrated how the three approaches that are most relevant to this thesis (NIS, BS and VoC) identify Germany as a typical case in terms of coordination. Germany is crucial in the wider argument of a coordinated institutional outlook, leading to the focus of national corporations on product markets which follow incremental trajectories of innovation. During the following chapters, the *deductive-nomological* model (Hempel 1962) of explanation, underlying the argumentation for the comparative historical analysis of VoC, is divided into its

separate parts of *explanans* and *explanandum*. In the case of the German CME, theory expects a focus on incremental trajectories of innovation. This *explanandum* phenomenon is the proposed logical result or output of the institutional determinants empirically identified by different authors. These institutional input factors for the process of creating certain types of innovation are the *explanans* in the described analytical model. General laws of logic (general skills leading to radical innovation) are presented to the reader in the context of specific occurrences from the observed cases. The following theoretical chapters discuss the validity of each of the *explanans* that was taken for granted in the influential theory, in detail.

For the empirical part, this dissertation uses a congruence analysis approach (CON) for the explanatory case study research of the critical case Germany. For explanatory case studies, small numbers of variables are usually selected (Blatter and Haverland 2012). In line with the CON approach to explanatory case studies, this thesis deduces propositions from the relevant theories that have been selected and specified ex-ante. These propositions are not treated as variables as such but, moreover, are used to determine whether the expectations formulated by the pre-existing theory on comparative capitalism are confirmed or contradict in the crucial case of Germany. The term critical case study is used in terms of a case which enables one to demonstrate that even under the "most likely circumstances for the causality or argument to hold, it does not" (Hancke 2009, 68) and that thus the original theory must have deeply problematic sides. This analytical strategy is followed in the empirical chapters of this thesis, illustrating the performance of German firms in so-called radically innovative sectors throughout the past 25 years and the (non-) change of the institutional framework in Germany. As a result of the analysis of this thesis, a set of confirmations and contradictions for each of the propositions is identified. In a second analytical step, the differences identified

between expectations and observations are used in order to combine the different theories into a comprehensive explanation. This thesis discusses insights from the analysis of the research questions to consider pre-existing theories. The relevance of the implications is viewed within a wider discourse. Comparative historical methods have a long tradition in political economy. Due to the case-specific focus of this dissertation, the comparative analysis can only be conducted in terms of comparative outlooks, particularly in the analysis chapter. An in-depth analysis of the institutional variables two CMEs is not intended in the methodology of this dissertation. Case specific in-depth analysis with a timeframe since reunification is necessary for a deep understanding of HOW institutions and innovation interact. It is not possible to understand the complexity of the political and institutional interaction of a nation if these factors are only viewed on one level, at one time or without at least a short look at practice in other comparable nations. A statistical design could never capture the complexity of political and institutional interaction in fostering innovative capabilities in Germany. It is not a goal of this thesis to generalise the findings to other nations. The methodological goal is a high degree of internal validity. The *explanans* which were used in VoC theory and wider comparative capitalism literature are re-thought. One goal of this thesis is not only to criticise the VoC approach and illustrate its simplicity and false arguments on different levels but to incorporate into the diversity of capitalism theory which treats the creation of innovative capabilities a notion of national skill equilibrium, interacting with institutions, policy and human beings.

1.4. The Structure of the Thesis

This doctoral dissertation is organised into nine chapters: This Introduction is followed by the Review of Innovation Literature. Chapter one, Introduction, provides the background and motivation for this study. It explains the purpose and raises the research questions, methodology and contributions briefly. The second chapter reviews relevant literature in the field of innovation management. It describes the emergence of innovation research and, with this, the construction of different innovation models in management research. The aim of this chapter is to evaluate the context within which the pre-existing theories were developed and to access how approaches developed. One focus is on innovation literature from an institutional perspective. A second focus is on innovation literature regarding coordinated market economies in general and Germany in particular. This chapter clarifies the theoretical and empirical gap in understanding institutional change and, in particular, skill formation, the labour market and corporate governance and financial institutions for the emergence of radical trajectories of innovation in coordinated market economies. It sets existing theories in wider contexts and considers the origins of propositions underlying different theories. The relationship between and relevance of the concepts of institutional complementarity and comparative economic advantage are discussed.

The third chapter is the Theoretical Framework, followed by the fourth chapter on this study's Methodology. In the Theoretical Framework, I develop the framework of analysis by incorporating the institutional approaches of NISs, BSs and VoC with dynamic models of innovation derived from the ideas of Schumpeter, Christensen and Rothwell. The second section discusses the ability of institutional theory in general and VoC/ NIS specifically to provide a framework for the analysis of trajectories of radical and incremental innovation within Germany. The influence

of public policy within this context is discussed. The third section discusses the ability of general institutionalist theory and VoC in particular to explain national trajectories of innovation in Germany. The supposed relationship between institutions and innovation is discussed. The last section draws a conclusion for further analysis based on the enhanced theoretical framework.

Chapter four, the Methodology, discusses the research design, data, and methods for this study. In the first part of this chapter, Epistemology and Research Strategy, I introduce the reader to the idea of using an explanatory case study methodology. Yin (1981) and Jick (1979) recommend the use of a case study research design for explanatory purposes. As Linda Kohn (1997, 3) puts it in *Methods in Case Study Analysis*: "(...) the [case study] methodology may actually be more powerful for explanatory purposes in its ability to answer questions on how and why". The VoC perspective draws a complementary picture of LMEs specialising in radical innovation, while firms in CMEs specialise in the production of incremental innovation, in terms of sector specialisation. Using a dichotomist view, the VoC framework does not acknowledge the performance of German firms, in so-called "radical" sectors. The data analysis used in VoC appears to mislead the reader in this matter. The second part of this chapter is on the case selection strategy. It describes why Germany is chosen as a crucial case. Germany has widely been described as a paradigmatic case of a coordinated market economy in the VoC approach, but also in the NIS and BS approaches (Akkermans, Castaldi and Los 2009; Thelen 2009; Trampusch and Eichenberger 2012). This country, therefore, is chosen for theoretical reasons following inductive typical case selection strategy (see Gerring 2007; Seawright and Gerring 2008). The two cases observed in this dissertation are biotechnology and the software industry. These are described as typical cases for radically innovative sectors in VoC. They are selected as the two cases which are

most unlikely to show high performance, following the theoretical background. The following section, Propositions and Questions, summarises the identified propositions of theory which are used for answering the research questions. The next section is on the methods which are used for sectoral analysis. I use a mixed methods and mixed data approach for measuring and presenting input and output variables. The last section of this chapter is about Validity, Reliability, and Generalisability of the empirical and descriptive analysis.

Chapter five is the first empirical chapter. It is on Institutional Change, Government Policy and Performance of the German Biotech Sector and is followed by Chapter six on Institutional Change, Government Policy, and Performance of the German Software Sector. Both chapters are identical in their sub-sections and general construction. The fifth and sixth chapters explore the historical and sector-specific background of the two radical sectors in Germany. A short outline on the definition of biotech/software is followed by an overview of societal discussions and policy that directly concerns the two sectors. In the next step, the performance of the biotech sector/software sector in Germany is evaluated using the VoC method and different data sources (patents, publications, R&D investments and sales). The performance of each sector's firms is viewed in comparison to other Western capitalists.

Chapter seven is the third empirical chapter. It is on Institutional Change in Germany: Capabilities for Radical Trajectories of Innovation. The proposed institutional foundations of the German NIS are the focus of this chapter. The propositions are kept in mind while compared to the author's own observations, including actual observable changes in institutions due to government policy.

The eighth chapter is called Analysis and Theoretical Implications. Following the empirical chapters, this analysis chapter compares the expectations of previously

identified theories and approaches with the empirical findings. The chapter is constructed in six sub-sections. The first section takes a short comparative look at the institutional framework of different CMEs. This chapter reflects institutional changes in Germany from a comparative perspective and brings together different points of view as found in the previous chapters. This chapter reflects on the differences between theory and findings and presents an enhanced theoretical framework deriving from the findings, in the last part.

The ninth chapter, Conclusion, Implications and Recommendations for further Research, provides a summary of the argument. The main conclusions of this thesis are presented following the research questions. Theoretical and practical contributions are discussed in the second section. Limitations and Research Implications are illustrated in the third part. The concluding remarks finalise this thesis.

1.5. Research Contributions

This dissertation contributes to the existing literature in different ways. It identifies the propositions underlying the dichotomist and determinist proposition of liberalism leading to radical innovation. An extensive critique of the existing theory is provided to the reader in order to later develop the theory.

It is illustrated how Hall and Soskice could have drawn different conclusions, using the same measures of EPO data. This thesis essentially questions the logic behind the VoC argument and considers the reasons behind the analytical flaws. Implications for wider theory are illustrated.

In the process of answering the research questions, it is found that the institutional framework of Germany has changed due to policy changes and

regulation. In spite of the changes, the institutional framework is still considered to be of a coordinated nature. The ability of German firms to create products in so-called radically innovative sectors is illustrated in detail, following the cases of German biotech and software. Due to the enhanced theoretical framework, we expect the national skill equilibrium to play a central role in shifts in new and emerging sectors. The role of innovation policy for changes in the educational system and, in turn, changes in the job market can be illustrated. Germany appears to have been and still be a highly competitive nation in terms of these sectors, from a comparative perspective. An outlook on the German automobile industry's attempts to prosper in future technologies illustrates the process of innovation which traditional corporations in Germany have chosen in order to change their product market strategy. The definition of radical innovation is discussed in this context and the relevance of differentiating between the process and the result is shown. VoC theory can prosper with a different notion of innovation.

The findings of this thesis offer contributions in different areas. Theoretical contributions are made in the field of innovation management for re-defining radical innovation and identifying possible sectoral/national differences in the ways to create such innovation. Concepts of radical, incremental, disruptive and step-wise innovation are established in this thesis.

A second theoretical contribution is the established enhanced theoretical framework. The new framework illustrates how radical innovation is created and fostered by the coordinated market economy of Germany. The framework illustrates changes in some areas, but especially in the logic of government policies, skill creation and the influence of human irrationalities on the product market strategies of the nation.

Thirdly, the theoretical and methodological explanations of VoC in relating institutions to innovation are being challenged. Using VoC's very own simple descriptive measures for the example of Germany and focusing on radically innovative sector cases allows us to take a more in-depth view than the original VOC analysis of Hall and Soskice. The previous discussion of institutional rigidity directly leading to incremental innovation is questioned and a more complex relationship between institutional spheres, such as changes in labour market institutions and skill creation on multiple levels, leading to multiple changes in innovation, is elaborated in chapters five and eight. Chapter eight reflects on institutional change leading to changes in the skill formation equilibria of Germany.

The second set of contributions from this dissertation is to give practitioners from different national backgrounds an impression of the possibilities of their firm's product market choice. If corporations in Germany can prosper in radical trajectories of innovation, there should be no self-fulfilling prophecy existing for industry to necessarily shift R&D into an LME. More careful consideration is needed. Similarly, start-ups should consider their location more carefully as well. The promise of higher national liberalisation (e.g. possible VC investment) might not be the only factor influencing stable and healthy growth for a firm in the long run.

Practical implications of this thesis are not only important for industry but also for policy. The role of R&D investments, LMIs and social policy and the welfare system for skill creation for national innovation is highly interesting. The argument that plain liberalisation leads to a firm's product market specialisation in new technology has to be rejected. Due to these findings, it is suggested that policy makers from LMEs re-consider possible institutional changes and see these not only in the light of potential economic growth. Economic growth can be achieved using

different types of capitalist variety. It is suggested that simplified views of liberal capitalism leading to economic growth should be rejected.

The role of the welfare state in the German process to create radical innovation is re-defined in this dissertation. It can be viewed not as a blockade for general skills, but as an enabler. In this context, it is illustrated how certain political instruments, which are brought in relation to a welfare state, e.g. employment and unemployment protection, government support for apprenticeship training and general education, apart from other political instruments, can be seen as highlt relevant to future firms' product market choices, through the institutionalised theorem of individual choice in skill creation. In *Skills and Skilled Work: An Economic and Social Analysis*, Francis Green (2013, 68) illustrates how "(…) raising the education level of the population helps to account for GDP per capita [growth] through augmentation of the quality of labor." The underlying argument is "(…) that greater skills enable a faster pace of technological innovation in the country" (Green 2013, 68). Economic growth is related to the educational attainment of a group. This thesis sets Green's insights in a wider context of economic theory in order to advise the development of general skills

The bulk of research criticises this plain differentiation between LMEs' radical innovation and CMEs' incremental innovation (Taylor 2004; Hancké 2009; Hancké, Rhodes and Thatcher 2007; Schneider and Paunescu 2012). These studies do miss out on an in-depth analysis of radical innovation and the origins of such within a coordinated market economy. Furthermore, the wider economic implications for the remaining key argument of comparative institutional advantage leading to certain trajectories of innovation and, with this, comparative economic advantage, has not yet been discussed. This dissertation scrutinises the data and propositions which underlie the dichotomist argument of a complementary variety of national

trajectories of innovation (Hancke 1999; Hall and Soskice 2001; Casper, Lehrer and Soskice 1999). It fills the previously described gaps by empirically analysing how CMEs' specific institutional and policy developments slacken and contribute to sector-specific innovation activities. Specifically the link between labour market reforms in Germany and the performance of biotech and software firms within the institutional framework is discussed and the identified different spheres of skill creation within one institutional framework are highlighted. Various levels of skill equilibria are discussed for different kinds of innovation resulting from within one institutional framework.

This chapter is an introduction to the following doctoral dissertation. It illustrates the motivation and purpose behind the work, followed by the emerging research questions. Following the research questions, the methodology on how these questions are answered in this thesis is briefly introduced. The fourth section illustrates the structure of the chapters which follow which have been constructed in order to answer the research questions. The contributions of this doctoral dissertation to wider theory and practice are briefly illustrated in the last part of the introduction.

2. CHAPTER TWO: REVIEW OF INNOVATION LITERATURE

The aim of this chapter is to contribute to the theoretical and analytical framework of this thesis. Since innovation is seen as a key source for economic development and success, a diverse range of academic fields conducts studies on this topic. Besides the field of engineering, researchers in the fields of management, economics, politics and sociology discuss diverse topics relating to innovation on different levels of analysis.

This critical review focuses on innovation literature which targets the macroeconomic context while acknowledging the role of the firm in national innovation. It focuses on institutional approaches in the field of political economy and specifically comparative capitalism.

A critical review of theoretical and empirical studies on innovation and the determinants of comparative economic advantage are discussed in the following sections: Section 2.1. reviews theoretical studies on innovation with a focus on different innovation models within the context of economic theory. Section 2.2. reviews the role of institutions from different theoretical perspectives in the context of national trajectories of innovation. In Section 2.3., studies on institutional change and innovation are reviewed. Section 2.4. brings together the body of innovation literature in the context of Germany.

2.1. From the Study of Production and Innovation to Comparative Economic Advantage

In 1841, the German economist Friedrich List published *The National System of Political Economy.* List criticises Adam Smith's *An Inquiry into the Nature and*

Cause of the Wealth of Nations (1979). Smith was born in England in 1723. He died in 1790. The cited book is a reprint of his original work, published in 1776. He harshly criticises Smith's argument on free market competition in trade, e.g. his analysis of the treaty of commerce between England and Portugal (Smith 1979, 546). Within his argument, List includes a picture of a competition (e.g. wrestling fight) between the former German market economy symbolised by a little boy who cannot possibly beat a grown man (English economy) when forced into direct competition without regulation. He emphasises the role of customs duties and state intervention in international treaties of commerce and trade (List 1841, 23). List's approach stresses the role of governments, protective mechanisms, and the role of nation states in contrast to Smith's cosmopolitan vision of free trade throughout all nations. Starting off with his twelfth chapter, List critically evaluates Adam Smith's approach on the *division of work* and focuses on what Smith calls *productive forces.* He asks two simple questions. Firstly: (in the division of work) What is the cause of work and effort? Secondly: What makes our hands and feet move, so we become productive and produce something of value for others? His answer is clear. List emphasises the role of our intelligent mind, moreover he cites values, attitudes, motivation and free choice which are evolving and acting within the framework of societal order, defined by the nation state (see especially Chapter twelve, 151–152). The questions and ideas of Smith and List can still be found underlying some approaches in political economy today. Contrary to earlier economists such as Adam Smith, Joseph Schumpeter (in line with Friedrich List) believes that “perfectly competitive markets had never existed and would never exist” (Schumpeter, 1946, cited in Cantwell 2000, 6). Schumpeter argues that this stationary state of equilibrium is interrupted by *creative disruption*, which is the creative response of the entrepreneur, who is the only agent of change in the circular flow, the personification of innovation, thereby

creating economic growth. Schumpeter further differentiates between ideas (the thought of a new way of doing something), inventions (a prototype of the idea) and innovations (a new product, process, or service which is successfully brought to the market).

The two approaches of List and Schumpeter emerged to construct the basis for the national innovation systems (NIS) approach. Apart from obvious adaptations of Schumpeterian thinking e.g. the business cycles (Freeman 1993), there are also similar propositions underlying NIS and Schumpeter. List constructed a direct path for Lundvall's (1992) book on *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning.* In his book, Lundvall acknowledges the role of nation states, their different political economies, and institutional frameworks. He adds to the perspective the notions of *radical* and *incremental* innovation as deriving from the creation of new knowledge. He further describes innovation as a process of uncertainty and disruption. Lundvall (1992, 12) differentiates between technical and economic dimensions of innovation. These lead to an incremental process of innovation or a (surprisingly) radical technical and/or economic development. In *Competitive Advantage of Nations*, Porter (1990) argues in favour of Smith for a rejection of managed trade. He uses a similar argument, e.g. "Rather than promoting innovation in a nation's industries, managed trade guarantees a market for inefficient companies" (Porter 1990, 89). Porter not only recognises economic perspectives but acknowledges institutions and the government's role in enabling firms to create innovation. "Government's proper role is as a catalyst and challenger; it is to encourage – or even push – companies to raise their aspirations and move to higher levels of competitive performance, even though this process might be inherently unpleasant and difficult" (Porter 1990, 87). His argument is in line with Lundvall on the importance of knowledge for economic development; he focuses on sectoral

specialisation and international competitive advantage between nations, whereas Lundvall concentrates on the nation itself and not on competition. The institutionalist NIS approach is one of the first approaches in the field of comparative capitalism, and it emerged broadly around 1989, with the fall of the Soviet Union and the demise of an alternative model to capitalism itself. Soon economics entered a debate on the question: "Which Capitalism will superior the other?" In Albert's (1992) dichotomising argument *Kapitalismus contra Kapitalismus*, two ways to organise Western societies are described. Besides the previously described economic competitiveness, he adds social solidarity to the debate. Michel Albert (1992) defines a set of three spheres which aim to symbolise *social solidarity*. In short, *security, inequality* and an *open society* are identified. Albert comes to the conclusion that "[I]t can be plainly demonstrated that social solidarity and competitiveness in the marketplace make excellent bedfellows" (Albert 1992, 148). Following Albert`s argument, scholars in the 1990s divide the ("free", Western, democratic) world (which is obviously limited to a specific range of wealthy nations) into two. The first group includes mainly English-speaking countries, representing the Anglo-Saxon model of capitalism. Exaggeratedly-speaking, these nations are organised around neo-liberal cutthroat capitalism which abandons social policy wherever possible. A second group encompasses the Rhenish model, often represented by Germany, as a social capitalist society with an emphasis on egalitarianism (see Albert 1992). Contrary to this dichotomist approach and focusing on the welfare state, Esping-Anderson differentiates *liberal Capitalism* from a *Continental European model* (Germany), and a third *social-democratic model*, which is geographically associated with Scandinavia (Esping-Anderson 1996, 1990). In *Divergent Capitalisms: The Social Structuring and Change of Business Systems*, Richard Whitley (1999) adds the perspectives of societal institutions such as trust, but also culture, to the discussion.

He is following Lundvall in taking the historical and cultural developments of a country into account and evaluating the path-dependent institutional and technological advances of business systems within nation states. His emphasis is not so much on the creation of knowledge but the link between corporate governance (specifically ownership coordination) and labour. Within his book, Whitley builds up the basis for his argument on business systems' institutional differences being the driver for variation in a nation's innovative performance. In *The Institutional Structuring of Innovation Strategies: Business Systems, Firm Types and Patterns of Technical Change in Different Market Economies*, Whitley (2000) differentiates between five kinds of innovation strategies (dependent, craft-based responsive, generic, complex and risky, and transformative). With the rise of globalization, intensified by digitalisation, some scholars argue that the institutional features of capitalist countries would now be under such pressure that only the one most competitive model could prevail. The harsher model of liberal capitalism, with the USA as the best practice model, is said to prevail over the European model in the long run. A liberalisation of the Rhenish capitalists has been presumed. These leverages are well-illustrated in Hall and Soskice's (2001) *An Introduction to Varieties of Capitalism.* Hall and Soskice`s dichotomous approach divides the world into coordinated and liberal market economies. Even though this theory declares a right and need to exist to coordinated capitalism in the first place, it does later argue for the slow liberalisation of CMEs in times of crisis. The main argument of VoC is a simplified interconnection between a nation's institutional framework and its ability to produce radical OR incremental innovation. "The key distinction we draw is between radical innovation, which entails substantial shifts in product lines, the development of entirely new goods, or major changes of the production process, and incremental innovation, marked by continuous but small-scale improvements to

existing product lines and production processes" (Hall and Soskice 2001, 38–39). Opposed to Anderson and Albert's argument, CMEs are said to be ruled by welfare production regimes (WPR), which is the reason for the continued existence of coordinated capitalism. The WPRs in CMEs are argued to be allowed and sustained by corporations' influence over government: "(...) quasi-corporatist regimes [which] provide producers with influence over government" (Hall and Soskice 2001, 49). It is assumed that corporations influence government policy-making, to create high levels of social protection, namely employment protection, unemployment protection, and, with restrictions, wage protection, which in turn reinforce employees' skill trajectories of firm or industry specific skills needed by corporations to contribute to the company's product market strategies of incremental innovation. The presumed inequality is an unwanted but accepted side effect of the WPR. In *Firms and the Welfare State* Isabela Mares (2001) continues this argument by interconnecting VoC theory with a theory on varieties of welfare regimes. Her argument is on the re-distribution of risk in society and on the ability of social policy to "offer distinct institutional advantages to employers" (Mares 2001, 211).

2.1.1. Schumpeterian Innovation

In order to create economic growth, literature suggests that innovation is a major source. As previously described, Friedrich List asks the questions about *who* creates the sold products and *why* these products are and can be created in a certain place. Let us bear this in mind while following Joseph Schumpeter's arguments on the role of entrepreneurship and innovation, and their role in creative disruption. The field of entrepreneurial research has been existent in academics since the 18th century, where it was introduced by Richard Cantillon (1759 as cited in Casson 2005, 2). Cantillon saw the entrepreneur as a specialist in taking risk, who "ensures workers by buying

their output for resale before consumers have indicated how much they are willing to pay for it". The search for the meaning of entrepreneurship went on and Knight (1921) later defined the entrepreneur as an "uncertainty-bearer, for which service the entrepreneur receives a reward of pure profit" (as cited in Casson 2005, 11) Twenty years later, Schumpeter took a different view, not regarding an entrepreneur as a coordinator or risk taker, but as an innovator. "Schumpeter seems to assume that speculation using other people`s money is necessarily riskless. An entrepreneur who starts with nothing, cannot lose" (Casson 2005, 41). He describes the task of the entrepreneur as being to reform the "pattern of production by exploiting an invention or, more generally, an untried technological possibility" (Schumpeter 1942, 1329).

Contrary to modern thinking, Schumpeter looked at the entrepreneur from a psychological rather than a systemic perspective. He characterised entrepreneurs in the first place through their "proactive behavior" (Frank 1998, 890): the "unusually strong character," and the "clarity of vision and ability to act (…) personified by the figure of a promoter or captain of industry" (Schumpeter cited in Freeman 2003, 380).

Contrary to the mainstream economic thinking of their time (Macdonald 1965, 381) Schumpeter as well as Weber rejected hedonism as the underlying motive of entrepreneurial action. Schumpeter, furthermore, saw entrepreneurs not just as being motivated by religious reasons, but through "the dream and the will to found a private kingdom", "the will to conquer" and "the joy of creating, of getting things done" (Hagedoorn 1996, 381). Schumpeter did also see the importance of role models for the purpose of motivation and the development of entrepreneurs and tried to generate a "sociological explanation of how cultural traits are transmitted, by trying to explain the way role models influence the behavior of entrepreneurs" (Schumpeter 1927; 1928, cited in Macdonald 1965, 382).

In contrast to earlier views, Schumpeter did not just talk about psychological characteristics and motives (other than gaining money for the entrepreneur), but clearly differentiated managers, inventors, capitalists, and entrepreneurs from each other. Thus, anyone who begins as an entrepreneur "actually carries out new combinations, and loses that character as soon as he has built up his business when he settles down to running it as other people run their business" (Frank 1998, 508) becomes a manager. Whereas an inventor creates something new, an entrepreneur is "concerned with the implementation of these new things" (Frank 1998, 508). And to receive the money for implementing the invention, the entrepreneur needs to "previously become a debtor" (Frank 1998, 508). He has to receive money from a capitalist (Schumpeter 1934, cited in Hagedorn 1996, 890). Being an entrepreneur is thus "not an occupation or a profession but a capacity or a function" (Lawton-Smith 2010), which gets lost when it is no longer performed. In viewing the entrepreneur as a capitalist, an inventor or a manager "the classical economist had overlooked the most important role (…) the dynamic task of innovation that is the distinctly entrepreneurial one" (Schumpeter, 1912, cited in Casson, 46). Thus the placement of the entrepreneur against the background of Schumpeter`s theory of innovation (Hagedoorn 1996, 884) turns out to be a premise for discussing Schumpeter's works. By dividing inventors from innovators "[I]t is not the entrepreneur who figures out new possibilities. These are already present, often in the form of common knowledge, abundantly accumulated by all sorts of people. It is the '*doing the thing'*; the will to demonstrate that mere possibilities can be turned into reality, that constitutes the special contribution of Schumpeter's entrepreneur" (Witt 2002, 13). Schumpeter contributed a big part to our modern understanding of the distinction between creativity, inventions, and innovations. He introduced the notion of *new combinations*, which referred to the introduction of a new product, or service, or a

new quality of a product [product innovation], a new method of production [process innovation], a new market [market innovation], a new form of delivery [delivery innovation], a new source of supply of raw materials [raw material innovation] or half-manufactured goods, and finally implementing a new organisation for any industry [organisational innovation] (see Schumpeter, 1934, 66; 1939, 84–85, cited in Hagedoorn, 1996, 888).

Schumpeter thought that "the success of capitalism depends on a process of constant economic evolution and fluctuation" (Frank 1998, 513). Since he also believed that "perfectly competitive markets had never existed and would never exist" (Schumpeter 1946, cited in Cantwell 2000, 6), comparisons with this hypothetical state seemed unhelpful. Thus, based largely on the works of Leon Walras, Schumpeter developed the theory of the *circular flow* as a "static state, in which all profits are reduced to zero, the economy is closed, and all is in perpetual equilibrium" (Frank 1998, 507). He argued that this stationary state of equilibrium is interrupted by *creative disruption*, which is the creative response of the entrepreneur, who is the only agent of change in the circular flow, the personification of innovation who thereby creates economic growth. Referring to Kondratieff's long-wave theory, Schumpeter argued that these disruptions to the circular flow would come in waves. The *primary wave* is the main effect of *innovation clustering*. It occurs because "the appearance of a few entrepreneurs facilitates the appearance of others, and these the appearance of more in ever-increasing numbers" (Schumpeter 1934, 228, cited in Frank 1998, 509). The wake of this primary wave is followed by more numerous *secondary waves*, "in which the initial increase in the purchasing power from new enterprises spreads over the whole economy giving rise to general prosperity" (Frank 1998, 509). Freeman (2003) honours Schumpeter's contribution of these cycles in terms "of successive technological revolutions" (Freeman et al. 2003, 12). He

criticises how Schumpeter failed to analyse satisfactorily either the timing or the phases of the technological revolutions or the timing of the related, but necessarily later, phases of the associated business cycles, however.

It is important to mention that there is an ongoing discussion concerning whether Schumpeter changed his opinion of the relevance of entrepreneurial innovation for economic growth later on in his life. Different authors (such as Freeman et al. 2003; Witt 2002; Hagedoorn 1996; Langlois 2003), assert that Schumpeter emphasised the importance of new venture development by individual entrepreneurs during his Early or European period, but seemed to adopt a new approach "in which large enterprises create economic change through routine and mechanical management" (Langlois 2003, 287) later on during his American period. Schumpeter has been criticised for his ignorance of the active role of consumers and businessmen in shaping innovations (Witt 2002, 15), the need to distinguish between original sources of innovation as opposed to subsequent imitation, as well as the aforementioned dichotomy between the early and late Schumpeterian theories, which implies that single entrepreneurs lose importance.

Schumpeter's work suggests a focus on the individual level. The entrepreneur as an agent of change and the individual human being (alone or within a corporation) as a source of innovation is recognised. Schumpeter does further describe the macro structure of innovation as coming in disruptive waves. The role of the nation state and institutional spheres is not of high relevance for his theoretical framework. It matters in shaping the action of the entrepreneur.

2.1.2. Five Generations of the Process of Innovation

In *Towards the Fifth-generation Innovation Process*, Roy Rothwell (1994) describes five different approaches to the process of innovation within a firm. Rothwell

contributed largely to the field of innovation management by not only recognising the role of innovation but recognising different firm strategies in order to create innovation throughout different decades. Rothwell differentiates between: 1) the first generation (1950–1960) innovation process, *Technology Push Model*; 2) the second generation innovation process (1960–1970), *Market Pull Model*; 3) the third innovation process (1970s–1980s), *Coupling Model of Innovation*; 4) the fourth generation of innovation (1980s–1990s), *Integrated Innovation Process*; and 5) a fifth generation innovation model, *5G*. Rothwell acknowledges that all types of innovation models continue to exist in various forms. He does further acknowledge sectoral differences in the concentration of innovation strategies. Rothwell does not define an end date for the fifth generation of innovation strategies. The twenty-four characteristics of the fifth generation process of innovation, which are identified, are inductive. The model is not operationalised as clearly as the previous four models. Still, Rothwell delivers important insights into firm-specific choice of an innovation strategy, depending on country, sector, and product.

Similarly to Schumpeter in his approach to innovation, Rothwell sees innovation as a process. Not only does the entrepreneur (inside or outside an existing firm) create innovation (by developing an idea and bringing it to the market), but innovation is influenced by strategic management decisions and the interplay between market need, technological development, investment (in technology and marketing), collaboration internally (e.g. different departments involved simultaneously) and externally (e.g. suppliers), and time/cost tradeoffs (a product introduced 1% faster means 1–2% more costs but only 0.1% more profit – see automobile industry in Germany/Tesla).

2.1.3. Disruptive Innovation

In *What is Disruptive Innovation?* Christensen, Raynor and McDonald (2015) discuss the issue of Tesla as a disruptive innovation. Since the publication of *The Innovator`s Dilemma*, Christensen's (2013) idea of disruptive innovation has been used in different contexts. The original idea of disruptive innovation was not in terms of Schumpeter's notion of creative disruption. His book described an innovation management strategy – one managerial approach or strategy in order to create an innovation. Disruptive innovation, after Christensen, is about a start-up's low price version of a pre-existing item. After entering the market and reaching a certain size, "[e]ntrants then move upmarket, delivering the performance that incumbents' mainstream customers require while preserving the advantages that drove their early success. When mainstream customers start adopting the entrants' offerings in volume, disruption has occurred" (Christensen, Raynor and McDonald 2015). A vital discussion has emerged in which one side argues that, for example, Tesla, Uber and Google have produced disruptive innovation (Boyadjis, Rassweiler and Brinley 2016), while the other group argues that disruptive innovation is misunderstood (Christensen, Raynor and McDonald 2015), and a third group suggests that Christensen has misunderstood the developments of his own idea (Wadhwa 2016).

Disruptive innovation after Christensen is an approach to innovation management which describes a certain process of a firm's strategic choice in order to gain market value. Current developments in literature intermingle Schumpeter's notion of the creative disruption of a market with Christensen's approach.

2.2. Institutional Approaches to the Study of Innovation

A diverse range of institutional approaches to the study of innovation has emerged since the 1990s. Comparative Capitalism (CC) literature defines institutions as shaping the supply side, "examining how various institutions shape the collective supply of inputs (e.g., skills, capital) available to firms and other economic actors" (Deeg and Jackson 2007, 7). CC literature does generally suggest a theory of comparative institutional advantage whereby the different institutional frameworks between countries are assumed to support certain economic activities, such as e.g. a country's ability to radically innovate in different ways. Table 1 summarises the three main approaches to the study of institutions and innovation. These three approaches are further described in the following sections. My focus is on the VoC framework.

Approach	Sources	Central concept of Innovation	Methodological issues	Findings	Limitations	Implications
National Innovation Systems	**Lundvall (1992)** *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning* **Nelson (1993)** National Innovation Systems: A Comparative Analysis	Focus is on the creation of knowledge. Institutional and cultural context determines learning (creation of knowledge) and innovation in a society. Focus on firm level and scientists. Case specific focus on the working of the national system in its own right – not in terms of international competition.	Single or comparative case studies of countries. Storytelling on complex historical and cultural interplay. Idiosyncratic elements depending on author's preferences.	Innovation as the result of interactive learning processes. Innovation as a process and not a single event.	• No diff. between knowledge and skill, learning and training – focus on scientists. • Focus on creation of knowledge for innovation – underplays role of institutional determinates influencing not only knowledge but firm choice and firm performance of a nation. • Role of government limited to learning incentives.	• Looks for one best way of economic policy making by emphasising the importance of a knowledge society • Incremental/ radical innovation divided on base of unexpected effects on economy or technological development • Cooperation among firms as necessary supplement to competition • Dynamic change within societies
Business Systems	**Whitley (1998, 1999)** *Divergent Capitalisms: The Social Structuring and Change of Business Systems*	Variation in particular institutions determines economic organisation and firm strategy. In addition to CG/LM, skill formation, societal institutions such as trust, but also culture and policy making are of relevance.	Comparative historical analysis of Continental European, Asian and former Soviet nations. Secondary data and descriptive methods used.	Coordinating activities within Continental Europe are further differentiated according to culture and history.	• No conclusive framework on certain institutional spheres determining particular types of innovation. • Wider approach which argues for a general path dependency in firm strategy depending on CG, human capital, historic, cultural and social institutions.	• Institutional change is path dependent. • Internationalisation of firms depend on nature of institutions. • Firm strategy develops according to national institutions • Emphasis on CG (e.g. ownership coordination), industrial coordination (e.g. alliance), employment relations (skill development and LM) & role of states
Varieties of Capitalism	**Hall and Soskice (2001)** *Varieties of Capitalism: The institutional Foundations of Comparative Capitalism*	Focus on five institutional spheres within which firms need to solve coordination problems. Complementary institutional frameworks reinforce each other and create comparative economic advantage in form of radical/ incremental innovation.	Comparative historical case study designs. Secondary data and descriptive methods used. Most prominent: Comparative analysis of Germany and the USA using patent counts, from the European Patent Office in thirty technology classes for 1983–84 and 1993–94.	Mirroring picture between Germany and the US. Specialising in technological fields dominated by incremental vs. radical innovation.	• Dichotomist views on CMEs/LMEs and incremental/radical innovations • Simplifying institutional complementarities onto: CME/incremental innovation and LME/ radical innovation • Methodological limitations due to single data source, method, and case selection. • Missing *institutional change* (endogen, globalisation or crisis) and its relationship to *economic change* in terms of innovation behaviour. • Institutional determinism missing the role of organisations, agents, power structures, role of government policy for innovation.	• National institutional frameworks complementing each other – right to exist. • Institutional frameworks featuring flexible LMs, shareholder value and general skills, being oriented to free market capitalism will prosper in sectors associated with radical innovation. • Rigid LMs, firm/industry specific skills and stakeholder orientation being oriented to coordination between different parties will create incremental innovation. • Welfare Production Regime

Table 1: Three Recent Institutional Approaches on National Trajectories of Innovation

Source: Own illustration using sources shown in Table

2.2.1. National Innovation Systems and Tripe Helix

Following Lundvall's approach on NISs, Etzkowitz and Leydersdorff construct the *Triple Helix* approach in *The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations.* The *Triple Helix* approach acknowledges the role of knowledge creation for the creation of innovation in new and emerging sectors, such as biotechnology and software. It focuses on clusters around universities. An entire field of research and policy making has emerged following this stream of research. It emphasises the role of university spin-offs and cluster policy emphasising knowledge-industry linkages to create innovation (Bergeron, Lallich and Le Bas 1998; BMBF 2006; BMWE 2015; Etzkowitz 2010; Etzkowitz 2004; Feldman, Francis and Bercovitz 2005; Liecke 2009). This dissertation focuses on national trajectories of innovation. Therefore, cluster policy and related literature is acknowledged, but not further considered. Due to its relevance for policy making, *Triple Helix* has emerged as an important approach in innovation management. It derives from the NIS framework. In general, we can differentiate between at least three types of approaches to the study of NISs – the *Statist*, *Laissez-Faire* and *Triple Helix Model*. All models inhibit the notion of interactive learning and knowledge creation within the nation state as one entity which is defined due to the government policy of one country. The models differentiate institutional spheres in the country and acknowledge the role of coordination for innovation. While, for example, the Business Systems approach appears to be a single and closed approach, NIS is characterised by complexity, as expounded by a variety of authors (Freeman 1995; Lundvall 1999; Nelson 1993). The macro perspective of NIS reunites the different approaches in the NIS context. Each nation is viewed as a learning and knowledge-creating entity in its own right.

The VoC approach can easily co-exist with NIS. Where NIS explains the dynamic approach of interactive learning, VoC sees nations as entities in complementing systems of institutional and, therefore, also economic advantage. This offers an easy explanation of why some nations specialise in incremental innovation.

2.2.2. Business Systems

In *Divergent Capitalisms: The Social Structuring and Change of Business Systems*, Richard Whitley (1999) re-focuses on the national level. Within his approach on Business Systems, he adds the perspectives of societal institutions such as trust, but also culture, to the discussion. He follows Lundvall in taking the historical and cultural developments of a country into account and evaluates the path-dependent institutional and technological developments of business systems within nation states. His emphasis is not so much on the creation of knowledge but on the link between corporate governance (specifically ownership coordination) and labour. This is obviously a supplement to the Triple Helix approach which focuses mainly on the creation of high-tech sector innovation within a certain knowledge-intense network. Whitley acknowledges the role of grown-up corporations in the creation of innovation and bringing trust into the picture for analysis, e.g. through laws enforced by governments. Whitley talks about trust from a societal perspective: The ability to trust other actors in a market economy. He does not talk about the psychology of trust or about Lundvall's definition of trust as resulting from values and personal experiences of individuals within the society. Within his book, Whitley builds up the basis for his later argument on business systems' institutional differences being the driver for variation in national innovative performance. In *The Institutional Structuring of Innovation Strategies: Business Systems, Firm Types and Patterns of Technical Change in Different Market Economies*, Whitley (2000) differentiates

between five kinds of innovation strategies (dependent, craft-based responsive, generic, complex and risky, and transformative), which are further distinguished in terms of certain characteristics: technical and user uncertainty, user differentiation and product quality specialisation, organisational competence destruction, use of codified knowledge, and the complexity of the knowledge base. Whitley's work might not be characterised as an approach within the field of innovation studies, but it has developed in the field of political economy, within the discipline of comparative capitalism. His work is highly relevant to the theoretical context of this dissertation. The NIS approach views institutional settings and the dynamic creation of learning and knowledge within each single country. BS encompasses a range of different countries (not only developed Western ones) and compares them to one another. Whitley tries to capture more than plain data about institutional settings and innovation, by telling stories (culture, historical developments, trust and fear) of the country.

2.2.3. Varieties of Capitalism

In 1989, East and West Berlin were reunited. This accomplishment was a far-reaching step for the previously divided country and an important signal for the world. Germans from both east and west celebrated freedom and free capitalism together on top of the Berlin wall. The images of this event were beamed across the world and became a symbol for the demise of the Soviet Union and, with this, an alternative model for capitalism itself. The study and comparison of different capitalist nations (mainly rich, highly industrialised Western nations) gained relevance from the 1990s. Soon it appeared to some scholars that there must be a single best way of organising a nation. Where the NIS approach emphasises the general importance of knowledge within any ("free," Western, democratic) nation,

BS differentiates much more according to historic and cultural issues and aims to observe and understand them instead of implementing certain measures. These approaches appeared to be quite complex. NIS scholars do mainly observe nations out of competition, while the BSs approach ascribes economic developments to unique cultural and historical issues (along with other comparable institutional measures). In an attempt to simplify the picture of VoC nations' diverse ways of organising their market economies, scholars aimed to divide the ("free," Western, democratic) world (which obviously is limited to a specific range of wealthy nations) into two. In this context, two ways to successfully organise Western societies were described. The first way described a group of mainly English-speaking countries, representing the Anglo-Saxon model of capitalism. Exaggeratedly-speaking, these nations are organised around a neo-liberal cutthroat capitalism which abandons social policy wherever possible. A second group points towards the Rhenish model, often represented by Germany, as a social capitalist system based on an egalitarian society (see Albert 1992). Contrary to this dichotomist approach and focusing on the welfare state, Esping-Anderson differentiates liberal Capitalism from a Continental European model (Germany), and a third social-democratic model, which is geographically associated with Scandinavia (Esping-Anderson 1996, 1990). In addition to this, in *The uncertain future of the Italian welfare state*, Ferrera (2000, 1997) describes a fourth type of a southern European model, which emphasises informal institutions and the role of the family. Later on, Ebbinghaus and Manow (2001) identified a fifth model in Japan. By simplifying a complex system of national institutions on the one hand, and national innovation behaviour into one dichotomous model of incremental and radical innovation, directly relating institutions to innovation, without acknowledging other factors, such as the heterogeneity of firms, natural resources, a country's political or military power, or the role of the state, but

only the one-dimensional framework of the co-ordinating strengths of a national market and its effect on specialising in certain (radical/incremental labeled) sectors, the VoC approach offered an easily understood framework. In their introduction, Hall and Soskice describe innovation as “one of the most crucial dimensions of economic success” (Hall and Soskice 2001, 44). They focus on the institutional influence of the development of certain kinds of innovation within the country. Hall and Soskice (2001, 6) describe five institutional spheres through which "firms must develop relationships to resolve coordination problems, central to their core competencies". The five spheres are the sphere of industrial relations, the sphere of vocational training and education, the sphere of corporate governance, the broad sphere of inter-firm relations, and finally coordination problems vis-à-vis with their own employees. Depending on a nation’s ability to solve these coordination problems on each sphere, the VoC approach divides nations into different categories of Liberal or Coordinated market economies, associating CMEs with incremental change and LMEs with the ability to specialise in radical innovation. Table 2: Characteristics of CMEs and LMEs displays the characteristics which allow them to specialise in a certain trajectory of innovation. It is argued that comparative advantage in high-tech economies with radical innovation may be supported by combinations of certain institutional conditions, such as “[l]ax employment protection, weak collective bargaining coverage, extensive university training, little occupational training, and a large stock market” (Schneider 1999, 250).

> “The basic idea is that the institutional structure of a particular political economy provides firms with advantages to (…) perform some types of activities, which allow them to produce some kinds of goods, more efficiently than others because of the institutional support they receive for those activities in the political economy” (Hall and Soskice 2001, 37).

VoC does not focus on a national level, but on the firm within the nation. The firm is seen as an entity striving to “develop and exploit core competencies or

dynamic capabilities". With dynamic capabilities, Hall and Soskice mean the "(…) quality of the relationships the firm is able to establish, both internal, with its own employees, and externally, with a range of other actors (…)" (Hall and Soskice 2001, 6). The authors continue their argument by saying that since many of firms' capabilities are of a relational nature, a firm does also experience a lot of coordination problems. Being successful in the production of a certain kind of product indicate sthat a firm is able to handle certain kinds of coordination problems well and is able to communicate with other relevant actors. Hall and Soskice acknowledge that although there may be types of comparative advantage, these institutional frameworks confer that they have not yet explored, they focus "on their impact on innovation since a firm's capacity to innovate is crucial to its long-run success" (Hall and Soskice 2001, 38). Taylor criticises the empirical basis of VoC (represented by Hall and Soskice 2001). He criticises the fact that Hall and Soskice`s "predictions are not supported by their empirical data and that the evidence offered by VoC proponents depends heavily on the inclusion of a major outlier, the United States, in the class of liberal-market economies" (Taylor 2004, 58). Despite critiques, Voc has become a key approach in the wider field of comparative capitalism. Its ability to interconnect national institutional frameworks with trajectories of innovation is highly relevant for national players in politics, economics and academia. More recent literature (e.g. Hoepner 2005) in the area of VC asks for the relevance of institutions and whether some of them might not be directly related to certain kinds of innovation but moreover "just" compatible with those institutions necessary to create a certain trajectory of innovation. A more differentiated, non-correlational view is slowly emerging within this highly relevant field.

	LMEs	CMEs
Characteristics	-Tolerant of merger and acquisitions	- Long-term investments
	- Top management has ultimate control over firm	- Consensus decision-making facilitates network monitoring
	- General skilled labour, transferable across firms	- Requires highly skilled labour; share of information and work autonomy
	- Lax employment protection	- Lifetime employment, equalised wages
	- Licensing agreements instead of inter-firm collaboration	- Inter-firm collaboration on R&D important
OECD countries belonging to a specific group[*1]	USA, Britain, Australia, Canada, New Zealand, Ireland	Germany, Japan, Switzerland, the Netherlands, Belgium, Sweden, Norway, Denmark, Finland, and Austria
Impact on innovation[*2]	Comparative advantage in producing **radical** innovation	Comparative advantage in producing **incremental** innovation

[*1] **S**ix OECD nations were left in "more ambiguous positions (France, Italy, Spain, Portugal, Greece, and Turkey)" (Hall and Soskice 2001, 20).
[*2] Hall and Soskice do not argue that one kind of innovation is superior to another; they only differentiate between the two forms: "(…) we are not arguing here that one is superior to another" (Hall and Soskice 2001, 20).

Table 2: Characteristics of CMEs and LMEs

Source: Own illustration using Hall and Soskice, 2001, 20–29

2.2.4. Varieties of Capitalism and Comparative Economic Advantage

In –the search for Economic Success, comparative capitalists (CC) have raised the previously described dichotomist argument of rational-functionalism, suggesting that national innovation capability is determined by complementary institutional settings in turn leading to complementary sectoral specialisation in production. The approach which emerged and is still taught argues for institutional features of LMEs such as stock market financing, external labour markets and shareholder orientation to provide firms with incentives to take risks, and, in contrast, the institutional features of coordinated market economies such as bank-based financing, internal labour markets, and stakeholder relationships encourage firms to exploit internally accumulated resources. Near the beginning of *An Introduction to Varieties of Capitalism*, Peter Hall and David Soskice, identify five institutional spheres "in

which firms must develop relationships to resolve coordination problems central to their core competencies" (Hall and Soskice 2001, 6–7). These spheres are identified as *industrial relations*, *vocational training and education*, *employees*, *inter-firm relations*, and *corporate governance*. A very simplistic picture is drawn, as illustrated in Figure 1: Complementarities between Institutions and Innovation between CMEs and LMEs.

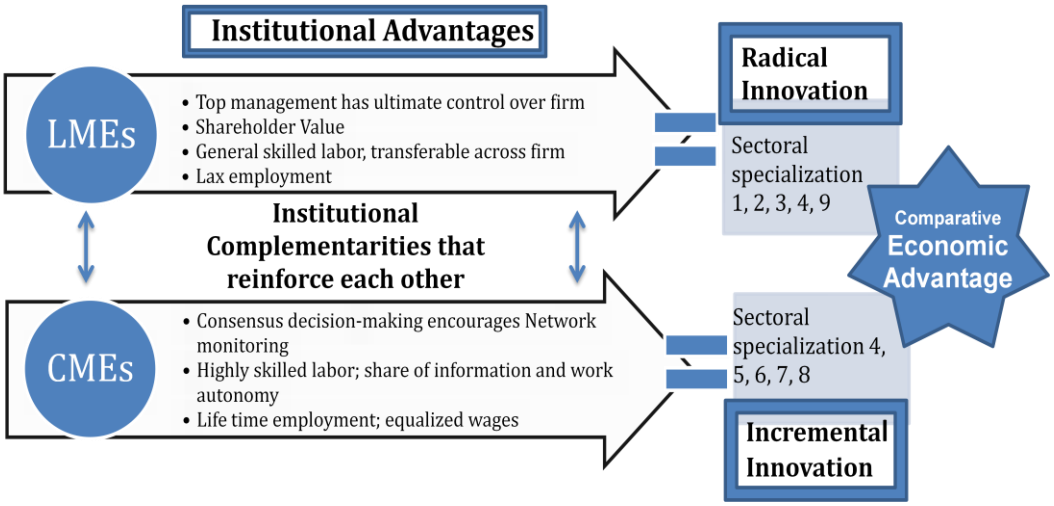

Figure 1: Complementarities between Institutions and Innovation between CMEs and LMEs

Source: Own illustration following Hall and Soskice (2001, 20-50) argument

Within this section, the underlying propositions of the VoC approach are identified. Following the summary of the *Introduction to Varieties of Capitalism*, several chapters of this volume focus on a further discussion of skills, LMIs, Industrial Relations (IR), CG and financial globalisation in relation to national trajectories of innovation. Comparative institutional advantage is seen as the source of comparative economic advantage. The summarised propositions in these chapters are evaluated within the following sections.

In *Social Protection and the Formation of Skills: A Reinterpretation of the Welfare State*, Estevez-Abe, Iversen and Soskice (2001) draw a simplistic picture of

a combination of Labor Market flexibility (LMf) and a general skill base leading national firms, e.g. in the USA, to superior performance e.g. in the software, biotechnology or telecommunications sectors. As argued in the Introduction of Hall and Soskice's (2001, 44) book, these sectors are characterised as sectors "where radical innovation is important". General skills are argued to be recognised by all employers; their value is independent of firm type or industry (e.g. university or college education). In contrast, nations such as Germany that follow a production strategy which mass-produces but specialises in incremental innovation of high-quality products require *firm-specific* and, in addition, *industry specific* skills. Firm-specific skills are not useful for the employee outside the context of the firm. They are created by on-the-job training. In contrast, industry-specific skills are recognised by any employer within a specific trade (e.g. apprenticeship and vocational training). A first proposition identified is that a relative abundance of high levels of general skills in a national market economy brings it a comparative advantage in terms of radical product innovation. High levels of firm/industry specific skills are required for the production of incremental innovation.

Proposition 1: General skills lead to radical innovation.

The second proposition can be identified as the relationship between flexible LMs and radical innovation. A flexible labour market is required for general skills to be transferable throughout industries. These are argued to dominate LMEs and thereby provide them with the ability to specialise their production in radically innovative sectors.

Proposition 2: LM flexibility leads to radical innovation.

In a second step, Estevez-Abe, Iversen and Soskice (2001) describe how Welfare Production Regimes dominate most CMEs, and create inequality in the affected nations, as a side effect of their chosen product market specialisation.

Welfare Production Regimes are said to produce inequality based on "the economic background of workers [and] (...) based on gender" (Estevez-Abe, Iversen and Soskice 2001b, 147). One might ask: Why would CMEs accept inequality in their society? Thelen (2001) and Wood (2001) answer this question. In *Varieties of Labor Politics in the Developed Democracies*, Thelen (2001) expands her approach, by adding a perspective on institutional change. Thelen argues that coordination "is a political process and an outcome that has to be actively sustained" (Thelen 2001, 73). On page 77, she further argues that this happens "through negotiation by highly organized employer organizations and unified and encompassing labor movement". Obviously, this is very different from her argument on process and the direction of change in LMEs. Thelen states that a reconfiguration of industrial relations within LMEs leads them to further liberalisation, and a "fundamental renegotiation of the terms of coordination" (Thelen 2001, 73) in CMEs. Emphasising these relationships, Steward Wood (2001) in his chapter on *Business, Government, and Patterns of Labor Market Policy in Britain and the Federal Republic of Germany*, points out that the content of LMP in CMEs derives from employer preference. Therefore, the degree of constraint on government is fundamental for corporations to pursue their variety of production strategies. The WPRs in CMEs are argued to be allowed and sustained by a corporation's influence over the government: "(...) quasi-corporatist regimes [which] provide producers with influence over government" (Hall and Soskice, 2001, 49). It is assumed that a corporation’s influence over government policy making creates high levels of social protection, namely employment protection, unemployment protection, and, with restrictions, wage protection, which, in turn, reinforces employees skill trajectories of firm or industry specific skills needed by corporations to contribute to the firm's product market strategies for incremental innovation. The presumed inequality is, therefore, an unwanted but

accepted side effect of the WPR. In *Firms and the Welfare State*, Isabela Mares (2001) continues this argument by interconnecting the VoC approach with theory on the varieties of welfare regimes. Her argument is on the re-distribution of risk in society and on the ability of social policy to "offer distinct institutional advantages to employers" (Mares 2001, 211). Two further propositions can be identified as showing how WPRs dominate most CMEs and thereby create inequality; secondly, CME's social and economic government policy is strongly influenced by its inner national corporations. In contrast, LME's policy making is not assumed to be controlled by corporations. Thus, radical innovation can be created.

Proposition 3: WPRs dominate CMEs and create inequality.

Proposition 4: CME's policy making is strongly influenced by corporations.

These first four propositions are illustrated in context with each other in Figure 2: Skills, LM, WPR and Corporations' Influence on Trajectories of Innovation in Germany.

Steward Wood (2001) argues that the stability of LMP over time is "determined by governments power to initiate reform or reversal" (Wood 2001, 248). Wood further rejects the "Dirigiste conception of policy-making" and argues that instead "government should produce policies that complement the institutional comparative advantage of their respective market economies" (Wood 2001, 274).

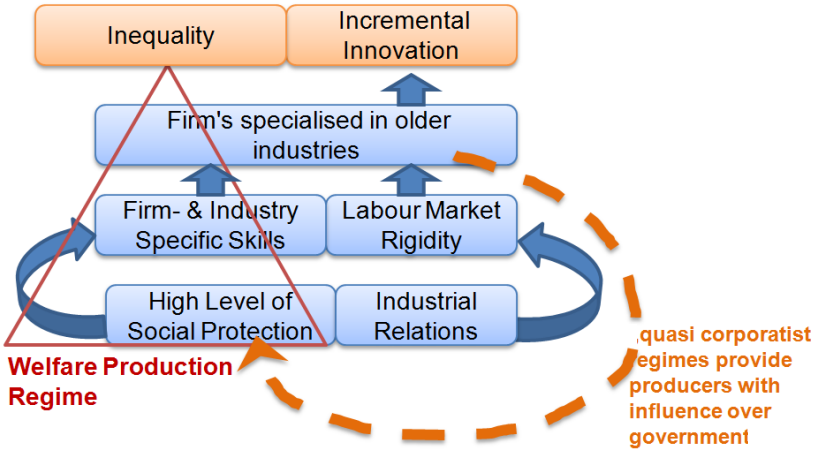

Figure 2: Skills, LM, WPR and Corporations' Influence on Trajectories of Innovation in Germany

Source: Own illustration following Hall and Soskice's argument (2001, 40–49)

By "dirigiste" Wood means: "according to which coordination is secured by designing a set of sanctions and incentives and imposing these patterns of behavior on firms" (Wood 2001, 274). One essential proposition of VoC is that the institutional outlook of the dichotomist capitalist groups is relatively stable and somehow path dependent if not change resistant. Therefore, Wood's argument needs to be evaluated within this context. In *Varieties of Labor Politics in the Developed Democracies*, Thelen (2001) expands this approach on the influence of LMI on the national production regimes, by adding a perspective on institutional change. Thelen argues for a reconfiguration of industrial relations within LMEs leading them to further liberalisation, and a "fundamental renegotiation of the terms of coordination" (2001, 73) in CMEs. Thereby she argues that coordination "is a political process and an outcome that has to be actively sustained (…) through negotiation by highly organized employer organizations and unified and encompassing labor movement" (Thelen 2001, 73–77). In the context of institutional change theory within the VoC approach, Hall and Soskice also comment on the influence of globalisation. They

divide globalisation into two streams of research: firstly, the monolithic political developments and secondly financial globalisation. As previously mentioned and contrary to previous approaches, VoC does not argue for general liberalisation due to globalisation pressuring for one best model of capitalism – at least not at first glace. Furthermore, Hall and Soskice (2001, 56) do not suggest that firms move their "corporate activities across national borders, as firms seek access to new markets and new sources of supply". Moreover, they suggests that "companies may move some of their activities to liberal market economies, not simply to lower labor cost, but to secure access to institutional support for radical innovation" (Hall and Soskice 2001, 57). This implies a bifurcated response by deregulation in LMEs and limited deregulation in CMEs and leads to a fifth proposition on the division of work, namely sectoral production over dichotomist national market economies being associated with a superiority in certain trajectories of innovation.

Proposition 5: CMEs will move activities to LMEs in order to create radical innovation.

In terms of financial globalisation, Hall and Soskice (2001, 60) describe extensive pressure on the institutional frameworks of CMEs. Large firms are described as increasingly relying on international financial markets. In this context, CME firms are expected to change their corporate governance (CG) strategy into shareholder value standards. This requires them, among other things, to "(...) revise their accounting standards, appoint independent directors, and deliver the high rates of return associated with shareholder value" (Hall and Soskice 2001, 60). This shift in CG standards is further argued to lead to changes in the other institutional spheres (LM, social policy and skill formation due to a corporation`s influence over the government) and could result in "shifts in strategy extending all the way down to production regime" (Hall and Soskice 2001, 61). In times of crisis, Hall and Soskice

(2001, 63) suggest: "[There are] (...) no such constraint[s] on CMEs deregulating to become more like LMEs".

Within the described context of shifts in CG within CMEs, and a slow liberalisation of the institutional spheres of CMEs due to financial liberalisation, sixth, and seventh underlying propositions can be identified. The seven identified propositions are illustrated in Figure 3: An Illustration of Propositions underlying VoC.

Proposition 6: CME's Corporate Governance structure will change towards shareholder value.

Proposition 7: CME's institutional foundations are under fundamental renegotiation and will liberalise.

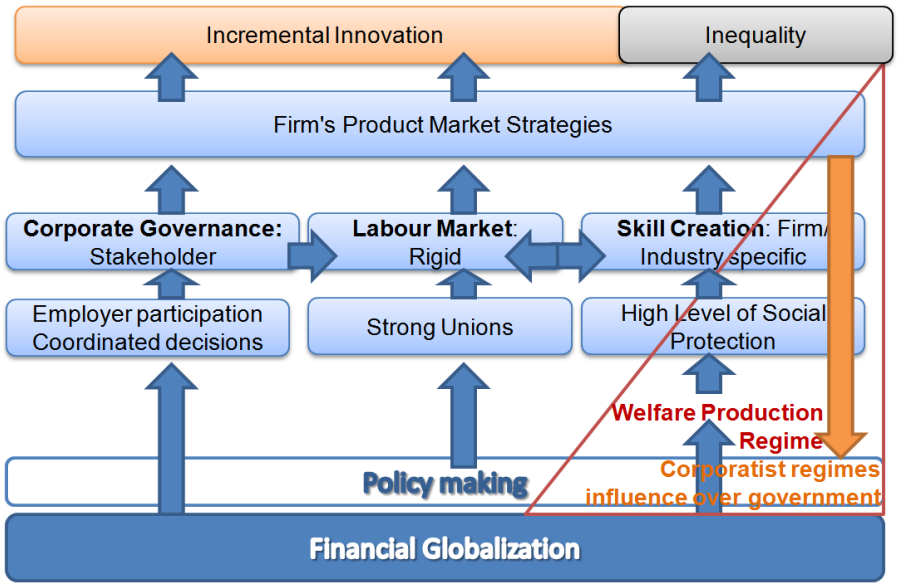

Figure 3: An illustration of propositions underlying VoC

Source: Own illustration following VoC arguments

This section identifies seven propositions underlying the VoC argument.

Proposition 1: General skills lead to radical innovation. Firm/Industry specific skills lead to incremental innovation.

Proposition 2: Labour market flexibility leads to radical innovation. Labour market rigidity leads to incremental innovation.

Proposition 3: WPRs dominate CMEs and create inequality.

Propositon 4: CME's policy making is strongly influenced by corporations.

Proposition 5: CMEs will move activities to LMEs in order to create radical innovation.

Proposition 6: CME's Corporate Governance structure will change towards shareholder value.

Proposition 7: CME's institutional foundations are under fundamental renegotiation and will liberalise.

2.3. Institutional Change Theory and Innovation

Depending on one's values and beliefs, each researcher develops a slightly different view on the topic of institutional change. A rational choice author may favour path dependency change models where historic institutionalism emphasises the importance of punctuated equilibrium. Interestingly, there is a dominant model of thinking existent in institutional change literature. This is the model of path dependency, which partly includes the concepts of punctuated equilibrium, and critical junctures (depending on the researcher's perspective). Originally, path dependency was an idea put forward by David (1985) and Arthur (1994), who were both teaching at Stanford University (USA), and had previously exchanged ideas with each other. David's short five-page QWERTY paper represents one of the most famous examples of path dependency applied to technological innovation (Ebbinghaus 2005). David (1985, as cited in Ebbinghaus 2005, 7) stated:

> "The keyboard layout of American typewriters was developed 130 years ago to cope with technical problems of mechanical typewriters, without

> considering a more efficient keyboard arrangement with respect to typing speed. As users invested in learning this established standard, more optimal alternative keyboards could not later overcome the predominance of QWERTY, even during the fundamental technology driven switch from mechanical to electric typewriters and then to computer keyboards. The diffusion of the technological standard became a self-reinforcing process: The more people learned to use this design, the less likely it was for competing keyboards to take over."

Ebbinghaus argues that there are actually two models of path dependency which exist in literature. For the first one, David and Arthur's work on technical innovation is converted and applied to the emergence of social convention, which emerges due to the "accidental but repeated use" of a trail. This model is also used in institutional change theory and takes more of a sociological perspective than any of the others. It may explain institutional construction and development. Two characteristics of path dependency have been universally criticised in the literature. An economist, who believes in the self-regulating power of markets, criticises the perception that inefficient paths are chosen in path dependency. Non-economists might then also see the *lock-in* phenomenon of chosen paths as problems in that it "denies individual actors freedom of action and excludes the potential for change" (Ebbinghaus 2005, 11). Another critique is that small events in early phases might have crucial long-term effects, which cannot be predicted but only analysed afterwards. Ebbinghaus does, therefore, conclude that this "deterministic model can only explain those hyper stable cases of path dependence that follow the proposition of stochastic events and unobstructed self-reinforcing processes" (Ebbinghaus 2005, 11). Page (2006) criticises the loose use of path dependency. He explains that David (1985) had already mentioned the concept of path dependency as being almost metaphorical when compared to that of equilibrium. "By equilibrium here I mean limiting distributions over outcomes" (Page 2006, 89). Thus, he continues by stating that path dependency originally meant that "current and future states, actions, or decisions

depend on the path of previous states, actions, or decisions" but that lately, path dependency has become a popular conveyor of the looser idea that history matters (Crouch and Farrell 2004; Pierson 2004). Page (2006) summarises common misunderstandings with the model of path dependency and also gives the reader an overview of different models of path dependency. The five misunderstandings which Page lists are: 1) “Increasing returns are neither necessary nor sufficient for path dependence (…)”; 2) “any constraint, (…) can create path dependence (…)”; 3) “outcomes in the Polya Process do not depend on the order of past events” (Page 2006, 90); 4) "Phat vs. Path dependency – even if the sequence of events in the past matters, it does not necessarily matter for the coming future"; 5) “The future is not deterministic, but stochastic and biased towards early decisions. The process exhibits early path dependence and not extreme sensitivity to initial conditions” (Page 2006, 91). He, therefore, classifies a variety of Ball and Urn models which are quite simple models of the familiar Polya Process. As a second class of models, he names the decision-theoretic models, which assume a “decision maker who takes sequential action” (Page 2006, 106). He describes a number of observations which can be made about such an approach to path dependency.

As previously described, institutional theories within the field of comparative capitalism do often anticipate a system of institutional complementarity within national market economies. This institutional complementarity is reinforcing. Therefore, the national institutions are expected to be relatively stable and to slowly develop in a path-dependent manner. Through this, the theories of institutional complementarities and the theory of institutional path dependency are interrelated in many cases. Even though both concepts can be united, they are distinct from each other in that they can exist there. Complementarities provide one explanation of why institutions may stay relatively stable even though there are strong pressures (from

globalisation) from outside. Incremental change is also explained due to step-by-step changes; the main argument is that institutional frameworks would stay stable over time if they were not destroyed my major external shocks. One of the most famous authors in the field of path dependency is Kathleen Thelen. Thelen emphasises that "institutions are constructed in the context of some historical choice point in the past, and then once they are in place, they lay out an enduring logic of political development (…) critical junctures (or choice point) (…) which occur in the past" and "produce historical trajectories" (Thelen 2009, 474).

In the development of a path dependency model explaining institutional change, Thelen makes a point by providing a toolkit to interconnect the questions of institutional reproduction and institutional change. Thelen (2005 and 2009) has widely argued, that "the key to understanding institutional evolving and change lies in specifying more precisely the reproduction and feedback mechanisms on which particular institutions rest" (Thelen 2009, 397). Prior to Thelen, the concept of feedback mechanisms was developed by Pierson, who is a representative of the rational-choice way of thinking. Thelen (2009) criticises his approach to change as being discontinuous and characterised by the breakdown of one set of institutions and its replacement by another. She does emphasise that external shocks do not necessarily have to lead to a large change in institutional behaviour. Secondly she (Thelen 2004) explains that, even in the absence of external shocks or historic ruptures, change does also take place in settled times, in an incremental way, and this is true in the context of Germany.

By taking a historical perspective on institutional development and change, Thelen (2004) has constructed an argument of a political-coalitional theory of institutional reproduction and transformation. In 2009, she gives further attention to gaps between institutional rules and their actual behaviour and the opportunities for

incremental change which occur as a result of these gaps. By drawing attention to her empirical research and case studies, she emphasises that most institutional change in real life does not occur due to big term external shocks which lead to institutional reproduction. "[R]ules are never simply applied, they are always interpreted, enforced and enacted, and, of course, by actors who have divergent and conflicting interests" (Streek and Thelen 2005a as cited in Thelen 2009, 491). She uses her empirical research to show how capitalist economies are changing and manages to show that changes in CMEs (incremental changes, rather than institutional reproduction) is not simply explained by existing theories of punctual equilibrium but by theories of change. Following this finding, she gives the reader case examples and builds up a comprehensive theoretical framework in explaining how gaps between the institution (a rule) and the actual behaviour of the institution can exist or develop and how these incremental changes can be the basis for larger real life changes in institutions. By not only recognising change in CMEs but also providing a framework for their explanation, she does make an important contribution to the research field in the area of institutional change in capitalist systems.

In addition to Deegs, in *Complementarity and institutional change in capitalist systems*,[1] Thelen does not just talk about possible drivers of change themselves but presents the reader with a model of four modes of change (layering, drift, displacement, conversion) and analyses the direction of institutional change in the VoC context. The following pages do develop an understanding of what underlies these and other approaches on institutional (non-) change in the field of comparative capitalism.

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[1] Deeg (2007, 612) describes how "[i]n the recent literature on comparative institutional political economy, complementarity has become a central concept (e.g. Aoki 2001; Milgrom and Roberts 1995; Hoepner 2005)". He uses the theory of Hall and Soskice (2001) as an example of complementarities influencing specific outcomes (LMEs vs. CMEs) and the approach of path dependency (Pierson, 2005) as it influences the stability of institutions.

It has been widely argued that the VoC approach is too static and has focused "on permanency and path-dependency, missing important dynamic elements of economic change (Crouch and Farrell 2004; Crouch 2005a; Hancke and Goyer 2005; Streek and Thelen 2005; Jackson and Deeg 2006)" (as cited in Hancké, Rhodes, and Thatcher 2007). The previously described path dependency approach, which has emerged as the dominant approach in explaining institutional stability and change, has been extensively criticised for ignoring "endogenous sources of national system transformation and within-system diversity" (Hancké et al. 2007, 7). VoC is not only an approach to compare differences across nations, but it is also helpful to "elucidate the processes whereby national political economies change" (Thelen 2001, 65). By talking about institutional change, Hall and Soskice (2001) mean the change of the set of rules that actors of our society (such as the members of an organisation) usually use as a basis for their actions. Institutions are not only shaping "the collective supply of inputs (e.g., skills, capital) available to firms and other economic actors" (Jackson and Deeg 2006, 7) but are also providing "comparative institutional advantages". The VoC approach links institutional variables with a variety of distinct economic outcomes, and, in particular, with a nation's specialisation towards either incremental or radical innovation. Institutional change does, therefore, not only mean a change in the institutional framework itself but also in its outcome in terms of the nation's trajectories of innovation. In the context of the VoC debate, institutions are seen as "durable entities" (Hall and Soskice 2001, 9) which resist the pressures of globalisation. This consistency is described as being a result of complementarities. Deeg 2007 (612) argues that "complementarities have become a central concept in comparative studies". Thereby, VoC's division of advanced capitalist economies into two primary types and its prediction that "when confronted with pressure for change, liberal market economies will get 'more liberal' and coordinated market economies

will resist liberalization in order to sustain complementarities" is given as a major example of complementarities (Deeg 2007, 612).

The review of innovation literature discusses the existing literature in innovation management and institutional theory. Three main approaches combining institutional spheres with research on innovation are identified, and the relevance for this literature in a wider economic context is illustrated.

3. CHAPTER THREE: THEORETICAL FRAMEWORK – NATIONAL TRAJECTORIES OF INNOVATION

For the case study analyses at the sector level, the dynamics of innovation and their consequences for comparative economic advantage of the nation are discussed in context of wider theory. As previously described, this dissertation explores two key issues: (i) the determinants of national trajectories of innovation, especially in terms of institutional complementarity and policy, and (ii) the effect of radical trajectories of innovation within a CME in the wider economic discussion.

In an attempt to create an enhanced theoretical framework in the analysis in this chapter, this dissertation addresses the theoretically given institutional factors that are described by different approaches to characterise coordinated/liberal nations. It further reflects identified propositions, and institutional change within these contexts. An integrated theoretical framework is drawn in order to describe the mechanisms of decision making for creating radical trajectories of innovation within Germany. Policy and contextual factors regarding trajectories of innovation are added to the perspective.

This chapter is structured in the following way. Section 3.1 provides a short overview of the terms and definitions used in this thesis. Section 3.2 provides the broad theoretical background on how institutional factors theoretically influence national trajectories of innovation in Germany. The usefulness of the VoC theory in this context is discussed. Institutional change theory in the context of VoC and innovation is shown. Section 3.3 provides a theoretical analysis of policy change and its expected effects on institutional spheres, such as the job market and skill

equilibrium, as it relates to decision making and, therefore, the trajectories of innovation in Germany. Section 3.4 concludes with a discussion and a newly suggested theoretical framework. It evaluates the strengths and weaknesses of this framework.

3.1. Definitions

This dissertation raises the issue of radical innovation within a coordinated market economy. It is clearly important to define the concepts of radical innovation and the institutional spheres within this context. Yet the definitions, particularly in the field of radical innovation, abound. “Depending on the researcher, essentially the same phenomenon may be labeled as discontinuous innovation (Anderson and Tushman 1990), emerging technology (Day and Schoemaker 2000), or even disruptive technology" (Christensen 2000, as cited in Hurmelinna-Laukkanen, Sainio and Jauhiainen 2008, 279).

These different definitions between radical and incremental innovation make it hard to actually compare existing research which is often conducted on the basis of different models. We can observe this even within institutional approaches in CC. Where NISs view radical innovation on different levels and would, for example, call an unexpected economic success (Lundvall 1999) a radical innovation, the VoC approach focuses on high-tech sector performance. It describes newly-emerging sectors which are automatically characterised by radical innovation. Still, within one sector, it may be possible to find incremental and radical innovation. For example, this dichotomy is very visible within the German automobile industry: a traditional industry that aims to create radical innovation. Nevertheless, there are often some common elements relating to the definition of radical innovation. Many definitions

are based on Schumpeter`s (1934) differentiation between day-to-day improvements and “radical changes with a great impact on sectors of industry and business cycles” (Hagedoorn 1996, 888).

The existing definitions do typically include aspects relating to “high market and technological uncertainty, new market creation, current product cannibalization, and even effects on the knowledge base of the company” (Hurmelinna-Laukkanen et al. 2008, 279). Radical innovation is said to “play a different role in the firm’s product portfolio”, but also in a whole market sector, compared to incremental innovation. Where radical innovation is generally called upon to transform whole product portfolios or market segments, incremental innovation is called upon to “provide low-risk potential for product upgrades” (Hurmelinna-Laukkanen et al. 2008, 279). These definitions or attempts to define the difference between radical and incremental innovation do not provide a clear framework in terms of what exactly may be called a radical/incremental innovation. For this thesis, I follow the definition of VoC which ascribes to new and emerging sectors the term radical: software and biotech are two major examples of radically innovating sectors. Hall and Soskice (2001) use this simplified definition in order to later explain CEA derived from CIA. This dissertation attempts to reflect on the idea of CIA directly leading to CEA. The sectoral perspective on innovation is, therefore, used in order to directly discuss the dominant VoC approach despite knowing the shortcomings of this approach. Casper, Lehrer and Soskice (1999) discuss, through themes, the ability of radical and incremental innovation to occur within one sector, e.g. the biotech sector of one nation. Later scholars (e.g. Hancke and Goyer 2005) discuss the influence of various institutional constellations within one nation upon not only one innovational outcome.

By not simply trying to identify radical innovation, but also the way in which it is created, it has been shown by different authors that the internal as well as external factors of firms are relevant for the creation of radical innovation, thus not only institutional factors. An example for this research is Hurmelinna-Laukkanen, Sainio and Jauhiainen (2008) who argue that the firm size generally influences a firm`s ability to radically innovate, and that smaller companies would thereby be experts in radical innovation, whereas radical changes in large firms would not be able to happen as easily. Other authors view radical innovation from a different point of view and argue that it "varies substantially in firms across nations (Diamond 1999; Furman, Porter and Stern 2002; Landes 1999)" (Tellis et al. 2009, 3), and also across different industry sectors. These cross-country and cross-industry differences are the basis of Hall and Soskice`s (2001) assertion that innovation is influenced by the kind of capitalist system in any given country. Identifying certain sectors which are more influenced by radical innovation than others offers a kind of definition, which the two authors use to measure cross-country differences in terms of the ability of a country to radically innovate. As argued by Hall and Soskice (2001) some nations such as the USA thereby specialise in radically innovating sectors, whereas others such as Germany focus on incrementally innovating sectors. This mirroring picture has been built upon by many other authors such as Porter (1990). Porter distinguished clearly between the two market economies of LMEs and CMEs, the first one being superior in new high-tech industries such as biotechnology and software, and the other one, being superior in industries such as machine tools, the chemical industry or luxury cars. The Fraunhofer Institute (Warschat 2009, Ardilio 2009) tries, for example, to enhance the radical innovativeness of firms by building

up a technology radar.[2] From a different perspective, Srwholec and Verspagen find, in their analysis of the Community Innovation Survey (CIS) Europe, that:

> "[d]espite the work on sectoral taxonomies of innovation, or sectoral and national systems of innovation, these two dimensions – sectors and countries – only capture a minor part of the variance in the innovation strategies that we observe at the firm level. Within sectors and countries, a multitude of innovation strategies is observed." Srwholec and Verspagen (2007, 35)

CC literature defines institutions as shaping the supply side, "examining how various institutions shape the collective supply of inputs (e.g., skills, capital) available to firms and other economic actors" (Deeg and Jackson 2007, 7). Within the VoC approach, these independent variables are limited to five spheres. CC literature does generally suggest a theory of comparative institutional advantage. The different institutional frameworks between countries are assumed to support certain economic activities, such as e.g. a countries ability to radically innovate, in different ways. The VoC (Hall and Soskice, 2001) approach was established in the field of CC. It does, therefore, inhibit propositions of institutionalism and institutional change. Debating its propositions on institutional change is relevant for understanding VoC's concepts of relative stability, institutional complementarities, and path dependency. The focus of this part of the thesis is on the intersection between institutional change itself and the outcome of capitalist variety as described by Hall and Soskice (2001): innovation behaviour of nations due to sectoral specialisation in radical vs. incremental sectors.

The nature of organisations and institutions themselves is to be differentiated. An organisation is defined as a "durable entity with formally recognised members, whose rules also contribute to the institutions of the political economy" (North 1990,

[2] A network between the 57 institutes and 12,000 employees of the Fraunhofer association and German firms to analyse the firm`s profiles and identify new technological trends in the German innovation system.

3 as cited in Hall and Soskice 2001, 9). Hall and Soskice refer to North when they define institutions as a "set of rules, formal or informal, that actors generally follow, whether for normative, cognitive, or material reasons" (North 1990, 3 as cited in Hall and Soskice 2001, 9). Organisations, as compositions of different members, create rules for interaction with each other. These evolving rules do influence the nature of a country's institutions, which are expected to stay relatively consistent towards change. The proposition of relative stability over time is not only of importance for understanding institutions themselves but is underlying Hall and Soskice's larger assertion that there are two different kinds of market economies. It is argued that one cannot find one superior market economy (either CME or LME) but that these two manage to co-exist throughout pressure of globalisation and competition, due to their relative stability. This co-existence does, in turn, explain the specialisation of countries in terms of their innovation behavior. Literature which compares capitalist systems not only discusses whether the differentiation between CMEs and LMEs is useful and correct, it also discusses its underlying proposition of relative institutional stability, but also why this stability exists.

There are three main perspectives notable in institutionalism: historic, rational choice, and the sociological perspective. Early institutional theory militates against cross-national comparisons. In contrast, the approach of *new institutionalism* "utilizes to identify the most salient institutional determinants" (Peters, Pierre and King 2005, 1280). Peters et al. (2005) describe the renewed scholarly interest "among comparative political sociologists in the state as an analytic concept (...) analytical significance ascribed to institutional arrangements" (Peters, Pierre and King 2005, 1280) in political science as having triggered the interest in new institutionalism in the past 15 years. *Historic Institutionalism* is characterised by three features. Firstly, it addresses substantive questions that are of interest to the

broad public; secondly, it specifies sequences and traces transformations and processes of varying scale, and thirdly it analyses "macro contexts and hypothesizes about the combined effects of institutions and processes rather than examining just one institution or process at a time". Historic institutionalism has not developed as a single point of view in the study of institutions. In a *rational choice tradition*, Weingast (2002) answers the question on why institutions are needed. He explains that they need to capture gains from cooperation. Weingeist describes a social dilemma which individuals do often face when there are no institutions constructed. This dilemma appears because individuals cannot agree on how to distribute the gains which they get from cooperation. Weingeist not only gives an answer about why institutions exist but also theorises about why institutions differ across nations: "because incentive problems differ greatly across environments, the type of institutions necessary to mitigate these problems also varies" (Weingeist 2002, 670). Weingeist states that "(…) institutions restructure incentives so that individuals have an incentive to cooperate" (Weingeist 2002, 670). It has been argued that, generally, contrary to historic institutionalism, *rational choice* tends to scarify the nuances for generalisability. Thelen (1999) argues that this differentiation does not fit well. She argues that good researchers in both areas try to generate hypotheses that are then brought to bear on empirical phenomena. They cannot simply be divided into "empirically" vs. "theoretically" driven work. She concludes that differences remain, but theorists work through these differences. She thereby views each approach as nearly fluid in terms of the other. Both perspectives on institutions are exogenous ones, which means that "institutions affect individual interaction and choice in a variety of ways: institutions constrain individual choice, how individuals interact, their information and beliefs, and their payoffs" (Weingeist 2000, 661). One might notice that this is in total contrast to the third approach which co-exists in

institutional studies. Contrary to historical institutionalism, the *sociological perspective* allows one to see institutions as being "socially constructed in the sense that (they) embody shared culture understandings (…) of the way the world works" (Thelen 1996, 386). Institutions are not seen as constructed by a country's cultural, but as part of it and continuing to form it as well. Parents, grandparents, and children follow the cultural perspectives of their previous generations and institutions, as demonstrations of culture. Institutions act as scripts that individuals enact, almost unconsciously.

VoC is not only an approach which compares differences across nations, but it is also helpful to "elucidate the processes whereby national political economies change" (Thelen 2001, 65). By talking about institutional change, Hall and Soskice (2001) refer to the change in the set of rules that actors in our society (such as the members of an organisation) usually use as a basis for their actions. Thereby institutions not only shape "the collective supply of inputs (e.g., skills, capital) available to firms and other economic actors" (Jackson and Deeg 2006, 7) but also provide "*comparative institutional advantages*". In particular, the VoC approach links institutional variables with a variety of distinct economic outcomes, and, in particular, with a nation's specialisation into either incremental or radical innovation. Institutional change, therefore, not only means a change in the institutional framework itself but also in the outcome of the nation's trajectories of innovation. In the context of the VoC debate, institutions are seen as "durable entities" (Hall and Soskice 2001, 9) which resist the pressures of globalisation. This consistency is being described as a result of complementarities. Deeg (2007, 612) argues that complementarities have "become a central concept" in comparative studies. Thereby VoC's division of "advanced capitalist economies into two primary types – coordinated market economies (CMEs) and liberal market economies (LMEs)" and

its prediction that “when confronted with pressure for change, liberal market economies will get ‘more liberal’ and coordinated market economies will resist liberalization in order to sustain complementarities” is offered as a major example of complementarities. Hall and Soskice themselves argue that there are two types of work existing in the literature, those that focus on institutions and the way in which they reproduce stable patterns of behaviour and on those that attribute great force to the pressures associated with globalisation. They tend to see national practices as inertial factors that will be transformed by these pressures. Hall and Soskice believe that their model “anticipates institutional change in all the developed democracies (…) but (also) provides a framework within which the importance of those changes can be assessed" (Hall and Soskice 2001, 66). Searching for this new approach on institutional change, the reader finds that the offered “approach” is mainly a proposition about how CMEs and LMEs would change. Therefore, diverse hypotheses are presented as given findings and, in turn, are used as direct behaviour rules for these two types of market economy. The main theory behind Hall and Soskice’s assertion is obviously Aokis’s (1994) approach on institutional complementarities. Hall and Soskice’s way of connecting institutional change with complementarities can also be found in other works (Deeg 2007; Person 2004; North 1991) which argue that the existence of “complementarities among institutions inhibits change, i.e. reinforces a given institutional path by generating increasing returns to actors. In this case, complementarities lead to predictions not of specific outcomes, but of institutional stability (until overwhelmed by other forces)” (Deeg 2007, 612). It is argued that VoC provides a framework by which to understand institutional stability and sectoral specialisation of nations even in times of globalisation and global pressure. One might criticise this assertion and argue that nation states are not “hermetically sealed”. As Hancké et al. (2007) illustrate, various

authors (see Crouch and Farrell 2004; Martin 2005; Panitch and Gindin 2005; Pontusson 2005) have criticised this. It is argued that VoC does not acknowledge exogenous pressure and its effect on institutional change. In addition to the expectation of institutional stability, VoC encompasses the idea that "only in times of economic shocks, the foundations of coordinated market economies could be unsettled and therefore CMEs could be deregulated to become more like LMEs" (Hall and Soskice 2001, 63). It is argued that the common knowledge which is required by CMEs cannot easily be adapted by LMEs. CMEs do not face such constraints. This argument leaves us with the expectation of a liberalisation of CMEs in times of global crisis. The question about whether such proposed deregulation goes hand in hand with a change in national trajectories of innovation is left open in VoC.

3.2. Background of Theoretical Framework: Perspectives on the Institutional Framework of CMEs and Innovation

Claiming to define a right to exist to relatively stable and co-existing market economies VoC draws attention to the influence of a complementary institutional framework on proposed mirroring of national trajectories of innovation. The approach draws on propositions which leave us with a set of questions as arising from the paradoxes appearing in economic developments in CMEs, such as Germany. By redefining the relationships between skill formation, LMIs, CG and their influence on sectoral production specialisation as representing trajectories of incremental/radical innovation, an attempt to refute this paradox and draw an alternative theoretical framework for observing developments in the German political economy needs to be undertaken. Placing the political economy of skill formation in

a key position in comparative capitalist debates on varieties of national innovation behaviour is a valuable approach which needs to be further discussed in the context of the propositions rising from VoC. This chapter aims to discuss the propositions underlying VoC in detail, through a comprehensive look at the literature. The structure of this section follows the previously identified propositions on innovation in CMEs:

Proposition 1: General skills lead to radical innovation.
Proposition 2: LM flexibility leads to radical innovation.
Proposition 3: WPRs dominate CMEs and create inequality.
Proposition 4: CME's policy making is strongly influenced by corporations.
Proposition 5: CMEs will move activities to LMEs in order to create radical innovation.
Proposition 6: CME's CG and finance structure will change towards shareholder value.
Proposition 7: CME's institutional foundations are under fundamental renegotiation and will liberalise.

3.2.1. The Political Economy of Skill Formation and Innovation

In their Introduction to *Are Skills the Answer?* Crouch, Finegold and Saki (2004, vii) describe a common belief of economists nowadays that, if standards of living are to advance, countries need to "secure competitive advantage in a global economy by moving into product markets requiring highly skilled and highly productive workforces". This approach can also be found within the VoC framework. Whereas CMEs such as Germany are described as using industrial or firm-specific skills, LMEs are argued to require university-level general education for their radical innovation. In a global world, supporting the division of work, it is not rare to discover policies which aim to fill the potential gaps in highly skilled labour. Thus, where the country’s own market economy does not produce enough of these general skills, policy making looks at supporting industry e.g. in terms of high skill immigration (BMBF 2012b; International Business Times 2015; Kahanec and Zimmermann 2011) or university level education (Band and Länder 2011; 2007).

The previously mentioned proposition on high skills and highly productive workforces as the solution in an attempt to gain comparative advantage has been criticised by different scholars, in terms of employment generation (Keep and Mayhew 2001), and national skills equilibria (Crouch, Finegold and Sako 2004). In the context of competitiveness in *High Skills: Globalization, Competitiveness and Skill Formation*, Brown, Green and Lauder "show that national economies can remain competitive without upgrading the skills of large sections of the workforce" (Brown, Green, and Lauder 2001, 12). Some other scholars have argued that the role of skills as such is often overrated and this deflects attention from a nation's actual measures of performance, such as equality and sustainability (Grugulis and Stoyanova 2011; Grugulis 2003). In *Skills and Skilled Work: An Economic and Social Analysis*, Adam Green (2013) divides evidence which links skills to performance into three spheres. For the purpose of a good overview, these three levels are adopted: firstly, the micro level of studies which examines detailed micro-settings of skill measures (e.g. pay depending on a certain skill); secondly, studies evaluate the effect of work-related training on job performance and intermediary organisational goals (Jones 2012; Jones and Grimshaw 2012). In *The Effects of Policies for Training and Skills on Improving Innovation Capabilities of Firms*, Jones and Grimshaw (2012, 1) describe how the relationship between skills and innovation can be identified in general but that "the mechanisms through which they interact in real-world economy remain somewhat opaque". As argued by Green (2013, 68) "[a]t the aggregate level, employers' performance is gauged by the productivity of the business sector". In accordance with *High Skills*, Green relates this macroeconomic productivity of certain sectors to the development of GDP. In the context of the previously described approach from an *Institutional Foundation of Comparative Advantage*, this dissertation focuses on literature regarding the link

between skill formation and innovation. One focus is on the aggregate level of sectoral innovation as it relates to incremental/radical innovation within the VoC framework, looking specifically at radical innovation in CMEs. The existing literature focuses on skills, skill creation, and economic performance, or on the relationship between skills (in general) and innovation. The sector-specific production of skills as related to the sector-specific product market specialisation of firms has hardly been captured. This might be due to a lack of available secondary data, but also due to dominating economic and sociological approaches which generally focus on the plain differentiation between forms of degrees (emphasising high levels of knowledge as the one superior thing, which can only be achieved by highly developed nations instead of newly industrialising countries), instead of fields of degrees. Studying fields of degrees appears to be essential in understanding sectoral development in nations. The German market economy, for example, is characterised by high levels of well-trained workers who have developed from the apprenticeship system, not just the university system. This system has a high reputation in Germany. Graduates of a three-year dual apprenticeship can hardly be compared to high school graduates from the US or UK. The industry-specific skills of these gradates not only enable them to study at a university but might even earn the students credit points in order to reduce the duration of their study while pursuing an undergraduate degree.

In general literature on the topic of skills and their relation to innovation can be broken down on several levels, which are more or less relevant for this dissertation. The vast majority of the literature focuses on the creation of skills. Different streams describe e.g. the effect of job training and HRM's relevance for innovation in firms (Amara et al. 2008; Baldwin and Johnson 1996; Freel 2005; Lopez-Cabrales, Pérez-Lu, and Cabrera 2009; Shipton et al. 2006). Following a

techno-sociological perspective on institutionalism (e.g. Cluster, Network), the *Triple Helix* approach on innovation (Etzkowitz 2004) received generous attention in the literature. A large amount of empirical work has been conducted on university (graduate and post-graduate) industry collaboration (Behrens and Gray 2001; Link and Scott 2005; Martinelli 2001; Salminen-Karlsson and Wallgren 2008; Shane 2004; Shane and Venkataraman 2000; Wallgren and Dahlgren 2005). Underlying these studies is a proposition on the general skills of university graduates in newly emerging technical fields and how they are highly relevant for existing firms and the foundation of firms.

In search of an answer to the question of whether market economies which are characterised by high degrees of coordination specialise in the creation of firm/industry-specific skills, Jonas Edland and Anne Grönland (2008) compare the levels of firm-specific skills across 21 coordinated countries. In *Protection of Mutual Interests? Employment Protection and Skill Formation in Different Labour Market Regimes*, they only partly support this proposition. Edland and Grönland identify the existence of a variety of types of coordination. They argue for a further differentiation of CMEs and point out different combinations of firm-specific and general skills inherent in each single CME and further required for each specific industry. Contrary to the position indicated by VoC, the authors further point out a high level of on-the-job training in LMEs. In *The Unexpected Appearance of a New German Model*, Werner Eichhorst (2014) describes the German experience of increasing levels of employment after global crisis. Counter inductively, a growing share of this employment is found to be of "low pay and non-standard work" with a growing "reliance on mechanisms of internal flexibility for the skilled core workforce" (Eichhorst 2014, 1).

From a different angle it is not only suggested that the "(...) impact of technology on employment skills is uneven (...) some jobs become deskilled or eliminated, others present the opportunity for re-skilling" (Brown, Green, and Lauder 2001, 17) and, therefore, in general, a relative abundance of general skills, such as those acquired from university or college education, does not necessarily lead national economies towards comparative advantage in terms of radically innovating sector performance. Contrary to Proposition 1 (P1) Keep and Mayhew (2001, 6) illustrate the paradox of low skill jobs dominating the UK (LME) economy, with only a small proportion of "well-developed high-performance work systems" in place (see also Lloyd 1999). In *The Contribution of National Vocational Qualifications, the Growth of Skills in the UK*, Irena Grugulis suggests that the British (LME) system lacks the ability to "encourage knowledge and skills". In terms of competitive advantage Drucker (1999, 88) calls for *technologists* as:

> "the one group in which developed countries can have a true and long-lasting competitive advantage (…). This group includes people who apply knowledge of the highest order" (...) "[t]hey include automobile mechanics and all kinds of repair and installation people." (Grugulis 2003, 457)

He re-emphasises the relevance of productivity but especially of knowledge-worker productivity for leadership in the world economy. IN a similar way to Drucker, in *The Search for Flexibility, Skills and Workplace Innovation in the German Pump Industry*, Finegold and Wagner (1998) stress that the modern metalworking apprenticeship in Germany provides individuals with strong theoretical and applied training to foster innovation. Moreover, *Meisters* have the right set of broad skills needed to act as effective team leaders. Without knowing it, they open up a new perspective on the interrelationship between skills and innovation. General skills can be created through traditional apprenticeship training, and technical skills are highly relevant for the ability of firms to face increasing

competition and innovation. In summary, even though a group of continental CMEs is characterised by the existence of types of traditional apprenticeship training which are broadly associated with firm-/industry specific skills in the VoC framework, modern apprenticeship training can provide workers with general skills. Moreover, within these systems, *Meisters* take on a special role with high-level skills being transferrable across industries through their leadership abilities. Empirical work suggests that the dichotomist view on general vs. specific skills for innovation is not sufficient. The role of technicians and experts within their respective fields is crucial for innovation in general. CMEs don't necessarily specialise in traditional apprenticeship training (country cases). Apprenticeship training doesn't necessarily lead to firm/industry-specific skills (*Meister*). Specific Skills (technicians) might be necessary for the creation of radical innovation.

3.2.2. Labour Market Flexibility and Innovation

Interrelated with the VoC proposition on skill formation, the approach assumes a relationship between labour market flexibility and a firm's ability to create radical innovation. P2 states: Labour market *flexibility leads to radical innovation* and this phenomenon was identified in the previous review of the VoC approach.

In an attempt to analyse labour market developments, both socio- and politico-economic institutionalism usually focus on analyses of the effects of social policy and industrial relations (Busemeyer and Iversen 2012; Crouch and Streeck 1997; Eichhorst, Grienberger-Zingerle and Konle-Seidl 2010; Esping-Anderson 1996a; West and Nikolai 2013). In many cases, the literature argued for the existence of a relationship between labour market rigidity and high unemployment (Mankiw and Romer 1991; Nickell 1997; Regini 2000; Siebert 1997). In *Unemployment and Labour Market Rigidities: Europe versus North America*, Stephen Nickell

differentiates measures of labour market rigidity and social policy. His findings suggest that certain spheres support unemployment whereas others don't. Unemployment is supported by "1) generous unemployment benefits that are allowed to run on indefinitely (...)"; 2) "high unionization with wages bargained collectively and no coordination between either unions or employers in wage bargaining (...)"; 3) "high overall taxes impinging on labor (...)" and 4) "poor educational standards (...)."(Nickell 1997, 73)

Opposed to this are: 1) "strict employment protection legislation and general legislation on the LM (...)"; 2) "generous levels of unemployment benefits, so long as these are accompanied by pressure on the unemployed to take jobs (...)" and 3) "high levels of unionization and union coverage, so long as they are offset by high levels of coordination in wage bargaining particularly in employers." (Nickell 1997, 73).

As illustrated by Western and Beckett (1999) in *How unregulated is the US Labor Market?"* factors other than labour market flexibility had an impact on employment numbers in the USA as well. The expansion of the US penal system influences the employment measures. Thus, for employment performance measures in the 1980s and 1990s, the US depended in part on a high and increasing incarceration rate. One more finding of Nickell is that LMIs "that conventionally come under the heading of rigidities have no observable impact on unemployment". Nickell further suggests a differentiation between coordinated labour markets. He describes finding continental European countries with flexible LMs and high unemployment rates, those with flexible LMs and low unemployment rates but also continental European countries with rigid labour markets and high unemployment (e.g. Netherlands) or low unemployment (e.g. Germany). A more differentiated

picture is being drawn. He concludes that "the broad-brush analysis that says that European unemployment is high because European labor markets are ‘rigid’ is too vague and probably misleading" (Nickell 1997, 73). Hall and Soskice (2001, 41–42) aim to illustrate the mirroring trajectories of innovation between the USA (arguably flexible LM) and Germany (arguably rigid LM), but, as previously illustrated, most empirical studies do not concentrate on the LMs influence on radical/incremental innovation, but on factors such as employment creation or overall performance. In the *OECD Jobs Study 1994*, John-Claude Paye suggests a liberalisation of labour markets to increase national productivity and innovation. Contrary to this suggestion, Zhou et al. (2011, 21) "warn against the unconditional plea by mainstream economists for the deregulation of labor markets". In *Flexible labor and innovation performance: Evidence from longitudinal firm-level data*, Zhou, Dekker and Kleinknecht use the European *Community Innovation Survey* (*CIS*) to illustrate the effect of temporary contracts on firms’ innovation behaviour. They find that "the ‘rigidity’ of insider-outsider labor markets also has advantages, as it allows for ‘functional’ flexibility. The often criticized protection of ‘insiders’ can be interpreted as an investment in the loyalty and commitment of workers" (Zhou, Dekker and Kleinknecht 2011, 72). The authors continue their argument by concluding that functional flexibility of internal labour markets may have advantages for organisational learning and the historical memory of firms. In this context, they illustrate how market leaders seem to have a need for continuity in learning and in preventing knowledge from leaking to competitors.

CMEs are characterised by diverse labour market arrangements. CMEs which are characterised by rigid LMs are found to create diverse innovation. Radically innovative firms might profit from long-term contracts with employers (developing a knowledge base).

3.2.3. Social Policy Making, WPRs and Innovation

The proposition raised by the VoC approach on the economic and social policy making of CMEs being strongly influenced by a nation's firms in order to reinforce national skill equilibria and rigid LMIs is another element in the ongoing discussion. As previously illustrated, VoC theory points to two propositions (P3: WPRs dominate CMEs and create inequality; P4: CME's policy making is strongly influenced by corporations) relating to social policies and the welfare state, which are interrelated with labour market arrangements and skill formation.

In her analysis of *The Paradox of Liberalization – Understanding Dualism and the Recovery of the German Political Economy*, Anke Hassel (2012, 57) questions this simplification and suggests that certain social policy changes are "driven by producer coalitions of export-oriented firms and core workers` representatives, rather than by firms per se". Busemeyer and Trampusch (2011) argue that, in the case of Germany, the country's VET system, which is an alternative to academic education, cannot be understood as being a result of firms' preferences, but must be understood in the historical Christian context of the country. As argued by Van Kersbergen (1995), it has arisen from rather a Christian approach to education and social equality and may, therefore, have been of ongoing relevance in election campaigns over the past decades in German political regimes. Several studies suggest adding a new perspective to this discussion by viewing large firms'/ MNCs' influence over government policy making in the face of financial globalisation (Becht and Röell 1999). Private governance mechanisms are argued to have an influence on policy making (Goyer et al. 2014). The role of MNCs (Filatotchev and Wright 2010; Witcher and Chau 2012) in shaping national LMIs, e.g. in terms of social dumping, is apparent. MNCs are described as having gained the ability to "regime shop by choosing where to locate their production" (Goyer et

al. 2014, 474) depending on labour market policies and other preferences. They are shaping globalised labour governance in terms of influencing the skill formation preferences of governments (e.g. towards a knowledge society in Western nations), but also social policy making (e.g. reduction of employment protection, emergence of alternative forms of employment in Germany – *Zeitarbeit*). The interlocking theme fields of skill formation, capitalist variety, and welfare regimes led to the sixth proposition identified through the VoC approach. The belief that coordination is a driver of inequality appears to be almost a paradox in the face of striking inequality and high unemployment in LMEs (Esping-Anderson 1996b). Thelen (2014) further differentiates CMEs indicating that egalitarian capitalism and social solidarity are not necessarily bound to coordination but can also occur in liberal market economies. She argues for changes within the LME and CME frameworks, illustrating a variety of new politics of social solidarity measures. Contrary to the proposition arising from VoC, welfare systems are, in general, associated with greater equality. Social policymaking in CMEs appears to be made by democratic processes, including unions and employee representatives.

3.2.4. Coordination and Innovation

Several studies have discussed the ability of CMEs to produce radical innovation (Bartholomew 1997; Casper, Lehrer and Soskice 1999; Hancke 2009; Heinrich 2012). In *Can High-technology Industries Prosper in Germany? Institutional Frameworks and the Evolution of the German Software and Biotechnology Industries, S*teven Casper, Mark Lehrer and David Soskice (1999) make a comparison of sectoral specialisation in German and US firms. Their argument is for the German "social and economic institutional patterns [to] encourage incremental innovation" (Casper et al. 1999, 22). Their argument is not that the coordinated

market economy is unable to produce radical innovation, but relates to the difficulties it has in specialising its production in incremental innovation even within radically innovative sectors. In *Varieties of Capitalism Revisited: Globalization and Comparative Institutional Advantage*, Bob Hancke (1999, 2) illustrates exactly the same picture of institutional complementary leading to dichotomist specialisation between Germany and the US. Hancke sharpens the illustration by arguing that "[t]he German innovation system, as it can be read in these data, is almost a mirror image of the American. Patents in incremental innovation dominate, while radical innovation is rather weak" (Hancke 1999, 2). The one, identical chart which is used in Casper, Lehrer, Soskice`s (1999), Hancke`s (1999) studies, and later becomes the key source of Hall and Soskice's (2001, 41–42) argument, is illustrated in *Chart 4: EPO Patent Distribution for Germany and the US*.

The simplistic picture which arises from VoC has been criticised extensively. In *Empirical Evidence Against Varieties of Capitalism's Theory of Technological Innovation*, Mark Taylor (2004, 601), suggests that VoC's "predictions are not supported by the empirical data" and that the evidence offered by VOC proponents "depends heavily on the inclusion of a major outlier, the United States, in the class of liberal-market economies". This critique is supported in *Mapping the Institutional Capital of High-Tech Firms: A fuzzy-set analysis of capitalist variety and export performance*, by Martin Schneider, Conrad Schulze-Bentrop and Mihai Paunescu (2010) whose fuzzy set analysis shows that a "high share of university graduates and a large stock market are complementary institutions leading to strong export performance in high-tech" whereas employment protection, which is another institutional domain of the VoC argument "is neither conducive nor harmful to export performance in high-tech". The authors also analysed mergers and acquisitions, and do not suggest that a high volume of those "as a form of

institutional arbitrage leading to knowledge flows, acts as a functional equivalent to institutions that support knowledge production in the home economy" (Schneider et al. 2010, 41). In *Do 'liberal market economies' really innovate more radically than 'coordinated market economies'?* Dirk Akkermans, Carolina Castaldi and Bart Los (2009, 181) "refine Taylor's analysis, using a broader set of radicalism indicators and making industry-level comparisons". They find some statistical confirmation of the position based on VoC, but only in terms of certain measures of radicalism within certain sectors. None of this literature comments on polito-economic institutional theory and how its findings might relate to theory and which implications this might have on theory. Moreover, their approaches in studying VoC are not based on qualitative analyses which could lead them towards these implications. In *Developing Innovative Competences: The Role of Institutional Frameworks*, Whitley (2002, 500) mentions, that "the variety of (…) innovation strategies within each kind of market economy is sometimes greater than the contrast between CME and LME would suggest". The role of complementary national innovation systems for production choices in MNCs has merely been neglected in the literature. Within this field, research has been conducted on the influence of MNCs e.g. on national LMIs but also policy making (Goyer, Reinecke and Donaghey 2014). MNCs arguably have the ability to "regime shop". They can choose a production site which best fits their needs e.g. in terms of cheap or flexible labour. In practice, representatives of energy intense MNCs such as BASF but also German automobile manufacturers represented through VDA do increasingly declare their willingness to shift production sites to market economies which offer cheaper natural resources and electricity (Diemer 2015; Niedermark 2015). Little research has been conducted on the proposed tendency of large corporations to shift production sites to LMEs in order to use their institutional systems and create radical innovation. Whilst this is a neglected field in

research, such tendencies are obvious within the economy. Especially high-performing technology clusters like Silicon Valley seem to attract diverse ranges of firms. In this context, firms such as Siemens (2015), SAP (2015), but also publishing companies like Axel Springer SE (2015), and automobile manufacturers like BMW (2015) have shifted labs to the US. In an argument pointing to the global division of work of MNCs according to national polito-economic institutional frameworks, the behaviour of the German automobile industry supporting a Transatlantic Trade and Investment Partnership (TTIP) is of relevance as well. The question is whether or not the industry's future projects (networked driving and electro mobility), which rely on software and high-technology, might push their engagement. A division of work between US software giants and German manufacturers does appear especially likely due to VDA's inability to answer any question on software patent or development within a potential and desired TTIP (Smethurst 2015). It may be that manufacturers believe they just don't need to take care of this element of development. This is in contrast to the German software sector's position on this topic (Digitaleurope, ITIC, and BITKOM 2015).

The literature suggests that the analysis arising from VoC is insufficient. CMEs inhibit the ability to produce radical innovation. Previous research fails to illustrate the potential attempts of MNCs to set production sites or labs in an LME in order to foster radical innovation.

3.2.5. Corporate Governance and Innovation

In the previous overview on the approach arising from VoC on National Trajectories of Innovation, a proposition on coordinated market economies' corporate governance structure (stakeholder) and its predicted direction of change due to financial globalisation has been identified. P6: CMEs' Corporate Governance structure will

change towards shareholder value. Following Albert's (1992) dichotomising argument in *Kapitalismus contra Kapitalismus*, comparing capitalist nations, two ways to successfully organise Western societies were described. The distinction between an Anglo-Saxon and a Rhenish model of capitalism was followed in a description of the dichotomising CG systems. The same dichotomy can now be found underlying the VoC perspective.

For the purpose of a clearer structure, this section discusses the literature on corporate governance and later links it to innovation. Section 3.2.6. is then structured around the topic of different types of globalisation and their effect on national institutions, e.g. liberalisation of CG; it's implicit effect on innovation behaviour and patterns of production.

The two ideal types of CG identified in the literature are the system of concentrated ownership, which is "characterized by controlling block holders, weak securities markets, high private benefits, of control, and low disclosure and market transparency standards, with only a modest role played by the market of corporate control, but with a possible substitutionary monitoring role played by large banks (...)" (Coffee 2000, 2 as cited in Herrigel 2010, 471) and the dispersed ownership system which is characterised "by strong securities markets, rigor disclosure standards, and high market transparency, in which the market for corporate control constitutes the ultimate disciplinary mechanism" (Coffee 2000, 2 as cited in Herrigel 2010, 471). Several approaches to the study of comparative CG can influence a researcher’s perception and position. Depending on one's point of view, corporate governance is conceptualised in different ways. In *Corporate governance and national institutions: A review and emerging research agenda*, Filatotchev, Jackson and Nakajima (2013, 965) argue that the principal-agency framework is the dominant approach in CG research. The shareholder perspective inherent in this approach

allows researchers to understand the behaviour of corporate investors, who aim to seek maximum returns on their investment. This perspective helps us to understand incentive schemes for top managers, which are designed to align shareholders' interests with those of the top management of the corporation, through bonus payments. Transaction problems are central to agency theory, raising questions such as: How can shareholders in a managerial-controlled firm minimise their agency cost? (Aguilera and Jackson 2010; Eisenhardt 1989; Filatotchev and Wright 2010). Such incentives aim to secure an intended monitoring effect of shareholders over top managers. This approach mainly focuses on the relationship between shareholders and managers. It remains insensitive to other stakeholders. In contrast, stakeholder theory acknowledges the existence of national differences in terms of a firm's shareholder or stakeholder orientation. In countries with stakeholder-oriented corporate governance, the focus is mainly on the impact of governance on labour management, but also suppliers (Jackson 2005; Neubaum 2006; Schmidt 2006; Vitols 2005) and in terms of corporate social responsibility for the wider economy (Aguilera et al. 2006; Jamali, Safieddine and Rabbath 2008; Johnson and Greening 1999). The team production model acknowledges the relevance of stakeholders. These stakeholders arguably invest in the firm as member of a cooperative team to produce new wealth. They do let a board of directors coordinate their investments to resolve coordination problems. This perspective changes the roles between shareholders, managers and stakeholders (Blair and Stout 1998; Ho 2014; Kaufman and Englunder 2005). In *A Team Production Theory of Corporate Law*, Blair and Stout argue that:

> "the essential economic function of the public corporation is not to address principal-agent problems, but to provide a vehicle through which shareholders, creditors, executives, rank-and-file employees, and other potential corporate "stakeholders" who may invest firm-specific resources

> can, for their own benefit, jointly relinquish control over those resources to a board of directors." Blair and Stout (1999, 248)

Contrary to these previously described society/interest group centred approaches, the perspective on institutional approaches for the study of comparative corporate governance suggests that the institutional frameworks of a nation complement each other and do thereby determine specific product market choices for firms, inherent to the market economy (Hall and Soskice 2004; Hall and Soskice 2001; Hancke and Goyer 2005; Höpner 2005). Both streams of research not only look at corporations and economic developments from a different angle but complement each other. This is described in *Globalization and Labour Market Governance*, in which Goyer, Reinecke and Donaghey (2014, 475) argue that "Institutional frameworks do preclude certain trajectories of change but do not specify how actors operate within an institutional framework".

In this dissertation, I follow Goyer et al.'s (2014) argument and define complementary national institutional frameworks to be the given playing field within which different interest groups play ongoing matches according to their own different perceptions. These perceptions, such as those of a shareholder, might be influenced by their national institutions in turn, as well as mechanisms of *group think*. The free will of an actor, allows him/her to shift from one perception to another – under the assumption of a *consistent personality*. Aiming to explain the origins of cross-national divergence in CG structures, Herrigel (2010, 488) finds that "the key problem of such an attempt lies in the finding that most national cases which are analyses in comparative capitalism do not fall into systems of dispersed/outsider and concentrated/insider systems". He describes why approaches to CG have issues with heterogeneity within national CG systems and ascribes it to their underlying belief in the Chandaliarian model of corporate development.

It is not the aim of this dissertation to discuss the development of CG theory in more detail. A focus is given on literature relating to the linkage between CG and innovation. In this context, the previously described model on team production is further advanced by Huse and Gabrielsson (2012, 233) in *Board Leadership and Value Creation: An Extended Team Production Approach*. The authors propose an advancement of the team production approach which assumes "that the firm is a separate and independent moral entity, and that the main task of a board is to create long-term values and sustainable competitive advantage in the firm". They combine traditional views with Aoki's (1984 as cited in Huse and Gabrielsson, 2012) notion of "cooperative game theory, and a behavioral theory of the firm (Cybert and March 1963)". In this approach, the board of directors and its cohesiveness plays a crucial role in mediating between "a firm's value-adding stakeholders to access relevant competence and strategic knowledge" (Huse and Gabrielsson 2012, 234). In this context, the board of directors is not viewed as instance mechanism for control (as in agency theory) but as a value creating mechanism which needs to cooperate in order to develop "critical and questioning attitude in the boardroom (...) A key issue is that the board members in their decision-making have the integrity to be independent and are allowed to ask challenging and discerning questions" (Huse and Gabrielsson 2012, 241) of the CEO.

When it comes to innovation, this approach argues that the task of a central board is strategic participation and collaboration in creating innovation. The strategic product market choice and development of (future) markets requires specific competencies within the core work force. The development of these competencies and skills needs to be led by the board of directors. Several empirical studies have looked at the relationship between corporate governance and innovation, from different perspectives. In *The Role of Finance and Corporate Governance in*

National Systems of Innovation, Andrew Tylecote (2007) emphasises the importance of CG as the framework through which a firm acquires and re-locates finance and this leads the decisions about R&D investments and potential new product market strategies. He illustrates how differently sized firms (e.g. start-ups in emerging technology sectors) require different sets of finance (see Tylecote and Ramirez, 2006). Even though he interconnects CG and finance he does, also, differentiate between sectoral behaviour and illustrates "how such differences could help explain the sectoral pattern of performance and specialization of national economies". He further finds that sectors "differ in technological regime: the knowledge environment in which firms operate" (Tylecote 2007, 1476).

In *Corporate Governance and the Innovation System in France*, Goyer (2001) argues from the perspective of polito-economic institutionalism for a relationship between complementary CG structures to relate to certain trajectories of innovation. Goyer follows Mayer's (1996) argument on a dichotomist CG structure, which "shapes the ability of firms to make credible commitments to its employees and suppliers – which, in turn, is a critical element for incremental innovation" (Goyer 2001, 137). In accordance with this argument, in *Ownership Structure and R&D Investments*, Lee and O'Neill (2003) illustrate how ownership structure might determine a firm's investment strategy. The relationship between ownership structure and technological innovation performance is analysed in Choi, Park and Hong (2012). In the case of Korean firms, the authors cannot find a relationship between concentrated ownership and technological innovation performance. In this context, Choi et al.'s (2012) approach, focusing on an entire nation (instead of being sector specific) and quantitative analysis may have led to these findings. A qualitative approach on the influence of concentrated (foreign) ownership and its influence on different kinds and processes of technological innovation within each sector might

have indicated different findings. Their study suggests "that it would be interesting for future research to examine what interests large shareholders might peruse other than technological innovation in emerging economies" (Choi, Park and Hong 2012, 280). In the context of the expectations arising from VoC on globalisation in general and financial globalisation specifically, one more proposition has been identified, namely P7: CMEs' institutional foundations are under fundamental renegotiation and will liberalise.

A wide range of CG structures within CMEs and LMEs exists even though there are accepted institutional differences between LMEs and CMEs. CMEs shift towards institutional spheres associated with liberal market economies at different speeds. Fifteen years after the publication of VoC, CMEs are still characterised by high degrees of coordination. In the face of the global financial crisis, attempts to coordinate the financial spheres of LMEs have been made. Attempts to enhance welfare and social policy have been made, for example in the US.

This chapter establishes the theoretical framework for the study of national trajectories of innovation from an institutional perspective. Definitions of institutions and institutional change are given, and the theoretical propositions inherent in existing approaches in theory are identified. This chapter is a preparation for the empirical chapters. It enables the later analysis and discussion leading to an enhanced theoretical framework for understanding how Germany as a CME enables innovative capabilities.

4. CHAPTER FOUR: METHODOLOGY

"The methods we use should reflect the causal complexity assumed by our theories."

(Haverland and Blatter 2012, 6)

Institutional theory in comparative capitalism requires the use of deep historical knowledge. The main research design in this field is the comparative historical perspective since it involves a large degree of explanatory variables and enables one to understand the full complexity of all visible relationships. This dissertation asks HOW the institutional foundations of Germany interact in order to create radical trajectories of innovation. This overarching question includes several propositions of pre-existing theory (e.g. in terms of case choice or the relationship between institutions and economic performance). This chapter introduces the reader to the research questions deriving from existing theory. It illustrates the propositions underlying existing theory.

This chapter is organised in the following way: Section 4.1. presents the Research Strategy and Epistemology. Section 4.2. discusses the Case Selection Strategy of Germany. Section 4.3. discusses the Propositions and Questions again. It describes the three analytical chapters. Section 4.4. describes the methods and Section 4.5. look at the Data. Section 4.6. reflects on the issues of Validity, Reliability, and Generalisability.

The relationship between national institutions and economic development has been of high importance in the field of comparative capitalism. Within this field, the VoC approach, in particular, assumes linear relationships between coordinated institutional frameworks and incremental trajectories of innovation. In this approach, Germany is described as a crucial case as a major example of a CME. The assumed

specialisation of the nation's firms in incremental trajectories of innovation is scrutinised in this thesis. This dissertation sheds light on how the institutional foundations of Germany support the creation of radical innovation, by discussing the meaning and aiming to fully understand what is meant by "specialisation", "radical innovation" and "institutional framework" in areas such as "social policy – WPRs". By understanding how the influential approach to VoC has attempted to analyse the ability of Western nations to prosper in emerging markets, and having focused on a variety of propositions regarding the identified institutional framework, it is obvious that within this field only a case specific, in-depth analysis makes sense to shed light on the questions being asked. The strong performance of German firms in so-called radical sectors appears to be paradoxical in terms of the expectations arising from the approach. Deriving from the analyses and their theoretical implications, the thesis aims to enhance the VoC approach. The research questions being asked are:

Research Question I:

In what ways have the institutional foundations underlying the German NIS changed since reunification?

Research Question II:

How do government policies and regulation affect the institutional foundations of the German NIS?

Research Question III:

How does German capitalism perform in terms of firm capability to produce radical innovation from a comparative perspective?

Research Question IV:

In what ways has the skill formation system of Germany oppressed or fostered radical trajectories of innovation in the country during the past three decades?

4.1. Epistemology and Research Strategy

This study conducts a comparison of descriptive and explanatory merits deriving from previously illustrated theory. Throughout the previous two chapters, the theoretical background and the key literature have been discussed extensively. The propositions underlying the theory have been identified, and the Research Questions have been developed: in order to answer the Research Questions, the deductive-nomological model of explanation underlying the VoC approach to comparative capitalism is divided according to its explanatory merits (the identified propositions) and the phenomenon of *explanandum* identified by VoC.

The critical case study design of this thesis aims to use the crucial case of the coordinated market economy of Germany's biotech and software sectors in order to test empirically how far the phenomenon of weak high-tech performance and strong specialisation in incrementally innovating sectors can be confirmed. This research design is not chosen in order to test the existing theory, but in order to further develop and enhance the findings of this in-depth analysis.

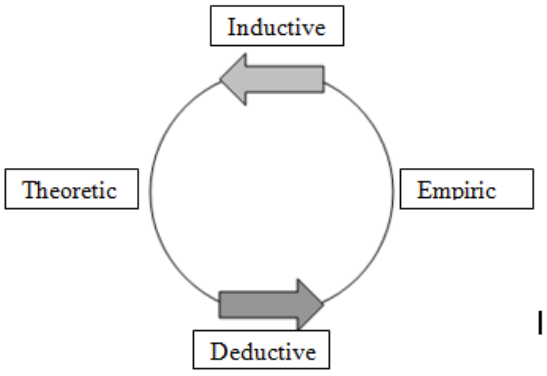


Figure 4: Research Strategy

Source: Own illustration

Yin (1981) and Jick (1979) recommend the use of a case study research design for explanatory purposes. As Linda Kohn (1997, 3) puts it in *Methods in Case*

Study Analysis: "(...) the [case study] methodology may actually be more powerful for explanatory purposes in its ability to answer questions on how and why". In *Qualitative Data as an Attractive Nuisance: The Problem of Analysis*, Matthew Miles (1979, 597) summarises some of the main critiques of qualitative studies and, in particular, case study research. He "(...) found that the actual process of analysis during case-writing was essentially intuitive, primitive, and unmanageable in any rational sense". Miles addresses the issues of a possible overload of data, an inapplicability of the quantitative notion of reliability, an essentially intuitive interpretation of the findings and, therefore, low validity, and, despite the existence of vague rules of thumb, the lack of clear rules and guidelines.

In *The Case Study Crisis: Some Answers*, Robert Yin (1981) discusses Miles' critiques by differentiating between data use, data collection methods, and research strategy. He disproves the interconnection between qualitative research and a case study research design. In this study, I have started off with a discussion of existing theories and identified their ability to explain or predict the observable trajectories of innovation in Germany. I am following George and Bennetts's (2005) method – a congruence (CON) analysis approach.

> "The typical goal of the congruence analysis approach to case studies is contribute to the theoretical debate in a discipline or field of research. [CON case studies] are used to elucidate and to compare the explanatory merits of competing or complementary theories" (Haverland and Blatter 2012, 10).

In this context, a critical case study is conducted. The term critical case study is used in terms of a case which enables one to demonstrate that even under the "most likely circumstances for the causality or argument to hold, it does not" (Hancke 2009, 68) and that thus the original theory must have deeply problematic elements. It is important to understand that the purpose of this study is to develop theory not to test it (Eisenhardt and Graebner 2007). In an attempt to further develop

theory in the field of comparative capitalism, congruence analysis appears to be particularly worthy due to its ability to give different meanings to concepts depending the way they are theoretically embedded. For example, Germany's specialisation in the engineering fields points to path dependency within historical institutionalism, but also illustrates domestic pressures in politics. As Sager, Thomann, Zollinger and Mavrot (2014) point out:

> "(…) one should rely not only on single observations, but on clusters of observations to obtain a picture which is meaningful in the light of the theoretical framework. This picture is then contrasted with the meanings to reduce the risk of a 'confirmation bias' (Blatter and Haverland 2012: 174)." (Sager et al. 2014, 463–464)

In, qualitative research in political science, Blatter, Haverland, and van Hulst (2016) go beyond a simple description of the of existing diversity in case study research; they aim to provide an orientation by creating their own system of classification. They point out that one of the main advantages of CON research in case studies is that it can serve as a bridge between theoretical paradigms. "In a congruence analysis, a broad set of empirical observations is compared to different sets of expectations that are derived from distinct comprehensive theories" (Blatter, Haverland and van Hulst 2016, 5). The authors further describe how also, in epistemological terms, CON takes an in between position. "The term 'congruence' points to the weight that is given to the correspondence between abstract theory and concrete observations; but both abstract concepts and concrete information are also judged according to how coherent they are in respect to other concepts and other pieces of information" (Blatter, Haverland and van Hulst 2016, 6).

Due to the small number of cases used in this study, the discussion about the reasonability of its determinist vs. probabilistic thinking needs to be discussed. Theda Skocpol (1984, 378) explains that "comparative historical analyses proceed through

logical juxtapositions of aspects of small numbers of cases. They attempt to identify invariant causal configurations that necessarily (rather than probably) combine to account for outcomes of interest.” In *Small N's and big Conclusions: An Examination of the Reasoning in Comparative Studies Based on a Small Number of Cases*, Stanley Lieberson (1991), argues that Mills’s methods for small N studies cannot be used with all macro societal data sets.

> "The methods require very strong assumptions: a deterministic set of forces, the existence of only one cause, the absence of interaction effects, confidence that all possible causes are measured, the absence of measurement errors, and the assumption that the same clean pattern would occur if data obtained for all relevant cases." (Lieberson 1991, 315–316)

In context of the VoC approach, these discussions of small N studies are of great interest. Not only does the determinist approach assume only one cause (liberalisation), the absence of interaction effects (only a further specialisation of a nation in its own way or a liberalisation of CMEs) but it is confident about its measurement, which can (and in this thesis is) easily shown to be misleading.

In a later discussion Liberson argues that:

> "The methods of agreement and difference are outdated and inappropriate procedures for comparative or historical analysis based on a small number of cases. The methods cannot employ a probabilistic perspective, deal with data errors, use multivariate analyses, or take into account interaction effects. All of these are critical features in contemporary ways of thinking about social processes." (Lieberson 1994, 1225)

Following Liberson, this thesis argues that "a probabilistic epistemology is the only realistic approach to social processes – since it enables us to deal with measurement errors, multiple causes, incomplete information, and factors (…)" (Lieberson 1994, 1236).

This thesis does not aim to construct a determinist image of relationships between institutional foundations in CMEs that necessarily lead to radical trajectories of innovation. Furthermore, the previously established image of a determinist

relationship is criticised and, through in-depth analyses and long term relationships, the thesis aims to increase the understanding of complex relationships in the political economy of Germany, that are influencing the performance of so called radically innovative sectors within the institutional and political context of the market economy. The plain differentiation between radically and incrementally innovative sectors as chosen by key approaches in the VOC context is criticised later on in this thesis.

In *Comparative-Historical Methodology*, James Mahoney (2004) illustrates some more recent approaches to the methods used in the qualitative methodology of comparative-historical studies. As stated by Mahoney and argued for in the design of this thesis, it is "to recognize that quantitative analysis is not the only or necessarily the best way to generate valid causal and descriptive inferences; in fact, for many research questions, one can and will do better with comparative historical methods" (Mahoney 2004, 97).

Due to the relevance of VoC, it is of great importance to illustrate that the linear relationship, which would create complementary institutional frameworks in nations, leading to complementary economic advantage, does not exist in this simplified way. The hope of complementing economic advantages, even within economically successful, well-developed and highly-advanced Western nations is an utopian illusion. This thesis uses the same kind of analysis, data and methods in a first attempt to illustrate the findings of Hall and Soskice (2001), Hancke (1999) and Casper et al. (1999); demonstrating how they came to their conclusions and why their conclusions are not sufficient for describing economic variety across nations. Beyond this, this thesis follows more recent discussions of the VOC approach. Acknowledging the perspective of Casper et al. (1999) (e.g. in differentiating between more and less radical innovation within one sector case), but by further

acknowledging that a variety of paths of adjustment are possible within a single institutional framework (e.g. government policy), the corporate choices of MNCs and institutional change might be two of the factors influencing corporate product market choice and performance within one sector (Hancke and Goyer, 2005; Wood, Dibben and Ogden 2014). This thesis enhances the original view of the VoC approach by adding other data sources and methods.

4.2. Case Selection Strategy

The German biotech and software sectors are chosen as crucial cases. Germany, as the context for the two sectors, has widely been described as a paradigmatic case of a coordinated market economy within the VoC approach, but also National Innovation System (NIS), and Business System (BS) approaches (Akkermans, Castaldi and Los 2009; Thelen 2009; Trampusch and Eichenberger 2012). Chapter eight illustrates this context in further detail. While Hall and Soskice (2001), Hancke (1999) and Casper et al. (1999) chose a direct comparison between sectoral developments within the two national contexts of Germany and the USA, other approaches in comparative capitalism view Germany in the context of a wider range of nations and aim to establish their own typologies depending on the nation`s institutional frameworks (e.g. Business Systems).

The simple differentiation between "radical" and "incremental" sectors has not only been criticised by Hancke (2009) and Taylor (2004) but even earlier by Casper, Lehrer and Soskice (1999) who describe that, even within one sector, there are different kinds of technologies existing which can again be differentiated into the two spheres. Thus even though the sectoral cases have generally been correctly identified by theory as being radical/incremental sectors, within one sector there may

still be different niches of production in which one economy could specialise, depending on its institutional framework (see Casper, Lehrer and Soskice, 1999). Casper, Lehrer and Soskice (1999) argue, for example, that "[b]oth the platform-technology segment of biotechnology and the services segment of software fit the inherited institutional framework of Germany better than many other segments of high-tech" (Casper, Lehrer and Hall 1999, 22). In addition to the argument of Casper et al. (1999) this thesis takes on a discussion about the creation of radical innovation within the typical case of the German automobile industry, a so-called typical old and incrementally innovating sector. While it is not a key focus of this thesis to differentiate technology classes in order to further measure innovativeness, a discussion about the approach of German corporations in creating radical innovation within crucial radical vs. incremental sectors is conducted.

Thus, the context of Germany for the two sector cases of biotech and software is chosen for theoretical reasons following the inductive typical case selection strategy (see Gerring 2007; Seawright and Gerring 2008) for the overall focus and analyses.

It appears highly relevant to the further discussion if and how the institutional foundations of Germany have changed over time. The comparison of observations with expected changes described in different theories is of great interest. Due to reunification, the chosen timeframe can only include the past 25 years. Before reunification, the western side of Germany could not easily be compared to the US in terms of data. In terms of the institutional foundations, five spheres were identified by Hall and Soskice. As described in the theoretical framework and further illustrated in Section 4.3. the propositions underlying the relationship between each of these spheres and the ability of national firms to produce "radical innovation" is questioned. As suggested by theory, VoC is neglecting the role of government policy

in institutional change and the NIS. The intervening sphere of government policy is added to the discussion in RQII. After discussing whether the German institutional framework is of a coordinated nature and how this has changed, the third research question is asked in order to discuss the comparative performance of German firms in radically innovative sectors. In the last step, the interrelationship between institutions in Germany, institutional change and the performance of German firms in so-called radical innovation are discussed. Derived from theory and in the analysis in this thesis, the sphere of skill formation is put into focus.

The biotechnology and software sector are typical cases of radical innovation. Case studies of these two so-called radically innovative sectors and their development over time in the context of a typical CME are of high interest.

Discussing the process of creating radical innovation within a so-called typical incrementally-innovating sector is of high relevance for theoretical implications as well, due to the in-depth view and further differentiation between different kinds of innovation.

Crucial cases are cases "which are ‘most-likely’ to show high levels of congruence with the expectations deduced from the dominant theory in the scientific discourse and ‘least-likely’ to conform to alternative theories" (Haverland and Blatter 2012, 11). It appears to be instructive to analyse the performance of radically innovative sectors, as crucial cases within the German context – a country which is characterised and described as having a highly successful economy but, due to VoC theory, is expected to fail in the production of high-tech innovation, the kind of innovation which might determine the economic success of this country in the future. It is important to determine the direction of change of the German political economy in terms of skill formation, LMIs, CG and (financial) globalisation's influence on these. Analysis suggests that these input factors may either liberalise or stabilise and

prevent the country from becoming a radical innovator. VoC is a powerful theory illustrating the ability of CMEs to create radical innovation. As a paradox to this theory, a slow, adaptive institutional change leading to a continuously coordinated outlook of the market economy with a past and present strong appearance of radical innovation behaviour is found. The main objective of this thesis is the further development of theory on institutional change in CMEs, and, foremost, an analysis of the impact on the nations' trajectories of innovation, by bringing aspects of other innovation-related aspects (e.g. policy influence) into the picture. It is particularly important to develop VoC theory due to its implications for national policy making in terms of labour markets and skill formation systems, but also corporate governance VoC theory would not be as powerful and influential without bringing together theory on institutional complementarities with the overall goal of comparative economic advantage in the form of innovation.

4.3. Variables and Propositions

The theoretical approach to VoC can be broken down into a number of propositions. The overarching propositions frame the relationship between coordination and innovation. In this context, innovation (i) can be identified as the dependent variable (DV). The institutional framework (if) of a nation is the independent variable (IV). VoC divides innovation into radical (R) and incremental (I) innovation. Simultaneously VoC views institutional frameworks dichotomously as coordinated (C) or liberal (L).

The primary proposition is as follows:

$$Cif \rightarrow Ii$$

$$Lif \rightarrow Ri$$

In an attempt to understand the theory, the literature review on VoC has identified intervening institutional variables which are used to explain coordination. The four main variables are skill creation (sc), labour market regulation (lmr), corporate governance structure (cg), and preferred financial institutions (fi). VoC does again draw a dichotomist picture of coordinated nations being characterised by firm and industry (FI) specific skill creation, rigour (R) labor markets and stakeholder oriented (ST) CG which primarily uses bank (B) finances. LMEs are characterised by general (G) skills, flexible (F) LMs and shareholder-oriented (SH) CG which primarily uses the stock markets (SM) for finances.

$$Cif\ [FIsc\ + Rlmr\ + STcg\ + Bfi]\ \rightarrow Ii$$

$$Lif\ [Gsc\ + Flmr\ + SHcg\ + SMfi]\ \rightarrow Ri$$

It is important to note the proposition, arising from VoC, that WPRs (wpr) dominate CMEs. This proposition is an explanatory variable in VoC's change theory, arguing for corporations to control social policy making and, therefore, create Rlmr and inequality (IQ). They, therefore, have an interest in keeping the institutional outlook stable, since they aim to continue production in their chosen product market strategy, which is characterised by incremental innovation but brings the firms a comparative economic advantage in world competition. Contrary to this, LMR are identified as being dominated by the free market (fm) and therefore inhibit equality (E). They are stable by definition, due to the invisible mechanisms of the self-regulating free market.

$$Cif\ [wpr\ (FIsc\ + Rlmr\ + STcg\ + Bfi) \rightarrow IQ]\ \rightarrow Ii$$

$$Lif\ [fm\ (Gsc\ + Flmr\ + SHcg\ + SMfi) \rightarrow E]\ \rightarrow Ri$$

These two distinct institutional outlooks of national market economies are not only described as co-existing, but they are called to be distinct from and complement each other, leading to institutional stability and comparative economic advantage in

the form of the two different types of innovation. At least, this is the basic theory. It gets more complicated with the second independent but intervening variable of globalisation. The VoC perspective expects that where the pressures of globalisation (GLO) and financial crisis meet the institutional foundations of CMEs and LMEs, these systems react differently towards the pressure. While LMEs are expected to stay stable, CMEs are expected to liberalise (this is extensively described in the literature review and theoretical framework). Two more propositions regarding the institutional change theory underlying VoC can be identified:

$$GLO + Cif\ [FIsc + Rlmr + STcg + Bfi]$$
$$\rightarrow Cif\ [FIsc + Rlmr + SHcg + SMfi]$$
$$\rightarrow Cif\ [Gsc + Flmr + SHcg + SMfi] \rightarrow ?i$$

$$GLO + Lif\ [Gsc + Flmr + SHcg + SMfi]$$
$$\rightarrow Lif\ [Gsc + Flmr + SHcg + SMfi] \rightarrow Ri$$

One large field of questions which has hardly been discussed in the literature yet is the expectation arising from VoC of institutional change in CMEs and its potential effect on trajectories of innovation in affected nations. It is not clear how the nations' trajectories of innovation would change as an effect of institutional change.

The first part of this dissertation is occupied with the deductive approach, aiming to discuss theoretical explanations for real economic developments. In a second step, I am exploring whether VoC theory holds its promise and is able to explain national trajectories of innovation. This thesis, therefore, looks at every single assumption underlying the propositions arising from VoC. In the last part of this dissertation, the findings are reviewed and existing theory is considered in response to these. The relationship between skill formation, corporate governance, and financial globalisation is re-thought in the context of government policy. Instead

of a mere linear relationship between certain institutional levels and one kind of innovation, one aim of this thesis is to describe the complexity between different institutional factors influencing a variety of resources needed for different kinds of innovation, e.g. labour market flexibility to influence the creation of low-wage jobs but also the creation of general skills.

The key argument of the findings in combination with the chosen methodology is that even though the institutional foundations of Germany have partly undergone liberalisation, in terms of financial institutions, globalisation and corporate governance in MNCs, German capitalism has focused its efforts on the sphere of national skill creation (clearly in interaction with the labour market and social policy). These efforts of the German government are to be differentiated from developments in other nations. The effects of nation-specific skill creation are highly relevant for the development of radical trajectories of innovation. Without an in-depth analysis of the single propositions underlying literature, a long term view, different data and an approach to the method of difference, as used by Mill, for example, these complex interrelations could not be understood.

4.4. Methods

The major CME example of Hall and Soskice's (2001) original *Introduction to Varieties of Capitalism*, Germany, has undergone severe change since reunification due to external pressures such as globalisation, EU membership, and global economic crisis. This thesis, therefore, takes the opportunity to look at the case from a longitudinal perspective, focusing on the past 25 years (since re-unification). In the literature review in this thesis, expectations of VoC theory have been identified. In the following chapter, it is analysed whether the expectations arising from VoC can

be found in the real economic behaviour of the German CME. For this purpose, the institutional variables which have previously been identified and the overarching questions which summarise these, are discussed. Within the German case, five institutional spheres of NIS have been identified for further analysis: skill formation, labour market, industrial relations/ WPR, CG and in the context of the influence of globalisation, the financial institution. These spheres represent the independent variables, which VoC assumes change towards liberalisation. Aiming to understand the developments in the German market economy, this chapter uses sense-making methods. Policy making is added to the perspective. A first analytical chapter descriptively analyses the effects of shifts in political regimes and policy change on the institutional foundations of the German NIS. The effects of these policy and regulatory changes as well as potential institutional (non) change are described in terms of the effect on the national skill equilibrium and derived job market. The impact of the change in job market structure is descriptively analysed using a comparative perspective and appreciating the role of the global crisis. A second part of the chapter looks at in-depth case studies of the performance developments of two radical sectors in the CME.

4.4.1. VoC Analysis

Peter Hall and David Soskice base their approach to VoC on the shoulders of a simple calculation which is illustrated in a single chart, which has been previously published numerous times in similar but distinct contexts (Casper, Lehrer and Soskice 1999; Hancke 1999). As previously described in the Theoretical Framework, this chart is highly misleading. It neglects the actual performance of nations in a sector and implies malperformance by Germany, which does not exist. The calculation underlying this chart goes as follows:

> "The data are from the European Patent Office and calculated for thirty classes of technologies. For technology class i (e.g. machine tools) Germany's relative specialization is measured by the share of German machine-tool patents in total German patents less the share of global machine-tool patents in global patents" (Hall and Soskice 2001, 41 in footnotes).

In Chapters six and seven I illustrate how the VoC calculation misleads the reader. It is not sufficient to draw any conclusion on the trajectory of innovation of a nation, due to the effect of the US (an outlier in all terms).

4.4.2. Other Descriptive Measures

In an attempt to analyse the performance of two radical sectors in the German market economy, a mixed methods approach is chosen. Besides the VoC calculation, I illustrate the numbers behind the calculation and give an overview on diverse, simple descriptive measures, such as the total patent counts, the national percentage of world share of patents in the chosen sector and foreign ownership of patent applications to the EPO. Each of these methods is illustrated from a comparative perspective using other highly developed industrial nations. These are chosen following VoC case selection strategy (Hall and Soskice 2001, 20). In contrast to VoC, I acknowledge Whitley's and Esping-Anderson’s findings and separate the Nordic capitalists from the continental/conservatives. Japan is observed as a CME, an Asian one which has grown out of a distinct culture and history. In a further analysis, five high-tech sectors are chosen, and their patenting performance and ownership in patent applications is compared throughout the nations. An important part of the chosen methods is the sense making and historical analysis. Developments in a sector, certain policy making decisions, and competitiveness can only be made sense of by observing the developments and describing them. A plain chart which shows one dimension of longitudinal performance might not make sense without knowing the story of the nation in an international context.

4.5. Data

This dissertation makes use of a mix of data. Patent data are generally used in terms of measuring the output factors of R&D. The view of patent data as an output variable has changed throughout time. The application for a patent, at the EPO, can illustrate a person's or corporation's intention to implement a new product within the market. Furthermore, the application could also be used in order to block other competitors or in order to reserve one's rights. These actions lack the intention to implement the new idea. Equally, an idea which is implemented, for example, in the European market does not necessarily show success. The Theoretical Framework of this dissertation argues for innovation to be the successful implementation of an idea (e.g. product, service, etc.). The data used for analysis represent input and output factors of the process of innovation: patent data and R&D investments are viewed as input factors while sales and publication are treated as output factors, in terms of academia and business. The theoretically- (following the VoC approach) given proposition of one method and data source (patent data) offering enough safety to build up a whole theory is criticised. This work uses a mix of methods, but also a mix of data sources, reflecting input and output factors of innovation, represented by patent data, but moreover by R&D spending on the input side and publications as well as the share of the sector's total annual sales on the output side.

4.5.1. Patent Data

Patent data have a wide use in the field of comparative capitalism. In general patents are seen as:

> "a key measure of innovation output, as patent indicators reflect the inventive performance of countries, regions, technologies, firms, etc. (…). They are also an intermediate output resulting from R&D inputs" (Patent 2009).

Thus, patents are often interpreted as an output indicator. This is also the context in which Hall and Soskice (2001) interpreted their patent data. In general, patent data are taken as indices for the economy's specialisation in a certain sector. A disadvantage relevant for this work is that the "value distribution of patents is skewed as many patents have no industrial application (and hence are of little value to society) whereas a few are of substantial value" (OECD 2002, 136). Thus one country may be strong in patenting for example in the sector of biotechnology, but these patents may be produced in research institutions, such as universities, without linkages to the industry, or missing biotech firms in the country one may never see an outcome with any value for society. Thus a country may hold a significant number of patents in their biotechnological sector, but might, for many reasons, be unable to bring a drug on to the point of commercialisation. This is also a point on which German patents are often criticised (Warschat 2009). Even though patents may have a close link to inventions, this work does not view them as a direct indicator of innovation. Thus, they may not be seen as a variable directly indicating the successful commercialisation of a product, which by defining innovations as a successfully commercialised new product, process, service or new material (Schumpeter 1939) means that patents may not be seen as an output factor of innovations, but moreover an input factor for an innovation which might or might not lead to successful commercialisation and thereby innovation. Thus patent data cannot be used as standalone data in a analysis of Germany's ability to radically innovate and an analysis of the past developments and cross-national differences of any specific sector case.

In their analysis, Hall and Soskice (2001) have focused on patent data in showing the parallel pictures of German and US firms, as major examples for a coordinated and a liberal market economy focusing on parallel trajectories of

incrementally vs. radically innovating sector cases. The use of patent data as a first step for analysis is attempted in this thesis, as following the argument of existing key theory. Besides the use of patent data which does obviously have certain shortcomings, other measures are used in order to reflect upon the shortcomings. The first step of following Hall and Soskice`s argument is followed by a more differentiated view on other data sources and, in the following chapters, a more detailed view within the institutional framework surrounding the two sector cases. As stated by Witt and Jackson in *Varieties of Capitalism and institutional comparative advantage: A test and reinterpretation* (2016), patent data and even patent citations have well-known limitations.

> "Not all innovations can be patented (e.g., new software), and firms do not necessarily patent their innovations for cost or strategic reasons (Archibugi & Planta, 1996). Moreover, radical innovation may also be associated with process innovations driven by changes in organization for which new technology is a necessary but not a sufficient condition" (Witt and Jackson 2016, 798).

Despite the general criticism of the use of patent data, more specific issues regarding the biotech and software sector need to be considered.

By analysing patent data, it is important to bear in mind that the EPO does not grant software patents as such. It hereby does "not grant patents for computer programs ('software patents') or computer-implemented business methods that make no such technical contribution" (SWPAT 2010, 3). The EPO's procedure for granting patents (only in cases that make a technical contribution) is very different from the USPTO`s practices. Thus, the USPTO does grant patents which would probably be rejected by the EPO.

> "Under the EPC a computer program claimed as such is not a patentable invention (Art. 52(2) (c) and (3) EPC). Inventions involving computer programs that implement business, mathematical or similar methods and do not produce technical effects (e.g. because they solve a business problem rather than a technical one) are not patentable, and no patents will be granted for such inventions in Europe." (SWPAT, 2010)

By fulfilling certain conditions, software patents are also filed at the EPO. Examples are the pop-out-context-menu “EP249293”, granted to Philips, or the Microsoft Patent “EP0618540”[3] (SWPAT, 2010). By only analysing EPO data, all patents being granted have to go through the same conditions. The EPO does not list “software patents” as such in its database. The following patent analysis had to be conducted using general ICT patents,[4] which do potentially include “software patents” and software patents indicating the largest share of growth within this sector. In order to enhance the reliability of the thesis's measurements, other measures of the output side of innovation are viewed in the context of biotech and software cases.

Secondly, not only does the general use of patent data have its advantages and shortcomings, which need to be considered, but it needs to be reflected upon the chosen database. As described by Kim and Lee (2015) in *Patent databases for innovation studies: A comparative analysis of USPTO, EPO, JPO and KIPO*, patent data analysis is the "most commonly applied one in order to monitor technological trends, analyzing technology innovation patterns, or developing technology strategies" (Kim and Lee 2015, 332). In this context, it is not only the selected technology class or chosen national context which affects the findings of the

[3] This patent is described as: “An operating system provides a common name space for both long filenames and short filenames. In this common namespace, a long filename and a short filename are provided for each file. Each file has a short filename directory entry and may have at least one long filename directory entry associated with it. The number of long filename directory entries that are associated with a file depends on the number of characters in the long filename of the file. The long filename directory entries are configured to minimize compatibility problems with existing installed program bases” (V3, 2010).

[4] ICT-related patents are currently identified using the following codes of the International Patent Classification (IPC): "Telecommunications G01S, G08C, G09C, H01P, H01Q, H01S3/025,043,063,067,085,0933,0941,103,133,18,19,25), H01S5, H03B, H03C, H03D, H03H, H03M, H04B, H04J, H04K, H04L, H04M, H04Q; Consumer electronics G11B, H03F, H03G, H03J, H04H, H04N, H04R, H04S; Computers, office machinery B07C, B41J, B41K, G02F, G03G, G05F, G06, G07, G09G, G10L, G11C, H03K, H03L; Other ICT G01B, G01C, G01D, G01F, G01G, G01H, G01J, G01K, G01L, G01M, G01N, G01P, G01R, G01V, G01W, G02B6, G05B, G08G, G09B, H01B11, H01J(11/,13/,15/,17/,19/,21/,23/, 25/,27/,29/,31/,33/,40/,41/,43/,45/), H01L" (OECD 2009).

researcher. Kim and Lee illustrate how the choice to analyse data from a certain patent database can affect the findings. The choice for the EPO within the context of this thesis is due to theoretical reasons. The analysis of Hall and Soskice (2001) was re-done and looked at in more depth. Despite this key approach in the given field of research, the national context for the two sector cases is Germany. Aiming to observe changes in patent applications to the EPO, this continental European country is best represented by choosing the European Patent Office.

4.5.2. R&D Investments and Sales

The data provided by the R&D Scoreboard are limited to Europe's 1000 largest R&D spenders vs. the rest of the world's largest R&D investors. Mostly, large firms are captured, and thus the results are limited to large firms. This is problematic when viewing the Japanese firms in the software sector, since thereby they were brought (by the data source) in a comparison with US firms. Thus capturing Japanese firms together with EU firms would have given an absolutely different picture to an anlaysis capturing them with US firms which so strongly dominate the market. A similar problem occurred in other contexts with the number of captured French and German firms. Thus the sample size was too small to actually draw conclusions, especially in the second instance where the captured R&D firms in the data set were viewed by the annual sales. Thus, where the data had legitimacy in terms of R&D was in terms of considering that these firms would be the strongest ones in Europe; this position was not legitimate for selecting such a small number of firms and judging their sales and this small sample size might be the reason for the large differences in German Biotech firms' sales between 2005 and 2008.

4.6. Validity, Reliability and Generalisability

This dissertation not only criticises the dichotomist world view of VoC in terms of complementary institutional frameworks but, moreover, in terms of the ability and influence of the VoC approach to draw a picture of comparative economic advantage (innovation) between nations depending on their institutional frameworks. Without going into more detail, it can be acknowledged that comparative economic advantage is an approach originally developed by Michael E. Porters *The Competitive Advantage of Nations* (Porter 1990, 16) which gives a fair overview of rationales of trade, such as the economies of scale. Porter explains how existing theories (e.g. economies of scale) reason competitive advantage. He identifies a major question which has not been acknowledged in existing theory: Which nation's firms will use competitive advantage and in what industries? By identifying this question, I argue that Porter lays the foundations for the VoC approach. The most important issue with these approaches and my own dissertation is the notion of validity. Do we describe what we say we describe; do we measure what we aim to measure? I would argue that we don’t. I will further argue that a comparative economic advantage as a parallel picture of specialisation in certain sectors does not exist. Even though the VoC calculation appears to measure a specialisation, it neglects actual performance. Furthermore, whilst we can illustrate total patent counts or other data sources, we cannot possibly illustrate real innovation. Any measures are only a symbol of innovation. Sectoral performance does not capture the notion of radical/incremental innovation properly. Radical innovation can be identified within any sector. What we measure is the performance of (relatively) new and emerging sectors within a market economy. We call this radical innovation. Similarly, the institutional spheres are extensively described in VoC. The identified institutional spheres are often not what

we would expect since the logic which constructs the propositions behind the institutional influence on innovative capabilities is not universal, but its correctness depends on individual sight. A labour market offers more than rigidity versus flexibility. Skills are not only general versus specific. An economic theory which expects humans to behave in rational ways needs to be re-thought and cannot be valid.

The internal validity of this dissertation's findings is increased compared to other literature on the VoC approach through the use of an in-depth perspective, different methods and sick description. The measures have been and can further be repeated. They prove to be reliable. In these two instances, the dissertation adds to pre-existing approaches. Generalisability is not a goal of this dissertation. There has been extensive criticism of the fact that VoC generalises its theory upon diverse nations. In turn, it is argued that, by illustrating paradoxical innovation behaviour in VoCs critical case, the ability to generalise the propositions arising from the theory for other nations is limited. The theoretical framework constructed in the conclusion of this thesis is conducted for the context of the German NIS with a particular focus on the creation of radical innovation – cases of biotech and software but also in the sense of new technology and changing/emerging markets. It may enhance existing approaches but is not to be generalised for other CMEs per se.

The theoretical implications for the study of innovation, which differentiate between incremental, radical, disruptive and stepwise innovation could, in a further step for testing within different fields of technological development, offer grounds for a generalisable theory – this, however, is for future research.

5. CHAPTER FIVE: INSTITUTIONAL CHANGE, GOVERNMENT POLICY, AND PERFORMANCE OF THE GERMAN BIOTECH SECTOR

By considering the proposition arising from VoC about coordinated market economies, such as Germany, performing more strongly in incremental trajectories of innovation (such as automobile or machinery industries) but performing more weakly in radical trajectories of innovation, one would expect Germany to perform weakly in the biotechnology and software sectors and to specialise its performance in other areas, such as the automobile industry. This proposition is questioned throughout this chapter.

In the context of this chapter, RQ III is the focus of the analysis. Later on, RQ1V is discussed. Within these two case studies, four second order chapters are created. The first section for each sector case consists of an analysis of national innovation policy regarding each sector. The second of these includes the VoC calculation as previously conducted in Hall and Soskice`s introduction to the VoC approach. It is uses exactly the same calculation, for more recent years – since re-unification. Following this calculation, the numbers behind the VoC-Chart (Casper, Lehrer and Soskice 1999, 22; Hall and Soskice 2001, 41–42; Hancke 1999, 2) are shown. Other countries are brought into the comparison, and other measures are added, still using patent data alone as previously mentioned authors have. A different conclusion is drawn. In the third section, other input factors for innovation are analysed – R&D investments and publications using the VoC calculation. A fourth section illustrates the output factor for innovations in terms of sales and exports. IN

conclusion, VoC theory's ability to explain the identified trajectories of innovation throughout the past 25 years is considered.

This chapter consists of an introduction, defining biotechnology and describing the German biotech market, as well as a review of German biotech policies. The heart of this chapter consists of key measures on the biotech sector's performance which include measures of two inputs (patent data and R&D) and two output factors of innovation (publications and share of total returns). These measures are compared with Hall and Soskice`s findings and are summarised in the last part of this section. Conclusions are drawn to finalise the chapter.

5.1. Defining Biotechnology and Biotech Policies

According to the OECD (as cited in BMBF – biotechnologie.de 2009, 20), biotechnology is "defined as the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods, and services". When talking about biotechnological activities, they can roughly being differentiated into three kinds of activities, which are each characterised by a colour. Green biotechnology is clearly the most unpopular form of biotech in Germany (chemie.de 2017). It is used to change plant characteristics to improve or change their abilities. Since the general opinion on gene manipulated food is rather sceptical in Germany, this kind of biotechnology is also still viewed very sceptically. Simple online research shows dozens of protest-websites, emphasising the dangers of gene-manipulated vegetables. German industry clearly specialises in red biotechnology (BMBF 2007), which, compared to green biotechnology, focuses on the development of new medication and diagnostics. It is frequently used in cancer research. *White* biotechnology is

industrial and involves work in such areas as cell production. Industrial biotechnology is also used to create insulin from bacteria. Besides the three big fields of biotechnology one can find smaller, rather badly defined fields. Thus the fourth colour in the biotech rainbow is blue biotechnology. The focus of this discipline is biological organisms in the world's oceans, especially bacteria found in the deep ocean. In short blue biotech describes the technical use of processes and organisms in marine biology (Chemie.de). It is possible that, with further developments in biotechnology, one may, later on, differentiate even more between disciplines. The most popular areas in biotech in Germany today are red, green and white. Many have argued that the German biotechnology sector has not been as successful in the past as it generally could have been (Nussbaum, 1983 as cited in Lehrer 2000). For example, Giesecke (2000) stated that even though the German federal government was the first to directly support biotech R&D, the outcome of this support has been quite different from the intention of making biotechnology a competitive industry. Different authors explain this "lack" differently, for example as a result of the institutional framework conditions (Hall and Soskice 2001). Giesecke sees it as a reflection of simple inferiority, compared with the sector's world leader – the USA. Thus even though the German biotech sector is promoted by the government to the tune of of €253m yearly (2009), which is a relatively high amount (The Boston Consulting Group 2017) compared to other sectors, such as the German energy technology sector, compared to the USA, where biotechnology has been called a key technology for the future, and where it is promoted with about $28,6 billion per annum, Germany does not provide enough resources to actually compete with this Goliath. Even a comparison between Europe and the US biotech environment might be very uneven, since both industries have around 2000 companies, but the US sector employs nearly twice as many people, spends around three times as much on research and development,

raises over twice as much venture capital, and has access to 10 times as much debt finance. It earns twice as much revenue (see Ernst & Young 2009). Therefore, the US is not only highly specialised but it does also have very different market structures leading to this performance compared to the EU. The US has the world's largest pharmacy market which has doubled its size within the past 20 years (The Boston Consulting Group 2017) and is "not only the biggest national market but also the fastest growing one" (Giesecke 2000, 4–5) in the world. The connection between a pharmacy industry and red biotechnology is obvious. In Europe and especially in Germany, where gene manipulation is strongly criticised by citizens, and the law, for a long time, did not allow genetic modification (seeing it as equally dangerous as atomic energy production) and still restricts them significantly now, there is also, automatically, a different market for green biotech than in the US, where customers are open to genetic modification. The market conditions for biotechnology are, therefore, very different in the US and most other countries, especially such extremely sceptical markets as the German market. The German biotechnology sector has not always been in focus politically. In contrast, the German government regulation system was considered to be one of the barriers for the development of the biotech industry in Germany and also for the adoption of biotechnological techniques in the pharma industry (Liecke 2009). This was due to non-regulation of the German laws according the new biotechnology sector in Germany. Thus Liecke (2009) draws attention to the case of the pharma company, Hoechst, which tried to establish a factory for the production of human insulin in 1984, close to Frankfurt. The Hessian administration court forbade Hoechst in 1989 from building the factory and compared the potential danger of such a factory with the dangers assocaited with the the atomic energy industry. This case is just an example of how missing national regulations led, automatically, to a ban in biotech activities, due to the very negative

image of biotech in society. In 1990, a liberalisation in the law took place due to the European Union regulation act of 1990 with guideline 90/219 EC about the treatment of genetically modified organisms in closed systems and 90/220 EC, which regulated field experiments. These changes were followed by other changes in 1996 and 1998, which led to a unification of the laws and conditions for the biotech sectors in Europe. These changes in the German regulatory system did not take place in 2000, as planned by the European Union, but in 2002 after the European Union had taken Germany, due to non-fulfillment of the regulations, to the European court (EuGH) (see Liecke 2009 for more details). These political activities led to a paradoxical situation in Germany, where certain Länder governments actively problematised the commercialisation of biotechnology, but, at the same time, federal government promoted the biotech industry with large amounts of public funds and pictured it as an industry with great future potential (see Liecke 2009). In the late 1960s, an OECD report identified biotechnology as an area that was expected to play a key role in future economic development; following this report the German government first began to support this sector (Buchholz 1979). Various research priorities were identified for biotechnology, on the understanding that "biotechnology had future scientific and economic potential" (Giesecke 2000, 3). In contrast with the politics (non-regulation of biotech and non-fulfillment of EU regulations) taking place at the same time, the government established a program in 1996, called the "BioRegio" competition. This involved the BMBF (Bundesministerium fur Bildung und Forschung 2008) organising 17 regional biotechnology centres in Germany. The programs typically included "free consulting services for business plan development and market scanning, subsidies to help scientists pay most patenting costs, the provision of low-cost lab space for fledgling start-ups in 'incubator labs' built in close proximity to university labs, and the provision of subsidized commercial space

in nearby life-science-oriented technology parks once new firms start to grow" (Handelsblatt 1998, as cited in Casper, Lehrer, Soskice 1999, 20). This competition is often referred to as the beginning of biotechnology developments in Germany. Three of the four largest biotechnology clusters in Germany are found in the "winning regions in 2009 – Munich and Rhineland (Cologne)" (Biotech Report 2009). The government intervention was very successful and not only led to a regional clustering of the biotech industry in Germany but also led to a strong increase in absolute patent numbers from 1996 to 2002, where the number of annually filed patents nearly doubled. The number of small start-ups also increased. The introduction of the *Neuer Markt,* "Germany's second stock market for low-cap issues" in 1997 (Lehrer 2000, 90) might have played its part in these developments, since, at this time, biotechnology was not only being recognised as a key sector by the German government, but increased capital enabled German firms to invest in R&D.

5.2. VoC Calculation on the Biotech Sector's Performance

This section leads to an analysis of the German biotech sector, focusing on the previously mentioned four key measures of patent data, R&D investments, as well as publications and sales in biotech firms. The four measures are the same for the software sector, where the same databases and calculations have been used. The tables and graphs are interpreted independently; secondary literature is used in the analysis where it seems useful for understanding the specific sector. The analysis is summarised at the end of each chapter – Biotech and Software.

5.2.1. VoC Calculation on the Biotech Sector's Performance - Patents

Giesecke (1997) shows that the United States are outperforming all other countries in the biotechnology sector. This finding, which is congruent with Hall and Soskice's assertion about LMEs specialising in radical innovation, can also be found by viewing the selected patent data. Taylor (2004) showed that the USA should not be taken as the only representative of LMEs, but that other LMEs' performances in radical sectors are very different from that of the US. Figure 5: Biotech Patent specialisation across nations shows biotechnology patent specialisation according to EPO data from 1986/87, 1996/97 and 2006/07. The data are OECD data from the European Patent Office and calculated for the biotechnology sector in each country (France, Germany, UK, USA and the European Union). Each country's relative specialisation was measured using the example of Hall and Soskice (2001, 41; as also shown in Diagram 1: EPO patent distribution for Germany and the US by Casper, Lehrer and Soskice, 1999, 6–7).

The share of one country's biotech patents in its total patents was taken as less than the share of global biotech patents in global patents. Thus this calculation is the same kind of calculation which Hall and Soskice (2001, 41–42) used. The calculation is limited to biotechnology patents[5] only; other sectors' patent specialisations of each country are not measured since they are not relevant for this work. The 0-achse in Figure 5 illustrates the world's average specialisation in biotechnology patents. Thereby one country, such as the UK in 1996/97, may have a higher share of biotech patents compared to its total patents, than the world's average. As a result, its diagram becomes positive. The illustration does, therefore,

[5] Biotechnology patents are currently identified using the following codes of the International Patent Classification (IPC): "A01H1/00, A01H4/00, A61K38/00, A61K39/00, A61K48/00, C02F3/34, C07G(11/00,13/00,15/00), C07K(4/00,14/00,16/00,17/00,19/00), C12M, C12N, C12P, C12Q, C12S, G01N27/327, G01N33/(53*,54*,55*,57*,68,74,76,78,88,92)" (OECD 2009).

strengthen the argument arising from VoC that Germany has been an incremental innovator in terms of specialisation in biotech patents for the previous 30 years. Other countries' relative specialisations, such as the French biotech specialization, seem to be negative compared to the world average and the United Kingdom (for the years 96/07 and 06/07) and the United States, which, as expected, has a positive outcome and is thus above the world's average for specialising in the production of patents in the biotech sector, compared to overall patent production. The overall European specialisation is also displayed and, throughout the years, negatively compared to the world's average. By analysing Figure 5, the US is clearly the country which specializes most in the production of biotechnology patents, compared to the word`s average.

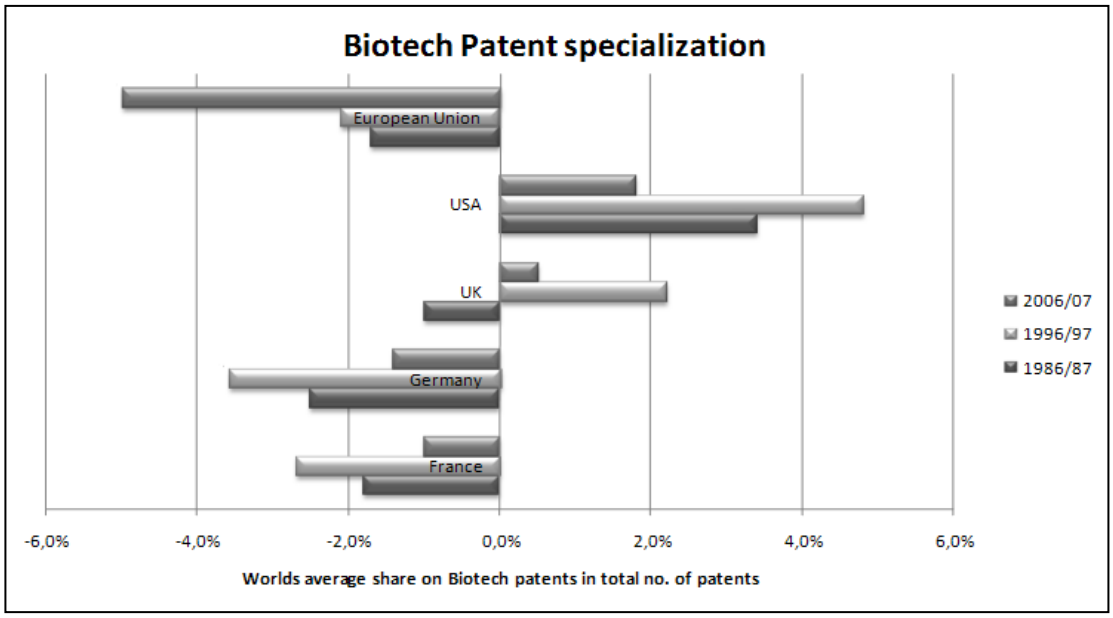


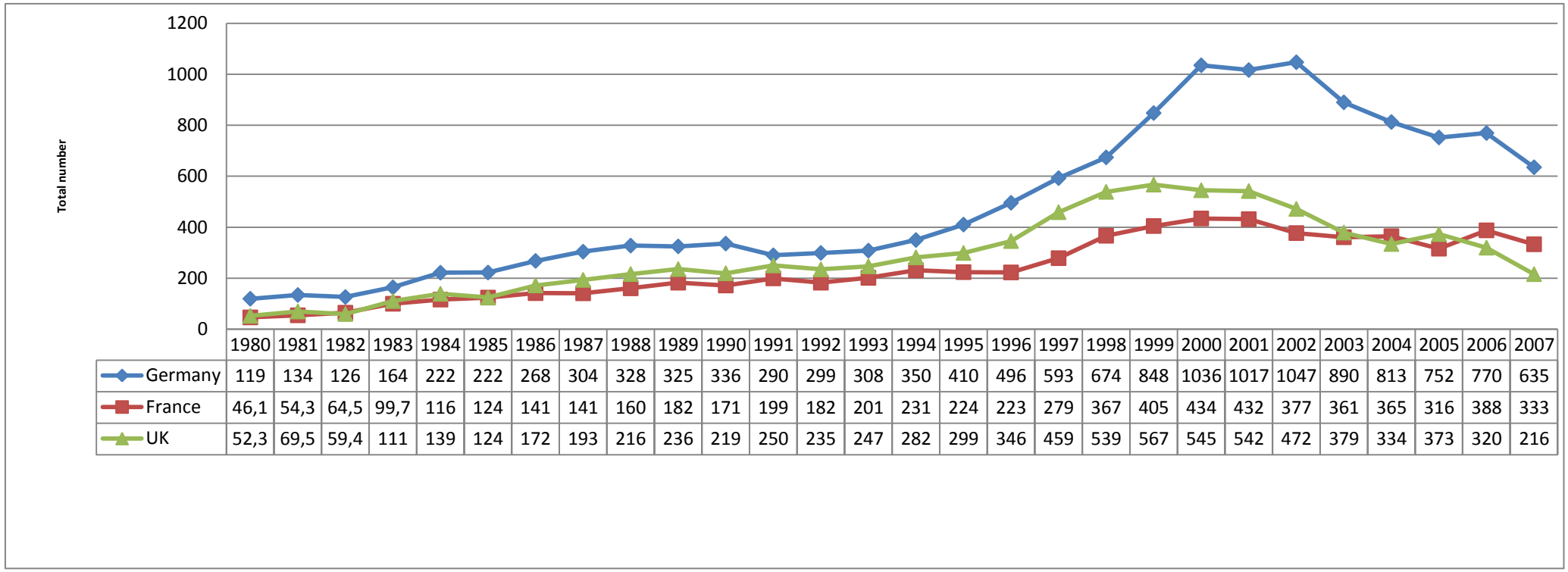
Figure 5: Biotech patent specialisation across nations

Source: Own illustration using OECD's European Patent Office data

By viewing the absolute data behind this figure, as illustrated in Table 3: Data based on Figure 5; world share and countries' shares of biotech patents in 1986/87,

1996/97, 2006/07 and the data calculation, one might note that the world's average is strongly influenced by the United States' numbers. These show that the US did hold a share of 50% of the world's biotech patents in 1996/97, thereby 11% of the nation's total patents were filed in the biotech sector. This strong specialisation is not being achieved by any other country and especially not by any other country holding such a huge share of the total biotech patents. In these terms, the US is outperforming all other nations, but its strong performance might not be a good anchor for measuring the world's biotech performance. Viewing the total values instead of the Figure tells us that Germany`s share of biotech patents, compared to the total number of patents in the country, has permanently been relatively low compared to the other countries over the past 30 years, but that, even though the total number of annual filed biotech patents has doubled over time, Germany maintains its total world share and did file 12% of the total filed patents in biotech in 2006/07. Thereby Germany produced around 30% of the European Union`s biotech patents. At the same time, the EU took the biggest share, by filing 40% of the world`s biotech patents. The EU did still have a relatively low (3.9% which is less than the 4.8% from the 1996/97 period) percentage of filed biotech patents, compared to its total filed patents. But the huge absolute numbers of EU patents influence the world's share of biotech patents in relation to total patents (from 5.3% to 6.9% and on to 4.4% in 2006/07). Figure 6: Total count of EPO patent applications in the technological field of biotechnology by priority date and inventor's country illustrates how the French, German and UK patent counts have developed throughout the previous 30 years. The US is left out of this analysis since it is clearly an extreme example and a comparison with this nation might let all other relative performances look weak, independent of their actual performance. From the total numbers of EPO patent applications, it is clearly visible that Germany not only holds a total share of 12% of biotech patents but that

Germany is and has over time been among the leading countries in the European biotechnology field.



	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Germany	119	134	126	164	222	222	268	304	328	325	336	290	299	308	350	410	496	593	674	848	1036	1017	1047	890	813	752	770	635
France	46,1	54,3	64,5	99,7	116	124	141	141	160	182	171	199	182	201	231	224	223	279	367	405	434	432	377	361	365	316	388	333
UK	52,3	69,5	59,4	111	139	124	172	193	216	236	219	250	235	247	282	299	346	459	539	567	545	542	472	379	334	373	320	216

Figure 6: Total count of EPO patent applications in the technological field of biotechnology by priority date and inventor's country

Source: Own illustration using OECD database on EPO data

	Total Patents	Total Biotech Patents	World Share of Biotech Patents	Share of Biotech. Patents compared to Countries' Total no. of Patents	VoC Calculation
Year: 1986/1987					
France	8146	281	5,5%	3,4%	-1,8%
Germany	20919	571	11,2%	2,7%	-2,5%
UK	7022	364	7,1%	5,2%	-0,1%
USA	25488	2208	43,3%	8,7%	3,4%
European Union	48107	1724	33,8%	3,6%	-1,7%
World	97081	5104	100,0%	5,3%	0,0%
	Total Patents	**Total Biotech Patents**	**World Share of Biotech Patents**	**Share of Biotech. Patents compared to Countries' Total no. of Patents**	**VoC Calculation**
Year: 1996/1997					
France	11871	500	4,3%	4,2%	-2,7%
Germany	33144	1087	9,4%	3,3%	-3,6%
UK	8826	804	6,9%	9,1%	2,2%
USA	49210	5754	49,6%	11,7%	4,8%
European Union	77122	3664	31,6%	4,8%	-2,1%
World	168484	11602	100,0%	6,9%	0,0%
	Total Patents	**Total Biotech Patents**	**World Share of Biotech Patents**	**Share of Biotech. Patents compared to Countries' Total no. of Patents**	**VoC Calculation**
Year: 2006/2007					
France	16705	720	6,3%	4,3%	-0,1%
Germany	47812	1404	12,4%	2,9%	-1,4%
UK	11000	534	4,7%	4,9%	0,5%
USA	64614	3972	35,0%	6,1%	1,8%
European Union	114840	4463	39,3%	3,9%	-0,5%
World	259247	11353	100,0%	4,4%	0,0%

Table 3: Data based of Figure 5 world share and countries' shares of biotech patents in 1986/87, 1996/97, 2006/07

Source: Own illustration, using OECD's European Patent Office data

5.2.2. VoC Calculation on the Biotech Sector's Performance – Research and Development Investments

The impact of R&D investments on a firm`s ability to create innovation, in general, has been discussed by many researchers (e.g. Piante and Bogiliacino 2008). It is discussed whether R&D investments can be seen as having a direct impact on a firm's ability to create patents in the first instance and new products in the second. On the one hand it is argued that, especially in highly knowledge intense sectors, such as the biotechnology sector, huge funds for the firm's Research & Development are needed, indicating that a firm can actually not merely file a patent, but has enough capability and funding to bring a patent through the different stages of the research pipeline. Thereby one might argue that a firm's ability to invest in R&D does, at least in part, depend on its size. This means that a one-person firm might not have the funds to further develop one patent through a long process and, after a possible failure, be able to raise enough funds to continue its research on a different site. This possibility becomes visible by looking at the German biotech sector in more detail. It takes a long time, compared to other sectors, to actually develop and approve a product in the biotech sector. This is especially true in red biotechnology which specialises in the development of drugs (therapeutics and diagnostics) and needs huge funds to develop one drug. Thus it takes approximately 15 years to develop one drug, which has to be financed somehow.

In the previous patent data analysis, it can be seen that Germany is relatively strong (compared to other big EU countries) in filing a total number of patents. Thereby one could view patents as being the first instance of R&D output and an indicator of a country's ability to innovate. On the other hand, considering the average firm size of German firms, which is rather small in a OECD-comparison, one may question the above assertion about firms' R&D investment (at least by

connecting a firm's size with its ability to invest a lot into the R&D of new products) influencing their ability to actually produce patents. The average German biotech firm is rather small since around 45% of the firms have fewer than ten employees. Quiagen is Germany`s largest biotech firm. It has 3,500 employees worldwide, and its headquarters is in North Rhine-Westfalia. The number of employees has continuously grown within the past five years. The German biotech sector has experienced a growth of 3% in 2009 and employs a total of 14,950 people in 531 dedicated biotechnology firms. The number of employees has grown parallel to the number of businesses (The German Biotechnology Sector 2009). Thus, one could argue that, especially small firms in the German sector can be seen as innovative ones, producing a large number of patents and that, thus, R&D investment does play a major role in this sector.

Looking again at the actual goal of firms, which is innovation through the commercialisation of an invention, one may find that companies working in the field of red biotechnology have been very active in Germany in 2009, compared to previous years. Thus, in 2009, eight drug candidates were approved with an increasing number (+2) of drugs in the third phase of the clinical pipeline and "a stable number of drugs in the other two phases compared to the previous year" (BMBF – biotechnologie.de 2009). This absolute number of actual products seems to be low, compared to the filed patents. Germany is not just some outlier in a negative sense, even though it overlaps with the UK, but it is one of the leading countries, even in this sense, in Europe.

> "The developments in Europe show that the pipelines grew across all three phases during 2008. Thereby more than 100 projects were added to the clinical pipeline of Europe's biotech and specialty pharmaceutical companies. Critically, Europe's Phase II product portfolio grew 15% to more than 600 products. Comparing the products in different stages of the pipeline), one finds the UK at the leading position of total products in development.

> Thereby Germany finds itself at the second place, followed by Denmark and France" (Ernst and Young 2005, 74–75).

This observation of only a few actual products being developed in comparison to the actually filed patents, emphasises that a firm's ability to spend money on R&D investments (e.g. through raising external funds or by investing its own money) may influence its ability to further develop a patent throughout all stages of the clinical pipeline and thus (by being a certain size) may even be able to handle backslides and invest in a new potential product. Building upon this position, R&D data by the "EU Industrial R+D Investment Scoreboard" are analysed in the same way as the patent data were previously viewed. The EURIS "presents information on 2000 companies from around the world reporting major investments in R&D. The set of companies it covers comprises the top 1000 R&D investors whose registered offices are in the EU and the top 1000 registered elsewhere" (IRI 2008). There are no fully satisfying data available in R&D investments in the biotechnology sector, which would enable a comparison over the past thirty years, as seen in the patent analysis. Moreover, the EU Industrial R&D Investment Scoreboard has only been available since 2004. During its first year, biotechnology was measured together with the pharmacy sector. Later on, these two sectors were separated. As a consequence, a direct comparison of the first and the later data seems uneven, and this work acknowledges the difficulties of comparison. As one can see in Table 4: Data based on Figure 6; world share and countries' shares of biotech R&D investments in 2005 and 2008, the United States not only dominated the biotechnology sector in terms of patents, as seen before, but it also dominates the sector in terms of firms' R&D spending. Thereby, 63 US biotech firms in 2008 made up a total of 46% of the world's firms spending most on R&D in biotech. This number might be compared to the European Union, which accounted for 70 firms

and thereby made up 51% of the world`s most heavily investing R&D biotech firms. By viewing the total values of investment per firm, the huge difference between EU companies in general and the US firms becomes apparent. With an average biotech R&D investment per biotech firm of €143,5m, the strong US firms have the ability to invest much more in R&D than strong EU firms, which had an average per firm investment of €22m in 2008 (about 15% of the average R&D investment for US firms). It can thus be seen that the US is again an outlier in these terms, since it alone accounts for 75.2% (in 2005) and 81.6% (in 2008) of the world's overall large R&D investments by firms (taking into account only the 2,000 largest firms). By again viewing the calculation of Hall and Soskice`s (2001) VoC argumentation, the US is again influencing the world's 0-Point meaning that the the EU average for the VoC calculation would be at -1.4% in both years, even though the average biotech R&D investment per biotech firm is around €22m which is higher than the averages of the big EU countries. To realise how strongly the outlier USA influences this calculation, one may view the corrected Table 5: Data based on Figure 7; world share and countries' shares of biotech R&D investments in 2005 and 2008 without the USA. This Table shows the same calculation leading to the VoC argumentation in Hall and Soskice (2001, 37), using absolutely the same data, but simply without the US. This is, of course, an unrealistic calculation since the US is, in reality, an existing partner globally. Even though the relative measurements remain equal to each other, the absolute numbers do seem to be much more even now, considering that over 50% of the actual biotech firms are in the EU. Therefore the EU's VOC calculation changes from -1.4 to around 0 in both years. Independent of this variation and of the US, the performance of heavy investment in R&D in firms in Germany is rather weak, which fits in with the observation that rather small firms dominate the German market. This pattern is also generally observable within other EU countries.

Some countries did manage to build up firms which invest heavily in R&D, compared to their overall R&D investments. Such countries are Denmark and the Netherlands, followed by the UK. Even though the absolute number of large R&D investors coming from Germany as well as the countries' world shares of biotech R&D investments have grown during the past few years, its share of world biotech R&D investment has not grown as fast as investment in many northern countries, as well as Switzerland, which, together, nearly doubled the corrected world share of biotech R&D investment. As seen in the uncorrected version, the US grew even stronger in the three year period than these countries and did therefore also manage to raise its world share from 75% to 81%. This development leads to the fact that the EU developments are not that visible in the non-corrected version (only a raise of 1.1%). The contribution of countries other than the big three, in terms of positive R&D investment developments for the EU average, becomes very obvious when viewing Table 7.

	Number of firms for calculation: Total number; *biotech firms*	Total R&D Investment €m	Total Biotech R&D Investment €m	Average Biotech R&D Investment per Biotech Firm in €m	World Share of Biotech R&D Investments	Share of Biotech Investments compared to Countries' Total Investments	VoC
Year: 2005							
France	112; *2*	21293,45	61,01	30,51	0,7%	0,3%	-2,2
Germany	167; *6*	38455,24	122,66	20,44	1,3%	0,3%	-2,2
UK	327; *27*	21402,39	513,36	19,01	5,5%	2,4%	-0,1
USA	587; *44*	151129,8	7019,81	159,54	75,2%	4,6%	2,1
European Union	1000; *57*	112876,47	1207,62	21,19	12,9%	1,1%	-1,4
World	2000; *111*	370576,25	9331,45	84,07	100,0%	2,5%	0,0

	Number of firms for calculation: Total number; *biotech firms*	Total R&D Investment €m	Total Biotech R&D Investment €m	Average Biotech R&D Investment per Biotech Firm in €m	World Share of Biotech R&D Investments	Share of Biotech Investments compared to Countries' Total Investments	VoC
Year: 2008							
France	125; *7*	25746,93	96,57	13,80	0,9%	0,4%	-2,2
Germany	200; *9*	45097,37	178,1	19,79	1,6%	0,4%	-2,2
UK	247; *18*	19672,24	331	18,39	3,0%	1,7%	-0,9
USA	531; *63*	159203,43	9046,07	143,59	81,6%	5,7%	3,1
European Union	1000; *70*	129030,81	1555,04	22,21	14,0%	1,2%	-1,4
World	2000; *137*	429444,79	11090,79	80,95	100,0%	2,6%	0,0

Table 4: Data based on Figure 6; world share and countries' shares of biotech R&D investments in 2005 and 2008

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

	Number of firms for calculation: Total number; *biotech firms*	Total R&D Investment €m	Total Biotech R&D Investment €m	Average Biotech R&D Investment	World Share of Biotech R&D Investments	Share of Biotech Investments compared to Countries' Total Investments	VoC World (-USA)
Year: 2005							
France	112/2	21293,45	61,01	30,51	2,8%	0,3%	-0,7
Germany	167/6	38455,24	122,66	20,44	5,7%	0,3%	-0,7
UK	327/27	21402,39	513,36	19,01	23,9%	2,4%	1,4
European Union	1000/57	112876,47	1048,08	18,39	48,7%	0,9%	-0,1
World	1413/67	219446,45	2152,10	32,12	100,0%	1,0%	0,0

	Number of firms for calculation: Total number; *biotech firms*	Total R&D Investment €m	Total Biotech R&D Investment €m	Average Biotech R&D Investment	World Share of Biotech R&D Investments	Share of Biotech Investments compared to Countries' Total Investments	VoC World (-USA)
Year: 2008							
France	125/7	25746,93	96,57	13,80	4,7%	0,4%	-0,4
Germany	200/9	45097,37	178,1	19,79	8,7%	0,4%	-0,4
UK	247/18	19672,24	331	18,39	16,2%	1,7%	0,9
European Union	1000/70	129030,81	1555,04	22,21	76,1%	1,2%	0,4
World	1469/74	270241,36	2044,72	27,63	100,0%	0,8%	0,0

Table 5: Data based on Figure 7; world share and countries' shares of biotech R&D investments in 2005 and 2008 without the USA

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

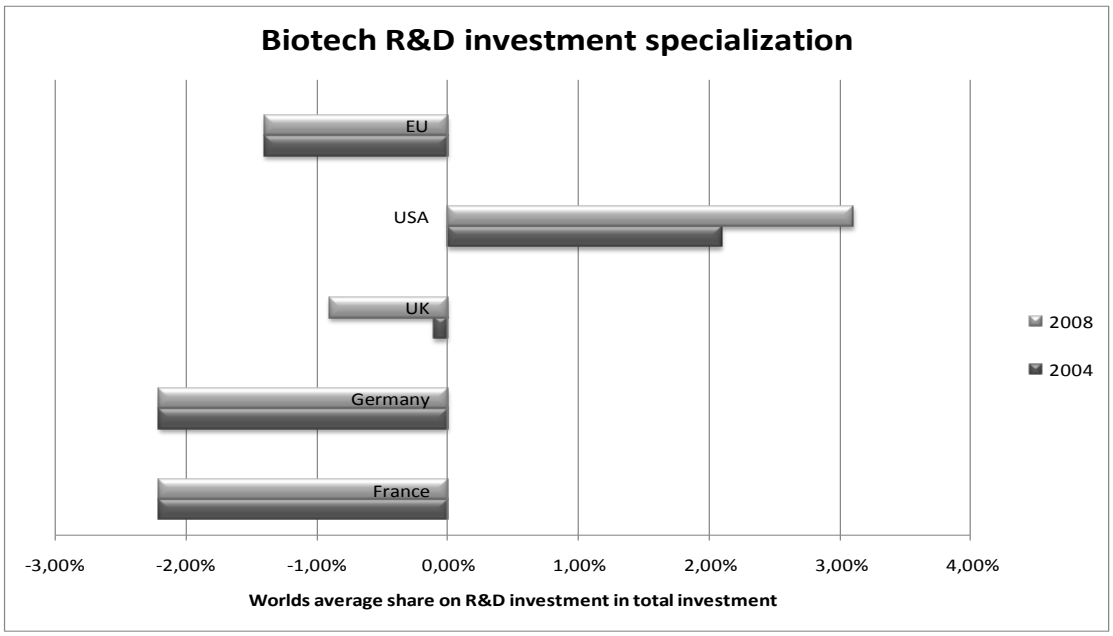


Figure 7: Biotech R&D specialisation across nations

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

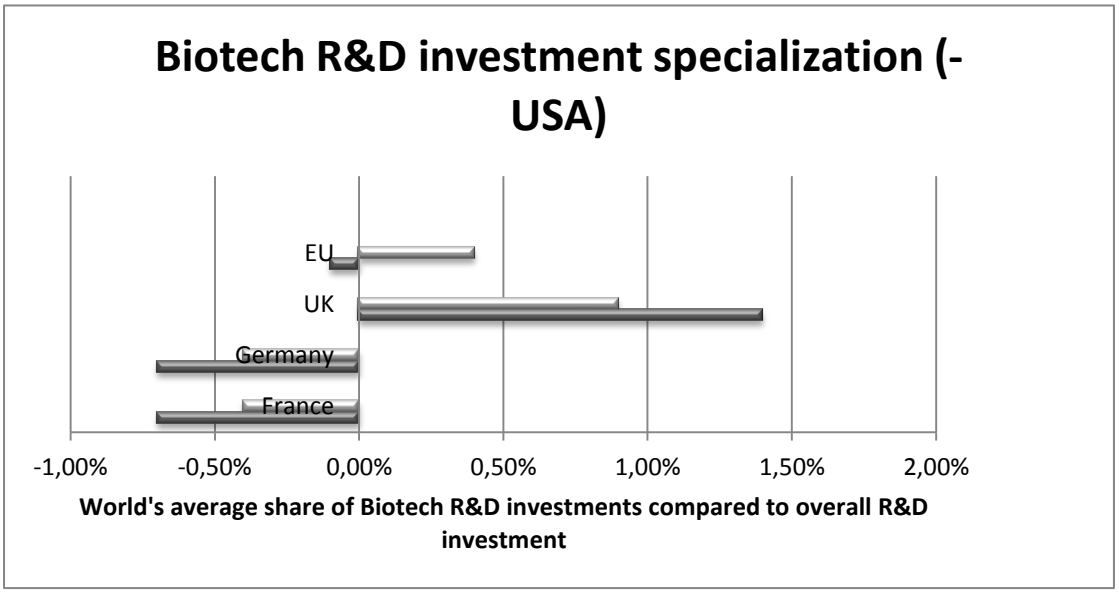


Figure 8: Biotech R&D specialisation across nations (-USA)

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

5.2.3. VoC Calculation forthe Biotech Sector's Performance – Publications and Sales

After analysing patent and R&D data on the input side, it is also important to use measures of the output of an innovation process to view Germany's performance in the radical sector. Schmoch and Qu (2009) state that the "scientific performance of a country may be seen as a basis for a country's ability to technological developments"(Schmoch and Qu 2009, 105). Scientific performance as such is hardly measurable since the structures in the different disciplines are often very different from each other. Schmoch and Qu, therefore, emphasise that statistical analyses of the number and citations of scientific publications have proven themselves to be useful indicators of countries' abilities to develop technologically. The *Science Citation Index* (SCI) is an international standard in the fields of natural sciences, techniques, medicine and life sciences". The Fraunhofer Institute used the SCI and thereby showed that Germany's specialisation in the field of biotech in 2007 was slightly positive in relation to other areas of publication. See Figure 9: Germany's specialisation with regard to the Science Citation Index (Selected fields). The analysis of the SCI by the Fraunhofer Institute indicates how much German publications specialise in the above-listed areas and shows that, in 2007, relatively many (compared to the overall publications in the country) publications on the topic of biotechnology were indicated in the SCI. This analysis is limited to one year and to the country level. To conduct a comparison between nations, the following analysis uses the same data source: the Science Citation Index Expanded which is published by Thomsen Reuters and was accessed via the Web of Science. Using these data, analyses were conducted as for the previous Figures and Tables on biotech patents and R&D investments.

Indices: Specialisation with reference to the world average: 0 = average, + = above average, - = beneath the average, above +20 or beneath -20 = strongly above/ beneath average

Figure 9: Germany's specialisation with regard to the Science Citation Index (Selected fields)

Source: Own composition of a calculation of the Fraunhofer ISI, published in Schmoch and Qu (2009, 10)

An analysis of the publications again shows a parallel, for all the chosen times (2004–08; 1994–98; 1984–88) between the USA and Germany, but this parallel exists not only between Germany and the US but all measured EU countries and the US. See Figure 10: Specialisation of countries in biotech publications with regard to the Science Citation Index Expanded. The relatively high world share of publications in the area of biotechnology influences the VoC calculation and gives it

some extreme values (see Table 6: Data based on Figure 10; world share and countries' shares of Biotech publications in the periods 1984–88, 1994–98, 2004–08).

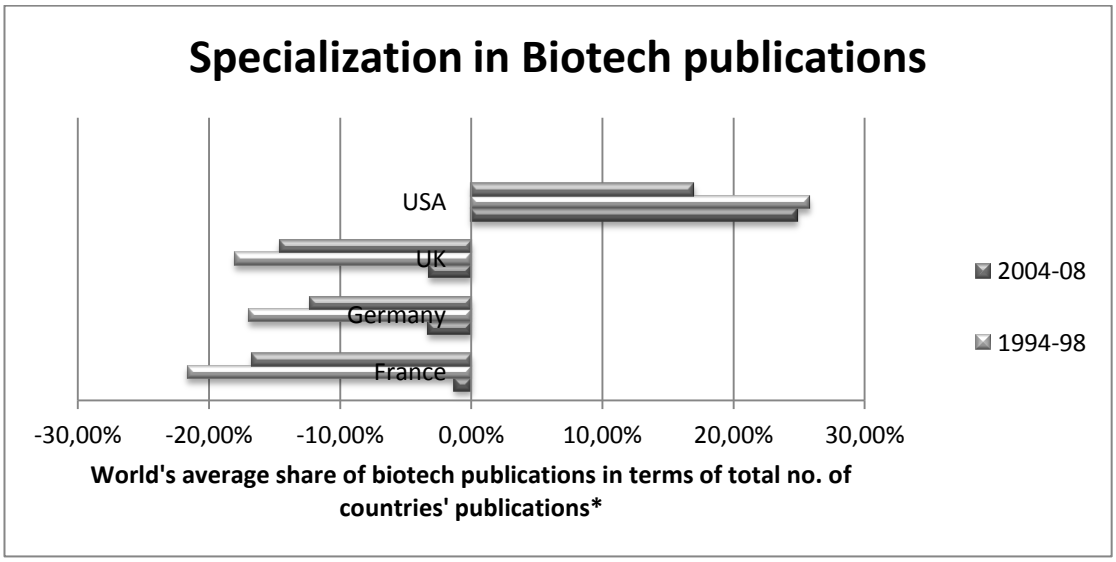


Figure 10: Specialisation of countries in biotech publications with regard to the Science Citation Index Expanded

Source: Own calculation using data from the (Reuter 2009) Science Citation Index Expanded in the selected areas of BIOTECHNOLOGY & APPLIED MICROBIOLOGY; BIOCHEMISTRY & MOLECULAR BIOLOGY and PHARMACOLOGY & PHARMACY; accessed via Web of Science @ Thomsen Reuters at 20.09.2010

Summarising the findings, for international comparison, the position of Giesecke (2000), who states that the US is outperforming any other country in terms of biotechnology specialization, can be confirmed by viewing Figure 10: Specialisation of countries in biotech publications with regard to the Science Citation Index Expanded. Looking at the detailed analysis behind this figure, Germany (after having a relatively weak start in 1984–1988) outperforms the other two European countries in terms of specialisation in biotech publications and also in terms of its world share of biotech publications. Unfortunately, the SCI does not provide the data

resources which it would take to build up a European average. The results of the analysis of this publication index show that, in relation to each other, Germany is overall leading the three nations in terms of publications, in the two time periods of 1994–98 and 2004–2008. Germany leads this measurement in terms of all four biotech measures, which are the total number of biotech publications, the whole share of biotech publications and the share of bBiotech publications for total publications, as well as the previously mentioned VoC analysis.

Like the analysis of patent data, the analysis of publication activities in biotechnology in the EU member states indicates strong growth in scientific output in biotechnology. The number of publications in the sectors of BIOTECHNOLOGY & APPLIED MICROBIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY and PHARMACOLOGY & PHARMACY have nearly doubled over the years, the number of biotech publications has increased tenfold. The publication intensity in biotechnology increased not only in absolute terms but also in relative terms as shown by the share of biotechnology publications compared to all publications calculated for the countries. This finding is close to the patent analysis as well and means that the overall significance of biotechnology in comparison with all scientific activities increased in the 1990s.

Year: 1984–1988	Total Number of Publications*	Total Number of Publications with the Topic Biotechnology*	World Share of Biotech Publications	Share of Biotech Publications compared to Countries' total Publications*	VoC
France	1.187	34	3,2%	2,9%	-1,3%
Germany	1.268	11	1,0%	0,9%	-3,3%
UK	837	8	0,8%	1,0%	-3,2%
USA	954	277	26,2%	29,0%	24,9%
World	25.498	1.059	100,0%	4,2%	0,0%

Year: 1994–1998	Total Number of Publications*	Total Number of Publications with the Topic Biotechnology*	World Share of Biotech Publications	Share of Biotech Publications compared with Countries' Total Publications*	VoC
France	3.789	157	3,2%	4,1%	-21,6%
Germany	3.604	318	6,6%	8,8%	-16,9%
UK	2.787	216	4,5%	7,8%	-18,0%
USA	2.875	1.482	30,6%	51,5%	25,8%
World	18.820	4.843	100,0%	25,7%	0,0%

Year: 2004–2008	Total Number of Publications*	Total Number of Publications with the Topic Biotechnology*	World Share of Biotech Publications	Share of Biotech Publications compared with Countries' Total Publications*	VoC
France	7.782	289	3,0%	3,7%	-16,7%
Germany	9.114	755	7,7%	8,3%	-12,2%
UK	7.643	449	4,6%	5,9%	-14,6%
USA	7.638	2.864	29,4%	37,5%	17,0%
World	47.627	9.746	100,0%	20,5%	0,0%

Table 6: Data based on Figure 10; world share and countries' shares of biotech publications in the periods 1984–88, 1994–98, 2004–08

Source: Own composition of data from the Science Citation Index Expanded in the selected areas of: BIOTECHNOLOGY & APPLIED MICROBIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY and PHARMACOLOGY & PHARMACY; accessed via Web of Science

Another way of viewing the performance of a sector and how many products are actually being sold is to measure its annual sales. This measure does have the advantage that it does not measure an invention or the number of ideas a firm has like patents do, but it measures how much is actually being sold and what the value of these sales was. This is unlike patent data which does not differentiate between strong and weak patents or their potential for commercialisation and whether other parties are willing to pay for the final product or whether it is a flop. The annual sales of a biotech firm do indicate how successful these firms have actually been at selling their products. Compared to other financial measures, such as profits, where other measures such as a firm's spending influence the figure, sales seem to be relatively pure indicators.

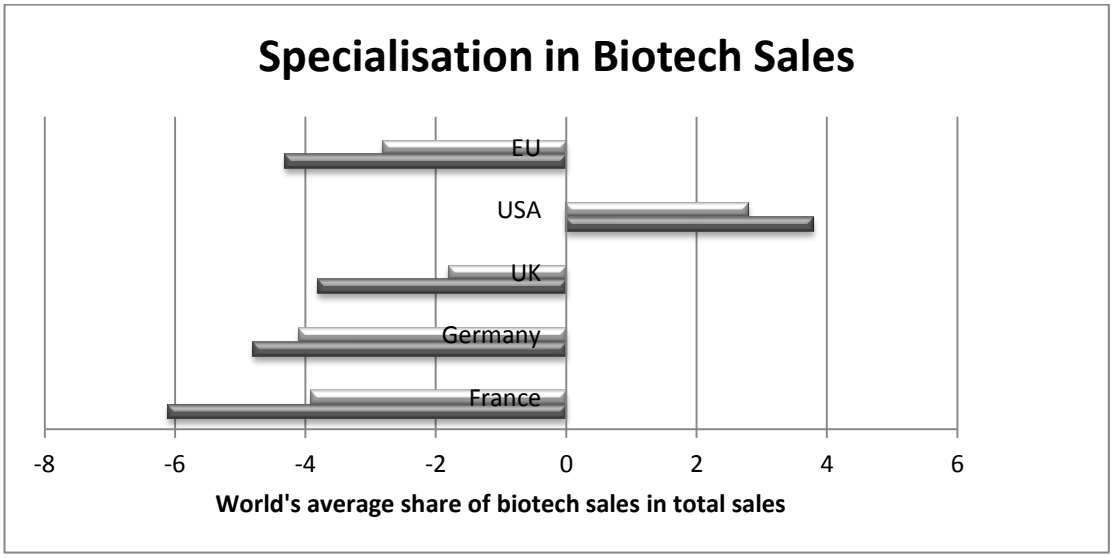


Figure 11: Specialisation in biotech sales across nations

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

By again viewing the data behind the VoC graph, it becomes obvious that the number of biotech firms included is not representative for measuring sales. Only two

French and six German biotech firms made it into the listing for the 1,000 strongest R&D investing firms in Europe. This selection criterion (R&D investment) might be legitimate for analysing R&D investments, for an analysis of sales but such legitimacy disappears since there are clearly other firms in the relevant countries which might be stronger sellers. Bearing this in mind, not just for the French but also for the German firms, this limitation clearly influences the world share of nations which is calculated by absolute numbers. VoC is later calculated using average sales per firm, even though this does not lead to a roundup of the given limitation (number of firms) but relative sales relative per firm seem to be fairer than absolute sales considering that there are only two firms measured in France in 2005.

Viewing the average net sales per firm in millions of Euro, the countries remain in the same relative order in relation to each other. French firms do have the average highest numbers of net sales per general firm, and German, US and UK firms follow. Viewing the same calculation for the average net sales per biotech firm, one does have to acknowledge the relatively weak performance of the small number of French and German firms in this analysis. Where German firms just manage to keep up with UK firms in 2005, their average sales decrease dramatically to only 16m average sales per firm in 2007. There is no direct explanation for this development available from viewing the given data; a larger sample size of German biotech firms might help to make sure that this development is not random. In terms of the VoC calculation, the UK is clearly the European country specialising most in the biotech sector. Thus, as mentioned before, by considering the other three measures, Germany does not appear to specialise in the biotech sector, when viewing the average net sales per biotech firm though it does (at least in 2005) still appear to be clearly above the EU average. It is not clear why this number dropped so dramatically in 2007; whether this was an effect of the financial crisis or a simple

random mistake due to the small sample size, will only become clearer with further analysis and research.

Year: 2005	Total Number of all Counted Firms	Total Number of all Counted Biotech Firms	Total Net Sales in Millions of Euro	Average Net Sales per Firm in Millions of Euro	Total Net Sales of Biotech Firms in Millions of Euro	Average Net Sales per Biotech Firms in Millions of Euro	World Share of Biotech Net Sales	Share of Average Net Sales per Biotech Firm compared to Countries' total Average Net Sales per Firm	VoC
France	112	2	856772	7649,8	23	11,5	0,1%	0,2%	-6,1%
Germany	167	6	1183080	7084,3	620	103,3	1,6%	1,5%	-4,8%
UK	303	27	1298605	4285,8	2839	105,1	7,4%	2,5%	-3,8%
USA	584	44	3469041	5940,1	26370	599,3	69,0%	10,1%	3,8%
European Union	1000	57	4376808	4376,8	5012	87,9	13,1%	2,0%	-4,2%
World*	2000	111	10942777	5471,4	38195	344,1	100,0%	6,3%	0,0%

Year: 2008	Total Number of all Counted Firms	Total Number of all Counted Biotech Firms	Total Net Sales in Millions of Euro	Average Net Sales per Firm in Millions of Euro	Net Sales of Biotech Firms in Millions of Euro	Average Net Sales per Biotech Firm in Millions of Euro	World Share of Biotech Net Sales	Share of Average Net Sales per Biotech Firm compared with Countries' Total Average Net Sales per Firm	VoC
France	125	7	1122020	8976,2	291	41,6	0,7%	0,5%	-3,9%
Germany	200	8	1574169	7870,8	127	15,9	0,3%	0,2%	-4,1%
UK	247	18	1347295	5454,6	2482	137,9	6,0%	2,5%	-1,8%
USA	531	63	3542441	6671,3	30013	476,4	72,9%	7,1%	2,8%
European Union	1000	70	5711891	5711,9	6243	89,2	15,2%	1,6%	-2,8%
World*	2000	137	13897407	6948,7	41188	300,6	100,0%	4,3%	0,0%

Table 7: Data based on Figure 11; world share and countries' shares of biotech sales in 2005 and 2008

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009, including the world's 2,000 strongest R&D investing firms

5.3. Summary of the Biotech Sector's Performance

As shown by Hall and Soskice (2001) Germany does generally not show a high specialisation in the biotechnology sector in terms of patents. This picture is not only demonstrated by patent data but may be confirmed by viewing the other measurements of R&D investment, publication counts, and annual sales, using the same basic calculation which was used by the two VoC authors. The German biotechnology sector does further (as also shown by Hall and Soskice) show a parallel picture in terms of specialisation, compared to the US in all four measures. Viewing only this part of the analysis, which is illustrated by the numerous figures and relative specialisations across the analysed nations in the biotechnology sector, the notion of Germany being a radical innovator can clearly be rejected and Hall and Soskice`s assertion that Germany lacks the ability to radically innovate and thereby specialises in incremental sectors can be supported. This chapter looks at the calculations for the VoC diagram and, by including other EU countries in the comparison, shows that such a conclusion be simplified. Several aspects are identified which call for a different conclusion on Germany's performance in this sector.

The USA is found to be such a huge outlier in any terms that comparison with any other country is limited. Among the other EU countries, Germany appears (apart from in any relative measures) in a leading position in terms of its patent data, the R&D investment per firm in 2008, and its publication strength from 1994 onwards. Compared to other nations, Germany`s performance does not appear to be as weak as expected. Germany does appear to be an equal competitor, with over-time growth performance in this sector. Its performance in terms of net sales appears to be comparatively weak. This result could be a simple outlier due to the small sample

size, but it could also be a sign of financial crisis. Since such a kind of sign is not observable in any other countries' measures, such a conclusion has not been drawn, but it would need further analysis. Generally, it is left to say that, as seen from the policy and market analysis before, German firms are rather small (which was supported by the BioRegio competition, enabling single researchers to start their own firms and supporting them in terms of patent applications). The chosen policy might not have been as helpful as supposed, considering that the number of filed patents and publications did clearly rise over time, but the R&D investments of big firms did not support the development for long enough. Thus it appears that even though Germany may be seen as a leader in terms of patents, many of the existing firms are not large or financially strong enough (consisting of only a few mainly academic members) to commercialise a product, considering a 15-year pipeline and potentially failure of many products. Therefore the BioRegio competition might have been helpful and a good start, but a further policy, focusing not only on the creation of start-ups but moreover explicitly on building strong alliances with large existing pharmacy firms (as is the case in the US) and on also supporting larger, not only research but growth and WIN-oriented biotech firms, might probably have helped to create more final commercialised products and sales. Even though the sales performance in the second year is significantly under the EU average, it is outside the scope of this work to analyse whether this is based on the sample size or on actual figures. The overall performance of the German biotech sector does, in all other terms, appear to be above the EU average and even leading on some issues. The notion of Germany being a radical innovator can, therefore, not be rejected in terms of a biotechnology sector analysis. A growing performance of the biotech sector is visible, which might be the case due to further EU regulations in 2002, or due to the recent additional governmental support for high-tech industries. The institutional

framework in terms of a better VC or other finance is not given. Also, there are no relevant changes found in the other four spheres, since 2001. The summarised findings criticise the basis on which Hall and Soskice drew their conclusions. Thus, at least in terms of biotechnology, Germany might not be seen as a purely incremental innovator, but as one of the countries striving for a leading position in the area in the EU.

6. CHAPTER SIX: INSTITUTIONAL CHANGE, GOVERNMENT POLICY, AND PERFORMANCE OF THE GERMAN SOFTWARE SECTOR

By questioning the proposition that Germany, as a major example of an CME, performs weakly in radical sectors, such as the biotech or software sector, the following chapter consists (as the chapter on biotechnology before) of an introduction, defining software and describing the German software market, as well as a Review on German Software Policies. The heart of this chapter consists of key measures on the Software Sector's Performance which again include measures of the input (patent data and R&D) and the output factors for innovation (publications and share of total returns). These measures are then compared with Hall and Soskice`s findings and are summarised in the last part of this chapter.

6.1. Defining Software and Software Policies

The OECD defines Software as "Programs, procedures, and data associated with the operation of a computer system" (OECD 2008, 500). As is the case with biotechnology, software can also be differentiated in different areas, such as "system software which controls the operation of the computer (i.e., Windows, DOS,) and application software (i.e., Word, EXCEL, MS ACCESS, Lotus)" (OECD 2010). Lehrer (2000) states that Germany specialises in the second field of software. A discussion exists (see Lehrer 2000) on whether a specialisation in the first or the second kind of software would reflect a country's ability to radically innovate better. Here the radical differences between the two kinds of software will not be differentiated since they are both a part of software and thus both represent an

emerging new growth sector; the degrees of radical differentiation will not be taken into account.

The software industry can be seen as part of the general ICT sector. The Datamonitor "is a leading business information company specialized in industry analysis" (Datamonitor 2002, 2). The London-based firm conducts annual analysis of sector performance in general and in specific countries. The 2002 Datamonitor report stated that:

> "Germany has the largest information, communication, and technology (ICT) market in Europe, with the software segment of this market being the largest in Europe and the third-largest in the world after the US and Japan." (Datamonitor 2002, 7)

In 2002, the German software market was valued at $6.15 billion, approximately 20.5% of the European market. Thus even Lehrer (2000, 592) stated that "[o]nce again, the aggregate performance of the German software sector seems mediocre compared with the US, but appears satisfactory when judged by any other standard".

By reviewing the policies of the German government in supporting the software sector`s development, it becomes obvious how different the government's approaches in supporting the two analysed sectors are. Where the biotech sector had to struggle for a long time under paradoxical government actions as described in the chapter before, the policies on software development were and are, up until now, not directly visible. Lehrer (2000) describes how "Germany's software sector has benefited from policies that differed in kind from the state support programs for software development that were attempted in France, Britain, and Japan". Thus the German government did not invest in "mission-oriented state support, relying on pre-defined industrial goals and concentrated resources", but "[i]n contrast, the more 'diffusion-oriented' government support policies for software in Germany are

generally credited as more effective (Malerba and Torrisi 1996)" (as cited in Lehrer 2000).

Broadly-speaking, the government's policies can be divided into three phases. The first phase was characterised by the BMFT's efforts to strengthen university research and education in the field of software since the early 1980s. The BMBF called this the *Initiative zur Förderung der Softwaretechnologie in Wirtschaft, Wissenschaft and Technik* (Initiative to promote the software technology in economy, businesses and technique), and 95 projects were supported in the period from 1995 to 1998/1999. Approximately 34 million Euro from the government and another 25 million Euro from the German economy were invested. This was followed by two similar projects, in 1999/2000 and in 2002–2006.

The central view of these policies changed slightly from the first stage supporting software in academia to build a base for the industry; a second phase connected academics and industry with each other and a third phase actually promoted start-ups and directly influenced the industry through academia. The large German software firms or growth-oriented medium-sized firms were strongly integrated into the whole process. This policy focus is supported by other projects, such as the previously mentioned establishment of the Neuer Markt and, with this, the "general high-tech boom in Germany" (Lehrer 2000), and also the establishment of the Virtual Competence Centre for Software Engineering by the BMFT and the Fraunhofer institute which is supposed to "provide information about the most advanced and most appropriate software engineering concepts, methods and tools" (VSEK 2010). There were hardly any policy papers or future strategy plans from the federal government available, stating software as a key industry of the German economy until 2010; unlike the papers existing for the biotechnology sector. The goals which were observed as being set in the biotech sector and the direct policies to

cluster biotech labs in German areas is not paralleled in the same way in the software sector. Even though some general cluster policies such as *Hightech Strategie-Spitzencluster Wettbewerb* also count software firms as their winners, they do not specifically support the software industry, but let all high-tech firms compete with each other independently of their industrial background.

6.2. VoC Calculation of the Software Sector's Performance

This section leads to an analysis of the German software sector, focusing on the previously analysed four key measures of patent data, R&D investments, as well as publications and sales in software firms.

6.2.1. VoC Calculation of the Software Sector's Performance – Patents

By analysing patent data, it is important to bear in mind that the EPO does not grant software patents as such. It does "not grant patents for computer programs ('software patents'), or computer implemented business methods that make no such technical contribution" (SWOAT 2010, 3). The EPO's procedure for granting patents (only in a case where they make a technical contribution) is very different from the USPTO`s practices. Thus, the USPTO does grant patents which would probably be rejected by the EPO. "Under the EPC a computer program claimed as such is not a patentable invention (Art. 52(2) (c) and (3) EPC). Inventions involving computer programs that implement business, mathematical or similar methods and do not produce technical effects (e.g. because they solve a business problem rather than a technical one) are not patentable, and no patents will be granted for such inventions in Europe" (SWPAT, 2010). By fulfilling certain conditions, software patents are also being filed at the EPO. Examples here are the pop-out-context-menu "EP249293", granted to Philips, or the Microsoft Patent "EP0618540" (SWPAT 2010). By analysing EPO

data alone, it is the case that all patents being granted had to fulfil the same criteria. The EPO does not list software patents as such in its data base. Therefore, the following patent analysis had to be conducted using general ICT patents,[6] which do potentially include software patents. The results of the VoC calculation, as shown in Figure 12: Specialisation in ICT patents across nations is, in consensus with Hall and Soskice`s assertions, negative and, therefore, it may be concluded that, in terms of patents, "[i]n sum, ITC is not a large sector of the German economy by international standards" (Lehrer 2000, 588). Germany is, therefore, not as strongly specialised in the production of ICT patents as in the production of other ones. This is the same result as for the biotech sector. Again, in accordance with the Biotech results, Germany does not perform badly considering the absolute world share of ICT patents. Germany is the leading country within the EU, being responsible for nearly 50% of the EU ICT patents granted in all three measured timeframes. Therefore, by comparing Germany with the other countries' performances, and after taking into account Japan as an additional strong non-EU nation in this field, Germany takes the first place in terms of world share for granted patents in all the measured periods. Therefore, it is to be concluded that, even though, according to Hall and Soskice`s calculation, Germany is not specialised in the ICT field, and even takes last place in the international comparison they conducted, in terms of its absolute world share, it has to be recognised as a highly competitive country, being amongst the leading three nations in the world. By discussing the software field as such within ICT, even

[6] ICT-related patents are currently identified using the following codes of the International Patent Classification (IPC): Telecommunications G01S, G08C, G09C, H01P, H01Q, H01S3/025,043,063,067,085,0933,0941,103,133,18,19,25), H01S5, H03B, H03C, H03D, H03H, H03M, H04B, H04J, H04K, H04L, H04M, H04Q; Consumer electronics G11B, H03F, H03G, H03J, H04H, H04N, H04R, H04S; Computers, office machinery B07C, B41J, B41K, G02F, G03G, G05F, G06, G07, G09G, G10L, G11C, H03K, H03L; Other ICT G01B, G01C, G01D, G01F, G01G, G01H, G01J, G01K, G01L, G01M, G01N, G01P, G01R, G01V, G01W, G02B6, G05B, G08G, G09B, H01B11, H01J(11/,13/,15/,17/,19/,21/,23/, 25/,27/,29/,31/,33/,40/,41/,43/,45/), H01L (Patent, 2010).

Lehrer (2000), who actually criticises the German ICT and general developments in radical sectors, appreciates that "[as] for the software industry *per se* (…) this is by far the fastest growing segment of Germany's ITC sector, with recent growth rates of approximately 15% annually" (Lehrer 2000, 588). These growth rates of the German software industry are, according to Lehrer, accompanied by a huge need for employees in the industry and result in the manifestation of "a phenomenon not seen on this scale in Germany for decades: a dire labor shortage" (Lehrer 2000, 587). The developments described by Lehrer in 2000 have continued to the present time. Leimbach (2010), who still talks about a labour shortage in the sector, found 45,206 firms in the software sector in 2004 and about 54,101 firms in 2007. The number of employees also grew from about 504,000 in 2004 to about 564,000 in 2007. As for the biotech sector, the software sector is also dominated by small firms; its largest and most prominent representative is the SAP AG & Co KG.

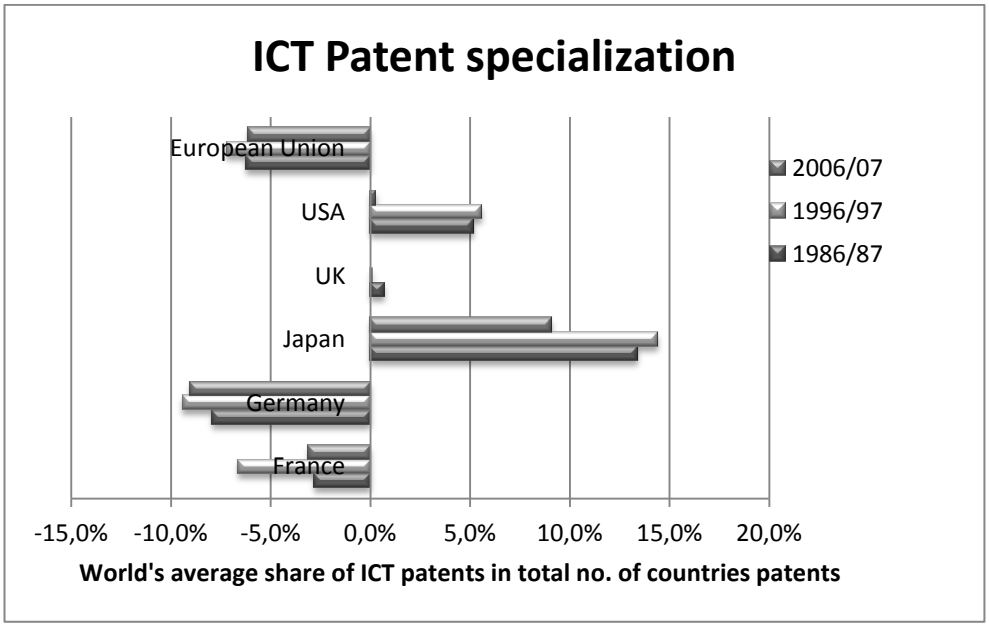


Figure 12: Specialisation in ICT patents across nations

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

	Total Patents	Total ICT Patents	World Share of ICT Patents	Share of ICT Patents in comparison to Countries' Total no. of Patents	VoC World
Year: 1986/1987					
France	8146	1991	7,5%	24,4%	-2,8%
Germany	20921	4048	15,3%	19,3%	-7,9%
Japan	17037	6931	26,2%	40,7%	13,4%
UK	7022	1958	7,4%	27,9%	0,7%
USA	25488	8266	31,3%	32,4%	5,2%
European Union	48107	10102	38,2%	21,0%	-6,2%
World	97081	26438	100,0%	27,2%	0,0%
	Total Patents	**Total ICT Patents**	**World Share of ICT Patents**	**Share of ICT Patents in comparison to Countries' Total no. of Patents**	**VoC Calculation**
Year: 1996/1997					
France	11871	3071	5,6%	25,9%	-6,6%
Germany	33144	7653	14,0%	23,1%	-9,4%
Japan	29659	13910	25,4%	46,9%	14,4%
UK	8826	2880	5,3%	32,6%	0,1%
USA	49210	18730	34,2%	38,1%	5,6%
European Union	77122	19529	35,7%	25,3%	-7,2%
World	168484	54769	100,0%	32,5%	0,0%
	Total Patents	**Total ICT Patents**	**World Share of ICT Patents**	**Share of ICT Patents in comparison to Countries' Total no. of Patents**	**VoC Calculation**
Year: 2006/2007					
France	16705	4304	5,7%	25,8%	-3,1%
Germany	47812	9502	12,7%	19,9%	-9,0%
Japan	42660	16192	21,6%	38,0%	9,1%
UK	11000	3180	4,2%	28,9%	0,0%
USA	64614	18843	25,2%	29,2%	0,3%
European Union	114840	26154	34,9%	22,8%	-6,1%
World	259247	74860	100,0%	28,9%	0,0%

Table 8: Data based on Figure12; world share and countries' share of ICT patents in the periods 1984–88, 1994–98, 2004–08.

Source: Own illustration, using OECD's European Patent Office data

6.2.2. VoC Calculation of the Software Sector's Performance – Research and Development Investments

The previously described R&D Scoreboard which annually lists the 1,000 strongest R&D investing firms in Europe and the 1,000 strongest firms in the rest of the world, has identified 13 (in 2005) and 16 (in 2008) German software firms amongst Europe's 1,000 strongest R&D investing companies. In 2008, these firms did invest more total money into their R&D than the 15 French and the 25 UK firms together. With 92 and €115m per firm invested, these big German software companies have invested more than the French and the UK firms have invested together, in both years, See Table 9: Data based on Figure 13; world share and countries' share of software R&D investments in 2005 and 2008.

In terms of absolute numbers, the Japanese numbers cannot be expected to be very representative since Japan is only represented by 2 firms in 2004 and 0 firms in 2008. Bearing in mind the filed patents in these years, as analysed before, it must be concluded that, in the face of very strong competition on the side of the USA (79% of the overall world share on R&D investments), the Japanese firms which were selected (as non-EU firms) in this extreme US context, could simply not have managed to maintain such a high level of investment. In real life, Japan is not only competing with the US (which is an extreme case compared to any other country) but also with the EU countries. A database, which would have selected the 1,000 strongest R&D investors in Europe and Asia, would have identified more Japanese software firms in a more appropriate way. In relation to the US, the Japanese measures cannot be seen as representative in showing Japan's actual performance in comparison to EU firms. Even though Germany does have a relatively high world share in terms of R&D investments, compared to other EU countries, it does, as for the ICT patents before, not show a high specialisation in this area and takes the last

place in a comparison of the three EU countries in both years in terms of the share of software investments in comparison to the countries' total investments. This can be seen when viewing Figure 13: Specialisation in software R&D investments across nations, which shows the VoC calculation based on each country's average share of software investments compared to countries total investments minus the world's average share of software investments compared to countries' total investments. With nearly a 10% share in software investments compared to the country's total investments, the US shows very high specialisation in this sector. The US (having a world share of nearly 80% of the total captured R&D investment in software firms, showing that it has many huge firms), as for the Biotech sector, strongly influences the world averages and, thereby, leads to a mirroring picture with any other country. The absolute numbers do indicate that, besides the huge outlier of the USA, the other countries, led by Germany are competitive in their own measures and do show growth in terms of total R&D investments from 2005 to 2008.

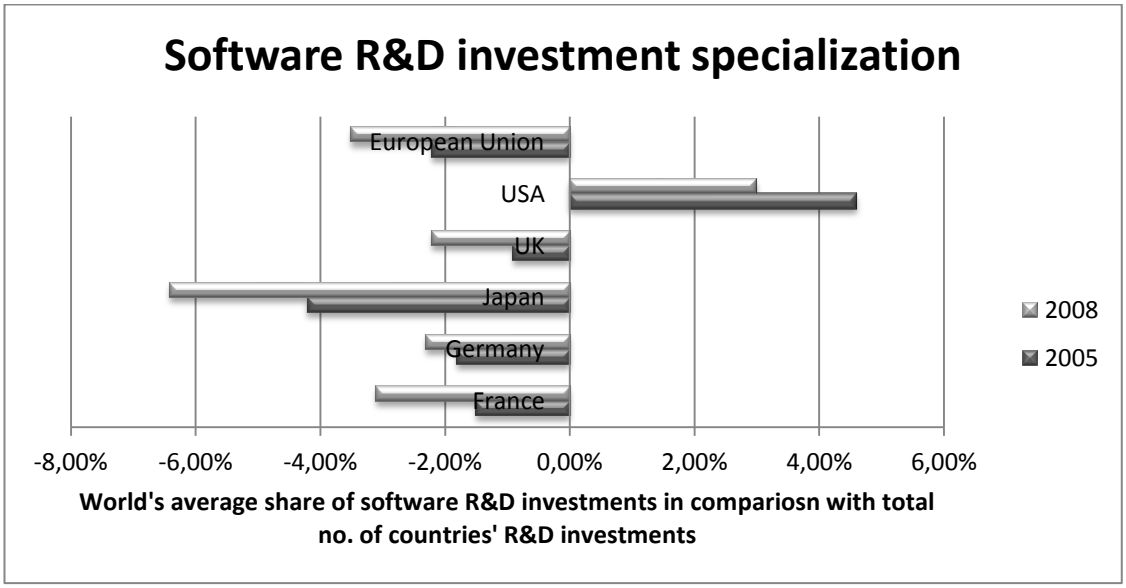


Figure 13: Specialisation in software R&D investments across nations

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

	Number of Firms for Calculation: Total Number; *software firms*	Total R&D investment €m	Total Software R&D Investment €m	Average Software R&D Investment per Firm	World Share of Software R&D Investments	Share of Software Investments in comparison with Countries' Total Investments	VoC
Year: 2005							
France	112; 17	21293,45	724,76	42,63	4,0%	3,4%	-1,5%
Germany	167;13	38455,24	1199,75	92,29	6,6%	3,1%	-1,8%
Japan	237;2	70075,21	446,07	223,04	2,5%	0,6%	-4,2%
UK	327;45	21402,39	848,42	18,85	4,7%	4,0%	-0,9%
USA	587;82	151129,80	14287,54	174,24	79,0%	9,5%	4,6%
European Union	1000;100	112876,47	3066,48	30,97	16,9%	2,7%	-2,2%
World	2000;189	370576,25	18094,76	95,74	100,0%	4,9%	0,0%

	Number of Firms for Calculation: Total Number; *software firms*	Total R&D Investment €m	Total Software R&D Investment €m	Average Software R&D Investment per firm	World Share of Software R&D Investments	Share of Software Investments in comparison with Countries' Total Investments	VoC
Year: 2008							
France	125;15	25746,93	852,55	56,84	4,4%	3,3%	-3,1%
Germany	209;16	45097,37	1846,79	115,42	9,6%	4,1%	-2,3%
Japan	256;0	93903,07	0	0	0	0	-6,4%
UK	247;25	19672,24	822,67	32,91	4,3%	4,2%	-2,2%
USA	531;54	159203,43	14956,63	276,97	77,6%	9,4%	3,0%
European Union	1000;77	130412,32	3835,06	49,81	19,9%	2,9%	-3,5%
World	2000;137	300414,34	19273,98	140,69	100,0%	6,4%	0,0%

Table 9: Data based on Figure 13; world share and countries' shares of software R&D investment

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

6.2.3. VoC Calculation of the Software Sector's Performance – Publications and Sales

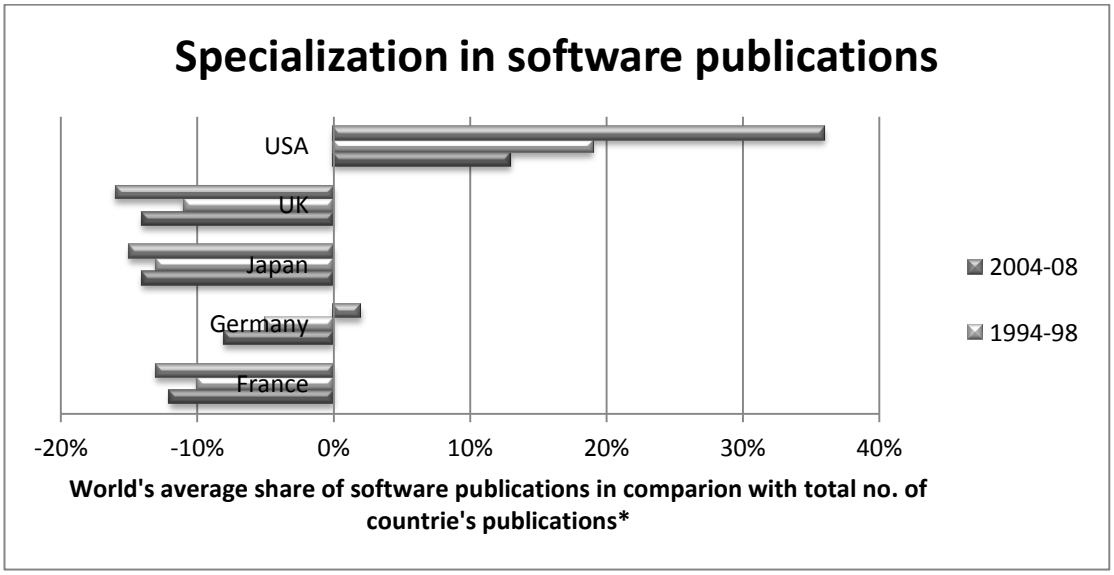
The *Science Citation Index Expanded* is again used to measure Germany's performance in publications, but this time for the software sector. By analysing the relative specialisation of software publications compared to other publications, the US outperforms all other nations, as seen in Figure 14: Specialisation of countries in software publications with regard to the Science Citation Index Expanded. The US does also show pretty impressive growth in terms of publication specialisation throughout the three measured timeframes.

Only Germany shows equally consistent growth in its software publications in relation to other publications in the measured fields. In relation to the other countries, it does, surprisingly, show the highest specialisation in this sector. An explanation of this pattern might be found in the previously described government policy which, contrary to government policies in the other two EU countries and Japan, from the early 1980s established a strong academic base for the software industry in Germany. This emphasis on academic strength and later on supporting university-company relationships may be seen also as the basis for the steadily growing number of scientific publications in the software sector, in relation to other areas.

As seen in the absolute counts of biotech publications before, the number of software publications does also appear to be very low in the first year, compared to the other EU countries and the following years. The absolute numbers, as illustrated by the total number of publications with the topic software and also the world share on software publications rose enormously in the two time periods which followed. Germany managed to publish nearly 10% of the world's publications on software in the period from 2004–2008 and, thereby, shows very strong specialisation in terms of

software publications of about 30% on total publications in the relevant area in the same period. For this time period, Germany managed to be above the calculated world average, which does appear again to be strongly influenced by the high US specialisation, which represents nearly 40% of the world's publications or four times as many publications as Germany.

It is not conclusive whether the number of publications, which showed a positive picture for German software firms in an EU comparison, and which goes hand in hand with the positive picture shown in terms of total R&D investments and patent counts, also indicates a high number of actual productivity, and more importantly, sold products. The further analysis of software firm sales will draw a clearer picture of the sector's overall performance.



*in the area of COMPUTER SCIENCE, MATHEMATICS and ENGINEERING

Figure 14: Specialisation of countries in software publications with regard to the Science Citation Index Expanded

Source: Own illustration, using data from the Scientific Citation Index Expanded for the periods 2004–08, 1994–98, and 1884–88

	Total Number of Publications*	Total Number of Publications with the Topic Software*	World Share of Software Publications	Share of Software Publications in comparison with Countries' Total Publications*	VoC
Year: 1984-1988					
France	8.702	229	2,4%	2,6%	-12%
Germany	318	22	0,2%	6,9%	-8%
Japan	10.035	135	1,4%	1,3%	-14%
UK	8.925	76	0,8%	0,9%	-14%
USA	12.616	3.496	36,8%	27,7%	13%
World	63.222	9.505	100,0%	15,0%	0%

	Total Number of Publications*	Total Number of Publications with the Topic Software*	World Sshare on Software Publications	Share of Software Publications in comparison with Countries' total Publications*	VoC
Year: 1994-1998					
France	18.962	1.510	4,3%	8,0%	-10%
Germany	18.026	2.388	6,7%	13,2%	-5%
Japan	20.950	1.160	3,3%	5,5%	-13%
UK	9.730	693	2,0%	7,1%	-11%
USA	36.946	13.747	38,7%	37,2%	19%
World	195.758	35.508	100,0%	18,1%	0%

	Total Number of Publications*	Total Number of Publications with the Topic Software*	World Share of Software Publications	Share of Software Publications in comparison with Countries' Total Publications*	VoC
Year: 2004-2008					
France	26.199	3.405	5,2%	13,0%	-13%
Germany	21.075	5.987	9,2%	28,4%	2%
Japan	23.963	2.774	4,2%	11,6%	-15%
UK	17.016	1.755	2,7%	10,3%	-16%
USA	39.210	24.198	37,0%	61,7%	36%
World	250.433	65.418	100,0%	26,1%	0%

Table 10: Data based on Figure 14; world share and countries' shares of software publications with regard to the Science Citation Index Expanded

Source: Own illustration, using data from the Scientific Citation Index Expanded for the periods 2004–08, 1994–98

Viewing the nation`s specialisation in software sales, the picture of Germany being most specialised within the three EU countries, which was indicated by the section on publications, can be confirmed. Over all, the US is once more the most specialised country in this measure as well. It is followed by Japanese firms, which, as mentioned before are not well represented in the used dataset and are, therefore, not even represented by a single firm in 2008. This representation is due to other reasons than a weak performance in the sales of Japanese software firms per se.

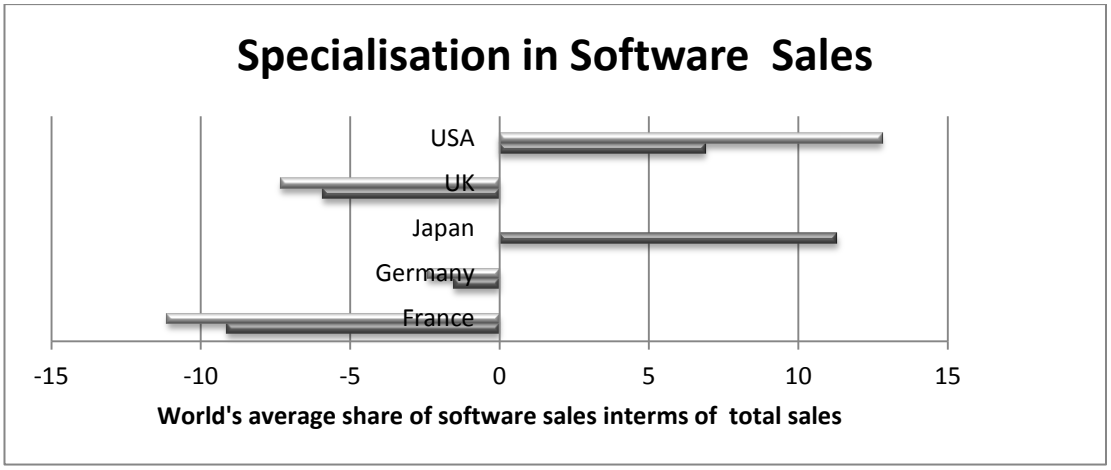


Figure 15: Specialisation in software sales across nations

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

By viewing the average net sales of software firms, Germany is again leading in comparison with other EU countries. German firms have as many sales in m€ as the French and UK firms together. These numbers have to be viewed carefully. The measured firms are large companies. These results would probably look different if more and differently-sized firms from each country were viewed. By viewing the world share of software sales, Germany is the only country which shows a significant increase in its share. German firms managed not only to hold but to increase their

sales from 2005 to 2008 even in comparison with other sectors' sales. They increased their sales more significantly than firms in other industries and even managed to increase their share of average net sales per software firm in terms of the country's total average net sales per firm in m€ from 10.5 to 11.3 million. Thus the analysis of net sales shows a positive picture for the performance of German software firms.

	Total Number of all Counted Firms	Total Number of all Counted Software Firms	Total Net Sales in Millions of Euro	Average Net Sales per Firm in Millions of Euro	Net Sales of Software Firms in Millions of Euro	Average Net Sales per Software Firms in Millions of Euro	World Share of Software Net Sales	Share of Average Net Sales per Software Firm in comparison with Countries' Total Average Net Sales per Firm	VoC
Year: 2005									
France	112	18	856772	7649,8	3981	221,2	3,2%	2,9%	-9,1%
Germany	167	13	1183080	7084,3	9652	742,5	7,8%	10,5%	-1,5%
Japan	237	2	1888390	7967,9	3704	1852,0	3,0%	23,2%	11,3%
UK	303	30	1298605	4285,8	7721	257,4	6,2%	6,0%	-5,9%
USA	584	81	3469041	5940,1	90885	1122,0	73,2%	18,9%	6,9%
European Union	1000	100	4376808	4376,8	23429	234,3	18,9%	5,4%	-6,6%
World	2000	190	10942777	5471,4	124167	653,5	100,0%	11,9%	0%

	Total Number of all Counted Firms	Total Number of all Counted Software Firms	Total Net Sales in Millions of Euro	Average Net Sales per Firm in Millions of Euro	Net Sales of Software Firms in Millions of Euro	Average Net Sales per Software Firm in Millions of Euro	World Share of Software Net Sales	Share of Average Net Sales per Software Firm in comparison with Countries' Total Average Net Sales per Firm in	VoC
Year: 2008									
France	125	15	1122020	8976,2	3609	240,6	2,8%	2,7%	-11,1%
Germany	209	16	1574169	7531,9	13665	854,1	10,5%	11,3%	-2,4%
Japan	256	0	2740655	10705,7	0	-	0,0%	-	-
UK	241	25	1347295	5590,4	8987	359,5	6,9%	6,4%	- 7,3%
USA	525	54	3542441	6747,5	96568	1788,3	73,9%	26,5%	12,8%
European Union	1000	77	5711821	5711,8	29194	379,1	22,3%	6,6%	-7,1%
World	2000	137	13897347	6948,7	130761	954,5	100,0%	13,7%	0%

Table 11: Data based on Figure 15: world share and countries' shares of software sales

Source: Own illustration, using data from "The EU Industrial R&D Investment Scoreboard"; 2006 and 2009

6.3. Summary of the Software Sector's Key Measures

As for the German Software sector, there appears generally not to be high specialisation in terms of ICT patents and also R&D investment. Viewing the other two measurements of publication counts, and annual sales, the VoC calculation does show that Germany (even though it is still mirroring the US) is the EU country leading in terms of specialisation. The argumentation of Hall and Soskice (2001) can still be confirmed, since even though the countries are compared, and not directly, the picture is still mirroring. As for the biotech sector, considered in the previous chapter, viewing only this part of the analysis, which is illustrated by the figures relating to relative specialisations across the analysed nations in the software sector, the notion of Germany being a radical innovator can clearly be rejected by viewing it in comparison with the US. Hall and Soskice`s conclusion that Germany lacks the ability to radically innovate and specialises in incremental sectors can be supported. Viewing the other countries' specialisations in the cross-national comparison on specialisation, Germany takes a leading role among the EU countries. Viewing the absolute numbers behind the VoC analysis seems to be even more relevant and exciting than before. From this perspective, Germany appears not just to be strong, but the leading EU country in this field. It produced between 12.5% and 15% of the world's ICT patents in the three measured time frames, raised its world share for software R&D investment to nearly 10% of the world share of investments in 2008 (raising its share more than any other country); it has almost 10% of the world's publications in the sector, publishing less only than the US, but as much as France and the UK together; after the US, Germany did also show the highest world share (from 7.8% in 2005 to around 10% in 2008) in software sales. Germany is not only found to be in a stable but a leading position for all measures in terms of an EU

comparison with the other two EU countries. Hall and Soskice`s assertion that Germany specialises in incremental innovation cannot be confirmed by these findings. It does appear, that an in-depth view opens up different perspectives and emphasises a critical view of the VoC calculation. The chosen policies in the software sector are very different from the policies in the biotech sector. Considering the growth of the measured data over time, the chosen approaches might have been helpful to support this development. The three steps of the government policies, starting with support of academics (establishing a strong research and training system in universities) and later its connection with industry can be argued to have positive effects, considering the high rates of publication and patents. Even though the software sector is (like the biotech sector) dominated by smaller firms, the active support of larger firms in terms of alliances, and of the growth of small firms, being supported by the government and the established alliances, seem to be of importance, considering the sales rates and the R&D investment rates. Government policies, even though they might have been implemented with less attention from the public and without picturing the sector as a key industry in the first instance, can be considered to have been very successful. In summary, Liecke`s (2009) findings on the German software sector being a "Hidden Champion" within the overall German economy may be confirmed. The notion of Germany being a radical innovator cannot be rejected, and, moreover, surprisingly it is confirmed by the measured data.

This previous chapter represents the first step towards understanding the reasoning behind VoC theory and assessing whether or not it can explain the trajectories of innovation found in a nation. The past chapter has discussed whether the changes in sectoral policy making might have influenced the ability of firms to prosper in this sector. It appears that, for example, in the case of biotechnology, various burdens were established through non-regulation, defamation and

obstruction, but were not given much public attention as negative emotions as well. In the case of the software sector, it appears that the sector was not well represented in the past. This has clearly changed recently. The reputation of the two sectors has increased, but their interests are still of secondary order compared to old, well established sectors which are well supported by lobbying e.g. in Bundestag (check the political consultancy Acatech).

7. CHAPTER SEVEN: INSTITUTIONAL CHANGE IN GERMANY: CAPABILITIES FOR RADICAL TRAJECTORIES OF INNOVATION

The theoretical framework of this thesis has identified several propositions for theoretical approaches. This chapter aims to examine the institutional changes in Germany since reunification. The results of the findings are discussed in the following chapter, aiming to identify answers to the first two research questions.

In 2014, Berlin celebrated the 25th anniversary of German reunification. This celebration reminded Germans of the fall of communism in the eastern parts of today's Federal Republic. Since the fall of the Berlin wall, a particular kind of free, American capitalism has been perceived to be superior to other forms of socio-economic systems (Ulrich 2014). In a country that is still feeling the aftermath of the recession following the global crisis of 2008, this celebration of capitalist superiority seemed strange to many observers. The public debates about economic restructuring (Zeit 2015) and (non-) growth that emerged at about the same time, seem to have become part of everyday life for members of all social classes (Schaper 2014). A particular *Zeitgeist* meeting a strong desire for sustainability was and still is driving public debates. Political parties (Kroker and Klös 2008; Özcüre et al. 2011) have tried to respond to these developments. Diverse discussions about finance (Sievers 2014; Neuhann 2014; Meyer-Rüth 2014), in line with a desire for restrictions to financial markets on an EU level, and in terms of the *black zero* on a national level (Oltermann 2014; The Economist 2014); social policy and the labour market (SPD-Parteivorstand 2013; Arni u. a. 2014; Knabe, Schöb, and Thum 2014) have emerged.

In November 2014, legislation was passed, that set the first national minimum wage of 8.50 Euro per working hour for employees. Germany`s Liberal Party (FDP) and employers` associations have criticised this bill and other recent policies by the government ("Investitionsschwäche in Deutschland" 2015). They have argued that federal chancellor Angela Merkel has reversed her previous course of action concerning the national innovation system ("Deutschlands Spitzencluster" 2014). These critiques have predicted economic stagnation arising from Germany`s non-investment and non-growth strategy. In *Europe's Economic Suicide*, Paul Krugman (2012, A19) strongly criticises German fiscal austerity as driving depressed EU countries "off a cliff". His article gained public attention internationally and adds to the debate on the role of German policy making in the EU and the current Greek crisis (Lewis 2015; Tompson, Price and Organisation for Economic Co-operation and Development 2009; Troianovski 2015). The political and socioeconomic developments, sketched so far, highlight the importance of *Soziale Marktwirtschaft* (BAVC 2009; Vogt 2010) not only in Germany but also for the whole of the European Union at this time (Scharpf 2010).

> "Christian Democrats and Social Democrats have finally managed to write the commitment to create a European social market economy (SME) into the hard letter of Art. 3(3) of the Lisbon Treaty on the EU. So the finalité of the European political economy is going to be redefined by the ideas that have shaped the socially inclusive and institutionally coordinated SMEs (...)" (Scharpf 2010, 211–12).

These observable developments stand in sharp contrast to some propositions underlying one of the most famous and still taught theories in European Management Classes: Varieties of Capitalism (VoC) theory. VoC theory assumes a liberalisation of the German CME (Eichhorst 2014; Herrigel 2014). A second contradiction appears in the proposition that Germany is an incremental innovator which is dominated by welfare production regimes (WPR) leading to inequaity. Compared to

other EU countries, my previously illustrated finding is that Germany appears to perform well in at least two new and emerging markets (Datamonitor 2011; Federal Ministry of Education and Research 2010; Lang, Schneider and Bauer 2012; Leimbach 2010). Since Germany is described as a major example of a CME in terms of VoC, this observation contradicts the general proposition that CMEs have weak performance in *radically* innovative sectors. Radical Innovation is one "(...) which entails substantial shifts in product lines, the development of entirely new goods, or major changes to the production process (...)" (Hall and Soskice 2001, 38). On the institutional level, the German labour market and, with this, the nation's collective skill formation system have undergone severe changes over the past 25 years. This has been as a result of cultural evolution, and these slow internal changes of the German political economy in the area of skill formation leave Germany with coordinated LMIs and a skill formation framework. Due to international pressure, the German CG system has developed into an internationally recognised and transparent standard. The CG system is still characterised dy employee participation and stakeholder orientation, including our present understanding of *soziale Marktwirtschaft*[7] which is incorporated into the German Corporate Governance Kodex (Ringleb et al. 2014). At the heart of the debate about which institutional outlook might lead democratic capitalist nations towards comparative economic advantage, this chapter aims to determine the directions of changes in German LMIs, skill formation, and the outlook of the German job market during different political regimes over the past 25 years. Comparative institutional advantage is defined as "(...) the institutional structure of a particular political economy [that] provides firms

[7]"Der Kodex verdeutlicht die Verpflichtung von Vorstand and Aufsichtsrat, im Einklang mit den Prinzipien der sozialen Marktwirtschaft für den Bestand des Unternehmens and seine nachhaltige Wertschöpfung zu sorgen (Unternehmensinteresse)" (Ringleb et al. 2014, 5:1).

with advantages for engaging in specific types of activities there" (Hall and Soskice 2001, 37). In a second step, changes in German CG in the context of financial globalisation are discussed. The third part of this chapter look at the institutional sphere of industrial relations and aims to discuss the proposition, arising from VoC, about corporation's influence over policy making. The relationships between actors within the German economy are discussed. It further aims to give meaning to the interconnection between changes in both LMIs and the skill formation system and what this means for international competition. The theoretical intention is to modify VoC theory so that it no longer offers such a simplified view of a CME's inability to create radical innovation. It is important to illustrate the functioning of different capitalist nations, with different actors within each society (non rational/ all-knowing workers, employee, and employer associations/and their associated research institutes, educational systems, as well as government policy). In this context, the given chapter focuses on the first two research questions.

This chapter aims to identify possible changes within the institutional spheres of the German CME. It focuses on such changes which might influence the skill formation system of the country, but also the decision making within firms. The following analytical part of this chapter consists of an analysis of changes in German institutions. The conclusion partly reflects on RQ IV and refers to its implications and theoretical contributions. Limitations are shown and further questions raised.

7.1. Skill Formation, Labour Market Changes, Job Market and the German Welfare State

A clear picture of the assumed relationship between CMEs' institutional spheres and trajectories of innovation in the context of VoC has been drawn and discussed in the

previous literature review. Several research questions have been identified. In an attempt to shed light on these, this chapter discusses the historical developments in skill formation, LMIs/ social policy as it influences the job market and skill profiles available for firms. The longitudinal view is from 1989–2014, 25 years (since reunification).

7.1.1. Changes in German Labour Market Institutions since 1990

With 41.6 million people employed in 2012, there have never been so many people employed in Germany before. In this context, the numbers of employees covered by social security contributions have increased (Jeder Job zählt 2013). Since then, the numbers of people in employment living in Germany have further increased and they reached another high of 43 million people in October 2014 (Erstmals 43 Millionen Erwerbstätige im Oktober 2014 2014). While employment has increased over the past ten years, unemployment as a percentage of total citizens has decreased. The question arises about how Germany has achieved these high numbers. The two figures below illustrate German employment over the past ten years.

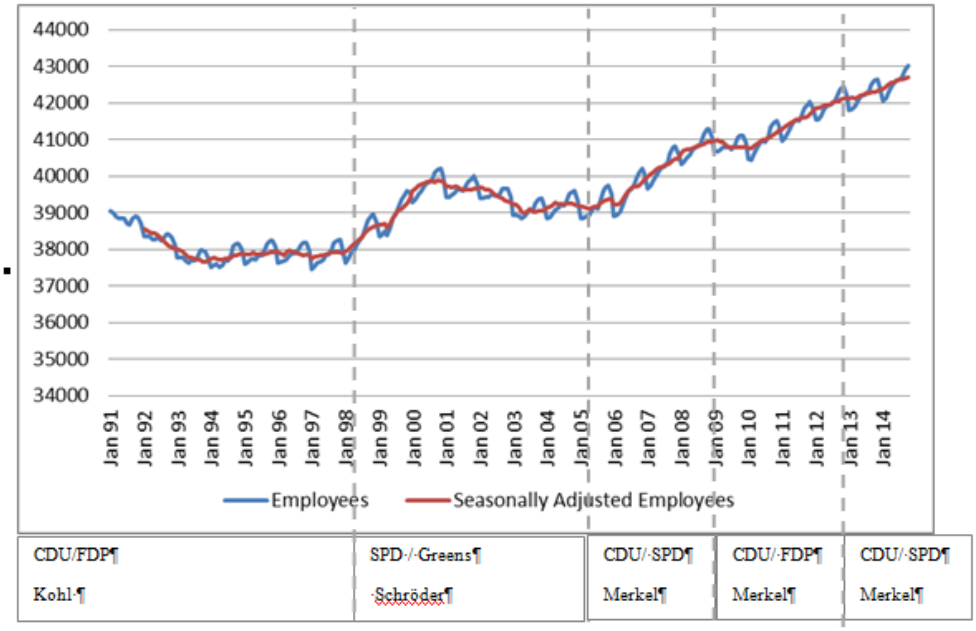


Figure 16: Employees covered by social security (employees and seasonally adjustment) contributions per quarter since 1991 and elected governments

Source: Own illustration

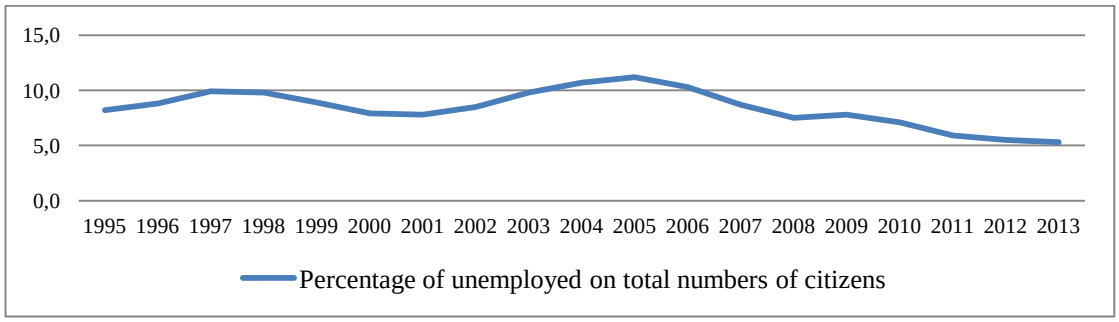


Figure 17: Percentage of unemployed people compared to total number of German citizens

Source: Own illustration using data from Eurostat (2014)

Compared to previous developments in the labor market, such an outlook is a surprise. In the face of reunification, various scholars (see e.g. Buttler, Schoof and Walwei 2006; Schneider 1999) who would have expected a rather strong increase in employment during the 1990s were disappointed. Contrary to expectations, the Federal Republic of Germany was achieved an average annual employment rate

increase of 0.3% between 1993 and 2003, and this was rated the lowest average growth by OECD in 2006 (OECD 2006). In *Arbeitsmarkt- and Beschäftigungspolitik nach der Wiedervereinigung* Feil, Tillmann and Walwei (2008) refer to OECD's (2005) emphasis on an increase in employment as the one central construct for the full development of Germany's potential for economic growth performance. Therefore, the question of how Germany might have achieve high employment, whilst paying social security contributions and, therefore, supporting the welfare system needed to be addressed. In terms of labour market policy, Feil et al. (2008) describe government action as focusing on two key themes: attempts to avoid the emergence of new unemployment and attempts to reduce existing unemployment. In this context, the regimes in power (differentiated into the Kohl, Schröder and Merkel regimes for reasons of simplicity), have initiated a variety of political reforms. In Table 12: Political Regimes and Reforms in the Federal Republic of Germany since 1990 diverse reforms which may have had an effect on the labour market are briefly outlined.

Year	Occurrences	Political Regime in Power	Date of Effect – Reform
1990 Elections	German reunification	Re-election of Federal Chancellor Helmut Kohl **CDU** (Christian Democratic Union of Germany) in a coalition with FDP (Free/Liberal Democratic Party)	11.1995 – first attempt at a *Bündnis für Arbeit* 09. 1996 – Agenda for the promotion of economic growth and employment – ***Programm zur Förderung von Wachstum and Beschäftigung***[8] – Continuation pay for employees on sick leave reduced from 100% to 80% of average salary – Lay-off protection reduced. Firms with less than ten employees (previously five) received no general protection against dismissal – The conclusion of temporary and short-term employment contracts made easier by changing the labour law regulation to promote employment 12.1997 – Formal introduction of *Sozialgesetzbuch III*[9] as the successor of *Arbeitsförderungsgesetz*[10]
1994 Elections			
1998 Elections	First complete voting out of a German Federal Government	Voting out of Helmut Kohl and the CDU	05.1998 – Kohl signs the EU contracts for the German redenomination into the Euro
1998- Elections		Election of Federal Chancellor Gerhard Schröder **SPD** (Social Democratic Party of Germany) in a coalition with Die Grünen (The Greens)	12.1998 – Laws for the correction of social insurance and to secure the rights of employees approved[11] (Bundesgesetzblatt 1998) 01.1999 – Continuation pay for employees on sick leave reinstated and increased from 80% to 100%, – Lay-off protection re-increased *Steuerreformen 2000 –* Reforms of corporate taxation in 2001 2001 – *Teilzeit- and Befristungsgesetz*[12] 11.2001 – Job-AQTIV Laws **2002 *Hartz I, II, III, IV* Laws** (see Schubert & Klein, 2011) – *Bildungsgutscheine* – *Personal-Service-Agenturen* – *ICH-AG* – *Mini and Midi Jobs* (400 Euro) – Reduction of the period for which unemployment benefit 1 is payable (12 months) – Jobcentres introduced and divided from Agentur für Arbeit – Combining unemployment and social
	Agenda 2010		
Elections 2003			

8 Esp. Arbeitsrechtliche Beschäftigungsförderungsgesetz
9 Code of Social Law
10 Law for the promotion of employment
11 "Korrekturen in der Sozialversicherung and zur Sicherung der Arbeitnehmerrechte" (Bandesgesetzblatt 1998)
12 Law for the regulation of part-time work and fixed-term contracts of employment.

			insurance into one. Aiming for improved flexibility of the labour market (Dingeldey 2010) 01.2004 – Bandesagentur für Arbeit (Jobcentre) can legally target agreements with individuals e.g. concerning individual job choice 01.2004 – Partial abolition of the *Großer Befähigungs-nachweis*[13] as a right to take up and pursue activities as self-employed persons 12.2003 – *Gesetz zu Reformen am Arbeitsmarkt*[14](Bundesgesetzblatt 2003) 12. 2004 – Removal of standard entitlement to unemployment benefits 12. 2004 – Introduction of *Arbeitslosengeld II/ Harz IV*[15]
Elections			
2005 -		Election of Federal Chancellor Angela Merkel **CDU (Christian Democratic Union of Germany)** in a coalition with SPD	03.2006 – *Acht Punkte Plan* including future strategies for Research and Innovation 01.2008 – Reduction of unemployment insurance 01.2008 – Increase of the period for which unemployment benefit I is payable to older employers (above 50 years – 24 months) **2008 – *Beschäftigungssicherung durch Wachstumsstärkung*** *2008– 09 Konjunkturprogramm I*[16] e.g. 2009 – *Umweltprämie* *2009–10 Konjunkturprogramm II* *e.g. 2010 – ZIM (Zentrales Innovationsprogramm Mittelstand)* 11.2014 – *Schwarze Null* was approved by the federal government 01.2015 – A minimum wage of 8.50/ work hour introduced for the Federal Republic of Germany
Elections 2009		Coalition with FPD	
Elections 2013		Coalition with SPD	

Table 12: Political regimes and reforms in the Federal Republic of Germany since 1990

Source: Own illustration using various sources cited in the text

13 Eligibility passport/certificate of competency
14 Laws for reformatting the labor market
15 Unemployment benefit 2 for long-term unemployed
16 Pakt für Beschäftigung and Stabilität in Deutschland zur Sicherung der Arbeitsplätze, Stärkung der Wachstumskräfte and Modernisierung des Landes

After the formal reunification of East and West Germany in 1990, the former federal chancellor Helmut Kohl was re-elected as representing the CDU in a coalition with the FDP (free/liberalist party). Following reunification and an extensive level of unemployment in Germany in 1991/92, a liberalist view of the labour market was to argue for more flexibility of the labour market and a higher degree of income inequality as the solution to encourage higher employment (Snower and Merkl 2006; Sturn and van Treeck 2010). It was argued that higher flexibility would weaken employees' power in wage negotiation and would, therefore, lead to lower wages for employees and thus job creation even though of consistent measures of inflation. In 1995, the Kohl regime aimed to introduce a first version of *Bündnis für Arbeit*, which incorporated the IG Metall as well as other trade unions and employer associations. In 1996, the evolving *Bündnis* aimed to trade in trade unions' wage-moderating powers in exchange for committed job creation by employers**.** Since the federal government was not willing to renounce modifications of social policy, German trade unions recalled their agreement (Bündnis für Arbeit, Ausbildung, and Wettbewerbsfähigkeit 2003). The Kohl regime further introduced the *Programm zur Förderung von Wachstum and Beschäftigung*[17] in 1996, characterised by measures such as reducing continuation pay for employees on sick leave from 100% onto 80% of average salary and reducing lay-off protection. Firms with fewer than ten employees (previously five) received no general protection against dismissal, and the conclusion of temporary and short-term employment contracts was eased by changes to labour law regulation to promote employment. Such reforms led to nationwide demonstrations against social cut-offs in health and social pension insurance and, in 1998, the government was voted out –the first time a

[17] Esp. *Arbeitsrechtliche Beschäftigungsförderungsgesetz*

German Federal Government has been completely voted out. In terms of labour market reforms, the Schröder regime can be divided into two periods. During the first period between 1998 and 2001, laws for the correction of social insurance and to secure the rights of employees were approved[18] (Bundesgesetzblatt 1998) followed by reforms of corporate taxation and the introduction of laws for the regulation of part-time work and fixed-term contracts of employment. These attempts were shortly followed by Job-AQTIV laws, the founding bricks of the 2002 *Hartz I, II, III,* and *IV* reforms (see Schubert and Klein 2011). The accompanying *Agenda 2010* and its extensive reform of German social- and labour-market policy have and are still being discussed (DIE WELT 2014; Dingeldey 2010; Fahr and Sande 2009; Krebs and Scheffel 2013; Schütz 2012) controversially throughout society. By combining unemployment and social insurance into one, introducing *Mini and Midi Jobs* (400 Euro) and reducing the period for which unemployment benefit I is payable to 12 months, the government`s aim was to establish a low-pay employment sector and improved flexibility in the labour market (Dingeldey 2010). Structural problems with the Bandesanstalt für Arbeit (Trampusch 2002) were targeted by dividing the agency into two independent institutions (*Agentur für Arbeit*[19] and *Jobcenter*[20]), which were enabled to legally target agreements with individuals e.g. concerning individual job choice, leaving unemployed without any standard entitlement to unemployment benefits. Additionally, the Agentur für Arbeit and the Jobcenter were enabled to promote self-employment financially, with additional social insurance payments and various training options. A partial abolition of the *Großer Befähigungs-nachweis*[21] as a right to take up and pursue activities as a self-employed person and the

[18] "Korrekturen in der Sozialversicherung and zur Sicherung der Arbeitnehmerrechte" (Bandesgesetzblatt 1998).
[19] Responsible for newly unemployed people receiving unemployment benefit I.
[20] Responsible for long-term unemployed people receiving unemployment benefit II.
21 Eligibility passport/certificate of competency.

establishment of alternatives to the common GmbH, e.g. *ICH- AG* and *GbR*[22] meant that easy ways to become self-employed got introduced. Obviously, these unexpected reforms of Schröder's second legislation period created massive protests and were followed by the re-election of a CDU/FDP regime led by Angela Merkel in 2005. Instead of further direct labour market reforms, Merkel presented a *Acht Punkte Plan* including future strategies for research and innovation aimed at changes such as cluster formation, the establishment of national champions, cooperation among these firms, and increases in R&D investments in innovation and new technology/renewable energy. Such government intervention in the National Innovation System of Germany represented a shift of thought away from increasing labour market flexibility and employment creation leading to higher growth and towards R&D investments in innovation leading to growth and, in turn, an increase in employment which could then facilitate social security and the welfare state. Schröder's self-sacrificing reforms which established a low-pay employee sector might be considered the enabling foundation for this development (Dustmann et al. 2014). Merkel further increased the period for which unemployment benefit I is payable to older employers (above 50 years – 24 months) and was re-elected in 2008. Following the global crisis of 2008, the Merkel government introduced a package of regulation called *Beschäftigungssicherung durch Wachstumsstärkung* (Securing employment by increasing economic growth) supporting German key industries like the automobile industry and eventually allowing these sectors to overcome the global crisis in a fair shape. In 2010, Merkel continued launching research and innovation and introduced *ZIM (Zentrales Innovationsprogramm Mittelstand)* which focuses on innovation in small and medium large firms dominating the German market economy

22 Gesellschaft bürgerlichen Rechts as a German version of the English Ltd.

and inhibiting a majority of employees. Since Merkel's re-election in 2013 and the complete removal of liberal democrats (FDP) from the Bundestag, the introduction of a nationwide minimum wage of 8.50 Euros was decided upon and introduced in January 2015. The effects of such a reform, as well as the aim to hold on to a Black Zero (Meyer-Rüth 2014) in Federal Governments household, is being critically observed and extensively criticised by employer associations and their research institutes e.g. Institut der Deutschen Wirtschaft Köln (IW) (CESifo-Gruppe München – Der flächendeckende Mindestlohn von 8.50 Euro gefährdet bis zu 900.000 Arbeitsplätze 2014; Knabe, Schöb and Thum 2014).

Government policy drifted away from employment creation as being the source of growth, towards R&D investments in innovation as a facilitator for economic growth and employment, in turn.

7.1.2. Changes in German Skill Formation

In *Capital and Competence – Can one be achieved without the other?* (*Kapital and Kompetenz – ist das Eine ohne das Andere zu haben?*), Vielberth (2004) raises the question of whether businesses could exist without skilled labour and concludes that businessmen can only be successful by not only optimally using skills inherent to their workforce but by assessing the additional knowledge which continuously emerges in all fields of the economy and applying this new knowledge to their own businesses, meaning to continuously let their workforce increase their skills by incentivising learning and training. Such an approach appears to make sense especially in times of globalisation and increasing competition. The underlying concepts of *Human Capital* (Becker 1962; Becker 2009; Becker, Murphy, and Tamura 1994; Heckman 2000), as well as those on a *knowledge society* and *learning organisation* (Bennett and O'Brien 1994; Foray and Lundvall 1998; Lundvall and

Johnson 1994; Nielsen and Lundvall 2003) as being important for economic performance (Hitt et al. 2001; Lundvall et al. 2002b) are obvious. When it comes to the *Political Economy of Skill Formation* (Green 2013; Brown, Green and Lauder 2001; Busemeyer and Iversen 2012; Vlandas 2013; Lucio et al. 2007), authors such as Marius Busemeyer and Christine Trampusch (2012a) who have studied a number of CMEs that share *collective organisation* as the main characteristic of their vocational training system find that, in countries such as Germany, "(...) firms, intermediary associations, and the state cooperate in the process of skill formation in initial vocational training". As mentioned during the theoretical introduction, the paradoxical reasoning of the VoC approach assumes that CMEs such as Germany inhibit firm-specific skills, rigid LMEs and therefore specialise their performance in so called incrementally innovating sectors. Busemeyer and Trampusch (2012a, 10) find that "[t]he distinction between (...) general and specific skill systems is very broad (...)" and therefore not satisfying. Research in the area of skill formation as a driver of specialised national production necessarily needs to focus on different levels. In order to properly operationalise the concept of *skills*, a micro-level approach, focusing on this construct, as an ability inherent to thinking and feeling creatures, needs to be developed in the first place. Therefore, topics such as needs, motivation, feelings and basic rules of human decision-making need to be addressed from a psychological perspective (Green 2013) bringing constructs of *Human Capital Theory* (Heckman 2000) and instruments of *Human Resource Management* (Marsden and Belfield 2010) into the picture with regard to skill formation (Busemeyer and Trampusch 2012).

The ways in which these skills are adopted and later applied in the work place by people, as well as the question of why these specific skills are being applied at that specific workplace, draws on the historical evolution of the nation’s standard

employment relationship (Bosch 2004) and most recent developments in times of global crisis (Heyes 2013) need to be assessed in the second instance. The question of who might be the drivers of the formation of skill equilibria should then be asked, reconsidering the role of Trade Unions (Mahnkopf 1992) in CMEs. Consideration of which skill equilibria might be needed in the future (Hilbert and Schömann 2004; Lowry, MoIloy and McGlennon 2008; Schmidt 2004) and how skill formation might than be established, should be given. Since, from a macro perspective, "[p]olicy debates across advanced industrial economies are stressing the centrality of skills and training to compete in the new ‘knowledge economy’" (Lloyd 2002, 64) an assessment of the ascribed and the actual found role of the political economy of skills and skill formation variation for national performance needs to be done. In this context the propositions on CMEs arising from VoC that they inhibit certain skill levels and LMIs and their relationship towards each other, as well as production specialisation and "cross-national variation in skill profiles and the association between firm-specific skills and levels of employment protection" (Edland and Grönland 2008), need to be re-considered. An alternative simplistic relationship between the influence of LMIs on the political economy of skill formation and further on the sectoral specialisation of innovation, all supported by incentives from federal government, is proposed and needs to be further assessed.

As previously shown by the examples of the Kohl, Schröder, and Merkel regimes, labour market politics in Germany has changed throughout the past two decades. Lowering the unemployment rate is no longer seen as the key to promoting the economy. Therefore LMIs have not continuously been reformed since 2005. In contrast, recent policy-making aims to promote innovation, which is seen as a solution for national economic performance and also lowering unemployment rates. Another focus of the Merkel regime lies in promoting national skill formation

(BMBF 2012a) especially in scientific areas, such as mathematics, informatics, natural science and technology. These fields are argued to be of high relevance for new and emerging technologies as well as economic sectors, such as nanotechnology, software, biotechnology and renewable energy which are associated with the term *radical* innovation. Changes in policy-making illustrate shifts in the understanding of the relationships between LMIs, skill formation and innovation, as interrelated concepts. The current outlook of German LMIs has found its basis in Merkel's incentives for national skill formation (such as Hochschulpackt 2020 and MINT) which have been created to complete Germany's first high-tech-strategy (Federal Ministry of Education and Research 2010). Aiming to promote national competitiveness and innovation, the German government has (besides other instruments e.g. the promotion of Clusters, university-firm linkages in R&D, governmental R&D investments in emerging markets) made it a task to promote national skill formation in chosen fields. Even though the OECD reports mention the high specialisation of Germany (compared to other nations) in MINT degrees, within Germany in August 2017 the industry was short of up to 274,600 mint workers for the first time. Due to demographic changes and Germany's further specialisation in high-tech areas, MINT graduates find their way into industry and the job market without problems (see Berger 2017; Berger et al. 2017).

The paradoxical reasoning in the VoC approach assumes that CMEs such as Germany inhibit firm-specific skills, rigid LMEs and therefore specialise their production in so-called incrementally innovating sectors. Busemeyer and Trampusch (2012a, 10) find that "[t]he distinction between (...) general and specific skill systems is very broad (...)" and, therefore, not satisfying. Research in the area of skill formation as a driver of specialised national production does necessarily need to focus on different levels. For this reason, I am choosing to take a more differentiated

view on skill formation. Instead of a dichotomist division between general vs. firm-specific skills, I am looking at sector specific developments in a second step. Within the given context, this dissertation focuses on the inability of CMEs to create radical innovation; therefore, I focus on sector-specific changes within the sphere of general skills (for which theory argues to create radical innovation). One of the main characteristics of the German skill formation system is the collectively organised dual apprenticeship system. For the past ten years, the German government (Merkel regime) has continuously emphasised the role of university level education (Nickel 2011). The *Hochschulpakt* (Higher Education Pact for more university entrants) (Band and Länder 2007; Band and Länder 2011), Exzellenz Initiative (Excellence Initiative for Cutting-Edge Research at Institutions of Higher Education) (Band and Länder 2009), MINT (short for Mathematics, Informatics, Natural Science and Technology) (BMBF 2012a) and the Pact for Research and Innovation (Pakt für Forschung and Innovation 2014) has shaped the outlook of German skill formation towards a generalisation of skills. In terms of general skills, Figure 18 below illustrates this increase quite well. Other nations are used for comparison.

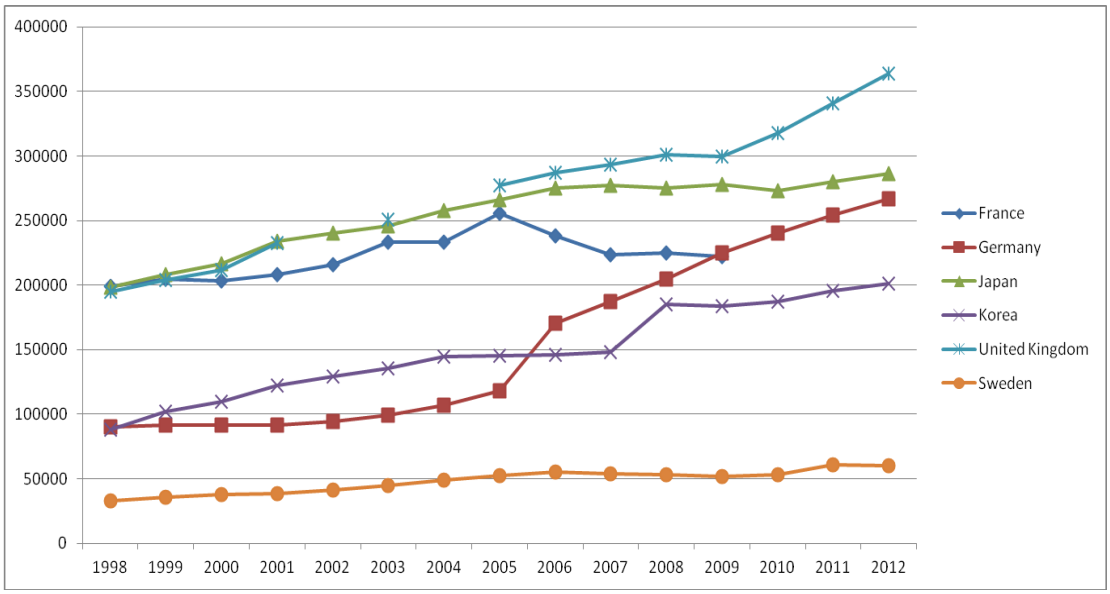


Figure 18: Graduates by field of education: Tertiary Type A and advanced research programs, all educational programs, total over all fields of study

Source: Own illustration using data from OECD.Stat. Dataset Graduates, all graduates in all fields for TertiaryType A and advanced research programs; data extracted on 16 Dec 2014 11:33 UTC (GMT)

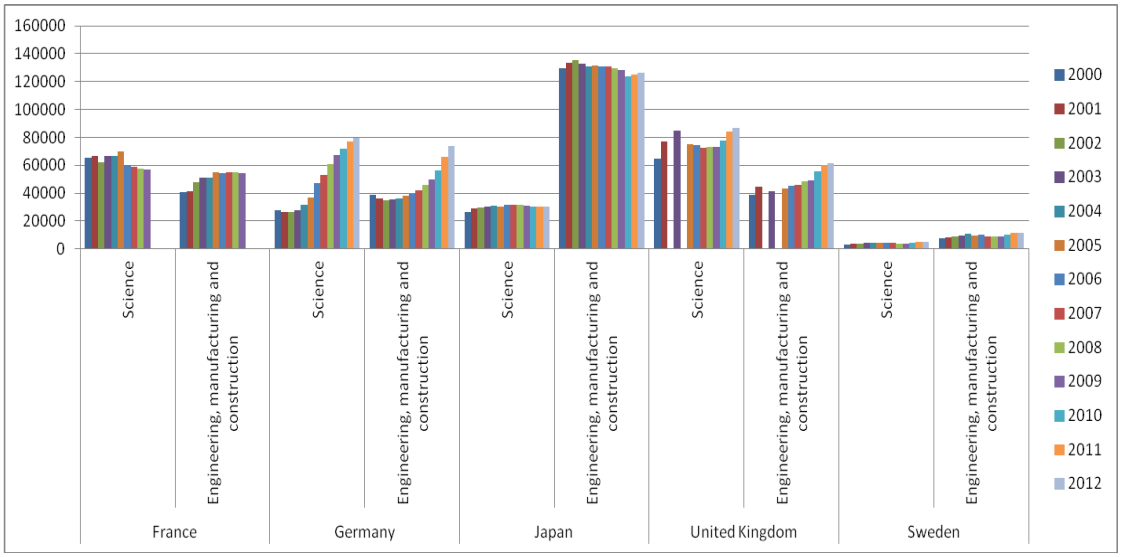


Figure 19: Total numbers of graduates in science and engineering for five countries

Source: Own illustration using data from OECD.Stat. Dataset Graduates, all graduates in two fields (Science, Engineering) for Tertiary Type A and advanced research programs, per country and year; data extracted on 16 Dec 2014 11:33 UTC (GMT)

As previously mentioned this thesis advocates a sector-specific view. Following the German federal government's policy incentives, one would not only expect to find an increase in the numbers of university graduates but specifically increased numbers of graduates in science. This expectation can be confirmed by looking at Figure 19 below.

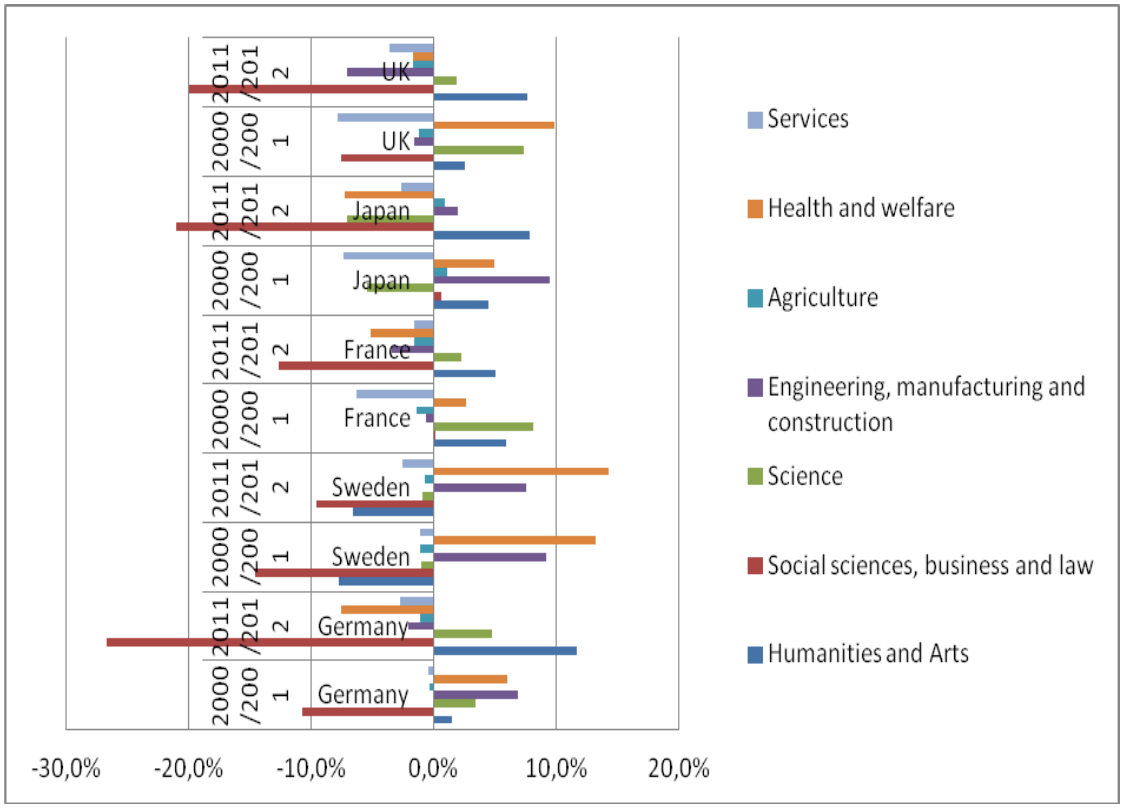


Figure 20: Relative specialisation of graduates in selected fields and countries 2000/2001 and 2011/2012

Source: Own calculation and illustration using Dataset Graduates by field of education from OECD.STAT for Tertiary Type A and advanced research programs.

This increase in university graduates in science appears to be strong enough to indicate shifts in the outlook of the nation's overall educational specialisation. In this context, Germany is the only country in comparison that has managed to further

specialise its university graduates in science, as illustrated in Figure 20: Relative specialisation of graduates in selected fields and countries 2000/2001 and 2011/2012.

The skill formation system is creating increasing numbers of general skills. Within the context of an increase in university graduates, there is further specialisation in science graduates.

7.1.3. Changes in the German Job Market: Where does the Work Force end up in Industry?

Due to the demographic changes, German firms now demand more new graduates than twenty years ago. So larger parts of the previously described university graduates go into Germany's well-established incrementally innovating firms without increasing the actual employment numbers in the sectors – due to an increased retirement rate. In the previous part of this thesis, I found that the relative specialisation of graduates in the machinery sector has decreased, in spite of continuously growing numbers of graduates. For this reason, one could argue that the overall employment e.g. in sectors such as manufacturing (related to the machinery sector as a potential employer) has decreased. This suggestion can clearly be supported by looking at numbers of actual employment per sector in Germany: Figure 21: Employment in Germany by sector in total/thousands. The previously described increase in Germany's science graduates in terms of proportion of total graduates was illustrated. Referring to the theoretical framework of skill formation shaping comparative economic advantage, I argue that we find that continuously increasing numbers of graduates end up in radically innovative sectors. With this, I mean sectors which focus on newly emerging technology (potential employers of science graduates). The demographic change outside the analysis can be considered by looking at changes in the relative specialisations of radical sectors in terms of total employment, in comparison with national total employment. This thesis takes a very specific view in the analyses by complementing OECD data with

sector-specific data extracted from the two German sector representatives' annual reports. Figure 22illustrates these developments.

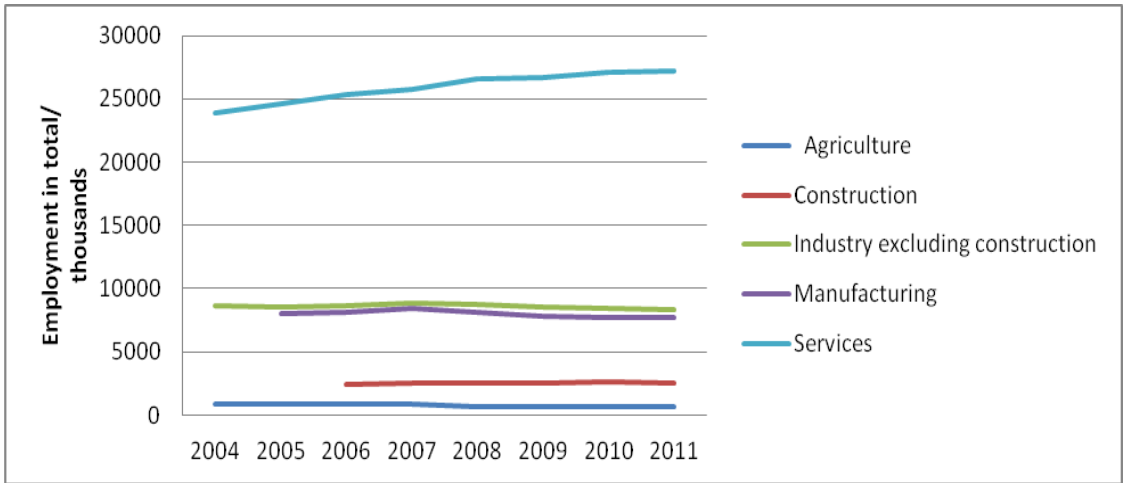


Figure 21: Employment in Germany by sector in total/thousands

Source: Own illustration using OECD data (2015)

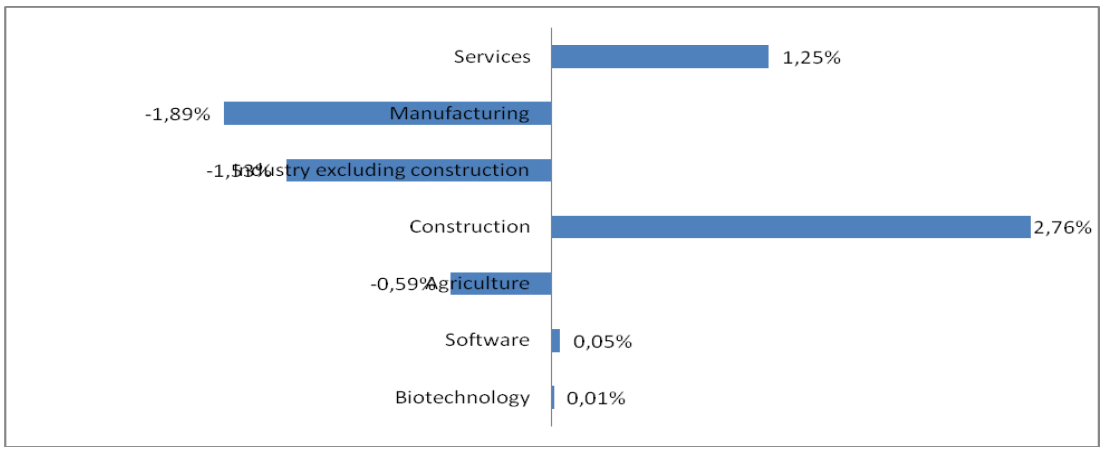


Figure 22: Growth rate of sectoral employment in comparison with total employment as different from 2004/2005 to 2010/2011

Source: Own illustration using data from biotechnologie.de (2014); BMBF – biotechnologie.de, 2013, 2012, 2009, 2007; BMWi, 2014, 2012, 2010

Whereas we can observe well-expected growth in the service and construction sector's employment, the two young and "radical" sectors, biotech and software are slowly increasing their employment in relation to the nation's overall employment rate from 2004/05 to 2010/11. Throughout the observed timeframe, the ICT sector became Germany's second largest employment sector after the machinery sector with software service and production being the ultimate reason for the sector's growth (BITKOM 2015).

Germany's graduates increasingly end up in radically innovative sectors. Since 2005, Merkel's government has focused policy on the national innovation system. One set of policy aims to strongly support university spin-offs and start-ups in general, but especially technology-oriented university spin-offs, with a focus on high-tech industries. These can receive special financial and other support for the first (up to) five years of their existence (see e.g. EXIST-Gründerstipendium 2012). As a result of this new regulation, we can find increased numbers of start-ups and small but innovative new firms in the technology sectors as well as increased levels of investment in these firms (Ernst and Young 2014). These new firms fit in well with the overall NIS of Germany, which is characterised by high numbers of small and medium large firms as on large firms in comparison to the outlook in other countries such as the UK or US (BMWE 2014).

Increased numbers of science graduates end up in Germany's radically innovative sectors, such as biotech and software. The overall outlook of SMEs dominating these new and emerging sectors is reinforced by the government's focus on supporting start-ups´in these fields.

7.1.4. Changes in German Social Policy and the Welfare State

Contrary to most of propositions arising from VoC, the proposition relating to WPRs dominating CMEs and creating inequality does not follow the usual arguments found in comparative capitalism. In contrast to this proposition, in Chapter 8 *The social superiority of the Rhine model*, Michel Albert (1992) defines a set of three spheres which aim to symbolize: *social solidarity* – in short, *security:* "How are citizens provided from the major risks (illness, unemployment, family breakdown, etc.?" (Albert 1992, 147); *inequality:* "What remedies are brought against the most obvious cases of neglect? How much help is available and in what form to the neediest members of society?" (Albert 1992, 1 47); and an *open society:* "(…) how easy (or how difficult) is it for different individuals to climb the socioeconomic ladder, to improve their lot?" (Albert 1992, 147).

In this context, his understanding of inequality is very similar to that of Hall and Soskice. Albert comes to a very different conclusion to that arising from VoC:"[I]t can be plainly demonstrated that social solidarity and competitiveness in the market place make excellent bedfellows" (Albert 1992, 148).

Albert refers to different measures which can still be observed: *Health costs*, *Social security*, and the logic of *egalitarian societies* – narrower income spectrum and a proportionally larger middle class. In the third sphere, America does continue "to demonstrate a capacity for social absorption and integration far superior to that of Rhine countries, Japan including" (Albert 1992, 158). In contrast to Albert, VoC argues that Germany is expected to perform weakly in terms of equality. The position arising from VoC can only be understood in the context of its theory and main argument. In this context, VoC theory gains its overall relevance (in contrast to previous institutional approaches) from its simplicity and the ease of understanding

the dichotomy between institutional spheres, leading to certain kinds of innovation. Thus, if we wanted to divide the world into two regimes of production and if we wanted to argue for a division of work between the two of them, emphasising the instability of the second model with the less attractive kind of capitalism, we would need some kind of argument which lets me explain why this second less attractive model might still exist, in some nations, but will disappear in continuous globalisation. Here we find the WPR. Neglecting Esping-Andersen's (1990) famous findings or moreover twisting these to an extent to which it fits the overall argument helps authors who ascribe to VoC. Only the sphere of inequality and only gender inequality, more specifically, is chosen to represent the negative effects of WPRs in Germany. All other spheres described by Albert or Anderson are simply ignored. The spheres of employment protection, unemployment protection and wage protection are further argued to influence citizens' decision-making in terms of their education and job choices and to, therefore, lead them to establish firm-specific skills (which are assumed to be of low pay) and thereby, again, create some kind of inequality. The notion of a human as a rational agent underlies these propositions. In this government environment and atmosphere of corporate intervention the workers are thought to be acting in rational ways (see e.g. p. 150), and this simplistic view of human decision-making still substantiates the relevance of labour market formation and social policy. Using these propositions, VoC theory draws a thoroughly complementary picture for contrasting CMEs and LMEs. In P*artisan Power, Economic Coordination and Variations in Vocational Training Systems in Europe*, Marius Busemeyer and Raphaela Schlicht-Schmalzle (2014) argue for a variety of skill formation systems within the national market economies. They highlight the interconnectivity between educational regimes and a nation's welfare regime (see also West and Nikolai 2013 for education as a key component for the welfare state).

With this, they argue in the reverse direction as VoCs. The relationship between WPRs, skill formation as well as WPRs and inequality appears to be questionable. At least one can not only find more extensive welfare regimes in Germany but simultaneously growing numbers of university-level graduates. One might also find not only a higher percentage of GDP spent on social insurance in Germany (than the US) but a larger middle class in proportion and lower differences between the poor and the rich. The underlying belief arising from VoC of a rational worker necessarily needs to be rejected. As described by Green (2013, 5), skills themselves are defined as "personal qualities with three main features: they are productive of value, expandable, and social". According to this definition, skills can, therefore, not be expected to be acquired in a rational way as assumed by VoC. There is no such thing as rational choice in workers' decision-making for participation in education and training, nor does a single rational worker exist who can act in a rational way – besides imaginary figures in business and society such as Homo Faber (Frisch, 1997) or Homo Economics (Dixon, 2012; Häring, 2001).

The relationship between potential WPRs and education in Germany is questioned. The relationship between a potential WPR and inequality is questioned as well: since when does higher spending on welfare result in inequality? The belief in a rational-acting human being (apart from in fantasy and economics) is rejected.

7.2. Corporate Governance, Industrial Relations and Financial Globalisation in Germany

The previous section has dealt with the potential input factor of created skills. This section deals with the interrelationship between skills available to corporations and corporations' strategic decision-making for product market choice. Waves of

globalisation are shaking up and possibly changing national institutional frameworks. In the context of institutional change in highly industrialised Western nations, a literature review was undertaken in this dissertation on comparative corporate governance (CG) in general. Additionally, it added an institutional perspective and evaluated the link between CG and innovation. There was a focus on making sense of existing theories' arguments and interconnecting their logics. The interrelating variable of collective skill formation (SF) was brought into the picture in the previous chapter. This chapter of the dissertation evaluates the derived argument on CG-SF linkage for innovation in the German context, featuring insights into CG in large, but also market-dominating, SMEs within the national innovation system (NIS). The interrelationship between large corporations, SMEs, employer associations and lobbying societies and their possible influence on government policy-making in terms of innovation-related policy, which, in turn, leads to a firm's product market strategies, is broadly discussed focusing on the case of the German automobile industry and its support for a Transatlantic Trade and Investment Partnership (TTIP). The question raised relates to the possible influence of Anglo-Saxon shareholders in the context of current negotiations. Electro Mobility and Networked Driving are being identified as the two radical innovations currently being worked on within the German automobile industry. These are further analysed within the following chapter on Germany’s actual radical innovation performance.

German CG, industrial relations and the influence of financial globalisation upon these two institutional spheres has widely been discussed in literature. Critiques of the German model have emerged internationally, but also within the country. Whereas, on an international level, most discussions in political economy question the institutional stability of the CME especially its transparency and accessibility, in the context of inner-national discussions, diverse topics were focused upon. Some of

the most difficult headwords might be the *Deutschland AG, Mannesmann Prozess,* and *Heuschrecken*. These are three words which are still used in the context of German CG. This chapter is divided into three sections. The first section summarises critiques of German CG and industrial relations complementing an inner German and international perspective. *Deutschland AG* is used as a symbolic case of inter-firm relationships in terms of labour and capital. In the second section, the *Mannesmann Prozess* is used as a symbol for political and legal development in German CG. In the third section, the inner-German discussion on liberalisation of CG, shareholder value and *Heuschrecken* is focused upon.

7.2.1. Change in German Corporate Governance and Industrial Relations - Deutschland AG

Comparing CG strategies, summarises the different approaches to CG as developed during the Literature Review. As previously mentioned, Germany follows a stakeholder strategy. In *Krise in der Deutschland AG: Der Fall AEG*, Dirk Ipsen and Jens Pfitzinger (2003) clarify that the principal-agent-argument which is often used in CG from an American perspective might fail to recognise the interests of conflict within the collective action of a corporation's board of directors in Germany. The German CG structure is characterised by insider-control due to high numbers of corporate shares being owned by banks and other corporations. Since employees are represented and supposed to actively shape the future action of corporations, the structure of German CGs is different from LME models. In this context, coordination is not only important within the national market economy but within one corporation in terms of recognising and representing the interests of different stakeholders. This coordination within a firm, leaving investors such as *Hausbanken* with insights and influence in terms of their investments is argued to lead to "long-term-oriented action

(...) where credits are given by *patient* actors rather than by *impatient* investors at the stock market" (Crouch and Voelzkow 2009, 4). The investment behaviour of these kinds of investors is risk-averse, while a stock-market would lead to larger amounts of risk-capital (Dore 2000). Corporate Governance has become a commonly-used phrase in Germany, referring to the regulation and control over corporations which are not managed by their owners. This is of special meaning for stock corporations.

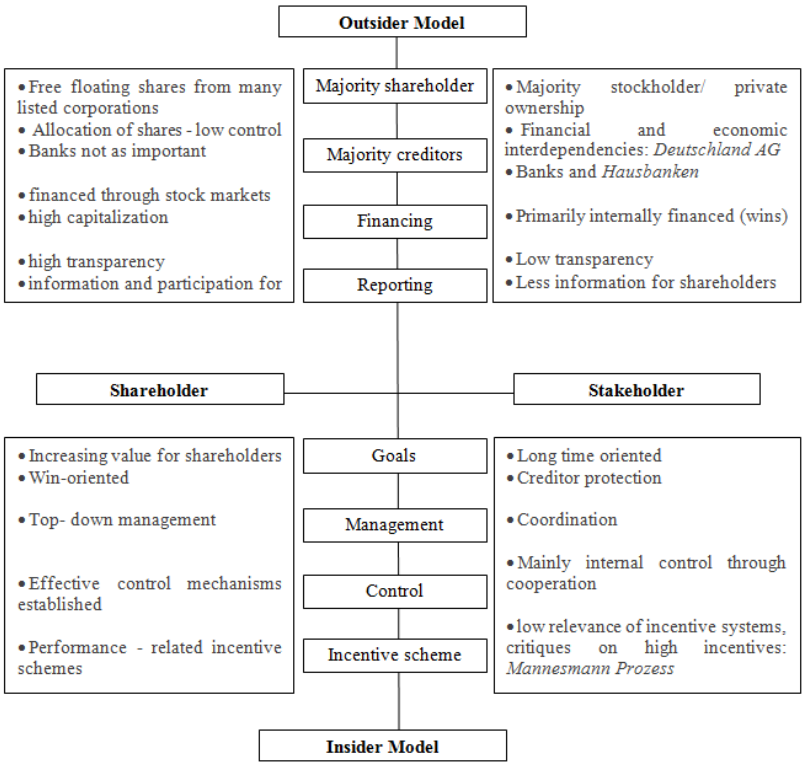


Figure 23: Comparing CG strategies

Source: Own illustration using diverse sources (e.g. Hausch, 2004)

The numbers of publications on German CG have increased throughout recent years. The Max Planck Institute played an important role in introducing a German perspective into the international debate from 2000 onwards. Researchers such as Jürgen Beyer, Anke Hassel, Wolfgang Streek, Martin Höpner, Sigurt Vitols, Gregory Jackson, Stefan Eckert, Dirk Ipsen and Jens Pfitzinger, Rainer Zugehör, and Britta Rehder co-worked on this topic within the institute. Even though the topic of

the CG structures of firms is of high relevance, one needs to recognise its limitations in the context of German trajectories of innovation. The market economy is dominated by SMEs (Hausch 2004), which are called the innovative motor of the nation (BMBF 2011). The debate surrounding *Deutschland AG* symbolises the influence of large corporations. The late 1990s gave rise to inner-German critiques on the highly influential network which arguably was or even still might lead German industry (Stuhr 2001). It is argued that a small number of men not only dominate the largest corporations' boards of directors but that this leads to interrelations between large corporations, with other interests than the one the corporation has in mind. In this context, boards of directors are meeting places for capitalist interests with macroeconomic interests. This network of inter-corporate relationships is often considered to be one characteristic of coordinated capitalism. In *Deutschland AG a.D.: Deutsche Bank, Allianz, and das Verflechtungszentrum des deutschen Kapitalismus*, Jürgen Beyer (2003) describes how large corporations and banks have established their labour and capital networks over the decades. He reasons this by pointing out the risk-averse pattern of large banks and the strategic advantage of corporations due to their ability to receive low interest rates in times of crisis. This system gave German corporations an advantage compared to e.g. US firms. La Porta et al. (2000, 18) summarise by stating that it "is easy to classify Germany as bank-centered because its banks influence firms through both debt and equity holdings and its stock market is underdeveloped". With *Deutschland AG*, the inner-German discussions went further than to the point of banks or private families' influence on firms' strategic decision-making. Moreover, a feeling of an emerging conspiracy theory arose in public (Manager Magazin 2002) focusing on a search for the powerful individuals who would lead the German economy. In this context, the publicly-illustrated interwoven relationship between federal chancellors Gerhard

Schröder drew a lot of criticism. In some interviews Schröder would even call himself the CEO of *Deutschland AG*, advocating this model as a symbol of Germany's social democratic style of capitalism. Critiques argued that this interrelationship between Schröder and corporate representatives neglected the interests of employees. In various publications, Martin Höpner illustrates how the network of capital and labour relations throughout the 30 largest corporations has been greatly diluted over recent years. He argues that financial globalisation has allowed this development, by offering banks different perspectives of investment banking (Höpner 2007; Höpner and Krempel 2006). Polemically, the foreign acquisition of Mannesmann by Vodafore is occasionally called not only the end of *Deutschland AG* but moreover the end of Rhenish capitalism in German CG.

Coming back to the meaning of *Deutschland AG*, one can not only identify the relationships between boards of directors or financial interrelationships between banks and corporations but moreover a personal network with certain key players – important personalities in the economy and politics. Within Germany, the relationships between certain key players are actively developed in elite education systems which start as early as high school and continue throughout university education and firm-level careers. In this context, private corporations have established and are supporting private schools which are mainly attended by children of firm owners and politicians' children. Depending on the political orientation of a family, the family chooses the right school – providing the right network for their child. This starts as early as elementary school and continues up to graduation from one of the most elite private boarding schools: Schloß Salem, Louisenland, and Marienau might be identified as three of the ten most influential private boarding schools within Germany. The elite path continues through university-level education when the right scholarship foundation is chosen. Foundations like the Foundation of

German Industry focus on increasing students' understanding of the German economy. The foundation has long been financed through large German corporations but is increasingly supported by federal government. Certain alumni and mentoring programs support graduates of one or other foundation after entering the job market. Other networks such as the traditional *Baden Badener* network continue to form individual personalities and networks between individuals with different backgrounds to the level of the boards of directors of firms. Even though we might find an erosion of the so-called *Deutschland AG* within the market economy, the networks and ideological machineries building relationships between certain families are continuing to shape future elites aiming to strengthen the traditional networks – though this is maybe in a different and not so obvious form.

7.2.2. German Corporate Governance Regulation: *Mannesmann Prozess*

The German stock companies act which is currently valid and was originally passed in 1965 (Bandesministerium fer Justiz and für Verbraucherschutz 1966) includes regulation for corporate governance which has become a part of German supplementary penal. It can, therefore, be enforced. Following the debates about a liberalisation of German CG structures, *Hans-Böckler Stiftung* published *Grundsätze ordnungsmäßiger Aufsichtsratstätigkeit* (Arbeitskreis Mitbestimmung beim DGB Bandesvorstand and Hans-Böckler-Stiftung 2011) in order to create a call for the participation of employees on the decision-making processes of large German corporations in 1998. *Hans - Böckler* is one of Germany's 11 scholarship foundations. It is opposed to the *Foundation of German Business* (employer side) as a union-close foundation. Hans-Böckler not only provides scholarships, including finance and idealistic training for students following the foundation's ideals but is, moreover, an employee close research institution which is actively advocating

participation. This part of the foundation is opposed to the employer-oriented research institutes. Hans-Böckler has aimed to secure well-established employee rights within German corporations even in the face of possible changes. Shortly after their call *KonTraG* (KonTraG 1998) was passed. This law basically enforces CEOs to install a system which recognises risks for the firm. It widens the liability of CEOs, and boards of directors aiming to encourage corporations to behave responsibly in terms of long-term goals for the firm. In 2002, federal government passed *TransPuG* (TransPug 2002), in order to increase transparency in corporate action. The international critique of German corporations acting in ways which are not transparent was thus acknowledged. In 2002, the German *Corporate Governance Kodex* was published (Ringleb et al. 2014). It not only relates German CG to a clear stockholder-orientation (now enforced by the law) but addresses this enforcement through the system of *soziale Marktwirtschaft*. In this context, a German corporation and also a corporation at the stock market is expected to act with a long-term orientation, bearing the interests of diverse stakeholders in mind. The German *Corporate Governance Codex* was followed shortly by changes in the German stock companies act. In 2005, *Bilanzrechtsreformgesetz* (Mandesministerium für Justiz and Verbraucherschutz 2005), which encourages international accounting and reporting standards, was passed. The *Vorstandsvergütungs-Offenlegungsgesetz*[23] (VorstOG 2005) changed § 87 Abs. 1 of the German stock companies act and aimed for more transparency in terms of CEOs' earnings. In this context, only transparency about the earnings gives employees and politics the ability to enforce the *Corporate Governance Kodex* which aims, among other things, to relate CEO earnings to relation to their own, industries' and firms' performance. All of these reforms aimed

[23] Transparency Law for the Compensation of Corporate Executives

to let German CG become more transparent and have arguably led to the first acquisition of a top 30 corporation by a foreign concurrent. The *Mannesmann Prozess* (2004–2006) gained international attention. It raised questions about the appropriate level of management compensation and the meaning of merger and acquisition by foreign corporations (FAZ 2006). The scandal around the key players in this process and the high amounts of annual rewards has not only gained public attention but led to the enforcement of VorstOG. Even though VoC argues for a liberalisation of German CG in times of financial pressure and especially in times of crisis, a different development is visible in German corporate stock market policy-making. In the context of e.g. management salaries, two more bills were passed in 2009. These bills were all passed for stock market corporations only. The usual, family-owned medium-sized German firm is excerpted from this regulation. In this context, policy makers believe that it is the right of corporate owners to establish whatever salary they wish to for their CEOs. A stock market corporation is expected to behave in the interests of the overall economy. German policy makers clearly ascribed this duty to stock market corporations only following the global crisis. Manager salaries did, therefore, need to be restricted. In 2009, further changes to § 87 AktG led to a gradual lowering of CEOs' and boards of directors' salaries. Furthermore, § 107, AktG was changed. Thus it is no longer allowed to discuss the contracts of CEOs within special committees of the boards of directors but only within the plenum. In this context, the roles of these laws are relevant signals in the context of the growing relevance of stock markets.

7.2.3. German Corporate Governance and Innovation

Contrary to the theoretical expectations (Hall and Soskice, 2001) two flagships of radical innovation within the German automobile industry can be identified as

Electro Mobility (EM) and Networked Driving (ND). These two projects are not only German ideas; the German automobile sector is heavily investing and aiming to develop a lead position within these fields (news 02, Abendblatt 2015; Schlick et al. 2011; Telekom 2015; Wirtschaftswoche 2015).

This section, gives a short overview of the developments of these two key projects and illustrates that the steps which have been undertaken by German corporations on their way to achieve a lead positions in these two radically innovative areas are not rapid and ground-breakingly disruptive, but incremental, slow and well-coordinated among stakeholders. Even though radical innovation can be found, the institutional foundations in which actors achieve this innovation are found to be of a coordinated nature. The German Association of the Automotive Industries (VDA) presents the current standing, past and future developments of ND. VDA is divided into six levels (0: driver only; 1: assistant; 2: partly automatic; 3: highly automatic; 4: fully automatic; 5: driverless), and each of these goals must be reached ultimately for driverless driving – which would allow a driver to enter a vehicle in one place, fall asleep and leave the vehicle in another place while driving over public and private streets at different speeds. Smethurst (2015) describes in detail why such a stepwise development is not only needed for technology and security reasons but is absolutely important for keeping all stakeholders at all levels of the firm (including suppliers – who will need to develop parts, employee associations like IG Metall for the potential future need of employees) informed and active within the process of opinion-making. Similar developments are observable in German electro mobility. Even though technically the German automobile firms have developed a relatively broad range of 29 electronic vehicles which are already sold on the market (Krähling 2015), practically speaking, these vehicles are mostly hybrid forms. Federal government and the German automobile industry have opened four

showcases (Bandesregierung 2014) with a sum of 140 projects and 9,000 electronic vehicles to actively test current vehicles while further developing these. In both streams of research, the government appears to be closely involved with the German automobile industry. The largest market for German electronic vehicles in 2016 and 2017 is China (Puls 2017). The association of German manufacturers (BDI), which includes VDA, seems to be less active in lobbying and cooperating with the government. In this context, VDA has recently moved its headquarters from Frankfurt to Berlin in order to have a better reach for German policy makers (Diemer 2015), while BDI's headquarters remain in Frankfurt, close to the represented industry. This might have something to do with the way VDA finances itself. VDA is not merely financed through membership fees, but by initiating events and fairs such as the IAA (Internationale Automobilausstellung). This fair is primarily a window for automobile manufacturers. It allows producers to show their new cars to the public and is a good advertiser. It is also about public opinion-making. A success at the IAA will be seen by millions. An opinion well presented at the IAA might shape someone's opinion. The current key topic in electro mobility and networked driving is pushing for a Transatlantic Trade and Investment Partnership (TTIP). In this context, diverse ranges of people are invited to VIP meetings, VIP areas, etc. Here we find managers, politicians but also students from the foundation of German business and potential future management offspring. Diemer (2015) further illustrates how well organised the VDA is, not only in terms of lobbying within the German federal government, but it sees one of its principle tasks as representing German automobile and supply (more than 600 large, but also SME firms) manufacturers and suppliers on an EU level in Brussels. Diemer illustrates very well how legislation at an EU level is passed, and how VDA aims to influence representatives of different nations. VDA's main task is described as being to

influence policy-making before a bill is published for discussion and starts at a point of formation of opinion (Diemer 2015, 17) in the EU commission, parliament, and council. Figure 24: Lobbying throughout every level of legislation illustrates this process.

Looking back in history VDA has contributed to different topics and has e.g. argued and lobbied extensively against a salvage policy for broken cars in 1999 (which was never passed). In 2008, VDA argued vociferously against EU regulation of CO2 emissions. This topic led to a defeat of VDA's lobbying work. Diemer (2015) argues that this decision hit the German automobile sector quite hard leaving manufacturers in an insecure position. Lobbying on the EU level was increased afterwards. As illustrated by Greenpeace (2013, 2007) and confirmed by Diemer (2015), VDA is able to directly consult the federal chancellor of Germany in order to apply pressure for certain policies, e.g. in 2013, Angela Merkel stood up for VDA's interests by directly contacting the President of the Council of the European Union (Irish) in an attempt to tip over the 95 gram/km CO2 rule for new automobiles from 2020. The nationality of the President of the Council of the European Union is relevant. VDA members have manufacturing plants all over Europe. Due to this, the complex is able to influence the opinion of diverse EU Parliament members. If one wants, foe example, to secure its numbers of employees in the Czech Republic then that person would need to support the opinion of VDA. This is not the case for Ireland. As illustrated in *Figure 25: VDA member's production sites*, there is not a single manufacturer in Ireland. In this context, the Irish have no interest in protecting VDA.

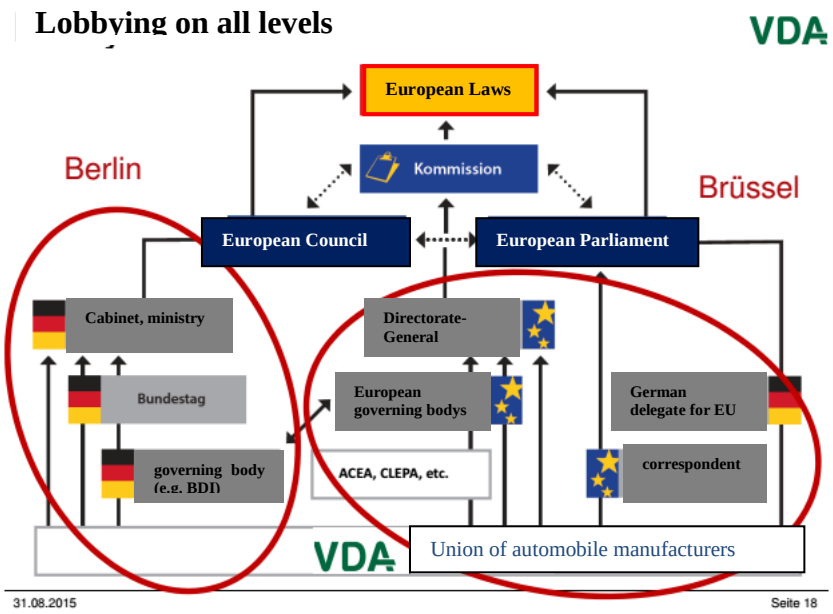


Figure 24: Lobbying throughout every level of legislation

Source: Diemer (2015, 18), translated by the author

Currently, VDA is extensively and aggressively pushing politicians and public opinion towards an agreement for a TTIP. VDA is arranging IIA (one of Germany's largest trade shows) around this topic, arguing that such an agreement would enable German and US firms to produce their electronic vehicles with the same plug – which would save millions of Euros (Diemer 2015). While aiming to become a market leader in high tech industries, VDA does not have an opinion about the different systems of patenting software at the European and American patent offices (Diemer 2015; Krähling 2015; Smethurst 2015) under TTIP.

Figure 25: VDA members' production sites across Europe

Source: Diemert (2015, 4)

This is in obvious, sharp contrast with the German and European software sector which has developed statements against TTIP – or at least supporting significant changes in this agreement. It might further be important to notice that VDA is not the only organisation pressuring for its own interests. In contrast, American corporations already play an important role in government action. In this context, one can find reports which confirm the role of industrial expansion for the US spy affair. It appears that these attacks have not only been conducted in order to gain information about sector developments but have informed certain persons in Germany who have then aimed to influence key policy or opinion-makers.[24]

This section aims to provide a very short overview of how large German corporations, e.g. in the automobile sector, represented by the VDA, aim to influence government policy-making in all matters that might be of importance for them. It is

[24] Search Wikileaks for: FY 2008/ 2009 BIOTECHNOLOGY OUTREACH STRATEGY AND DEPARTMENT RESOURCES; Report RL34493 Nanotechnology and U.S. Competitiveness: Issues and Options; FAST CARS AND HOT TIMES IN SOUTHWEST GERMANY (Powell, 2007).

further illustrated how the complexity of developing innovation in automobiles represents the interplay between coordination and radical innovation in Germany.

The example of German car manufacturers represents the slow processes of innovation which can be influenced by policy-making. Even though there have been some early attempts to mass produce electric vehicles in Germany e.g. in the case of *Hotzenblitz*[25] (Die Welt 1998), German incumbents did not mass produce an electronic vehicle until 2013 (Spiegel 2011). The product developed by *Hotzenblitz*, a young entrepreneurial German firm, failed for several reasons. A lack of start-up finance due to the German bank-based financial system and a lack of consumer demand in 1993–96 were some important reasons for the failure of *Hotzenblitz*, which was sold for 36000DM[26] in its basic version. In 2003, Martin Eberhard and Marc Tarpenning founded *Tesla Motors*, with the strategic goal to create affordable mass market electric vehicles. In 2009, Tesla had delivered 147 cars, a similar number of cars to the bankrupt[27] *Hotzenblitz* GmbH in Germany in 1995. At this time Tesla was primarily financed by Elon Musk and had survived several rounds of near bankruptcy. In 2010, Tesla Motors launched an initial public offering at NASDAQ. Its "initial public offering of 13,300,000 shares of its common stock at a price to the public of $17.00 per share" (Tesla Team 2010) raised US $226 million for the company. The obvious differences in financial institutions seem to have led German car manufacturers into a poor position in this radically innovative field. In spite of the failure of *Hotzenblitz* and the arguably disruptive nature of Tesla's technology, German automakers are still hoping to achieve a superior position in the markets for electro mobility and networked driving in the long run. In *Identifying trends in*

[25] Hotzenblitz was produced from 1993–1996 by Hotzenblitz Mobile GmbH & Co. KG in Ibach (area called Hotzenwald).
[26] app. 18,000Euro
[27] German Länder had to pay off 8 million in debt for the insolvent corporation.

battery technologies with regard to electric mobility: evidence from patenting activities along and across the battery value chain, "relevant International Patent Classification (IPC) codes are assigned to the different value chain steps and used to analyze the worldwide patent developments" (Golembiewski et al. 2015) for batteries related to electric vehicles. Golembiewski et al. suggest an interesting picture in patent applications. Contrary to expectations, due to the previously presented figures, the USA is not in a lead position when it comes to the development of battery patents. Germany is in third place behind Japan and South Korea. Since electric mobility is a convergence of at least three fields, there is no plain patent class existing.

The highly coordinated and stakeholder-oriented nature of the German market economy with a high degree of governmental intervention is very visible in the case of the German automobile industry. German automobile firms have developed a relatively broad range of 29 electronic vehicles which are already sold on the market (Krähling 2015), but practically all these vehicles are mostly hybrid forms. Federal government and the German automobile industry have opened four showcases (Bundesregierung 2014) with a sum of 140 projects and 9,000 electronic vehicles to actively test current vehicles while further developing these. In both streams of research, the government appears to be closely involved with the German automobile industry. The federal government’s high-tech strategy, as well as the Federal Government Joint Unit for Electro Mobility and the National Platform for Electro Mobility, are some of the government units aiming to achieve an industrial lead position for German industry in this technological field (NPE 2011). In April 2016, the federal government announced support for the German automobile industry to the tune of up to 1.2 billion Euro on a buyer's premium for electronic vehicles manufactured by VW, Daimler, and BMW, including 300 million Euro designated

for building charging points in Germany. Charging points fit the standardised German plug-ins (Tesla obviously did not participate in the process of standardising their plugs). This plug in system has been developed and agreed on by all stakeholders in Germany, and many European automobile manufacturers. The intervention of federal government is in line with the federal government's high-tech strategy (Federal Ministry of Education and Research 2010). Similar action was observed in the biotech and software sectors.

This chapter has briefly led the reader through the relationship between CG, LMIs, SC and innovation. It has also provided an overview of the case of the Germany national corporate governance system of stakeholder orientation, which influences the process through which the automobile sector is producing its innovation, in cooperation with federal government, suppliers (within VDA) and employees (represented by IG Metall). It has also illustrated what VoC calls a production regime by illustrating how VDA aims to influence politics.

7.3. Résumé: Directions of Change in Germany's Political Economy of Skill Formation, CG and its Trajectories of Innovation

The illustrated direction of change in Germany's political economy of skill formation, meaning the LMIs' and skill formation systems' developments cannot be simplified into calling out a liberalisation of the system. Furthermore, in this study, incremental, slow change of the labour market regulation has been shown to happen through political incentives and shifts in expectations of the political parties. In terms of skill formation, an increase in general skills is clearly observable. By looking at these developments more specifically, I find a political focus on science and

technology. These policy effects in the field of science are clearly observable. Following the VoC argument, one would expect Germany to perform weakly in radical innovation, but to liberalise due to crises. This expectation cannot be confirmed in terms of liberalisation. Even though we find an increase in alternative job organisation defined by *Zeitarbeit*, other incentives such as *1 Euro Job*, passed under the Schröder legislation have already been reversed.

The focus of this chapter's argument has been on giving a rich description and making sense of the paradox appearing in developments in Germany. In terms of making sense of the propositions, the theoretical background has to be enhanced, and the order of constructs as they influence each other has to be changed.

8. CHAPTER EIGHT: ANALYSIS AND THEORETICAL IMPLICATIONS

This chapter is divided into four parts. The first section provides a comparative analysis of the German NIS with Japan, France, and the Nordic capitalists. The second section reflects on changes in German NISs in times of crisis and provides an analysis of Germany's high-tech performance from a comparative perspective. Implications of the findings for the theoretical framework are provided in the third section, developing an enhanced framework. In this context, the institutional relevance of the creation of innovative capabilities is re-organised. The last section develops implications for the study of innovation.

The institutional frameworks of coordinated market economies, such as Germany, are expected to foster the creation of incremental innovation in the nation's firms. The group of coordinated market economies is composed of diverse continental European nations plus Japan. LMEs are expected to stay relatively stable over time, but a liberalisation of the institutional framework of CMEs, especially in times of crisis, is expected by the theory. The implications of such a theoretical change in the institutional framework on nations' trajectories of innovation have been discussed in the theoretical framework of this dissertation. This chapter aims to discuss the question of how the actual trajectories of innovation in Germany have changed throughout time from a comparative perspective. This chapter discusses the third Research Question in more detail and then summarises the implications of this dissertation in terms of existing theory.

Research Question III: What is the ability of German firms to produce radical innovation from a comparative perspective? A comparative analysis of

Germany with other countries is crucial for this dissertation, since the institutional frameworks of the countries e.g. within the group of CMEs, are of a diverse nature. Besides continental European countries, Japan is classified as a CME. Section 8.1.1. gives a comparative analysis of the German and the Japanese NISs in order to create an in-depth understanding of the institutional similarities, as well as government policy and differences which might affect each nation's national trajectories of innovation. Japan is chosen for its relevance in terms of its ability to create radical innovation as illustrated in the fifth and sixth chapters. The second crucial case is the neighbouring country to Germany, France. France is of comparable size and geography. Its dirigiste institutional frameworks are different from those of the German CME. It is of high interest how these different systems, together with differences in policy-making, might have an effect on the nations' trajectories of innovation – in spite of the similar geography, size and industrial history, and operating within the EU legal framework. Section 8.1.2. presents a discussion of this issue. Besides the continental European countries and Japan, a group often referred to as the Nordic capitalists is classified as of a coordinated nature. Section 8.1.3. reflects on the group of Nordic capitalists. Different approaches to the study of comparative capitalism give the Nordic countries a special position in theory. This is illustrated in Figure 26: Comparison of Key Approaches in Literature, which illustrates different country classifications.

Countries	Comparison of key approaches in Literature		
	Three Worlds of Welfare Capitalism	Varieties of Capitalism	Diversity of Capitalism
Sweden Denmark Iceland* Finland Norway	Social-democratic Model	Coordinated Market Economies	Social-democratic Capitalism
Germany Austria France	Conservative-corporatist Model	a	Continental European Capitalism
Japan Australia USA Canada UK	Liberal Model	Liberal Market Economies	Asian Capitalism Market-based Capitalism
Spain Portugal		Mediterranean c	Mediterranean Capitalism

* Hall and Soskice (2001, p.21) leave France in an "more ambiguous position" suggesting another type of capitalist economy (see Lee and Yoo, 2007). * Only considered by the VoC approach * "(...) show some signs of institutional clustering as well, indicating that they may constitute another type of capitalism, sometimes described as `Mediterranean` (...)" (Hall and Soskice, 2001, p.21)

Figure 26: Comparison of key approaches in literature

Source: Own illustration using given sources

Section 8.2 summarises these briefly illustrated comparative sectins, by drawing a picture of national high-tech performances in comparison with each other, within the group of CMEs and in comparison to LMEs, and discussing RQIII. Section 8.3, Implications on the Theoretical Framework, constructs an alternative theory which reflects on the complex relationships which have been found and described throughout this thesis. The last section constructs a summary of the analysis and the implications which have arisen.

8.1. A Comparative Analysis of German NISs

This section evaluates the validity of different approaches to comparative capitalism in terms of their ability to explain national variation in innovation behaviour and performance in the context of the current global crisis with a focus on Varieties of

Asian Capitalism. The works of Whitley (1992), and Hall and Soskice (2001) are considered to be key literature for the comparison of Western and Asian national institutional frameworks.

8.1.1. A Comparative Analysis of German and Japanese NISs

For this purpose, two country cases, Germany and Japan are chosen as examples representing Asian and Western capitalism (Sako and Kotosaka 2012; Streeck 2008). As argued by Hall and Soskice (2001, 20, both countries might be categorised as Coordinated Market Economies (CME) but still show clearly differentiated institutional features of non-liberal capitalism (see Streeck and Yamamura 2001; Yamamura and Streeck 2003). As argued by Whitley's (1992) institutional pluralism, the differences between the two CMEs might be found in terms of their ability to sustain distinct institutional outlooks that manage to produce innovation in times of global crisis. Whitley further argues that where institutions are "relatively homogenous and mutually reinforcing" (1992, 247), as in Western economies such as Germany but also Japan, fundamental change of the business systems can only take place through external shocks. These two countries are chosen as examples of distinct nations within the same group of CMEs. Continual innovation is seen as "key to the sustained competitiveness of nations, industries, and firms" (Dodgson 2009, 604).

The findings of this dissertation suggest that the two nation's institutional frameworks do not, as suggested by VoC theory, become even more liberal in times of crisis. As suggested by Morgan and Goyer (2012) in their analysis of national financial systems, the two countries retain their national differences e.g. in terms of their financial systems, but also their resilient national innovation systems. As for Asian capitalism, Lundvall, Intarakumnerd and Vang (2006, 3–5) examine *Asia's*

Innovation System in Transition, emphasising the role of institutions and change. Vogel (2006, 11) presents a review of changing Japanese capitalism and outlines a model of institutional change constructed on the shoulders of the VoC approach and economic sociology in *Japan Remodeled: How Government and Industry Are Reforming Japanese Capitalism*. More recently, Walter and Zhang (2012) have examined *East Asian Capitalism*, again focusing on institutions, institutional change, and rigidity in times of crisis in an attempt to reconsider the VoC approach, as well as Vogel (2006). While Walter and Zhang (2012) argue for viewing each Asian country as distinct, illustrating a variety of country cases, they do use the summarising term "East Asian Capitalism" for comparison with Western economies. In the *Oxford Handbook of Asian Business Systems*, Witt and Redding's (2012) *Institutional Comparison, Clusters, and Implications for Varieties of Capitalism and Business System Theory*, further differentiates Asian capitalism as embodying the concepts of social capital, culture, informality and multiplicity. They find five major clusters of Asian capitalism and Japan stands alone within this analysis. The distinct character of Japan within Asian capitalism has previously been recognised by others, such as Dore (1998): *Asian crisis and the future of the Japanese model*. It is argued that even though Japanese capitalism appears to feature its own distinct institutional system, this system is embedded within the Asian capitalist cultural and institutional system and thus influences other Asian countries' developments. Witt and Redding (2012, 15) argue that "[f]urther exploitation of the institutional structures and internal dynamics of Asian Business Systems and extended comparison with the western nations" would be necessary for further understanding the distinctiveness of each Asian Business System itself. In response to recent debates in the fields of Asian capitalism and VoC, this thesis, therefore, compares the two CMEs, Japan and Germany as representatives of Asian and Western capitalist nations. VoC and the

Business Systems (BS) approach are considered key literature in terms of institutional theory in the field of comparative capitalism, focusing on national innovation behaviour. Compared to the National Innovation System (NIS) approach, which explicitly focuses on the production of knowledge and innovation in society, VoC and BS focus on national institutions, categorising country groups depending on the degree of coordination among national actors. They further analyse changes in these institutional spheres and the impact of certain institutional characteristics on a nation's production/innovation behaviour. While Hall and Soskice divide the world into two groups of countries, Whitley's approach on BS is more differentiated. Whitley (2000) does distinguish six groups of BSs. In contrast to the NIS approach, and in line with the field of political economy, as described by Ibata-Arens`s (2003) *The comparative political economy of innovation*, the VoC and BS approaches focus on the firm level, observing firm behaviour in national institutional contexts. Thus, "[i]n sum, firms have a number of choices in developing innovative competences and selecting innovation strategies that are guided by dominant institutions" (Whitley 2002, 523).

In his book, *Business Systems in East Asia*, Whitley (1992) studies the development of Asian business systems and proposes three interrelated components, namely: the nature of the firm; market organisation; and employment practices and authority system. Whitley (1992) distinguishes the Japanese Kaisha from the Korean Chaobol, and the Chinese family business. He argues for a stronger influence of pre-industrial institutions in East Asian business systems, and suggests that "the relatively high level of ethnic and cultural homogeneity within these countries and the heterogeneity between them (…) have generated strongly distinctive types of business system (…)" (Whitley 1992, 218). He reviews this in contrast to the West where "institutional pluralism within countries and the institutional commonalities

across them (...) have reduced both the distinctiveness of national business systems in the West and their explanation in terms of national divergent institutions" (Whitley 1992, 218).

In *Innovation in Times of Crisis: National Systems of Innovation, Structure, and Demand*, Filippetti and Archibugi (2011, 179) illustrate that "the effects of the economic downturn in terms of firms` innovation investment are not the same across European countries". Nations with stronger innovation systems, such as Germany, seem to emerge from the crisis with a relatively stronger position, whereas the UK and France as representatives of liberal and Dirigiste market economies (DME), "are likely to lose additional relative positions" (Archibugi 2011, 189). Filippetti and Archibugi argue for this to be due to the nation's specialisation in the high-tech sectors and developments of the financial system. Their findings seem to be counter intuitive to the VoC argument in terms of LMEs being superior to CMEs in terms of a specialisation in radical innovation.

Reading VoC, one would generally not expect CMEs to sustain better growth than LMEs in times of crisis, as LMEs are arguably superior in terms of radical innovation. Although the German and Japanese political economies are lumped together as CMEs in contrast to LMEs in the VoC typology, a conspicuous variation in their patterns of institutional change and innovation behaviour is still visible. Despite belonging to the same category of CMEs, the Japanese system is distinguished from the German system in that it is embedded in different cultural and historical backgrounds (Whitley 1992; Hofstede 2003). In *Culture and the Business Systems of Asia*, Redding, Bond, and Witt (2012) comlement Whitley's work on Asian capitalism by establishing clusters of Asian cultures and the each culture's impact on national organisations. As for Japanese culture, similarly to Witt &

Redding's (2012) observations in terms of its business systems, the country takes a unique position.

In contrast to the argument arising from VoC on Japan being a coordinated market economy, Vogel argues that the Japanese institutional system has undergone fundamental change (2006, 10). He argues for a liberalisation of the Japanese model. Sako and Kotosaka (2012) suggest that the Japanese financial system has slowly "shifted its goal and function from being part of the Japanese institution of relational banking towards being more part of an equity-based finance system (…)" (Sako and Kotosaka, 2012 155). They further argue that, in the labour market, the changes are much more drastic – "unlike the *financial markets*, layering and conversion in labor market institutions are stronger and appear irreversible". In this context, employees lose their power in working councils and also in terms of wage bargaining (Sako and Kotosaka, 2012, 156), while the power of managers in large corporations and the influence of policy maker's grows. Therefore, internal firm decisions are increasingly made top-down and less through consensus. In terms of government strategy, Japan has, similarly to Germany, launched an Innovation Strategy in 2007 called Innovation 25.

The German High Tech Strategy appears to be very similar to the Japanese one. It also focuses on the educational sphere and, with this, basic research on universities and their connections to firms. It also emphasises the importance of high tech research, entrepreneurships and clusters (Nishiyama 2008). In this context, Japan has launched partnerships with the EU – especially encouraging innovation and financing R&D (INCJ 2009, 1). Whereas "Innovation is mostly financed by the public sector in the EU (…) in Japan 80% of research expenditure comes from the private sector". It is hoped that cooperative networks between Japan and the EU will encourage innovative clusters, but also "bring together private equity and venture

businesses from Japan and Europe in order to create a positive synergy" (INCJ 2009, 1). A quarterly view of GDP in Germany, Japan, France, and the UK illustrates well the difficulties of Japan throughout the financial crisis and also before, as described by Vogel (2006). It illustrates Japan's positive economic development closely after the crisis, in comparison to other nations. This thesis argues that Japan's positive performance as observed in GDP growth rates after the global crisis was partly due to its government's changed focus on innovation. Not only did the Japanese GDP growth increase after the crisis, but the nations R&D expenditures as a percentage of national GDP are still at a higher level than the equivalent expenditures of the other illustrated countries. Japan has not only invested more in R&D in relation to GDP than other nations, but it seems that these investments have had the highest numbers of high-tech patent applications to the EPO when making a comparison. As for specific radical sectors, such as the software sector (Hall and Soskice, 2001) *The EU Industrial R&D Investment Scoreboard* (2006, 2009 and 2011) unfortunately does not, as mentioned before, provide a clear picture of Japanese performance. The 2012 *EU Industrial R&D Investment Scoreboard* offers a comparison of the 1,500 largest R&D investing firms. Choosing France, Germany, Japan, the UK and the USA for a world comparison leaves us with more than two thirds of the captured firms for the 2011 R&D investments (1,045 firms within these five countries). There is a very different picture of Japanese firms' performance here. Large Japanese firms account for 10 per cent of the globally spent R&D investments in 2011 and for almost 20 per cent of the sector's sales. The European Commission changed the categories criteria in 2011. The selected category for software firms is now called "software and computing services". For Japan, two large firms, Fujitsu and NEC, accounted for about 75,000 million Euros of sales in 2011. The VoC column in the tables demonstrates each nation's specialisation in the sector.

Hall and Soskice used this calculation (2001, 41–41) to illustrate the relative specialisation of LMEs in radical sectors and CMEs in incrementally innovating sectors. In the first two tables, Germany clearly illustrates a stronger specialisation in the software sector than the EU average. In terms of the VoC calculation, this table allows Japan to appear as the one nation's most specialised in software sector sales and R&D investment in 2011, just after the giant USA. As mentioned before, the 2012 "EU Industrial R&D Scoreboard" data need to be reviewed carefully, since the database only "contains economic and financial data of the world's top 1500 companies ranked by their investments in research and development" (European Commission 2013, 5). The selection criterion of high spending on R&D often fits large firms better than smaller firms. These firms are mainly found in the United States, whereas European firms are, on average, smaller. European high tech sectors are characterised by small firms, which cooperate with each other as well as with universities and independent research institutions in terms of their R&D. Their own R&D spending is, therefore, lower than their actual activities, and obviously, those firms' sales are not captured in the Scoreboard. This is clearly visible in the 2012 edition of the R&D Scoreboard, where only 500 European, but 1,000 other (more than 500 US) firms meet the criteria for the selection process – compared to 1,000 EU and 1,000 other chosen firms in the previous years). The selection criteria for the Scoreboard do not, therefore, let the instrument capture data which fully illustrate the high-tech sector's performance, in general. In this context, it is sufficient to conclude that Germany and Japan have coped well with the global crisis in terms of their national innovation systems. The expectation of CMEs suffering more than LMEs in times of crisis, due to their supposed inability to cope with new market needs in terms of new technologies cannot be supported.

Even though the two countries are generally categorised as CMEs, both nations have previously developed differently with Japan adjusting to a more liberal financial system and therefore, coping differently with the global crisis. Apart from both countries being relatively successful in terms of GPD development, patent applications to the EPO, their R&D investment as a percentage of GDP and within the radical sector of software, a clear difference between the national performances is visible. In terms of R&D investments as a percentage of GDP, the Japanese performance slightly decreases (having had the highest level before and after the crisis) from 2008 to 2009, and the German performance increases. As for all the countries, high-tech patent applications to the EPO decreased for Japan and Germany; for Japan, the numbers decreased by 17,000 applications per annum from 2004 to 2008, whereas the German numbers only decreased by 7,000 applications per annum still leaving the two countries in the highest ranks. The sales and R&D investment measures for the case of the software sector are almost contrary depending on the Scoreboard selection criteria, but leave both countries in strong positions – though,of course, well behind the USA.

Carney, Gedajlovic and Yang (2009) point out that the global crisis starting in 2008 was a product of the previously praised model of liberal or Anglo-Saxon capitalism. The two coordinated market economies of Germany and Japan seem to have coped well with the crisis in terms of their GDP development as well as R&D investments in high-tech, and patent applications. Even though both nations are bunched together as CMEs, they do show different institutional frameworks and different ways of coping with crisis. The previous analysis illustrates partly contrary developments in the chosen measures, still leaving both countries and their innovation systems in strong positions in comparison to others. This suggests that alternative models of capitalism, such as the German or Japanese ones, should be

given closer attention. The two governments' chosen strategies to further R&D investments in times of crisis to "large investment projects such as alternative sources of energy, transport as well as the public service" (Ietto-Gillies 2010, 910) appear to support the idea of national innovation systems in the face of lacking financial support for innovation from stock markets. On the other hand, the vulnerability of the shareholder-oriented financial system and the loss of coordination in LMEs have undermined the kind of security which is necessary for navigating a global crisis. It is clearly visible that external pressures of the global economic crisis on the German and Japanese NISs have not led to a decrease in innovation in a cyclic manner. With the new focus on high-tech industries as well as alternative energy programs, policy makers in both governments have tried to overhaul their innovation systems. While both countries have, throughout time, incrementally changed their institutional outlook (as argued in Hall and Thelen 2009; Vogel 2006), policy makers have also managed to push for a more radical emphasis on innovation due to external pressures in times of crisis. In *How National are Business Systems? The Role of States and Complementary Institutions in Standardizing Systems of Economic Coordination and Control at the National Level*, Whitley (2005, 212) finds that "[T]he growing internationalization of markets has ,been seen as reducing the strength and the complementarity of national institutions especially in the more coordinated market economies such as Germany and Japan". In contrast, this chapter does not find a reduction in institutional complementarity but changes. The main institutional features of both countries and especially of the German market economy have, despite policy changes, stayed unchanged even in times of global crisis. Such differences in their institutional outlooks appear to influence their ways of coping with global crisis and supporting their national innovation systems. Due to government intervention and innovation policies, the

resilience of the NIS, and its ability to adapt to a new crisis situation, which is not considered by VoC, becomes visible. It seems as if both countries do not become more coordinated nor liberal in terms of market economy due to external pressure, but find more individual ways of coping with the global crisis (see Morgan and Goyer 2012). A further analysis and international comparison of each national sector's performance would be necessary to draw conclusions about the two nations' specialisations in either radical or incremental sectors. In observing the changes in the software sector, Hall and Soskice's general implication of specialisation in incremental innovation and lack of ability to produce radical innovation, cannot be supported by this thesis.

8.1.2. A Comparative Analysis of German and French NISs

The French innovation system is characterised by a process of ongoing change, as well as the academic debates trying to finally define the complex French system. In the 1980s and 1990s, the French NIS was often described as "an interventionist philosophy ("technological Colbertism", cf. Laredo and Mustar 2001)" (as cited in Muller, Héraud and Zenker 2009). Mustar and Larédo (2002) analyse the disappearance of the Colbertist state model in more detail. Similarly to Germany, in 2009, the French Ministry of Higher Education and Research launched a strategy to promote innovation. As described by the Directorate-General of Global Affairs (2010) the newly established National Research and Innovation Strategy focuses on three key sectors: bio-, eco-, and nano-technologies. This emphasises certain sectors due to France`s attempt to achieve a leading European and international position in these sectors. The French focus on these three sectors indicates the areas in which it realistically sees the potential to achieve a leadership position. This focus on certain spheres can be observed in other places as well. Amable and Hancké (2001),

Directorate-General of Global Affairs (2010), and Goyer (2001) describe how the French government focuses on supporting some large firms, identifying national champions which are expected to lead their industries at an internationally competitive level. Therefore, some of the literature argues that the French government forgets about SMEs but can still achieve leading positions and outperform other nations in the emphasised sectors (Amable and Hancké 2001). Nevertheless, the Directorate-General of Global Affairs (2010) emphasises that, since 1999, the French government is also emphasising its support for the creation of start-ups. Nationwide business incubators and systemic university-industry partnerships have been established to promote the creation and growth of innovative start-ups. In addition, Muller, Héraud and Zenker (2009, 1) describe how "Unlike federal states, no clear legal distribution of roles is fixed and as a result, complex multi-level/multi-actor processes in the design and implementation of policies can be observed".

In comparison with France, the German high-tech strategy emphasises the importance of small- to medium-sized businesses. Whereas French policy supports the international competition of some large firms (national champions), and the creation of new innovative businesses, the German way of thinking appears to be less ambitious and more indigenous. The ascribed goal of German policy to focus on medium-sized businesses is due to the attempt to promote employment and wealth within the country. International competitiveness of the German high-tech sector is often due to the accumulation of the performance of many SME firms, and not due to single large, internationally-leading firms (Simon 2007, 11). Simon describes how all industrialised nations manage to give rise to large firms which inhibit the ability to internationally compete and to export. He does further argue that the German economic system is characterised by its "Hidden Champions", some SMEs which

dominate world markets. SMEs do, therefore, play a different role in Germany than in France and a different role for policy makers. It can be argued that the variation in government policy, focusing on hidden champions (SMEs) in the German and national champions (large firms) in the French case, is due to this. Another difference found in literature is that the French NIS is continuously described as an ongoing changing system whereas the German innovation system has been described as stable towards external pressures. The argument of external and internal pressures is used in this context for different reasons. It is argued that, due to institutional complementarities, Germany continues in a stable institutional framework, whereas the same argument is used in the French case (Kang 2010; Muller, Héraud and Zenker 2009) to explain its continuous change process. The missing link in the French case is the notion of "institutional complementarities" which is argued to be the reason for institutional stability in other market economic models such as the coordinated or liberal model (Hall and Soskice 2001). In their *Introduction to Varieties of Capitalism*, Hall and Soskice do not further describe the French system, but refer to other authors such as Hancke and Culpepper (see 35, and 275 ff.) in the same book. France is viewed as a third model of capitalism or at least not a CME or LME. Thus, Hall and Soskice suggest that there:

> "may be a 'Mediterranean' type, but the discussion of alternatives to liberal market economies and coordinated market economies is perfunctory, and the emphasis upon institutional complementarities makes it unclear how effectively, for example, a coordinated system of corporate finance would function with a competitive labour market" (Howell 2003).

In the same book, Hancke and Culpepper investigate deeper into two institutional spheres of the French national economy. Hancké (2001) discusses the developments of the French system in a 15-year period from 1980–1995. In summary, he suggests that the changes in the French system have enabled French firms to compete for foreign capital on the newly grown stock market in Paris and

thus enable an opening of the financial system. In the same book, Culpepper (2001) analyses and compares the French vocational training and educational system with the German system. He concludes that French firms "are able to get away with a flexible Fordist production model, in which they use the educational system to provide general skills and then train only in firm-specific skills at the firm level" (Culpepper 2001, 297). In a VoC context, France is described as an alternative model which has changed its outlook significantly within the last decade by liberalising at least its financial system (Hancké 2001; Lee and Yoo 2007, 454). Lee and Yoo illustrate the persistently important role of the state in the French NSI. They do further illustrate how the institutional frameworks of major examples of LME (USA) experience a strong influence from the state. Within the sphere of industrial relations, the French system is (similarly to the German system) also characterised by trade unions, employee federations and works councils (ETUI 2012; Piganiol 1989). Thus, Amadieu (1995) describes certain problems in this sphere which nowadays can still be partly observed in spite of European integration. The Brussels-founded NFP organisation, ETUI, which was founded and financially supported by Hans Boeckler Stiftung and the European Union have summarised key figures and statistics on workplace representation throughout Europe since 2012 (ETUI 2012). ETUI illustrates, in 2012, what has been previously described by Amadieu in 1995 – a rate of 98% of collective bargaining coverage with "too many levels of collective bargaining", but only an 8% proportion of employees in unions standing in for "too many and inefficient employee representation bodies. The Dirigiste nature of the French economy encourages inter-firm coordination, but also interaction with the state. Thus there is an attempt to make decisions through consensus internally in a firm but also through inter-firm relationships and state-firm interaction.

8.1.3. A Comparative Analysis of German and Nordic NISs

The debate on the superiority of certain capitalist models has been intensified in times of global crisis. Due to the crisis, and in context of the VoC approach (Hall and Soskice 2001), a new focus on national innovation behaviour influencing overall economic success can be observed (Archibugi, Filippetti and Frenz 2012). In the given context, this chapter focuses on variety in national institutions as it influences the innovation behaviour of the five Nordic countries (Denmark, Finland, Iceland, Norway, Sweden). Referring to VoC, each nation's innovation behaviour is descriptively analysed using patent data, in the following chapter.

Following the traditional approaches for comparative capitalism (see e.g. Esping-Anderson, Whitley) one would argue for Nordic countries to be characterised by egalitarian capitalism. Following the VoC approach, a proposition on welfare or WPRs being interrelated with incremental innovation and inequality due to corporations' influence on the government, social policy and labour market policies increasing firm-specific skills, is indicated. This proposition has previously been discussed in the literature review. A very different picture is drawn by authors such as Robert Boyer in *New growth regimes, but still institutional diversity* (Boyer, 2004). Boyer argues that the social democratic institutions underlying Nordic capitalists lead towards a good and homogenous general education. As previously argued, a well-established knowledge base is the foundation for numerous approaches to innovation (NISs). Boyer follows these approaches in arguing for this to enable a nation to master ICT and innovation.

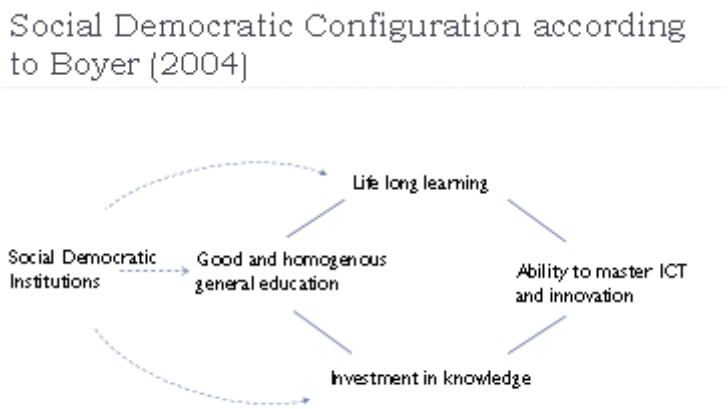


Figure 27: Social Democratic Configuration

Source: Boyer (2004, 18)

In Figure 28, one can clearly observe the five countries' performances in filing patents with the EPO. In this context, Iceland appears to be too tiny a nation, Norway seems to focus its economy on different sectors (the natural resources which are available to its inhabitants make it difficult to compare), but Denmark, Sweden and Finland do prove themselves capable takeoff taking on a share in the high-tech world markets. Even though their share is quite small when compared to other CMEs such as Germany or Japan, it appears to be relatively high if compared to other LMEs such as Canada, New Zealand or Australia which have larger populations. This is illustrated later in Figures 22 and 34 and discussed in Section 8.2.2..

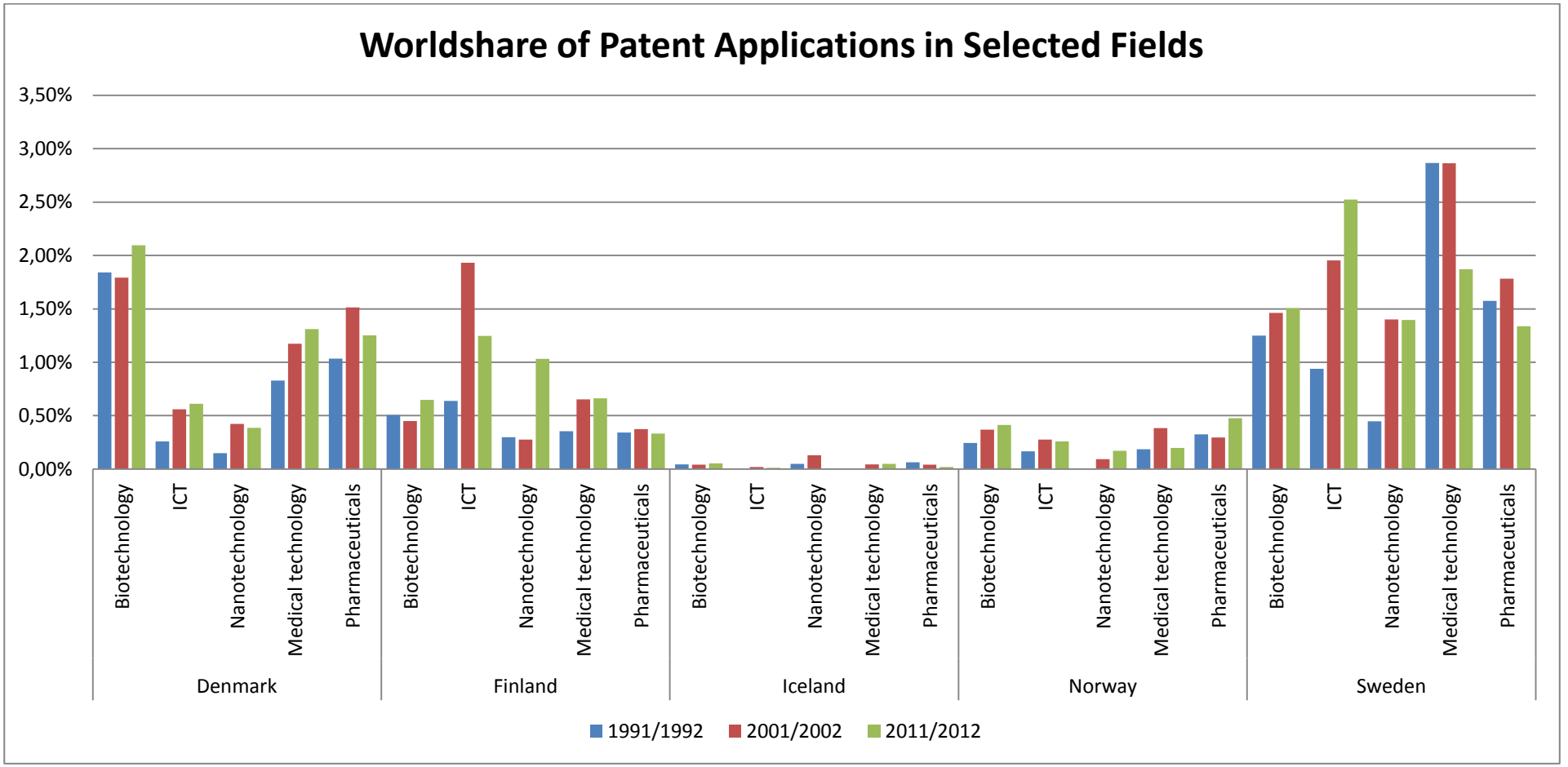


Figure 28: World share of patent applications in selected fields by country of residence of inventor – Nordic market economies

Source: Own illustration using OECD patent data by the EPO, country of inventor

8.2. German High-Tech Performance: A Comparative Perspective in Times of Crisis

In terms of Germany's ability to create innovation in high-tech sectors, this chapter gives an overview of the German NIS from a comparative perspective. This section consists of four parts and is followed by a further section which focuses on German high-tech performance. The following chapter aims to return to the VoC proposition of CG relating to innovation. This chapter focuses on a general description of the German NIS in times of global financial crisis starting in 2008. The crisis is of importance due to the argument arising from VoC of a liberalisation of CMEs in crises. Therefore, the general knowledge and science-creating system of the CME is in focus. In a second section (7.3.2.), implications from the analysis of the NIS in times of crisis are discussed. In a third section (7.3.3.), the CME is brought into comparison with a second, economically strong and culturally very different Asian CME: Japan. Both NISs are compared in times of crisis. In section 7.3.4., the German and the dirigiste French NIS system and their reactions in times of crisis are looked at briefly. A fifth section (7.3.5.) uses the comparative perspective to briefly bring the Nordic countries into the picture. This section merely discusses the proposition arising from VoC of welfare being related to incremental innovation.

Filippetti and Archibugi (2011) view the European union as one unit of analysis within which they observe the impact of a global crisis, whereas the VoC approach differentiates between the performances of CMEs and LMEs, and Redding et al., as well as Witt and Redding (2012) do further differentiate Asian capitalism into certain clusters. Each approach within the field of comparative capitalism establishes different aspects of the phenomenon of crisis and its impact on the

development of national economies and innovation behaviour. These different approaches to comparative capitalism are taken into account in the context of the changes in Germany. The global economic crisis has already passed through its third round. Streeck and Beckert (2011) demonstrate that the impact of the crisis varies substantially across nations. Thus, contrary to fundamental academic approaches, such as the VoC approach, they do not argue that neoliberal economies are more successful (see e.g. in Petersdorff-Campen, Streeck, and Beckert, n.d.). In times of crisis, the two authors emphasise the importance of national economies being in need of market regulations and ethical guidelines, in constructing trust and stability for the actors in their NIS. This argument of stable NISs enabling their actors to continue investing in innovation and technological capabilities throughout times of crisis is consistent with Filippetti and Archibugi (2011), as well as Williamsc (2012).

8.2.1. German NIS in Times of Economic Crisis – Changes

Since 2005, the German government has established a variety of policies, new to the country. Thus, it is the first time the federal government has established a high-tech strategy; emphasising regional high-tech clusters, large scale investments in R&D on innovation, and also focusing on establishing an internationally competitive university and research landscape. It is clearly visible that the external pressures of the global economic and the European crisis on the German NIS have not led its ability to innovate to decrease in a cyclic manner. Schumpeter's arguments on creative disruption can be observed here. Due to the new situation, the German politicians and policy makers have managed to change their focus, away from passively accompanying economic developments and supporting the long-established strong industries (e.g. the automobile industry), towards playing an active and aware

role in supporting the development of national innovation systems. The new opportunities which occurred due to the crisis have been recognised along with Germany's strengths in terms of a stable and knowledge-based economy with highly skilled labour in a government coordinated environment (Hall and Soskice 2001), and these have been taken as strengths of the system. With the new focus on high-tech industries and new technologies, as well as alternative energy programs, sponsored by the government, the German policy makers have tried to overhaul other nations in economically difficult times. The results of these policy changes, which mainly took place since 2007 – in times of the global economic and current EU debt crisis – have been significant. BUFI (Bundesministerium fuer Bildung and Forschung 2008) describes how the country's position in terms of its research and innovation landscape has dramatically shifted during recent years to become one of the most attractive ones worldwide. Overall the percentage of R&D investments compared to GDP has clearly increased from 2005 (2.51%) to 2010 (2.82%). The government's goal is to increase these investments to 3% of GDP by 2020. In this manner, the German economy has managed to use the global crisis to its advantage. As shown by the 2009 Innobarometer survey, Germany (together with Denmark, Finland, Sweden, Switzerland and the UK) has managed to achieve a position as an innovation leader (Kanerva and Hollunders 2009) In response to the above illustration about changes in the German NIS in times of crisis, RQI "Has the German NIS transformed throughout the past years?" can clearly be answered with a "Yes". In the face of the global financial crisis and the following European sovereign-debt crisis, the German NIS has clearly transformed. It has, therefore, coped with the new situation and managed to use it to its advantage, through the

changes which took place in the NIS. It does appear to have remained a coordinated market economy.

The German government has done a lot to support new, high-tech sectors. As Casper et al. (1999) and Lehrer (2001) have described before, the German government has continued to focus its attention on the development and support of new industries. In particular, the policy changes for the biotechnology sector appear to be dramatically different in comparison to their roots. In contrast, the software industry appears to still obey open issues, e.g. due to the differences between the world's patent office guidelines for patenting software. This issue is not that much of a problem for the German government, as it is a topic which needs further discussion in the European Union. At first glance, the policy changes made by the government seem to have had a real impact on the development of both of the two sectors. As mentioned before, the government policies in the software sector are *diffusion-oriented* (Lehrer 2000) and thus they are sometimes seen as being more effective. Thus, where small research-oriented firms dominate the German biotechnology sector, the large international firm SAP has established itself as a leading firm in the software sector. The very different starting points of the two sectors (biotechnology and gene manipulation being stigmatised as evil in Germany) have called for these different policy strategies. It is questionable whether diffusion-oriented policy support would have had any positive effect on the biotechnology sector in the 1980s. It might be argued that, due to the very different national cultures and market structures in Germany compared to the USA, such step-wise policy development was the best method of successful development within the country; it led existing resistance to be largely dissolved. Thus, whereas Germany was limping behind many

other OECD nations in the 1980s; it can now be identified as one of the leaders of the European Union in these two radical sectors. Therefore, the simple differentiation between CMEs and LMEs in the VoC approach needs to be re-thought. There might be more diversity within one country than between countries. The proposition arising from VoC that institutions and institutional complementarities are the ultimate factor for establishing a nation's sectoral specialisation should be rethought. As suggested by Taylor (2004) it can be supported that a state's influence on the innovation pattern of a country might be stronger than is sometimes assumed.

Taylor's suggestion of the role of the state being of importance for innovation behaviour cannot be rejected in this thesis. There seems to be a relationship between policy changes and innovation behaviour in sectors. No policy can be found which directly supports neither "radical nor incremental" innovation. Therefore the dichotomy might be softened. Talking about the state's policy support for certain sectors appears to be a better description of what happens in reality. The sectors which are strongly supported in Germany are new ones at the beginning of their life cycles with lots of potential to generate new workplaces and economic success. Therefore, it might even be concluded that Hall and Soskice's five institutional spheres are not sufficient for explaining the differentiation between nations and for explaining innovation behaviour itself. The question of the role of the state and the role of government policy and policy change is relevant for the VoC field. The proposition arising from VoC of relative stability also needs to be rethought. There are massive changes going on in the innovation behaviour of nations. It also needs to be questioned whether these changes can still be described as path dependent. This thesis suggests that through incremental policy changes, large shifts in innovation

behaviour can be found, which can no longer be referred to as path dependent. Whether this goes in hand with institutional change is a question which cannot be answered at this stage. In this context, institutional change and changes in innovation behaviour are better viewed as independent concepts.

8.2.2. Implications for the German NIS

In the context of Schumpeterian thinking, German policy makers used the crisis as a chance for something new and to get ahead of the competition (Warschat 2009). This intention could not have been achieved without direct implications for the NIS. Three key transformations of the German NIS can be found:

Focus on high-tech and new technologies

Ietto-Gillies has already emphasised that, in times of crisis, governments should support "large investment projects such as alternative sources of energy, transport as well as the public service" (Ietto-Gillies 2010, 910). This is what actually happened in the German case. As illustrated above, the German government used the crisis as an opportunity to specialise its policies on new technologies and thereby tried to overtake the research of other nations in economically difficult times. This is an obvious change in the German NIS, which previously focused on established sectors, adopting more incremental approaches to innovation (as argued by Hall and Soskice 2001).

Supporting Regional Clusters, communication of various actors in the cluster and competition in between national clusters

For their new strategy of specialising in new and high-tech industries, policy makers acknowledge the importance of an NIS. The EU and the German government are aware of NIS and cluster theory (European Presidency Conference on Innovation

and Clusters 2008) and actively support the formation of high-tech clusters throughout Germany. Some cluster policies have been mentioned above (Bundesministerium fuer Bildung and Forschung 2008; Bandesministerium fuer Bildung and Forschung 2012; Federal Ministry of Education and Research 2010). The German structure of a federal government and independent state governments, as well as research institutions, such as the Fraunhofer or Goethe Institute, cooperating with universities and focusing on basic research within these clusters and between them, is a basic element of the recent transformation of the German NIS.

Supporting national research and training institutions and their communication with other research institutions and the industry.

One of the strengths of the German NIS is its stable economic environment and the highly-educated human capital within this. No high-tech strategy would work out, if the German government did not manage to activate enough labour for it; therefore, the government has developed a variety of strategies to support basic research and, at the same time, to generate more highly skilled labour (Bundesministerium fuer Bildung and Forschung 2012). On the other hand, there is already a lack of labour visible. Therefore, the governmenthas already launched a "Blue Card" in order to allow Germany to attract more qualified workers from abroad (FOCUS 2012; Tagesschau 2012).

The global financial and European sovereign debt crisis has had severe impacts on global and national economies. In regard to the German NIS, three measures of innovation, namely R&D investments, patent counts (input), and publications (output) are used as indicators of the development of the system. It has been found that these measures of innovation have changed over time. The amount

of R&D spending on innovation by industry as well as the federal government reached a new height in 2010. In terms of patents and publications, Germany has managed to establish itself as one of the leading contributors worldwide. The impact of R&D investments on a firm`s ability to create innovations, in general, has been discussed and illustrated by many researchers (see e.g. Pianta and Bogliacino 2007). In the context of this thesis, the various sources of R&D spending in the German economy, in general, as well as the development of industry-specific investments, and an international comparison over time are chosen for analysis. As illustrated in Figure 29, the R&D investments in Germany have continued to grow over time, even in times of crisis. It is obvious that the government and industry are the largest sources of finance for R&D. One might argue that (in spite of times of crisis) this could be the case for many leading OECD nations. Figure 30 illustrates the two largest sources (government and industry) of R&D spending in the context of equivalent international figures. The *EU Industrial R&D Investment Scoreboard* includes data from the 1,000 largest R&D investors in Europe/ or alternatively the rest of the world. It does focus on the 1,000 largest firms within either the EU or the rest of the world and illustrates their R&D investment behaviour. Therefore, it is not representative of one whole national economy since only a country's largest (in comparison to other EU firms) nations are observed. The largest proportion of the German economy is driven by small- and medium-sized firms. Their development is obviously neglected in the *EU Industrial R&D Investment Scoreboard*. Therefore, the illustrated data can be taken as an indicator of the development of NISs, but not as a complete truth in terms of how exactly industrial investment has developed. Figure 29 gives a summary of the Innoscore 2006, 2009, and 2011 reports, focusing

on the five chosen countries (France, Germany, UK, USA, EU) and total R&D investments in millions of Euro/year (2005, 2008, 2010). It illustrates the developments of R&D investments amongst the largest firms in each country. It is clearly visible fromthis that the German industrial R&D investments have continuously increased in recent years, though the data only relate to the large firms in the captured countries. As mentioned before, a major proportion of German firms are small- and medium-sized. One might argue that these firms may not be such strong R&D investors in times of crisis.

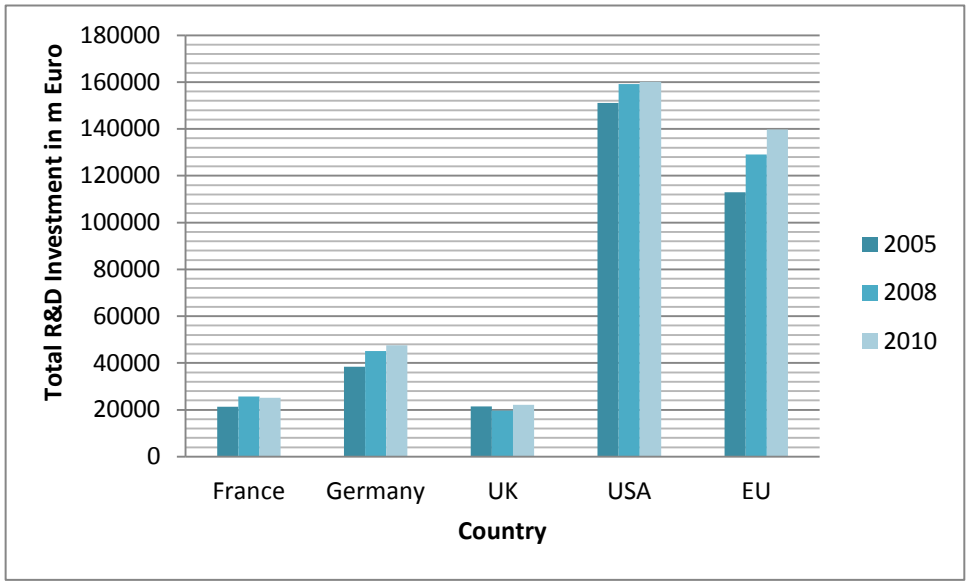
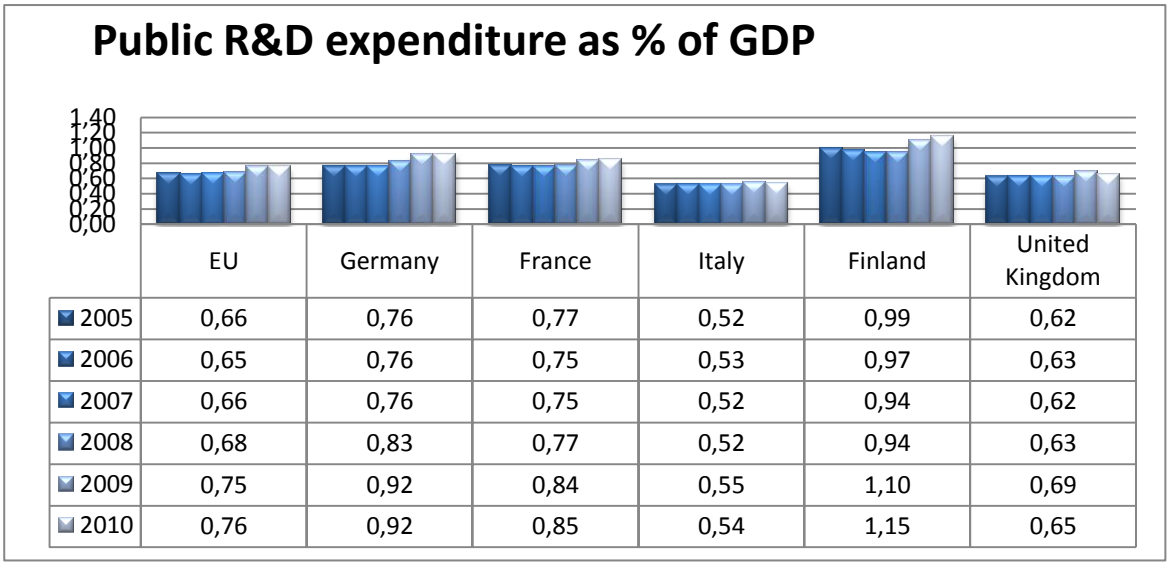


Figure 29: Total R&D investment per country (2006, 2009, 2011)

Source: Own illustration using the 2006, 2009, 2011 EU Industrial R&D Investment Scoreboard

In this context, General Electrics (2012) clearly illustrates, in its European SME investment Barometer, that within the four strongest European macroeconomies (Italy, France, Germany, UK) German small- and medium-sized firms are increasingly stronger than the other countries' firms, and more willing to

invest into R&D. Therefore, the trends observed for investment in Figure 30 can be confirmed in an international comparison. Compared to other leading OECD nations, German industry is quite strongly and continuously stable, increasing its investments in R&D, throughout times of economic, financial and European crisis. In a comparion with EU countries, the development of German public spending on R&D is notable. It appears that, in times of crisis, public spending is an important source of German R&D investment. This government strategy – invest in times of crisis – promoted attempts to overtake other nations in technological developments, and was possible and sensible only in the context of an otherwise stable national economy.



	EU	Germany	France	Italy	Finland	United Kingdom
2005	0,66	0,76	0,77	0,52	0,99	0,62
2006	0,65	0,76	0,75	0,53	0,97	0,63
2007	0,66	0,76	0,75	0,52	0,94	0,62
2008	0,68	0,83	0,77	0,52	0,94	0,63
2009	0,75	0,92	0,84	0,55	1,10	0,69
2010	0,76	0,92	0,85	0,54	1,15	0,65

Figure 30: Public R&D expenditure as % of GDP

Source: Own illustration using data of the Pro Inno Europe- Innometrics (2011)

It might even be argued that this government strategy was also the source of the increasing industrial R&D investment since industry (especially small- and medium-sized firms) might orientate depending on government policies. Germany

has not suffered under the crisis in terms of its ability to produce innovation (represented by the outcome factors for publications and patents). Not only in terms of patents, but also in its publications per citizen, the German economy has even managed to overtake the giant USA. The illustrated counts are in relation to the population. Thus, the USA does obviously still have a higher total number of publications and patents. In terms of its NIS, relative counts show quite well that the NIS is strengthened and that the governent has been successful in not only establishing a culture of knowledge and basic research (as this has always been a strength of the country's NIS before) but moreover interconnects basic research with industry and independent research institutions, establishing regional (high-tech) clusters.

The chosen policy changes by the German government appear to have been successful. Considering the previous chapter, recognising the global crisis as an opportunity and government's taking an active role in supporting the developments of key technologies seem to have resulted in a positive effect. The neo liberal argument that a capitalist economy is economically successful when it is not coordinated by government, but corporations and banks can act freely in society according to their will, does not seem to be relevant to the production of the most important factor for economic success – innovation. The opposite seems to be the case. Diverting on to another related topic, in terms of the VoC debate (Hall and Soskice 2001) that CMEs such as Germany are weaker at producing radical innovation (e.g. high-tech industry) and stronger at specialising in incremental innovation (e.g. automobile industry), a counter-intuitive development is apparent here as well. The characteristics of the German CME as having a high knowledge

base, and highly skilled labour, the coordination of industry, by workers' councils and the government – leading to long-term employment, coordinated bargaining, and high worker participation– as well as the strong inter-firm and inter-institutional relations, are found to be supportive for the country's specialisation in high-tech industries.

Two implications for future government policies are suggested. Firstly, the increase in government spending on R&D, focusing on high-tech and new sectors is found to be positive for system development. It is suggested that such spending and programs to support new technologies should be continuously increased in the future leading the CME to establish even more internationally competitive high technology clusters. Such a suggestion is significant particularly in the context of current discussions about federal government debates about supporting vs. cutting off government subsidies (Deutsche Welle 2012). The solar industries fear that such cuts in times of crisis would erase a large number of solar energy firms in Germany. Further investments in R&D in this field might even manage to catapult the sector into a more competitive position internationally. A major future problem of the German NIS, due to an aging society on the one hand and further specialisation in high-knowledge-based industries on the other, is the lack of skilled labour. A second implication specifically relevant to German policy is clearly demonstrated by the need for more trained and highly educated staff, especially in the areas of natural science (as described in the previous chapters (see Tutmann 2011; OECD 2007; Preisendörfer 2008, BMBF 2008)). A larger number of nurseries (also for children under three years) and flexible work contracts, as well as a women's quotas in companies and mentoring programs in science, are suggested to activate the female

potential in society after the Norwegian model (Storvik and Teigen 2010). Additional scholarship possibilities and on the job trainee/university programs for children/young people especially from non-academic families, and migrants could also lead to more skilled labour. Streeck (2008, 149) argues for a disorganisation of the German capitalist system, meaning the liberalisation of the German institutional spheres. Since Hall and Soskice's book was originally published in 2001, the five mentioned institutional spheres, which are argued to characterise Germany as a coordinated market economy, have largely stayed stable. Even in times of crisis, the sphere of industrial relations is characterised by strongly coordinated bargaining and works councils. The internal structure of firms is mainly characterised by consensus decision-making and network monitoring. During the past five years, the government has established policies on the remaining three institutional spheres, aiming to support German high-tech industries and, with this, the development of employment in SMEs in high-tech areas. On the sphere of vocational training, the federal government and the states signed the Hochschulpackt 2020 in the summer of 2009. This program is tailored to suit the market needs of the German economy in terms of skilled labour and to enable the German universities and research landscape to compete internationally. This emphasis is not only necessary for further production of innovation but also necessary due to the already emerging lack of skilled labour in Germany. In terms of inter-company relations, the government has actively supported the formation of high-tech clusters throughout Germany since 2009 (BMBF 2008, 2012; Die Bandesregierung 2010). The German NIS is structured by a federal government and independent state governments, as well as research institutions, such as the Fraunhofer or Goethe Institute which cooperate with

universities. Therefore, basic research within clusters and cooperation with companies is a basic element of recent government incentives to innovate against the crisis. In spite of the liberalisation of the German financial system, firms' R&D investments are still highly dependent on banks and the government. As such, shareholder value approaches, as well as stock markets, in general, are being looked at critically. The government has been strongly pushing investments into R&D since 2009. Due to these government policies (see Federal Ministry of Education and Research 2010) investments have been available to firms, especially to new, high-tech firms and to entrepreneurs throughout times of crisis. The German government has, for the first time, constructed a high-tech strategy, emphasising regional high-tech clusters, large-scale investments in R&D, and an internationally competitive university research landscape. By focusing on the NIS approach, the government has led the CME to its current position of economic success (as visualised in Figure 31: GDP growth rates per country) even in times of crisis (DAPD 2012). The relative strength of the German system in terms of GDP growth is, among other things, dependent on innovation behaviour.

In terms of innovation behavior, the VoC approach draws a parallel picture between the innovation behaviour of CMEs and LMEs, such as the USA and Germany or Japan. Whitley (2002, 500) mentions, that "the variety of (…) innovation strategies within each kind of market economy is sometimes greater than the contrast between CME and LME would suggest. In the German case we not only observe GPD growth, but, as illustrated in Figure 32, the total expenditure on Research and Development in terms of the nation's GDP has also increased, especially during but also after the global crisis (the particular sources of the German

R&D increases are shown in Bandesministerium fuer Bildung and Forschung (2008, 2012)).

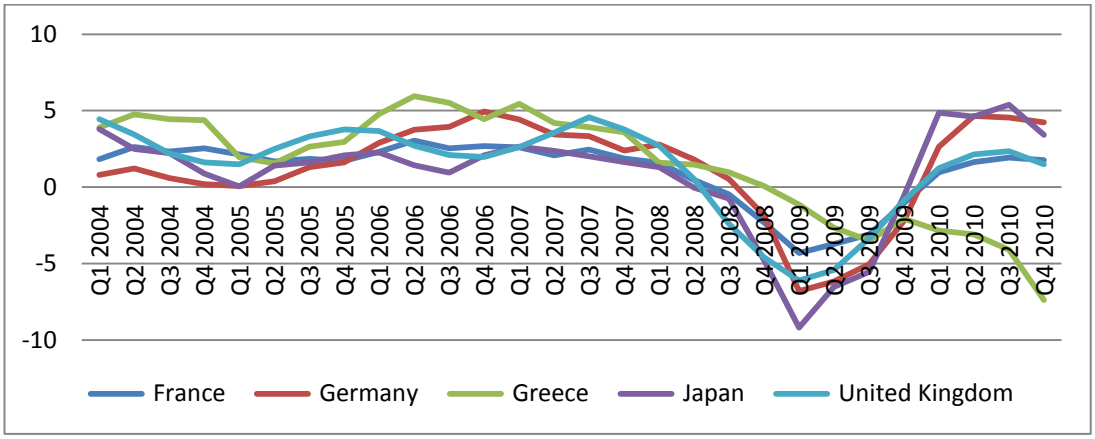


Figure 31: GDP growth rates per country [Growth rate same period previous year, s.a.]

Source: Extract from Organization for Economic Development and Cooperation (2012): Main Economic Indicators (edition: November 2012); ESDS International, University of Manchester

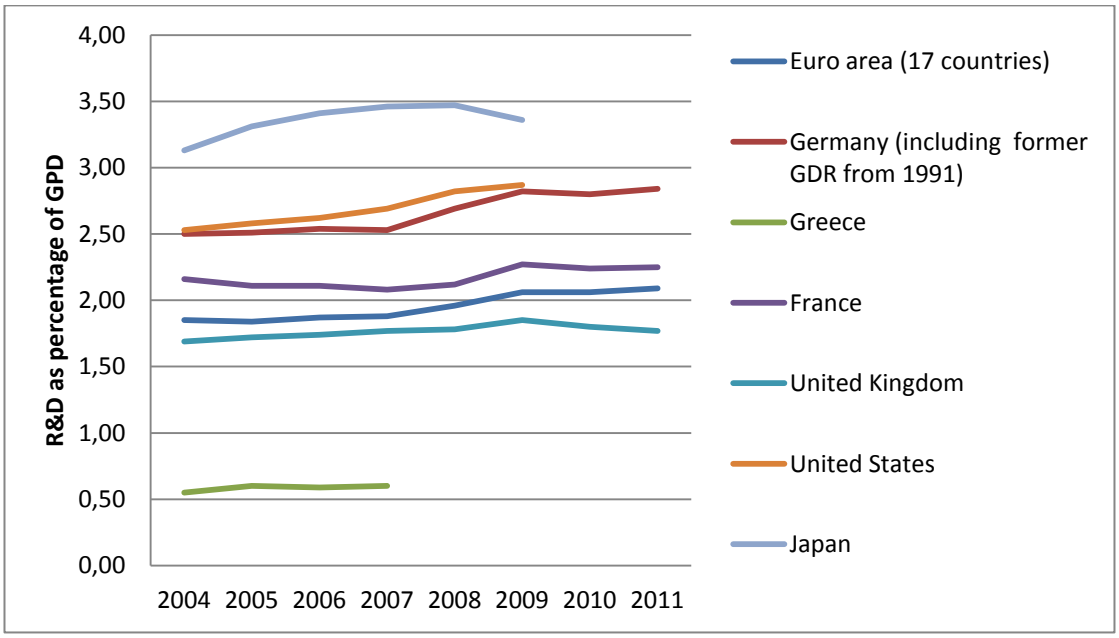


Figure 32: Total intramural R&D expenditure as percentage of national GDP

Source: Extract from Organization for Economic Development and Cooperation (2012): Main Economic Indicators (edition: November 2012); ESDS International, University of Manchester

In times of global competition and ongoing crisis, a country's ability to produce radical innovation is argued to be of high relevance for its wealth creation. High-tech industries and new sectors such as the software or biotech sector are meant to represent radical innovation (Hall and Soskice, 2001). Using *The EU Industrial R&D Investment Scoreboard*, one can specifically observe that, in the German case, not only general R&D investments have increased, but also the investments in this radically innovating sector (see Investments in research and development in countries' software sector 2005, 2008, and 2010.) Germany increased its world share of R&D expenditure in the software sector from 6.6% (2005) to 11.6% (2010).

The R&D Scoreboard is not representative for Japanese firms since Japan is only represented by two firms in 2004 and 0;1 firms in 2008 and 2010. The R&D Scoreboard only uses the 1,000 largest non-EU countries' firms for data collection. As such, the countries are in direct competition with the USA (79% of the overall world share of R&D investments). It is argued that the Japanese firms have not managed to compete with US firms in terms of. In reality, Japan is not only competing with the US but also with EU countries. A database, which would have selected the 2,000 strongest R&D investors in Europe and Asia, would, therefore, have identified more Japanese software firms. The input factor for R&D investment influences innovation performance. Patent applications can be understood as an input factor as well – a filed patent may never lead to a new product on the market; one may also consider it as the output of an innovation process symbolising the strength of a national innovation system in one sector. In these terms, Germany, as well as Japan, show high numbers of high-tech patent applications sent to the EPO (see

Table 13: High-tech patent applications to the EPO by priority year at the national level in total). In fact, Germany and Japan show the highest total counts.

As one more indicator illustrating the strength of a national economy's specialisation in one sector, the output factor of total sales in one industry can be viewed. This might represent the outcome of an innovation process: a product which is implemented in the market and sold successfully. With increasing numbers of software firms and net sales, the German economy produces almost half of the EU net sales in the software sector. Beside the giant US software industry, German firms have managed to acquire an increased percentage of the world share of software sales since 2005 from 7.9 to 9.1 per cent in 2010. Similar developments are visible for biotech sales, as illustrated later on. In sum, German institutional frameworks as well as government policy changes in the face of a global crisis, focusing on further investment in high-tech industries and radically innovating sectors such as software or biotech, as well as supporting the research landscape and linking it with university research and industry, seem to have led the country to a better economic position after the crisis than before. In terms of innovation performance in high-tech sectors, Figure 33 and Figure 34 give an overview of how the German, but also the Japanese high-tech strategy (discussed in the following section) might have had effects on each nation's performance in the area of patents. The two charts which illustrate data from the EPO which have been calculated for the countries' world shares of patents in the selected sectors, illustrate the diverse innovation behaviours of LMEs and CMEs themselves, within the two groups. Similarly to the previous chapter, we can again find that Germany outperforms the UK, which is a counter intuitive finding following the VoC argument. We do not find that LMEs generally perform well in

sectors associated with radical innovation, nor do we find that CMEs generally perform weakly in these sectors. In 2011/2012, Germany took a world share of around 10 percent in all observed high-tech sectors. Japan even outperformed Germany in ICT and nanotechnology. This finding leaves us with some questions. First of all, even though we look at absolute numbers and each country's world share on high-tech patents it cannot be found that changes in a CME's institutional framework lead to shifts in trajectories of innovation. Even though the political intervention and (negative) attitude towards new technology might have influenced Germany's performance in certain high-tech sectors like biotech, the CME still appears to be a highly coordinated nation. Furthermore, the ascribed relationship between radical/incremental innovation and coordination is rejected as one can observe different attitudes towards innovation within nations. This might be discussed in the overall conclusion.

GEO/TIME	2004	2005	2006	2007	2008	2009
European Union (27 countries)	22.173	21.326	20.928	20.653	19.596	15.489
Germany (including former GDR from 1991)	44.18	40.507	39.182	39.978	37.736	29.96
France	30.303	29.777	29.804	30.661	29.983	25.976
United Kingdom	23.87	23.066	21.023	19.975	17.834	14.868
United States	39.108	36.941	32.863	29.191	26.686	:
Japan	60.136	52.817	50.892	46.291	43.237	:

Table 13: High-tech patent applications to the EPO by priority year at the national level in total numbers

Source: Extract from Organization for Economic Development and Cooperation (2012): Main Economic Indicators (edition: November 2012); ESDS Inter

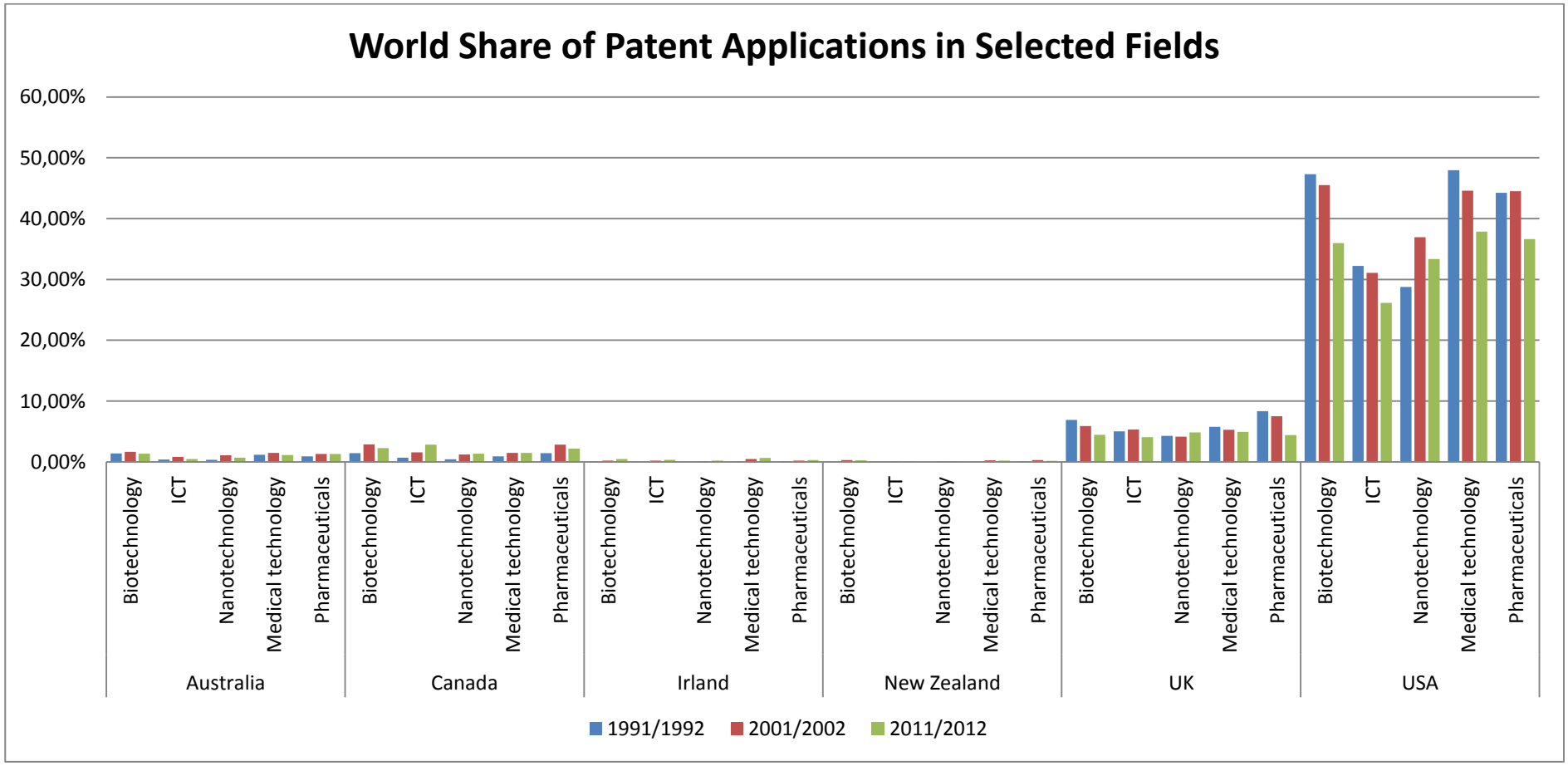


Figure 33: World share of patent applications in selected fields by country of residence of inventor – liberal market economies

Source: Own illustration using OECD patent data by EPO, country of inventor

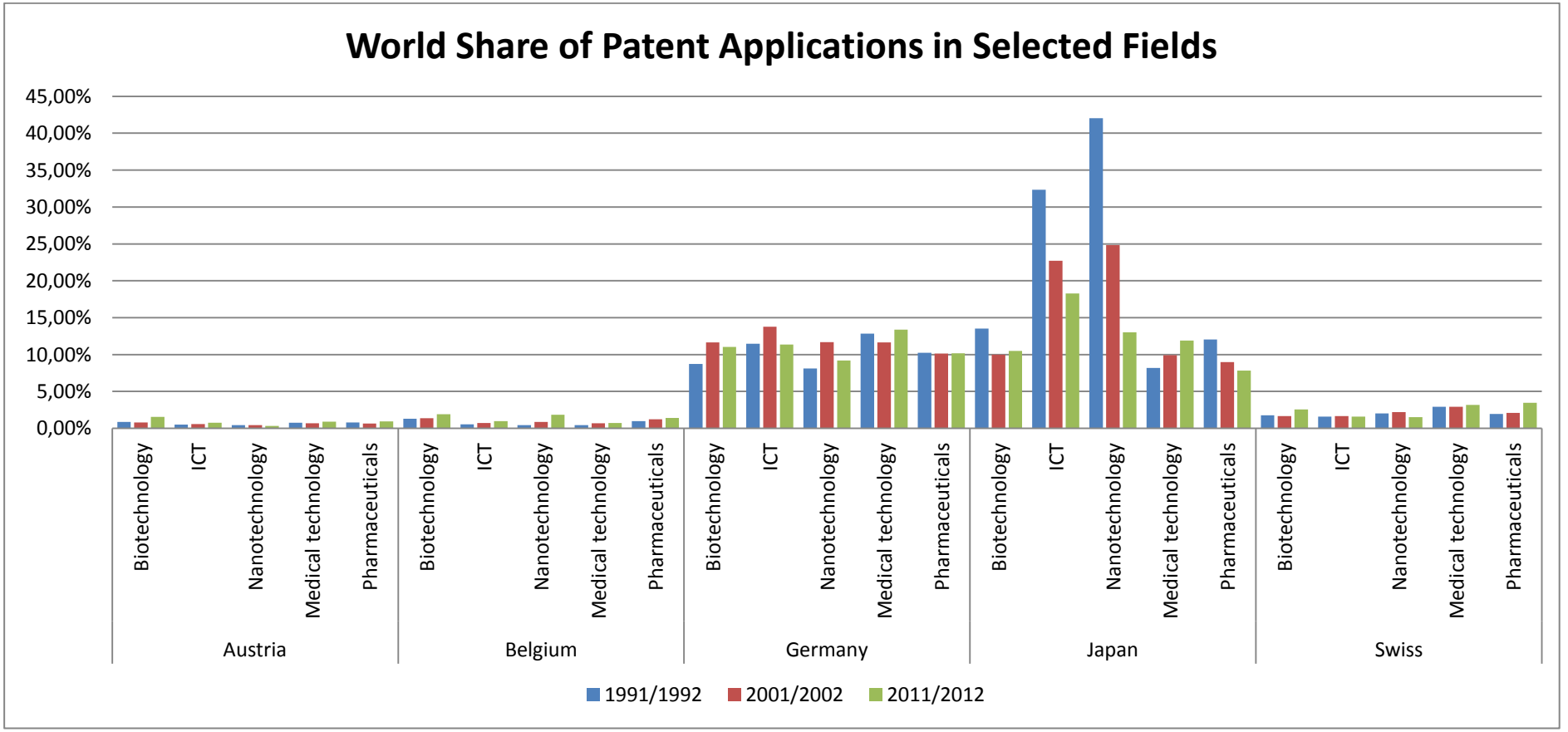


Figure 34: World share of patent applications in selected fields by country of residence of inventor – coordinated market economies

Source: Own illustration using OECD patent data by the EPO, country of inventor

8.3. Implications of the Theoretical Framework

Government policy is found to be of high relevance for skill creation, labour market rigidity, and industrial relations as well as corporate governance and the functioning of financial institutions in Germany. Some of the most relevant changes in the institutional framework of Germany were led by national or EU government policy making. During his second legislation period, Gerhard Schröder introduced major shifts in the German labour market by changing employment and especially unemployment and social protection (Knuth 2006; Trampusch et al. 2005). The package of reforms, called *Agenda 2010* led Schröder in June 2005 to call parliament for a vote of confidence. The parliament did not have confidence in Schröder's action. Before the government was due to revote, Schröder introduced the Hartz-legislations (Schubert and Klein 2011; Schütz 2012; Fahr and Sunde 2009). In order to align with EU university education (Nickel 2011; Wächter 2004), but also to prepare for direct competition with the US economy (Charlier and Croché 2007), Germany entered the Bologna Process. In 2005, the majority of German universities was able to offer Bachelor's and Master's degrees instead of a Diploma. Angela Merkel used these previous developments in the general skill creation system and labour market by emphasising a complete national innovation system (Federal Ministry of Education and Research 2010; Lang, Schneider ans Bauer 2012; Kaiser 2008). In 2006, she introduced a high-tech strategy (Bundesregierung 2006) focusing on 17 fields of research, e.g. biotech and renewable energy. A major concern of the German high-tech strategy was to establish industry-university linkages in research and development. Due to the large amount of SMEs dominating the German market economy, R&D cooperation with universities was argued to be of high relevance. A series of competitions were called for

by federal government in order to create clusters (BMBF 2006; BMBF 2013; BMWE 2015) which still exist in Germany. The establishment of regional clusters was not only supported by federal government, but also by Länder governments as well as independent research associations e.g. Fraunhofer. The coordinated nature of German firms, traditionally emphasising stakeholder value and long term investments is argued to be one strength in the process of establishing regional clusters. In order to create the skill base necessary for the future high-tech nation of Germany, federal government introduced further reforms of university level education (BMBF 2015). Between 2005 and 2014 the percentage of high school graduates registering at university rose from 37% to over 50%. Due to further focus on MINT (BMBF 2012a ; Bund and Länder 2007; Bund and Länder 2011) policy for the encouragement of mathematics, informatics, natural science and technology in education, Germany (in contrast with France and the UK) continuously increased not only the numbers of students at university but also the students pursuing a MINT degree. Numbers of patents per county, R&D investment and employees per sector illustrate that we can well argue for an effect of government policy on the ability to create radical innovation, in spite of the previously described developments. The influence of government policy on the national institutional framework and innovation as its output is clearly visible.

It is important to clarify that the institutional framework of Germany is still distinct and of a coordinated nature even though there has been a change towards high-tech R&D. Government and national players are clearly supporting a stakeholder-oriented CG system (Pfitzer, Oser and Orth 2003; Regierungskommission Deutscher Corporate Governance Kodex 2015). In reaction

to the EU financial debt crisis, calls for the regulation of stock markets, etc. became louder (Moshirian 2011). The German government introduced a minimum wage of €8.50 in 2015 which was increased onto €8.84 in January 2017 (tagesschau.de 2016). While employer representatives were striving to demolish the introduction of a minimum wage, representatives of employees welcomed the introduction as a first step towards support of the working class after the introduction of Hartz legislation. Employment numbers reached an all-time high in 2015 and unemployment an all-time low since the reunification of Germany (Bundesagentur für Arbeit 2016). In, *Der Arbeitsmarkt in Zahlen 2005–2015*, Agentur für Arbeit illustrates these developments. Theory needs to acknowledge the role of government but also employer and employee representatives in the coordinated market economy of Germany. The government's influence not only shapes the outlook of national institutions but also offers developments in the product market choices of firms in the nation. The creation of financial support e.g. in terms of competition and skill equilibria might lead the product market choice not only of start-ups but also of traditionally oriented firms more towards future industries. The theoretical framework underlying comparative capitalism needs to change away from a purely institutionalist notion to acknowledging the role of government and employee/ employer representatives. The dichotomist notion aims to explain the creation of radical innovation as associated with liberal capitalism and this needs to change as well. Friedrich List asks WHO would produce new goods, WHY this person decides on a certain product and HOW the production can be supported. List's questions might be out of date but are highly relevant in our current discussion. The role of individual choice, irrational human nature which follows religious beliefs and culture

has only partly been recognised. *Religionssoziologie* (sociology of religion) was a field of research which began to emerge in Germany, following the lectures of Max Weber (Weber 1904), Georg Simmels *Philosophie des Geldes,* (Simmel a.o. 1900) and Stark and Bainbridge (1986) in *The Future of Religion*. The common belief of authors in this field is that, even though religion might be a private issue behind closed doors, the value system behind one's system of religious beliefs influences personal action. The paradoxical actions of German policy in the case of biotechnology represent one example for religious beliefs' influence on government policy-making, in terms of the limited ability of firms to develop skills or attract financial support. Following Hofstede (1983; 1984) and Trompenaars (Trompenaars and Hampden-Turner 2011; Smith, Dugan and Trompenaars 1996), various authors (Rossberger and Krause 2013; Tatschl 2013) argue for a cultural influence on leadership, innovation or decision-making. In terms of decision-making psychologists such as Hans-Jürgen Pfister argue that human decision- making is irrational (Jungermann, Pfister and Fischer 2010) in terms of trust, feelings and sense of fairness. Cognitive dissonance (Akerlof and Dickens 1982; Schlicht 1984; Knobloch-Westerwick 2007) and group thinking effects influence these areas (Hart 1990; Weis and Wiesmann 2014). This dissertation does not aim to discuss the cognitive processes of individuals, but one important implication of this dissertation on existing theory is the recognition of irrationality and imperfection in the human being/worker. In this sense, this thesis argues for a limited view of a potential worker in terms of his/her choices relating to skill formation and investment in future work. A worker's choice to pursue apprenticeship training versus general education at the university level is not merely a financial decision. Besides the cultural and religious

beliefs dominating the group which the individual is part of, cognitive dissonance might lead to irrational choice. Even though government, employee and employer representatives might be able to influence institutional foundations, the human being needs to be viewed as another complex variable in the process of innovation in the CME, Germany. The worker can potentially have some propositions about the future job market as well. Due to the worker's own abilities and propositions due to own position the worker will make a decision on his/her future skill development. No "normal" worker can have a complete overview of all national institutions influencing the future product market choices of firms, e.g. in order to find a secure working place.

The third force influencing a firm`s product market choice in the suggested theoretical model is globalisation. Globalisation not only puts pressure on national government policy in terms of competitiveness, it is creating a globalised educational system (at least on a university level), a globalised financial market and a globalised product market. Research on national trajectories of innovation must, therefore, change in the future, taking into account the national level in terms of focusing on international relations and their influence on one nation. A reorganisation of the theoretical framework states a newly suggested focus on skill equilibria. Skill equilibrium is not merely influenced by government and policy, but by globalisation and individual choice.

Future developments in MNCs might make use of the different national job markets and skill equilibria, and the different national regulations for financial support or corporate governance available to them. Figure 36 illustrates the

potentially growing influence of MNCs over national governments, which could result in competition.

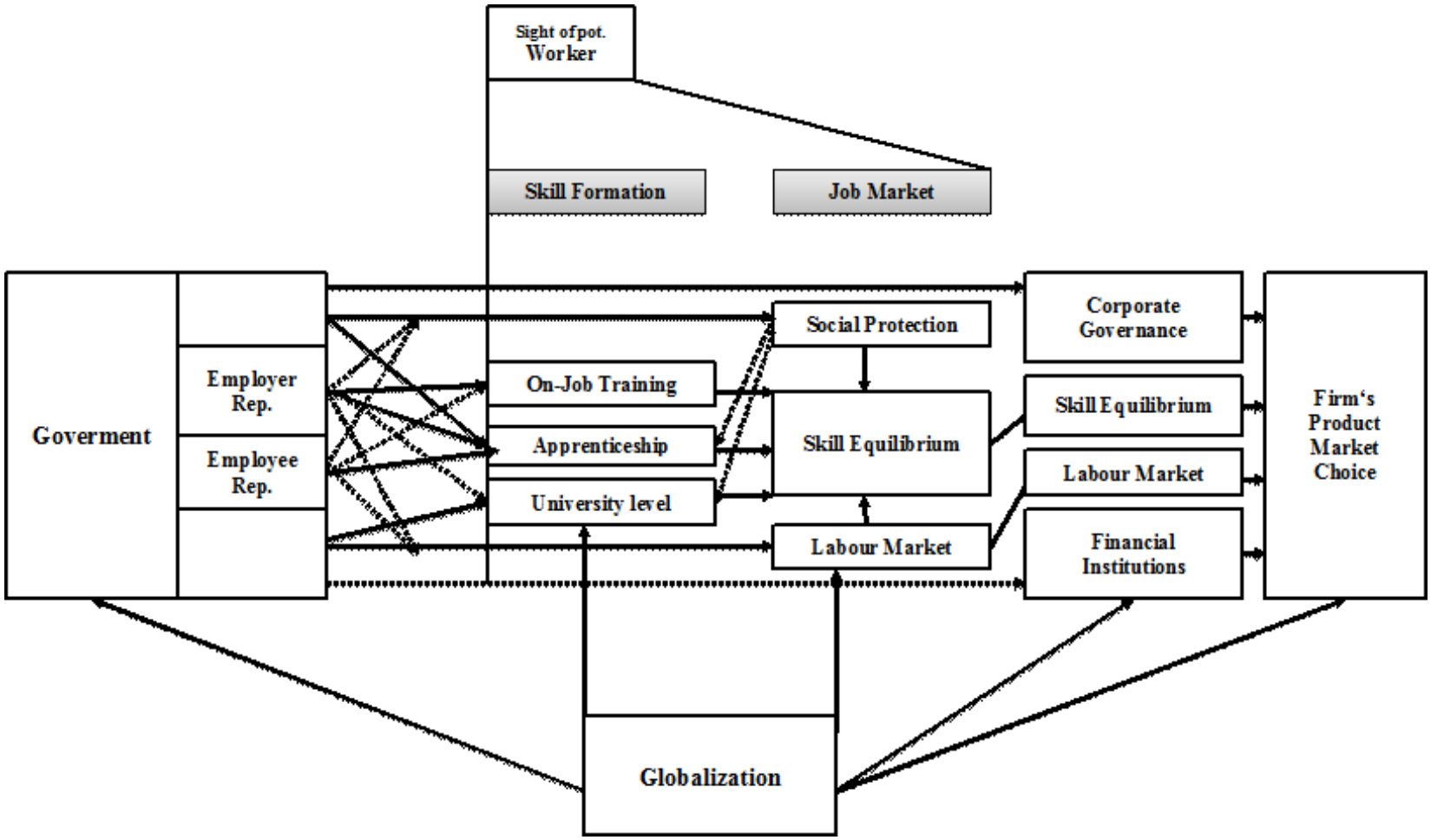


Figure 35: Reorganisation of theoretial framework.

Source: Own illustration

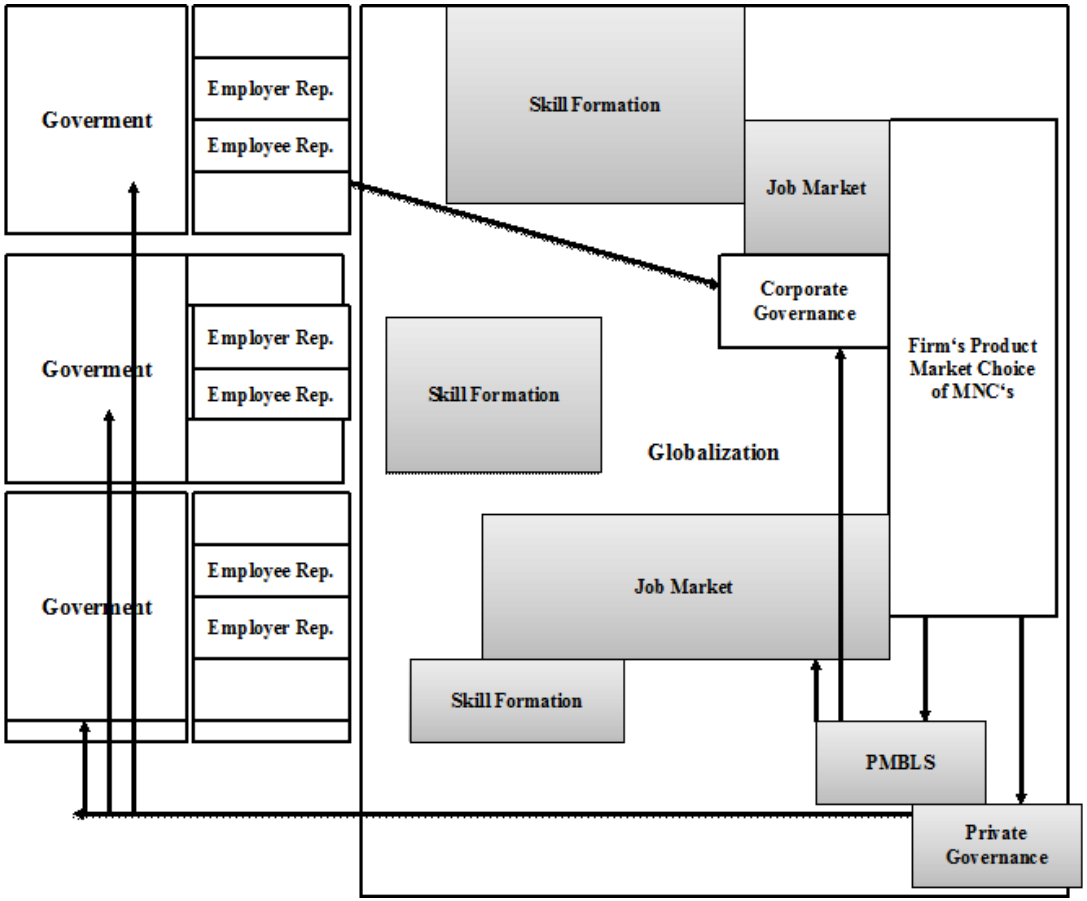


Figure 36: Potential future organisation of institutional frameworks and MNCs

Source: Own illustration

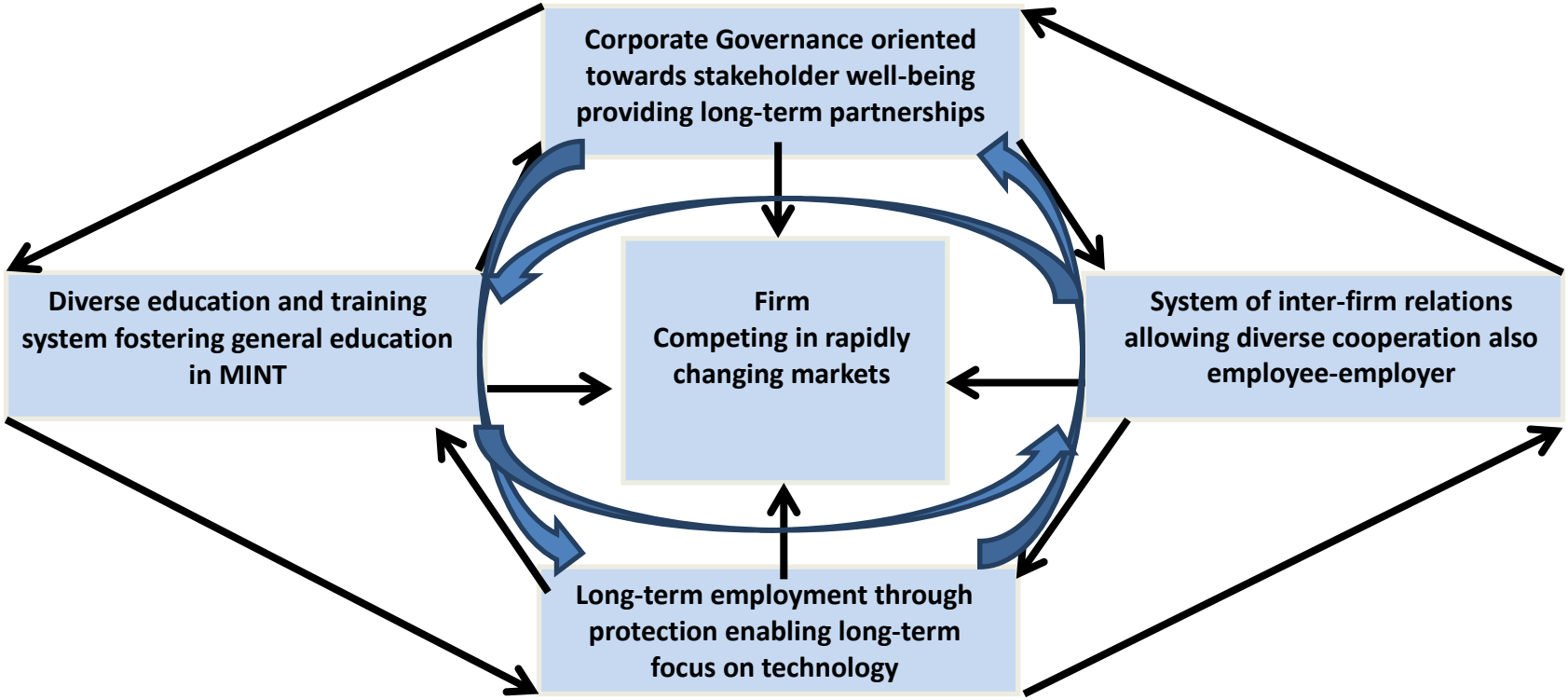


Figure 37: Enhanced theoretical framework on how the CME institutions in Germany support firms competing in rapidly changing markets

Source: Own illustration referring to Hall and Soskice (2001)

8.4. Theoretical Implications for the Study of Radical Innovation

The stakeholder orientation of German firms influences a firm's attitude on how to create innovation. Even though it is not found that coordination directly determines one certain trajectory of innovation, I argue that coordination – in terms of stakeholder orientation – determines a firm's attitude in the process of innovating. The German automobile sector is found to be forced to produce radical innovation in an incremental way, due to the high degree of stakeholder orientation, which is necessary in the national framework and in terms of acquiring reliable long-term partners (e.g. suppliers).

Whereas Schumpeter's notion of disruptive change for radical innovation might be strived for e.g. in the USA, this is something which German manufacturers actively aim to avoid. For them, disruptive change implies the loss of something pre-existing, the destruction of something of value. German manufacturers prefer a different approach to creating innovation. If possible, this approach follows a staircase formation, which leads manufacturers from one step of innovation towards the next, with the clear goal of one highly innovative technological development in mind.

The stepwise approach to innovation offers a series of advantages and disadvantages compared to a disruptive approach. Our way of looking at innovation is strongly influenced by Joseph Schumpeter's theory on creative disruption. This theory is often raised in the context of product life cycles, business cycles and it is often implicitly argued for in terms of radical innovation which necessarily destroys an industry. Some major examples of this are the

introduction of electricity, or most recently the introduction of the CD. Each introduction is argued to have made an earlier discovery useless. It destroyed one industry/product and created a new one, which gives citizens a higher value.

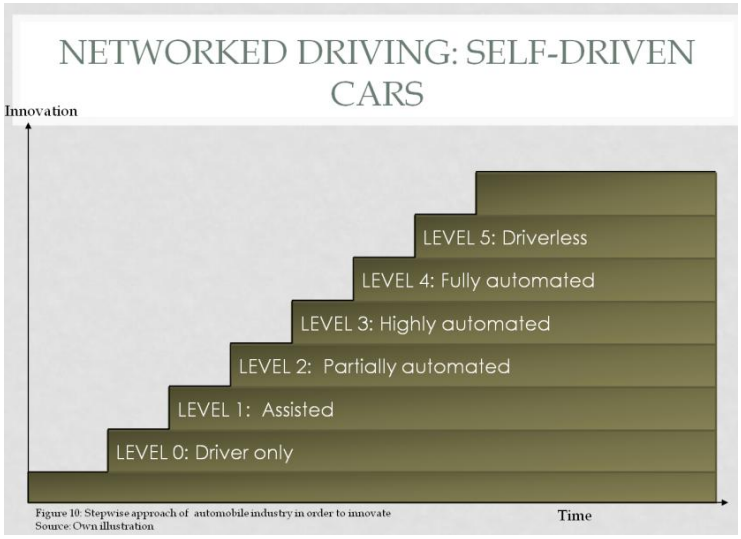


Figure 38: Networked driving stepwise approach

Source: Own illustration using Smethurst (2015)

As previously described, Schumpeter's view on entrepreneurs (as agents of change) and creative disruption fits well into the context of existing economic theory. The NIS approach or VoC approach provides the institutional framework within which the entrepreneur creates a firm and later this firm is managed and chooses certain product market strategies depending on the institutional framework and degree of national coordination. Throughout the case study of Germany, it was found that the institutional spheres, together with national policy-making, trigger a certain approach to creating innovation in Germany. It was found that the CME is highly innovative. VDA describes a different approach to creating this innovation. In this context a stepwise approach to creating innovation

is striven for. Manufacturers aim to create innovation in a way which enables them to offer safety to workers and suppliers due to their stakeholder-oriented approach. In this context, IG Metall (as representing employees) and suppliers (through VDA) are informed about future developments. Skill creation (therefore through IG Metall) can be fitted to future demands. Suppliers can develop fitting technologies in order to continue their relationship with the manufacturer even when there are changing demands for future products. This approach does not mean that development of innovation is not conducted in a cyclic manner as argued by Schumpeter. Research and development activities are distinct from a firm's processes for entering a product market, and this again needs to be differentiated from the firm`s product market strategy (not every development needs to be implemented). In terms of patenting in the area of automated vehicles, contrary to possible expectations, Germany is in a leading position. As Bardt (2017) describes, German manufacturers account for about 80 percent of patents in the area of automated driving. Corporations such as Google or Tesla only account for up to seven percent of patents, in spite of the increasing position of Ford Motors in terms of patents in this area.

The stepwise approach to national innovation provides some advantages compared to creative disruption. First of all, it is implied that if one type of innovation needs to be taken out of the market, one can return to a previous step of technological development. Furthermore, even though one sector might choose to continue developments in one direction, these developments do not necessarily need to be implied in the market. While the internet was a radical innovation, it

was not implemented at the time of creation. Creative disruption might take place underneath the visible developments in the product market.

It is important to mention that not every radical innovation automatically leads to disruption of a market. Disruptive innovation after Christensen is an approach to innovation management which describes a certain process of a firm's strategic choice in order to gain market value. Current developments in literature intermix Schumpeter's notion of creative disruption of a market with Christensen's approach. There is a clear differentiation between radical, incremental, disruptive and stepwise innovation:

Radical innovation: Young and growing, ground-breaking, industry changing

Incremental innovation: Old industries, slow changes, not significantly new, e.g. variation of colour or taste

Disruptive innovation: after entering the market and reaching a certain size:

> "[e]ntrants then move up market, delivering the performance that incumbents' mainstream customers require while preserving the advantages that drove their early success. When mainstream customers start adopting the entrants' offerings in volume, disruption has occurred" (Christensen, Raynor, and McDonald 2015).

Stepwise innovation: an approach to innovation management that purposely chooses a stepwise process of innovating in order to reach a higher goal or radical innovation but avoids disruption of existing structures.

An aeroplane is a highly innovative method of transport but it does not exclude automobiles or ships: product markets might have differentiated but one can now choose between the three. Even though Schumpeter divides ideas into inventions and innovations, as well as further differentiating between different kinds of innovation (product innovation, process innovation, etc.), as well as roles

(entrepreneurs vs. creditor) he does not account for national differences in aiming to implement innovation in the market. The NIS approach focuses on science and knowledge creation; it provides a much deeper understanding of the development and implementation of innovation on the national scale. In *National Innovation Systems: A Comparative Analysis*, Richard Nelson describes how the development of the aircraft took place as a non-destructive innovation, requiring high technology.

> "The rise of scientific understanding supporting aircraft design reflects a similar story. Again the technology, or a primitive version of it, came first, and the "science" or engineering discipline developed to support it. Thus the frail apparatus that the Wright brothers managed to get airbone for a few seconds in 1903 had very little well-understood 'science' behind its design, the promise of those early flying machines gave rise to the modern disciplines of aerodynamics and aeronautic engineering" (Nelson 1993, 7)

Acknowledging the role of science and technology for innovation, stepping back from beliefs in magically-appearing creative explosions of radical innovation leaves us dismantled when analysing the ability of VoC to explain national innovation. While the majority of propositions on innovation arising from VoC can be rejected, it has been found that the relationship between coordination in terms of stakeholder orientation might be an explanation not for incremental innovation, but for an incremental approach to create a highly innovative national innovation system: the stepwise approach aims for a secure process to acknowledge the interests of diverse stakeholders in an attempt to achieve success in highly complex innovation while fostering national welfare and employees' interests.

9. CHAPTER NINE: CONTRIBUTIONS AND LIMITATIONS

This concluding chapter illustrates the key findings raised by the research questions. In a second section, the theoretical and practical contributions which derive from the findings are discussed. In the third section, the limitations of this thesis are illustrated and used to illustrate future fields of research which are to be explored. A concluding remark closes this doctoral dissertation.

9.1. Key Findings

The Varieties of Capitalism (VoC) approach is still of high relevance for discussions in the field of political economy (Lazonick 2007; Coffey and Thornley 2009; Coen 2010; Ebenau, Buff and May 2015). The discussions on the VoC approach have drifted away from the pure original propositions. However, the underlying assumption of liberalisation leading to increased performance in radical innovation continues to survive in political debates and industrial thinking. The past chapters of this dissertation have debated the research questions and developed an enhanced theoretical framework. Some important findings from the past empirical chapters are briefly described here, answering the research questions. This dissertation has focused on the question of institutional (non-) change within the German market economy. In particular, the question of whether policy might have influenced these changes and whether there might be an effect

on radical trajectories of innovation is discussed in respect of the first two research questions:

Research Question I:

In what ways have the institutional foundations underlying the German NIS changed since reunification?

Research Question II:

How do government policies and regulation affect the institutional foundations of the German NIS?

Following the identified assumption of liberalisation of CMEs, the typical CME, Germany, is expected to change its institutional framework and to liberalise over time. In order to evaluate this expectation, this doctoral dissertation analyses the institutional changes in the German labour market, skill formation, the job market as well as corporate governance and financial institutions. The question of institutional change gained relevance in the light of the global financial crisis. External pressure, due to crisis, was expected to enforce the assumed changes. It is found that, in terms of labour market policy, however, the government's policy-making drifted away from a belief in employment creation as being the source of economic growth and low levels of unemployment, towardso R&D investment in innovation as a facilitator for economic growth and, with this, levels of employment. Contrary to theoretical expectations, the German labour market has not simply become more flexible. The past chapters illustrate the contradictory policy-making of different political parties, especially in terms of social policy and the LM. The regime under Gerhard Schröder was divided into early and late

Schröder. The later Schröder regime led to a re-organisation of the LM. A low pay sector was established. The regime of Angela Merkel, however, established a minimum wage. The German skill creation system is leading to increased numbers of general skills. Within the groups of university graduates, a further specialisation in science graduates is found. In this context, Germany is developing differently compared to other EU nations. This development might be due to the government's active support for MINT. Looking at the job market, we find that increased numbers of science graduates end up in Germany's radically innovative sectors, such as biotech and software. Again, the government seems to play an important role in shaping the overall outlook of SMEs, which are dominating these new and emerging sectors.

Following financial globalisation, Germany is expected to shift corporate governance activities towards a shareholder-oriented model. This expectation cannot be confirmed. Furthermore, government and employer associations in Germany appear to be interested in creating a stakeholder-oriented CG system. The distinct structure of German CG, which not only dominates stock listed firms but also large (more than 500 employees) GmbHs and other firms, is shaping German firms' attitudes towards employees, suppliers, and their surroundings. The institutional foundations of Germany have clearly changed since re-unification. Following this institutional change, they are still found to be of a coordinated nature. The institutional complementarity in terms of a re-enforcement within each other could be re-thought as a societal desire for safety, equality and long-term relations. It is obvious within the political processes, that those political parties that have aimed to make the German institutional framework more flexible

e.g. through lax unemployment protection, were quickly removed or not voted for in following elections (Kohl, Schröder). Thus, while employer associations were supporting the establishment of a low-pay sector in Germany, labor unions and wider society were not. The argument of VoC theory that corporations would control the welfare system in Germany and would re-enforce its mechanisms is more of a conspiracy theory. The approach can be extended by acknowledging the important role of labour unions in shaping economic development. As described by the Institute of German Industry, strong unions are important for bargaining coverage, whereas weak unions lead to weak coverage and thus to the intervention of the government in collective wage agreements for industries. Government law-giving processes are much slower than labour unions. Therefore reform backlog often leads to aggression towards national governments (Lesch, 2017). These processes can be observed in the French case of labour market reforms initiated by president Macron in 2017 (Schubert 2017; Wagner 2017).

This dissertation finds that corporations in Germany work in a stakeholder-oriented way, and widely accept the social and welfare system. Institutional (non-) change is influenced by policy-making. Political parties are influenced by democratic processes, and representatives of all sides of society. Following the first two research questions, the third question addresses the performance of German firms in radically innovative sectors:

Research Question III:

How does German capitalism perform in terms of firm capability to produce radical innovation from a comparative perspective?

In order to answer this question, the biotech and software sectors in Germany were analysed as a first step. It is illustrated that even under the same conditions, using the same data in the same timeframe, Hall and Soskice (2001) could have come to different conclusions. The influence of innovation policy on sectoral developments is considered. The thesis finds that Germany's performance from a comparative perspective is in a leading position in Europe. A wider comparison of Germany's performance in high-tech sectors shows that the CME is outperforming all liberal market economies apart from the non-comparable USA. German firms are well able to prosper in the area of so-called radical innovation. The crucial case of a major example for a CME leading in radical innovation contradicts VoC theory. One more finding is that VoC scholars may well have discovered this at the time when the theory was established. The data source used by Hall and Soskice has been published in diverse articles and books previously. In the process of drawing the sectoral specialisation picture, the relevant scholars could have noted the good performance of Germany. Analytical and methodological flaws of the VoC approach have been found in this doctoral dissertation.

To establish an influential theory of political economy is a lot like writing a sound melody that sticks in the listener's brain forever. Therefore this thesis does not aim to completely dismiss the VoC approach, but the aim was to establish a re-think on the issue. German firms are not found to specialise in the production of radical innovation. A solid working middle class in Germany is employed in the traditional sectors. Therefore, it is important for economic growth and well-being not only to prosper in new and emerging markets but, as illustrated in the

German case, to keep and develop old industries while preparing and building future technologies. A stepwise approach to creating radical innovation is found in Germany. The difference between the innovation strategy of firms in achieving a product innovation and the production of innovation on a macro level is shown and the diverse concepts of disruptive, incremental, radical and stepwise innovation are illustrated.

The last research question in this thesis is RQ IV:

> In what ways has the skill formation system in Germany oppressed or fostered radical trajectories of innovation in the country during the past three decades?

Skill formation theory assumes a rational worker who follows imaginary rules of action due to a more or less liberal institutional foundation. These expectations were extensively discussed in this thesis. It is found that no rational worker exists. The influence of government policy on university education in Germany and in enforcing MINT degrees together with national innovation strategy illustrate the interacting and central role of skill equilibria and the emergence of new technological sectors. Skill formation plays a central role in the enhanced theoretical framework of this doctoral dissertation.

The findings of this dissertation do further suggest that a dichotomist framework for specialisation in innovation of nations does not exist. The reflectance of a mirroring innovation behavior brings us back to Adam Smith. A simple division of work (sector specialisation) cannot be found. VoC appears to be misleading in terms of offering a conclusive framework for the institutional

variation of nations leading to variation in comparative economic advantage which did not and does not exist in this simplistic form.

9.2. Theoretical and Practical Contributions

The chosen methodology for this thesis contributes to the ongoing discussion of comparative capitalism in several ways. This section reflects on the implications which can be derived from the chosen research strategy. It first reflects on the theoretical contributions from analysing different institutional spheres and their (non-) change due to government policy throughout the years. In a second step, it reflects on the use of the "VoC calculation" for the cases of German biotech and software. Theory and empirical findings led the analysis in chapter eight to a further focus on skill formation within the institutional foundations of Germany leading to radical innovation.

By taking an in-depth view on the institutional framework of the German CME, it is possible to discuss the propositions underlying the VoC approach. This thesis illustrates how the logic behind the reasoning of these propositions can be seen from a different angle. By analysing the impact of government policy on the German LMIs, it is obvious that social policy (described by VoC as employment and unemployment protection) have not been majorly implemented by WPRs but through democratic processes. The belief that social policy is desirable appears to be within the German culture/belief system of the individual.

The importance of government policy for institutional change is easily observable in this analysis within the German capitalist system. Different regimes in power attempted to change national labour market rigidity, skill creation, and

social protection. Following the global financial crisis of 2008, the government focused more on corporate governance and financial institutions as well. The role of government for institutional change in Germany has been found to be of great relevance. Without a case-specific long-term view, these implications could not be drawn, as change would not be visible. The analysis of two so called radically innovative sectors left this thesis with a range of theoretical implications in relation to the VoC approach. Firstly, it was found that the theoretical construct built in the VoC literature could have drawn different conclusions from the start. A misleading image was established, which cannot easily be erased from one's mind. Instead, an attempt to enhance theory is made by differentiating between specialisation and actual performance. Germany is performing relatively well in so called radically innovative sectors – also in comparison with LMEs. Compared to other nations, the ability of firms to also produce patents in other sectors, however, is relatively high. It can be argued that the high-employment sectors of traditional industry are well developed in spite of Germany's focus on new and emerging technologies. The findings of this dissertation suggest essential flaws in the empirical and analytical framework of Hall and Soskice's introduction to the VoC approach. In the first instance, the given *explanandum* phenomenon of VoC bears a range of flaws: the data provided by the two authors describe a mirroring specialisation of product market activities in German and US firms in terms of patent applications to the EPO. Using extensive explanations in terms of thick description of multiple institutional frameworks of nations, this finding is further generalised. Briefly described liberalism is referred to as a source of radical innovation. It has widely been acknowledged in the literature (Hancke 2009) that

the USA is an outlier in all terms. This thesis shows how a direct comparison of high-tech patent applications to the EPO illustrates the outlier position of the USA, even more so if viewed within the group of LMEs. A direct comparison with this national case is, therefore, potentially misleading in terms of further interpretation. This thesis further finds that the data basis of Hall and Soskice (2001, 42–43) is not as convincing as it actually pretends to be on first view. IN spite of a low specialisation of German patenting activities in emerging sectors, the actual patenting performance does not follow the expectation of a weak performance. This thesis illustrates how VoC could contribute from using the other side of this same data in building an alternative *explanandum* phenomenon. As expected according to the theory, this thesis briefly finds that the USA is highly specialised in applying for patents in emerging sectors. In contrast, Germany shows strong patenting behaviour in different sectors. National firms appear to be active in diverse areas, leaving them in a comparatively strong and highly competitive international position in emerging markets, but even more specialised in developing well established sectors. Simplifying this observation into the described *explanandum* of coordination leading to incremental innovation and/or a weak performance in radical innovation is incorrect. VoC theory contributes to a more complex view proposed in this thesis.

By conducting a short analysis of the way in which corporations in a traditional German industry (automobile) aim to foster radical innovation, this thesis illustrates the unique way in which German firms proceed stepwise in order to safeguard long-term relationships with suppliers and protect employment. This

thesis differentiates between radical, incremental, disruptive and stepwise innovation, as a theoretical contribution from this analysis.

Chapter eight illustrated how the changes in German skill formation influence changes in the German job market and potential high-tech employment. By re-thinking skill creation as an individual choice within a globalising system, the simplistic framework of VoC arguing for globalisation as a "pressure" needs to be re-thought. Moreover, an entirely different system of analysis in terms of a globalised skill creation system with MNCs as key players as rule makers emerges. The need for distinct associations of MNCs for value creation and for fostering government influence over social protection for employees emerges.

This thesis extensively discusses the institutional spheres of the German CME. Not only the observed institutional (non-) change but moreover the logic behind each interconnection with the creation of radical trajectories of innovation are discussed. As a theoretical contribution, the universal logic behind the explanations for radical innovation is questioned and re-thought.

The paradoxical finding of comparatively strong activities of German firms in emerging sectors, with an even further specialisation of activities in established sectors, offers not only theoretical but also practical contributions. The national innovation management of Germany and other countries contributes in several instances to the findings of this dissertation.

The case of Germany illustrates how innovation management on the national level does not attempt to make sectoral specialisation propser but overall economic wellbeing and overall economic growth. The goal of innovation management appears to be technological leadership in relation to wider economic

well-being. Several aspects influence this goal. If a national framework continuously focuses on creating the skills needed for prospering in emerging sectors, it might well be argued that a large part of society is neglected. The German institutions illustrate how, even though there are shifts in skill development and economic activities, the traditional well-established sectors are continuously supported and further developed for the future, in order to keep societal prosperity and employment alive. The attempts of traditional German firms to follow a long-term, stakeholder-oriented path are well illustrated in the case of the German automobile sector. Traditional, well-established firms and partners are not left in order to create something new. In this case, even the old partners are drawn into the journey to create new technologies. This finding offers practical contributions for other national frameworks. The German example illustrates how new and emerging technologies can successfully be created in a capitalist country which has been called coordinated, social or a welfare country. There is more than one capitalist variety that can create economic growth, more than one innovation strategy in firms that can lead to success, more than one possible change in innovativeness due to changes in the labour market and skill equilibrium of a nation.

Additionally, the process of the success of radical innovation in Germany really is different from that in the UK/US. One of the most eye-catching issues is the average firm size. I argue that the different financial and corporate governance systems of the countries mediate between the skill-innovation framework and shape the different outlooks of success in radical innovation. I argue for more than one possible way of being a radically-innovative nation.

In spite of increased numbers of university graduates and highly innovative SMEs which produce a significant amount of radical innovation in Germany, these firms lack financial support for their further growth. To date, government policy focuses on start-ups, SMEs and easing business for the well-established large employers represented by large lobbying associations and research institutes. The desperately needed financial support e.g. for average sized biotech firms, to compete with large UK firms, for example, is hardly available – neither through government support, nor through the bank-oriented financial system. Private investments are desperately needed by these firms. Therefore employer associations demand government to subvert these private investments to give private persons incentives to invest in medium-sized technology-oriented firms with high risk and long-term investments needed. Where international attention for German SMEs in the high-tech field is growing (CureVac and Bill and Melinda Gates foundation 2015; Ettel and Haseborg 2015), lots of firms are bought up by larger (especially US) firms, in which enough capital is available due to the very different financial system. My argument is not for liberalising Germany's financial system but for increased government support for medium-sized technology-oriented firms. Identifying national champions through competition and further supporting these would be one way.

A second practical implication is the following scenario. Due to a continuous focus on general, science-oriented skills and the overall demographic change, German angst focuses on the growing importance of university education together with severe demographic changes which are currently leading the German market economy towards a lack of industry- and firm-specific skills (EY

2015; Fachkräftemangel in Deutschland: 'Blue Card' soll Ingenieure aus Fernost anlocken - Fachkräftemangel in Deutschland - FOCUS Online - Nachrichten 2012; Tagesschau 2012). This is already visible in the national agency for work`s labour market statistics and is predicted to become severe in the next ten years. Large employer associations and the chambers of crafts (Handwerkskammern) in Germany have already entered public discussion on this point. The employer associations describe how firms already experience and fear a further lack of industry-specific skilled labour. As a result, the government and chambers of crafts are actively advertising German dual apprenticeship training, and trade unions are currently very active in raising wages for these employee groups. Thus an apprenticeship is to be made more attractive again. Following the theory, I would argue that industry-specific skills, which are developed by the German apprenticeship system, could be acquired by adjusting immigration law in terms of refugees being supported to acquire German language skills even faster, their applications being processed faster and finally being allowed to join the apprenticeship system with school degrees from other nations. A liberalisation of sector-specific skill creation would help. Compared to the government's current focus on increasing a family and child friendly environment, such policy would more quickly increase the potential skilled labour in the field. Besides non-EU immigration (see Geis 2017a), eastern European workers are of increasing importance in the German labour market (Geis 2017b). The institute of German industry supports these claims by speaking out for more industry-based immigration (Koppel 2017).

In parallel, the government has already opened up immigration laws to high-skilled immigrants and university students and is discussing further openings since general skills are argued to be exchangeable and do not need to be produced within the German market economy. Here we come to high skills and high skill immigration as is visible in the US. So, in the long run, the German government should aim do develop high university standards (the government's university elite initiative is going in this direction – competition between universities), and aim to become more attractive for international highly skilled labour, not only for study but for living and working in Germany.

9.3. Limitations and Research Implications

Several limitations of this dissertation and arising future fields of research exist. The used data which are provided by the R&D Scoreboard are limited to Europe's 1,000 largest R&D spenders. Mostly large firms are captured, and thus the results are limited to large firms. This became apparent as a problem when viewing the Japanese firms in the software sector since they were brought in a direct context with US firms. Selecting the 1,000 largest Japanese and EU firms would have brought more Japanese firms into the picture. A similar problem occurrs with the number of captured French and German firms. The sample size is small. Selected firms with high R&D investments were later compared by their annual net sales. Thus, where the data have legitimacy is in terms of large R&D spenders, in the sense that these firms would be the strongest ones in Europe; this assertion is not legitimate in the context of such a small sample size for firms when judging their sales. Especially European markets are dominated by highly innovative SMEs. In

the context of this thesis, the sales and R&D data were only used in order to give a different data source to EPO data for comparison. For the purpose of a comparative outlook on the patent data measures, the limitations of R&D Scoreboards data were accepted. For further research, different sources of data would have to be considered.

The blank differentiation of countries being “radical” innovators has to be re-thought. Every sector includes radical and incremental areas. As illustrated in this thesis, a nation contributes from fostering new and emerging sectors, but older sectors have their own rights and requirements for existence (e.g. employment). A differentiation between “new” sectors meaning sectors at the beginning of their life cycles and “older” sectors meaning those ones which have already reached a certain stage in their general life cycle and which are now characterised by more incremental improvements appear to make more sense. Still, older sectors might also strive for radical innovation. Future research needs to acknowledge the differences between a nation’s way of creating innovation and the result. Christensen's concept of disruptive innovation is often misinterpreted as the Schumpeterian view on the nature of a product or service. What Christensen means in his approach is to describe a firm`s strategies for innovation in order to enter a pre-existing market field. He does not talk about the degree or novelty so much as about the firm's ability to ease the entrance by lowering the burden to make a change from a pre-existing market field. In the context of comparative capitalism literature, a variety of ideas and contexts from the field of innovation research get mixed up and confused. Moreover, the institutional foundations of a nation are brought into the picture as a direct reason for radical or incremental

innovation, one often excluding the other. This dissertation finds and implies, in existing approaches to comparative capitalism, the necessity of differentiating between innovation output (product or service), and innovation process (within the firm's organisation) and the possibility of creating different levels of each of these within one national market. The institutional changes of a partially flexible labour market in Germany during the Hartz reforms have been shown as one example for the later creation of low pay but, on the other hand and simultaneously, an increase in general skills.

In the sectoral studies, it is found that government support for each of the two sectors has differed significantly over the past 30 years. The two sectors' performances, within the German economy but also in terms of international comparison, differ from each other. It has been found that the paradoxical political situation (supporting biotech and not fulfilling EU regulations; regarding biotech as equal to the atomic industry) in the 1990s had a negative influence on already existing larger firms which had the wish to expand, but could not (see example of Hoechst). Even though these different policy styles are very obvious and have, on their own, been described exhaustingly in Germany, to the knowledge of the author, the two sectors have not been viewed before in direct comparison with each other, and there are thus no cocnlusions about these differences yet in existence. Research on national innovation management should further aim to find out how industry-specific governmental support can best support emerging sectors within the traditional economic framework, opening new routes for entrepreneurs as well. Many papers treat the effect of government intervention on single sectors

in Germany. A comparison of the effect of these different policies on emerging sectors would be of great interest.

The view of humans as rational entities is found to underlie existing theory and appears to be a paradox. Human beings are, by nature, non-rational. It can be argued that humans, more or less, follow self-interest or might even like to see themselves in a better position than others, but these positions cannot be considered rational. Further research needs to address human emotions and cognitions.

There is, therefore, the need for a theory which combines the disciplines of macroeconomics and psychology –a field of economic psychology. The search for value systems underlying attempts to structure an economy by establishing institutions in certain ways would belong to this field. It is important to identify the value systems and beliefs underlying our actions in creating economic systems. Understanding human action and behaviour in different economic systems is of great interest and would enable us to reflect on the existing systems in different ways. A second topic of research within this field would be socio-technical systems within a society. The emotional recognition of technological developments and their (non-) acceptance in society would be one area of interest here. Emotions play a huge role in industry and policy. Technological development not only fosters fears but also enhances the group feeling of societies. In terms of bringing people together for a common goal, the role of fighting climate change could, for example, take the place of a war against country XYZ. The motivation for new technology could, therefore, have wider

economic effects than “only” economic growth. Research in this area is recommended. As described by Wood and Bewster (2016):

> "There are many different dimensions to national corporate governance regimes, encompassing the legal, the political, the economic, and, indeed, embedded patterns of social behaviour; there is much debate within the literature as to which is the most important aspect of each" (Wood and Bewster 2016, 249).

The (as Wood and Beswster call them) “patterns of social behavior” are an important issue which need further research, even though they might just be one of many dependent variables within an analysis.

9.4. Concluding Remarks

This thesis has provided insights into how the coordinated institutional framework of Germany is supporting the emergence of new technological fields in Germany. The critical case studies of the software and biotech sectors which are presented here, two radically innovative sectors in the typical CME make several contributions to theory and practice. An enhanced theoretical framework for the creation of emerging technologies in the CME Germany is developed following the findings of this thesis. It has been found that a change within the institutional sphere of the labour market (Hartz reforms) resulted not only in the creation of a low-pay employment sector, but moreover might be the foundation brick for the further generalisation of skill equilibria in Germany. Government policy, e.g. in terms of fostering MINT degrees, was found to be of great importance for the further specialisation of the nation in these fields. The role of social and economic policy in terms of institutional change and direct sectoral development has been illustrated on the cases of biotech and software in Germany. It has been illustrated

how firms can develop new technological fields, not only in LMEs but in the coordinated institutional framework of Germany. The term radical innovation for research in the area of innovation management is re-defined and differentiated from other concepts.

This dissertation is of relevance for scholars and policy-makers in the field of innovation management. A focus is on institutional change and its influence on new and emerging technologies within a national framework. The role of skill creation for technological development is identified. The development of an image of a (non-) rational human in the context of fostering innovative capabilities in a political economy is discussed.

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