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**INNOVATION POLICIES OF CYPRUS DURING THE GLOBAL ECONOMIC CRISIS: ALIGNING
FINANCIAL INSTITUTIONS WITH NATIONAL INNOVATION SYSTEM**

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Abstract

Previous research has overlooked the complementarity between National Innovation Systems and financial institutions. This paper extends the literature on National Innovation Systems, arguing that innovation policies should incorporate the particular needs of a nation's innovation system and the current conditions of that nation's financial environment. This development is important because the financial environment is malleable and subject to exogenous events, such as the recent global financial crisis. The relationship between a National Innovation System and the financial environment is presented through an analytical framework, which can be used to assess and instigate national innovation policies. The analytical framework is demonstrated using the case of Cyprus, which was on the frontline of the European debt crisis. By integrating the views of leaders from the Cypriot manufacturing and service sectors with widely available reports and indices concerning innovation performance, we demonstrate that the lack of a developed financial environment impedes national innovation performance. This research introduces policy and managerial implications for innovation, especially within the context of underdeveloped national innovation systems, which focus on improving innovation performance by enhancing the availability of financial instruments and the access that entrepreneurs have to them.

Keywords

Financing innovation; National Innovation System; innovation policy; economic crisis.

1. Introduction

In the wake of the recent financial crisis in 2008, finance has become an increasingly significant barrier to innovation (Mason & Harrison, 2015). Restrictions in credit in many countries around the world have decreased the availability of finance for all firms, and particularly, for innovative firms (Lee et al., 2015). The difficulty in accessing external finance highlights the importance of financial resources for innovation and underlines the critical role of institutions in providing innovation investments. However, the National Innovation System (NIS) framework has been unjustifiably disconnected from the financial environment and has not scrutinised the impact of the financial environment on innovation performance measured at the national level (Freeman, 1995; Lundvall, 1992; Nelson, 1993). In this paper, we address the significant gap in knowledge concerning the ways in which the NIS, a conceptual framework pioneered by Freeman (1987) to instigate and evaluate innovation policies within a national institutional setting (Filippetti & Archibugi, 2011), accommodates financial market institutions. The present paper addresses this research gap by developing an analytical framework which connects the financial environment with national innovation policies.

Individual firms play a crucial role in the development of innovation, but the process of nurturing innovation involves continuous interactivity between firms, banks and other critical social and economic actors (Feinson, 2003). The NIS emphasises that national firms are not isolated 'islands', but members of networks which operate within a national infrastructure in order to produce and innovate (Hadjimanolis & Dickson, 2001; Lundvall & Borrás, 2005). However, the National Innovation System (NIS) framework has not paid sufficient attention to the financial institutions of a country and their vital importance for innovation (Freeman, 1995; Lundvall, 1992; Nelson, 1993). Schumpeter (1934) emphasised the paramount importance of credit as a catalyst for entrepreneurship and new product development. Entrepreneurial ideas cannot be converted into innovation unless entrepreneurs can gain access to financial resources, and so financial markets are an antecedent of innovation and a critical component in an NIS (King & Levine, 1993; Brown et al., 2009; Hsu, Tian & Xu, 2014).

Financial development and financial institutions should be regarded as catalysts for the acceleration of economic development (Lechman & Marszk, 2015). It is therefore essential to assess the impact of innovation policies and financial institutions on the access that

companies have to finance, especially within the context of the 2008 financial crisis which restricted the availability of capital resources to entrepreneurs (Mason & Harrison, 2015). It is necessary to scrutinise the relationship between an NIS and its financial environment, because, on the one hand, the financial environment provides the conditions for innovation performance within a country (Beck & Demirguc-Kunt, 2006), and, on the other hand, innovation policies can reduce the financial barriers encountered by firms (Patel, 1995). A well-functioning financial and institutional context helps to improve firms' credit (Beck & Demirguc-Kunt, 2006), but what happens in countries with a less developed NIS and a poor financial environment remains uncertain.

This paper develops an analytical framework that addresses the complementarity between an NIS and funding instruments, arguing that a strong innovation system requires a strong financial environment, and vice versa. The analytical framework is illustrated by the case of Cyprus, a country with a less developed NIS which has been at the frontline of European sovereign debt crisis since 2009 (Financial Times, 2013; The Economist, 2013). The study is based on in-depth interviews with entrepreneurs and on secondary data, with the aim of answering the following questions: i. What is the current relationship between an NIS and its financial environment? ii. How can innovation policies align a nation's financial institutions with its NIS, in order to boost innovation performance?

The case of Cyprus, which exemplifies the Eurozone sovereign crisis in an extreme form (Consiglio & Zenios, 2015), is a suitable context in which to illustrate this significant gap in our knowledge. The Republic of Cyprus witnessed a severe financial crisis which was exacerbated in 2013, when an international bail-out by the European Commission (EC), European Central Bank (ECB) and International Monetary Fund (IMF) was agreed with the Cyprus Government. A new bail-in strategy was tested internationally for the first time in Cyprus. More specifically, a bail-in was agreed involving unsecured senior debt from the two largest banks of the country, the Bank of Cyprus and the Laiki Bank, and as a result of the crisis the Laiki Bank closed. The secured bail-out and bail-in to combat the crisis in the Cypriot banking system has had detrimental effects on the economy and on the innovation performance of firms (e.g., The Economist, 2013). Cyprus experienced the largest falls in innovative enterprises in the EU as the innovative performance of companies shrank. It is possible for public financial support to mitigate the effect of such a crisis on innovation (Paunov, 2012), but in Cyprus state aid and public procurement have been almost

nonexistent. In addition, the absence of venture capital, business angels and crowd-funding platforms have also been significant barriers to innovation in the country.

By considering innovation as a catalyst for economic growth and as a response to an economic crisis, we argue that innovation policies designed at a national level should also aim to improve the financial environment in which firms operate. The NIS, in tandem with a developed and stable financial environment, can contribute to innovation performance at both company level and the national level. The paper is organised as follows: Section 2 explores the literature, while Section 3 explains the research method used; Section 4 presents the empirical findings; and Section 5 discusses theoretical, policy and managerial implications for innovation.

2. The National Innovation System and the Financial Environment

Existing studies have investigated, on the one hand, the relationship between the NIS and innovation (e.g., Freeman, 1995; Lundvall, 1992; Nelson, 1993); and, on the other hand, the impact of financial instruments on companies' ability to innovate (e.g., Agarwal et al., 2015; Block & Sadner, 2009; Cumming et al., 2017; Grilli et al., 2017). By synthesising these two bodies of literature, we bridge the gap between the NIS and the financial environment within a specific national context.

2.1. National innovation system and innovation

The National Innovation System (NIS) is a conceptual framework pioneered by Freeman (1987), which frames innovation within a national institutional setting (Filippetti & Archibugi, 2011). This systemic approach defines innovation as an interactive process, in which the competence of a firm matters, along with the competence of suppliers, customers, knowledge institutions and policy-makers. The links and the quality of interactions between them are important, as they combine with the surrounding physical, technological and institutional infrastructure to support innovation and competence-building for firms (Lundvall & Borrás, 2005; Patel & Pavitt, 1994; Woolthuis et al., 2005).

The national institutional setting has a major impact on the performance of firms (e.g., Freeman, 1995), and therefore a well-developed NIS will affect the persistence of innovation within companies. The system of innovation approach can be used to delineate, evaluate and influence the process of innovation (Chang & Chen, 2004). An NIS relates innovation policy

to companies' ability to innovate, and therefore to a country's economic growth (Edquist, 1997; Freeman, 1995). In this way, a country's NIS "expresses the importance of forging liaisons and links between the various networks related to innovation in increasing an economy's capacity to innovation" (Marques et al., 2006:1).

Interactions between different actors in the innovation systems are essential to produce, accumulate and diffuse knowledge in order to introduce innovation and promote competitiveness (Johnson & Lundvall, 1994; Lundvall & Archibugi, 2001). However, although an NIS places emphasis on the areas of the national infrastructure which facilitate knowledge distribution, insufficient emphasis is placed on the financial setting. As a result, the NIS approach does not sufficiently address the financial innovation system, which is outlined in the next section of the paper.

2.2. Financial environment and innovation

Schumpeter (1934: 126) argues that the money market is the "headquarters of capitalism", and for this reason called the banker the "ephor" of the exchange economy (Schumpeter, 1934 [1912]: 74). As innovation must be financed, finance must likewise be at the centre of any theory of capitalist economies (Grilli et al., 2017; Wonglimpiyarat, 2011). Developed financial markets are a fundamental condition for innovation (Brown et al., 2009; Hsu, Tian & Xu, 2014; King & Levine, 1993). Studies of the financing of innovative companies point to the existence of a funding gap which exists because innovation is "a bet on the future, and most attempts fail" (Mazzucato, 2013:851).

Filippetti and Archibugi (2011:10) argue that a robust financial sector for innovation "is not only an engine in times of growth, but also as a buffer during a downswing". The relationship between innovation and economic fluctuations has been largely addressed in previous research (e.g. Freeman, 1984). The most common view is that innovation is cyclical, increasing during economic booms and declining during economic busts (Archibugi et al., 2013; Francois & Lloyd-Ellis, 2003; Filippetti & Archibugi, 2011; Kleinknecht & Verspagen, 1990). In particular, an economic crisis produces the significant negative effect of financing constraints on innovation. Internal sources of finance, such as retained profits, are reduced because of decreasing demand for products, which is the primary impact of the crisis (Paunov, 2012). The transaction costs of raising external funds are high, due to the reluctance

of financial institutions to fund activities characterised by high levels of uncertainty and risk (Grabowski, 1968; Grilli et al., 2017).

In the wake of the global financial crisis in 2008, finance has been an increasingly significant barrier to innovation (Mason & Harrison, 2015). Earlier studies found a differential treatment of the price of credit, with innovative firms being penalised the most (Mina et al., 2013). Such restrictions in credit have decreased the availability of finance for innovative firms. However, the impact of the crisis on the various financing sources that firms are exposed can vary (see Table 1).

Table 1. The Impact of Financial Crisis on Financial Instruments for Innovation

Financial Instruments for Innovation	Financial Crisis Impact (Yes/No)	Sources
Public Funding	Yes. National public subsidies towards innovation decrease during crisis due to austerity measures.	Hyytinen & Toivanen (2005) Mold (2009) Mytelka (2000) Paunov (2012)
Banks	Yes. In times of crisis, the borrowing cost increases and banks are reluctant to fund risky projects.	Antonioli et al. (2010) Coad & Rao (2008) Mazzucato (2013) Freel (2007) Hutton & Lee (2012) Lee et al. (2015) Mina et al. (2013)
Business Angels	No. There is no evidence that angels' investments on SMEs decrease during crisis.	Mason & Harrison (2015) The World Bank (2014) Wiltbank et al. (2009)
Venture Capital	Yes. A financial crisis has a direct effect on venture capital markets which decline during a financial crisis.	Agarwal et al. (2011) Block & Sadner (2009) Cumming et al. (2014) Hellman et al. (2013) Ingram & Teigland (2013) Mason & Harrison (2015) Sorenson & Stuart (2001) Zook (2002)

Crowdfunding	No. Crowdfunding platforms are not directly affected by the financial crisis as they can source .	Agrawal et al. (2011)
		Bechter et al. (2011)
		Bruton et al. (2015)
		Ingram & Teigland (2013)

Source: the authors

The development of public funding mechanisms is necessary for the promotion of innovative activities (Mold, 2009; Xu et al., 2014). Public funding can create an incentive for the diffusion of knowledge and the consolidation of scientific networks (Hall & Maffioli, 2008). It is particularly important because it stabilises innovation investments during periods of recession (Paunov, 2012). However, during an economic crisis, government financing declines and the responsibility for funding research and innovation relies mainly on private sources (Cruz-Castro & Sanz-Menéndez, 2015; Hausman & Johnston, 2014).

In addition, not all firms encounter the same level of credit constraint. Access to loans is more difficult for more innovative firms than for their less innovative counterparts, especially during periods of crisis (Lee et al., 2015). Banks which depend on debt repayments are relatively reluctant to invest in risky entrepreneurial endeavours (Coad & Rao, 2008; Mazzucato, 2013). As a result, younger and smaller firms are more likely to face difficulties in accessing external finance (Antonioli et al., 2010; Freel, 2007; Hutton & Lee, 2012; Mina et al. 2013), as their projects are considered to be risky. In addition, bank loans are often denied to them due to a lack of collateral, a relatively short operating history and the absence of a proven track record (Mina et al. 2013). For this reason, these entrepreneurs increasingly rely on angel investors and venture capital (VC) firms (Hellmann & Thiele, 2015; Wiltbank et al., 2009).

However, the lack of angel investors and developed VC markets in many countries has a negative effect on innovation (Cumming et al., 2017). This problem is intensified in times of crisis, as even developed VC markets face significant decreases in VC funds during periods of economic decline (Block & Sadner, 2009). As a result, a financial crisis has a direct effect on the venture capital industry (Cumming, 2012). In contrast, angel investments are not influenced by periods of crisis and may actually increase (Mason & Harrison, 2015). As Mason and Harrison (2015:22) argue, “the performance of the angel market during the financial crisis serves to underline its critical importance for an entrepreneurial economy”. However, angel investors and venture capitalists usually prefer to be in close geographical

proximity with firms they are investing in (Ingram & Teigland, 2013). This is because the cost of activities including information gathering and progress monitoring are distance-sensitive (e.g., Sorenson & Stuart, 2001; Zook, 2002; Agarwal et al., 2015).

More recently, entrepreneurs have started to rely on the internet for financial help (Gabison, 2015; Lambert & Schwienbacher, 2010). The recent emergence of crowdfunding practices — “that is, efforts by entrepreneurial individuals and groups to finance ventures based on small contributions from many individuals over the internet” (Chan & Parhankangas, 2017:237) — has allowed geographical barriers to be overcome and capital to be accessed globally (Agrawal, Catalini, & Goldfarb, 2014). Since the global financial crisis, crowdfunding has proved to be a valuable source of seed capital for entrepreneurs and a significant alternative form of finance (Lee et al., 2015).

Overall, the financial environment is a critical part of innovation activities, and all nations need to consider devising effective financial policies to strengthen their financial environment in order to achieve sustainable growth. As Table 1 shows, this need has become clearer during the financial crisis, when there was a decrease in financial capital invested in high-risk innovation projects, as a result of which the propensity of companies to invest in innovation was significantly reduced (Grilli et al., 2017). Studies have shown that a lack of credit for innovation was more evident in countries with a less strong National Innovation System (Archibugi & Filippetti, 2011), implying that financial market institutions have an impact on the performance of the NIS. Countries with a strong NIS, as well as a strong financial system prior to the crisis, were better able to respond to the recession and to recover swiftly (Archibugi & Filippetti, 2011).

2.3. The national innovation system and the financial environment

There is still a significant research gap on how the NIS accommodates financial market institutions, and on the relationship between it and financial instruments. The literature on finance and innovation contains several attempts to examine innovation activities, but the recent evidence concerning the dynamics of financial markets suggests that a more inclusive approach is needed which integrates these different streams. The financial environment is a critical aspect of the NIS, and those in charge of national innovation policies need to consider devising effective financial policies to strengthen the innovation system and achieve sustainable growth (OECD, 2009).

There is significant complementarity between the NIS and funding instruments. Based on the main characteristics of the NIS, public and private financial instruments vary in different countries. Firstly, funding schemes may be bureaucratic and may discourage firms from applying for funds, while poorly conceived public calls stifle, retard or penalise innovation (Mytelka, 2000). Secondly, countries experience different credit constraints. A poor lending infrastructure influences the access to credit of small firms (Rigby & Ramlogan, 2013). Thirdly, angels are almost nonexistent in some countries, while new start-ups face challenges such as a lack of awareness of angel investment and weak entrepreneurial ecosystems that fail to produce and support innovative start-ups (World Bank, 2014). Fourthly, many countries lack developed VC markets, due to a lack of both capital gains taxes and hi-tech firms, conditions which have negative effects on innovation (Cumming et al., 2017). Finally, cultural barriers such as a risk-averse culture and the risks involved with crowdfunding, such as fraud, are viewed as barriers to crowdfunding and other methods of alternative funding.

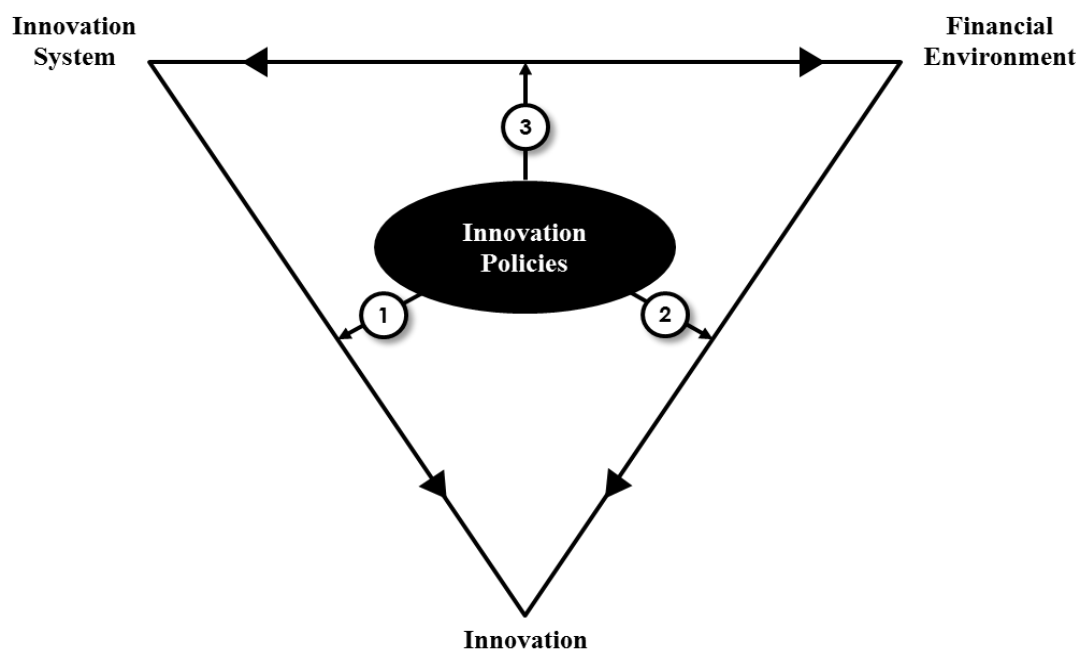
As a result, governments should implement innovation policies that aim to reform the financial environment in conjunction with the NIS of their country (see Figure 1), thus boosting the innovation performance of firms. For example, public policy-makers should design funding programmes, which promote innovation activities and leverage the resources of SMEs (Radicic et al., 2016). If public funding seems impossible during a crisis, then the problem arises of how to create institutional and market conditions which are able to attract private capital from investors other than the more traditional bank lenders. Public policy can develop several types of intervention to encourage and support business angel activity, such as providing tax incentives for investors, raising awareness of its importance, and supporting the development of the angel investment market (Da Costa et al., 2011). In addition, reductions in capital gains tax rates and the encouragement of those R&D activities which give rise to technological spillovers and hi-tech start-ups could spur venture capital markets (Keuschnigg & Nielsen, 2001; Keuschnigg, 2004). Furthermore, governments could create a greater awareness of the benefits of crowdfunding and facilitate a proper institutional and regulatory environment, with elements such as platform licensing, which can support crowdfunding (Gabison, 2015; Ingram & Teigland, 2013). Finally, encouraging a culture of innovation and entrepreneurship is critical. Initiatives to raise awareness about innovation and entrepreneurship play a key role in encouraging investments (Da Costa et al., 2011).

It follows that an attempt to build a developed financial environment should take into account

the institutional context of the country instead of simply following best practice. Economies should build more innovation-friendly financial instruments and policies which are tailored to the idiosyncrasies of the particular national context, in order to support investment in innovation during periods of both prosperity and crisis (Castaño et al., 2016). Institutional characteristics, including technological intensity, R&D intensity, entrepreneurial culture, and collaborations between universities and firms, can have a significant influence on the development of financial systems, allowing countries to better exploit technological innovations. This paper therefore suggests that the NIS of each country should be aligned with its financial environment, because the NIS and the financial system contribute jointly to the innovation performance of firms (see Figure 1).

The literature of finance and innovation demonstrates several attempts to examine innovation. In particular, as Figure 1 shows, previous studies have mainly focused on: (1) strengthening the relationship between the existing NIS and the innovation of companies; and (2) strengthening the relationship between the existing financial environment and the innovation activities of companies. However, “more attention must be placed on institutional features, and the dynamic interaction between heterogeneous financial and policy instruments” (Grilli et al., 2017: 2). Nations, and in particular those nations with an underdeveloped NIS and poorer financial environments, should introduce innovation policies that aim to strengthen the relationship between the NIS and the financial environment in order to improve the functioning of both. Innovation policies that reform the financial environment of the country would at the same time reform that country’s NIS, boosting the innovation performance of business.

Figure 1. An Analytical Framework for National Innovation Policies and Finance



Source: the authors

3. Research Design and Method

The case of Cyprus, which exemplifies the Eurozone sovereign crisis in an extreme form (Consiglio & Zenios, 2015), was examined in order to illustrate the relationship between the financial environment and a national innovations system. This case is interesting because Cyprus's debt experience combined a banking crisis, a sovereign debt crisis and excessive debts from corporations and households. A policy of depositor bail-in was implemented in Cyprus for the first time in the Eurozone, in order to deal with the crisis (Michaelides, 2014; Zenios, 2014).

Due to the exploratory nature of our research, it seemed advisable to use a qualitative research methodology in order to study the phenomenon in detail (Eisenhardt, 1989). By developing an explanatory case study (Yin, 1989), the goal of this paper is to determine how the financial environment and national innovation system are connected in Cyprus, and then to address the implications of these connections, to suggest why this relationship should be improved. A case-study research strategy is appropriate for this evolving topic, as the data gained can serve as the base for theory-building (Eisenhardt, 1989).

The qualitative study was based on a broad, diverse empirical base that comprised primary data and secondary sources. Interviews were conducted to develop an understanding of institutions and the financial environment, and to identify problems and challenges facing innovation actors. Secondary data were used to gain a better understanding of the full context of the research and to control for biases. Multiple sources of data including widely available reports and indices, including the European Innovation Scoreboard, the Global Competitiveness Index, Knowledge Assessment Methodology and the Global Innovation Index, were used to gain summative statistics concerning Cyprus's innovation performance. These indicators should be used with caution, as they do not take into account the importance of the variables used in the calculation process (Kaynak et al., 2017). Considering the weight

of the variables could change the performance of the indicators (Kaynak et al., 2017). Archibugi and Coco (2005:176) argue that “if taken with due caution, these indicators help to understand the reality of certain situations, and can assist in devising strategic decisions” (Archibugi & Coco, 2005:176-177). Therefore, secondary data was integrated with data drawn from the interviews, in a triangulation process, in order to avoid post-hoc rationalisation and to ensure construct validity (Yin, 1989).

3.1. Data sampling

We first identified a set of innovation-active firms that could potentially be included in the study through preliminary interviews with directors of the Ministry of Commerce, Industry and Tourism, which is responsible for the promotion of innovation, and national industry associations including the Cyprus Chamber of Commerce and the Cyprus Employers and Industrialists Federation. This sample was thought to be sufficiently large and diverse to provide an excellent opportunity to examine innovation activities in private firms. Altogether, forty companies were included in the database. We considered firms from various industry sectors, including pharmaceuticals, biotechnology, electronics and software companies; and of various sizes, from micro- and small firms to large companies, suggesting that a reasonable cross-section of different views would be covered.

Table 2. Demographics of Respondents

Respondents	Firm Size	Industry	Number
Chief Executive Officer	SME	Service	A1
Founder and Chief Executive Officer	SME	Service	A2
Founder and Chief Executive Officer	SME	Service	A5
General Manager	SME	Service	A6
Chief Executive Officer	SME	Service	A7
Senior Consultant	SME	Service	A8
Co-founder and Chief Executive Officer	SME	Service	A9
Founder and Chief Executive Officer	SME	Service	A10
Founder and Chief Executive Officer	SME	Service	A11
Head of R&D Department	Large	Service	A14
Regulatory Affairs and Interconnect Manager	Large	Service	A15
Founder and Chief Executive Officer	SME	Manufacturing	A3

General Manager	SME	Manufacturing	A4
General Manager	SME	Manufacturing	A12
Head of R&D Department	SME	Manufacturing	A13
Chairman	Large	Manufacturing	A16
General Manager	Large	Manufacturing	A17
Head of R&D Department	Large	Manufacturing	A18

Source: the authors

In order to select our informants, we specifically focused on senior managers involved in the innovation process, because they are clearly the most knowledgeable sources of information about innovation investments. A total of eighteen in-depth interviews were conducted in two separate rounds over a three-year period, with managing directors who were highly involved in R&D and innovation activities in Cyprus. In the period between the two rounds, we began processing our data (see Table 2). The initial round of twelve interviews occurred in 2011-2012 during the world economic crisis. The extended data collection and analysis period allowed us to meet participants over the period of the crisis in Cyprus. Six additional interviews were conducted in 2013, when the financial crisis was exacerbated.

3.2. Data collection

Email invitations were used to recruit the pool of potential informants and a self-introduction and a brief description of the study were given. The firms approached indicated their willingness to participate in the research project. Sampling proceeded until the gathering of new information was terminated so that new theoretical categories or critical issues could be added (Glaser & Strauss, 1967). The interviews were conducted face-to-face at the headquarters of each firm and lasted between one and two hours. The interviews were recorded.

In-depth interviews were conducted in order to seek deep insights into financial institutions and innovation (Eisenhardt, 1989; Yin, 1989). The interviews were based on an open-ended interview protocol that consisted of four main sections. The first section contained questions on the demographic details of the interviewees and their companies. The second main section examined the nature of the financial environment and its influence on innovation activities. This was followed by a series of subsections concerning financial instruments including the banking sector, angel investors, public funding and venture capital. The third section

contained questions on national institutions and innovation policies. In particular, it examined the influence on innovation activities of various institutional characteristics such as industries, entrepreneurial culture, innovation policies, universities, collaborations between universities and firms, and R&D intensity. The fourth and last section included questions about the potential impact of the crisis on innovation activities. This final section aimed to summarise the relationship between the financial environment, innovation activities and institutions.

3.3. Data analysis

The interviews were initially transcribed into Word documents. After the transcription of the interviews, their content was analysed thematically. Since the aim was to shed light on the relationship between institutions and the financial environment, the content analysis of the text offered considerable potential in obtaining otherwise unavailable information (Kabanoff, Waldersee & Cohen, 1995). An inductive approach enables patterns, themes, and categories to emerge from the data (Patton, 1980).

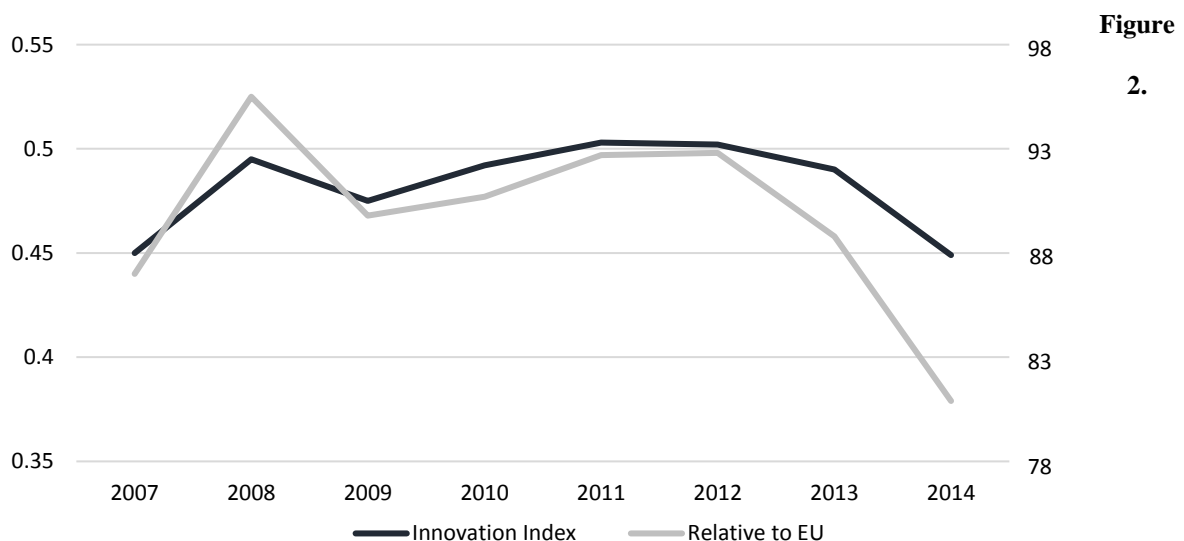
We followed a systematic step-wise recursive process for the identification of repeated patterns of meaning (Braun & Clarke, 2006). The data analysis was initiated with several readings of all the field data, to obtain an overall overview of the research. Phenomena in the data were then identified and emerging categories were coded. The codes were developed as patterns in the data emerged for the identification of categories (Flick, 2002). During the development of categories, broad themes were set up, and links and connections were identified. The data analysis ceased when it was evident that no new themes were emerging, suggesting that all the major themes had been captured. The emergent themes were written up by comparing them with the extant literature to enhance their internal validity, generalisability and theoretical level (Eisenhardt, 1989). This process of coding yielded three major themes: the NIS; financial instruments; the relationship between the NIS and financial environment. Representative quotations were shortlisted for illustration purposes.

4. The National Innovation System and Financial Environment of Cyprus

The accession of Cyprus to the European Union in 2004 was the driving force behind the increased emphasis of the country on innovation (Tsipouri & Rublova, 2010). After many years of uninterrupted economic growth, the international financial crisis, which had an immediate effect on the UK banking system, led to a recession in Cyprus in 2008. The UK

banking crisis hit Cyprus's major tourism and real estate sectors, more than half of which were accounted for by the British market. The exposure of the major Cypriot banks to Greek debt and the partial default by Greece in 2012 worsened the impact of the economic crisis on Cyprus. The Cyprus government and the EU-ECB-IMF agreed to a bail-out to combat the crisis in Cyprus. Cyprus closed its second-largest bank, the Laiki Bank, and a bail-in was agreed with the creditors of the two largest banks of the country, the Bank of Cyprus and Laiki Bank. The impact on the real economy of the country was significant. The Cypriot financial crisis had detrimental effects on the economy, with the rate of economic growth falling sharply (World Bank, 2016).

Cypriot companies experienced negative growth in the period 2008-13, with significant consequences for their innovation performance. The Cypriot economy is dominated by SMEs: 99.8% of total firms are SMEs, with 92.1% employing fewer than nine people (EY, 2015). However, the number of Cypriot SMEs declined by 17.6% between 2008 and 2015, in contrast with an average increase in SMEs of 1.8% in the EU-28 (EY, 2015). The share of innovative enterprises in the EU-28 decreased by 2.6% in 2010-12 compared with 2006-08, with the largest fall (of 14%) observed in Cyprus (Eurostat, 2015a). Various innovation indices, including the Global Innovation Index and the European Innovation Scoreboard, which summarise the performance of different indicators, show that the economic crisis had a negative effect on innovation activities. For example, the European Innovation Scoreboard shows that the performance of firms in Cyprus started to increase from 2009, but declined from 2012 onwards. The innovation performance relative to the EU peaked at 95% in 2008, but dropped to 80% in 2014 (see Figure 2; European Commission, 2015b). Cyprus's declining innovation performance resulted in a change of innovation category from 'innovation follower' to 'moderate innovation'. The decreased innovation activities in Cyprus during the period 2009-2014 was mainly due to the negative growth experienced in 2013 and 2014 (EY, 2015).



Innovation Index of Cyprus Relative to EU (2007-2014)

Source: European Commission (2015b: 57)

4.1. The national innovation system of Cyprus

A National Innovation System is the basis of a knowledge economy. According to Lundvall (1992: 2), an innovation system consists of “the elements and relationships, which interact in the production, diffusion and use of new, and economically-useful, knowledge.” To evaluate the adaptation and use of knowledge in Cyprus, we first need to look at the Knowledge Economy Index, which represents the overall level of development of a country towards a knowledge economy (World Bank, 2012). According to the Knowledge Economy Index, Cyprus has not focused on the transition to a knowledge economy and no major improvements have been made since 1995.

Similarly, the European Innovation Scoreboard (European Commission, 2015; 2016; 2017), which captures the multi-dimensional nature of knowledge and innovation, the Global Competitiveness Report (WEF, 2015; 2016; 2017), and the Global Innovation Index (Global Innovation Index, 2015; 2016; 2017) all show that an absence of creation, sharing and use of knowledge are the main issues for the Cypriot innovation system. In particular, Cyprus’s innovation system is characterised by a low level of involvement in Research and Development, together with a lack of university-business collaborations (e.g., Tsipouri & Rublova, 2010). Interviewers commented that the Cypriot NIS has many limitations, particularly low R&D involvement and a lack of collaborations between universities and industry:

“There is a significant low involvement in R&D activities. Firms are not interested in engaging in R&D. This lack of interest is mainly due to the absence of hi tech industries. The structure of the economy, including small firms and the service-based economy, suggests that R&D should be encouraged using government policies”. [A1]

“Universities do not engage in collaborations with business. Academics prefer to stay in the protected environment of the university and conduct research for publication purposes. They are not interested in commercialising their research, and turning it into products”. [A10]

“There is no such thing as an entrepreneurship university here. Business and universities are coming from two completely different words. We care about different things. For example, I want to engage in R&D activities and then proceed with the development of a new product. However, academics end the projects when their research is completed”. [A2]

Governments need to stimulate collaboration between universities and business. Universities should share internal knowledge gained from research with firms, in order to help them to commercialise new technologies and absorb knowledge. In addition, higher education is crucial for the creation of new firms and for the broader innovation system (Galán-Muros & Plewa, 2016). Proof of concept programmes should be developed in universities, in order to support the commercialisation of academic research and in this way to attracting investors. According to the World Intellectual Property Organisation (2007:12), measures to bring universities closer to industry include: “defining the legal status of universities and their professors, relaxing or removing regulations that prevented faculty members from working with companies, developing policies on intellectual property rights, establishing technology transfer offices”. Moreover, the cultural factors influencing entrepreneurial behaviour must be at the centre of the research agenda.

As cultural values are not inborn and can be taught (Hofstede, 1980), the task for governments and policymakers is to direct the national cultural values of each country towards innovation by teaching the concept of ‘entrepreneurship’ in schools and higher education institutions (Henry et al., 2005), as institutions and policies shape the structural conditions of innovation with national contexts. Interviewees argue:

“There is an absence of measures in favour of innovation, such as infrastructure support schemes in the form of high-technology business incubators, and a

technology park. In fact, infrastructure support has been postponed because of national funding limitations. The economic crisis has made innovation performance worse in Cyprus”. [A12]

Cyprus has always been behind other countries in many of the standard R&D indicators, including GERD (Gross domestic expenditure on R&D) and BERD (Expenditure for Business Enterprise R&D), which are among the lowest of the EU countries (European Commission, 2014). However, the financial crisis has increased these problems and made it clear that underdeveloped financial environments create barriers to innovation. The recent European crisis offers evidence that barriers to external finance are faced by firms which tend to rely on internal funds to finance their innovation activities.

4.2. The financial environment of Cyprus

Finance has been acknowledged as being a vital part of the innovation process (O’Sullivan 2005; Mazzucato 2013). The slowdown in business innovation in Cyprus due to limited access to finance, particularly during the crisis, emphasises the integral relationship between finance and innovation. The Planning Bureau (2011:20) has stated that “There is a limited capacity for Cyprus to increase private R&D, due to the considerable number of micro enterprises”. However, it is difficult to finance research and development (R&D) and innovative activities in a market in which financial instruments are not developed. When the financial tools are underdeveloped, then financial constraints will prevent firms from taking the risks required to innovate. According to the Knowledge Economy Framework (World Bank, 2012), the economic incentives and institutional regime in Cyprus are huge barriers to a knowledge economy and may even discourage the efficient generation and use of existing or new knowledge.

In particular, Cyprus lacks a VC market, as well as crowdfunding, while the numbers of angel investors are minimal. The angel market in Cyprus is the smallest in the EU, with an average investment size per business angel of about €16,000 (Tsipouri & Athanasopoulou, 2015). Fiscal incentives for either VCs or business angels are nonexistent. Although public funds dominate total R&D funding, most government funding is allocated to the higher education sector, while only 15% is allocated to the business sector (European Commission, 2016a). GERD and BERD both decreased steadily in the period 2008-2013 (European Commission, 2016a). The interviewees argue that the reduction in government funding led to a decrease in innovation activities:

“With the current economic crisis, the government is trying to save on what it considers to be discretionary expenses, and research is one of the first to be cut. As there are no any external funding sources, we invest less in innovation”. [A13]

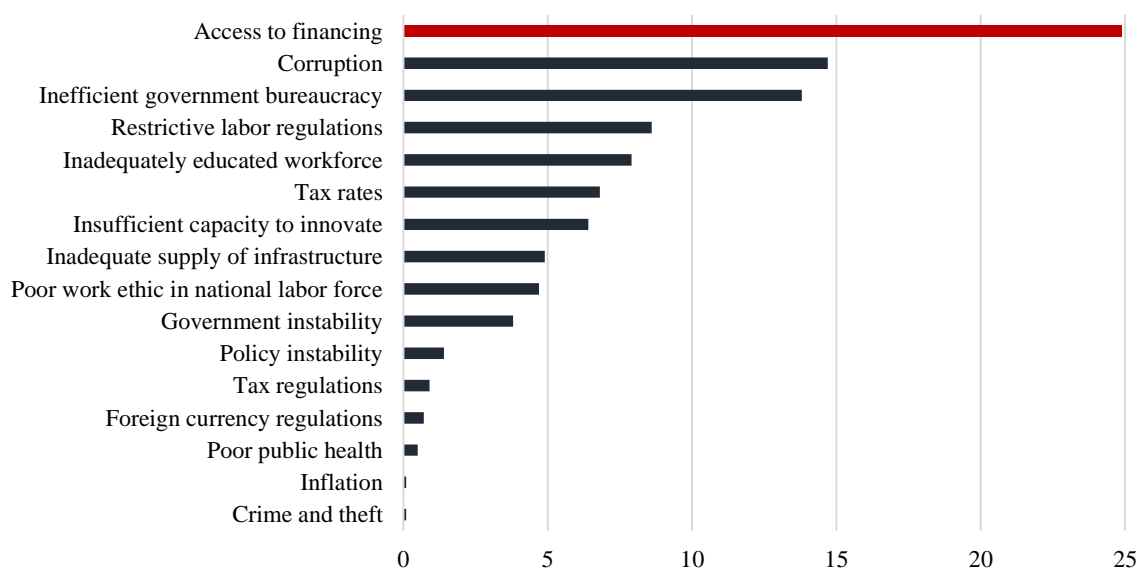
The local banking system, which has been the main source of funding, has suffered. Despite its critical effect on the economy, there have been many problems with the banking system, according to interviewees:

“The banking system is not structured properly. The banks do not give loans to investments that involve risk, including innovation projects, and this has been particularly true during the crisis. You will get a loan only if you already have money. If you want to do business that involves risk, then they will reject your application”. [A8]

“There are two funding sources: family and grants. Banks do not work for most of us who do not have guarantees. During the crisis, the credit supply has been reduced. In time of crisis, there are no options. The government cuts spending on R&D and innovation, and so if you do not come from a rich family, it is impossible to invest in innovation”. [A14]

According to Figure 3, access to finance is the biggest barrier to doing business in Cyprus (World Economic Forum, 2017). The percentage of SMEs that indicated increased difficulty in accessing finance was more than twice as high as the EU average in 2015, whereas in 2011, finding funds was not seen as such a significant problem in Cyprus (see Table 3).

Figure 3. Most Problematic Factors for Doing Business in Cyprus



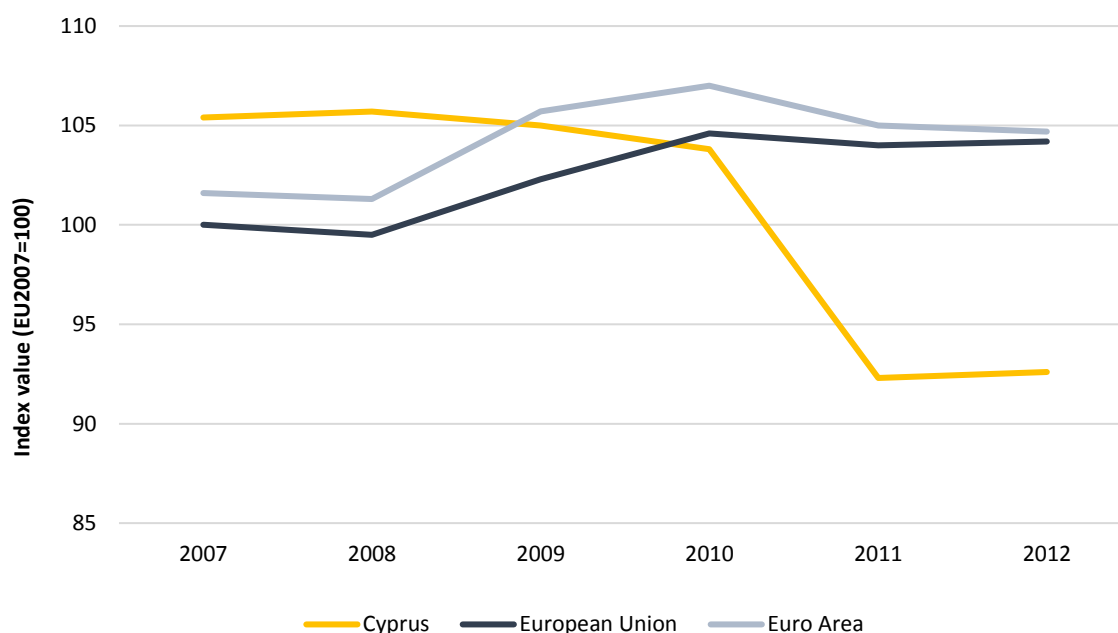
What is the most pressing problem your firm is facing?	2011		2015	
	EU27	Cyprus	EU28	Cyprus
Finding customers	% 24,1	16,8	25%	17%
Competition	% 14,6	20,5	14%	18%
Access to finance	% 15,1	14,3	10%	25%
Costs of production or labour	% 12,2	9	13%	9%
Availability of skilled staff or experienced managers	% 13,6	2,8	18%	7%
Regulation	% 7,7	4,1	13%	8%
Other	% 9,7	29,7	6%	16%

Table 3. Most Pressing Problems of SMEs in Cyprus and EU 27/28

Source: European Commission (2012; 2015a)

The SMEs Access to Finance (SMAF) index provides an indication of the conditions of the access to finance that SMEs have, and the way this changes over time, based on access to debt finance and equity finance (see Figure 4). The index shows that the Cypriot financial crisis plunged Cyprus into a deep and prolonged recession. The Euro area and European Union index value for 2013 was more than 100, indicating an improvement since 2007. In contrast, the index shows that Cyprus has experienced a notable decrease in its access to financial environments since 2007 and particularly since 2010. The lack of a well-functioning financial market and the over-reliance on only one source of access to finance had a negative impact on the funding of companies during the crisis decreasing their level of innovation.

Figure 4. SME Access to Finance in Cyprus, European Union and Euro Area



Entrepreneurs face difficulties engaging in innovation. The financial environment has a significant impact on innovation. Without external funding, businesses have difficulty in innovating. Although the financial market in Cyprus has generally been problematic for entrepreneurs, as it has failed to provide firms with funding, this failure became more apparent during the economic crisis. Financial development outcomes largely result from contextual conditions and institutional features. Therefore, the focus should be on drafting institutions and innovation policies which could change the contextual conditions and enhance the access that firms have to finance.

4.3. Alignment between NIS and financial sector

Institutions and policies should shape the structural conditions of innovation by aligning the NIS with financial instruments and improving the relationship between them. The financial environment needs to be aligned with the NIS, and its performance depends on different institutions and policies simultaneously determining the performance of innovative companies. For example, the National Reform Programme noted in 2011 that while public efforts to improve R&D performance through public funding have been significantly enhanced in the past, the participation of the business sector in R&D has remained poor.

There are few opportunities for public funding in Cyprus, and all are administered through the framework programme of the Research Promotion Foundation (RPF) under the auspices of the Ministry of Finance. These opportunities have mostly been taken up by universities, and a smaller proportion of businesses have done so. Despite its responsiveness, the RPF has some major shortcomings, such as the absence of performance monitoring and impact assessment, and the lack of a specific service providing the support necessary to extend its reach to SMEs. The bureaucracy related to support programmes discourages enterprises from applying for support (Bougiouklis & Altsitsiadis, 2010). All the interviewees admitted that the Cypriot financial environment lacks policy instruments. For instance, some of the interviewees claim:

“The only source of money for innovation prior to the crisis was subsidies. However,

government funds do not help us to innovate. The funding is focused on research. Therefore, when companies complete their research, they have to deal with many financial problems. Taking the next step to commercialise the product involves risk and so most firms avoid it. They do not have the necessary capital to proceed”. [A8]

“Funding from the government is suitable only for universities. Grants focus on research. There is no comprehensive plan that includes the whole process of innovation. Academics care only about their articles or patents and not about the final products. Companies, on the other hand, want to develop products that will be commercially successful”. [A4]

“The RPF has much paperwork and causes headaches. If I had the money, I would have never applied for government funding. But there is no other way. Unfortunately, we have never applied for European funds due to lack of time. When you're a small company with few employees without prior experience of European programmes, then it is very difficult to go for it”. [A3]

Similarly, according to the Global Competitiveness Report, inefficient government bureaucracy is cited as a significant problem for businesses (WEF, 2017). It recommends that the government should develop programmes that consider the whole innovation process including the commercialisation of research, rather than only considering the research stage, in order to help firms improve and speed up their innovation processes. The supply of funding during the early stages of research is not adequate for innovative firms, particularly SMEs, because there is a high risk either of a funding shortage in the later stages of development and/or of exploitation of the innovation. Intermediaries, such as consultants or national contact points (NCPs), could also take a leading role in connecting entrepreneurs with investors, thus bridging the gap between research and commercialisation. Moreover, incentives, such as R&D tax credits, should be given to firms to increase their investment in R&D and innovation.

Furthermore, while business and government funding decreased during the crisis, funding from abroad was alone in increasing, and remained steady at very low levels for private firms (European Commission, 2016). HEI funds from abroad significantly increased in the period 2008-14 (European Commission, 2016), whereas collaborations with firms remained low (Eurostat, 2015b). HEIs received most of the funding from abroad, specifically 61.6% of all foreign-financed GERD, with only 12% allocated to business enterprises (Tsipouri &

Athanasopoulou, 2014). An interviewee claimed that firms lack awareness of European funding and the IPO:

“Cypriot businesses are not aware of how European programmes work or how patents work. A lack of funding results in low investment in patents. Firms do not have the money and therefore do not take the risk. Moreover, there is a huge amount of ignorance. Cypriots need to become aware of European programmes and how crucial they can be”. [A11]

There is a lack of awareness of funding from abroad, patents and the importance of innovation for economic growth. The government must highlight the role of entrepreneurs in providing innovative products and emphasise the role of entrepreneurship in creating new jobs. Intermediaries should act as technology brokers to reduce information asymmetries (Lichtenthaler, 2013). The government should also use the media to promote entrepreneurship and innovation. More specifically, innovation policies should be based on the quadruple helix (Carayannis et al., 2012), which focuses on the three helices of university-industry-government relations and a fourth helix of the ‘media-based and culture-based public’ and ‘civil society’.

Studies have shown that spatial proximity may influence the institutional venture capital market and angel investors (Mason & Harrison 2002; Florida & Kenney, 1988; Zook, 2002). Crowdfunding could be used as a method of finding investors in new business ideas, not only for hi-tech products but also for the non-hi-tech. Cyprus does not have a strong entrepreneurial culture, which could encourage individuals to create start-ups and attract investors. The government could promote an entrepreneurial culture by providing incentives, such as tax relief, in order to develop a venture capital industry and networks of angel investors. In the present circumstances, universities could be a catalyst for the creation of new hi-tech firms, thus attracting investors. Interviewees claimed that the financial environment has led to a decrease in innovation:

“Our company moved to America because the Cypriot environment is poor for entrepreneurship. High-risk projects do not attract funding from private companies. The only source of funding here comes from European programmes or the RPF”. [A5]

“Governments should give incentives for investments in research and development. This is particularly true during periods of crisis. The most important factor that will

stimulate the private sector to invest in research is tax breaks for research, a reform that other countries have introduced. However, the Cypriot government has not done so yet". [A17]

Institutions and policies shape the structural conditions of innovation within national contexts, determining the ability of some countries to respond better than others to major economic downturns (Filippetti & Archibudgi, 2011). The case of Cyprus shows that a 'one size fits all' approach is not possible across the EU, as the specific institutional environment of each country plays a crucial role in policy-making for innovation. Nevertheless, the National Innovation System (NIS) approach has not given the necessary focus to the financial environment and its vital importance for innovation (Lundvall, 1992; Nelson, 1993; Freeman, 1995). National institutions and innovation policies could promote an environment that is supportive to innovation by developing infrastructure that facilitates access to finance and provides credit availability (Beck & Demirguc-Kunt, 2006).

The evolution of new financial instruments and the introduction of policy instruments for financing innovation are crucial factors in today's markets. Financial development and institutions, according to Lechman and Marszk (2015), should be regarded as the critical factors underlying economic prosperity. In the particular case of Cyprus, the lack of funds for innovation and the absence of sufficient long-term funding policy create financial barriers for business. If the government intends to avoid retrenchment among SMEs, it should consider access to finance to be its single most important policy area.

Bank loans and public funding are the only financial instruments available in Cyprus. Policies could facilitate new financial tools which promote innovation and improve those policies that do so already. In the foreseeable future, access to finance should be one of the most important policy areas for the Cypriot government. The government should take the necessary steps to create a less problematic financial environment, in which firms can find funds for innovation and growth. Nevertheless, firms need not only financial capital, but also support from a broader policy framework that aligns the financial environment with the NIS, setting the conditions for risk-taking and collaboration, which in turn lead to innovation.

5. Discussion and Conclusion

The purpose of this research was to understand how an NIS accommodates financial market institutions. Based on primary and secondary data, we have developed an analytical

framework that presents the relationship between an NIS and financial instruments. The analytical framework synthesises existing studies that focus on the relationship between an NIS and business innovation (e.g., Lundvall, 1992; Nelson, 1993; Freeman, 1995), incorporating research that scrutinises the relationship between funding instruments and business innovation (e.g., Agarwal et al., 2015; Block & Sadner, 2009; Cumming et al., 2017). This paper contributes to the literature on the NIS by inserting the financial environment, and in particular a developed financial market, as a key component. As the case of Cyprus illustrates, the NIS interacts directly with the financial environment, so innovation should also aim to improve this relationship.

More broadly, successive periods of financial crisis demonstrate that innovation activities are not affected by liquidity problems to the same extent. Previous research has shown that countries with a more developed NIS respond better to the shocks caused by an economic crisis and overcome them more quickly (Fillipetti & Archibugi, 2011). An advanced NIS can enable a country to escape an economic crisis more quickly, and also to attract and maintain investors while taking full advantage of decentralised funding, such as crowdfunding. However, for countries with an underdeveloped NIS, the challenges triggered by an economic crisis are greater, as entrepreneurs and firms face disproportionate difficulties in financing innovation. Countries with an underdeveloped NIS face two specific challenges, which are triggered during times of crisis. Firstly, the financial environment of a country deteriorates during an economic crisis, increasing barriers to funding innovation. Secondly, public funding, which could mitigate the impact of an economic crisis on innovation, is reduced due to the austerity measures which have to be introduced. As a result, countries with an underdeveloped NIS encounter further difficulties in funding innovation during periods of crisis, and, crucially, they seem unable to design innovation policies which could provide a way out of the economic crisis. Policy-makers should therefore aim in times of crisis to improve conditions within the financial environment, identifying financial instruments which could support the innovation performance of SMEs. For instance, during a crisis, the cost of money may increase, and policy-makers should aim to provide the right incentives to angel investors which enable them to support innovation.

Empirically, this paper focuses on the context of Cyprus, which exemplifies the Eurozone sovereign crisis in an extreme form (Consiglio & Zenios, 2015) and illustrates the detrimental effect on innovation performance when the financial environment is disconnected from the

NIS. As angel investors, venture capitalists and crowdfunding platforms are nearly nonexistent, the funding of innovation in Cyprus mostly relies on credit from banks and public subsidy. Since 2008, the only increase has been in EU funding of innovation. However, the majority of the European resources has been absorbed by universities, although ties between universities and the industry are almost nonexistent (Telemachou, 2014).

The findings from the case study of Cyprus suggest that innovation policies should be designed which take into account both the NIS and the particular needs of the national financial environment. Policy-makers can improve an underdeveloped NIS by ameliorating the conditions of the financial environment. This research shows that the financial environment is an integral element of a NIS, supporting innovation in terms of both the breadth (types of financial instrument) and depth (scale and availability) of funding sources. We argue that innovation policies that reform the financial environment of the country will also have an impact on the NIS of that country, boosting the innovation performance of business. The government should take initiatives to improve innovation performance by cultivating an entrepreneurship culture which promotes angel investment, and by strengthening the relationship between investors and universities, in order to promote the commercialisation of innovation. More broadly, the government should introduce innovation policies that aim to strengthen the relationship between the NIS and the financial environment, because they jointly influence the innovation performance of firms. These policies should take into account the institutional environment of each country, and the current status of its financial market.

This issue becomes pressing when governments react to an economic crisis by becoming risk-averse in terms of the direct funding of science, technology and innovation. Within the EU, governments and pan-European institutions should focus their efforts on providing and maintaining a stable economic environment. In this way, innovation policies should aim to mitigate the unexpected shocks caused by the crisis, nurturing structures that maintain and promote innovation. If this does not take place, the divide in Europe between the more advanced NIS in the 'North' and the less developed NIS in the 'South' is expected to grow, prolonging uncertainty.

Our study also has managerial implications. Due to an absence of local funding, many firms may need to look for cross-border investors to a greater or lesser extent. While government funding is even more important in countries with declining funding for innovation, venture

capital and angel investors have increased exponentially in terms of geographical proximity and have become more visible and active through dedicated groups and networks (Hazarika et al., 2012). The responsibility of funding research and innovation devolves to international sources. As a result, firms in Cyprus need to engage in international collaborations and identify cross-border investments with angel investors, venture capital, and European funds. These in turn have important implications for organisations that act as agent or broker between parties, particularly in the case of SMEs, due to their limited resources and lack of a strong knowledge base (Harris et al., 2009). Intermediaries, such as national contact points, need to intensify their work in linking firms and potential investors across national borders, particularly in times of crisis. In addition, crowdfunding is a significant alternative form of financing at such times. Compared to other private funding services, crowdfunding offers small firms a flexible way to transcend national boundaries in order to raise funds. Greater effort is therefore required from policy-makers and universities to educate entrepreneurs to use these platforms, and to present and promote their ideas online (Agrawal et al., 2011; Kuti & Madarász, 2014).

Our results suggest areas for future research. Firstly, our analytical framework could be applied in other countries, in order to assess current innovation policies and suggest new policies. Further research is necessary to understand how countries at different stages of economic development could exploit different routes in order to develop and maintain financial instruments, which in turn would influence innovation performance. Secondly, future research could focus on the attraction and circulation of investments in an international context. Venture capitalists and angel investors are increasingly pursuing international investment patterns. Given that firms aim during periods of crisis to approach investors from abroad, it can be expected that future research will need to examine the performance of different types of cross-border investment. Finally, further research is needed into the role of innovation intermediaries in the context of national systems of innovation (Lichtenthaler, 2013). This relatively limited understanding of innovation intermediaries is particularly remarkable, as the misalignment of financial environment and institutions points to a relatively high potential for intermediary services.

In conclusion, we feel that capturing the ways in which the financial environment is linked with the NIS has allowed us to develop a framework capable of analysing the many areas that various policies can affect. Future researchers could use the framework to build an

understanding of the mechanisms at work, while practitioners could search for a range of national and international funding opportunities with the help of intermediaries, and policy-makers could explore the wider potential of pro-innovation policies, beyond simply encouraging innovation activities.

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