J. Int. Financ. Markets Inst. Money xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of International Financial Markets, Institutions & Money

journal homepage: www.elsevier.com/locate/intfin

A new macro stress testing approach for financial realignment in the Eurozone

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ARTICLE INFO

Article history:
Received 7 September 2018
Accepted 11 February 2019
Available online xxxx

JEL classification:
G21
G28

Keywords:
Macroprudential policy
Financial stability
Macro stress test
Systemic risk
European Banking Union

ABSTRACT

Contrary to the common approach of stress-testing under which banks are evaluated whether they are distressed, this empirical study chooses to move from the micro stress test approach to a wider new macro stress test category. By being able to stress testing the entire economy of the Eurozone, it will permit big banks to fail and, at the same time, will open room for new banking players to enter the sector, promoting the essence of a healthy destruction. The analysis performs a battery of stress tests, by implementing VaR, Cornish-Fisher VaR, Monte Carlo VaR, Expected Shortfall, Cornish-Fisher Expected Shortfall, and Monte Carlo Expected Shortfall. At the same time, it explicitly considers the new regulatory approach of IFRS9 to incorporate extreme values from forecasted series in the distributions. The analysis also performs two versions of stress tests, one including TARGET2 and one without it. The results document that future stress tests should include TARGET2 values in order to capture a better picture of the stressed economy. The findings from these stress tests clearly illustrate that although there has been a trough after the distress call of 2008, this trough ended. These are results derived without including the TARGET2 transfers. By including the TARGET2 transfers we receive a different picture that possibly acts as a protective mechanism against any future crisis. Caution is still advised, possibly due to some lingering imbalances within the Eurozone.

1. Introduction

In their notable parallelism between the overall economy and the human body, Kahou and Lehar (2017) sketch the financial system as the cardiovascular system, with the banks representing the veins while the capital corresponds to blood. For the sake of financial stability, core banks are crucial for their extensive networks, carefully developed with other financial institutions. Papadimitriou et al. (2013) stress out that we should shift our attention to financial institutions' relevant neighbourhood, rather than focus on the misleading narrative of being 'too big to fail' institutions. The repercussions of this tenacity generate a wrong direction towards future regulatory arrangements and raise suspicions when the potentially excessive protection deprives the financial system of the Schumpeterian creative destruction. Creative destructions stand as a fundamental feature of a healthy capitalism (Schumpeter, 1928) for the development of future products (financial in our case). One

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https://doi.org/10.1016/j.intfin.2019.02.002
1042-4431/

of the outcomes of Basel III adds pressure to financial institutions and leads to the deceleration of money circulation available for households and businesses (Samitas and Polyzos, 2015). The effects of the recent credit crunch are alarming, which build up to a 30% reduction of total bank credit, triggering as a consequence a credit-recession vicious circle.

The policy response has been a call for support for ailing banks to restore their capital position from fiscal resources. The injection of fresh capital was requested firstly through recapitalization,[1] secondly through additional purchases of their impaired assets at above market prices, third, through the provision of guarantees over existing and new financial products and, finally, by permitting tax concessions, even support from non-state investors.[2] To this end, central banks provide a ready alternative of the last resort when the above measures fail to deliver the expected results.[3] Hence, prudential regulation is needed in the form of capital liquidity to provide resilience against systemic risk.[4]

In the European context, the flight to quality of deposits from the periphery of Eurozone to stronger German banks (Abad et al., 2013) appears to have had a huge governmental backing (Acharya and Mora, 2015). Bailing out banks does not deny the fact of raising social welfare costs (Rochet and Vives, 2004), or the fact that European banks were encouraged to borrow cheap money from the European Central Bank (ECB) and buy their home country's sovereign debt (Drechsler et al., 2016). The Europeanized bank safety net architecture erected to combat the diffusion of contagion by applying macroprudential policies, which in the end, resulted in the European Banking Union (EBU). The EBU consists of four main pillars, namely, the Single Supervisory Mechanism (SSM), the Single Resolution Mechanism (SRM), and the Single Resolution Fund (SRF), while a Single Deposit Insurance Scheme (SDIS) is still pending construction. All of these are being coupled by a single rulebook,[5] containing certain rules in relevance to prudential regulation, supervision, resolution and the guarantee of bank deposits. The mechanisms are a by-product of the financial crisis and designed to apply mainly for the euro area countries.

This infrastructure is in contrast opposition to the no-bailout orthodoxy in the Eurozone,[6] under which to avoid moral hazard, any ailing institution should be preferably restored to soundness with private resources or bailed-in at a pre-resolution stage. In practice, the resolution proved to be the rule rather than the exception. The repercussions are evident in fuelling a debt-deflation spiral when countries are deprived of their monetary policy tools. Currently, the ECB is responsible for the supervisory responsibility of the Systemically Important Credit Institutions (SICI).[7] When a bank is found to be non-viable,[8] then under the first pillar, its resolution will be carried out by the Banking Union's second pillar: the SRM, supported by the third pillar or the SRF. To make a comparison with the US, it is worth mentioning at this point that the supervisory landscape on the other side of the Atlantic is a mix between supervisory authorities and rating agencies (Apergis et al., 2012). This is contrasted with the Eurozone, where only a regulatory supervision mechanism is in place. One of the major criticisms today is that there is not only a declining competition in the banking sector with oligopolistic tendencies (Apergis, 2015), or barriers to new bank entries (Apergis et al., 2016), but also that bank opaqueness is a serious issue (Berger and Davies, 1998; Iannotta, 2006). In this case, supervisory tools are put in place to reduce bank opaqueness, including deposit insurance and risk-based capital requirements (Petrella and Resti, 2013).

Out of experience, bank stress tests are still no transparent and regulatory bodies make that information available on an aggregate cross-country basis, rather than on a bank-specific one. The approach in this paper aims at providing a new policy orientation, under which not even a single bank would be big enough to fail, with small or core banks being allowed to compete for depositors.[9] The framework for macro stress testing the economy allows banks to default and to pursue collateral in their interbank transactions, while it promotes a liberal approach towards bank entries. If macro stress tests are designed correctly, they can prevent unnecessary credit crunches (Arnold et al., 2012). The analysis wishes to believe that a minimum deposit guarantee is important for new entrepreneurs to enter the banking sector.

Section 2 begins by outlining the literature on contagion, macroprudential policies, the importance of which lies on policy responses to absorbing spillovers from the financial sector towards the real economy and argues how we should move from micro-macro stress tests to pure macro stress tests (stress testing the economy) by presenting the methodological approach followed. Section 3 presents the data and the methodological strategy applied. To this end, the analysis practically incorporates the new International Financial Reporting Standard 9 (henceforth, IFRS9), which introduces a new way of performing stress tests from January 1st, 2018. Section 4 reports the empirical findings and introduces levels of readiness, conditional on the increasing severity of the alert. Section 5 concludes by discussing the findings within the existing bank safety net infrastructure in the Eurozone. The findings offer the opportunity to shift away from strict regulations on banking to specific play-

[1] Which can reach up to a bank's full nationalization.
[2] With government connections buying the portfolios of problematic assets.
[3] Volcker (1984) argues that the principal reason for the foundation of the Federal Reserve Bank in the US in 1913 was to assure a smooth operation of the payments system. Lessons from history advise that the Bank of England was a mature lender of a last resort, a role it had perfected in the course of the nineteenth-century (Billings and Capie, 2011). Back then, commercial banks were obscuring on the purpose of publishing their true positions, firstly, to smooth out fluctuations of performance over the business cycle and, secondly, to present a picture of strength and stability for foreign investors, thus, gaining their trust to easily place their money on them (Billings and Capie, 2009).
[4] As long as it does not protect shareholders who are favoured too much with political support to bear the cost of their investment choices.
[5] The prudential framework is supported by the Capital Requirements Directive and the Capital Requirements Regulation taking place before a bank fails; once it fails, the Bank Recovery and Resolution Directive take place.
[6] Supported by the Bank Recovery and Resolution Directive.
[7] They have to be EBU members.
[8] When national Deposit Guarantee Arrangements (DGA) have failed.
[9] New technology and blockchain will allow an upwards moving trend.

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ers and open the profession to new players. Finally, in Section 6 policy implications are included with wider applications to the Eurozone economy and its implicit infrastructure safety net.

2. Literature review

2.1. Contagion

An accurate definition of contagion comes from Hasman (2013). He defines it as the transmission of the idiosyncratic risk from one bank towards other credit institutions or businesses. As Cifuentes et al. (2005) adhere, uncertainty is stimulated when forced sales of assets generate a volatility feedback, which, in turn, are producing a downward spiral in asset prices. In the literature, bank failures can be interpreted through a different lens. One line of thought suggests that this is a coordination problem across depositors with different consumption horizons (Bryant, 1980; Diamond and Dybvig, 1983).

In light of the 2008 financial crisis, bank failures tend to favour a chain reaction of events materialized from asymmetric information. Based on the existing literature, asymmetric information is accentuated by excessive risk-taking (Fortin et al., 2010) when management focuses on size,[10] rather than on performance (Boyd and Runkle, 1993; Bhagat et al., 2015), when regulatory authorities permit soft lending controls or predatory lending (Tippit, 2014), when there is a lack of accurate monitoring from credit agencies (Bozovic et al., 2011), and liquidity mismatches due to premature liberalization (Bird and Rajan, 2001). As if these were not enough, bad news alarms investors adding exogenous information on already liquidity problems (Gorton and Metrick, 2012) and volatile equity prices (Apergis and Apergis, 2017).

That spiral resembles very much a Minskian transformation, with financial positions evolving from hedge to speculative when financial arrangements are disrupted (Papadimitriou and Wray, 1997). To withhold contagion, scholars have argued for government intervention through a central bank as a lender of last resort (Goodhart, 1987), as well as reforms in banking regulations (Allen and Carletti, 2010). In the same manner, contagion can be contained when the regulator provides insurance to uninsured depositors and when the number of banking failures is quite large, helping eventually banks to attract deposits at cheaper costs (Penati and Protopapadakis, 1988). The domino effect can be generated by the uncollateralized exposure of commercial banks' risk in the interbank market (Rochet and Tirole, 1996), despite the fact that maintaining these credit lines reduces the cost of maintaining reserves. In effect, this ultimately causes frequent coordination failures (Freixas et al., 2000), especially when banks use this channel to protect themselves against real shocks, instead of fuelling the economy (Hasman and Samartin, 2008). Towards this end, microprudential regulations from Basel I and II were designed in a manner to minimize the risk of each institution in isolation and protect depositors. The unintended contribution made the system more fragile to macroeconomic shocks generated by counterparty risks (Zawadowski, 2013). It is that dimension Basel III is trying to resolve by considering the importance of systemic risk (Drumond, 2009).

2.2. Macroprudential policies

Before Basell III the argument was that the existing regulatory framework from Basel I and II had a micro-based nature and could not ensure the safety of the financial system as a whole (Borio, 2003). The underlying logic of microprudential orientation rests on the notion that if each financial institution is given assurances of its soundness, then the aggregate result would be financial stability (Borio, 2011). A penetrated insight from Geanakoplos (2010) informs us how it all starts with an expansionary policy from the central bank, while optimism flourishes in the economy. As the story goes, suddenly the economy is exacerbated and the potential losses are requested to be covered by a deposit insurance guaranteed by the government (Anginer et al., 2014). In parallel, banks' shareholders have limited liability to exercise any influence[11] (Keeley, 1990). Then all of the sudden, the tap is turned off and volatility arises in asset prices (Tirole, 2011), leading to a credit crunch or scarcity in the loan markets (Bernanke et al., 1991). As a result, this forces financial institutions to fire sales or sell some of their assets, inaugurating a dramatic drop in their prices (Shleifer and Vishny, 1992). This contributes to feedback effects, generating a cascade of fire sales (Shleifer and Vishny, 2011). Hanson et al. (2011) argue that the ultimate course of action of such macroprudential policies is to minimize the social cost of banks' balance sheet shrinkage, stemming mainly from credit crunches and fire sales.

Rochet and Tirole (1996) define systemic risk as the propagation of an agent's economic distress to other agents linked to the first agent when financial transactions between them fail. In this paper, we define systemic risk in a manner that brings us closer to market risk. Hence, the economic risk would be a more suitable definition, because we do not wish to restrict ourselves with agents who link themselves directly. Indirect influences by unforeseen changes of the underlying positions in banking portfolios, such as stock and bond prices, exchange rates or any variable might imply useful information on where to position itself. For instance, we do believe that if the counterpart is a bond issuer, then the risk of her default due to factors beyond her control are there. Still can be foreseen and allow for early action.

To examine the consequences of macroeconomic shocks we consider that banks have correlated portfolios or established networks (Papadimitriou et al., 2013). However, macroprudential policies are accompanied by limitations to credit growth

[10] Usually hiring for political favours.
[11] As long as they are satisfied with their dividends.

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(Akinci and Olmstead-Rumsey, 2018), with an increase in capital requirements, lower lending to domestic firms and households and reduced aggregate expenditures (Meeks, 2017) or international lending (Avdjiev et al., 2017). That might make sense, since taming a financial boom requires first taming the source that keeps inciting it or having countercyclical effects (Altunbas et al., 2018). That is tricky when macroprudential measures are introduced concurrently with a lax monetary policy (Farhi and Tirole, 2012). No matter how somebody looks at it, the role of macroprudential policies is to limit risks in the banking sector, while the governments can still follow their own monetary policies most suitable for their constituents.

2.3. Stress testing

The role of macroeconomic factors is so important driving deposit withdrawals, apart from bank-specific variables (Levy-Yeyati et al., 2010). In our view, this independent exposure can have significant macroprudential implications for macroeconomic risks, with Calomiris and Mason (2003) calling for an early attention to macro factors in banking supervision. Drehmann and Tarashev (2013) ascertain that banks can transfer the shocks that affect them to the real economy. The financial crisis of 2008 gives us a recent image of the pervasive implications for GDP growth, trade and employment rates.

An early attempt to analyse the impact of macroeconomic factors in stress testing was employed by Apergis and Payne (2013). However, there is still no mechanism in the literature that can act as an early warning signal when the economy is facing the risk of financial instability. Our methodology, however, is different and aims at incorporating stress tests and risk modelling. Kupiec (1998) and Alexander and Sheedy (2008) try to bridge these distinctive frameworks.[12] In particular, Kupiec (1998) examines cross-market effects resulting from a market shock, while Alexander and Sheedy (2008) argue that due to this approach, promising nonetheless is being vulnerable to a considerable degree of model risks and back-testing methodologies should be performed in order to tackle the issues of misspecification. Moreover, Zayernyuk et al. (2015) argue that the macroeconomic models used for stress testing barely take into account the full spectrum of shocks and risk factors and require satellite models, rather than focusing on specific financial variables.

Foglia (2009) defines macro stress tests as the method that links macroeconomic drivers of stress with bank-specific measures of the credit risk. Borio et al. (2014) have introduced the role of systemic importance, as well as the notion of macro stress tests, while Adrian and Brunnermeier (2016) highlight the importance of forward-looking risk measures. In this paper, we use both approaches to measure risk exposures and correlations between the banking system and the macroeconomy, with IFRS9 incorporating the forward-looking tenets. It is because financial intermediation promotes economic growth (Benhabib and Spiegel, 2000; Apergis et al., 2007) that forces government regulation to offset the instability caused by the presence of deposit insurance (White, 1989). Usually, the approach goes as stress events happening in macroeconomic variables[13] and that is linked to variables measuring asset quality,[14] which impacts on banks' balance sheets in terms of earnings or capital. This whole design, though it has a rudimentary rationale behind it, we do believe that it would easier give an idea of what the banks actually see with their own eyes. To be explicit, instead of the 'bird's eye view' of usual macro stress tests, we choose a 'wearing your shoe approach'. Essentially, we use the variables any bank would use to construct a portfolio assuming that every bank thinks the same way. Demirguc-Kunt et al. (2013) support that portfolio risks or stock market performance is associated with stronger capital positions. Usually, a bank estimates the entire portfolio loss distribution. We expect the shape of the right-hand tail of the portfolio distribution to be to a large extent dependent on key risk factors or correlations between the risk components of macroeconomic and financial variables. Stressed loss distributions are used to examine stressed scenarios in a consistent setting (Foglia, 2009).

In their stress test scenario, Jimenez and Mencia (2009) introduce artificial 3-standard-deviation shocks in only two macroeconomic variables (i.e., GDP and interest rates) separately and report percentage changes caused in their Value at Risk (VaR). Here, we need to highlight that VaR helps us to measure the potential loss magnitudes experienced by banks associated with tail events in the financial sector or the general economy. This effect is sensitive when banks have invested in non-traditional bank activities, influencing their profitability or insolvency (Apergis, 2014). This approach clearly sends an early warning about the potential systemic risk existing in financial markets, which is the outcome of the entanglement of the financial sector with other economic activities.

3. Data and methodology

3.1. Data

Equity indices are a good measure to provide evidence of contagion effects or systemic risks in the banking sector (Kupiec, 1998; Kanas, 2004; Lehar, 2005). Depending on the interest rate, the 10-year bond positions must be held to generate investments of a size comparable to an investment in the equity market index. In this paper, we will not use the probability of defaults as suggested by Basel III for micro stress tests, because we do believe that the probability of defaults is underestimated in the pre-crisis period due to large banks groups owing a significant number of subsidiaries (Li and Dong, 2016).

[12] Stress tests combined with risk modelling.
[13] In the literature is known as the macroeconomic model.
[14] In the literature is known as the satellite model.

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Additionally, we use government bond yields in order to capture stock-bond correlations. According to Petmezas and Santamaria (2014), portfolio rebalancing can have substantial contagion effects.

One of the major characteristics of the European sovereign debt crisis has been the strong nexus between Euro area sovereigns and banks. This nexus was the end result of the large holdings of sovereign debt by financial institutions across the Eurozone. According to this, adverse shocks stemming from sovereign banks contributed to the rise in that sovereign credit risk. In addition, a deterioration in a country's fundamentals, as well as a surge in sovereign credit risks fuelled the increase in bank credit risks (Alter and Beyer, 2014; Fratzscher and Rieth, 2018). In order to take explicitly into account this nexus in our modelling approach, the analysis calculates the credit default swap spreads, with Germany being the base reference for our calculations. This enables us to consider any potential contagion effects and, thus, to include them in the modelling approach.

We further use the TARGET2 loans[15] received by the ECB, which is a credit transmission mechanism and works when credit institutions cannot find any credit line in the private interbank market (Sinn and Wollmershauser, 2012; Abad et al., 2013; Auer, 2014; Erler and Hohberger, 2016). The transmission mechanism of the crisis starts when investors diversify during a crisis period by short selling bonds and acquiring long positions in equity markets, while the opposite is supported by Baur and Lucey (2009). Whatever the direction, Brunnermeier and Pedersen (2008) argue in favour of a volatile liquidity spiral between stock and bond markets. As far as the foreign exchange rates are concerned, we will rely on Falcetti and Tudela (2008) who link banking with currency crises in addition to further macroeconomic variables that can help to pinpoint contagion. Risks spill over into the European markets due to the exposure and trade activities with foreign trade of financial partners (Gramlich et al., 2017).

In the build-up, as well as during the crisis, TARGET2 balances reflect the capital flights directed from the financial institutions of the EMU South to the financial institutions of the EMU North. These balances were primarily reduced in the period following the main stage of the Eurozone crisis (i.e., during the period 2012–2014). However, since the first quarter of 2015, the ECB has embarked on massive government bond purchases under its quantitative easing (QE) program. As a result, TARGET2 balances increased significantly, reflecting the ECB's bond purchases activities. We adjust the weights in TARGET2 balances, thus, removing any divergent information when moving from the pre- to the post-2015 period. More specifically, we make use of weights on TARGET2 balances derived from these ECB bond purchases activities. Bond purchases, however, from the ECB do not enter into our model as exogenous variables. They are used only to weight our primary variable.

As far as the ECB policy rates is concerned, Apergis (2017) demonstrates that interest rates affect not only price and output stability, but also financial stability. Financial stability is reflected on the recent trend of central banks acquiring macroprudential portfolios. The two major methods of measuring risks are those of the VaR (plus two extensions) and the one of the Expected Shortfall (plus two extensions). Although in the literature both of them have been used to measure risks in individual institutions, we are extending it to macro stress testing as if the Eurozone economy is a single institution by itself. VaR_{β} is the maximum possible loss that the Eurozone economy experiences with probability β, while ES_{β} measures the average of the worst losses that occur with probability $1-\beta$. They are trying to capture risks conditional on an adverse scenario. Because our macro stress test aims at measuring the risk in the financial market from a macroeconomic perspective, rather than a microeconomic one, the analysis makes use of quarterly data to capture potential risks (see descriptive Table 1A in the Appendix A for more details). In our case, instead of measuring returns, which is usually the common trend in micro stress tests, we estimate growth rates in our distributions, which are more relevant in measuring the economy instead of the Profit and Losses (P&Ls) of specific banks. We run the simulations for 10,000 times, which is the standard procedure in many statistical simulations.

3.2. Including or not TARGET2

VaR relies on the greatest lower bound on an arbitrarily defined risk frontier over an arbitrary fixed period of time, with Basel II prescribing at 99% confidence interval over a holding period of ten trading days (Chen, 2014). However, as Chen (2014) notes, Basel III appears poised to replace VaR with Expected Shortfall as the theoretically coherent alternative risk measure, with, however, one problem, that Expected Shortfall cannot be reliably back-tested, something for which VaR holds a regulatory advantage. For clarity, we are not performing back-testing here.

When there is a procyclical relationship between bank profitability and business cycles, during the booming phases of the cycle there is a stronger impact on bank profitability, whilst during the recessionary phases, the performance of banking loan portfolios is jeopardised. This leads to credit losses and, thus, to lower banking profits (Apergis, 2009). To address this issue in our economy, we perform a rolling window approach that surfs over the business cycle in order to examine the VaR evolution over time. Equal risk weighting allows us to pinpoint which variable has the greatest impact apart from the TARGET2 rates, which have been weighted according to ECB loan purchases. We are familiar though that risk-weighting was introduced in Basel II and allows, for example, risk-sensitive capital charges to counter the procyclicality effect by mitigating its impact (Heid, 2007). Our approach is expected to help by reflecting the current outlook for business-cycles conditions, which is in accordance with the European Banking Authority's stress-testing methodology (EBA, 2017). The dependence

[15] Although we approximate to ECB loans since they represent claims and liabilities of Euro area national central banks vis-à-vis the ECB, technically TARGET2 balances are the cross-country capital transfers across Euro area banks.

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on the business cycle is less pronounced when credit is more available (Antonakakis and Scharler, 2012), while our inclusion of TARGET2 balances is expected to remove any business cycle effects.

3.3. Three different VaRs and expected shortfalls

Historical simulation is a method for estimating VaR and was introduced by Boudoukh et al. (1998) and Barone-Adesi et al. (1998, 1999). The historical simulation is still predominant in a way that from Perignon and Smith's (2010) survey of firms using risk modelling, 64.9% disclosed their methodology and 73% reported that they were still using historical simulation. The advantage of the historical simulation is that we do not have to make an assumption of the parametric form of the distribution and instead the dynamic evolution and the dependencies of the risk factors are inferred directly from historical observations.

Monte Carlo VaR simulation is a very flexible methodology and can be applied to any assumed distribution for risk factor returns. The great advantage of Monte Carlo VaR is that historical data place no restriction on simulations. We can simulate as many data or risk factor returns as possible (the more simulations used, the more accurate the VaR estimates are). Given that sampling errors can be controlled, the main source of model risk in Monte Carlo VaR models lies with the specification of the statistical model for the risk factor growth rates. These models are used to translate standard uniform simulations into the risk factors growth rate simulations. We derive the Monte Carlo VaR from a quantile of the simulated portfolio growth rates. At extreme quantiles, it is not easy to estimate historical VaR, even with several thousand observations. The semi-parametric expansion of Cornish-Fisher is applied to improve the precision of quantile estimates. The problem with the Cornish-Fisher estimates is that they substantially overestimate VaR when data are leptokurtic. The procedure will also be implemented on a rolling window in order to examine the VaR over time. Stress tests will then take place by implementing the most extreme observations in order to examine how well portfolios will fare with the presence of TARGET2. Additionally, we consider a Monte Carlo approach for the VaR, sampling 1000 observations and forming the distribution for each iteration.

3.3.1. Historical VaR

Despite that Pritsker (2006) has raised the alarm on the dangers of using a VaR through a historical simulation, the analysis in this work employs Historical Average VaR for benchmarking and compares the results with the Modified Cornish-Fisher VaR (Favre and Galeano, 2002). The Modified Cornish-Fisher VaR is an expansion that manages to encompass the variability that would have been explained by a more computationally intensive resampling approach, such as the Monte Carlo VaR. Additionally, both the Variance-Covariance VaR and the Expected Shortfall approaches will be employed. Still, when appropriately constructed, the objective information, such as historical correlations and volatility, can play an important role in stress testing (Kupiec, 1998). A common issue in many asset distributions is when the normality assumption of common VaR can be violated, because many assets may have fat tails (Tan and Chan, 2003), implying that there are far more occurrences at the tails than the Gaussian distribution would lead us to believe (Pafka and Kondor, 2001). The historical VaR is estimated as follows:

$$HVaR = quantile(-R, p) \tag{1}$$

with –R being the period negative returns for the p confidence level. The procedure will also be implemented on a rolling window in order to examine the VaR evolution over time. Stress tests will then take place by implementing the most extreme observations in order to examine how well portfolios will fare with the presence of TARGET2. Additionally, the analysis considers a Monte Carlo approach for the VaR, sampling 1000 observations and forming the portfolio for each iteration.

3.3.2. Monte Carlo VaR

We simulate a distribution for the h-quarters growth rates and the 100a% h-quarter VaR estimate is determined empirically as -1 times the quantile a of the distribution. Specifically, we simulate data derived from a normal, $N(\mu, \sigma^2)$, distribution, with μ, σ^2 respectively being the sample mean and variance of the rolling window in the first exercise, and the stress size in the second, over 10,000 simulations.

3.3.3. Cornish-Fisher VaR

The Cornish-Fisher expansion (Cornish and Fisher, 1937) to VaR is a semi-parametric method that estimates quantiles of non-normal distributions as a function of standard normal quantiles and the sample skewness and excess kurtosis. This method allows us to estimate the extreme quantiles from standard normal quantiles at high significance levels. The fourth order Cornish-Fisher approximation $\hat{x}_a$ to the a quantile of a distribution with mean 0 and variance 1 is:

$$x_a \approx \omega_a + \frac{\widehat{\zeta}}{6}(\omega_\alpha^2 - 1) + \frac{\widehat{\theta}}{24}\omega_\alpha(\omega_\alpha^2 - 3) - \frac{\widehat{\zeta}^2}{36}\omega_\alpha(2\omega_\alpha^2 - 5) \tag{2}$$

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where $\omega_a = \Phi_{(\alpha)}^{-1}$ is the a quantile of a standard normal distribution and $\hat{\zeta}$ and $\hat{\theta}$denote the skewness and excess kurtosis of the distribution, respectively, implying that if we have a mean $\hat{\mu}$ and standard deviation $\hat{\sigma}$ derived from the same distribution, then the quantile a of the distribution would be:

$$x_\alpha = x_a\hat{\sigma} + \hat{\mu} \tag{3}$$

To calculate the Cornish-Fisher VaR we need to ignore the mean and standard deviation and to apply the expansion (2) to approximate the 1% quantile of the normalized distribution having zero mean and unit variance.

3.3.4. Historical expected shortfall

VaR defines the level of loss that one is reasonably certain will not be exceeded. But VaR tells us nothing about the extent of the losses that could be incurred in the event that the VaR is exceeded. Historical expected shortfall is a more informative risk metric than VaR, because VaR does not measure the extent of exceptional losses. However, we obtain information about the average level of losses, given that the VaR is exceeded from the conditional VaR. The conditional VaR measure we consider is the Expected Shortfall or Conditional VaR (or expected tail loss). If X denotes the discounted h-quarter growth rate, and set:

$$VaR_{h,a} = -x_a \tag{4}$$

where x_a denotes the quantile a for the distribution X, i.e.$P(X < x_a) = a$. The expected tail loss or expected shortfall is expressed as a percentage of the distribution value:

$$ETL_a(X) = -E(X|Z < x_a) \tag{5}$$

and since ETL is a conditional expectation, it is obtained by dividing the probability-weighted average of the values of X that are less than x_a by $P(X < x_a)$. But $P(X < x_a) = a$, so if X has density function$f(x)$, then:

$$ETL_a(X) = -a^{-1}\int_{-\infty}^{x_a} xf(x)dx \tag{6}$$

or the 100^{α}% h-day expected shortfall defined as:

$$ES_{h,a} = -E\left(X_h|X_h < -BVaR_{h,a}\right)xP \tag{7}$$

where X_h denotes the discounted h-day active growth rate and $BVaR_{h,a}$ is the 100^{α}% h-day benchmark. The 1% expected shortfall is the average of the ten largest relative losses.

3.3.5. Monte Carlo expected shortfall

To account for path dependence, such as volatility clustering in risk factor growth rates (instead of returns used in finance), the general algorithm of ETL is modified for multistep Monte Carlo (MC). The MC method allows for a simulation environment in which each variable's data are simulated from a Normal Distribution. As a result, the Traditional Means VaR/ES are able to perform far more adequately, compared to when the data distributions deviate from the normal. As seen in Table 1A and Fig. A1 in the Appendix A, there is a plethora of variables that have high skewness and kurtosis values.

3.3.6. Cornish-Fisher expected shortfall

Here we present some analytic formulae for the ETL when the historical distribution is fitted with a generalised Cornish-Fisher expansion. This is approximated by:

$$ETL_a = f\left(a^{-1}f(Z_a)\right)\hat{\sigma} - \hat{\mu} \tag{8}$$

where according to (2):

$$f\left(a^{-1}f(Z_a)\right) = a^{-1}f(Z_a) + \frac{\hat{\zeta}}{6}\left(\left[a^{-1}f(Z_a)\right]^2 - 1\right) + \frac{\hat{\theta}}{24}a^{-1}f(Z_a)\left(\left[a^{-1}f(Z_a)\right]^2 - 3\right) - \frac{\hat{\zeta}^2}{36}a^{-1}f(Z_a)\left(2\left[a^{-1}f(Z_a)\right]^2 - 5\right) \tag{9}$$

3.4. Scenarios of extreme values with IFRS9

Following the replacement of the IAS39 with IFRS9 on January 1st, 2018, the argument is that the new international accounting standard is expected to reduce information asymmetries across countries and, subsequently, to increase cross-country comparability (Onali and Ginesti, 2014). According to the new tax regime, banks in the Eurozone were requested to report under IFRS9 in the first quarter of 2018. Based on the methodological approach of the European Banking Association, stress tests need to take explicitly into consideration not only point data, but also projections (EBA, 2017). Subsequently, that introduces forecasting from a mere divination to actual scientific methods and is requested from banks to employ professional forecasters if they need to comply with future stress tests. For the stress test methodology, the analysis

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encompasses the IFRS9 for which we forecast time series values from Q2:2017 to Q4:2020. Usually, the forecasted period for performing stress tests is five years. Those values are forecasted with two benchmark methodologies, i.e. the historical mean and the median. For stress tests, we examine the worse scenarios, starting with the most five extreme values (out of 80), up until to a less 'stressed' scenario of the 40 most extreme values. For all cases, we consider results for three significant levels, i.e. 90%, 95%, and 99%.

With IFRS9 including forecasting, it is mandatory to predict values up to 2020 (Q4:2020) (a typical forecast window is two years) and then we take extreme values to account for the stress testing scenarios. The initial plan was due to the ex-ante nature of the forecasts; benchmark models had to include historical mean and historical median, but because there were not any differences between those two, for the sake of space we included only historical means. Forecasting under IFRS9 will help us to estimate future expected credit losses (Chawla et al., 2017) and arrange our scenarios based on a distribution that includes forecasted variables as well, and not only historical variables which were the common trend among scenarios before 2018 under the old accounting regime. It is anticipated that the expected losses approach of IFRS9 will widen the scope of judgements triggered by market signals (Novotny-Farkas, 2016).

4. Generating macroeconomic stress tests

In this estimation strategy, we have applied six different VaR metrics. Firstly, a rolling window estimation, and secondly a stressed environment setting. Weights to the TARGET2 values have been added in an attempt to extract more robust metric values. The weights are based on the relative ECB Bond Purchases.

The stressed tests involve a scenario which includes the most volatile observations of a variable from our dataset. We perform multiple stress tests for an increasing number of observations, starting with the five most extreme up to the forty most extreme observations. The VaR methodology is different from others (i.e., regressions, panel, time-series) because this methodology does not require the presence of depended and/or independent variables. All variables are treated likewise simultaneously (equally weighted as well, if so required), and then, they are used to estimate the VaR. Dynamic Stress test, as explained in Gersl et al. (2013), which involves the estimation of the predictions of the dependent variable using additionally the predictions of the independent variables. Because VaR does not require such an approach, we still enter a dynamic approach by including the predicted values of the variables in the sample to select the extreme values.

We generated 3D graphs of the mean values for the following metrics: VaR, Cornish-Fisher VaR, Monte Carlo VaR, Expected Shortfall, Cornish-Fisher ES and Monte Carlo Expected Shortfall including TARGET2 (Fig. 2) and without TARGET2 (Fig. 1). The rolling window test values are plotted in Fig. 1 in time up to the fourth quarter of 2020 for different alphas. These are set out in column one. It can be illustrated how the values of the abovementioned metrics are fluctuating as we move in time against different confidence intervals. In the second column, we replace the axis of time with the number of extreme values in our stressed scenarios.

We can early derive from these comparisons that the rolling window scenarios are more pessimistic of the future. At the same time, when the number of extreme values increases, then the stressed scenarios are smoothed, implying that the importance of a shock is reduced. Additionally, when the variable TARGET2 is included in the distributions, the importance of the coming crisis is reduced. We are trying here (Fig. 2) to improve the stress test values by adding in the data pool the values from TARGET2. In other words, it shows the robustness of the stress tests and its ability to withstand tinkering without its main message being affected. This is true as both capture the shocks from the 2008 financial crisis. What is happening is that without including the TARGET2 variable, the stress tests indicate that the economy is heading for a crisis even more serious than the one experienced in 2008. The conclusion at this stage must be that the leap to adding TARGET2 values in the scenarios is optimistic and by implementing this treatment it is very early to head to a new crisis. Yet, can we safely say that voices of a coming crisis are not taking into consideration the implicit mechanism of Eurozone?

Take, firstly, the metrics values (Fig. 1), they denote a somewhat stable period between Q1:2009 to Q1:2016, followed by a rapid increase in VaRs. C-F VaR, which for the same period denotes a rapid decrease, followed by a similar scale increase in Q3:2017. Moreover, C-F ES denotes a rapid increase during the Q2:2016 period, which is followed by a decrease after Q4:2018. Q2:2016 is the period of a rapid increase in VaR metrics values, continued to the forecasted period. For the same period, CF VaR denotes a decrease in values, which for the quarters of 2020 are increasing. Using the five most volatile observations of each variable, we proceed to add in the stress sample the immediate following less volatile observations. Following the guidelines of the IRFS9 in the selection sample, we have included the forecasted observations (derived using a simple mean forecast) as well. This implies that for these stress tests, if a forecasted observation is highly volatile, it will then be included in the sample. We conclude this part when the sample consists of the 40 most volatile observations. All metrics follow a similar pattern, but for the case of MC ES there is a curve peaking at 22 extreme values. The MC ES increased rapidly after the 15th observation, finishing with the highest value of all metrics. In the right panel, MC ES increases constantly until the 24th observation, followed by a steady decline, leaving the MC ES with the highest value of all metrics.

At this point, there is a fundamental question to answer, which may radically affect the perspective in which we view the quality of the stress tests for the Eurozone stability. Potentially, there exists other evidence which points the other way, i.e. to a sharpened increase in 2008 and less sharp values for 2020. For this reason, we need to add a variable often disregarded in the macroeconomic analysis; this is the value of interbank transfers. In Fig. 2, for the time span between Q2:2011 and Q1:2016, the VaRs are the lowest throughout the whole span across all portfolio metrics. After Q1:2016, there is a small rise

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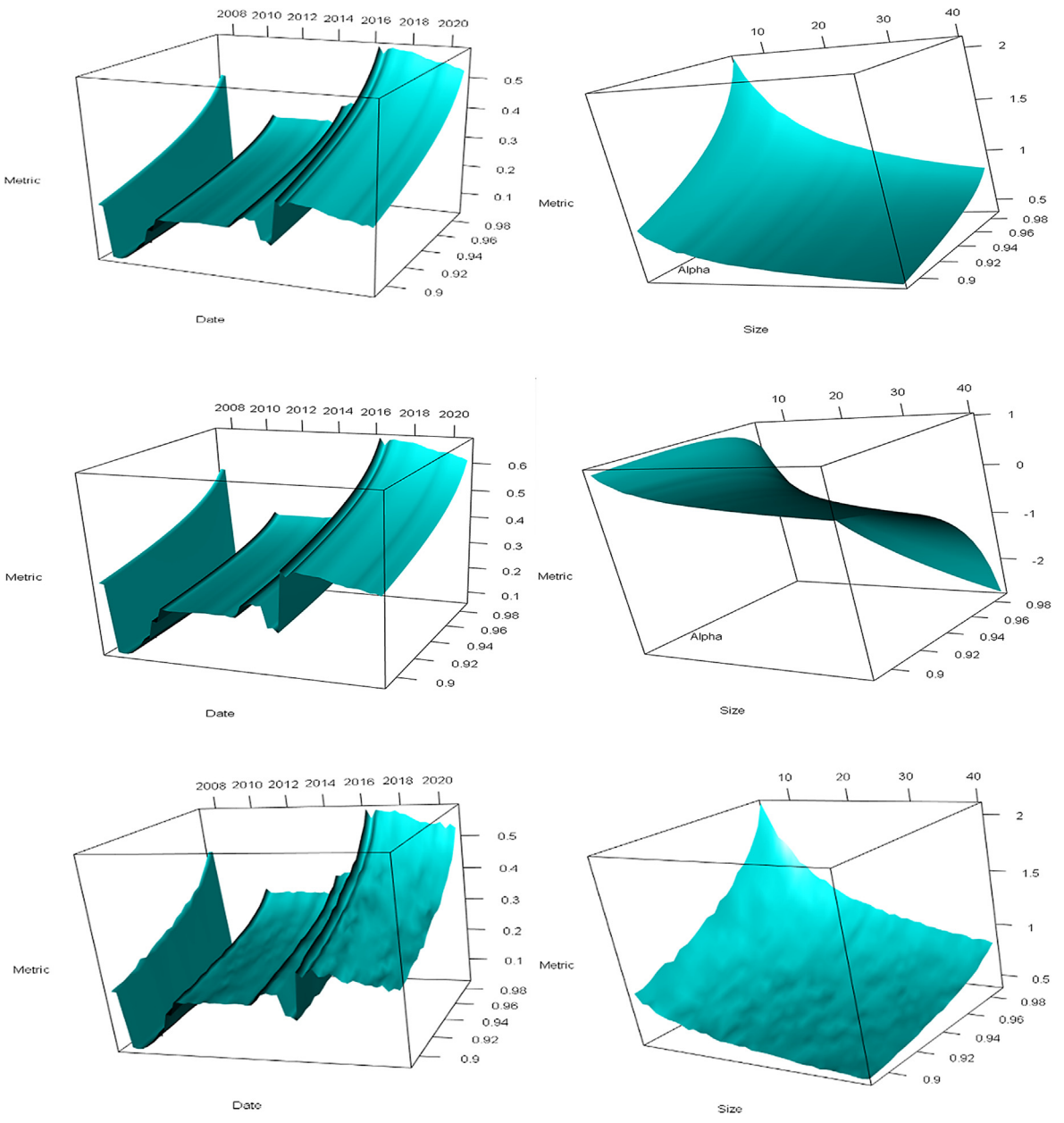

Fig. 1. No TARGET2 stress tests of VaR, Cornish-Fisher VaR, Monte Carlo VaR, Expected Shortfall, Cornish-Fisher Expected Shortfall and Monte Carlo Expected Shortfall for both time and extreme values.

in these metrics and then becomes stable. This stability continues over the forecasted time period. C-F ES's values follow a slight increase, which is followed by another decrease at the Q3:2017. All forecasted periods are denoted by a steady increase in VaR. Over the period Q1:2012 to Q1:2016, the VaRs are the lowest throughout the whole time span across all portfolio metrics, except in the case of C-F ES, which reports a small increasing trend. After Q1:2016, there is a small rise in all metrics and stability, which continues over the forecasted time period. There is a noted decrease in the values of the metrics until Q1:2016. After Q2:2016, all metrics values remain stable, except in the case of the CF VaR. Overall, the conclusions derived from the stress tests in Figs. 1 and 2, are always subject to a question mark, because of the unavoidable arbitrariness of the variables used or the forecasted horizon. The crudest way of coping with this includes the typical set of macroeconomic variables as we did here.

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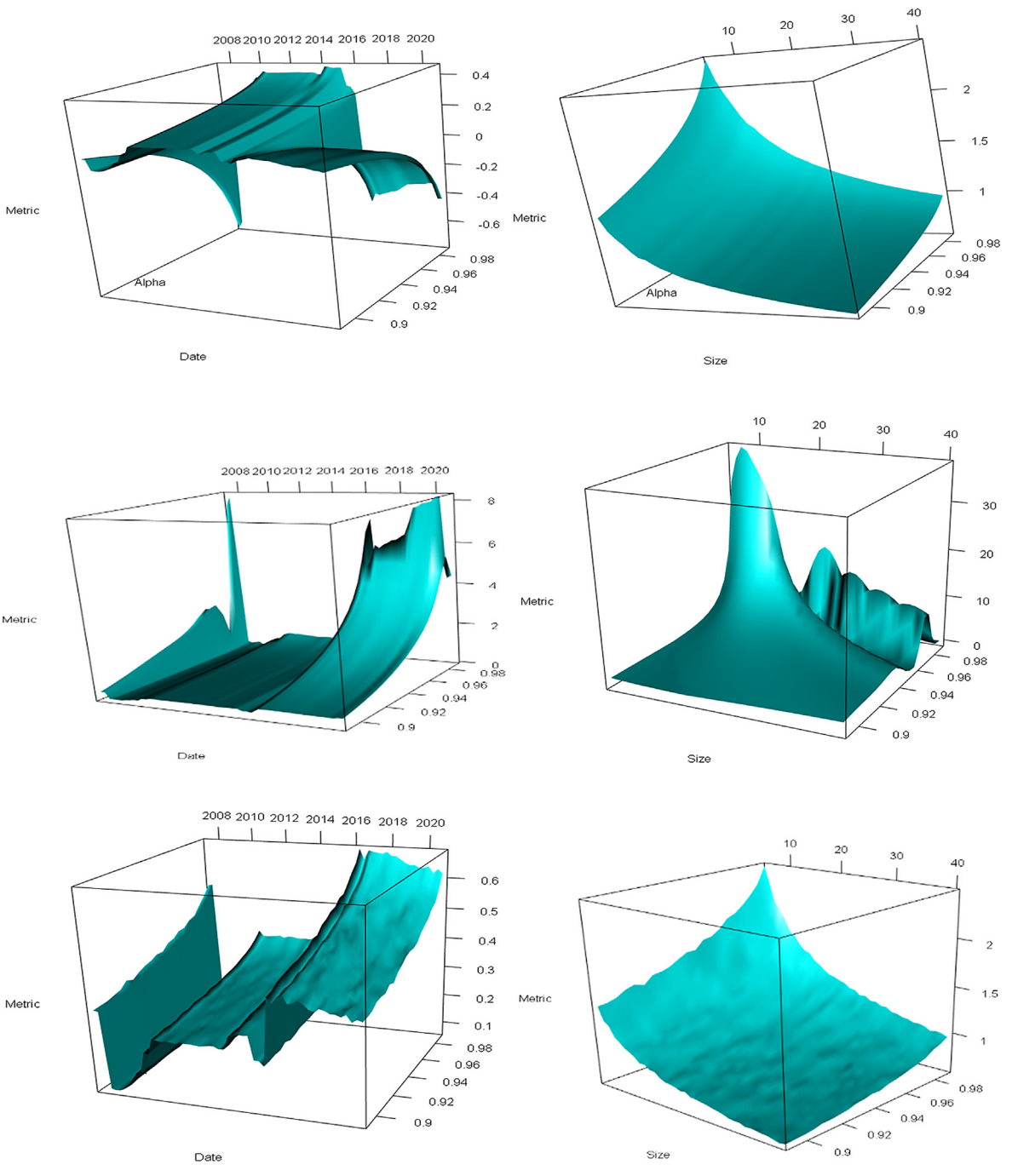

Fig. 1 (*continued*)

5. Final remarks

The outcome of economic downturn, apart from the reduction or deceleration in GDP growth (Serva, 2010), and the rise of unemployment, has a serious social impact, such as rising suicide rates (Fountoulakis et al., 2015), which can further be exacerbated by the negative climate generated during policy uncertainty and attributed to the way in which particular incidents are handled by authorities (Antonakakis and Gupta, 2017). The recent economic downturn occurred mainly by a financial

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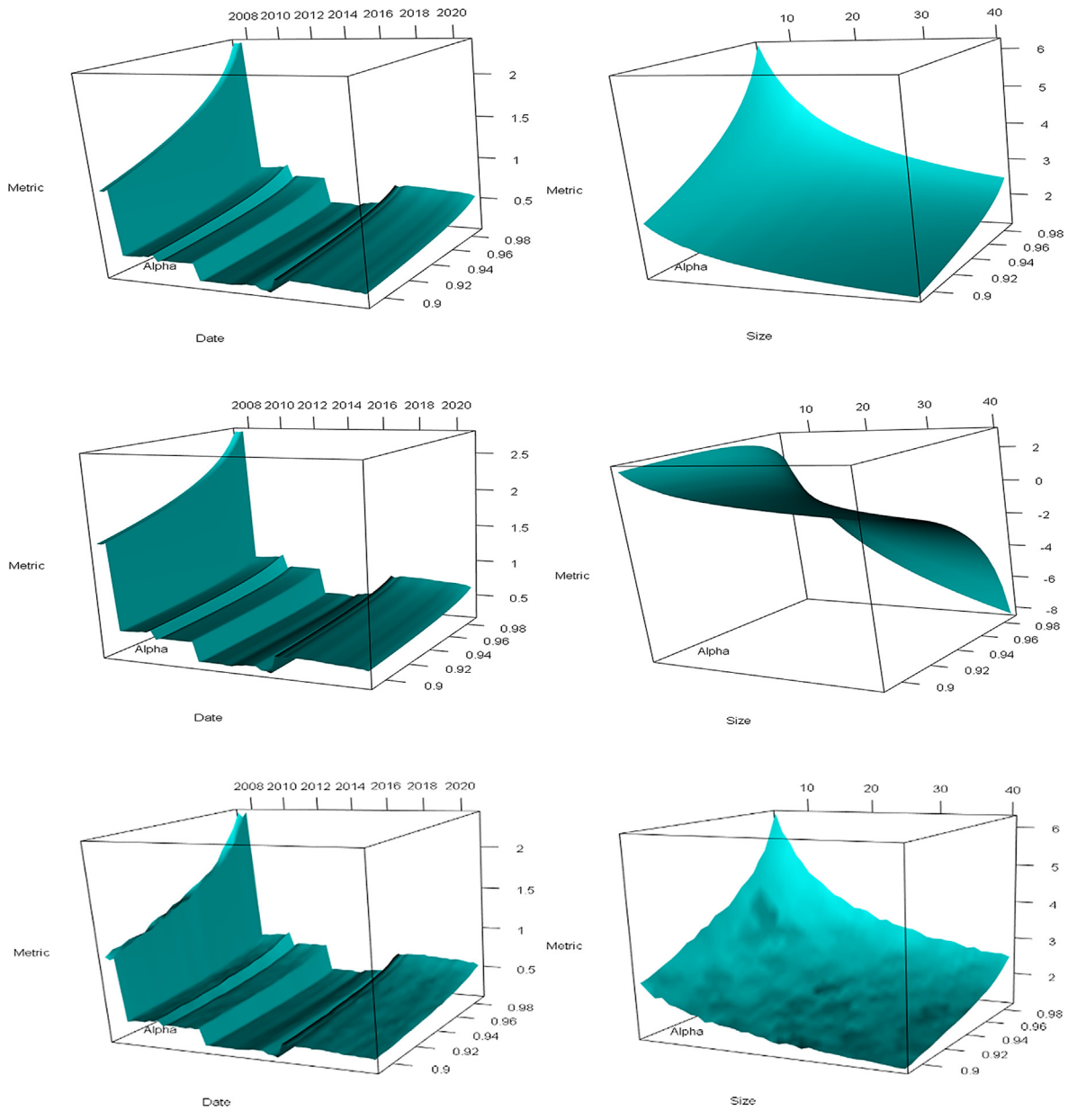

Fig. 2. TARGET2 stress tests of VaR, Cornish-Fisher VaR, Monte Carlo VaR, Expected Shortfall, Cornish-Fisher Expected Shortfall and Monte Carlo Expected Shortfall for both time and extreme values.

crisis when a significant portion of toxic financial instruments found their way into commercial and investment bank balance sheets and raised suspicions over their solvency (Brunnermeier, 2009). Not surprisingly, though, they managed to honour their credit lines drawn by firms only because liquidity provision was largely supported by governments or governmental agencies (Acharya and Mora, 2015). With this paper, our intention has been to prevent protectionism to establish itself in the banking sector and to allow entrepreneurial human capital to contribute with new businesses in this sector. With our stress test methodology, instead of focusing directly on the existing banks and their efficiency, the empirical findings suggest that the lens should zoom out and focalise on the entire economy. With this approach, instead of trying to protect the existing banking establishments, we can safely assume that lowering down the volatile curves of our stress test will effectively require new players to enter the banking arena. New players carrying with them their new marketing method-

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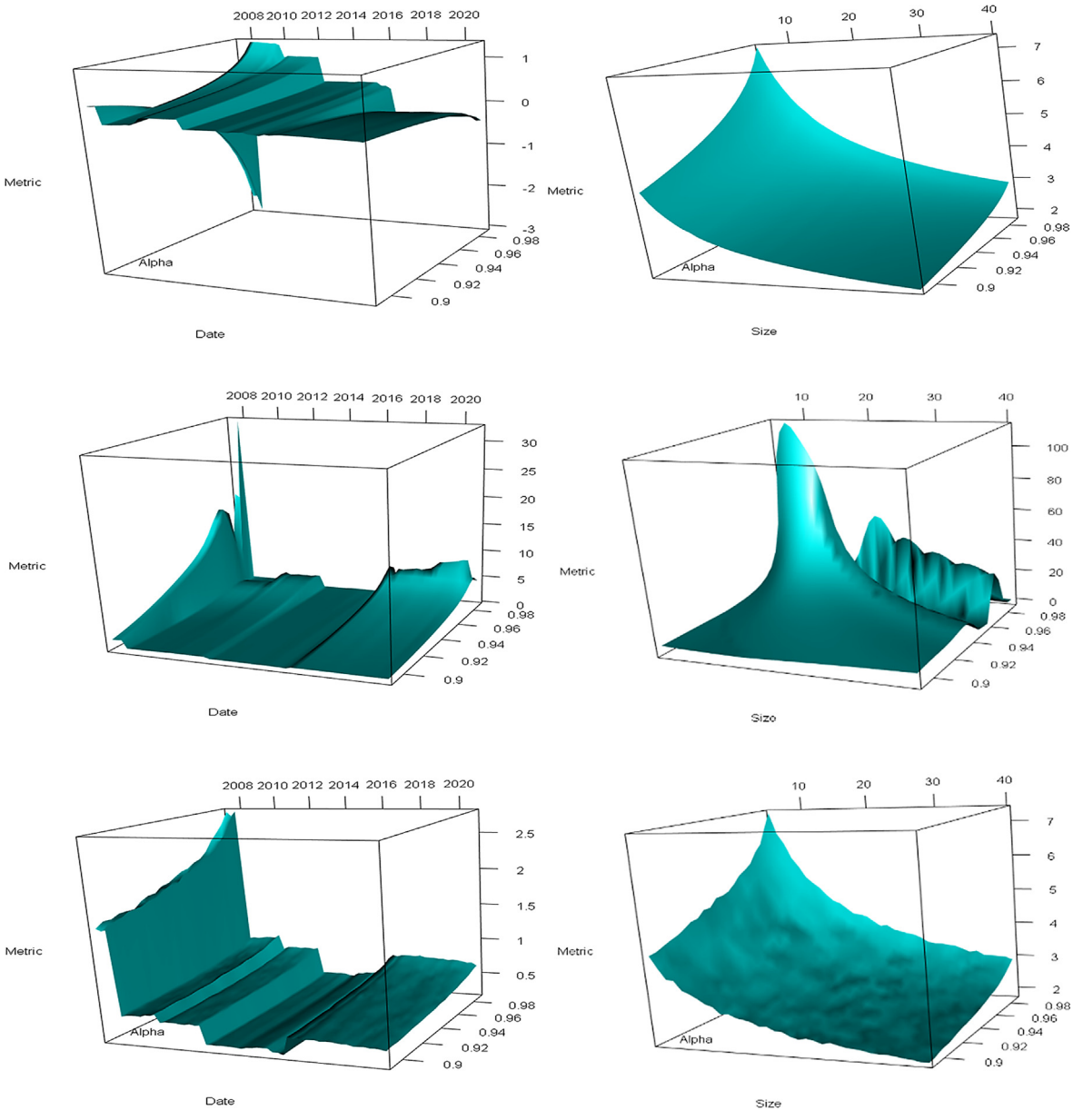

Fig. 2 (*continued*)

ologies and new technology, can now compete against the existing banks and allow for more employment vacancies. However, there is a key point, here we need to learn. A serious crisis is coming in 2020, but the TARGET2 mechanism seems to mitigate the forthcoming crisis. Can we say that the TARGET2 infrastructure will help Eurozone to protect itself from another crisis? Probably yes. But there is more to that story as TARGET2 is not only an anticyclical tool, but also is accompanied by imbalances, which need to be rectified, if Eurozone policy makers wish to keep this mechanism working and convince country-members against exiting the mechanism. But is the TARGET2 mechanism sustainable? This argument is discussed in the next and final section.

6. Policy implications for the Eurozone

The Eurozone is geographically so large and economically so heterogeneous that the different regions are subject to different business cycles and asymmetric macroeconomic and financial shocks (Bayoumi and Eichengreen, 1993). Before the

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recent financial crisis, when capital flowed in towards the core countries of the Eurozone in the belief that it was safe against the peripheral countries leaving the euro,[16] at that point, the Eurozone lacked a centralised fiscal stabilization mechanism by which to provide counter-cyclical intervention (Fingleton et al., 2015). Some of the optimal currency area theory (Mundell, 1961) conditions were met, but others were missing. The common fiscal capacity was the main missing element. The effectiveness of the current common budget as a shock absorption mechanism is negligible. Financial integration allows funds to be channelled from core countries to peripheries. When the long-feared shock of the global financial crisis hit, the cost of adjustment fell mainly on labour; as a result, higher and longer unemployment occurred (Pasimeni, 2014).

The Eurozone has certain structural and investment funds whose presence is to invest in job creation and to a sustainable European economy as part of the Stability and Growth Pact (SGP),[17] the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF). None of them, however, is intended to address the shorter economic problems that arise due to the presence of asymmetric macroeconomic and financial shocks.

Despite claims of the optimal currency area, there is no effective single market in services, workers and capital. There is no mutual recognition of qualifications between member countries, no portability of pension rights, wage rigidities, while despite the presence of a capital markets union, European markets are far from being integrated. In response to the Global Financial Crisis (GFC) and the banking crisis that pushed toward this direction, the EU set up the European System of Financial Supervision (EFSF). The EFSF comprises the European Systemic Risk Board (ESRB), with its aim to mitigate systemic risk and the three European Supervisory Authorities (ESA) to incentivise banking, financial and pension institutions from taking excessive risks.[18] Additionally, the European Stability Mechanism (ESM) set up to preserve financial stability and provide financial assistance in order to bail out banks in distress,[19] and the Securities Market Program (SMP) to ensure liquidity in malfunctioning segments of the bond markets, where transactions had a significant effect on bond prices. European bond markets are complicated by different insolvency laws across member countries, which implies that the lack of a unified European corporate bond market raises costs for companies, deters investors and holds down liquidity that funds growth activities. That makes EMU members rely solely on a combination of market forces (labour and capital mobility) and structural funds to achieve long-run convergence of per capita GDPs.

This policy, however, has been unsuccessful. Instead, we have seen an agglomeration effect, where the wealthier areas attract capital and skills (Akiba and Iida, 2009). According to Connolly and Whittaker (2003), the euro has enabled fiscally-lax governments to gain from core countries' reputation for fiscal and monetary prudence, implying that the membership in the EMU 'club' dilutes the financial discipline that would be faced by an independent government and makes it more likely that some governments will succumb to this pressure. We argue that certain policies are needed to escape the liquidity trap, either by unconventional monetary policies or a strong fiscal stimulus. ECB's slow response towards quantitative easing (QE) is evidence that it is the wrong bank for this role. To be exact, it is the wrong mechanism.

QE is an unconventional form of monetary policy, where the central banks create new money electronically to buy financial assets, such as government bonds. This will raise the prices of financial assets and lower their yields with the hope to increase private sector spending and lower the returns to savings. In our analysis above we introduced TARGET2 capital flows, instead of national debt. The reason was that a country's national debt to Eurozone governments is the sum of its government bonds held by other Eurozone national central banks plus the TARGET2 liability of its national central bank.[20] According to Blake (2018), QE operates like that: QE is principally implemented by the National Central Banks which purchase their own government bonds in proportion to their capital key, which is the proportion to the NCB's share in the capital of the ECB. The ECB sets collateral standards for refinancing the QE purchases, but has weakened those to enable the peripheral NCBs to continue providing liquidity. In fact, when the quality of available collateral became so poor, the ECB allowed NCBs to extend Emergency Liquidity Assistance (ELA).[21] This is how and why the TARGET2 imbalances grew high. When a peripheral bank was making a loan to a consumer to import from a core country, the bank could use that loan as a collateral for a new loan to another consumer wishing also to import from a core country. This implies that at a certain point of time, TARGET2 debits are liquidity created in one part of the Eurozone to finance the acquisition of goods imported from another part of the Eurozone.[22]

[16] Or forced to do so.

[17] With focus on restricting members from running budget deficits exceeding 3% of their GDP with a fine of 0.5% of their GDP if they do so, or having national debts exceeding 60% of their GDP.

[18] Namely, these are the European Banking Authority (EBA), the European Securities and Markets Authority (ESMA) and the Insurance and Occupational Pensions Authority (EIOPA).

[19] In September 2012, the ECB introduced the program of Outright Monetary transactions (OMT) under which it makes purchases or outright transactions in the secondary market of bonds issued by Eurozone members, with the aim to safeguard an appropriate monetary policy transmission and the singleness of the monetary policy or to rescue ailing Banks. The ESM was originally formed as an alternative for Eurobonds and was introduced when core countries objected bailing out peripheral countries.

[20] Owed to ECB.

[21] That meant that the NCB approved the collateral, where the NCB carried the risk rather than pooling them via the ECB.

[22] Similar is our story of one wine trader and one potato seller who was alcoholic. Both of them carried one coin and on their way to town the potato seller was buying wine from the wine trader and keep borrowing from the same coin again and again. The coin was in a physical form. However, that does not mean that the debt has been repaid. Like the Target 2 mechanism, the coin was exchanging hands when the wine seller was giving the coin in the potato seller palm. The potato seller still has his potatoes to sell, pay his debt and buy food for his family. So the problem is not the medium. In the Eurozone case, a core country is the wine trader who does not eat potatoes.

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The question goes like this: Is TARGET2 bailing out the Euro? The answer is you bail out the Eurozone economy. You cannot bail out the medium (e.g., the currency). This is evident from our 3D graphs. However, that is happening temporally, because the trough ends (Fig. 1) and a new crisis arrives at the gates. This is what our stress tests for Eurozone indicate. TARGET2 has allowed core countries to repatriate capital and convert private claims into sovereign claims, thus mitigating the impact of crisis (Fig. 2). Governments did use the TARGET2 mechanism to finance deficits, through borrowing from commercial banks by selling them short-term T-bills. The debts of the TARGET2 mechanism are effectively being mutualised across Eurozone members. Under the EBU, bank rescues would include Private Sector Involvement (PSI), including depositors, shareholders and junior bondholders who share the burden alongside taxpayers. To this end, the European Commission has pushed for the harmonisation of national insolvency laws and a further tightening of the state aid rules.

Another question remains: is there a solution to this spiral or a vicious cycle of rising TARGET2 imbalances? Can we keep the mechanism afloat? The answer is in the affirmative, and the solution is twofold. First, EMU members should work on the strengthening of the long-term sustainability structural funds and secondly, they should work on empowering a short-term shock absorption mechanism that will preserve TARGET2 as a counter-cyclical effect on the next crisis.

Specifically, empowering the European Commission Investment Plan for Europe, which is known as the EU Infrastructure Investment Plan,[23] with the aim to unlock public and private investments in the real economy. As research from Apergis and Apergis (2018) indicates, infrastructure investments[24] are endogenous to economic growth and the margin from investing in countries with already advanced infrastructure is non-existent compared to the massive return on investments from investing in countries with low infrastructure. For instance, in a country like Greece,[25] we observe that from the total of 75 infrastructure and innovation projects requested funding across all Eurozone countries, 49 of them were requested by Greece alone. That corresponds to 65.3% of the total Eurozone needs that still need to be met, thus, ranking the country first in the European Fund for Strategic Investment per GDP. How can we possibly speak about optimal currency area and convergence when the infrastructure disparities are so high? Currency alone will reflect this heterogeneity in the business cycles process and the subsequent disparity in infrastructure funding. By unlocking the tap in infrastructure periphery countries can finally exploit their competitive advantage and reverse the financial flows of TARGET2 by mitigating any imbalances. This can happen when firms find the prerequisite infrastructure to facilitate their operations, thus, minimizing the impact of the next crisis and acting as the long awaiting need for a fiscal union.

Overall, we have come to these conclusions, because the TARGET2 system assists by mitigating the impact of the next financial crisis on the Eurozone. Yet, the imbalances might not be enough to keep the mechanism from preventing the next crisis from occurring. As a result, we need to fix these imbalances, while keeping the mechanism operating at full capacity and help to reduce the effects of another crisis.

Acknowledgements

The authors wish to thank an anonymous referee for his/her valuable comments and suggestions that enhanced the merit of this work. Special thanks also go to the Editor who gave them the opportunity to revise their work.

Appendix A

See Table 1A and Fig. A1.

Table 1A
Descriptive statistics.

Variables used	Kurtosis	Skewness
Price indexes or Eurozone countries and more		
FRANCE CAC 40 - PRICE INDEX	−0.63	0.55
DAX 30 PERFORMANCE - PRICE INDEX	−0.89	1.46
FTSE 100 - PRICE INDEX	−0.36	0.48
ATX - AUSTRIAN TRADED INDEX - PRICE INDEX	−0.78	0.73
BEL 20 - PRICE INDEX	−0.88	0.96
ATHEX COMPOSITE - PRICE INDEX	−0.22	−0.13
OMX TALLINN (OMXT) - PRICE INDEX	0.28	0.63
OMX HELSINKI 25 (OMXH25) - PRICE INDEX	−0.52	−0.16
ISEQ 20 - PRICE INDEX	−0.75	0.62
FTSE MIB INDEX - PRICE INDEX	−0.16	−0.09
OMX RIGA (OMXR) - TOT RETURN IND	−0.35	0.64
OMX VILNIUS (OMXV) - TOT RETURN IND	0.60	2.39
LUXEMBOURG SE LUXX - PRICE INDEX	−0.82	0.56

[23] Its purpose is to invest in infrastructure needs in Eurozone and start-up companies.
[24] Including infrastructure in energy utilities, motorways, railway, renewable, pipeline, port, airport, LNG terminals, waste treatment etc. on conditions that they will be under public-private partnerships (3Ps) or concession license and not state-owned enterprises.
[25] And we invite the readers to do the same for every Eurozone country.

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Table 1A (*continued*)

Variables used	Kurtosis	Skewness
MALTA SE MSE - PRICE INDEX	0.72	1.07
AEX INDEX (AEX) - PRICE INDEX	−0.83	0.41
PORTUGAL PSI-20 - PRICE INDEX	0.05	−0.50
SX SAX 12 SHARE PRICE INDEX (EP) NADJ	1.18	2.40
IBEX 35 - PRICE INDEX	−0.09	−0.76
Unemployment rates of Eurozone countries and more		
BD UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.09	−1.31
LX UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	−0.45	0.32
FN UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	−0.82	−0.22
EO UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.64	−0.04
IR UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.37	−1.54
BG UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	−0.56	−0.74
PT UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.34	−0.93
OE UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	−0.38	−1.01
IT UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.31	−1.24
GR UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.52	−1.52
SJ UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.26	−0.81
FR UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.03	−1.08
NL UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.33	−1.01
SX UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.13	−0.99
ES UNEMPLOYMENT RATE, ALL PERSONS (AGES 16 AND OVER)	0.15	−1.56
IT UNEMPLOYMENT RATE, ALL PERSONS (AGES 15 AND OVER)	0.31	−1.24
LN UNEMPLOYMENT RATE (AR)	0.03	−0.97
CP LABOUR MARKETS: UNEMPLOYMENT RATE NADJ	0.68	−1.17
ECB main rate		
ECB MAIN RATE ANNOUNCEMENT DAY - MIDDLE RATE	0.41	−1.07
Euribor rate		
EK 3-MONTH EURIBOR NADJ	0.40	−1.11
Inflation rate		
IT CONSUMER PRICE INDEX – HARMONISED	7.64	57.50
LX CONSUMER PRICE INDEX - HARMONISED	5.11	37.17
EO CONSUMER PRICE INDEX - HARMONISED	7.12	52.27
ES CONSUMER PRICE INDEX - HARMONISED	0.79	11.65
BG CONSUMER PRICE INDEX - HARMONISED	6.09	43.27
FR CONSUMER PRICE INDEX - HARMONISED	1.19	7.59
IR CONSUMER PRICE INDEX - HARMONISED	−4.77	22.87
OE CONSUMER PRICE INDEX - HARMONISED	−6.53	46.03
FN CONSUMER PRICE INDEX - HARMONISED	5.11	39.42
GR CONSUMER PRICE INDEX - HARMONISED	4.75	27.76
BD CONSUMER PRICE INDEX – HARMONISED	−1.01	16.12
NL CONSUMER PRICE INDEX – HARMONISED	−6.44	45.08
PT CONSUMER PRICE INDEX - HARMONISED	6.24	43.88
SJ CONSUMER PRICE INDEX - HARMONISED	−3.68	23.40
SX CONSUMER PRICE INDEX – HARMONISED	−7.18	53.33
Eurozone GDP growth rate		
FN GDP (\%QOQ)	−2.64	13.88
GR GDP (\%QOQ)	−0.45	0.32
FR GDP (\%QOQ)	−1.78	5.39
PT GDP (\%QOQ)	−0.85	0.44
BD GDP (\%QOQ)	−2.72	13.34
IT GDP (\%QOQ)	−1.58	3.73
NL GDP (\%QOQ)	−1.85	8.05
BG GDP (\%QOQ)	−1.49	5.41
OE GDP (\%QOQ)	−0.80	1.10
ES GDP (\%QOQ)	−1.02	−0.11
IR GDP (\%QOQ)	3.75	21.46
SX GDP (\%QOQ)	−3.31	22.13
Exchange rates		
JAPANESE YEN TO EURO (WMR) - EXCHANGE RATE	−0.60	0.08
CHINESE YUAN TO EURO (WMR) - EXCHANGE RATE	−0.08	−0.32
US \$ TO EURO (WMR\ DS) - EXCHANGE RATE	−0.03	−0.53
UK £ TO EURO (WMR\ DS) - EXCHANGE RATE	1.61	5.34
SOUTH AFRICA RAND TO EURO (WMR) - EXCHANGE RATE	1.25	1.81
RUSSIAN ROUBLE TO EURO (WMR) - EXCHANGE RATE	2.43	11.36
INDIAN RUPEE TO EURO (WMR) - EXCHANGE RATE	0.01	−0.37
NEW TURKISH LIRA TO EURO (WMR) - EXCHANGE RATE	2.95	11.80
SWISS FRANC TO EURO (WMR) - EXCHANGE RATE	−2.03	7.33
NORWEGIAN KRONE TO EURO (WMR) - EXCHANGE RATE	1.31	2.67

(*continued on next page*)

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Table 1A (*continued*)

Variables used	Kurtosis	Skewness
SOUTH KOREAN WON TO EURO (WMR) - EXCHANGE RATE	0.19	0.25
SAUDI RIYAL TO EURO (WMR) - EXCHANGE RATE	−0.02	−0.54
CANADIAN \$ TO EURO (WMR) - EXCHANGE RATE	0.13	0.05
BRAZILIAN REAL TO EURO (WMR) - EXCHANGE RATE	1.50	3.64
Oil price is US dollars		
OPEC Oil Basket Price U\$/Bbl	−0.53	0.85
Volatility index		
VDAX-NEW VOLATILITY INDEX - PRICE INDEX	2.27	7.10
EM FINANCIAL DERIV ASSETS (NET, MARKED TO MKT), SWAPS, MON AUTHS	6.98	50.67
GDP growth rates of countries with trade links with EU		
CH GDP (\%QOQ)	−1.05	−0.76
US GDP (\%QOQ)	−1.64	4.69
JP GDP (\%QOQ)	−1.77	6.91
SA GDP (\%QOQ)	−0.71	0.92
IN GDP (\%QOQ)	0.48	−0.60
RS GDP (\%QOQ)	−0.94	−0.67
TK GDP (\%QOQ)	−0.52	−1.20
SW GDP (\%QOQ)	−1.13	2.35
NW GDP (\%QOQ)	0.11	0.44
KO GDP (\%QOQ)	−1.65	8.65
UK GDP (\%QOQ)	−2.19	6.18
BR GDP (\%QOQ)	−0.99	1.33
CN GDP (\%QOQ)	−1.74	5.15
10-year long term government bond yields		
BG	3.66	21.09
OE	4.23	25.90
FR	4.86	30.81
BS	−4.68	26.97
GR	1.21	3.84
IR	1.22	4.48
IT	1.08	4.61
NL	6.83	49.57
PT	−0.09	0.11
ES	−0.00	0.25
US	0.94	1.64
UK	1.24	6.45
CN	0.94	2.77
JP	−7.21	52.77
Target 2 balances for Eurozone countries		
IT TARGET2 BALANCES (AVERAGE)	−2.19	9.35
OE TARGET2 BALANCES (AVERAGE)	7.68	58.00
LX TARGET2 BALANCES (AVERAGE)	−3.20	17.92
BG TARGET2 BALANCES (AVERAGE)	0.39	4.81
IR TARGET2 BALANCES (AVERAGE)	2.09	11.27
BD TARGET2 BALANCES (AVERAGE)	−2.33	19.22
NL TARGET2 BALANCES (AVERAGE)	7.67	57.80
FN TARGET2 BALANCES (AVERAGE)	−7.55	56.65
GR TARGET2 BALANCES (AVERAGE)	4.15	18.58
PT TARGET2 BALANCES (AVERAGE)	1.63	7.14
ES TARGET2 BALANCES (AVERAGE)	−7.46	55.67
FR TARGET2 BALANCES (AVERAGE)	0.66	16.78
Credit Default Swaps Spreads – 10 year premium for Eurozone Countries		
IT CDS spread	5.10	1.98
OE CDS spread	−0.36	0.90
LX CDS spread	.	.
BG CDS spread	.	.
IR CDS spread	2.68	1.44
BD CDS spread - base country	0	0
NL CDS spread	.	.
FN CDS spread	.	.
GR CDS spread	0.18	1.37
PT CDS spread	2.63	1.51
ES CDS spread	10.13	2.84
FR CDS spread	−0.20	0.92
CY CDS spread (added to compensate for lack of data for LX, BG, NL & FN)	4.92	1.86
SL CDS spread (added to compensate for lack of data for LX, BG, NL & FN)	10.13	2.84

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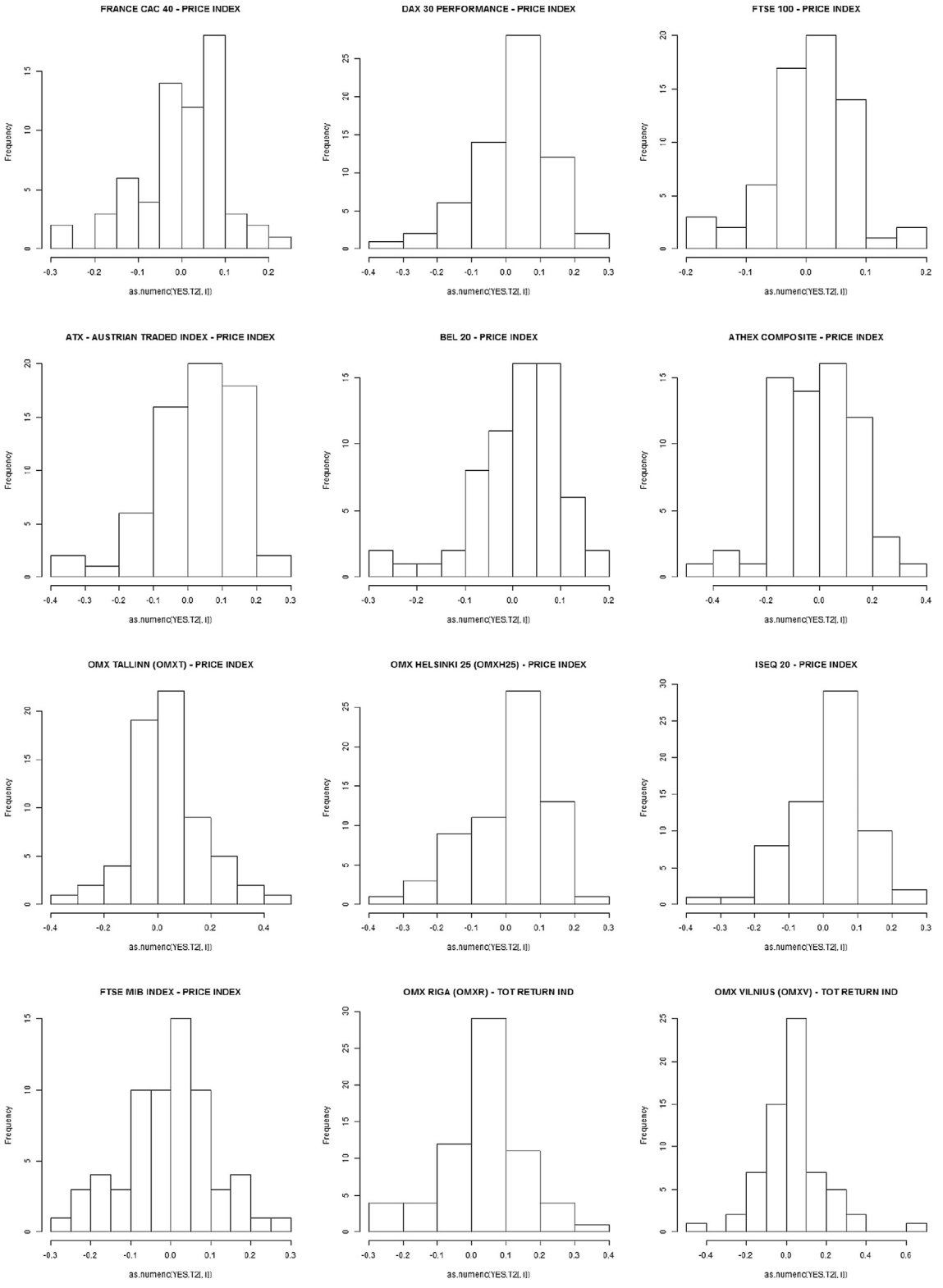

Fig. A1. Distributions of variables.

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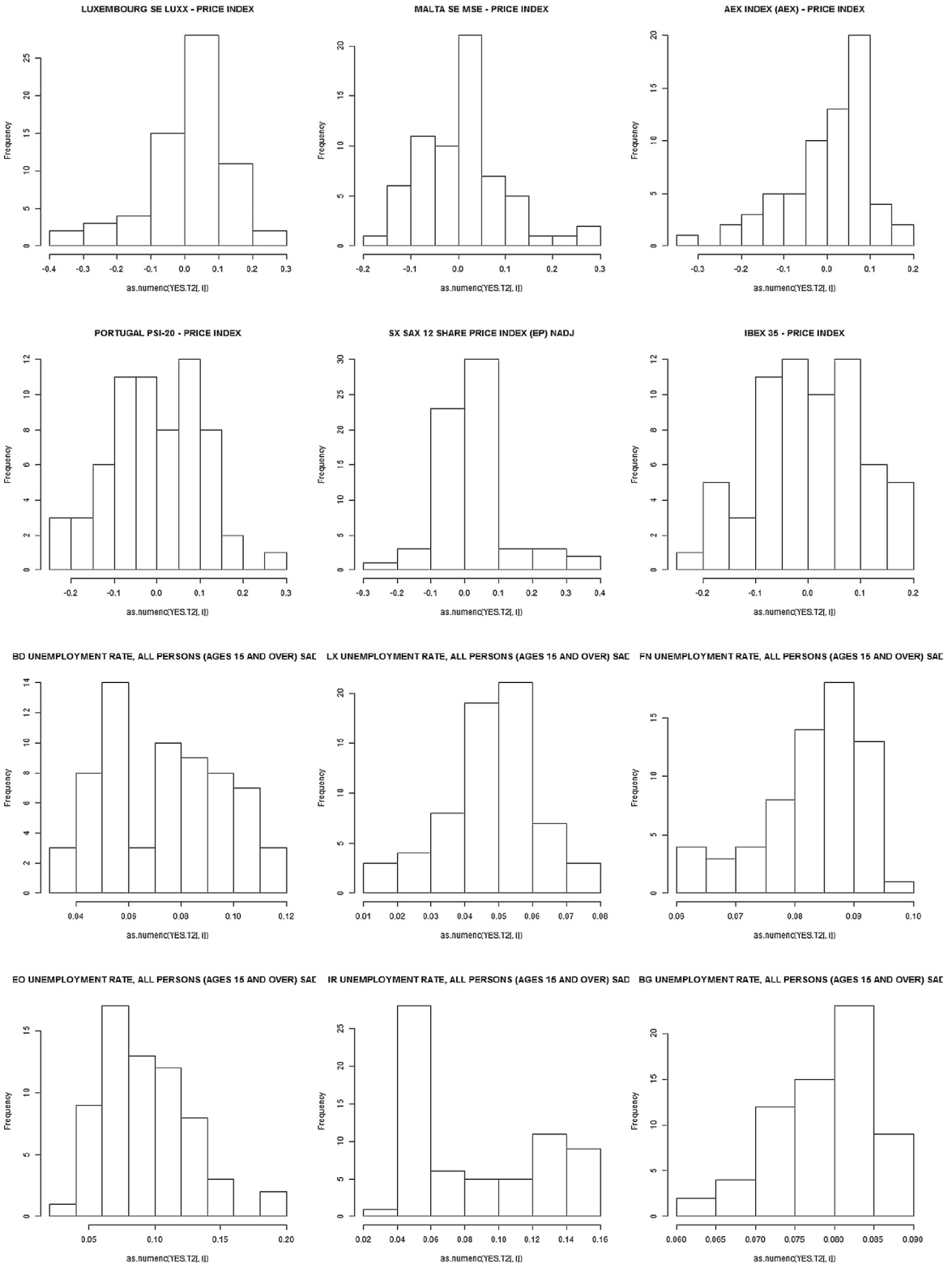

Fig. A1 (*continued*)

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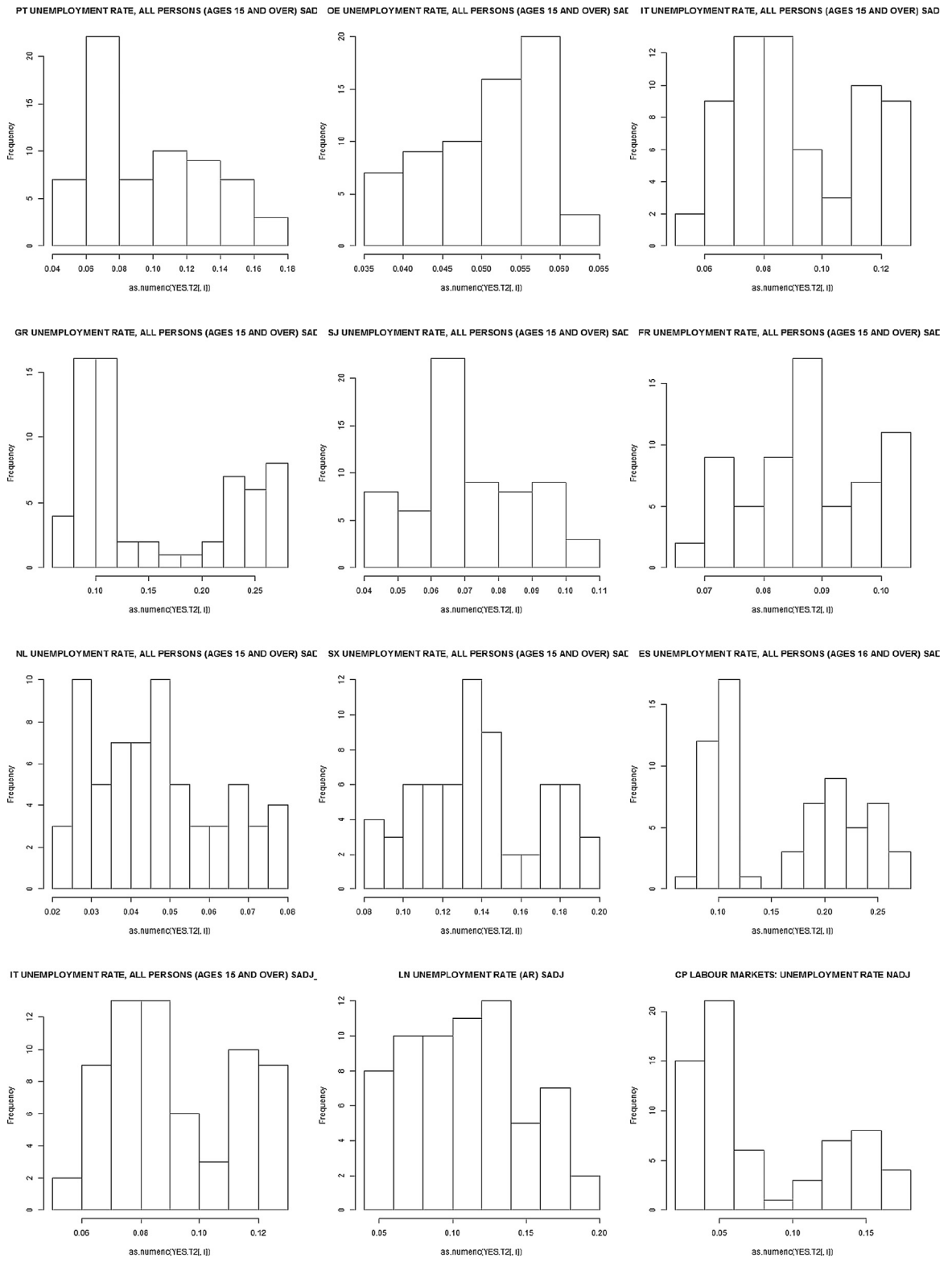

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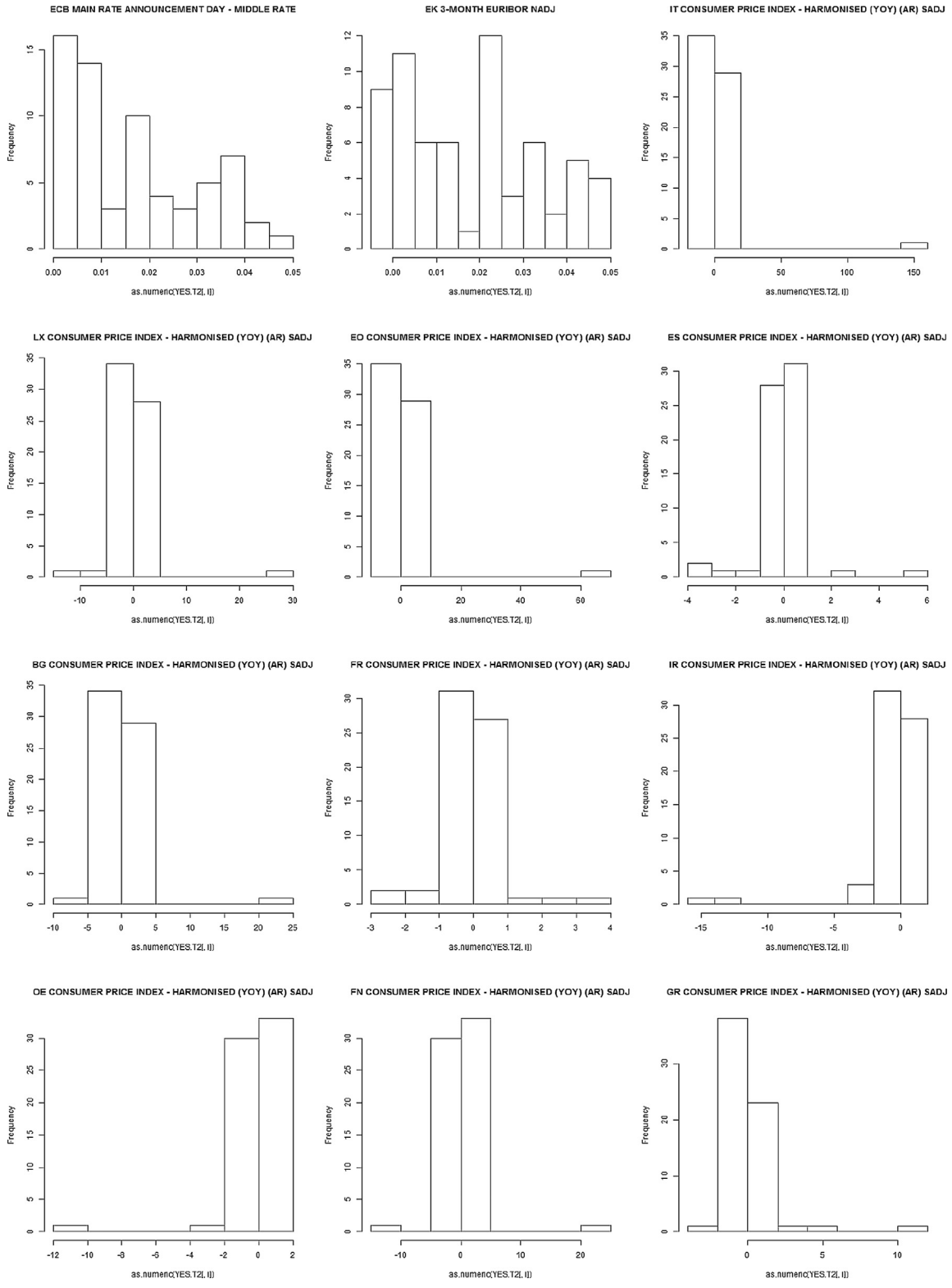

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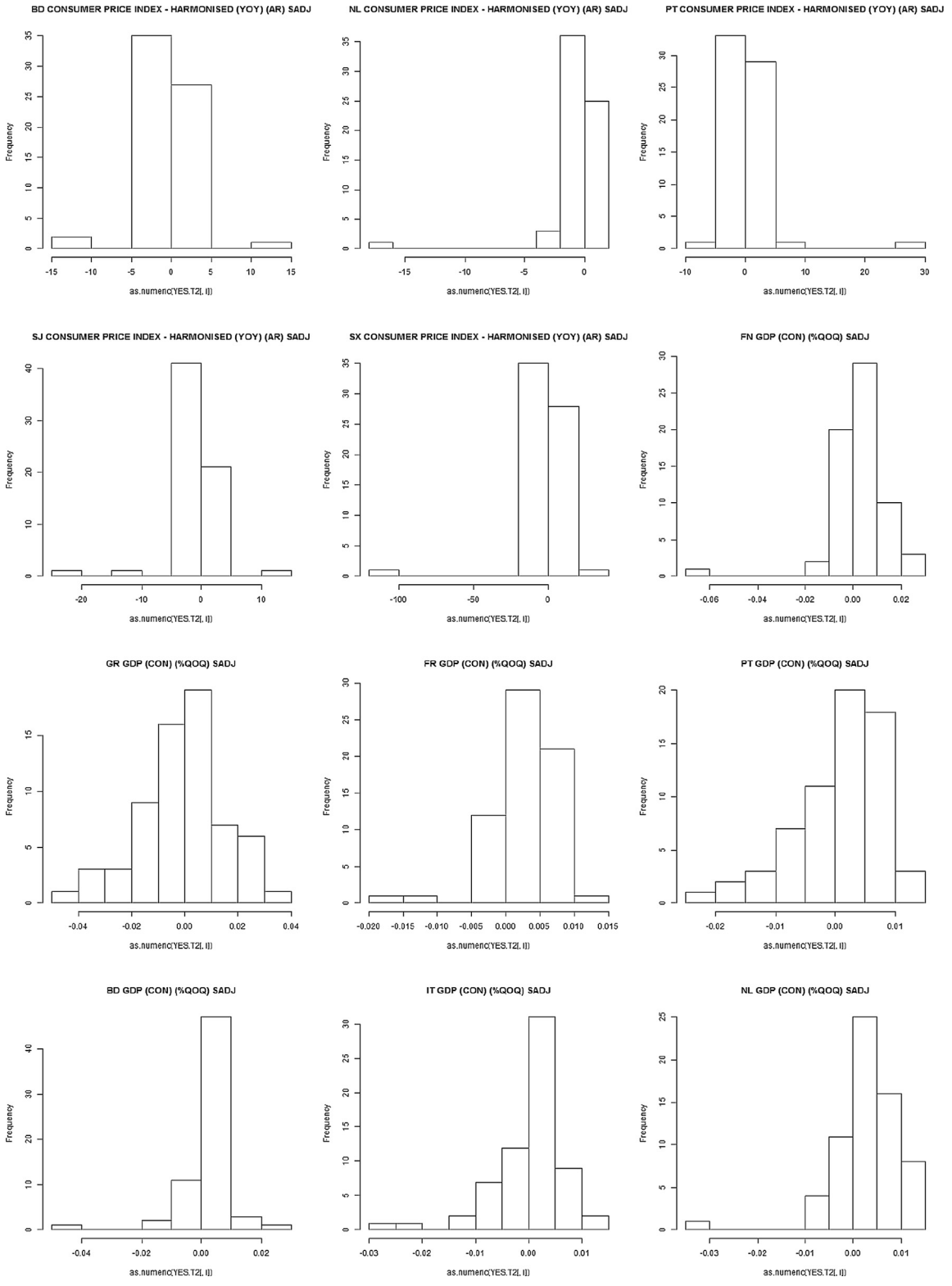

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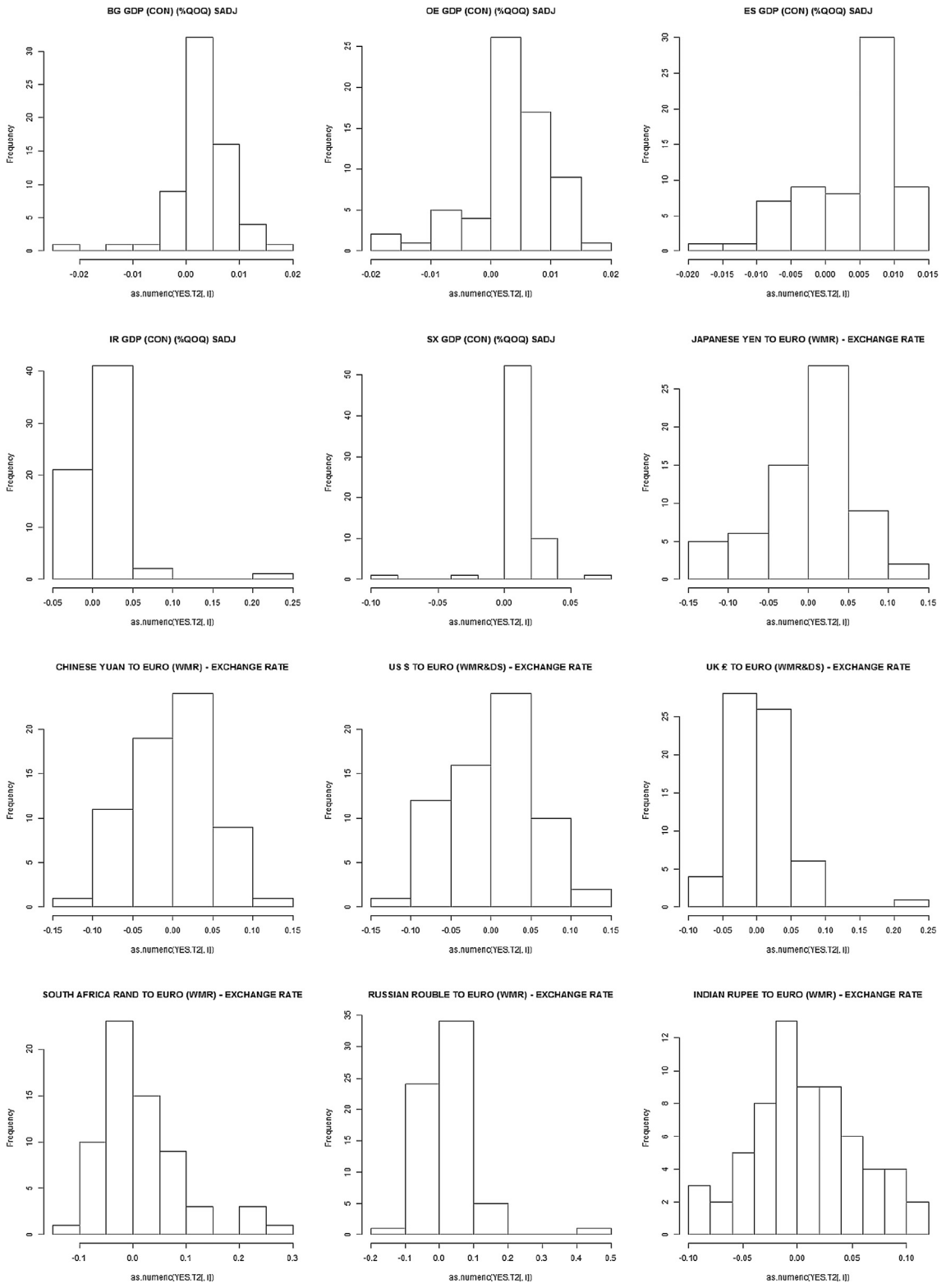

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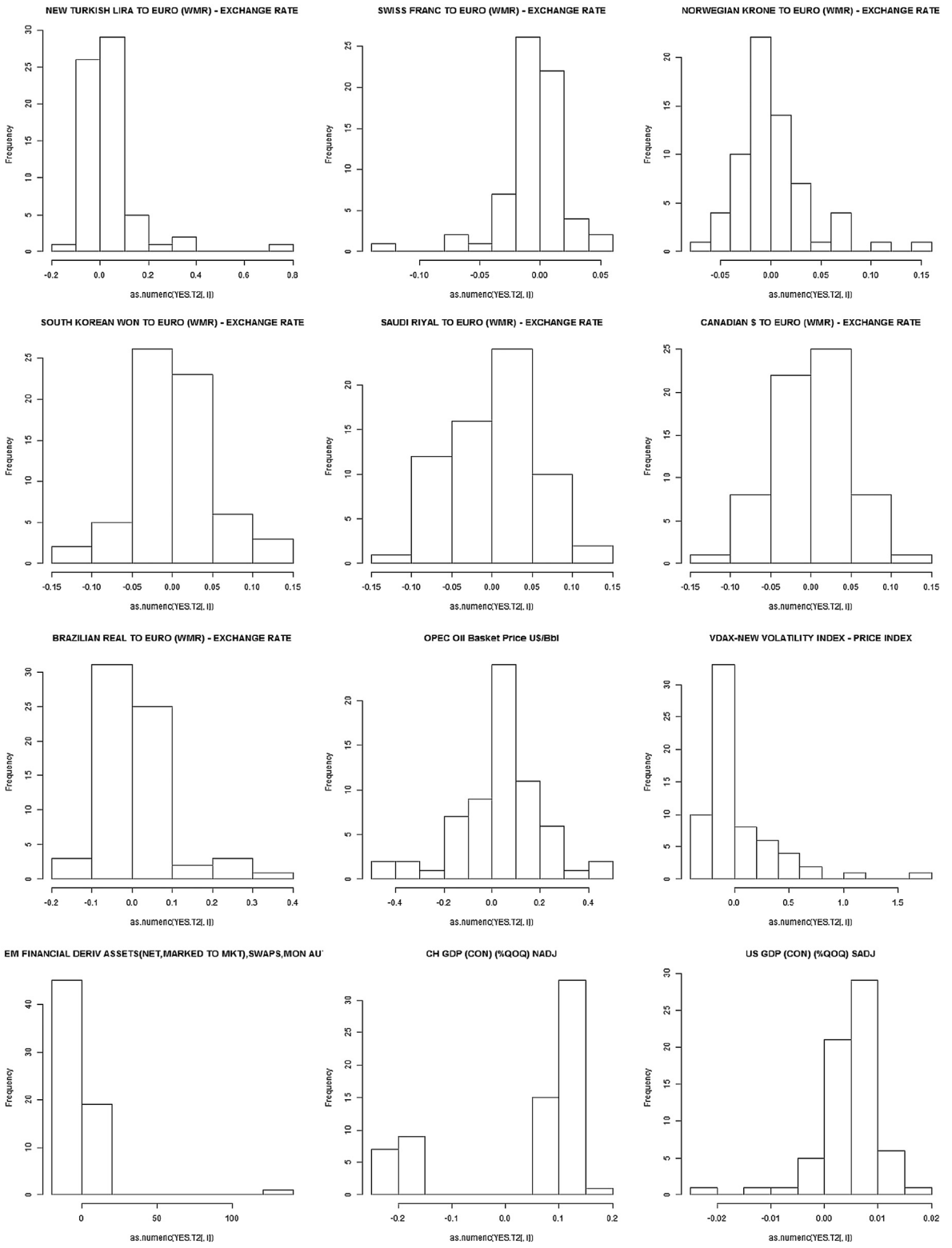

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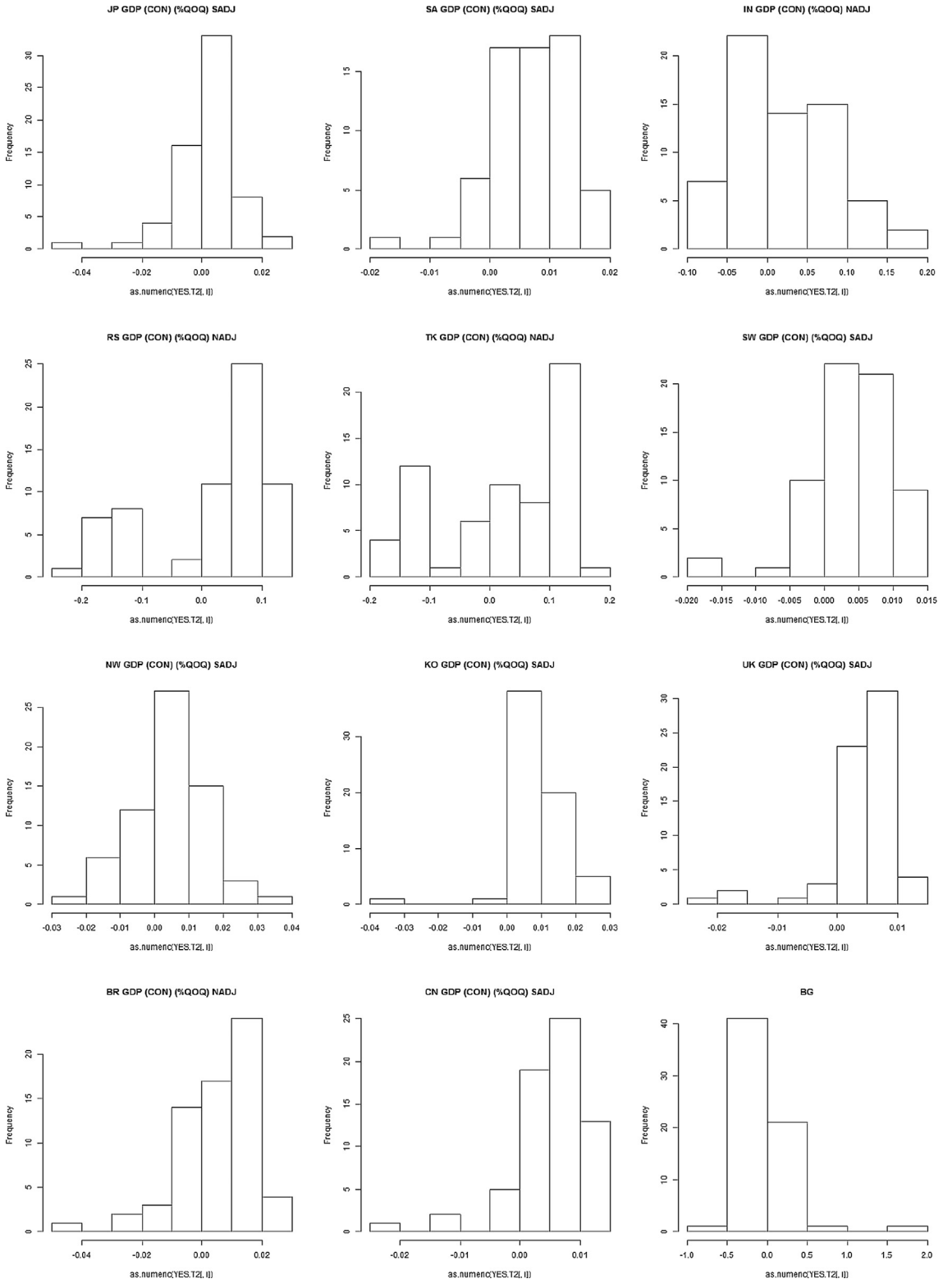

Fig. A1 (*continued*)

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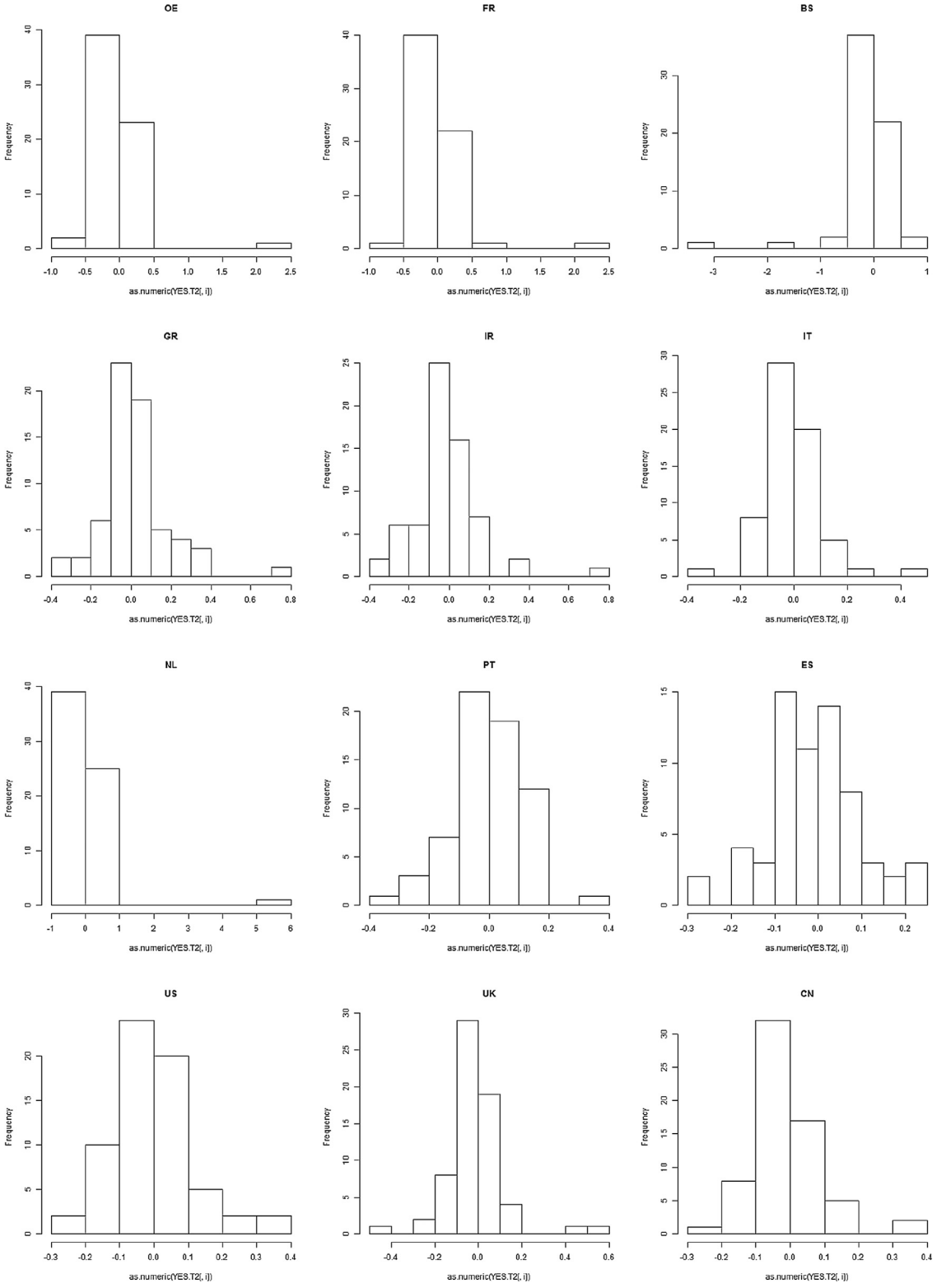

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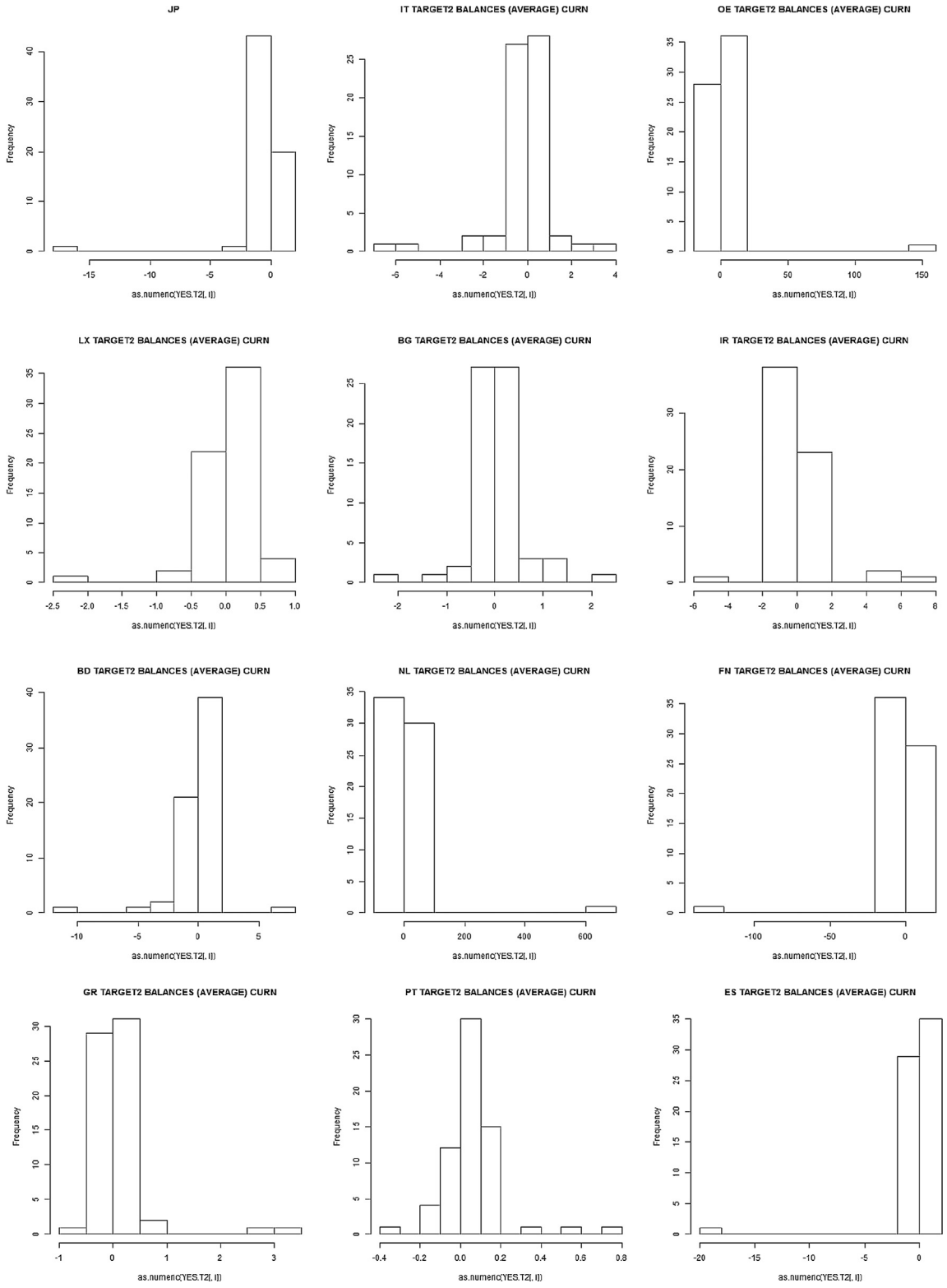

Fig. A1 (*continued*)

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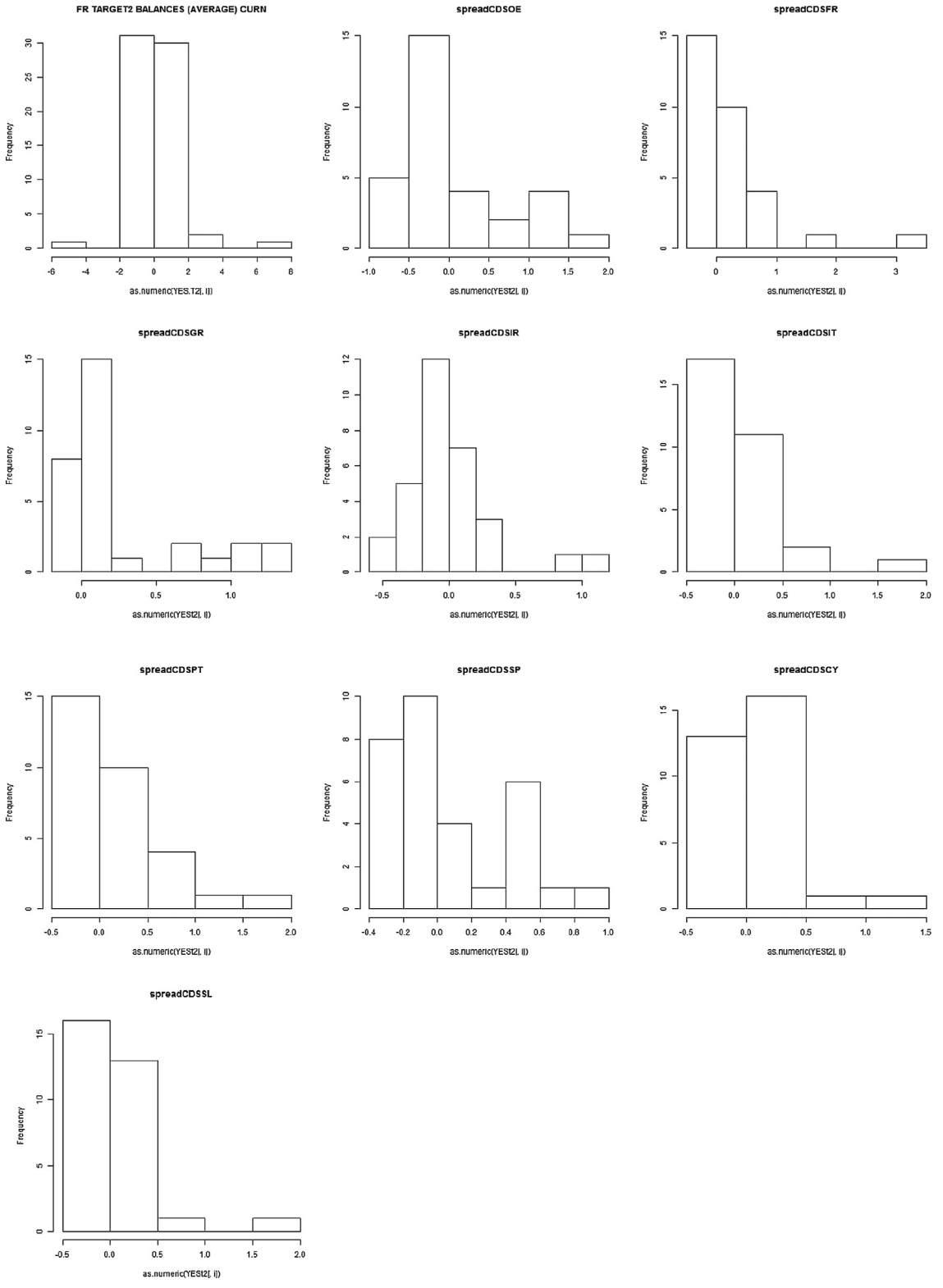

Fig. A1 (*continued*)

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Please cite this article as: E. Apergis, I. Apergis and , A new macro stress testing approach for financial realignment in the Eurozone, Journal of International Financial Markets, Institutions & Money, https://doi.org/10.1016/j.intfin.2019.02.002