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Debt Finance and Economic Activity in the Euro-Area: Evidence on Asymmetric and Maturity Effects

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Keywords

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JEL Classification

E3, E4, G1

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DEBT FINANCE AND ECONOMIC ACTIVITY IN THE EURO-AREA: EVIDENCE ON ASYMMETRIC AND MATURITY EFFECTS

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I. INTRODUCTION

The introduction of a common currency in Europe in the late 1990s marked the beginning of a new stage in the development of the continent's monetary and financial integration. Since then the financial landscape in Europe has undergone some dramatic changes. Two major financial crises have inflicted a heavy toll on the banking sector throughout Europe, forcing many banks to downsize. At the same time, the corporate bond market has made significant strides as an alternative source of credit relative to bank-intermediated credit. This is a clear indication that non-financial firms in particular have increasingly turned to open-market credit. In September 2017, the total volume of corporate bonds outstanding amounted to more than € 6.12 trillion. Of the total, the share of bonds issued by non-financial corporations was 29.4 percent or € 1.8 trillion, a three-fold increase over a 10-year period. The sustained gains in developing a deeper corporate bond market in Europe have not been spread evenly across the continent, however. The corporate bond market remains heavily fragmented along national lines and is concentrated in the larger economies of France, Netherlands, Germany, and Italy.[1]

Two important factors have facilitated the ongoing transition from a bank-centric to a more heterogeneous provision of debt finance in Europe. First, in the aftermath of the Global Financial Crisis during the Sovereign Debt Crisis, banks became more cautious in their lending practices, forcing non-financial firms to tap the bond market to secure external funding. In 2009 bond-finance by non-financial corporations rose by more than 50 percent compared to 2008 (from slightly less than € 100 billion to approximately € 160 billion). In 2012 net issuance of bonds by non-financial corporations rose to more than € 250 billion, an increase of more than € 100 billion compared to 2011, and exceeded the € 200 mark in every year through to 2016.[2] Second, non-financial firms have been accessing credit increasingly through bonds because bond finance has become cheaper than bank-intermediated credit since the ECB

[1] Report from the Commission Expert Group on Corporate Bonds (2017).

[2] Ibid. For a recent paper that documents the increasing importance of the bond market in Europe through a micro lens see Darmouni and Papoutsi (2021). They report a somewhat lower volume of bonds outstanding in 2018 at € 1.4 trillion based on data from Capital IQ. According to their analysis of the sample firm-level data, the average bond share in total debt rose from 10 to 24 percent in Europe over the 2002-2018 period. Berg et al. (2019) review differences between the US and European corporate bond markets and conclude that European firms rely far more on bank loans and take on debt with longer maturity than their US counterparts.

began its systematic easing of monetary policy. Kaya et al. (2014) document that the corporate bond market has periodically absorbed up to one third of the demand for credit as banks have retrenched and begun charging higher borrowing rates in the process. The substitution away from bank towards open-market credit reached unprecedented levels in the wake of the two financial crises that hit Europe in 2008 and 2011. The retrenchment of European banks continued in subsequent years while the bond market continued to expand. A key question is whether this marked shift in external debt finance – the substitution of bond for loan finance – was a seamless process across the Euro area without adverse consequences for aggregate production and capital spending. Answering this and related questions is what motivates this paper.

Most of the existing empirical literature on external debt finance applies a micro lens and studies firm-level data. Gambacorta and Marquez-Ibanez (2011), Jiménez et al. (2014), Adrian, Colla, and Shin (2013), Becker and Ivashina (2014), and Grosse-Rueschkamp et al. (2019)) examine credit conditions using micro panel data. Of these earlier studies, the last three are particularly relevant as they examine the debt (credit) substitutability hypothesis in US and European micro data. The studies by Adrian et al. and Becker support the view that distressed firms with access to both loan and bond facilities switch from bank loans to bonds during economic downturns in the United States. Grosse-Rueschkamp et al. trace the implications of the quantitative easing programme of the European Central Bank (ECB). They find that its targeted asset purchases of corporate bonds lowered yields to such an extent that non-financial corporations began to rely less on bank loans and more on bonds. Indeed through its actions the ECB eased the leverage constraints of banks, thereby enabling banks to offer loans to otherwise non-eligible firms.

There is, however, no consensus in the empirical literature on the substitutability hypothesis between bank loan and bond finance. Other recent micro data-based studies by Goel and Zemel (2018), Fernandes et al. (2018), and Serena and Tsoukas (2020) cast doubt on the notion that the loss of bank credit is made up by increases in bond finance. Using US data over the 1988-2011 period, Goel and Zemel find that a large majority of publicly traded firms could not access the bond market as bank loans dried up during four crises, and were thus heavily exposed to the vagaries of the banking sector. Casting a wider net by also considering non-bank loans in addition to bonds as alternatives to bank loans and institutional details

germane to financial contracting, Fernandes et al. report that during the 2007-09 crisis period, the reduced supply of bank loans was partially compensated by an increase in private non-bank loans in 34 countries. This effect was particularly strong in countries with substantial creditors' rights protection. Serena and Tsoukas provide evidence that in the wake of tighter bank capital requirements in Europe in 2011 and 2012, US firms' access to cross-border bank loans (from EU banks) shrank mainly because of cuts in credit lines. Additional funding by non-bank financial institutions rather than bond financing helped soften the impact of reduced bank lending by European banks.

A comprehensive empirical investigation of the evolving bond market in the Euro area by Darmouni and Papoutsi (2021) challenges the substitutability of bond for bank finance altogether. They find that the growth of the bond market has been spurred by the entry of new *unrated* firms that are smaller in size than their established counterparts. Rather than substituting away from loans, these growth-orientated firms use the bond financing facility primarily to increase their leverage to finance additional capital spending.

Our interest in this paper centers on exploring whether the movements in aggregate financial information variables conform to the substitutability hypothesis between bank and market debt. We thus shift the debate on the plausibility of the substitution hypothesis from a microeconomic to a macroeconomic level. Beginning with Stock and Watson (1988), Friedman and Kuttner (1992), Kashyap, Stein, and Wilcox (1992) (KSW), studies of aggregate credit conditions in a macroeconomic context have focused on the information content of aggregated financial variables for future economic activity.[3] In this paper, we follow this approach and limit our focus to aggregate data. We take a closer look at the sources and composition of external debt finance in ten countries of the Euro area since the early 2000s. Our intent is to analyse how both the price and provision of bank-financed and bond-financed credit have varied over time and shaped the business cycle in the countries in question. The paper adopts the time-honoured practice of using aggregate financial indicator variables to capture exploitable information inherent in the dynamic behaviour of the loan and bond markets. Owing to their signalling properties, price- and quantity-based financial information

[3] Subsequent contributions that employ and/or extend this methodology are by Stock and Watson (2003), Meeks (2012),Gilchrist and Zakrajšek (2012), Krishnamurthy and Muir (2015), Lòpez-Salido et al. (2017), Bernanke (2018), to name but a few.

variables are employed to measure shifts in risk sentiments amongst financial market participants and their likely consequences for economic activity.

Our paper contributes to the literature that explores the effect of changing conditions in different segments of the credit market and their potential ramifications for aggregate economic activity in the center and the periphery of the Euro area. Guender (2018) reports limited support for the notion that a cut in bank loan supply is accompanied by an increase in the quantity of bonds outstanding but finds no evidence that movements in a finance mix variable predict future real economic activity in the Euro area. In contrast, price-based measures of aggregate credit have substantially more explanatory power for future real economic activity than the quantity-based measures. Other papers take a more nuanced view of the role of credit in the macro economy and consider only aggregate credit spreads as financial indicators. Gilchrist and Mojon (2016) focus exclusively on aggregate bank and non-financial credit spreads derived from secondary bond prices in France, Germany, Italy, and Spain and check their information content for future real economic activity. Both types of credit spreads perform very well for France and Germany over the 1999-2013 sample period while for Italy and Spain only bank credit spreads contain useful information for future real economic activity. Saunders et al. (2021) challenge the view that the same financial frictions are at play in the loan and corporate bond market. They construct an aggregate loan market credit spread to capture frictions in the secondary syndicated corporate loan market. In their view, this particular spread reflects more accurately the stringent borrowing conditions faced by firms that cannot issue bonds in a credit squeeze. Their empirical findings reveal that the loan market credit spread dominates the forecasting ability of a corporate bond market spread for macroeconomic outcomes in the US, France, Germany, and Spain.

The current paper extends the literature on the credit substitution hypothesis along two different dimensions. First, our empirical analysis investigates the potential existence of asymmetric effects on aggregate economic activity brought about by changes in a risk premium or a finance mix. Towards this end, we dissect changes in the financial information variables to explore, for instance, whether an increase in the risk premium signals a subsequent decrease in economic activity while a decrease in the risk premium imparts little or no stimulus at all to economic activity. A similar analysis is carried out for changes in the finance mix. The second contribution of this paper lies in its examination of the connection

between changes in the maturity structure of debt finance and aggregate economic activity. We break down the maturity structure of outstanding credit quantities into short-term and long-term credit and distinguish between short-term and long-term borrowing cost to ascertain whether the short-term/long-term distinction has any material consequences for predictive content.[4] Our econometric analysis focuses first on the experience of individual countries as the structure and depth of credit market varies considerably across the European continent. We then compile a panel data set to verify a possible connection between financial information variables and economic activity in the 10 countries over the sample period.

Overall, the empirical evidence for the credit substitution hypothesis in 10 countries of the Euro area is mixed. Our empirical findings reveal that the predictive content of a simple credit spread for economic activity is one-sided. It is found almost exclusively in positive changes of the credit spread that reflect increasing credit risk and therefore signal a future slow-down in economic activity. The evidence for the asymmetric predictive power of the credit spread is particularly strong in pooled data where it is manifest in three credit spreads that differ by maturity. In country-specific time series regressions, positive changes in the long-term credit spread have high forecasting power for the turnover of capital goods in all but one of the countries included in this study. The predictive ability of the short-term credit spread is weaker by comparison but still observable in at least half of the countries. Taken altogether, the empirical findings lend weight to the notion that aggregate demand (and components thereof such as capital investment) is acutely sensitive to positive changes in credit spreads.[5] By contrast, we find no substantive evidence that changes in finance mixes, composed of short-term, long-term or total quantities of bonds and loans, have robust predictive power for changes in economic activity.

[4] The emphasis on asymmetric and term to maturity effects in the Euro area and consideration of both price- and quantity-based financial information variables sets our paper apart from Saunders et al. (2021) and Akinci and Queralto (2022). The latter report a closer negative correlation between quarterly GDP growth and positive (rather than negative) deviations in the corporate bond – government bond yield spread in the US and major European countries but they do not follow through with a closer empirical examination of the asymmetry. Neither do Gilchrist and Mojon(2016) who construct country-specific (and also Euro-area) indices of credit risk from the bottom-up where the yield on domestic sovereign bonds (or yield on German Bunds) is subtracted from the yield on corporate bonds.

[5] Our empirical findings support the theoretical insight that financial frictions impact economic activity. Gertler and Karadi (2011, 2013) or Curdia and Woodford (2011) emphasize that financial frictions give rise to the existence of interest rate spreads that drive a wedge between market-determined interest rates and the policy rate. Friedman (2013) introduces the long-term interest rate into the IS relation.

The structure of this paper is as follows: Section II presents a highly stylized model to rationalise the behaviour of banks, firms, and households in the face of worsening economic prospects. Section III introduces the simple time-series based forecasting framework used to examine the substitution hypothesis. Section IV extends the analysis to panel data estimation and discusses robustness checks. Section V offers a brief summary and conclusion.

II. THEORETICAL FRAMEWORK

In this section, we investigate the effect of changes in default risk on the absolute and relative size of the credit market. The framework we adopt bears similarities to the static model of debt finance proposed by Adrian, Colla, and Shin (2013) in that there is only one lending rate. It does, however, model the banking sector in a somewhat different fashion.

Previous theoretical contributions of debt finance such as Fiori and Uhlig (2011) assess the circumstances under which a firm opts for complete bank or complete open market debt financing. They do not focus on the debt composition issue which is central to our analysis. Crouzet (2018, 2021) addresses the substitutability of bond for bank loans in a richer dynamic model of debt choice where the scale of investment is itself endogenous. A prominent feature of his model is that bond financing is less flexible in bad times than financing through loans. Firms trade off the flexibility of bank loan contracts against the cheaper cost of bond financing. Darmouni and Papoutsi (2021) probe the composition of debt finance between bonds and bank loans from the perspective of a representative firm. Drawing on Holmstrom and Tirole (1997) and Crouzet (2018), they propose a model with a pledgeability friction and conclude that the share of bond finance is positively related to the cost of intermediation in the banking sector, risk appetite of bond investors, and lower downside risk.

Our set-up focuses instead on the suppliers of credit. The credit market is fed on the supply side by two sources.[6] Banks supply intermediated credit while households offer direct credit through the purchase of bonds from companies. The two suppliers of credit have

[6] A third source of funds would be the issuance of equity. Trade credit would be yet another source of funds. Neither source appears in the model which can accommodate the issuance of credit only through bank loans or bonds. Because the credit substitution hypothesis revolves mainly around bank loans and bonds, we limit attention to these two forms of (debt) finance in both the theoretical and empirical analysis.

different attitudes towards risk. While banks are risk-neutral, households are risk-averse. The recipients of bank credit and open-market credit invest the funds in projects that have a certain probability of failure. We posit a direct link between changes in market perceptions and the probability of projects failing. Such changes set a chain of events in motion. An increase of the probability of project failure prompts lenders to charge a higher risk premium and hence a higher lending rate. Changes in the risk premium change the composition of credit supply through opposite shifts in bank credit and household credit with only a secondary effect on credit demand.

We next sketch out the essential elements of the model.

A. *Banks*

Banks accept deposits (liabilities) and make loans (assets). Lenders use the loans to invest in projects, each of which has a probability of success equal to $1-\varepsilon$. In the event of a successful outcome, the bank receives the loan principal plus interest. A project fails with probability ε in which case the bank recoups only a fraction of the amount lent and, importantly, suffers a loss of reputation.[7] The latter is modelled as a cost to banks which increases in the probability of project default and is quadratic in banks' assets. Banks fund their lending with equity and interest-bearing deposits from households. A representative bank maximizes expected profit to determine optimal loan supply:

$$\max_{L} E[Profit] = (1-\varepsilon)(1+r)L + \varepsilon\lambda L - \frac{\phi(\varepsilon)}{2}L^2 - (1+r_D)(L-K) \qquad (1)$$

where r = lending rate, r_D = interest rate on deposits (riskless rate), L = loans, D = deposits , K = bank capital, $L=K+D$ = balance sheet constraint, $1-\varepsilon =$ probability of loan repayment, i.e. project success, λ = fraction of loan recovered in the event of borrower default $(0<\lambda<1)$, and $\phi(\varepsilon)$ = cost of loss of bank reputation in the event of borrower default with $\phi'(\varepsilon)>0$.

Solving the maximization problem yields the supply of bank credit:

[7] Banks may require the posting of collateral which may be retained in case a project fails and the borrower defaults. Substantial losses on the loan portfolio damage the reputation of the bank, decrease the confidence and trust in the bank's management and increase the likelihood of a bank run.

$$L = \frac{\pi + \varepsilon\lambda}{\phi(\varepsilon)} \tag{2}$$

$\pi = (1-\varepsilon)(1+r) - (1+ r_D)$ denotes the bank's interest rate margin. Loan supply is, ceteris paribus, increasing in the interest rate margin but inversely related to the cost of loss of reputation.

B. *Households*

Risk averse households have mean-variance preferences. They have a choice between holding safe demand deposits and a risky asset, bonds, which fund risky projects that succeed with probability $1-\varepsilon$ and fail with probability ε. To determine the optimal mix *w* in their portfolio, households, whose risk tolerance is denoted by *T,* solve the standard optimisation problem:

$$\max_{w} E(r_p) - \left(\frac{1}{2T}\right) V(r_p) \tag{3}$$

where $r_p = (1-w)(1+r_D) + wx$

x = pay-off on risky asset: $1+r$ with probability $1-\varepsilon$

0 with probability ε.

The expected return and the variance of return on a household's portfolio is given by

$$E(r_p) = (1-w)(1+r_D) + w(1-\varepsilon)(1+r) \qquad V(r_p) = w^2(1+r)^2\varepsilon(1-\varepsilon) \tag{4}$$

Substituting the expected return and the variance of return into equation (3) and carrying out the optimisation exercise determines the optimal weight on the risky asset in the portfolio, i.e. households' supply of credit in the form of bonds *w=B,*

$$B = \frac{T\big((1-\varepsilon)(1+r) - (1+r_D)\big)}{(1+r)^2\varepsilon(1-\varepsilon)}\,. \tag{5}$$

The risk premium is the expected return on the risky asset minus the return on the riskless asset (and equals the interest margin charged on loans by banks):

$$\pi = (1-\varepsilon)(1+r) - (1+r_D\,) \tag{6}$$

Equation (5) has a simple interpretation: the supply of direct household credit varies proportionately with the risk premium on bonds adjusted for risk.[8]

C. *Market Clearing Condition*

Combining equations (2) and (5) yields the total supply of credit in the economy:

$$C^S = L + B \tag{7}$$

The demand for credit C^D depends inversely on the risk premium.

$$C^D = C(\pi) \qquad \text{with } C'(\pi) < 0 \tag{8}$$

Setting credit supply equal to credit demand yields

$$L + B = C(\pi) \qquad \text{or} \tag{9}$$

$$\frac{\pi + \varepsilon\lambda}{\phi(\varepsilon)} + \frac{T\pi}{(1+\pi)^2\varepsilon/(1-\varepsilon)} = C(\pi) \tag{10}$$

where the definition of the risk premium (equation (6)) has been used to substitute for the interest rate and r_D has been set equal to zero.

Defining the excess supply of credit as $G(\pi, \varepsilon) = L + B - C(\pi)$, we can use the implicit function theorem to show that

$$\frac{d\pi}{d\varepsilon} = -\frac{\frac{\partial G}{\partial \varepsilon}}{\frac{\partial G}{\partial \pi}} = -\frac{\left(\frac{\partial L}{\partial \varepsilon} + \frac{\partial B}{\partial \varepsilon}\right)}{\frac{\partial L}{\partial \pi} + \frac{\partial B}{\partial \pi} - \frac{\partial C}{\partial \pi}}. \tag{11}$$

Partial differentiation yields $\frac{\partial L}{\partial \varepsilon} = \frac{1}{\phi(\varepsilon)}\left(\lambda - (\pi + \varepsilon\lambda)\frac{\phi'(\varepsilon)}{\phi(\varepsilon)}\right)$ $\quad \frac{\partial B}{\partial \varepsilon} = -\frac{\pi T}{\varepsilon^2(1+\pi)^2} < 0$

$\frac{\partial L}{\partial \pi} = \frac{1}{\phi(\varepsilon)} > 0$ $\quad \frac{\partial B}{\partial \pi} = -\frac{(1-\varepsilon)(\pi-1)}{\varepsilon(1+\pi)^3}$ $\quad \frac{\partial C}{\partial \pi} < 0.$

[8] Two simplifying assumptions need brief comment. Notice that the risk premium on bonds equals the interest margin charged by banks. To keep the current model analytically tractable, we can introduce only one "lending" rate. For firms not close to default and investment-grade firms, Schwert (2020) reports surprisingly similar loan and bond spreads. So having only one spread in the model should be an innocuous assumption. The other assumption concerns the pay-off function for banks and bond holders. The former can recoup a fraction of the loan while atomistic bond holders cannot in case a project fails. This also reflects the fact that banks are senior to bondholders in bankruptcy.

Two of the partial derivatives can be signed only under special conditions. $\frac{\partial L}{\partial \varepsilon} < 0$ if the fraction of the original loan λ that can be recovered is small relative to the size of π.[9] At the same time the risk premium cannot be too large as $\frac{\partial B}{\partial \pi} > 0$ only if $\pi < 1$. In the event both derivatives satisfy the sign restrictions, an increase in the probability of project default leads to an increase in the risk premium (interest rate margin), i.e. $\frac{d\pi}{d\varepsilon} > 0$.

A central insight coming out of the model is that a worsening economic outlook – reflected by an increase in the probability of project default – leads to a substitution of bonds for bank loans in company finance through an increase in the risk premium. Figure 1 illustrates this scenario with the help of isoquants for the two sources of credit finance.[10] A worsening economic outlook prompts risk-neutral banks to cut their lending, leading to a rightward shift of the isoquant representing bank credit and an increase in the risk premium. The increase in the risk premium in turn induces risk-averse households to absorb more bonds. Firms turn to open market credit, i.e. issue more bonds (the upward shift of the isoquant representing bond volume), to compensate the reduced availability of bank loans. A new equilibrium is reached at the intersection of the new isoquants (dashed curves) at a higher risk premium.

D. *Macroeconomic Implications*

The model just described gives rise to two clear-cut predictions about the behaviour of credit quantities and credit prices as the state of the economy – proxied by default risk – deteriorates. First, there are opposite movements in the components of credit: the volume of bank loans (L) decreases while the volume of bonds (B) increases. These movements imply that the debt finance mix, consisting of the ratio of bank loans to the sum of bank loans and bonds ($\frac{L}{L+B}$), decreases. Second, the increase in the risk premium (π) raises borrowing costs (r) as the spread between the cost of borrowing and the riskless interest rate (r_D) increases. These predictions embody the credit substitution hypothesis in our model.

[9] For instance, if $\phi(\varepsilon) = \frac{\varepsilon^{1-\gamma}}{1-\gamma}$ the necessary condition for $\frac{\partial L}{\partial \varepsilon} < 0$ is $(1-\gamma)\pi > \gamma\epsilon\lambda$. This particular choice of $\phi(\varepsilon)$ has the added property that the slope of the isoquant in Figure 1 goes toward infinity as the probability of project default approaches zero. This property ensures that at low levels of ε the slope of the bank credit isoquant is steeper than the slope of the bond credit isoquant.

[10] The isoquant represents combinations of the risk premium and the probability of default for a given volume of bank loans (bonds).

The model-based predictions are reversed if the risk premium decreases. In this case, the spread narrows and the debt finance mix increases. The model is built on the assumption of symmetric effects. The notion that the absolute quantitative effect on economic activity of a change in the risk premium or the finance mix is independent of the direction of change may be violated in the real world though. In the next section, we verify empirically whether movements in the quantity- or price-based measures of credit have asymmetric effects on economic activity in EMU countries.

III. THE EMPIRICAL ANALYSIS OF ASYMMETRIC EFFECTS

A. Data

The data was sourced from the European Central Bank's Statistical Data Warehouse and from Eurostat, a statistical information provider of the European Union (EU). The sample period runs from 2003 to 2017 (July). The data frequency is monthly. The ten countries included in this study are Austria, Belgium, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, and Spain.[11]

B. The Credit Spread

The credit spread used in the empirical analysis is calculated as the cost of borrowing (CoB) from banks for non-financial corporations minus the 3-month money market rate. In this section we use the cost of borrowing for all loans irrespective of term to maturity. The 3-month money market rate is the interest rate that sufficiently large banks offer each other for euro interbank term deposits. This is a fairly accurate measure of current conditions in the financial sector and reflective of the stance of monetary policy (Sander and Kleimeier (2004)). While not entirely riskless, the money market rate represents a return on a comparatively low-risk investment in normal times compared to a financial institution's retail lending operations.

[11] These countries were selected due to data availability.

Figure 2 provides an overview of conditions in the Euro-area money market since the early 2000s. The figure also tracks the behaviour of the cost of borrowing from banks and the spread in each individual country included in the study. It is clear from the outset that borrowing conditions in the credit market varied markedly over time and followed similar patterns in each country until the first signs of problems with government finance emerged in 2010/11. The cost of borrowing was fairly steady initially, rose as monetary conditions tightened in the lead-up to the Global Financial Crisis, and then fell abruptly as monetary conditions eased dramatically in the wake of the collapse of Lehman Brothers. The credit spread decreased to varying extent in all countries over the 2003-August 2008 period but spiked upward (in all countries but Finland where it increased more slowly) following the financial meltdown in the autumn of 2008 and remained at elevated levels thereafter. However, there is a clear and distinct difference in the way the credit spread behaved in central and northern Europe (A, B, FI, F, G, NL) and southern Europe (GR, I, P, S). The credit spread continued to hover around 2 percent in the former countries whereas it tracked upwards in the countries on the southern periphery, reaching 6 percent in Greece and Portugal in 2012. By the end of the sample period the credit spread had come down in the southern countries but remained substantially higher at the end compared to the beginning of the sample period.

C. The Finance Mix

The finance mix is a simple way to capture the way non-financial corporations tap alternative sources of credit. In the current context, the mix is defined as the ratio of bank loans to the sum of bank loans and bonds outstanding. Figure 3 underlines the importance of bank credit as a source of debt finance in continental Europe. Unlike in the case of the spread the finance mix in the ten countries defies simple categorisation into "North" and "South". However, countries can be grouped together by their relative appetite for bank loans. Those countries with over 85 percent of total finance sourced from bank loans (G, GR, I and S) make up one group, those with bank loans accounting for 70 up to 85 percent of total finance constitute another group (A, B, NL and P), and those countries with less than 70 percent of total finance through bank loans (FL and F) fall into a final group.[12] Inspection of Figure 3

[12] Based on sample median.

reveals that bonds have become relatively more important as a source of debt finance for non-financial corporations over time in the majority of countries. In Finland and France where bond finance has been a significant alternative to bank loans for some time the finance mix remained fairly steady. Variations in the finance mix over the sample period were more pronounced in Germany and the Netherlands. Greece's bond market essentially shut down in June 2010 and remained subdued until the end of the sample period. The marked increases in the finance mix at the end of 2012 and beginning of 2013 in Austria, Belgium, the Netherlands, and Portugal were caused by redemptions of bonds that were not replaced with new issues.

D. Specification of the Regression Equation

The forecasting equation specified below serves as our baseline equation to test the predictive ability of price-based and quantity-based measures of credit. The approach taken here dissects movements in the credit spread and finance mix into positive and negative changes. Doing so enables us to capture the potential asymmetric effects changes in the financial information variables have on economic activity. Accordingly, we regress a given measure of economic activity on lags of itself and positive / negative changes in the price- and quantity-based credit variables.[13]

$$\Delta y_t = a_0 + \sum_{i=1}^{l} a_i \Delta y_{t-i} + \sum_{i=1}^{m} b_i(+)\Delta spr_{t-i} + \sum_{i=1}^{m} c_i(-)\Delta spr_{t-i} + \sum_{i=1}^{n} d_i(+)\Delta mixnfc_{t-i} + \sum_{i=1}^{n} f_i(-)\Delta mixnfc_{t-i} + \sum_{i=1}^{p} g_i \Delta totcredit_{t-i} + e_t \qquad (12)$$

[13] We employ 12 lags of each right-hand side regressor so that *l=m=n=p=12*. Using the AIC as specification selection criterion, we found that the chosen lag structure was adequate.

The growth rate of real economic activity for a given month is calculated as the difference of the log of real economic activity over a 12 month period:

$$\Delta y_t = 100 \log\left(\frac{y_t}{y_{t-12}}\right) \qquad (13)$$

The finance mix variable is the proportion of bank loans outstanding to total credit outstanding to non-financial corporations (NFC):[14]

$$mixnfc = \frac{Loans\ to\ NFC}{Loans\ to\ NFC + Bonds\ Issued\ by\ NFC}$$

The credit spread is the difference between the two-market determined interest rates:

$$spr = Cost\ of\ Borrowing\ for\ Non - Financial\ Corporations - 3\ Month\ Euro\ Money\ Market\ Rate$$

To control for the effect of general credit conditions on economic activity, we include the change in total real credit in the specification. It is defined as the change in the sum of all bank loans to NFCs and bonds issued by NFC and deflated by the CPI.

Standard testing procedures are followed to determine the predictive content of positive and negative changes of the credit spread and the finance mix for two indicators of economic activity. In the first instance, we test the hypothesis that *m* lags of the positive (negative) change in the credit spread are jointly insignificant by means of an F-test.[15,16] The same procedure is followed to test for the possible existence of asymmetric effects of positive and negative changes in the finance mix.

We also employ a t-test to verify the hypothesis that the sum of the coefficients (SoC) $b_i, c_i\ (d_i, f_i), i = 1, 2, \ldots m\ (n)$, on *m* (*n)* lags of the change in the credit spread (finance mix) equals zero. The "sign" test is supplementary. Its purpose is to check whether the effect of observed changes in the financial market indicator on the economic indicator accords with

[14] The narrow definition of total credit outstanding arises from necessity. Data limitations rule out including trade credit in the definition of total credit.

[15] Because the standard errors are computed in accordance with Newey and West (1987), the computed F-statistic does not have the standard finite sample properties. Hence the reported F-statistics are indicative only.

[16] When appropriate, the forecasting equations include indicator variables to mark significant exogenous events such as the reclassification of loans in Austria in 2004 or in Spain in 2012. No indicator variable is included in the forecasting equation if the changes in the finance mix were due to economic events.

economic theory. Drawing out the implications of the theoretical framework of Section II, which is predicated on symmetric effects, we would expect the sign on the sum of the coefficients on (both positive and negative changes of) the credit spread to be negative for industrial production and capital turnover. The expected sign on the sum of the coefficients for negative changes of the finance mix variable is positive. The credit substitution hypothesis is not consistent with observed positive changes of the finance mix. They arise only if both bank loans and bonds increase or decrease simultaneously, i.e. they are pro-cyclical, or if loans increase and bonds decrease, which runs counter to the essence of the credit substitution hypothesis.[17]

E. Empirical Results

This section reports our empirical findings for the ten countries included in this study. At the outset, we investigate whether changes in the financial information variables have asymmetric effects on economic activity without any regard to the time frame of credit quantities outstanding or prices. Following this initial analysis, we distinguish between prices and quantities of short-term as opposed to long-term credit. Short-term is held to be a period of up to one year. Long-term is held to be a period of more than one year.[18]

Each table in this section shows the F-test statistic of the exclusion restriction applied separately to positive and negative changes of the financial information variable, the t-test statistic for the hypothesis that the coefficients on the lags of positive (negative) changes of the financial indicator sum to zero, and the measure of the goodness of fit of the estimated regression equation. In the interest of brevity, we report only empirical findings for the credit spread and the finance mix variables.

No Distinction between Short- and Long-Term Finance

Inspection of the results shown in Tables 1 and 2 provides partial support for the notion that changes in the credit spread have asymmetric signalling effects on economic activity: an increase in the credit spread matters much more than a decrease. An increase in

[17] The appendix lays out in more detail how changes in bonds and loans can lead to observed negative or positive changes in the finance mix. It further spells out the implications of observed changes in the finance mix for economic activity and ties them to existing views on the nexus between credit and economic activity.

[18] Here we adopt the convention of the ECB's Statistical Warehouse that defines long-term securities as securities with a term of maturity greater than one year. We return to this point later in the paper.

the risk premium – reflected by an increase in the credit spread – precedes a slowdown of industrial production in six countries (A, B, FI, F, GR, I) though in two countries – Belgium and France - this asymmetric effect is only marginal. In a similar vein, increases in the credit spread are linked to a subsequent decrease in the turnover of capital goods in five countries (A, F, G, I, NL). By comparison, the adverse effect of an increase in the credit spread on the turnover of capital is stronger than on industrial production (judging by the p-values of the F-test and the statistical significance of the t-statistics of the sum of coefficients). There is virtually no evidence to suggest that a decrease in the credit spread spurs economic activity. Only in Greece does a decrease in the credit spread have marginal predictive power for an increase in industrial production.

In contrast, there is no convincing evidence that positive or negative changes in the quantity-based finance mix bear a strong systematic statistical relationship with changes in industrial production. For the turnover of capital goods the picture changes somewhat. Positive changes in the finance mix have some predictive content in Finland, Greece, and Austria though for the latter two countries the sum of the coefficients test reveals no evidence of a systematic positive or negative linkage. In Finland, positive changes in the finance mix are inversely related to subsequent changes in economic activity, i.e. the prediction is at odds with the credit substitution hypothesis. Instead the estimated negative coefficient is consistent with a demand-driven change in credit or a substitution away from bond finance towards bank loans. In Italy, a negative change in the finance mix through partial substitution of bonds for loans in external debt finance, is associated with a reduction in the turnover of capital goods.[19] This observation is consistent with the credit substitution hypothesis underlying the bank-lending view.

Short-Term vs. Long Term Financing

We now introduce a maturity split of nominal credit outstanding into short-term and long-term instruments. That such a distinction is warranted is shown by Figure 4. For each country Figure 4 records the volumes of short-term and long-term bank loans as well as short-term and long-term bonds outstanding. It is evident that there exists no uniform pattern that

[19] Not all firms can make a successful switch from bank to open-market credit as banks cut their lending. Thus economic activity suffers.

characterizes the way non-financial corporation in Europe raise their financing needs. Still, certain commonalities exist. For instance, long-term bank loans are by far the most important source of company finance, exceeding all other forms of borrowing in all countries but Greece and Portugal where short-term loans outstanding were higher in the initial stages of the sample period. In Greece the volumes of short-term and long-term bank loans outstanding remained roughly equal through 2009 when short-term loans dipped below long-term loans. Pronounced decreases in long-term bank lending occurred in three of the four countries on the southern periphery (GR, P, S) with the onset of the Sovereign Debt Crisis. In Italy the decrease in long-term bank lending was less severe. The experience of the southern European countries contrasts markedly with what happened in central and northern Europe. There long-term bank lending continued to surge in Finland and France, recorded positive growth rates over time in Austria and Belgium, or experienced mild increases as in Germany. Only the Netherland bucked this trend with long-term bank loans actually decreasing towards the end of the sample period after they had steadily increased up to 2012. Notice that the decrease in long-term bank loans in the Netherlands was more than offset by a sizeable increase in short-term bank lending in 2014, only to be followed by a steady decrease in short-term bank lending that persisted until the end of the sample period. Short-term bank lending had reached its peak in central and northern Europe in 2008/2009 with the exception of the Netherlands. In the ensuing years short-term bank lending decreased mildly in Austria, Belgium, Finland, France, and Germany. By comparison, the volume of short-term bank loans fell proportionally more in southern Europe with the outbreak of the Sovereign Debt Crisis.

With reference to the capital market, long-term bonds are a more important source of company finance than short-term bonds in all but one country. Portugal is the only exception in this regard. There the volume of short-term bonds outstanding exceeded long-term bonds outstanding well into 2013. Notice the change in the relative importance of short-term bank loans and long-term corporate bonds. At the beginning of the sample period, long-term bonds outstanding exceeded short-term bank loans only in Finland and France. By the end of the sample period, long-term bonds outstanding exceeded short-term bank loans in six of the ten countries. This is proof that the corporate debt market is gaining ground relative to the banking sector in continental Europe but only in the segment for long-term debt. Short-term bonds remain a trivial source of external debt finance in most countries.

When we distinguish between short- and long-term borrowing, our estimated specification of the regression equation remains equation (12). However, the definition of the spread and finance mix variable (as well as the definition of the control variable (total real credit)) changes. Specifically,

> Δspr_{t-i}^{j}= the change in the spread where the spread is defined as the short-term (long-term) cost of borrowing for NFCs and the euro-area 3-month money market interest rate. *j=ST (short-term borrowing cost)* for loans with maturity of up to one year or *LT (long(er)-term borrowing cost)* for loans with maturity of more than one but less than five years.

The analogous quantity-based finance mixes appear below:

$$\Delta mix^{ST} = \Delta\left(\frac{Short\ Term\ Loans\ to\ NFC}{Short\ Term\ Loans\ to\ NFC + Short\ Term\ Securities\ issued\ by\ NFC}\right)$$

$$\Delta mix^{LT} = \Delta\left(\frac{Long\ Term\ Loans\ to\ NFC}{Long\ Term\ Loans\ to\ NFC + Long\ Term\ Securities\ issued\ by\ NFC}\right)$$

The long-term mix is based on loans and securities with terms to maturity greater than one year.

Tables 3A and 3B show the empirical results for industrial production. Table 3A examines the sensitivity of industrial production to changes in short-term finance while Table 3B reports the findings for the case of long-term finance.

Inspection of the results in these tables vindicates the separation of external debt finance into short-term and long components. There are strong asymmetric effects on industrial production associated with changes in the short-term credit spread. A positive change in the short-term credit spread predicts a negative change in industrial production in six of the ten countries (A, FI, F, G, I, P). For four of these countries the sum of coefficients is negative and statistically significant at the 5 percent level or lower. A negative change in the short-term credit spread has predictive power for industrial production only in Italy although the sum of coefficients on its lags turns out to be statistically insignificant. There is no evidence that changes in the short-term finance mix mattered at all for industrial production in any country. Even stronger support for the presence of asymmetric effects of the credit spread on industrial production appears in Table 3B. There is clear evidence of a sustained inverse relationship between positive changes in the long-term credit spread and subsequent negative changes in industrial production. Both the exclusion restriction and the zero sum of

coefficients hypotheses are rejected in seven of the ten countries (A, B, FI, F, G, I, P). Notice though that in the case of long-term finance, a negative change in the spread also predicts a positive change in industrial production in Belgium and Finland, thus attesting to symmetry in the nexus between the long-term credit spread and industrial production

By contrast a change in the long-term finance mix has very poor predictive power. For Germany there is marginal evidence for a positive effect of an increase in the long-term finance mix on industrial production, a result not compatible with the credit substitution hypothesis. For Spain the results show a tight inverse relationship between negative changes in the long-term finance mix and industrial production. This is in large part due to the transfer of non-performing loans from domestic banks to SAREB, Spain's state-owned resolution agency. As such, the seeming relationship between the two variables is an artefact of the data.[20]

Tables 4A and 4B present the empirical findings of the forecasting exercise for the turnover of capital goods. The tables are organised in the same fashion as the previous tables, with Table 4A describing the predictive ability of short-term financial information variables and Table 4B doing the same for long-term financial information variables. Undoubtedly, the findings reported in Table 4B provide the strongest evidence for the existence of asymmetry in the relation between the credit spread and economic activity. Positive changes in the long-term credit spread predict decreases in the sales of capital goods in every country but Portugal. The sum of the coefficients on lagged positive changes in the long-term credit spread is negative and statistically significant in nine out of the ten countries. In marked contrast, the ability of negative changes in the long-term credit spread to predict increases in the turnover of capital goods is confined to Italy. Predictive power of changes in the long-term finance mix surfaces only in Greece albeit with a puzzling negative coefficient on the sum of coefficients for positive changes in the mix and Italy where negative changes in the mix are associated with subsequent negative changes in the sales of capital goods. Thus Italy appears once again to validate the credit substitution hypothesis.

[20] Banco de Espana (2013) and Deutsche Bundesbank (2014) provide further details on this point. During the second recession (2011:10-2013:3) the cumulative decrease in real loans in Spain amounted to 182,496 million euros, largely the result of the transfer (Guender (2018)).

Turning attention to Table 4A, we find that positive changes in the short-term credit spread also have strong predictive power for changes in the turnover of capital goods. This inverse relationship exists in seven of the ten countries. Negative changes in the short-term credit spread appear to be unrelated to changes in the turnover of capital goods. Interestingly, increases in the short-term (but not long-term) credit spread in Portugal are a powerful predictor of reduced turnover of capital goods in this country. This ties in nicely with our earlier observation that short-term credit has played a relatively significant role in external debt finance in Portugal. Changes in the short-term finance mix are not in any way related to the turnover of capital goods in any country except Finland where positive changes in the finance mix have predictive power, a result contrary to the credit substitution hypothesis and more in line with both credit components being pro-cyclical.[21]

IV. Extensions and Robustness Checks

A. Panel Data Analysis

In this section, we report the results based on panel data estimation. To check the robustness of our results in Section III, we now exploit the panel structure of our dataset which better accounts for the observed and unobserved sources of heterogeneity in the data. In particular, we run panel fixed-effects regressions to control for the time-invariant unobserved individual characteristics that can be correlated with the observed dependent variables in our regressions. The fixed effects model will remove omitted variable bias by measuring changes within countries across time.

The estimated regression specification takes the following form:[22]

[21] Closer inspection of the results in Tables 4A and 4B also reveal that for Greece and Italy the goodness of fit of the estimated regression specification based on the long-term finance variables is markedly superior to that based on their short-term counterparts. For Greece it rises from 0.46 to 0.55 and for Italy from 0.58 to 0.72. This improvement in predictive power reflects the greater information content inherent in changes in the long-term financial prices and quantities in both countries.

[22] Similar to the earlier specification, we employ 12 lags of each right-hand side regressor so that l=m=n=p=12. Relying on the AIC as specification selection criterion, we found that the chosen lag structure was adequate.

$$\Delta y_{kt} = a_0 + \sum_{i=1}^{l} a_i \Delta y_{kt-i} + \sum_{i=1}^{m} b_i(+)\Delta spr_{kt-i} + \sum_{i=1}^{m} c_i(-)\Delta spr_{kt-i} + \sum_{i=1}^{n} f_i(-)\Delta mixnfc_{kt-i} + \sum_{i=1}^{n} d_i(+)\Delta mixnfc_{kt-i} + \sum_{i=1}^{p} g_i \Delta totcredit_{kt-i} + \mu_k + \gamma_t + e_{kt} \quad (14)$$

where μ_k is the country fixed-effect and γ_t is the year fixed-effect. All other variables in the regression specification are as defined earlier in Section III.

No Distinction between Short- and Long-Term Finance

Table 5 reports the results of the regressions where the distinction between short- and long-term financing does not apply. Panel A presents the estimated coefficients on the credit spread and the finance mix for industrial production and panel B reports the estimated coefficients for the turnover of capital goods. The results from both panels reinforce our earlier findings that the predictive ability of changes in the credit spread for economic activity is largely one-sided, i.e. limited to positive changes in the credit spread. In both regressions a Wald test of exclusion restrictions is soundly rejected as is the hypothesis that the sum of estimated lagged coefficients is zero. An increase in the credit spread signals a downturn in economic activity. In comparison, we find no evidence that negative changes in the credit spread signal subsequent increases in economic activity.

Turning attention to the finance mix variable, we find mixed evidence that changes in the finance mix signal future changes in economic activity. Positive changes in the finance mix (brought about by a shift from bond financing to loan financing, an outcome inconsistent with the credit substitution view) are loosely associated with a subsequent decline in industrial production. For the turnover of capital goods, positive changes in the finance mix have predictive power but the cumulative effect of these positive changes amounts to very little statistically. By contrast, negative changes in the finance mix bear a strong negative and statistically significant relationship with changes in industrial production. This negative association runs counter to the credit substitution hypothesis. Rather, it suggests that

companies increase their borrowing from both banks and the capital market as their outlook on the overall economy improves. However, we do not find a similarly strong association of negative changes in the finance mix with changes in the turnover of capital goods. We conclude that there is scant evidence for the signalling property of the finance mix being aligned with the prediction of the credit substitution view.

Distinguishing between Short- and Long-Term Financing

We now verify our earlier findings regarding the asymmetric signalling properties of the credit spread and finance mix at different maturities. For this exercise, our regression specification takes the same form as equation (14) except that the financial indicator variables are either short-term or long-term, respectively (as defined previously in section III).

Panels A and B in Table 6 present results for short-term maturity financing, while panels C and D report the results for long-term maturity financing. Once again, our earlier findings are validated. Across all four specifications (panels A, B, C and D), a positive change in the credit spread signals a decrease in future economic activity. In all specifications estimated, this signalling property is very strong. The exclusion restriction and restriction on the sum of the coefficients on positive changes in the spread are soundly rejected. In contrast, a change in the negative spread lacks predictive power for economic activity. Panel data estimation thus strengthens the argument that positive changes in the credit spread are far more relevant for predicting future economic activity than negative changes.

Interestingly, the maturity split brings out a special connection between the finance mix and industrial production. For short-term maturity financing (panel A), we find that a positive change in the finance mix has no predictive power. However, a negative change in the finance mix has predictive power but is negatively related to a future change in industrial production, again a finding at odds with the credit substitution hypothesis. Instead demand-driven increases of both loans and bonds account for the inverse relationship.

Panels C and D also cast doubt on a robust and clear-cut relationship between the long-term finance mix and economic activity. In panel C, a negative change in the finance mix is marginally related to an increase in future industrial production, while in panel D it is weakly associated with a subsequent decrease in the turnover of capital goods. The latter finding is consistent with the credit substitution hypothesis while the former is not. Inspection of positive changes in the finance mix reveals further evidence against the credit substitution

hypothesis in panels C and D. A positive change in the finance mix is strongly correlated with a future negative change in industrial production in panel C. This finding is supportive of a demand-driven decrease in both forms of credit resulting in a positive change in the finance mix but to a subsequent decrease in industrial production. For the turnover of capital goods (panel D), positive changes in the finance mix have predictive power but the sum total of these effects amounts to very little.

B. Sensitivity Tests

B.1 Controlling for Additional Factors to Suppress Omitted Variable Bias

Another robustness check adds an additional control variable to the time series and panel data regression specifications. We include a variable that controls for economic policy uncertainty (EPU) in each country.[23] This measure is taken from Baker, Bloom and Davis (2015), who argue that increasing policy uncertainty is associated with greater stock price volatility which in due course leads to reduced investment and employment.[24] Controlling for this additional factor (or adding changes in the real exchange rate to the individual country regressions to capture external competitiveness) leaves intact our main finding that a positive credit spread has predictive power for a decrease in economic activity.

B.2 Endogeneity / Exogeneity Concerns

To address these concerns, we returned to the time series regressions for individual countries. We carried out bivariate Granger causality tests for positive changes in the long-term credit spread and changes in the turnover of capital goods, the combination that yields the strongest evidence for a linkage between a financial information variable and economic activity (Table 4). The tests for bivariate causality reveal that in seven of the ten countries causality is uni-directional, running from positive changes in the credit spread to subsequent changes in the turnover of capital goods. A test of bivariate causality on the panel confirms yields the same result. For industrial production bivariate causality tests on time series data

[23] The EPU measure is not available for three countries in our sample – Austria, Finland and Portugal. Hence, the panel regressions consist of the seven other countries. These results are not reported for the sake of brevity but are available upon request from the authors.

[24] Baker, Bloom and Davis (2015) create the index of EPU based on newspaper coverage frequency of various uncertainty-related terms. Details about the construction of the variable for each country can be found at https://www.policyuncertainty.com/index.html.

and panel data are less conclusive. On balance, however, the time-series regression evidence is more supportive of a causal link between positive changes in the credit spread and subsequent changes in industrial production than vice versa, an indication that our baseline results are robust. [25, 26]

V. SUMMARY AND CONCLUSION

Predictions about credit prices and quantities grounded in theory guide our empirical analysis of the credit substitution hypothesis. A poor outlook on the economy leads banks to cut their loan portfolio and forces firms to tap the bond market for funding. The risk premium rises, leading to higher borrowing costs. The volume of bonds outstanding rises but bank loans shrink. These testable predictions about the behaviour of credit prices and quantities form the basis of our empirical tests in ten countries of the Euro area. This study covers a period when frictions and fissures in credit markets in the Euro area loomed large. Initially, we take a country-specific perspective to trace developments in the market for bank versus open market credit over the 2003-2017 sample period. Doing so allows us to appreciate the institutional differences that exist at the country level.

The focus of our empirical analysis is on two key questions concerning the role of credit prices and quantities. First, do changes in the credit spread, a proxy for the risk premium, and the finance mix, which is meant to capture the substitutability of bond for bank finance, have asymmetric effects on economic activity? Second, what is the relevance of maturity in the empirical assessment of the predictive ability of the credit spread and the finance mix for economic activity?

On balance, the empirical findings based on times series data for individual countries suggest that asymmetric effects do exist in the transmission of impulses from the financial to

[25] We have also investigated the effects of shifts in maturity-based finance mixes on economic activity. This involved constructing the ratio of the sum of *short-term* bank loans and bonds to total borrowing or the ratio of the sum of long-term bank loans and bonds to total borrowing. Shifts in either maturity-based finance mix have no predictive power for the two measures of economic activity.

[26] The results of the bivariate Granger causality tests for changes in the turnover of capital goods / industrial production and positive changes in the two spreads appear in the appendix. The appendix also shows the results of block-exogeneity tests based on a five-variable VAR for time series data and the panel. These results are less conclusive than those based on the simple bivariate Granger causality tests. Hence some caution in interpreting the results as regards causality is warranted.

the real sector of the economy. Increases in the credit spread signal a future slow-down in economic activity. But this asymmetric effect in the credit spread is not pervasive; it is found only in roughly half of the countries included in this study. We find evidence of a strong linkage between decreases in the finance mix and a decrease in the turnover of capital goods only for Italy.

Dividing the cost and the volume of external debt finance into their respective short-term and long-term components allows the greater relative importance of long-term finance to shine through. The asymmetric signalling property of positive changes in the long-term credit spread for future changes in the turnover of capital goods permeates the Euro area – both the center/north and the south – and is exceptionally strong: it is found in nine of the ten countries. For industrial production empirical support for the existence of asymmetric effects of changes in the long-term credit spread is somewhat weaker but still very much in evidence in the countries under investigation. A robust connection between increases in the short-term credit spread and a decrease in sales of capital goods is found in seven countries while for industrial production this number reduces to four.[27]

Pooling the data brings out even more the asymmetric character that marks the relationship between the credit spread and economic activity: a positive change in the credit spread- irrespective of term to maturity - signals a weaker economy in the future. In contrast, the predictive power of positive or negative changes in finance mix variables is weak and marred by inconsistencies with predictions underlying the credit substitution hypothesis.

In sum, the evidence from panel data estimation and estimation based on aggregate time series data from individual countries does not unearth a consistent pattern for movements in bank loans and bonds – quantity variables - that fits the credit substitution hypothesis. The evidence does, however, point to the strong signalling power of increases in the credit spread, a price variable in the credit substitution framework. The greater ability of increases in the credit spread to signal future decreases in economic activity may be due to a variety of factors. One explanation would be that prices convey signals better and faster than quantities. Another would be that the model of debt finance in section II does not capture all relevant sources of finance, and therefore omits important quantity variables such as trade credit,

[27] Based on significance of F-test statistic and t-statistic.

non-bank loans, crowd funding, and private equity. To what extent these additional factors play a role in the credit substitution framework is left for future research.

Our empirical findings underscore the importance of increases in the credit spread as a leading indicator of near-term decreases in economic activity in the Euro area. Prudent monetary and prudential policy calls for leaning against a widening and/or outright spikes in the credit spread by appropriate counter measures to quell any nascent unease about counter-party risk in the credit market. With the increasing importance of the bond market as a source of credit for non-financial companies, the supervisory umbrella of the ECB may have to be widened to include riskier segments of the bond market.[28] Just as the avoidance of runs on banks is a core responsibility of central banks, so is the avoidance of runs on bond funds which have emerged as important new players in the bond market next to the traditional "buy and hold" insurance companies and pension funds.

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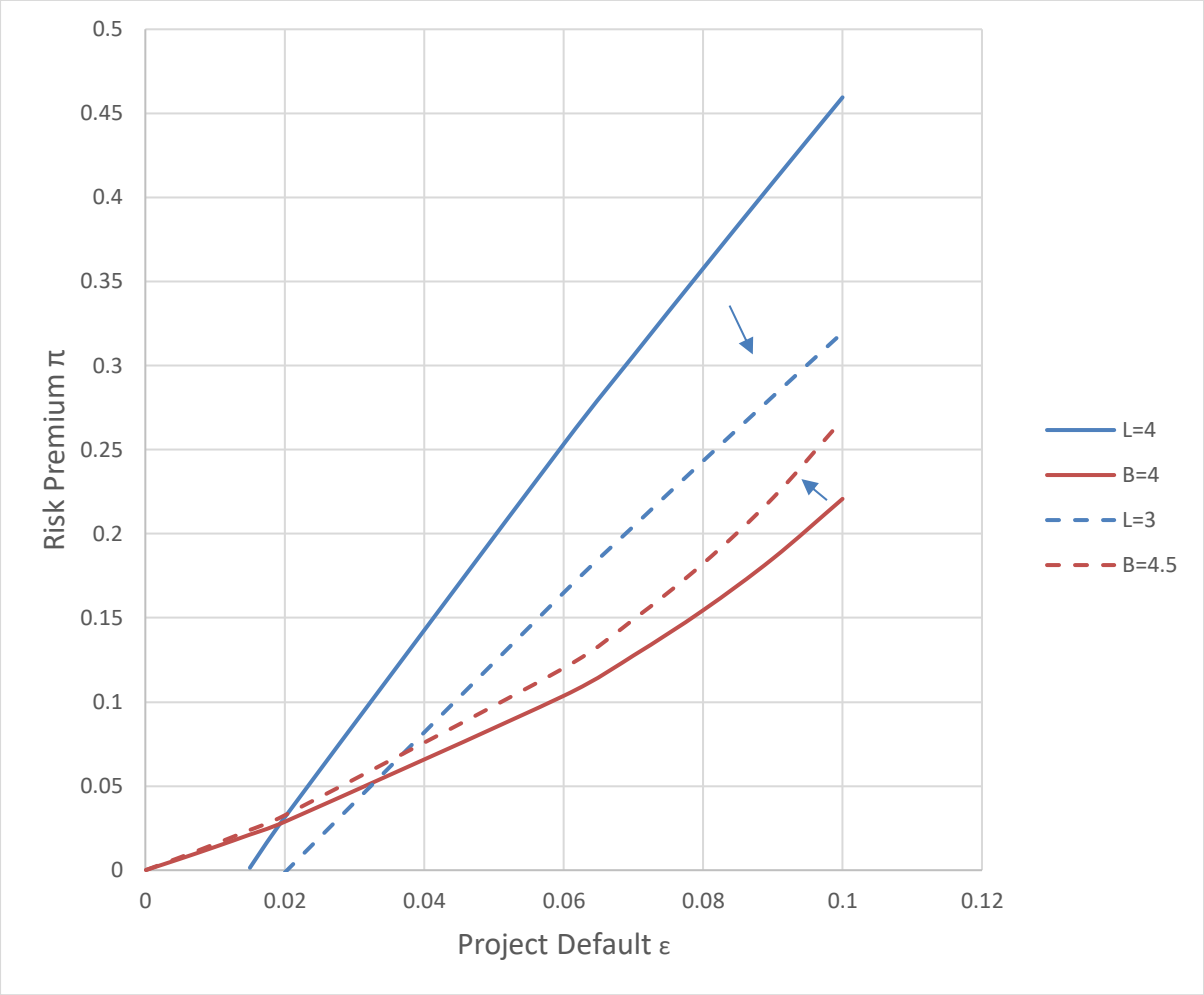
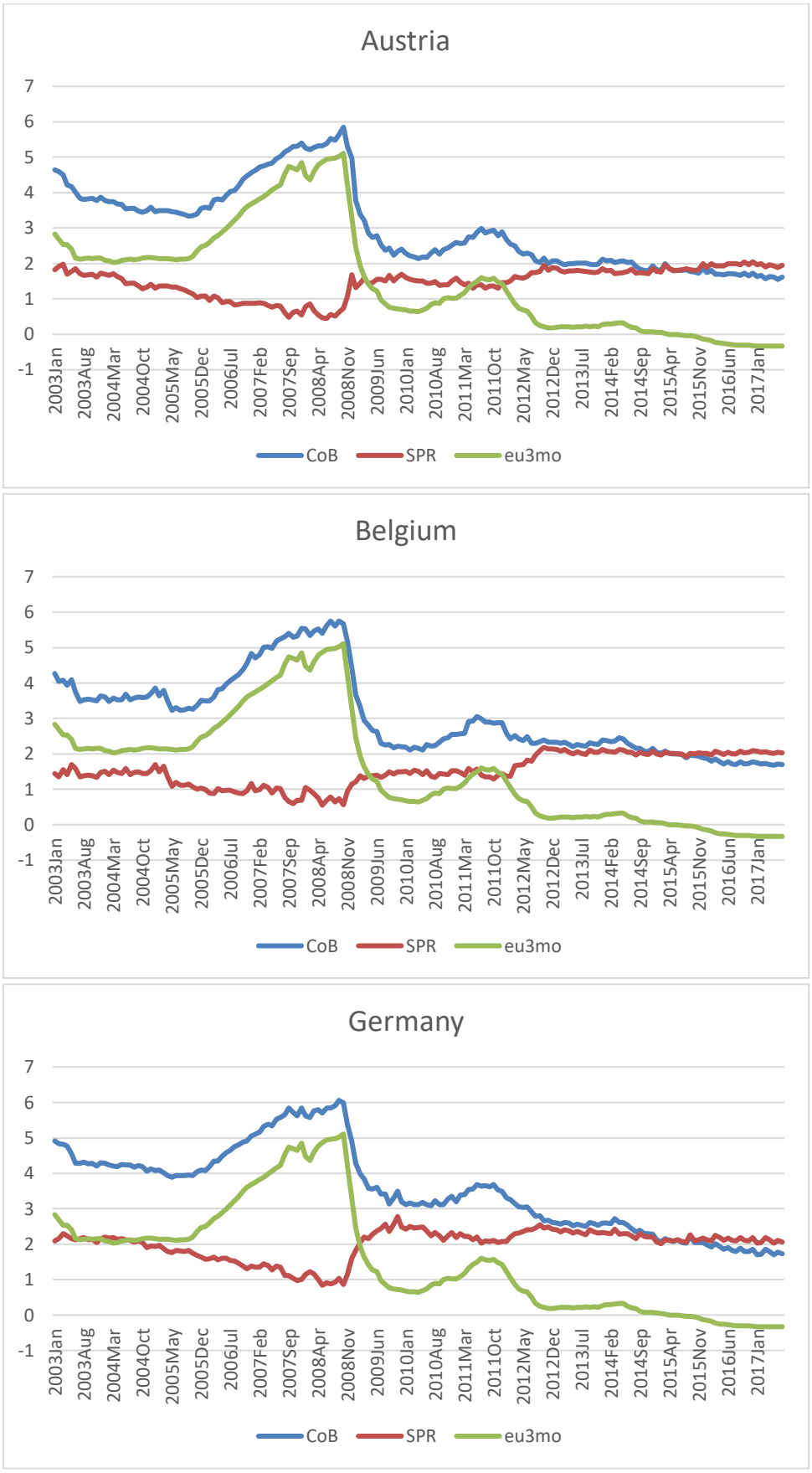
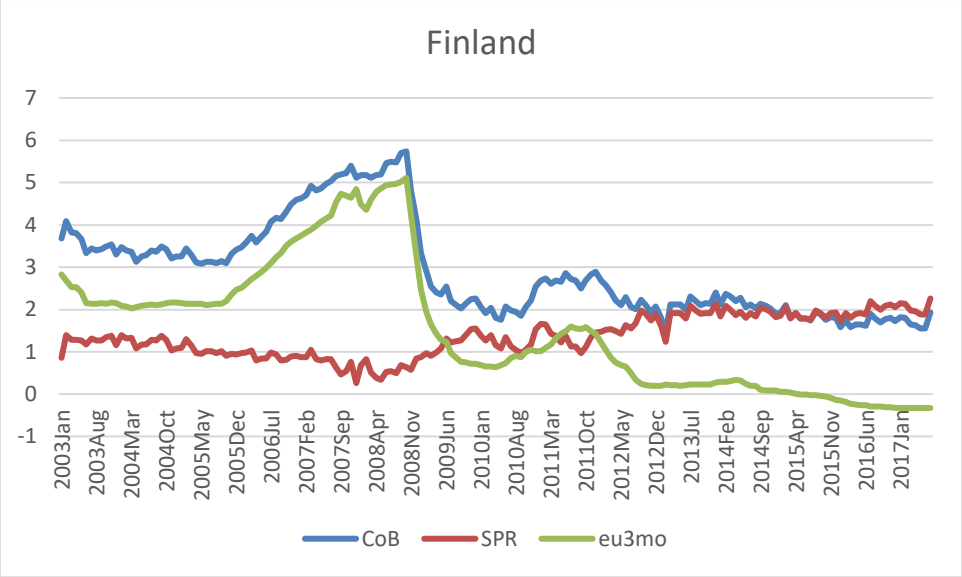
Figure 1: Bank- versus Bond-Finance as Project Default Increases

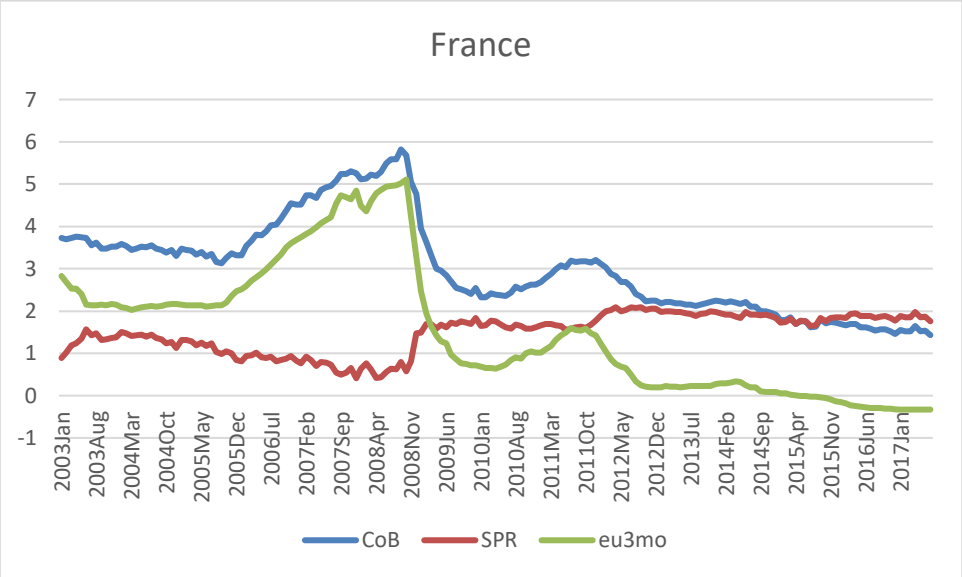


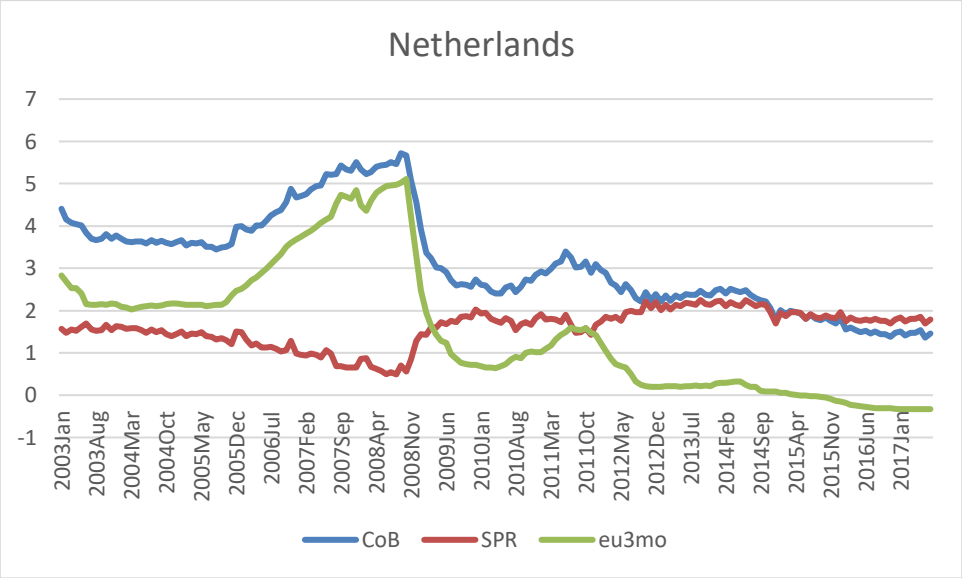
Example based on: $\gamma = 0.1, \lambda = 0.1, T = 3$.

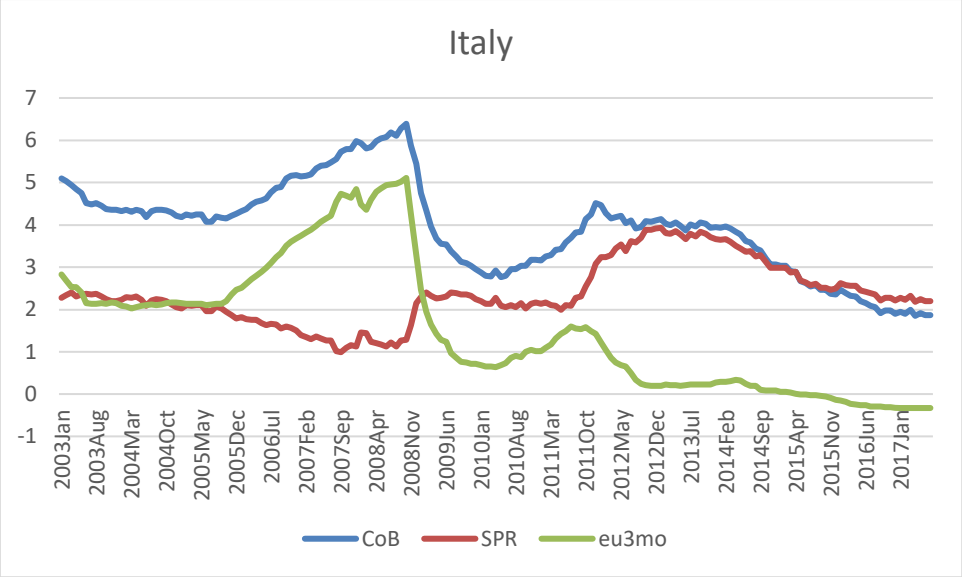
Figure 2: The Credit Spread and its Components

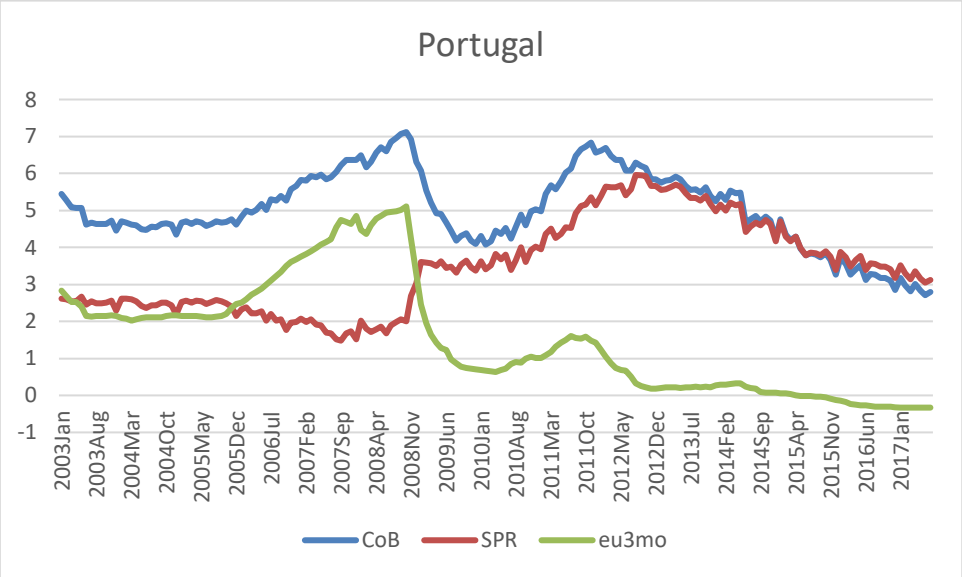


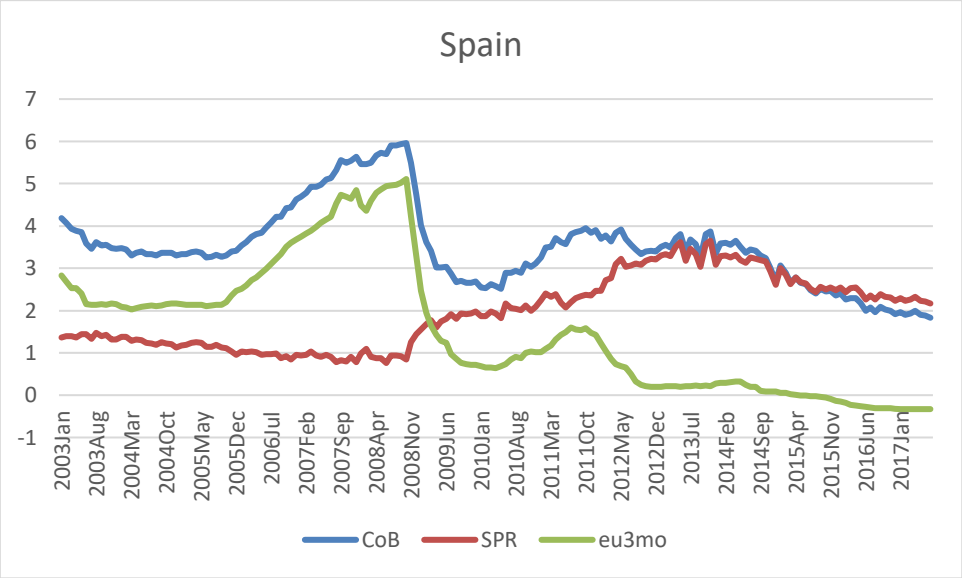

Finland
7
6
5
4
3
2
1
0
-1
2003Jan
2003Aug
2004Mar
2004Oct
2005May
2005Dec
2006Jul
2007Feb
2007Sep
2008Apr
2008Nov
2009Jun
2010Jan
2010Aug
2011Mar
2011Oct
2012May
2012Dec
2013Jul
2014Feb
2014Sep
2015Apr
2015Nov
2016Jun
2017Jan
CoB
SPR
eu3mo


France
7
6
5
4
3
2
1
0
-1
2003Jan
2003Aug
2004Mar
2004Oct
2005May
2005Dec
2006Jul
2007Feb
2007Sep
2008Apr
2008Nov
2009Jun
2010Jan
2010Aug
2011Mar
2011Oct
2012May
2012Dec
2013Jul
2014Feb
2014Sep
2015Apr
2015Nov
2016Jun
2017Jan
CoB
SPR
eu3mo


Netherlands
7
6
5
4
3
2
1
0
-1
2003Jan
2003Aug
2004Mar
2004Oct
2005May
2005Dec
2006Jul
2007Feb
2007Sep
2008Apr
2008Nov
2009Jun
2010Jan
2010Aug
2011Mar
2011Oct
2012May
2012Dec
2013Jul
2014Feb
2014Sep
2015Apr
2015Nov
2016Jun
2017Jan
CoB
SPR
eu3mo


Italy
7
6
5
4
3
2
1
0
-1
2003Jan
2003Aug
2004Mar
2004Oct
2005May
2005Dec
2006Jul
2007Feb
2007Sep
2008Apr
2008Nov
2009Jun
2010Jan
2010Aug
2011Mar
2011Oct
2012May
2012Dec
2013Jul
2014Feb
2014Sep
2015Apr
2015Nov
2016Jun
2017Jan
CoB
SPR
eu3mo


Portugal
8
7
6
5
4
3
2
1
0
-1
2003Jan
2003Aug
2004Mar
2004Oct
2005May
2005Dec
2006Jul
2007Feb
2007Sep
2008Apr
2008Nov
2009Jun
2010Jan
2010Aug
2011Mar
2011Oct
2012May
2012Dec
2013Jul
2014Feb
2014Sep
2015Apr
2015Nov
2016Jun
2017Jan
CoB
SPR
eu3mo


Spain
7
6
5
4
3
2
1
0
-1
2003Jan
2003Aug
2004Mar
2004Oct
2005May
2005Dec
2006Jul
2007Feb
2007Sep
2008Apr
2008Nov
2009Jun
2010Jan
2010Aug
2011Mar
2011Oct
2012May
2012Dec
2013Jul
2014Feb
2014Sep
2015Apr
2015Nov
2016Jun
2017Jan
CoB
SPR
eu3mo

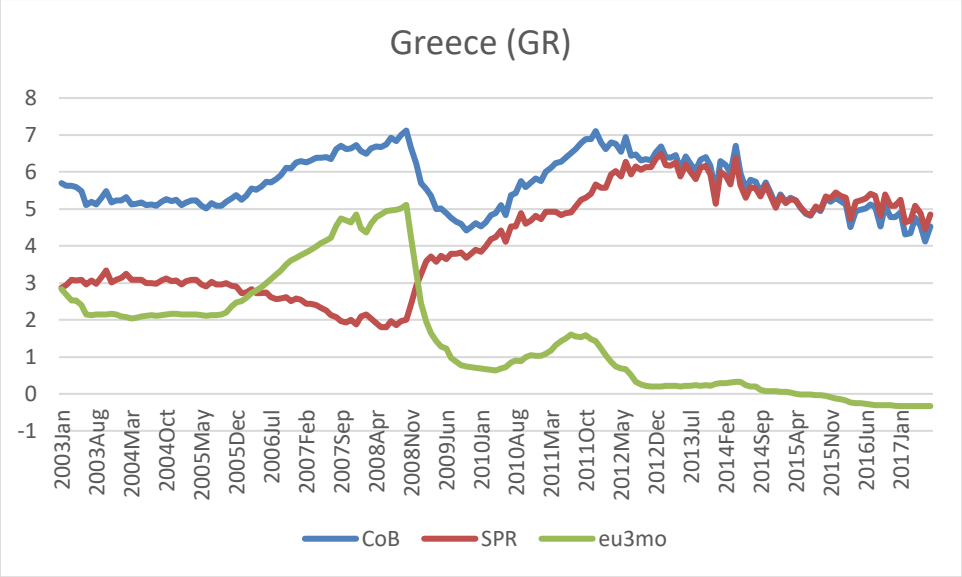

Greece (GR)
8
7
6
5
4
3
2
1
0
-1
2003Jan
2003Aug
2004Mar
2004Oct
2005May
2005Dec
2006Jul
2007Feb
2007Sep
2008Apr
2008Nov
2009Jun
2010Jan
2010Aug
2011Mar
2011Oct
2012May
2012Dec
2013Jul
2014Feb
2014Sep
2015Apr
2015Nov
2016Jun
2017Jan
CoB
SPR
eu3mo

Figure 3: The Finance Mix (Based on Total Quantities of Bonds and Loans) in 10 European Countries

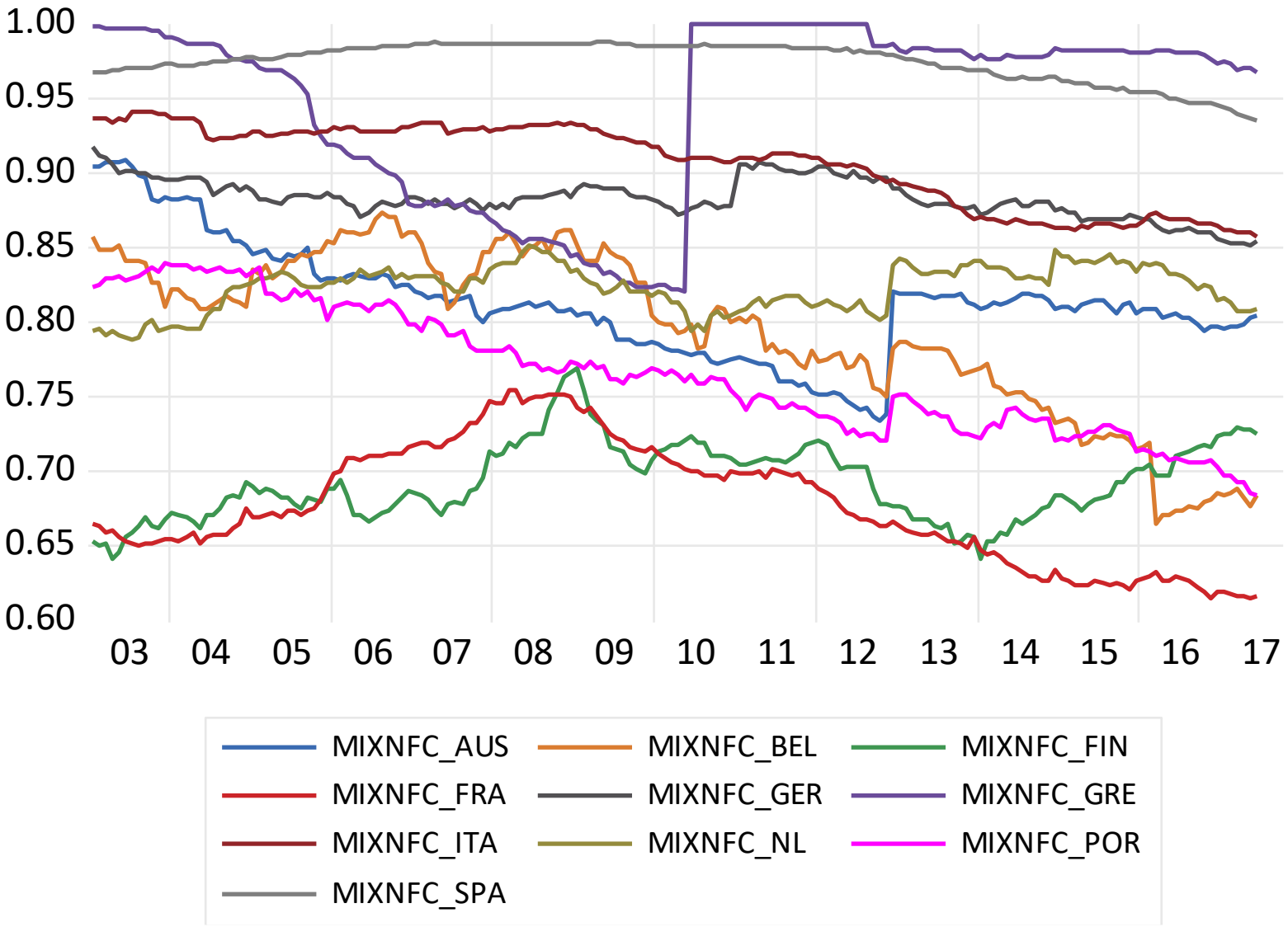
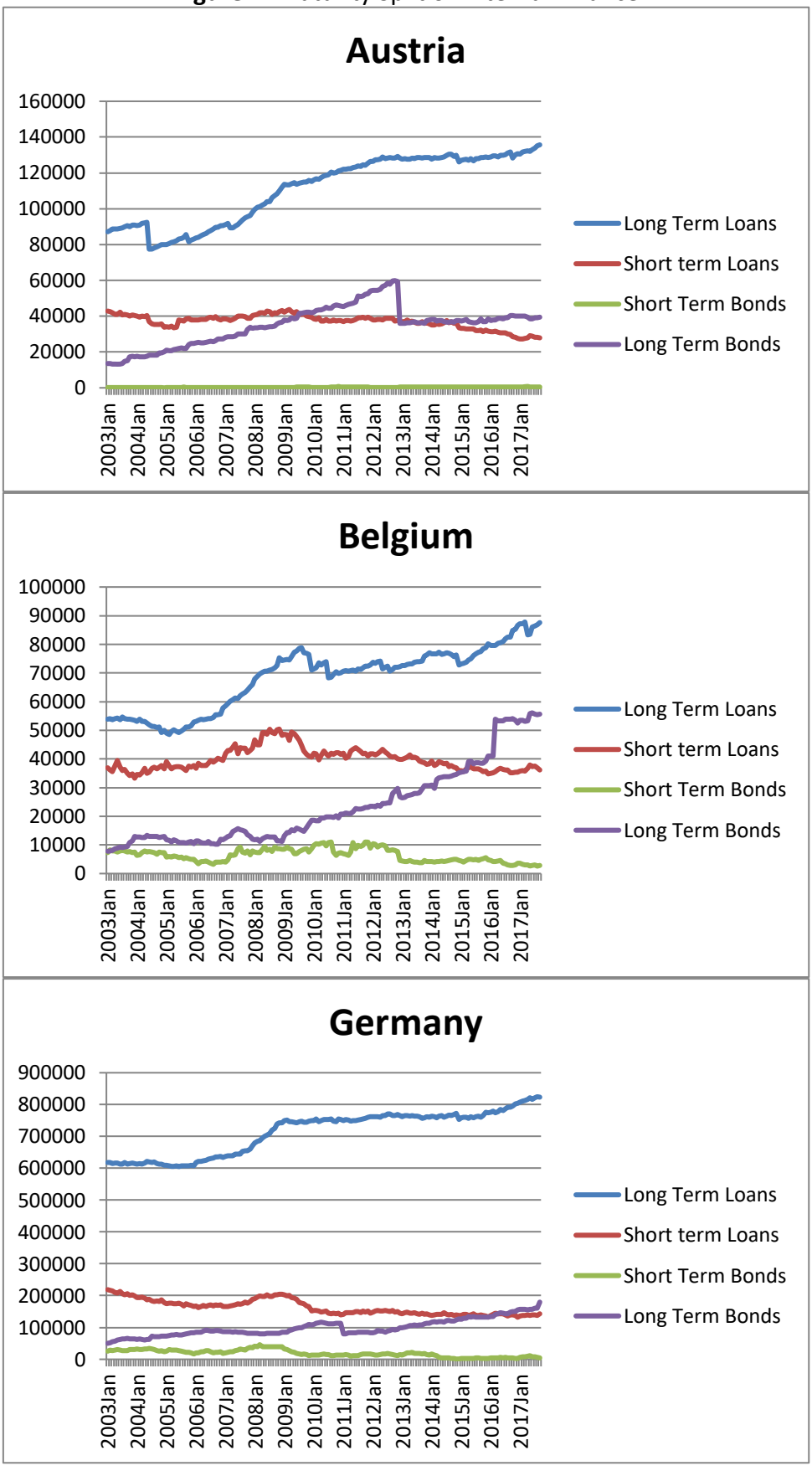
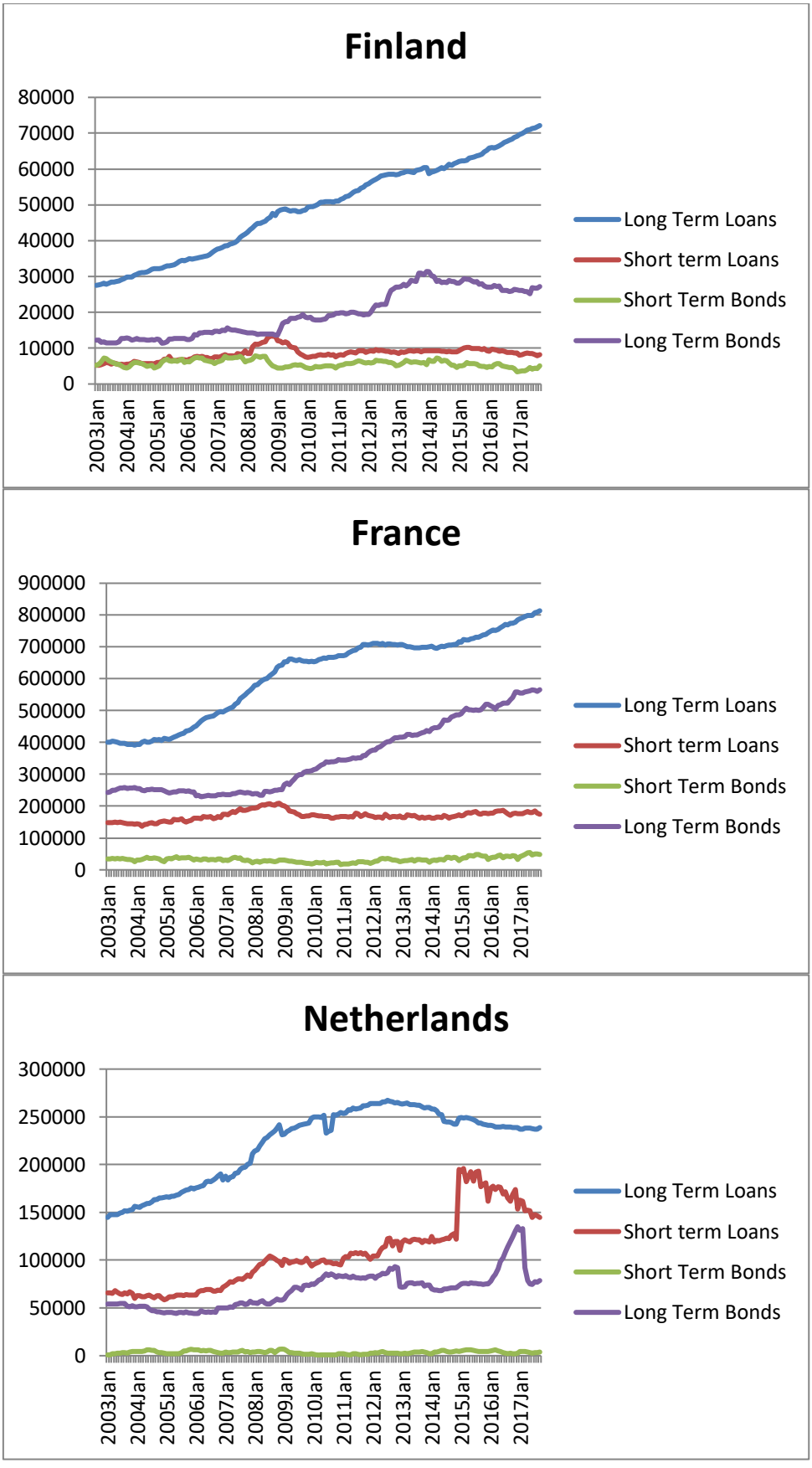
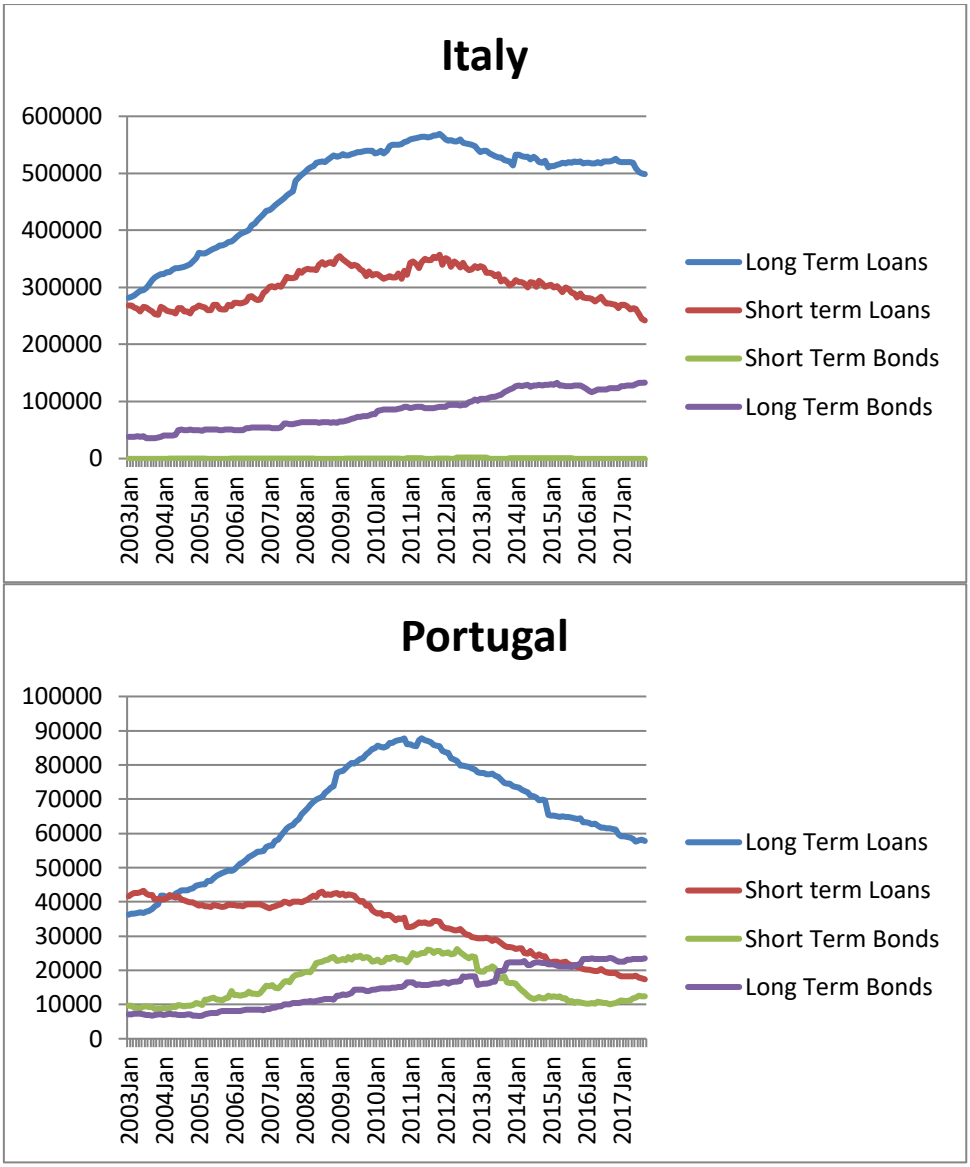
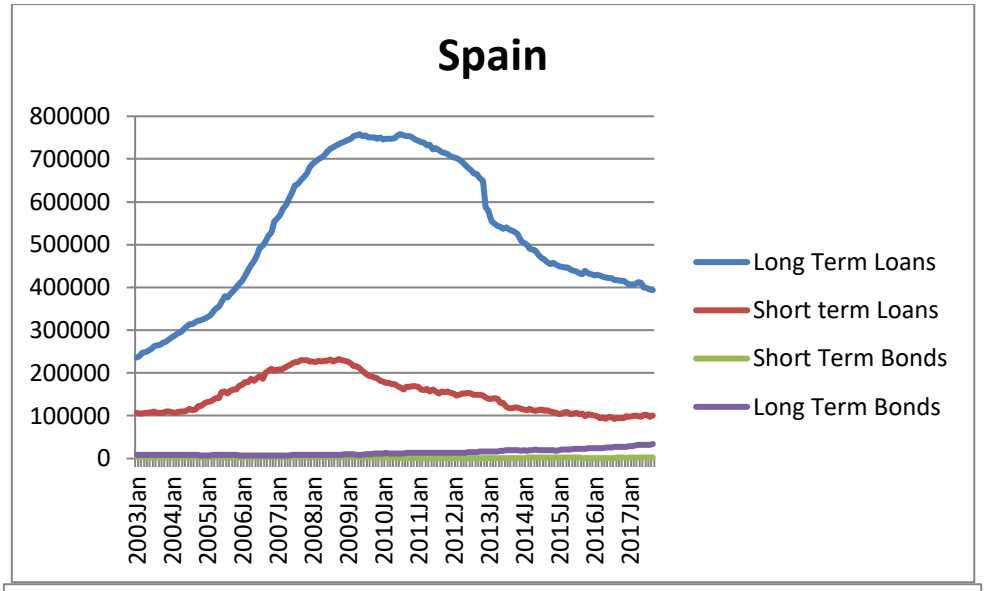


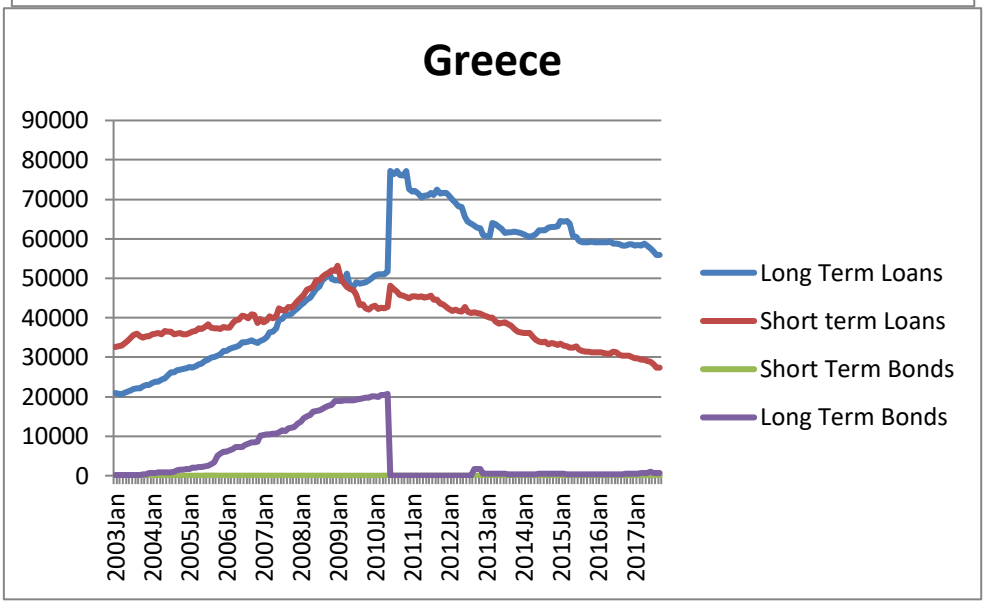
Figure 4: Maturity Split of External Finance




Finland
80000
70000
60000
50000
40000
30000
20000
10000
0
2003Jan
2004Jan
2005Jan
2006Jan
2007Jan
2008Jan
2009Jan
2010Jan
2011Jan
2012Jan
2013Jan
2014Jan
2015Jan
2016Jan
2017Jan
Long Term Loans
Short term Loans
Short Term Bonds
Long Term Bonds
France
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
2003Jan
2004Jan
2005Jan
2006Jan
2007Jan
2008Jan
2009Jan
2010Jan
2011Jan
2012Jan
2013Jan
2014Jan
2015Jan
2016Jan
2017Jan
Long Term Loans
Short term Loans
Short Term Bonds
Long Term Bonds
Netherlands
300000
250000
200000
150000
100000
50000
0
2003Jan
2004Jan
2005Jan
2006Jan
2007Jan
2008Jan
2009Jan
2010Jan
2011Jan
2012Jan
2013Jan
2014Jan
2015Jan
2016Jan
2017Jan
Long Term Loans
Short term Loans
Short Term Bonds
Long Term Bonds


Italy
600000
500000
400000
300000
200000
100000
0
2003Jan
2004Jan
2005Jan
2006Jan
2007Jan
2008Jan
2009Jan
2010Jan
2011Jan
2012Jan
2013Jan
2014Jan
2015Jan
2016Jan
2017Jan
Long Term Loans
Short term Loans
Short Term Bonds
Long Term Bonds
Portugal
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
2003Jan
2004Jan
2005Jan
2006Jan
2007Jan
2008Jan
2009Jan
2010Jan
2011Jan
2012Jan
2013Jan
2014Jan
2015Jan
2016Jan
2017Jan
Long Term Loans
Short term Loans
Short Term Bonds
Long Term Bonds





Note: “Loans” refers to Bank Loans.

Table 1: Measuring the Asymmetric Effects of the Credit Spread and the Finance Mix on Industrial Production									
(2004:2-2017:6)									
		Credit Spread				Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
Countries		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Austria	Coefficient	2.71***	-2.06**	0.66	-0.04	0.99	-2.41***	0.72	-0.99
	[p-val]	[0.003]		[0.79]		[0.46]		[0.73]	
	Adjusted R2	0.88							
Belgium	Coefficient	1.73*	-1.40	0.92	-2.17**	0.44	0.27	1.41	-1.51
	[p-val]	[0.07]		[0.53]		[0.94]		[0.17]	
	Adjusted R2	0.77							
Finland	Coefficient	2.01**	-3.58***	1.00	-1.49	1.73*	-2.86***	1.26	-0.04
	[p-val]	[0.03]		[0.49]		[0.07]		[0.25]	
	Adjusted R2	0.88							
France	Coefficient	1.68*	-1.92*	0.92	0.78	0.40	0.24	0.41	0.67
	[p-val]	[0.08]		[0.52]		[0.96]		[0.96]	
	Adjusted R2	0.83							
Germany	Coefficient	0.78	-1.01	1.55	0.003	1.56	1.12	0.68	-0.56
	[p-val]	[0.66]		[0.12]		[0.12]		[0.67]	
	Adjusted R2	0.93							
Greece	Coefficient	1.91**	-0.07	1.77*	-0.64	1.15	-2.73***	0.53	0.31
	[p-val]	[0.04]		[0.06]		[0.33]		[0.89]	
	Adjusted R2	0.63							
Italy	Coefficient	2.59***	-2.91***	1.14	1.95**	0.77	-1.13	1.01	0.79
	[p-val]	[0.005]		[0.34]		[0.68]		[0.44]	
	Adjusted R2	0.91							
Netherlands	Coefficient	0.77	-1.36	0.86	0.71	0.73	-0.36	1.14	-0.04
	[p-val]	[0.68]		[0.58]		[0.72]		[0.36]	
	Adjusted R2	0.63							

Portugal	Coefficient	0.77	-1.68*	1.24	-2.86**	0.22	-0.49	0.3	-0.36
	[p-val]	[0.68]		[0.26]		[0.99]		[0.99]	
	Adjusted R2	0.57							
Spain	Coefficient	1.25	0.89	1.03	0.95	1.29	2.72***	1.45	-2.61***
	[p-val]	[0.26]		[0.43]		[0.24]		[0.15]	
	Adjusted R2	0.91							

Note: SoC = sum of coefficients.

Specification of the estimated regression:

$$\Delta y_t = a_0 + \sum_{i=1}^{l} a_i \Delta y_{t-i} + \sum_{i=1}^{m} b_i(+)\Delta spr_{t-i} + \sum_{i=1}^{m} c_i(-)\Delta spr_{t-i} + \sum_{i=1}^{n} d_i(+)\Delta mixnfc_{t-i} + \sum_{i=1}^{n} f_i(-)\Delta mixnfc_{t-i} + \sum_{i=1}^{p} g_i \Delta totcredit_{t-i} + e_t$$

$$\Delta y_t = 100 \log\left(\frac{y_t}{y_{t-12}}\right)$$

$$spr = Cost\ of\ Borrowing\ for\ Non-Financial\ Corporations - 3\ Month\ Euro\ Money\ Market\ Rate$$

$$mixnfc = \frac{Loans\ to\ NFC}{Loans\ to\ NFC + Bonds\ Issued\ by\ NFC}$$

Total credit (*totcredit)* consists of loans to NFC and bonds issued by NFC. It is expressed in real terms, i.e. deflated by the CPI.

See the notes to Table 4B for further details on the specification of the estimated regression.

Table 2: Measuring the Asymmetric Effects of the Credit Spread and the Finance Mix on the Turnover of Capital Goods (2004:2-2017:6)									
		Credit Spread				Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
Countries		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Austria	Coefficient	4.36***	-2.26**	0.94	-0.76	1.65*	-0.03	1.59	-1.99**
	[p-val]	[0.000]		[0.51]		[0.10]		[0.12]	
	Adjusted R2	0.89							
Belgium	Coefficient	1.44	-2.07**	1.21	-1.14	0.81	0.79	0.46	-0.86
	[p-val]	[0.16]		[0.29]		[0.64]		[0.93]	
	Adjusted R2	0.77							
Finland	Coefficient	1.13	-2.15**	1.03	-0.84	2.28***	-2.04**	1.41	0.08
	[p-val]	[0.35]		[0.43]		[0.01]		[0.17]	
	Adjusted R2	0.70							
France	Coefficient	1.95**	-2.52***	0.98	-0.42	0.92	1.05	0.59	-0.80
	[p-val]	[0.04]		[0.47]		[0.53]		[0.84]	
	Adjusted R2	0.63							
Germany	Coefficient	2.15**	-4.01***	0.75	-0.41	1.23	1.82*	0.87	1.34
	[p-val]	[0.02]		[0.70]		[0.22]		[0.58]	
	Adjusted R2	0.86							
Greece	Coefficient	1.35	-1.95**	0.94	-0.76	1.88**	-0.24	1.17	0.69
	[p-val]	[0.21]		[0.51]		[0.05]		[0.31]	
	Adjusted R2	0.52							
Italy	Coefficient	4.04***	-2.31***	1.21	1.26	0.76	-0.73	2.12**	2.07**
	[p-val]	[0.000]		[0.28]		[0.69]		[0.02]	
	Adjusted R2	0.69							
Netherlands	Coefficient	2.42***	-2.09**	1.06	0.20	1.13	0.89	1.64*	1.04
	[p-val]	[0.008]		[0.40]		[0.35]		[0.09]	
	Adjusted R2	0.69							

Portugal	Coefficient	0.55	-1.00	0.38	-0.14	0.70	-0.78	0.84	0.16
	[p-val]	[0.87]		[0.57]		[0.75]		[0.61]	
	Adjusted R2	0.37							
Spain	Coefficient	1.20	0.34	0.65	0.22	0.79	1.50	0.64	-1.29
	[p-val]	[0.29]		[0.80]		[0.66]		[0.80]	
	Adjusted R2	0.74							

Note: SoC = sum of coefficients.
See the notes to Table 4B for further details on the specification of the estimated regression.

Table 3A: Measuring the Asymmetric Effects of Short-Term Finance on Industrial Production									
(2004:2-2017:6)									
		Credit Spread				Short-term Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
Countries		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Austria	Coefficient	2.46***	-2.16**	1.39	-0.81	0.78	2.36**	0.37	0.35
	[p-val]	[0.01]		[0.18]		[0.67]		[0.97]	
	Adjusted R2	0.88							
Belgium[a]	Coefficient	1.58	-3.49***	1.17	-2.03**	1.04	1.32	0.84	-0.97
	[p-val]	[0.12]		[0.32]		[0.43]		[0.61]	
	Adjusted R2	0.77							
Finland	Coefficient	1.88**	-4.17***	1.46	-1.24	1.21	-0.67	0.77	-0.92
	[p-val]	[0.05]		[0.15]		[0.29]		[0.68]	
	Adjusted R2	0.88							
France	Coefficient	2.62***	-1.46	0.51	0.43	0.80	-1.05	0.60	-0.60
	[p-val]	[0.004]		[0.90]		[0.65]		[0.84]	
	Adjusted R2	0.85							
Germany	Coefficient	2.27***	-1.37	0.96	0.13	0.37	0.70	0.69	0.10
	[p-val]	[0.01]		[0.49]		[0.97]		[0.76]	
	Adjusted R2	0.93							
Greece	Coefficient	0.96	-1.77*	0.66	1.59	0.78	-0.01	0.93	0.81
	[p-val]	[0.49]		[0.78]		[0.67]		[0.52]	
	Adjusted R2	0.59							
Italy	Coefficient	3.00***	-2.36**	1.89**	1.50	0.98	-0.82	0.51	-0.21
	[p-val]	[0.01]		[0.04]		[0.47]		[0.90]	
	Adjusted R2	0.91							
Netherlands	Coefficient	1.07	-1.74*	0.34	0.20	0.74	0.19	1.12	-2.00**
	[p-val]	[0.39]		[0.98]		[0.71]		[0.35]	
	Adjusted R2	0.64							

Portugal	Coefficient	2.09**	-3.23***	0.42	0.67	0.86	0.54	0.73	-0.72
	[p-val]	[0.02]		[0.95]		[0.59]		[0.72]	
	Adjusted R2	0.61							
Spain	Coefficient	1.12	-1.00	1.19	0.15	0.55	1.06	0.53	-0.28
	[p-val]	[0.35]		[0.30]		[0.88]		[0.89]	
	Adjusted R2	0.92							

[a] Not distinguishing between positive and negative changes in the short-term spread and employing instead simple changes in the short-term spread produces a negative and statistically significant link between lagged changes in the short-term spread and changes in industrial production; the F-test statistic is statistically significant at the 1 percent level.

Table 3B: Measuring the Asymmetric Effects of Long-Term Finance on Industrial Production									
(2004:2-2017:6)									
		Credit Spread				Long-term Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
Countries		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Austria	Coefficient	2.54***	-3.04***	1.39	-1.39	0.86	-2.22**	0.76	-0.89
	[p-val]	[0.01]		[0.18]		[0.59]		[0.69]	
	Adjusted R2	0.89							
Belgium	Coefficient	2.90***	-2.86***	1.85*	-1.85*	0.86	-0.37	1.17	-0.68
	[p-val]	[0.00]		[0.06]		[0.59]		[0.33]	
	Adjusted R2	0.82							
Finland	Coefficient	3.81***	-3.58***	1.97**	-2.44**	1.14	-1.08	0.96	0.99
	[p-val]	[0.00]		[0.04]		[0.33]		[0.50]	
	Adjusted R2	0.89							
France	Coefficient	2.26**	-1.74*	0.63	0.56	1.03	-0.3	0.61	0.82
	[p-val]	[0.01]		[0.81]		[0.43]		[0.83]	
	Adjusted R2	0.85							
Germany	Coefficient	2.21**	-2.07**	0.98	-1.19	1.62*	1.73*	0.76	0.27
	[p-val]	[0.02]		[0.48]		[0.098]		[0.69]	
	Adjusted R2	0.93							
Greece	Coefficient	1.49	-1.64	1.23	0.96	1.55	-3.10***	0.33	0.53
	[p-val]	[0.14]		[0.28]		[0.12]		[0.98]	
	Adjusted R2	0.62							
Italy	Coefficient	4.23***	-5.26***	3.17***	1.33	0.87	-0.76	1.5	0.86
	[p-val]	[0.00]		[0.00]		[0.58]		[0.14]	
	Adjusted R2	0.94							
Netherlands	Coefficient	1.47	-1.56	0.87	-1.87*	0.44	1.27	0.7	-0.26
	[p-val]	[0.15]		[0.58]		[0.95]		[0.75]	
	Adjusted R2	0.64							

Portugal	Coefficient	2.81***	-3.96***	1.45	1.95*	1.34	-2.65***	0.83	-0.04
	[p-val]	[0.00]		[0.16]		[0.21]		[0.62]	
	Adjusted R2	0.67							
Spain	Coefficient	1.54	-1.32	0.94	0.73	1.01	2.44**	1.89**	-2.74***
	[p-val]	[0.12]		[0.51]		[0.44]		[0.04]	
	Adjusted R2	0.92							

Table 4A: Measuring the Asymmetric Effects of Short-Term Finance on Turnover of Capital Goods									
(2004:2 – 2017:8 or 2017:9)									
		Credit Spread				Short-term Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
Countries		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Austria	Coefficient	3.22***	-1.79*	1.11	-0.92	1.52	1.78*	0.73	0.54
	[p-val]	[0.001]		[0.37]		[0.14]		[0.72]	
	Adjusted R2	0.85							
Belgium	Coefficient	2.07**	-4.50***	0.86	-1.16	1.57	2.37**	0.64	-1.27
	[p-val]	[0.03]		[0.56]		[0.13]		[0.80]	
	Adjusted R2	0.74							
Finland	Coefficient	1.88**	-4.17***	1.46	-1.24	1.97**	-0.87	0.80	-0.84
	[p-val]	[0.05]		[0.15]		[0.03]		[0.65]	
	Adjusted R2	0.75							
France	Coefficient	1.94**	-1.96**	0.76	-0.41	0.31	0.61	0.41	-0.48
	[p-val]	[0.04]		[0.69]		[0.99]		[0.96]	
	Adjusted R2	0.59							
Germany	Coefficient	4.13***	-2.95***	1.02	-0.89	0.51	0.31	0.19	-0.33
	[p-val]	[0.001]		[0.43]		[0.90]		[0.99]	
	Adjusted R2	0.87							
Greece	Coefficient	0.96	-1.77*	0.66	1.59	0.92	0.88	0.39	-0.41
	[p-val]	[0.49]		[0.78]		[0.53]		[0.97]	
	Adjusted R2	0.46							
Italy	Coefficient	3.00***	-2.36**	1.89**	1.50	0.45	-0.42	0.64	-0.15
	[p-val]	[0.01]		[0.04]		[0.94]		[0.80]	
	Adjusted R2	0.58							
Netherlands	Coefficient	1.25	-0.98	0.61	0.20	0.71	0.96	1.07	0.14
	[p-val]	[0.26]		[0.83]		[0.74]		[0.39]	
	Adjusted R2	0.64							

Portugal	Coefficient	2.09**	-3.23***	0.42	0.67	1.02	-2.38**	0.83	-1.49
	[p-val]	[0.02]		[0.95]		[0.43]		[0.62]	
	Adjusted R2	0.41							
Spain	Coefficient	1.12	-1.00	1.19	0.15	0.44	0.10	0.81	0.45
	[p-val]	[0.35]		[0.30]		[0.94]		[0.64]	
	Adjusted R2	0.76							

Table 4B: Measuring the Asymmetric Effects of Long-Term Finance on Turnover of Capital Goods									
(2004:2 – 2017:8 or 2017:9)									
		Credit Spread				Long-term Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
Countries		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Austria	Coefficient	4.42***	-1.95*	0.91	-0.58	2.38***	0.17	1.52	-2.45**
	[p-val]	[0.00]		[0.54]		[0.01]		[0.14]	
	Adjusted R2	0.89							
Belgium	Coefficient	2.63***	-1.87*	1.37	-0.003	0.80	0.16	[0.24]	1.24
	[p-val]	[0.008]		[0.21]		[0.65]			
	Adjusted R2	0.74							
Finland	Coefficient	3.36***	-3.66***	1.38	-2.50**	0.87	0.33	1.26	0.61
	[p-val]	[0.00]		[0.19]		[0.58]		[0.25]	
	Adjusted R2	0.73							
France	Coefficient	1.70*	-3.17***	0.60	-1.06	0.87	-0.39	0.76	1.06
	[p-val]	[0.08]		[0.87]		[0.58]		[0.69]	
	Adjusted R2	0.60							
Germany	Coefficient	4.37***	-3.44***	0.80	-1.11	1.21	1.28	0.98	1.55
	[p-val]	[0.00]		[0.65]		[0.29]		[0.47]	
	Adjusted R2	0.88							
Greece	Coefficient	1.71**	-3.38***	1.59	-0.66	2.78***	-2.64***	2.17**	1.09
	[p-val]	[0.08]		[0.12]		[0.003]		[0.02]	
	Adjusted R2	0.55							
Italy	Coefficient	2.82***	-2.96***	2.43***	0.58	0.87	0.99	1.81**	1.95**
	[p-val]	[0.00]		[0.008]		[0.58]		[0.07]	
	Adjusted R2	0.71							
Netherlands	Coefficient	1.67**	-2.24**	0.92	-0.22	1.10	-0.22	1.25	0.30
	[p-val]	[0.08]		[0.53]		[0.36]		[0.26]	
	Adjusted R2	0.65							

Portugal	Coefficient	1.19	-3.55***	1.09	1.22	0.21	-1.11	1.46	3.81***
	[p-val]	[0.30]		[0.39]		[0.998]		[0.15]	
	Adjusted R2	0.41							
Spain	Coefficient	2.55***	-2.57**	0.98	-0.75	0.52	1.41	1.19	-1.16
	[p-val]	[0.005]		[0.48]		[0.90]		[0.30]	
	Adjusted R2	0.79							

Estimated specification of the regression equation (unless indicated otherwise):

$$\Delta y_t = a_0 + \sum_{i=1}^{l} a_i \, \Delta y_{t-i} + \sum_{i=1}^{m} b_i \, \Delta^{+} spr_{t-i}^{j} + \sum_{i=1}^{m} c_i \, \Delta^{-} spr_{t-i}^{j} \sum_{i=1}^{n} d_i \, \Delta^{+} mix_{t-i} + \sum_{i=1}^{n} f_i \, \Delta^{-} mix_{t-i} + \sum_{i=1}^{p} g_i \, \Delta totcredit_{t-i} + e_t$$

where Δy_t = difference of the log of a measure of economic activity (over a twelve-month span).

Δspr_{t-i}^{j}= change of the spread, defined as the cost of borrowing for NFC (non-financial corporations) and the euro-area 3-month money market interest rate. *j=ST (short-term borrowing cost)* for loans with maturity of up to one year or *LT (long(er)-term borrowing cost)* for loans with maturity of more than one but less than five years.

The analogous quantity-based finance mixes appear below:

$$\Delta mix^{ST} = \Delta\left(\frac{Short\ Term\ Loans\ to\ NFC}{Short\ Term\ Loans\ to\ NFC + Short\ Term\ Securities\ issued\ by\ NFC}\right)$$

$$\Delta mix^{LT} = \Delta\left(\frac{Long\ Term\ Loans\ to\ NFC}{Long\ Term\ Loans\ to\ NFC + Long\ Term\ Securities\ issued\ by\ NFC}\right)$$

The long-term mix is based on loans and securities with terms to maturity greater than one year. See footnote 16 for an alternative definition of "long-term".

Table 5: Measuring the Asymmetric Effects of the Credit Spread and the Finance Mix									
Panel A: Industrial Production (2004:2-2017:6)									
		Credit Spread				Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Panel	Coefficient	7.87***	-6.37***	1.44	-2.32**	1.56*	-1.89*	2.36***	-4.18***
	[p-val]	[0.000]		[0.138]		[0.0961]		[0.0052]	
	Adjusted R2	0.82							
Panel B: Turnover of Capital Goods (2004:2-2017:6)									
		Credit Spread				Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Panel	Coefficient	6.95***	-6.32***	1.39	-2.46**	4.72***	0.04	0.61	1.22
	[p-val]	[0.000]		[0.16]		[0.000]		[0.83]	
	Adjusted R2	0.65							

Note: SoC = sum of coefficients.
See equation 13 for further details on the specification of the estimated regression.

Table 6: Measuring the Asymmetric Effects of Short-Term and Long-term Finance									
Panel A: Short-term Finance Industrial Production (2004:2-2017:6)									
		Credit Spread				Short-term Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Panel	Coefficient	10.26***	-6.46***	0.63	-0.22	0.87	-1.99**	2.50***	-3.87***
	[p-val]	[0.000]		[0.819]		[0.573]		[0.003]	
	Adjusted R2	0.82							
Panel B: Short-term Finance on Turnover of Capital Goods (2004:2-2017:6)									
		Credit Spread				Short-term Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Panel	Coefficient	8.57***	-8.02***	0.84	-1.26	0.44	-0.54	1.03	-2.08**
	[p-val]	[0.000]		[0.613]		[0.949]		[0.421]	
	Adjusted R2	0.64							
Panel C: Long-term Finance Industrial Production (2004:2-2017:6)									
		Credit Spread				Long-term Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Panel	Coefficient	13.26***	-6.91***	0.96	-1.15	2.44***	-2.33**	1.55*	-1.76*
	[p-val]	[0.000]		[0.481]		[0.004]		[0.099]	
	Adjusted R2	0.83							
Panel D: Long-term Finance on Turnover of Capital Goods (2004:2-2017:6)									
		Credit Spread				Long-term Finance Mix			
		Positive changes		Negative changes		Positive changes		Negative changes	
		F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC	F-stat	t-stat of SoC
Panel	Coefficient	10.67***	-7.88***	0.90	-1.31	6.14***	-0.89	1.55*	3.28**
	[p-val]	[0.000]		[0.548]		[0.000]		[0.100]	
	Adjusted R2	0.65							

Appendix:

1. Interpreting Changes in the Finance Mix

The intent here is to dissect the observed positive and negative changes in the finance mix variable into changes in their underlying components. Importantly, whether a change in the observed finance mix turns out to be negative or positive depends on the direction and size of the change in loans relative to bonds. Each row in the two tables below represents a hypothesized relationship between changes in bank loans, bonds, the finance mix and economic activity. The first two columns in the tables indicate observed changes in loans and bonds that lead to an observed change in the finance mix in column three. The fourth column shows the hypothesized flow-on effect on economic activity while the entry in column five indicates the expected sign on the coefficient of the change in the finance mix variable in a linear regression specification. The empirical counterpart in the paper is the sum of the lagged coefficients on changes in the finance mix. Column six reconciles the observed changes with existing views on the credit-economic activity relationship.

Suppose our starting point is an observed negative change in the finance mix ($\Delta mix_t < 0$).

ΔL	ΔB	Δmix	Δy	$\frac{\Delta y}{\Delta mix}$	Comment
< 0	> 0	$\Delta mix < 0$	< 0	> 0	Credit substitution hypothesis
> 0	> 0	$\Delta mix < 0$	> 0	< 0	Demand-driven increase of credit
< 0	< 0	$\Delta mix < 0$	< 0	> 0	Demand-driven decrease of credit
> 0	< 0	Not observed in data			

The first row shows the combination of changes in bank loans and bonds that are synonymous with the credit substitution hypothesis: a decrease in loans is accompanied by an increase in bonds outstanding. Changes in both sources of credit lead to an observed negative change in the finance mix in the data. Because of the existence of financial imperfections, the decrease in bank loans cannot be fully offset by an increase in bonds issued, as a result of which economic activity decreases. Rows two and three show alternative scenarios. Both presume that loans and bonds move in the same direction, i.e. that the credit cycle is demand driven. In both scenarios observed changes in loans and bonds lead to a negative change in the finance mix. The two scenarios differ from each other with respect to the presumed effect (expansionary or contractionary) on economic activity. For negative observed changes in the finance mix increases in loans are not paired with decreases in bonds.

Next, consider observed positive changes in the finance mix and their underlying sources ($\Delta mix_t > 0$).

ΔL	ΔB	Δmix	Δy	$\frac{\Delta y}{\Delta mix}$	Comment
< 0	> 0	Not observed in data			Rules out credit substitution hypothesis
> 0	> 0	$\Delta mix > 0$	> 0	> 0	Demand-driven increase of credit
< 0	< 0	$\Delta mix > 0$	< 0	< 0	Demand-driven decrease of credit
> 0	< 0	$\Delta mix > 0$	?	?	Effect depends on substitutability of loans for bonds.

Here we see that our scrutiny of the data reveals that an observed positive change in the finance mix cannot be due to a decrease in bank loans and a simultaneous increase in bonds outstanding. Positive changes in the finance mix cannot be reconciled with the credit substitution hypothesis. Observed positive changes in the finance mix are consistent with demand-driven changes in credit. In case of a decrease in open-market credit and a simultaneous increase in loans, the effect on

economic activity depends on the extent to which bank loans can substitute for the loss of bond finance.

2. Bivariate Granger Causality Tests:
    a. Turnover of Capital Goods: Monthly Time Series Data (2003:2-2017:8); 12 lags

Country	$\Delta TCG \rightarrow \Delta^{+}SPR5$	$\Delta^{+}SPR5 \rightarrow \Delta TCG$	$\Delta TCG \rightarrow \Delta^{+}SPR1$	$\Delta^{+}SPR1 \rightarrow \Delta TCG$
Austria	0.06	0.01	0.16	0.01
Belgium	0.55	0.01	0.42[#]	0.02[#]
Finland	0.27	0.01	0.21	0.01
France	0.33	0.01	0.81	0.01
Germany	0.86	0.01	0.70	0.01
Greece	0.22	0.24	0.53	0.02
Italy	0.26	0.01	0.01	0.01
Netherlands[#]	0.90	0.07	0.63	0.04
Portugal	0.97[#]	0.49[#]	0.88	0.88
Spain	0.01	0.01	0.01	0.01

The numbers indicate the probability that the exclusion restrictions on lags of the first variable to predict the second variable in the estimated specification can be rejected by means of a Chi-square test.
[#] denotes 6 lags.
ΔTCG= Change in the turnover of capital goods
$\Delta^{+}SPR5$= Positive change in the long-term credit spread
$\Delta^{+}SPR1$= Positive change in the short-term credit spread

    b. Industrial Production: Monthly Time Series Data (2003:2-2017:8); 12 lags

Country	$\Delta IP \rightarrow \Delta^{+}SPR5$	$\Delta^{+}SPR5 \rightarrow \Delta IP$	$\Delta IP \rightarrow \Delta^{+}SPR1$	$\Delta^{+}SPR1 \rightarrow \Delta IP$
Austria	0.01	0.01	0.01	0.03
Belgium	0.46	0.01	0.99[##]	0.05[##]
Finland	0.21	0.01	0.20	0.01
France	0.02	0.01	0.21	0.01
Germany	0.60	0.01	0.05	0.01
Greece	0.03	0.18	0.58[#]	0.03[#]
Italy	0.01	0.01	0.01	0.01
Netherlands	0.63	0.01	0.02	0.04
Portugal[#]	0.04	0.01	0.09	0.01
Spain	0.01	0.10	0.01	0.01

ΔIP = Industrial production
$\Delta^{+}SPR5$= Positive change in the long-term credit spread
$\Delta^{+}SPR1$= Positive change in the short-term credit spread
[##] denotes 4 lags.

c. Panel Data

Pairwise Dumitrescu Hurlin Panel Causality Tests

Sample: 2003:2 2017:8
Lags: 12

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
Δ^+SPR5 does not homogeneously cause ΔTCG	34.2955	13.3090	0.01
ΔTCG does not homogeneously cause Δ^+SPR5	12.5965	0.24398	0.81

The first hypothesis is clearly rejected while the second is not.

Sample: 203:02 2017:8

Lags: 12

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
Δ^+SPR1 does not homogeneously cause ΔTCG	29.9869	10.7147	0.01
ΔTCG does not homogeneously cause Δ^+SPR1	12.1135	-0.04684	0.96

The first hypothesis is clearly rejected while the second is not.

Sample: 2003:2 2017:7
Lags: 12

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
Δ^+SPR5 does not homogeneously cause ΔIP	34.6665	13.5568	0.01
ΔIP does not homogeneously cause Δ^+SPR5	22.1566	6.01249	0.01

Pairwise Dumitrescu Hurlin Panel Causality Tests(cont.)

Sample: 2003:2 2017:7
Lags: 12

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
$\Delta^{+}SPR1$ does not homogeneously cause ΔIP	27.1816	9.04289	0.01
ΔIP does not homogeneously cause $\Delta^{+}SPR1$	23.9957	7.12157	0.01

For the case of industrial production the existence of bivariate causality cannot be ruled out.

3. Results Based on Five-Variable VAR
   a. Turnover of Capital Goods: Monthly Time Series Data (2003:2-2017:8); 12 lags

Country	$\Delta TCG \rightarrow \Delta^{+}SPR5$	$\Delta^{+}SPR5 \rightarrow \Delta TCG$	$\Delta TCG \rightarrow \Delta^{+}SPR1$	$\Delta^{+}SPR1 \rightarrow \Delta TCG$
Austria	0.01	0.01	0.77	0.01
Belgium[#]	0.69	0.06	0.51	0.08
Finland	0.82	0.01	0.22	0.03
France	0.07[#]	0.01[#]	0.41	0.01
Germany	0.94	0.01	0.85	0.01
Greece	0.79	0.17	0.78	0.53
Italy	0.66	0.04	0.01	0.10
Netherlands	0.83	0.12	0.72[#]	0.08[#]
Portugal	0.82	0.49	0.93	0.47
Spain	0.01[#]	0.01[#]	0.16	0.01

The variables included are: turnover of capital goods, positive changes of the credit spread, negative changes of the credit spread, real (short or long-term) total credit outstanding, and the CPI inflation rate.
The numbers indicate the probability that the exclusion restrictions on lags of the first variable to predict the second variable in the estimated specification can be rejected by means of a Chi-square test. The test follows the procedure suggested by Toda and Yamamoto (1995) except that the estimated specification is in changes of the data.
[#] denotes 6 lags.
ΔTCG= Change in the turnover of capital goods
$\Delta^{+}SPR5$= Positive change in the long-term credit spread
$\Delta^{+}SPR1$= Positive change in the short-term credit spread

b. Industrial Production: Monthly Time Series Data (2003:2-2017:8); 12 lags

Country	$\Delta IP \rightarrow \Delta^{+}SPR5$	$\Delta^{+}SPR5 \rightarrow \Delta IP$	$\Delta IP \rightarrow \Delta^{+}SPR1$	$\Delta^{+}SPR1 \rightarrow \Delta IP$
Austria	0.01	0.01	0.07	0.04
Belgium	0.46#	0.04#	0.49	0.14
Finland	0.97	0.01	0.43	0.05
France	0.01	0.03	0.02	0.01
Germany	0.60	0.04	0.39	0.03
Greece	0.08	0.01	0.56#	0.03#
Italy	0.25	0.01	0.01#	0.03#
Netherlands#	0.77	0.08	0.01	0.26
Portugal#	0.24	0.01	0.16	0.01
Spain	0.01	0.01	0.01	0.04

ΔIP = Industrial production
$\Delta^{+}SPR5$= Positive change in the long-term credit spread
$\Delta^{+}SPR1$= Positive change in the short-term credit spread
# denotes 6 lags.

4. Panel Data: Granger-Causality Tests on VAR Specification (12 lags)

Sample Range: 2003:2 2017:8
1574 observations for industrial production
1549 observations for turnover of capital goods

Dependent variable: $\Delta^{+}SPR5$

Excluded	Chi-sq	df	Prob.
ΔTCG	20.74	12	0.05

Dependent variable: ΔTCG

Excluded	Chi-sq	df	Prob.
$\Delta^{+}SPR5$	104.04	12	0.01

Dependent variable: $\Delta^{+}SPR1$

Excluded	Chi-sq	df	Prob.
ΔTCG	20.60	12	0.06

Dependent variable: ΔTCG

Excluded	Chi-sq	df	Prob.
$\Delta^{+}SPR1$	87.90	12	0.01

Dependent variable: $\Delta^{+}SPR5$

Excluded	Chi-sq	df	Prob.
ΔIP	37.98	12	0.01

Dependent variable: ΔIP

Excluded	Chi-sq	df	Prob.
$\Delta^{+}SPR5$	136.90	12	0.01

Dependent variable: $\Delta^{+}SPR1$

Excluded	Chi-sq	df	Prob.
ΔIP	67.02	12	0.01

Dependent variable: ΔIP

Excluded	Chi-sq	df	Prob.
$\Delta^{+}SPR1$	102.70	12	0.01

The block exogeneity tests for the panel data suggest bi-directional causality between positive changes in the credit spread and changes in economic activity. The country-specific time series evidence is far stronger for the view that positive changes in the spread lead to subsequent decreases in the turnover of capital goods than the other way around. For industrial production a somewhat murkier picture emerges, though on balance it appears that causality from positive changes in the spread to changes in industrial production is more evident in the data than vice versa.

There are slight differences between the results from the vector autoregressions and the results reported in the paper. The VAR specification upon which the block exogeneity restrictions are tested includes more variables and a longer lag structure (typically 14 instead of 12). The longer lag structure is required by the Toda-Yamamoto procedure.

In case there was no evidence of causality at a 12-month lag, we reduced the lag length to 6 months and in one case even to 4 months.

5. Data Series:

Series (followed by ECB Warehouse identifier (for Austria)):

Bonds: SECURITIES OTHER THAN SHARES, EXCLUDING FINANCIAL DERIV
SEC.M.AT.1100.F33000.N.1.Z01.E.Z
SHORT-TERM SECURITIES OTHER THAN SHARES SEC.M.AT.1100.F3…
LONG-TERM SECURITIES OTHER THAN SHARES SEC.M.AT.1100.F3….

Bank Loans: UP TO 1 YEAR BSI.M.AT.N.A.A20.F.1.U2.2240.Z01.E END OF
OVER 1 AND UP TO 5 YEARS BSI.M.AT.N.A.A20.I.1.U2.2240.Z

OVER 5 YEARS BSI.M.AT.N.A.A20.J.1.U2.2240.Z01.E END OF
TOTAL BSI.M.AT.N.A.A20.A.1.U2.2240.Z01.E END OF PERIOD

Cost of Borrowing: MIR.M.AT.B.A2I.AM.R.A.2240.EUR.N AUSTRIA AVERAGE OF OBSERVATIONS
MATURITY OVER 5 YEARS MIR.M.AT.B.A20.J.R.A.2240.EUR.O
MATURITY OVER 1 YEAR UP TO 5 YEARS MIR.M.AT.B.A20.I.R.A.2240.EUR.O
MATURITY UP TO 1 YEAR MIR.M.AT.B.A20.F.R.A.2240.EUR.O

Three month money market rate: Eurostat

Industrial Production Index: Total Industry - NACE Rev2; Eurostat; Working day and seasonally adjusted.
Turnover in Industry Index: MIG - Capital Goods Index Eurostat, seasonally adjusted.

References:

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