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Measuring and Testing Complementarity and Co-evolution in Financial Systems

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Abstract

The distinction between bank- and market-based economies has a long tradition in applied macroeconomics. The two types of financial architecture differ not only with respect to the amount of funds channeled through private banking versus the capital market but with respect to several other characteristics, suggesting a competitive rather than a complementary relation between bank- and market-based institutions. Following the idea of Song and Thakor (2010) we test for the hypothesis that the efficiency of financial systems increases for more balanced financial systems, featuring both kinds of institutions in equal measure. We compute an index of complementarity and relate this index and other variables representing various feedback channels fur co-evolution to measures for the efficiency of credit and capital markets in a panel of industrial countries.

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1 Introduction

Firms need up-front external funds to finance their investment plans, production processes and deliveries, i.e. to exploit and develop market opportunities. Therefore, efficient ways to transfer capital from savers to firms become crucial for economic development. From an intertemporal perspective, financial systems allow private households to smooth consumption and firms to spread their expenditures over time. Moreover, financial systems offer risk sharing mechanisms to households and firms alike (Allen and Gale, 2000). Financial development also exerts an influence on the organization of production and the market structure, specifically the degree of vertical integration within an industry responds to easier start-up finance and to readily accessible expansion finance (Macchiavello, 2012). This reasoning highlights the importance of an efficient financial system for social welfare and motivates the comparison of systems with different institutions, specifically we are interested in the efficiency of financial markets versus financial intermediaries in collecting and allocating funds.

Standard microeconomic theory and the ability of markets to reveal scarcities through price signals (Hayek, 1945) provide a strong indication for the higher efficiency of market-based systems. The first theorem of welfare economics shows the implications of a frictionless financial market in the sense of Arrow-Debreu-MacKenzie (ADM). Under the assumptions of perfect competition, absence of taxes and transaction costs, full information, and convex preferences a Walrasian equilibrium will always yield a Pareto efficient allocation. This result also holds under uncertainty if financial markets are complete. Competition among investors and firms will spread information and risks widely across market participants and provides correct signals for efficiently allocating risks and resources. If the ADM-assumptions are violated, e.g. by asymmetric information, incomplete markets, transaction costs, or lack of perfect competition, the development of financial institutions and intermediaries may mitigate market failures and offer a second-best alternative (Allen and Gale, 2000).

Already a minor deviation from the ADM-assumptions like the introduction of costs of information gathering weakens the comparative advantage of market solutions to detect the equilibrium prices of assets because the possibility of free-riding creates an incentive to avoid the costs of information collection (Stiglitz, 1985). Financial intermediaries, on the other hand, usually have a large stake in the firm and they benefit from returns to scale and scope in monitoring standardized business projects thus offering minimum costs of monitoring (Diamond, 1984). Then again

financial markets have an advantage in evaluating new business projects with diverse opinions on best management practice and their net present value (Allen and Gale, 1999).

Arguments from contract theory provide another example for particular characteristics of financial markets and intermediaries which are favorable under different circumstances. Securities, for example, create a distant relation between potentially many investors and a single firm. If moral hazard is a dominant problem between investors and the borrower, securities may provide a credible commitment device because contract changes are difficult to implement. On the other hand, the credit contract between the intermediary and the firm is a bilateral and close relation, thus in a risk-sharing problem it offers benefits from the potential for continuous contract renegotiations (Allen and Gale, 2000). Private equity is an example for a close and non-public relationship between investor and borrower blurring the distinction between market- and bank-based finance.

These examples show that financial markets and intermediaries treat information in different ways and that their comparative advantage stands out under alternative circumstances. It appears self-evident to conclude that financial markets and intermediaries complement rather than compete with each other (Holmstrom and Tirole, 1997; Boyd and Smith, 1998; Sylla, 1998; Huybens and Smith, 1999). This may explain the empirical evidence by King and Levine (1993), Demirguc-Kunt and Maksimovic (1998), Levine and Zervos (1998), Rajan and Zingales (1998), Beck and Levine (2002), Levine (2002), and Hahn (2008) confirming the importance of financial system development for economic growth or the creation of new establishments, while the use of either market- or bank-based institutions themselves does not emerge as a significant explanatory variable.

Song and Thakor (2010) develop a model supporting this idea by creating a positive feedback loop between improved efficiency in the banking sector and a bigger capital market. Their model assumes three sources of financial funds for a borrower: (i) direct capital market financing, (ii) securitization of loans by banks, and (iii) relationship loans from banks. Without a feedback loop between credit and capital markets the model predicts a competitive relation between banks and market-based finance. If a feedback loop is introduced a complementary relation emerges and bank- and market-based institutions co-evolve.

Two frictions in the Song and Thakor (2010) model impair the ability of borrowers to receive funds from savers. The first friction results from observationally identical heterogeneous bor-

rowers with different degrees creditworthiness. Banks possess a certification technology which enables them to distinguish authentic borrowers from crooks. Typically they are better at screening borrowers than capital markets yet the precision of bank screening is not perfect. Banks will therefore sometimes refuse credit to creditworthy borrowers or incur losses from loans to crooks. The second friction results from diverging views between firms and those providing finance about a project's surplus. This financing friction makes capital markets more costly.

Song and Thakor (2010) connect banks to the capital market by introducing the securitization of loans and the requirement for bank solvency capital into their model. Securitization implies that the bank certifies a borrower but then shifts the credit into a special purpose vehicle which is then financed by the capital market. Consequently, securitization transmits technological improvements in the certification technology of banks to the capital market and helps to reduce the financing friction by increasing liquidity. The other link from the capital market to the banking sector is bank equity. Regulatory requirements force banks to raise their solvency capital if they provide more riskier loans. If capital market development reduces the bank's financing friction its cost of bank equity will decline and banks are able to offer loans to more risky borrowers. The requirement for solvency capital transmits capital market advances to banks and closes the feedback loop.

In this paper we aim to test the conclusion by Song and Thakor (2010) that more complementary financial systems allocate funds more efficiently to households and firms. Our measure of efficiency is based on transaction costs in credit and capital markets. We construct an index of complementarity between the banking sector and the capital market which is based on variables already included in the conglomerate index of financial structure suggested by Demirguc-Kunt and Levine (1999). We rearrange the components of the conglomerate index in a way to reflect the complementary relation between markets and intermediaries rather than a competitive interaction between them. Our complementarity index takes on high values for countries with a more balanced structure between financial markets and intermediaries. Low values, on the other hand, indicate countries with a financial system which is either dominated by markets or by intermediaries. Our fundamental question is: Are countries with more complementary financial systems more efficient in transferring capital from savers to investors and are the channels suggested by Song and Thakor (2010) responsible for the creation of positive feedback loops?

Our measure for the efficiency of financial markets is based on the wedge between what

households earn on their savings and what firms have to pay for external finance. This concept uses the frictionless ADM-model by Freixas and Rochet (1997) with a fictitious banking sector as the starting point. In this model the interest rates on deposits, loans, and securities are identical, i.e. there is no spread between borrowers' and lenders' interest rates. Allowing for deviations from the ADM-assumptions creates a business opportunity for financial intermediaries and therefore interest rate spreads and fees for financial services. We consider a financial system more efficient if the interest rate spread or the level of fees is small relative to the amount of assets under management.

In the following we relate transaction costs in financial markets to our index of complementarity and to variables measuring co-evolution like the level of securitization and the amount of bank equity. A view at the balance sheet of banks in 2008 reveals a more traditional channel between banks and capital markets: banks issue bonds for refinancing purposes. The issuance of bonds provides a considerably stronger link between banks and the capital market than securitized assets or bank equity. In 2009 the average ratio of bonds to loans in our cross country sample was 0.29, while this ratio for securitized assets amounted to 0.04 and that of bank equity to 0.13. Consequently, we add the volume of bonds issued by banks as an additional indicator for co-evolution to our empirical model. We apply panel random coefficient and generalized equation estimators to a macro panel composed of industrialized countries.

Our approach is somehow related to the analysis of the determinants for bank profitability and efficiency in the banking sector but we concentrate on indicators for the wedge between the cost of finance and the yield earned by households rather than returns on equity or operational costs. Nevertheless, this literature provides a set of useful conditioning factors for our model. For example Hancock (1985) examines the effect of monetary policy changes on bank profitability for a panel of US-commercial banks. She concludes from the estimation of a translog profit function that bank profits increase in response to a raise in monetary policy rates. This result is confirmed by Saunders and Schumacher (2000) in a panel of individual banks from six European countries and the USA. Additionally, they identify the degree of competitiveness in the banking market as a significant source for the cross-country variation in profitability. For an international panel of banks Demirguc-Kunt and Huizinga (2001) show that bank margins and profits decline with the level of financial development of a country. Out of several macroeconomic variables only the cross country variation in inflation and tax rates were significant. In a test for the persistence

of bank profitability with a panel of commercial, savings, and co-operative banks from five major European economies Goddard et al. (2004) identify the GDP growth rate as a significant macroeconomic indicator of the business cycle. Albertazzi and Gambacorta (2009) take a macro-prudential view and use aggregate data from the OECD bank profitability data base to analyze the response of bank profitability to business cycle variations. They use OECD data for ten industrialized countries over the period 1981 through 2003 and find strong pro-cyclicality of net interest income and loan provisions. Furthermore, financial development, gross domestic product, and the long-term interest rates significantly explain income and cost components in the banking sector. Dietrich and Wanzenried (2011) provide a short survey on the literature about the relation between the profitability of banks and firm specific, industry specific, and aggregate variables. We will use the significant variables identified in those studies as conditioning information in order to achieve reliable estimates for the indicators of complementarity and co-evolution. Variables that are constant or almost constant over time, like the degree of competitiveness in a country's banking market, will not be included in the model, because they are already captured by the unobserved fixed component of panel estimators.

In the following section we present our index of complementarity and section 3 derives the ADM equilibrium condition for fully efficient financial markets. Deviations from the ADM-assumptions create a wedge between interest rates on deposits and loans as well as fees for security transactions. We discuss the data and estimation techniques subsequently and present the results in section 6; finally we conclude.

2 A measure for complementary in financial markets

The conglomerate index of financial structure suggested by Demirguc-Kunt and Levine (1999) is a continuous number increasing in the extent of market-based finance of domestic firms and households. The index compares the level of financial activity channeled through the stock market to that intermediated by private banks. The index combines indicators of size, activity, and efficiency (total assets of banks, TAB, private credit by banks, PCB, the stock market capitalization, SMC, overhead costs of banks, OCB, and the stock market total traded value, SMT) into an index. The first two components of the conglomerate index are the ratio of the stock market capitalization to deposits at banks, A_{it}, and the ratio of the stock market total traded value to private credits by banks, B_{it}:

$$A_{it} = \frac{SMC_{it}}{TAB_{it}} \qquad B_{it} = \frac{SMT_{it}}{PCB_{it}}. \tag{1}$$

Both components are computed for each country i and year t. Furthermore, Demirguc-Kunt and Levine (1999) use the ratio of bank overhead costs to total assets of banks and multiply it by the stock market total traded value to GDP ratio to compute the third component, C_{it} [1]:

$$C_{it} = \frac{OCB_{it}}{TAB_{it}} \frac{SMT_{it}}{GDP_{it}}. \tag{2}$$

Then all three components, A_{it}, B_{it}, and C_{it} are mean corrected by subtracting the mean over all countries and years, cf. in the case of the stock market capitalization to deposit at banks ratio we obtain $a_{it} = (A_{it} - A_{..})$, where $A_{..}$ represents the mean of A_{it} across countries and years. Finally, the index of financial market structure, IFS_{it}, is computed as the average of the three components:

$$IFS_{it} = \frac{a_{it} + b_{it} + c_{it}}{3}. \tag{3}$$

A higher value of this index clearly indicates a higher degree of market-based finance for country i.

In order to obtain a measure of complementarity in financial markets we rearrange the first two components of the index by Demirgurc-Kunt and Levine such that those components increase if marked and bank-based characteristics within a country are more balanced. Specifically, we compute products rather than ratios between marked- and bank-based variables and normalize all variables with respect to GDP to make numbers comparable across countries:

$$A^*_{it} = \frac{TAB_{it}}{GDP_{it}} \frac{SMC_{it}}{GDP_{it}} \qquad B^*_{it} = \frac{PCB_{it}}{GDP_{it}} \frac{SMT_{it}}{GDP_{it}}. \tag{4}$$

By construction the modified ratios achieve a maximum if market- and bank based finance are of equal size, i.e. they grow with the degree of complementarity within an economy but take small values for one-sided funding by either credit or capital market instruments. This hump shape pattern is illustrated in Figure 1 for a stylized economy. If the economy is fully market-based, firms will be completely financed by securities and equity and the economy will

[1] All data are from the current release of the World Bank Financial Development and Structure Dataset, http://go.worldbank.org/X23UD9QUX0.

show up at the origin of the horizontal axis with a low value of the index of complementarity. In a fully bank-based economy firms will be completely financed by loans and they will show up at the right hand corner again with low values of the complementarity index. The index of complementarity will consequently have low values at both extreme points but will have its maximum if market- and bank-based features are balanced. The third indicator, C_{it}, does not have a similar reinterpretation; we therefore take C_{it} as in Demirguc-Kunt and Levine. Again we subtract means across countries and years from the modified components, making the index of complementity, IC_{it}, increasing in the size of financial markets within country i relative to the sample average:

$$IC_{it} = \frac{a^*_{it} + b^*_{it} + c_{it}}{3}. \tag{5}$$

The demeaning is indicated in Figure 1 by the dashed horizontal line. Countries above this mean have highly developed financial markets, in the sense that deposits, loans, and other means of finance are large in comparison to GDP. Countries with less developed financial markets will show up below the dashed line, as their financial indicators are comparatively small.

As a further illustration, we show in Figure 2, a ranking of the countries according to the conglomerate index by Demirgurc-Kunt and Levine (left panel) and compare it to the index of complementarity (right panel). In general most of the bank-based countries also have a one-sided financial structure, whereas more marked-based countries appear as neutral with respect to the index of complementarity.

The index of co-evolution reveals a new financial architecture classification with Switzerland, the United-Kingdom, and the Netherlands showing-up as very complementary systems, whereas the United States, Sweden, and Finland are identified as less balanced financial markets. The very bank-based economies Austria and Portugal also have one-sided financial markets and middle of the ground economies like Greece and Norway appear to have very one-sided financial markets.

3 Measures for the efficiency of financial markets

The Arrow-Debreu-MacKenzie (ADM) general equilibrium model presented in by Freixas and Rochet (1997) serves as our theoretical starting point for the empirical work. Notice that this choice is motivated by the fact that the ADM-model provides an excellent starting point to assess

the efficiency of a financial system because the transfer of funds from households to firms is not constrained by frictions. The model economy is populated by households, firms, and banks. Under the assumptions of perfect competition, the absence of taxes and transaction costs, full information, and convex preferences the only possible equilibrium solution has equal interest rates on deposits, securities, and loans.

In the following we will briefly describe the optimization problems for households, firms, and banks in a two-period model and their solution.

Household's Problem.

The representative household chooses a utility maximizing consumption, C_t, profile over the two periods using deposits , D^+,and securities, B_h, to transfer funds from the first, $t = 1$, to the second, $t = 2$, period:

$$\begin{aligned} & \max u(C_1, C_2) \\ \mathcal{P}_h \quad & C_1 + B_h + D^+ = \omega_1 \qquad (6) \\ & C_2 = \pi_f + \pi_b + (1+r)B_h + (1+r_D)D^+, \qquad (7) \end{aligned}$$

where ω_1 represents the initial endowment with consumption goods. The firms', π_f, and the banks' profits, π_b, are distributed to the household in $t = 2$. The representative household chooses a consumption profile (C_1, C_2), so as to maximize utility, u, under the two budget constraints (6)-(7). Finally, r and r_D denote the interest rates paid on securities and deposits, which are considered to be perfect substitutes.

Combining budget constraints for $t = 1, 2$ we get:

$$C_1 + \frac{1}{(1+r)}C_2 = \omega_1 - B_h - D^+ + \frac{1}{(1+r)}\Big[\pi_f + \pi_b + (1+r)B_h + (1+r_D)D^+\Big]. \qquad (8)$$

We solve the consumer problem by the Lagrange-Multiplier method. The Lagrange function is:

$$L = u(C_1, C_2) + \lambda\Big[C_1 + \frac{1}{(1+r)}C_2 - \omega_1 + B_h + D^+ - \frac{\pi_f}{(1+r)} - \frac{\pi_b}{(1+r)} - B_h - \frac{(1+r_D)}{(1+r)}D^+\Big],$$

with the following first-order conditions:

$$\frac{\partial \mathcal{L}}{\partial C_1} = \frac{\partial u}{\partial c_1} + \lambda = 0, \tag{9}$$

$$\frac{\partial \mathcal{L}}{\partial C_2} = \frac{\partial u}{\partial c_2} + \frac{\lambda}{1+r} = 0, \tag{10}$$

$$\frac{\partial \mathcal{L}}{\partial B_h} = \lambda - \lambda = 0, \tag{11}$$

$$\frac{\partial \mathcal{L}}{\partial D^+} = \lambda - \frac{\lambda(1+r_d)}{1+r} = 0. \tag{12}$$

The last first-order condition (12) directly yields

$$r = r_D.$$

Firm's Problem.

The firm maximizes its profit with the following program:

$$\begin{aligned} & \max \pi_f \\ \mathcal{P}_f \quad & \pi_f = f(I) - (1+r)B_f - (1+r_L)L^- && (13) \\ & I = B_f + L^-, && (14) \end{aligned}$$

where f represents the production function of the representative firm depicting the relation between the only input investment, I, and output. Investment spending is financed by either issuing securities, B_f, or by taking out loans, L^-. Interest rates on loans is denoted by r_L and the interest rate on securities by r. The choice variables of the firm are the investment level and both sources of finance.

We use again the Lagrange-Multiplier method to solve the firm's program by taking the first order conditions of the Lagrange function:

$$
\begin{aligned}
L &= f(I) - (1+r)B_f - (1+r_L)L^- + \lambda(I - B_f - L^-) \\
\frac{\partial \mathcal{L}}{\partial B_f} &= -(1+r) - \lambda = 0 \qquad (15) \\
\frac{\partial \mathcal{L}}{\partial L^-} &= -(1+r_L) - \lambda = 0. \qquad (16)
\end{aligned}
$$

As noted by Freixas and Rochet (1997) the only interior solution for (15)-(16)) requires:

$$r = r_L.$$

Bank's Problem.

The objective of the bank is to maximize its profit, π_b:

$$
\begin{aligned}
& \max \pi_b \\
\mathcal{P}_b \quad & \pi_b = r_L^+ - rB_b - r_D D^- \qquad (17) \\
& L^+ = B_b + D^-, \qquad (18)
\end{aligned}
$$

consisting of the difference between the interest received and paid. The variables L^+ and D^- represent the supply of loans and the demand for deposits by the bank, respectively. The Lagrange function and the first-order conditions of the bank's problem are:

$$
\begin{aligned}
L &= \pi_b - r_L L^+ + rB_b + r_D D^- + \lambda(L^+ - B_b - D^-) \\
\frac{\partial \mathcal{L}}{\partial B_b} &= r - \lambda = 0 \qquad (19) \\
\frac{\partial \mathcal{L}}{\partial D^-} &= r_D - \lambda = 0 \qquad (20) \\
\frac{\partial \mathcal{L}}{\partial L^+} &= -r_L + \lambda = 0, \qquad (21)
\end{aligned}
$$

and give the following solution to the bank profit maximization problem:

$$r = r_D = r_L. \tag{22}$$

The equality of interest rates is the only possible general equilibrium solution of this model and implies that banks make zero profit in equilibrium (Freixas and Rochet, 1997). Banks are redundant in this model and the size and composition of the bank's balance sheet have no feedback on other agents in the model. This result carries over to the case of uncertainty as long as financial markets are complete.

Song and Thakor (2010) add incomplete information between borrowers and lenders and valuable services provided by banks to households and firms. A borrower has three sources of finance at disposal: (1) issuing equity directly at the capital market, (2) taking out a relationship loan from a bank, or (3) using the screening services of a bank but tapping capital markets indirectly through a securitized loan. The choice between these three sources depends on the ability of the borrower to solve the certification and the financing friction, respectively. The certification friction arises from observationally equivalent but heterogeneous borrowers, who differ with respect to their creditworthiness. If the certification friction becomes more serious, the likelihood of credit rationing increases and even creditworthy borrowers will be refused a credit. The financing friction results from a valuation discount by investors relative to the valuation of the project surplus by borrowers.

In this model the bank screens borrowers before lending and offers accepted borrowers a relationship loan to realize the project. The bank incurs costs from screening, issuing equity and setting up a branch network to collect deposits. The securitization of a loan is attractive to the bank if it is able to identify borrowers with high enough creditworthiness and avoids holding capital against the securitized loan. For securitized loans the bank incurs screening costs, fixed costs of setting-up the special purpose trust to which the loan is transferred, costs for the collateral which compensates investors in case of a default by the borrower, and funding costs. Borrowers opting for direct finance through capital markets will receive funds only from investors with a low level of disutility in case of a default by the borrower. The costs for direct market access are limited to the valuation discount and induce the finance friction.

Financial development in this model results from improved screening technologies of banks. A better screening technology enables banks to offer loans to previously unaccepted borrowers and

consequently the certification friction becomes less binding. In this case banks need additional funds by either securitizing loans or issuing equity, consequently broadening capital markets. Capital markets evolution results from a deepening of the securities market and organizing trading platforms that facilitate information collection by investors. Both developments attract new investors, hitherto absent from the capital market, to invest in securities and consequently liquidity increases and financing costs for the borrower decline. The complementary relation between bank- and market-based institutions results in a co-evolution of both sectors because they mutually support each other: Technological progress provides additional securities from banks to the market and higher investor participation expands the funds available to banks and financing costs for a project decline.

4 Data and Estimation

The general equilibrium solution 22 serves as a benchmark for a more complex world in which transaction costs and incomplete information characterize the relation between households, financial intermediaries, and firms and in which banks offer services in addition to the pure reallocation of funds. In this case the equality condition from the Arrow-Debreu world will be violated and fees for the services of banks, brokers and other intermediaries will create a wedge between interest rates on deposits, loans, and on securities. We interpret financial systems as being more efficient, if this wedge is smaller.

Intermediation fees are either hidden in interest rates spreads or directly charged as fees and commissions. They represent a second best solution for channeling funds from savers to investors under asymmetric information. The size of transaction costs reflects the degree of inefficiency in a financial market with respect to the first best solution characterized by equation 22.

Credit market efficiency can be measured by using the discrepancy between interest paid on deposits and loans. The national accounts system uses Financial Intermediation Services Indirectly Measured (FISIM) in order to derive the value added in the banking sector resulting from this spread. Since these data are not available for the whole sample period from 1992 to 2009, we use an alternative measure based on OECD data for interest income and interest expenses in the banking sector. To get a comparable measure across countries, we normalize the difference between interest income and expenses by the stock of loans:

$$\text{Credit market efficiency}_{it} = \frac{\text{Interest income}_{it} - \text{Interest expenses}_{it}}{\text{Loans}_{it}}. \tag{23}$$

Intermediation fees in the capital markets, on the other hand, show up as fees and commissions to brokers and investment banks paid by households and firms. For this reason we directly collect the income from fees and commissions in the banking sector and relate this figure to the stock market turnover.

$$\text{Capital market efficiency}_{it} = \frac{\text{Fees and commissions receivable}_{it}}{\text{Stock market value traded}_{it}}. \tag{24}$$

The two critical links in the Song and Thakor (2010) model creating a virtuous circle between bank- and market-based finance are the securitization of loans and the issuance of equity by banks. Co-evolvement implies that securitization improves the liquidity of capital markets alleviating the financing friction. The less costly access to financial funds then increases the ability of banks to provide loans, in turn relaxing the certification friction. The positive feedback loop in the Song and Thakor model suggests that economies with a more complementary financial sector, i.e. with large volumes of bank bonds, bank equity, and securitized assets should have higher credit and capital market efficiency compared to economies with one-sided financial systems and weaker links between banks and the capital market. We use the amount of securitized financial assets issued in a country (securitization), total equity of the banking sector, and the amount of bonds issued by banks for refinancing purposes (bonds) as direct measures for the role of co-evolution between banks and the capital market [2]. Tables 1 and 2 provide summary statistics for our data and reveal considerable negative correlation between transaction costs and the index of complementarity. The correlation between explanatory variables is low in most cases.

5 Estimation

We test the hypothesis that a higher degree of complementarity results in lower transaction costs of finance. Furthermore, the concept of co-evolvement suggests a relation between the issuing activity of banks on the capital market and the size of transaction costs. We will test for

[2] All variables are divided by the amount of outstanding loans. The OECD data set minimizes errors from differences in data collection and classifications across countries and improves comparability.

complementarity and co-evolvement in a macro panel of 19 industrialized countries for the period 1992 through 2009 [3]. The F-test by Hsiao (1986) on the homogeneity of the k slope parameters in the panel regression produces an F-statistic of 28.3 with a p-value of zero. We thus reject the hypothesis of common slope parameters and proceed with a panel random coefficient model:

$$y_{it} = \sum_{k=1}^{K} \beta_{ki} x_{kit} + u_{it} \tag{25}$$

$$= \sum_{k=1}^{K} (\beta_k + \alpha_{ki}) x_{kit} + u_{it}, \tag{26}$$

where y_{it} represents the explained variable, in our case the indicators of financial market efficiency and x_{kit} includes the constant and $K-1$ time varying explanatory variables. The parameters of this model β_{ki} are split into a common mean across countries, β_k, and stochastic country specific deviations from this mean, α_{ki}. We have no reason to believe that the random coefficients are correlated among each other, thus we consider α_{ki} as random variables with zero mean and constant diagonal covariance matrix Ω. The regression error, u_{it}, is assumed to be identically and independently distributed with zero mean and block diagonal covariance matrix (Hsiao, 1986).

The random coefficient models does not account for the non-negativity and the noticeable positive skewness of the dependent variables shown in the density probability plot of Figure 3 as diamonds [4]. Both characteristics suggest a generalized estimating equation (GEE) with a Gamma distribution $\Gamma(\mu, \nu)$ for y_{it} as a reasonable alternative to the random coefficient model. A Maximum Likelihood estimate of the two parameters of the Gamma density gives $\mu = 6.38$ and $\nu = 0.006$ and the solid line in Figure 3 shows a close fit of this simple model.

The GEE is an extension of the Generalized Linear Model to longitudinal data with a possibly correlated error structure by Liang and Zeger (1986). The basic specification of a GEE is as follows:

[3] These are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and the USA.

[4] A similar distribution is also found by Berger (1993) for inefficiency scores for US banks with statewide branching.

$$g(E(y_{it})) = \mathbf{x}_{it}\beta, \qquad y \sim \Gamma(\mu, \nu),$$

where we assume $\mu > 0$ and $\nu > 0$. The function $g()$ is the link function between the linear predictor and the expected value of the outcome variable; in our case we use the reciprocal function. The correct specification of the correlation structure within the panel group augments the efficiency of the estimator. We assume a simple and data saving exchangeable correlation structure but use a Huber-White sandwich estimator of the variance to achieve robustness against misspecification of the correlation structure. The goodness of fit of this model can be judged by a q-q-plot of quantiles of the Pearson residuals against quantiles of a zero-mean normally distributed random variable with identical variance. This plot is provided in the right hand panel of Figure 3. We can see some departure from normality in the tails of the distribution and a remarkably good congruence in the center of the distribution which also motivates the use of robust standard errors.

6 Results

We test the hypothesis whether more complementary financial systems are more efficient at transferring funds from savers to investors. For this purpose we use the equilibrium solution in equation 22 as a first best solution from which economies with less efficient financial system will deviate ever more strongly. Because a higher value for credit or capital market efficiency indicates higher transaction costs and the complementarity index increases with a more balanced financial system both variables should be negatively correlated under the hypothesis of complementarity.

Models (1) to (3) in Table 3 show the results for a panel random coefficient model relating credit market efficiency to the complementarity index and our measures of co-evolution. Models (4) through (6) do this for capital market efficiency. We have available data from at least 11 up to 19 countries and the number of observations varies between 143 and 307. The smallest models (1) and (4) include only the index of complementarity while the full model contains all measures for a feedback. Albertazzi and Gambacorta (2009) analyze the profitability of banks over the business cycle and find a significant relation between several of their revenue components and GDP-growth, the inflation rate, and nominal interest rates. Due to the high positive correlation

between interest and inflation rates (0.7) we condition on business cycle movements and monetary policy by adding GDP-growth and the 3-month money market rate in all models. Table 4 uses the same set-up but the results are based on a generalized estimating equation (GEE) and numbers refer to the marginal effects rather than the coefficients of the model. Because the generalized estimating model uses a panel population-averaged estimator it can use observations from countries with a shorter time series dimension for which a random coefficient model cannot be estimated, expanding our minimum number of countries to 16 and the minimum number of observations to 163.

Independent of the estimation method and the size of the model we find a significant negative marginal effect of our complementarity index on credit and capital market efficiency, i.e. a higher degree of complementarity is significantly related to higher efficiency in the banking sector as well as in the capital markets. By introducing variables representing possible channels of co-evolution into the regression we lose more than half of our observations due to missing data and our results become ambiguous. If we consider models including only the feedback channels, i.e. (2), (5), (8) and (11), financial systems with a higher degree of securitization have significantly lower transaction costs. Only model (8) provides evidence that deeper bond markets increase credit market efficiency. In the full model including all explanatory variables securitization is again significant in half the cases. Bank equity and bond issuing activity show up with the wrong sign in some of the models, i.e. higher bank equity or deeper bond markets are significantly associated with higher transaction costs in financial markets. In many specifications there is no significant relation at all. We check for the robustness of our results by excluding outliers, excluding the years of the financial market crisis 2008 and 2009, excluding the first years of our sample for which we had to chain the data for the computation of the complementarity index from the models; and by introducing non-linearities and interactions between feedback channels into the models. We also allowed for an AR(1) correlation structure in the GEE-models and removed securitization from the model in order to increase the number of observations, cf. Table 1. The basic result that complementarity significantly decreases transaction costs and that securitization does so in about half the models remains valid. The expected negative marginal effect of bank equity and bonds issuance on transaction costs is not significant in most and it remains significantly positive in a few cases.

7 Conclusion

In this paper we address the question whether financial systems with a more balanced structure between credit and capital markets provide more efficient finance to firms as compared to financial systems which are biased either towards bank- or market-based finance, respectively. We measure complementarity by rearranging the conglomerate financial structure index developed by Demirguc-Kunt and Levine (1999) such that our new complementarity index rises with a more balanced financial system and takes lower values for highly bank- or market-based financial systems. We also use indicators for the channels creating positive feedback loops between credit and capital markets in the model by Song and Thakor (2010). These are the securitization of loans and the need for solvency capital by banks. Additionally, we add bonds issued by banks for refinancing purposes as another traditional channel between banks and the capital market.

We relate measures of credit and capital market efficiency based on transaction costs to indicators of complementarity and co-evolution in panel random coefficient regressions and generalized equation estimators and find strong and robust evidence that countries with more complementary financial markets have significantly higher credit and capital market efficiency, i.e. lower transaction costs. The evidence on the importance of individual feedback channels between credit and capital markets remains ambiguous. About half of the specifications show that a higher degree of securitization significantly improves the efficiency of financial systems but bank equity and bond issuance remain insignificant in most specifications, sometimes they enter the model with the wrong sign. Future theoretical development of models for co-evolution in credit and capital markets should concentrate on securitization and identify alternative feedback channels.

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A Description and source of variables

Bank equity: Capital, issue premiums, write-ups, reserves, profit or loss carried forward and profit or loss for the year in current prices in millions of national currency divided by loans. Source: OECD Bank Profitability, Financial Statements of Banks.

Bonds: Securitised debt, includes certificates of deposit, savings bonds and debt issues (subordinated and non-subordinated) in current prices in millions of national currency divided by loans. Source: OECD Bank Profitability, Financial Statements of Banks.

Credit market efficiency: Own computation according to equation 23.

Capital market efficiency: Own computation according to equation 24.

Complementarity Index: Own computation according according to equations 4 and 5.

Credit: Private credit by deposit money banks to GDP. Source: World Bank Financial Development and Structure Dataset.

Fees and commissions: Fees and commissions receivable in current prices in millions of national currency. Source: OECD Bank Profitability, Financial Statements of Banks.

GDP growth: Change in real GDP over previous year. Source: Eurostat, WIFO-Data base.

Exchange rates: Exchange rate from US-Dollar and Euro, respectively, to national currency. Source: Eurostat, OECD Main Economic Indicators.

Interest Rate: 3-month money market interest rate. Source: OECD Main Economic Indicators.

Interest income: Total interest income in current prices in millions of national currency. Source: OECD Bank Profitability, Financial Statements of Banks.

Interest expenses: Total interest and related expenses in current prices in millions of national currency. Source: OECD Bank Profitability, Financial Statements of Banks.

Loans: Claims on clients in respect of lending operations in current prices in millions of national currency. Source: Bank Profitability, Financial Statements of Banks.

Overhead: Bank overhead costs to total assets. Source: World Bank Financial Development and Structure Dataset.

Securitization: Issuance of securitized assets by country of collateral in millions of US-Dollar divided by loans. Source: Securities Industry and Financial Markets Association (SIFMA, sifma.org), Reserve Bank of Australia, Bank of Canada.

Stock market capitalization: Value of listed shares to GDP. Source: World Bank Financial Development and Structure Dataset.

Stock market value traded: Total shares traded on the stock market exchange to GDP. Source: World Bank Financial Development and Structure Dataset.

Total assets: Deposit money bank assets to GDP. Source: World Bank Financial Development and Structure Dataset.

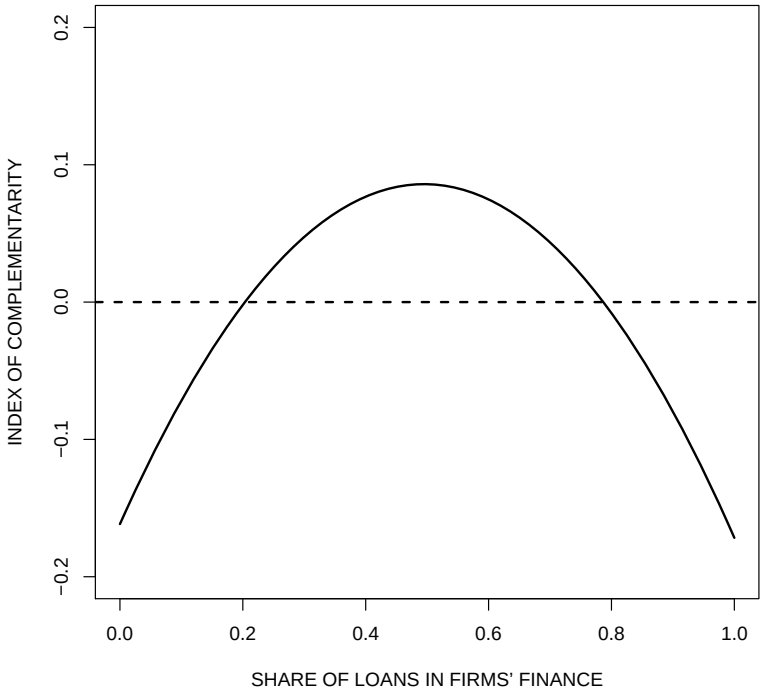

Figure 1: A stylized Complementarity Index

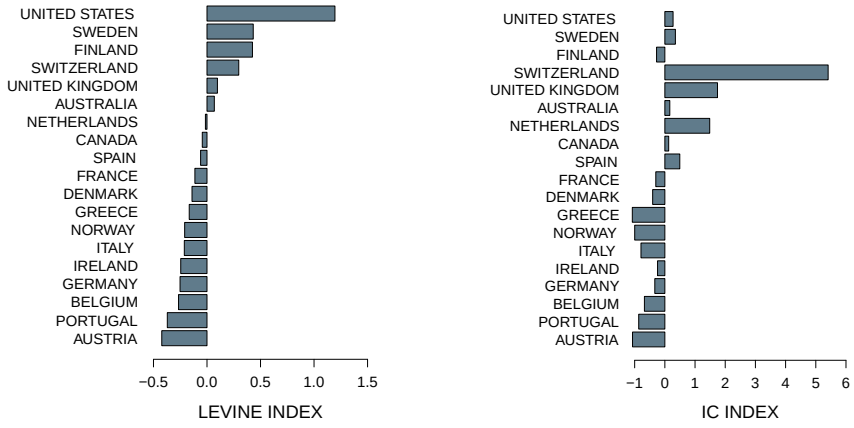

Figure 2: Classification of countries into competitive and complementary financial markets

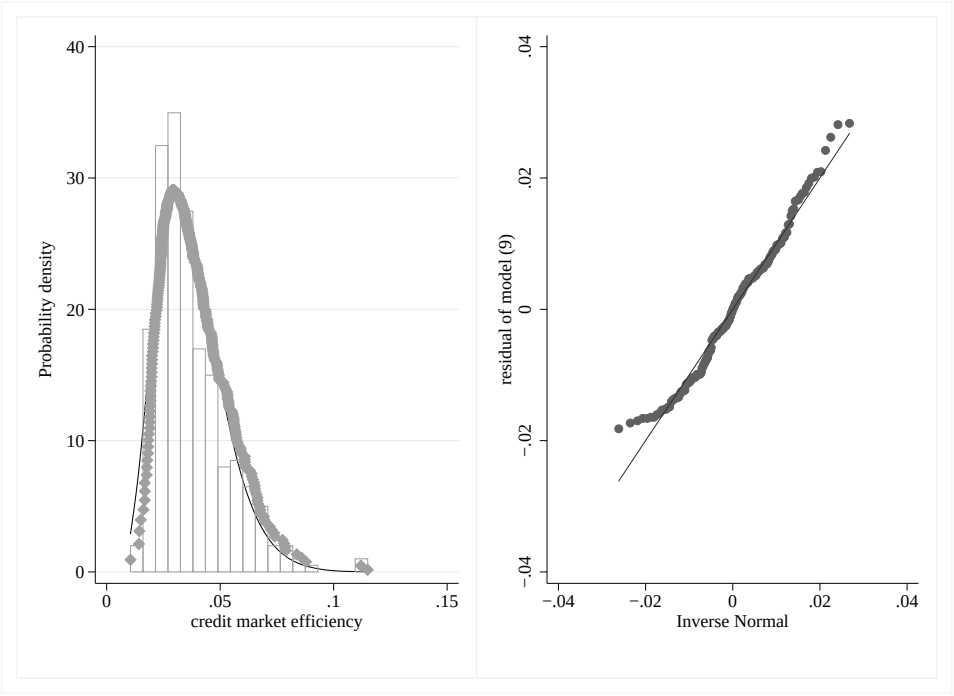

Figure 3: Density probability plot for credit market efficiency based on $\Gamma(6.4,0.006)$ distribution and histogram and q-q-plot of residuals from credit market efficiency model (9) in Table 2

Table 1: Summary statistics

Variable	**Mean**	**Std. Dev.**	**N**
credit market efficiency	0.037	0.016	364
capital market efficiency	0.059	0.082	293
Complementarity Index	0.079	1.711	377
Securitization	0.026	0.038	191
Bank equity	0.124	0.045	365
Bonds	0.230	0.158	351
GDP growth	0.021	0.025	418
Interest rate	0.049	0.038	437

Table 2: Cross-correlation table

Variables	Credit m.e.	capital m.e.	Compl. index	Securitization	Bank equity	Bonds	GDP growth	Int. rate
Credit market efficiency	1.00							
Capital market efficiency	0.13	1.00						
	(0.03)							
Complementarity Index	-0.43	-0.34	1.00					
	(0.00)	(0.00)						
Securitization	0.19	-0.21	0.17	1.00				
	(0.01)	(0.01)	(0.02)					
Bank equity	0.51	0.02	-0.15	0.19	1.00			
	(0.00)	(0.75)	(0.01)	(0.01)				
Bonds	-0.58	0.12	0.12	-0.37	-0.29	1.00		
	(0.00)	(0.03)	(0.04)	(0.00)	(0.00)			
GDP growth	0.10	-0.06	-0.05	-0.11	0.02	-0.13	1.00	
	(0.07)	(0.30)	(0.30)	(0.11)	(0.71)	(0.02)		
Interest rate	0.60	0.38	-0.38	-0.07	0.17	-0.31	0.08	1.00
	(0.00)	(0.00)	(0.00)	(0.31)	(0.00)	(0.00)	(0.13)	

Notes: Values in parentheses are significance levels

Table 3: Complementarity and Coevolution in financial markets - Estimation results from Random coefficient models

	Credit market efficiency			Capital market efficiency		
	(1)	(2)	(3)	(4)	(5)	(6)
Compl. Index	-0.009***		-0.006***	-0.039**		-0.030**
	(0.001)		(0.001)	(0.017)		(0.012)
Securitization		-0.084***	-0.002		-0.193	-0.191*
		(0.032)	(0.014)		(0.118)	(0.105)
Bank equity		0.018	0.034		0.093	0.122
		(0.042)	(0.043)		(0.216)	(0.200)
Bonds		-0.121	-0.156		-0.010	0.112***
		(0.109)	(0.162)		(0.097)	(0.035)
GDP growth	0.034	-0.031**	-0.025	-0.430	-0.353**	-0.164
	(0.026)	(0.015)	(0.029)	(0.276)	(0.139)	(0.108)
Interest rate	0.123***	0.073*	0.103***	0.410**	0.364*	0.414**
	(0.031)	(0.043)	(0.027)	(0.173)	(0.188)	(0.182)
Constant	0.024***	0.041***	0.033***	0.017	0.014	-0.016
	(0.003)	(0.009)	(0.011)	(0.011)	(0.026)	(0.018)
Observations	324	167	158	269	152	143
No. Countries	19	12	12	17	11	11

Notes: Coefficients from a panel random coefficient regression. The explained variables credit and capital market efficiency are described in equations 23 and 24. Values in parentheses are bootstrapped standard errors. ***, ** , and * indicate coefficients with p-values below 1%, 5%, and 10%, respectively.

Table 4: Complementarity and Co-evolution in financial markets - Estimation results from GEE models

	Credit market efficiency			Capital market efficiency		
	(7)	(8)	(9)	(10)	(11)	(12)
Compl. Index	-0.006***		-0.005***	-0.016***		-0.010***
	(0.001)		(0.001)	(0.003)		(0.003)
Securitization		-0.041	-0.041***		-0.570**	-0.085*
		(0.028)	(0.009)		(0.238)	(0.050)
Bank equity		0.037	0.047**		0.001	-0.009
		(0.025)	(0.019)		(0.107)	(0.018)
Bonds		-0.041***	-0.007		0.023	0.018***
		(0.016)	(0.011)		(0.018)	(0.006)
GDP growth	0.087***	0.038	0.022	-0.063**	-0.168*	-0.075**
	(0.025)	(0.024)	(0.021)	(0.026)	(0.095)	(0.035)
Interest rate	0.069***	0.049**	0.014	0.005	0.119**	0.029**
	(0.025)	(0.020)	(0.014)	(0.009)	(0.060)	(0.014)
Observations	324	189	178	269	174	163
No. Countries	19	18	17	17	17	16

Notes: Marginal effects (at mean) from a Generalized Estimating Equation (GEE) model with reciprocal link function, gamma distribution, and exchangeable correlation structure, except model (11) with independent correlation structure. The explained variables credit and capital market efficiency are described in equations 23 and 24. Values in parentheses are Huber-White sandwich estimators for standard errors.***, ** , and * indicate coefficients with p-values below 1%, 5%, and 10%, respectively.