# Financial dependence and industry growth in Europe: Better banks and higher productivity

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**Abstract:** Financial development stimulates growth, in particular in industries dependent on external finance. In this paper we show that more efficient banks are particularly important in stimulating both output and productivity growth, while traditional volume measures of finance are much less important for productivity growth. For this we exploit firm-level information to measure the dependence of industries on external finance and the efficiency of intermediaries. Our results are in line with Schumpeter's (1912) contention that bankers provide resources to the most deserving entrepreneurs. Within the EU-25, growth gains are concentrated in the new member states.

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# Introduction

Most economists would agree that a better developed financial system is beneficial for economic growth (Levine, 2005). The seminal contribution of Rajan and Zingales (1998) strengthened this notion by alleviating concerns of reverse causality.[1] They exploit cross-industry differences in dependence on external finance to identify the growth effects of international differences in financial development for a heterogeneous sample of countries. But sampling such different countries might lead to biased results.[2] Furthermore, financial development is measured by volumes of financial funds intermediated, which may be poor proxies of theoretical priors (Levine, 2005). Also, the channel through which economic growth is affected is not clear. Finally, financial dependence is measured with the assumption that the U.S. is the benchmark financial system for the rest of the world.[3]

In this paper we extend the Rajan and Zingales (1998) results for 25 countries of the European Union (EU), a particularly policy-relevant sample given the efforts to construct a single European market for financial services.[4] We cover the period 1994-2004 and address three questions, namely how measurement of financial development can be improved; whether financial development stimulates factor accumulation or productivity growth; and whether EU countries benefit uniformly from financial development.[5] Our results corroborate and extend the findings of Rajan and Zingales (1998). Both bank cost and profit efficiency scores are economically and statistically significant factors in spurring economic activity and they facilitate both output and productivity growth. In contrast, traditional volume measures of financial development are much less important in stimulating productivity growth in particular. Within the EU,

[1] See Robinson (1952) for an early critique that financial services and products depend on rather than ignite economic activity. Likewise, Levine et al. (2000) discuss methods to address econometric endogeneity aspects, which, however, are different from the inherent reverse causality concerns voiced by Robison.
[2] See e.g. Manning (2003), Rioja and Valev (2004) and Guiso et al., (2004).
[3] See Furstenberg and von Kalkreuth (2006) for a critical discussion of this assumption.
[4] We cover the countries that were member of the European Union before the accession of Bulgaria and Romania in January 2007.
[5] For other studies focusing on Europe specifically, see e.g. Fernández de Guevara and Maudos (2007), Romero-Ávila (2007) and Hartmann, Heider, Papaioannou and Lo Duca (2007).

the growth gains from financial development are concentrated in the new member states that acceded to the EU in 2004.

The first question we address is which aspects of the financial system are of key importance for growth. Theory suggests that better financial development reduces the negative effects of information asymmetries, thereby facilitating the flow of funds from savers to borrowers. However, most empirical studies rely on measures of private credit or stock market capitalization as a percentage of GDP.[6] But such volume proxies may increase for other reasons than more efficient financial systems, for instance due to an inflating stock market bubble.

We use instead banks' relative ability to channel financial funds efficiently from savers to investors as additional indicators of financial development in a country. We estimate cost and profit efficiency of European banks relative to the best-practice frontier with a latent-class stochastic frontier model. For instance, a cost efficiency score measures to what extent a bank uses resources, such as deposits and labour, in optimal proportions to provide financial services at the lowest possible cost.[7] While a handful of studies investigate the relation between bank efficiency and economic growth at the country or regional level, this is the first study to use industry data, and hence avoid many endogeneity concerns.[8] We hypothesize that relative efficiency scores are informative in addition to the conventional volume measures since they emphasize the quality of financial institutions. Efficiency measures are by no means a perfect reflection of financial development. But they constitute in our view an important additional quality dimension next to the quantity channel.

Our results confirm previous studies that deeper credit and capital markets spur growth. In addition, we find that both quality proxies, bank cost and profit efficiency, exert an independent as well as statistically and economically significant growth impetus.

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[6] These two measures are used very often, see also Beck et al. (2000b) for a host of other financial volume measures; Rajan and Zingales (1998) on accounting standards; Wurgler (2000) on the investment elasticity of output as a measure of allocative efficiency of capital; La-Porta et al. (1997, 1998) on legal origins as an underlying determinant of financial development; de Serres et al. (2006) and Romero-Ávila (2007) on the regulatory framework as a feature of financial development; and Hartmann et al. (2007) on a diverse collection of financial system indicators.

[7] See e.g. Berger and Humphrey (1997) for more on such measures.

[8] See Berger et al. (2004) for a cross-country application and Lucchetti et al. (2001) for a regional study.

Hence, it is not only the quantity of financial funds, but also the quality of intermediation that spurs growth.

The second question is *how* growth is stimulated by a well-developed financial system. Schumpeter (1912) conjectured that bankers and other intermediaries allocate funds to the best firms and most promising entrepreneurs. This should not only increase the overall flow of funds but in particular the allocation of funds to more productive firms, thereby ultimately fostering growth. Better financial development can therefore lead to both higher factor accumulation and higher multifactor productivity growth, the growth in output that cannot be accounted for by the growth in labour and capital. We are not able to test this directly at the industry level since we lack data on multifactor productivity growth for a number of European countries, but we argue our two-part test achieves the same result. First, we eliminate growth of employment as a source of growth by using labour productivity growth instead of output growth as the dependent variable. Second, we use investment growth as a dependent variable to test whether financial development stimulates capital accumulation. We find that financial development can explain differences in labour productivity growth but not in investment growth. This leads us to conclude that financial development has a positive effect on multifactor productivity growth. Our findings are broadly in with the cross-country literature, which tends to find more support for an effect of financial development on productivity growth than on investment.[9] Carlin and Mayer (2003) also tried to explain investment at the industry level and found similarly insignificant results.

Finally, most finance-growth studies aim to maximize country coverage. While this is useful for some applications, it is less helpful in formulating policy recommendations. A study focusing on European countries can illuminate the gains from moving to a single, best-practice financial system in Europe. While the EU still does not constitute a harmonised market for financial services, efforts in this direction have long been underway.[10] Our analysis for 25 EU countries for the period 1994-2004 should be useful in this policy endeavour and supplement the insights on the gains from policy harmonisation of Romero-Ávila (2007). We find that most of the gains in growth from

[9] See e.g. King and Levine (1993a, b), Benhabib and Spiegel (2000) and Beck *et al.* (2000a).
[10] See e.g. Romero-Ávila (2007).

financial development over this period were concentrated in the 10 new member states, which are characterized by lower average levels of financial development.[11]

In the remainder of this paper, we will first discuss the methodology in more detail and next discuss the data sources and the construction of our measures. After this, we present our main results and robustness analyses before concluding.

# Methodology

A key challenge in establishing the effect from increased financial development on economic growth is the potential for reverse causality, i.e. the possibility that finance follows growth. We adopt the method first used by Rajan and Zingales (1998) because it does not only address the econometric aspect of endogeneity.[12] They hypothesize that if financial development in a country improves, industries that are more reliant on external finance would benefit most. This led to the following estimating equation:

$$\Delta \ln V_{ij} = \alpha_1 S_{ij} + \beta_1 DEP_i \times FD_j + \varepsilon_1 . \quad (1)$$

In equation (1) growth of real value added $V$ of industry $i$ in country $j$ is explained by the initial share of that industry in overall value added $S$ and the interaction between financial dependence $DEP$ of that industry and financial development $FD$ of that country. Growth, financial dependence and financial development are all averaged over a decade and country and industry fixed effects are also included. The key identifying assumption of Rajan and Zingales (1998) is that the financial dependence of US firms is an 'inherent' characteristic of the industry and relevant for other countries too.[13]

How to empirically implement these concepts will be discussed in the next section. Our main methodological innovation will be to test how financial development affects the sources of value added growth at the industry level. In a standard growth accounting framework,[14] output grows either because of growth in inputs or growth in productivity:

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[11] This is in line with Manning (2003), who finds that the Rajan and Zingales (1998) results are much weaker for OECD countries.

[12] A comprehensive review of various methods used in the literature is Levine (2005).

[13] This assumption has been questioned (Furstenberg and Kalckreuth, 2006) and we return to some of these criticisms in the data section below. However, this is not the focus of our paper and we mostly follow the literature. In the robustness analysis, we also use a measure of growth opportunities as in Fisman and Love (2007).

[14] See e.g. Jorgenson, Ho and Stiroh (2005) or Timmer, O'Mahony and van Ark (2007a).

(2) $$\Delta \ln V = s\Delta \ln L + (1-s)\Delta \ln K + \Delta \ln Z ,$$

where $L$ is labour input, $K$ is capital input, $s$ is the share of labour compensation in output and $Z$ is multifactor productivity (MFP).[15] This equation implies that if $\beta_1$ in equation (1) is positive, this could be because financial development enables greater labour input, capital input, productivity growth or a combination of the three.

A finding that financial development stimulates productivity growth would be of particular interest since this would imply that financial development not only affects the overall flow of funds, indicated by faster factor accumulation, but also how well those funds are used. The theoretical literature has advanced numerous explanations for this. For example, King and Levine (1993b) build a model where financial development increases the speed of innovation by improving the return to innovation; Almeida and Wolfenzon (2005) show how financial development can stimulate intermediaries to invest in higher-return/higher-risk projects and Aghion, Angletos, Bannerjee and Manova (2007) show how financial development can stimulate long-run investments in, for example, research and development by protecting against liquidity risk. The implications of these theories differ at the micro-level, but they all imply that improved financial development stimulates industry productivity growth.

Ideally, we would run separate regressions for each of these three sources of output growth, but data limitations preclude this. For quite a number of the new member states from Central and Eastern Europe, long time series of investment data are not available for reliable estimates of capital stocks.[16] However, sufficient investment data are available to test whether investment is influenced by financial development. So in addition to equation (1), we will estimate two further equations with labour productivity growth and investment growth as dependent variables:

(3) $$\Delta \ln LP_{ij} = \alpha_2 \ln\left(LP_{iF} / LP_{ij}\right) + \beta_2 DEP_i \times FD_j + \varepsilon_2$$

(4) $$\Delta \ln I_{ij} = \alpha_3 S_{ij} + \beta_3 DEP_i \times FD_j + \varepsilon_3$$

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[15] In the most basic set-up, labour and capital are homogenous inputs. Labour is often measured as the total number of workers or hours worked and capital is estimated by cumulating overall investment. In more sophisticated work, different types of workers and capital are distinguished.

[16] A related issue is that for sophisticated MFP measures, data is needed on investment by asset type. This is lacking for many of the new member states as well. Inklaar, Timmer and van Ark (2008) show that such detailed data can be quite important in empirical work relying on MFP measures.

where $LP=V/H$ is value added per hour worked and $I$ is investment. Instead of the industry's share in total value added, we now use the labour productivity gap as an initial value for labour productivity growth. This gap is defined for each industry and gives the percentage difference in labour productivity relative to the most productive country and is an indicator of the potential for labour productivity growth through convergence to the productivity frontier.[17] For the investment equation (4), we use in analogy to (2) the initial share of capital in industry income to control for different convergence speeds.

From equations (1), (3) and (4) we obtain three sets of $\beta$'s. If $\beta_1$ is positive, there is an effect of financial development on growth, either through an increased flow of funds or through an improved use of funds. If $\beta_3$ is positive, this provides direct evidence that financial development increases the overall flow of funds. If $\beta_3$ is zero, while $\beta_2$ is positive, this provides evidence that financial development mainly has an effect on the use of funds. If both are positive, it is not clear whether financial development improves the use of funds.

## Data sources and methods

The described analysis requires data on industry growth, financial dependence, and financial development, each of which we discuss next.

### *Industry growth*

The main data source on industry growth is the EU KLEMS database (March 2007 version). This database is described in detail in Timmer *et al.* (2007a). In essence, it contains detailed industry-level data on outputs, inputs and productivity, starting in 1970 and covering 25 EU countries as well as important non-EU countries like the US. All data are on the same industry classification to make international comparisons feasible.

We use data on 25 industries covering the non-financial market economy at the one to two-digit level of industry detail and omit the financial sector, government, education,

[17] See e.g. Griffith, Redding and van Reenen (2004) for a similar specification. See Timmer et al. (2007b) for details on the purchasing power parities (PPPs) used to convert data at national prices to a common price basis.

health and real estate.[18] The financial sector is omitted because we are interested in testing whether financial development has an effect on growth in other industries. Government, education and health are excluded because output measurement in those industries is particularly problematic. Real estate is excluded because much of the value of output consists of imputed rents from owner-occupied housing. While this will be affected by financial development, it does not tell us much about how financial intermediaries allocate funds to entrepreneurs.

We use two variables directly from the database, namely growth of value added and labour productivity growth. The third, investment growth, is calculated using the underlying source material and data from the National Accounts for countries where these data are not sufficiently detailed for inclusion in capital stock estimates of EU KLEMS. In our robustness analysis, we also use the growth of gross output. Although the data go back to 1970 for many countries, data for the Central and Eastern European countries are only available from the mid-1990s onwards. As our measures of financial dependence and development are available from 1994 onwards, we use the 1994-2004 period throughout.

### *Financial dependence*

Rajan and Zingales (1998) use Compustat data on listed U.S. firms to construct a measure of dependence on external finance, which they assume to constitute the benchmark for all other countries. In contrast, we use European firm-level data from the Amadeus database to construct a measure of the dependence on external finance. A first advantage of this approach is that we can evaluate if our results depend on the choice of a benchmark country to measure the dependence on external funds. This is important since Furstenberg and Kalckreuth (2006) argue that external dependence is not a 'structural' parameter, as implicitly assumed by Rajan and Zingales (1998). We do not propose to formulate an explicit test for whether using a benchmark applicable for all countries is appropriate, but we do test whether variation across industries is at least in part systematic. If this is the

[18] At more detailed levels, investment data is lacking and financial dependence measures are based on too few firms. The omitted industries correspond to ISIC/NACE industry codes J, L, M, N and 70.

case, it suggests that some industries (for structural or other reasons) systematically rely more on external finance than others.

Another important advantage of the Amadeus database is that it also covers non-listed firms. In fact, Klapper, Laeven and Rajan (2006) show that it provides a fairly representative overview of economic activity in European countries. Since listed firms are generally much larger, older and by definition have direct access to financial markets, their dependence on external finance may be quite different from the average firm.

The wider country and firm coverage are clear advantages of using the Amadeus database. A disadvantage is that fewer data items are available for each firm. This precludes us from using the same measure of financial dependence as Rajan and Zingales (1998), namely capital expenditure less cash flow as a percent of capital expenditure. Instead we use the share of debt in total assets as a measure of financial dependence, which is in line with Fernandez de Guevara and Maudos (2007), the only other EU industry study we are aware of. We exclude trade credit from our definition of debt because it does not relate to borrowing from the financial sector. Indeed, Fisman and Love (2003) show that trade credit tends to be a substitute for borrowing from financial intermediaries or financial markets.

We only include firms with positive debt and calculate an unweighted average for the 25 EU countries, the 25 industries and the period 1994-2004.[19] Underlying these summary measures are almost 13 million firm-year observations.[20] This allows us to examine one of the issues raised by Furstenberg and Kalckreuth (2006), namely whether dependence on external finance is a measure with a systematic between-industry component.[21] We run a series of regressions with only year, industry or country dummies as explanatory variables.

[19] The panel is not balanced, out of the 7500 possible observations (25*25*11) we have 5985 observations.
[20] We exclude firms with a debt-to-assets ratio larger than two. This is only a very small fraction of the observations and avoids extreme outliers.
[21] They also investigate structural implications, an interesting issue outside the scope of our paper.

**Table 1, Percentage of variance in external dependence explained by year, industry and country dummies (%)**

| | EU-25 | EU-15 |
|---|---|---|
| Year | 1.6 | 1.0 |
| Industry | 7.0 | 11.7 |
| Country | 24.3 | 17.1 |
| Year & industry | 8.6 | 12.8 |
| Year & country | 25.5 | 17.8 |
| Industry & country | 31.1 | 28.5 |
| Year, industry & country | 32.3 | 29.3 |

Notes: table entries show the r-squared from dummy regression with the average industry share of debt in total assets as the dependent variable and year, industry and country dummies as explanatory variables. EU-25 are all the EU member states up to the accession of Bulgaria and Romania; EU-15 are all the EU member states before the accession of 10 new member states in 2004.

Table 1 compares the percentage of variance explained by the different combinations of dummies.[22] As the table shows, the industry dimension explains 7 percent of variance across all countries, rising to almost 12 percent if the 10 countries that joined the EU in 2004 are excluded. The various combinations also show that the variation explained by the industry dimension is stable. Obviously, it is not a perfect measure as country-specific and idiosyncratic variation is substantial. However, when the 10 new member states are excluded, country-specific variation decreases and industry-specific variation increases. Since these countries are among the least financially developed (see the next section) this suggests that as financial development advances, the industry dimension becomes more important. This is obviously no proof that this is a good measure of dependence on external finance or that it represents a structural feature of an industry's production function but provides some suggestive results that using financial dependence for a country with a high degree of financial development would provide useful results.

## *Financial development*

Directly measuring the effect of information asymmetries is not feasible, so we look at different proxies for 'true' financial development. In measuring financial development, we aim to capture both quantity and quality aspects of the financial system. As our

[22] No adjustment for the degrees of freedom is made, but those numbers are very similar.

quantity measures, we use two traditional variables, the private credit and stock market capitalization shares in GDP (see Beck, et al., 2000). To capture the quality dimension we propose two new measures based on the efficiency of banks in each country.

Improvements in 'true' financial development are likely to imply larger financial volumes. For example, credit scoring technology improves how banks process information, in particular for smaller firms. Berger, Frame and Miller (2005) show that the use of this technology in the US has led to increased lending to small businesses, confirming that an improvement in financial development can lead to larger financial volumes.

But volumes remain a decidedly imperfect proxy for financial development: as Robinson (1952) remarked, financial funds may merely follow firms. Also, financial assets are subject to price developments that may inflate volumes without fundamental improvements of financial systems to overcome adverse selection and moral hazard problems. For example, stock market bubbles inflate market capitalization without underlying improvements in financial development. Recent turmoil in real estate markets further highlight that financial asset prices derived from underlying real assets are prone to deviate from fundamentals (Calomiris and Mason, 2003). This casts doubt on measures of financial development that rely on volumes alone.[23]

In line with Lucchetti *et al.* (2001) and Berger *et al.* (2004), we suggest a more direct measure of financial intermediaries ability to perform their core functions, namely selecting the most profitable investment projects to fund and to efficiently monitor these loans. We propose to measure the quality of bank intermediation by the efficiency with which they employ resources in the production of financial products and services. We assume that banks aim to minimize cost (maximize profits) when conducting this intermediation function and are price takers in factor markets. To supply financial services and products $y$ (e.g. loans), an efficient bank demands factor amounts $x$ (e.g. labour and deposits) in optimal proportions at given input prices $w$ (e.g. wages and deposit rates). Inefficiency arises when managers employ too many input quantities and/or allocate them in wrong proportions to produce an optimal output portfolio.

[23] Financial development may actually be low if price deviations are sustained and lead to bubbles.

Deviations from optimal cost $C^*$ in year $t$ can either be due to random noise or suboptimal employment of inputs. A baseline stochastic cost frontier for a bank $k$ is then:

$$\ln C_{kt} = f(y_{kt}, w_{kt}, t \mid \beta) + v_{kt} + u_{kt}, \tag{5}$$

where lower case letters indicate logs, $t$ denotes a time trend to capture technical change and $\beta$ is a vector of parameters to be estimated. The total error in equation (5) is $\varepsilon_{kt}=v_{kt}+u_{kt}$ where $v_{kt}$ denotes random noise, and $u_{kt}$ stands for deviations due to inefficiency. To identify the model we use standard distributional assumptions on error term components and impose the required restrictions.[24]

Consider an example for the link between efficiency and the quality of banks. If banks are better developed, they hire the optimal amount of risk managers and credit officers given their choice of a loan portfolio and respective wages. Let a bank grant relatively many customer loans, which we assume to be on average more risky compared to, say, money market securities. Consider now a management that hires too few (or not appropriately trained) credit officers to monitor these exposures and also too few risk managers to price the loan during the negotiations prior to lending appropriately. This may save the bank labour costs in the short run. But if the bank consistently underprices risky loans, subsequent defaults will result in write-offs of bad loans, thereby increasing cost, decreasing profits and ultimately leading to inefficiency.

While the bank efficiency literature is abundant by now, Berger (2008) emphasizes that international comparisons are cumbersome since they often compare banks that do not share an identical frontier. Some studies demonstrate that systematic differences continue to exist both across and within European banking markets and should be distinguished from (managerial) inefficiency.[25] Merely adding control variables inevitably introduce some degree of is arbitrariness.[26] Instead, we estimate bank efficiency with a latent class frontier model, which allows the simultaneous estimation of multiple technology regimes in European banking without augmenting bank's technology in an ad hoc fashion.[27] We write a latent class stochastic frontier model as:

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[24] Kumbhakar and Lovell (2000) review and discuss various error term assumptions. We assume $v_{kt}$ is i.i.d. as $N(0,\sigma_v^2)$and $u_{kt}$ is i.i.d. with $N|(0,\sigma_u^2)|$. Point estimates of cost efficiency are obtained by $E(u_{kt}|\varepsilon_{kt})$.
[25] See Bos and Schmiedel (2007) and Bos et al. (2008).
[26] See e.g. Dietsch and Lozano-Vivas (2000), Maudos et al. (2002) and Casu and Molyneux (2003).
[27] Orea and Kumbhakar (2004); Greene (2005).

(6) $$\ln C_{kt|j} = f(y_{kt|j}, w_{kt|j}, t_j \mid \beta_j) + v_{kt|j} + u_{kt|j}$$

The difference of the latent class equation (6) and the frontier model in equation (5) is that parameters differ across classes $j=1,...,J$. Equation (6) is estimated with maximum likelihood methods. To separate random noise from inefficiency, we use the standard re-parameterization of error term components $\sigma=\sigma_u+\sigma_v$ and $\lambda=\sigma_u/\sigma_v$. Greene (2005) shows that the (joint) likelihood function also depends on the unconditional likelihood for each bank $k$ to belong to group $j$. These group membership probabilities can be estimated conditional on the observed cost and production set f(y,w,) chosen by the bank, error term components σ and λ, and further characteristics $z_{kt}$. To estimate group memberships $P_{kj}$, we use a multinomial logit model of the form:

(7) $$P_{kj} + \frac{\exp \pi_j z_{kt}}{\sum_{m=1}^{J} \exp \pi_j z_{kt}}$$

for $\pi_j=0,...,J$, such that the last group $j=J$ serves as a reference group. The upshot of this model is that we remain fully agnostic as to which banks belong to which technology regime. This is important since it is plausible that some large financial powerhouses compete across borders with each other in many product markets, other small banks might focus on regional lending to both corporate and private customers, and yet other banks might specialize in certain niches such as consumer finance. However, which banks ultimately belong to one regime remains unknown and we rely on the data to estimate these groupings rather determining them ex ante.

We use data on bank production from the Bankscope database and construct variables according to the intermediation approach (Sealy and Lindley, 1977). In line with most European bank efficiency studies, we approximate the price of labour $w_1$ by personnel expenses divided by total assets and the cost of funds $w_2$ as interest expenses divided by total interest bearing liabilities. We specify customer loans and securities and other earning assets as outputs $y_1$ and $y_2$ respectively. In addition, we follow Mester (1997) and include equity $z$ as a control for different funding structures and risk-preferences across banks in the kernel of the frontier, too. As the first dependent variable we specify total operating cost $C$. To estimate the parameters of equations (6) and (7), we

follow the majority of the literature and specify a translog functional form for the deterministic kernel and condition group membership on country dummies.[28]

A banking system that intermediates funds better relative to its peers in Europe might not only be characterized by low costs but even more by a superior ability to generate profits. In fact, expertise in lending to certain customers is one of the very reasons why banks exist. Since we are interested in explaining output and productivity growth of industries, it is reasonable to assume that some banks have informational advantages for specific industries that permit them to set output prices within the limitations of a pricing opportunity set. Therefore, we also estimate the latent class frontier model according to the alternative profit specification suggested by Humphrey and Pulley (1997). This model entails some market power for banks when maximizing profits. Therefore, the explanatory variables remain the same as in the cost frontier but the dependent variable changes to profit before tax *PBT*. Descriptive statistics are shown in table 2.[29]

**Table 2, Descriptive statistics European bank production 1994-2004**

| Variable | | Mean | Stdev | Min | Max |
|---|---|---|---|---|---|
| Customer loans | Y1 | 1.436 | 6.266 | 0.005 | 129.101 |
| Securities and other earning assets | Y2 | 1.727 | 7.865 | 0.005 | 157.491 |
| Price of labour | W1 | 1.452 | 0.575 | 0.079 | 4.762 |
| Price of funds | W2 | 3.575 | 1.608 | 1.062 | 15.409 |
| Equity capital | Z | 0.183 | 0.988 | 0.002 | 27.176 |
| Total operating cost | C | 0.075 | 0.425 | 0.000 | 21.145 |
| Profits before tax | PBT | 0.022 | 0.186 | -17.251 | 8.585 |

Notes: 27,248 observations Volume variables denoted in billions of Euro; Price proxies in percentages.

For both cost and profit frontiers, we identify three distinct technology regimes in European banking.[30] Next to bank's observed production technology itself, technology regime membership probabilities are conditioned on country dummies. Both cost and profit kernel parameters are mostly significant at the one-percent level.[31] Since we do not

[28] Since efficiency estimates are not the focus of our paper, we leave the investigation of more meaningful banking group membership determinants to further research.

[29] We followed Maudos et al. (2002) and excluded the top and bottom percentile of production variables to eliminate extreme outliers in the data. As in Bos et al. (2008) we censor negative profits before taking logs and add a negative profit dummy to avoid the bias from scaling up the entire sample by maximum losses.

[30] Corresponding parameter estimates are shown in Appendix A.

[31] Both Akaike information criteria and log-likelihood ratio tests favor the latent class model over single panel frontier estimates. It is nonetheless comforting that the results on the relation between finance and growth reported later on are by and large not sensitive to such alternative frontier estimators.

focus in this paper on efficiency estimation per se, the dispersion of mean cost and profit efficiency scores across European countries is more interesting to approximate each economy's development of the financial system.[32]

**Table 3, Financial development measures for EU countries averaged over 1994-2004, ranked by average across measures**

| | Private credit (% GDP) | Stock market capitalization (% GDP) | Cost efficiency | Profit efficiency |
|---|---|---|---|---|
| Netherlands | 148 | 109 | 0.78 | 0.75 |
| United Kingdom | 122 | 140 | 0.71 | 0.60 |
| Luxembourg | 98 | 155 | 0.70 | 0.68 |
| Germany | 109 | 40 | 0.79 | 0.79 |
| Spain | 87 | 55 | 0.78 | 0.75 |
| Finland | 60 | 105 | 0.60 | 0.69 |
| Sweden | 56 | 94 | 0.70 | 0.73 |
| Malta | 97 | 29 | 0.73 | 0.91 |
| France | 86 | 62 | 0.72 | 0.69 |
| Belgium | 75 | 63 | 0.78 | 0.69 |
| Cyprus | 94 | 35 | 0.73 | 0.78 |
| Denmark | 74 | 48 | 0.73 | 0.85 |
| Portugal | 100 | 35 | 0.64 | 0.62 |
| Austria | 97 | 16 | 0.67 | 0.76 |
| Italy | 65 | 36 | 0.79 | 0.74 |
| Ireland | 82 | 61 | 0.56 | 0.51 |
| Greece | 44 | 53 | 0.77 | 0.57 |
| Slovenia | 30 | 12 | 0.74 | 0.68 |
| Estonia | 20 | 29 | 0.60 | 0.75 |
| Czech Republic | 52 | 21 | 0.45 | 0.60 |
| Hungary | 28 | 18 | 0.63 | 0.59 |
| Slovakia | 43 | 7 | 0.46 | 0.70 |
| Poland | 22 | 11 | 0.71 | 0.52 |
| Lithuania | 17 | 6 | 0.52 | 0.78 |
| Latvia | 13 | 12 | 0.64 | 0.59 |
| *Correlation* | | | | |
| Private credit | | 0.59 | 0.42 | 0.31 |
| Stock market capitalization | | | 0.29 | -0.04 |
| Cost efficiency | | | | 0.28 |

Notes: see main text for detailed source and method description

[32] In addition to latent class model efficiency, we also tested each result reported below for pooled cross-sectional frontier and panel fixed effect cost and profit specifications as well as broader input and output vector specifications, respectively. While cost efficiency measures are entirely unaffected, some of the more restricted profit efficiency measures failing to account for differences in European banking yield diverging results. Based on specification tests, we prefer here the latent class model for both CE and PE.

Consider to this end Table 3. It shows the average values by country for both the traditional financial volume measures and our cost and profit efficiency measures. Efficiency scores are relative measures. For example, the value of 0.78 for the Netherlands indicates that banks could have provided the same financial services at only 78% of the actually incurred cost if resources had been employed efficiently.

Countries are ranked by the average value across measures. At the top of this ranking are mostly Western European countries with well-developed and efficient banking systems and deep financial markets. The bottom eight countries are all Central and Eastern European countries that became EU member states in 2004. There are many similarities between these measures as illustrated by the correlation coefficients at the bottom of the table. However, the efficiency measures in particular seem to measure distinct aspects of financial development.

# Results

## *Financial development, output, and productivity*

Given data on financial development, financial dependence and industry growth, we turn next to the estimation of equation (1), which explains industry value added growth. Results are shown in Table 4. As in Fernandez de Guevara and Maudos (2007), the financial dependence measure is based on UK firms as the benchmark country and we exclude the growth observations for the UK to avoid endogeneity. We choose the UK because it is among the countries with the highest levels of financial development according to both conventional quantity and efficiency measures. Furthermore, the sample of UK firms is one of the largest, ensuring that the financial dependence measures will not be unduly influenced by industries with few firm observations.[33]

[33] The Amadeus database is backward-looking, which means that firms that disappear at some point are no longer part of the database. As a result, the sample of firms in 1993 and 1994 is much smaller than in later years. Our results are not sensitive to omitting 1993 and 1994 form our external dependence measures.

**Table 4, Industry output growth and financial development**

| | Financial volumes | | Financial volumes & efficiency | | | |
|---|---|---|---|---|---|---|
| *Dependent variable:* growth of real value added | Private credit to GDP | Stock market capitalization to GDP | Private credit to GDP | | Stock market capitalization to GDP | |
| Industry share in market economy value added | -0.2693*** [0.0843] | -0.2545*** [0.0849] | -0.2749*** [0.0839] | -0.2684*** [0.0837] | -0.2670*** [0.0839] | -0.2580*** [0.0832] |
| Financial dependence x Financial volume | 0.2396*** [0.0595] | 0.1672*** [0.0613] | 0.1785*** [0.0619] | 0.1889*** [0.0644] | 0.0915 [0.0571] | 0.1467** [0.0596] |
| Financial dependence x Cost efficiency | | | 0.4895** [0.2152] | | 0.6549*** [0.2018] | |
| Financial dependence x Profit efficiency | | | | 0.4254* [0.2218] | | 0.6523*** [0.1957] |
| Number of observations | 575 | 575 | 575 | 575 | 575 | 575 |
| Adjusted R-squared | 0.36 | 0.35 | 0.37 | 0.36 | 0.36 | 0.36 |

Notes: Dependent variable is average growth of industry real value added between 1993 and 2004. Independent variables are the initial share of the industry in market economy value added and the interaction between financial dependence and one of two volume measures and one of two bank efficiency measures. Financial dependence is measured as the average ratio of debt to assets of UK firms (excluding trade credit), see main text for details. Robust standard errors are in parentheses. Country and industry dummies are included in all specifications (not reported). The UK itself is excluded to avoid endogeneity concerns. * denotes a coefficient significantly different from zero at the 10%-level, ** at the 5%-level and *** at the 1%-level.

The first two columns show regressions using two financial volumes measures, a specification very similar to that of Rajan and Zingales (1998).[34] We likewise include country and industry dummies to remove any unmeasured country-specific or industry-specific factors. In line with their results we find that financial development, as measured by financial volumes, has a positive influence on output growth.

In the remaining columns, we include our preferred cost efficiency and profit efficiency measures. With one exception, these have a positive and highly significant influence on growth in addition to the effect of financial volumes. Perhaps not surprisingly, the additional effect of the efficiency measures is less for private credit than for stock market capitalization. This could be because both efficiency measures are based on data for banks, making them more similar to a bank-related measure like private credit. Put differently, industries grow faster not only if more credit is available, but in particular if more efficient financial institutions intermediate savings in the form of loans. The result that higher stock market capitalization is less strongly related to growth after accounting for the quality of financial institutions might reflect that most industries in our sample do not rely extensively on financial markets.

Overall, Table 4 suggests that bank efficiency measures have an important additional role in explaining output growth alongside traditional financial volume

[34] We also checked the robustness of our results using growth in gross output. Results are qualitatively comparable to those on gross value added. Estimations using multifactor productivity measures suffered from prohibitively small sample size due to constrained data availability in EU KLEMS.

measures. To shed more light on *how* growth is stimulated, Table 5 shows results using labour productivity growth as the dependent variable. Note that the initial level of productivity is measured as the gap to the leading industry-country. Hence, the positive coefficient is in line with the notion of convergence since it implies that industries with larger gaps relative to the productivity leader exhibit faster productivity growth.

**Table 5, Industry labour productivity growth and financial development**

| | Financial volumes | | Financial volumes & efficiency | | | |
|---|---|---|---|---|---|---|
| *Dependent variable:* labour productivity growth | Private credit to GDP | Stock market capitalization to GDP | Private credit to GDP | | Stock market capitalization to GDP | |
| Initial labour producitvity | 0.0207*** | 0.0208*** | 0.0207*** | 0.0207*** | 0.0208*** | 0.0207*** |
| gap relative to the frontier | [0.0038] | [0.0039] | [0.0038] | [0.0038] | [0.0039] | [0.0038] |
| Financial dependence x | 0.1276*** | 0.0372 | 0.1020** | 0.0658 | 0.0095 | 0.0278 |
| Financial volume | [0.0472] | [0.0397] | [0.0508] | [0.0497] | [0.0399] | [0.0380] |
| Financial dependence x | | | 0.2081 | | 0.3473** | |
| Cost efficiency | | | [0.1728] | | [0.1588] | |
| Financial dependence x | | | | 0.5465*** | | 0.6326*** |
| Profit efficiency | | | | [0.2036] | | [0.1869] |
| Number of observations | 595 | 595 | 595 | 595 | 595 | 595 |
| Adjusted R-squared | 0.53 | 0.52 | 0.53 | 0.53 | 0.52 | 0.53 |

Notes: Dependent variable is average growth of industry labour productivity between 1993 and 2004. Independent variables are the labour productivity gap for each industry relative to the country with the highest labour productivity level and the interaction between financial dependence and one of two volume measures and one of two bank efficiency measures. Financial dependence is measured as the average ratio of debt to assets of UK firms (excluding trade credit), see main text for details. Robust standard errors are in parentheses. Country and industry dummies are included in all specifications. The UK itself is excluded to avoid endogeneity concerns. * denotes a coefficient significantly different from zero at the 10%-level, ** at the 5%-level and *** at the 1%-level.

Compared to Table 4, the effect of financial volumes on growth is smaller, both in terms of the magnitude of the coefficients and their significance. This suggests that merely expanding credit might facilitate output growth but seems less important in stimulating productivity growth.

This indication is further corroborated when assessing both quantity and quality indicators of financial systems simultaneously. With the exception of credit quantities jointly specified with cost efficiency, all quantity effects vanish. The coefficients for both cost and profit efficiency are lower as well. However, the effect of profit efficiency declines only marginally. This suggests that especially the profit efficiency of banks becomes more important once a source of factor accumulation, growth in hours worked, is taken out of the equation. This is in line with the notion that banks with superior skills in identifying high-quality projects for funding indeed contribute both statistically and economically significant to productivity improvements. It also implies that banks that can exploit pricing power when funding productivity-enhancing projects. This result is to some extent in line with Cetorelli (2004) who reports that some degree of market power

among banks facilitates the funding of new, innovative entrants, helping to increase productivity in European manufacturing industries.

As discussed above, there are two possible explanations for the positive relationship between financial development and labour productivity growth. First, financial development may improve multifactor productivity growth. Second, it might stimulate capital accumulation. The data to test both hypotheses directly is not available for a sufficiently large group of countries, so we try to explain investment growth. Table 6 shows the results from this exercise.

**Table 6, Industry investment growth and financial development**

| | Financial volumes | | Financial volumes & efficiency | | | |
|---|---|---|---|---|---|---|
| *Dependent variable:* investment growth | Private credit to GDP | Stock market capitalization to GDP | Private credit to GDP | | Stock market capitalization to GDP | |
| Share of capital income in value added | 0.0141 | 0.0142 | 0.0142 | 0.0139 | 0.0143 | 0.0141 |
| | [0.0183] | [0.0183] | [0.0183] | [0.0181] | [0.0183] | [0.0182] |
| Financial dependence x Financial volume | 0.005 | 0.2075 | -0.0545 | 0.1062 | 0.1879 | 0.2342 |
| | [0.1985] | [0.1490] | [0.2168] | [0.1799] | [0.1514] | [0.1658] |
| Financial dependence x Cost efficiency | | | 0.9284 | | 0.8026 | |
| | | | [0.6152] | | [0.5474] | |
| Financial dependence x Profit efficiency | | | | -0.6602 | | -0.6378 |
| | | | | [0.7574] | | [0.8312] |
| Number of observations | 474 | 474 | 474 | 474 | 474 | 474 |
| Adjusted R-squared | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 |

Notes: Dependent variable is average growth of industry investment between 1993 and 2004. Independent variables are the share of capital income in value added and the interaction between financial dependence and one of two volume measures and one of two bank efficiency measures. Financial dependence is measured as the average ratio of debt to assets of UK firms (excluding trade credit), see main text for details. Robust standard errors are in parentheses. Country and industry dummies are included in all specifications. The UK itself is excluded to avoid endogeneity concerns. * denotes a coefficient significantly different from zero at the 10%-level, ** at the 5%-level and *** at the 1%-level.

Perhaps counter-intuitively, there is no significant relationship between financial development and investment growth. Referring back to equation (2), industry output growth can be due to growth in labour input, capital input and multifactor productivity growth. If we look at labour productivity growth as in Table 5, we eliminate the labour input as a possible source of growth. So our results in Table 5 imply that output growth is not just stimulated because of increases in labour input. Table 6 shows that we can eliminate the other explanation, increases in capital input, since industry investment growth is not affected by financial development. Therefore, Table 5 and 6 together show that financial development has a stimulating effect on multifactor productivity growth. In other words, it provides supportive evidence for the Schumpeterian notion that banks stimulate growth by funding the most deserving entrepreneurs.

However, Table 6 also raises the question why investment is not affected by financial development. The finding is not uncommon: Carlin and Mayer (2003) also aim to explain industry investment in a similar framework and find only insignificant effects and Beck *et al.* (2000, p. 261) describe the relationship between financial development and capital accumulation in their cross-country study as 'tenuous'. Furthermore, Benhabib and Spiegel (2000) also find that including fixed country effects often removes the effect of financial development on investment (as well as multifactor productivity growth). Other research also suggests that the cross-industry variation in investment growth in countries tends to be fairly limited (Inklaar and Timmer, 2007), which leaves less to be explained by financial development.

To sum up, bank efficiency is an important added dimension of financial development and stimulates output growth, but more importantly also productivity growth. As one robustness check we sequentially removed each industry or each country from the sample and the results are very similar. This suggests that single outlying industries or countries are not driving the main results from Tables 4 and 5.

## *Economic significance*

To determine the economic importance of our results, we should assess the marginal benefits from improvements in either financial intermediation efficiency or an increase in the structural reliance on external funds among industries. Table 7 therefore shows marginal effect results for both the output and the labour productivity equations as in Tables 5 and 6 for the sample comprising all 25 EU countries.

**Table 7: Marginal effects of output and labour productivity growth EU-25**

| *Dependent variable:* | Output growth | | | | Labor productivity growth | | | |
|---|---|---|---|---|---|---|---|---|
| | Private credit to GDP | | Stock market | | Private credit to GDP | | Stock market | |
| Initial labour producitvity | -0.3377*** | -0.3297*** | -0.3279*** | -0.3169*** | 0.7539*** | 0.7525*** | 0.7577*** | 0.7516*** |
| gap relative to the frontier | [0.1031] | [0.1028] | [0.1033] | [0.1021] | [0.1432] | [0.1413] | [0.1462] | [0.1427] |
| Financial dependence x | 1.3413*** | 1.4197*** | 0.4398219 | 0.7047** | 0.6426** | 0.4143587 | 0.0419366 | 0.121935 |
| Financial volume | [0.4729] | [0.4980] | [0.2763] | [0.2912] | [0.3219] | [0.3141] | [0.1752] | [0.1670] |
| Financial dependence x | 3.8132** | | 5.1013*** | | 1.337304 | | 2.2313** | |
| Cost efficiency | [1.7183] | | [1.6389] | | [1.1086] | | [1.0184] | |
| Financial dependence x | | 3.4212* | | 5.246*** | | 3.6152*** | | 4.1853*** |
| Profit efficiency | | [1.7879] | | [1.5988] | | [1.3421] | | [1.2343] |
| Number of observations | 575 | 575 | 575 | 575 | 595 | 595 | 595 | 595 |
| Adjusted R-squared | 0.37 | 0.36 | 0.36 | 0.36 | 0.53 | 0.53 | 0.52 | 0.53 |

Notes: * denotes a coefficient significantly different from zero at the 10%-level, ** at the 5%-level and *** at the 1%-level. Marginal effects calculated as elasticities dlnY/dlnX.

Holding constant the level of dependence on external finance and accounting for both the quantity and quality channel of financial development, the left panel of table 7 shows the economic relevance of bank efficiency for industry output growth. An increase of either efficiency measure by 1% increases output by approximately 3.4 to 3.8%. This effect is around three times larger than the volume channel and thus illustrates that it is better and not necessarily more banking that matters. The right-hand panel reports similar findings for labour productivity growth. Note, however, that especially banks' abilities to generate profits matter for industry improvements in labour productivity and that a deepening of credit or capital markets contributes only to a limited extent to productivity growth of European industries.

## *How are new members affected?*

A second important question is to what extent the effect of financial development on growth is uniform across the European Union. In particular, Manning (2003) has shown that the Rajan-Zingales (1998) results mostly disappear for the sample of OECD countries. From a policy point of view it is also of particular interest to know whether economic gains can be expected from improvements in the financial development of new member states (EU-10). Table 8 shows results for this sub-sample of countries for both output and labour productivity growth as dependent variables.

**Table 8: Output and labour productivity growth in the EU-10**

| *Dependent variable:* | Output growth | | | | Labor productivity growth | | | |
|---|---|---|---|---|---|---|---|---|
| | Private credit to GDP | | Stock market capitalization to GDP | | Private credit to GDP | | Stock market capitalization to GDP | |
| Initial labour producitvity | -0.6252*** | -0.6048*** | -0.6045*** | -0.5982*** | 0.0274*** | 0.0259*** | 0.0276*** | 0.0258*** |
| gap relative to the frontier | [0.1451] | [0.1494] | [0.1513] | [0.1524] | [0.0061] | [0.0060] | [0.0061] | [0.0060] |
| Financial dependence x | 0.3752*** | 0.1319 | 0.7207* | 0.2025 | 0.1828* | -0.0837 | 0.3468 | -0.2314 |
| Financial volume | [0.1199] | [0.1585] | [0.4222] | [0.4102] | [0.1061] | [0.1231] | [0.3282] | [0.2788] |
| Financial dependence x | 0.5563* | | 0.6077* | | 0.0498 | | 0.0777 | |
| Cost efficiency | [0.3299] | | [0.3349] | | [0.2795] | | [0.2903] | |
| Financial dependence x | | 1.2493*** | | 1.3798*** | | 1.1352*** | | 1.0940*** |
| Profit efficiency | | [0.3997] | | [0.3322] | | [0.3359] | | [0.3003] |
| Number of observations | 250 | 250 | 250 | 250 | 248 | 248 | 248 | 248 |
| Adjusted R-squared | 0.46 | 0.47 | 0.45 | 0.47 | 0.57 | 0.59 | 0.56 | 0.59 |

Notes: * denotes a coefficient significantly different from zero at the 10%-level, ** at the 5%-level and *** at the 1%-level. EU-10 includes Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. For other notes, see Table 5.

The results in Table 8 indicate that especially the less mature economies in Europe benefit from better financial systems.[35] While results are less clear-cut than those reported for the full sample in Tables 5 and 6, the consistently positive significant effect is the strongest among EU-10 countries for profit efficiency. In other words, our results are in line with those of Manning (2003) who emphasizes that especially less mature economies benefit from better financial systems.

We find weak results for incumbent EU-15 countries, which might to some extent be attributable to the smaller sample size. But since the younger EU-10 samples clearly exhibit a positive relation with (profit) efficiency, the integration of financial markets in the old member states may already have progressed much further compared to the fairly heterogeneous financial systems in the new member states. The results for the credit quantity in Table 8 indicate some positive growth and productivity effects. However, a policy to enable banks in these countries to improve their abilities to generate profits appears to benefit these countries' industries the most. In sum, the efficiency of banks is an important aspect of financial development, which has a growth-stimulating effect especially in the new EU member states.

### *Is it the measure of dependence on external finance?*

Our analysis rests on identifying the need for external financing of industries through the average debt-asset ratio of UK firms. This might be challenged since most continental European economies are more bank- than market-based. To examine the robustness of our results, we consider two alternatives. First, we use the average debt-asset ratio of French firms. As a more bank-based system (cf. Table 3), it could capture some different aspects of financial dependence. The choice for France is also motivated by a sufficiently large number of firms to permit reliable debt-asset estimates for all industries.

The results using French debt-asset ratios and labour productivity in the left panel of Table 9 are very similar to those in Tables 5, except that private credit is no longer significant in the first column. This suggests that the quality effect of financial institutions is even more important when considering a bank-based (France) rather than a

[35] We also ran separate regressions for incumbent EU countries (the EU-15) and found very weak relations between any financial development measure, growth, or productivity.

market-based (UK) financial system as a benchmark. Results for output and investment growth using French debt-asset ratios are very similar to the UK results and we also find that most of the gains in growth accrue in the EU-10.[36]

**Table 9, Industry labour productivity growth and financial development–robustness to the dependence on external finance measure**

| | Average debt-asset ratio of French firms | | | | Average sales growth of the median UK firm | | | |
|---|---|---|---|---|---|---|---|---|
| *Dependent variable:* labour productivity growth | Private credit to GDP | | Stock market capitalization to GDP | | Private credit to GDP | | Stock market capitalization to GDP | |
| Initial labour producitvity | 0.0176*** | 0.0183*** | 0.0179*** | 0.0183*** | 0.0211*** | 0.0208*** | 0.0211*** | 0.0209*** |
| gap relative to the frontier | [0.0034] | [0.0034] | [0.0034] | [0.0034] | [0.0039] | [0.0039] | [0.0039] | [0.0039] |
| Financial dependence x | 0.0758 | 0.0519 | 0.003 | 0.0335 | 0.0655 | 0.29 | 0.2539* | 0.3298** |
| Financial volume | [0.0502] | [0.0478] | [0.0347] | [0.0357] | [0.1963] | [0.1785] | [0.1526] | [0.1360] |
| Financial dependence x | 0.2475 | | 0.3573** | | 1.0269* | | 0.8471* | |
| Cost efficiency | [0.1845] | | [0.1714] | | [0.5521] | | [0.5106] | |
| Financial dependence x | | 0.5957*** | | 0.6596*** | | -0.8623 | | -0.522 |
| Profit efficiency | | [0.1896] | | [0.1826] | | [0.6233] | | [0.5904] |
| Number of observations | 595 | 595 | 595 | 595 | 595 | 595 | 595 | 595 |
| Adjusted R-squared | 0.53 | 0.54 | 0.53 | 0.54 | 0.53 | 0.52 | 0.53 | 0.53 |

Notes: Two different measures of financial dependence are used to evaluate the robustness of results in Table 5, namely the average debt-asset ratio of French firms instead of UK firms and the average real sales growth between 1994 and 2004 of the median UK firm. In the regressions using data on French firms, France is excluded; in the regressions using real sales growth, the UK is excluded. Robust standard errors are in parentheses. * denotes a coefficient significantly different from zero at the 10%-level, ** at the 5%-level and *** at the 1%-level. For other notes, see Table 5.

As a second alternative to our UK firm based measure of external finance dependence, we use a measure similar to Fisman and Love (2007) in combination with labour productivity in the right panel of Table 9. They argue that industries with larger growth opportunities will have a greater need for external financing, without necessitating assumptions about an industry's 'inherent' debt-asset ratio. Our measure of growth opportunities is based on UK firms again and is measured as the average real sales growth between 1994 and 2004 of the median firm in each industry.

The results using the Fisman/Love growth opportunities measure are noticeably weaker. Only the cost efficiency measures and stock market capitalization show significant positive effects. This could indicate that especially banks (in mature economies) are less suited to identify investment *opportunities*.[37] Indeed, EU economies are not famous for deep venture capital, private equity or other financial markets to fund young, innovative entrepreneurs, who elsewhere might tap relatively liquid (private) equity markets. The weak significance reported in Table 9 could thus represent the limited extent to which stock markets in the UK cover this 'opportunity' funding. In fact,

[36] Result are not reported to conserve on space and are available upon request.
[37] The weak relation between measures of financial development and Fisman/Love measures extend to other regressions, too.

Bekaert, Harvey and Lundblad (2005) report evidence that financial liberalization spurs growth especially due a better ability of markets to fund growth potentials and our measure of financial institutions' intermediation abilities appears to measure something else. Future research on a European finance-growth nexus at the industry level should therefore aim to develop further quality measures for segments of the financial system other than banks.

# Conclusions

In this paper we provide new evidence on the finance-growth nexus using data on financial development and growth in 25 industries operating in 25 EU countries between 1994 and 2004. In the vein of Rajan and Zingales (1998), we test whether financial development fosters industry growth especially for those sectors that are more dependent on external finance.

Our study differs in three important respects from previous industry growth analyses. First, we analyze both overall output growth and the *sources* of output growth since the original notion of Schumpeter (1912) implies that better financial development would stimulate productivity growth rather than factor accumulation alone. We use the new EU KLEMS database as our source for internationally comparable industry data. Second, we derive measures of financial dependence from firm-level data using the Amadeus database. Thus, we avoid the assumption that stock market-listed U.S. firms represent the best developed and most appropriate benchmark regarding optimal capital structures. Instead we also cover small and medium-sized firms and conclude that our results are invariant to whether the UK or France is used as a benchmark. Third, we derive measures of the quality of financial intermediaries to channel funds from savers to investors. These measures are rooted in microeconomic theory of banking. To this end we estimate bank-specific measures of cost and profit efficiency of European banks using a novel latent class model that allows for different banking technology regimes. This allows for greater flexibility in accounting for both observed and unobserved differences between banks than more traditional efficiency estimates. Using relative efficiency scores avoids many of the problems associated with traditional volume measures of financial

development, such as asset price inflation during bubbles or reverse causality concerns in the vein of Robinson (1952).

We confirm the established result that deeper credit and capital markets spurs output growth. Our first new finding is that the cost and profit efficiency are important additional dimensions of financial development. We find that these efficiency measures have an additional explanatory power alongside the more traditional financial volume measures. This result complements earlier evidence on the finance-growth nexus, but emphasizes the original notion that it is better and not only more intermediation that spurs growth.

Second, we find that financial development does more than just stimulate factor accumulation but also enhances productivity growth. While there is a positive relationship between financial development and labour productivity growth, investment growth is unaffected. This leaves multifactor productivity growth as the main reason for higher labour productivity growth. Moreover, cost and profit efficiency are particularly important in explaining labour productivity growth, while deeper credit and capital markets are less significant.

Third, we find from a number of robustness checks that neither the specification of different benchmarks of optimal industry capital structures nor bank efficiency estimates alter the qualitative implications of our results. Finally, we find that the growth gains from financial development are concentrated in the new EU member states, which have lower levels of financial development.

Future research should therefore focus on further proxies that measure the quality rather than the quantity of financial development as well as additional models that more explicitly incorporate the lender-borrower relations at the microeconomic level. From a policy point of view, these results imply that there are still important growth dividends from improving financial systems in new EU member states.

**Appendix Table A1, Latent class frontier parameter estimates**

| **Dependent** | ln(C) | | | | | | ln(PBT) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LL** | 6061 | | | | | | -20259 | | | | | |
| **Group** | *1* | | *2* | | *3* | | *1* | | *2* | | *3* | |
| | *b* | *p-value* | *b* | *p-value* | *b* | *p-value* | *b* | *p-value* | *b* | *p-value* | *b* | *p-value* |
| Constant | -1.045 | 0.001 | 1.871 | 0.207 | 1.782 | 0.000 | 3.416 | 0.000 | 4.413 | 0.000 | 2.397 | 0.000 |
| ln(Y1) | -0.059 | 0.314 | 0.522 | 0.000 | 0.294 | 0.000 | -0.066 | 0.032 | 0.293 | 0.000 | -0.349 | 0.000 |
| ln(Y2) | 1.043 | 0.000 | 0.338 | 0.000 | 0.115 | 0.000 | 0.286 | 0.000 | 0.013 | 0.843 | -0.080 | 0.031 |
| ln(W1) | 0.432 | 0.000 | 1.029 | 0.000 | 0.964 | 0.000 | 2.161 | 0.000 | 1.609 | 0.000 | 1.062 | 0.000 |
| ln(Z) | 0.083 | 0.281 | 0.063 | 0.002 | 0.550 | 0.000 | 1.140 | 0.000 | -0.127 | 0.146 | 0.648 | 0.000 |
| ln(Y1*Y1) | 0.146 | 0.000 | 0.186 | 0.000 | 0.206 | 0.000 | 0.090 | 0.000 | -0.009 | 0.310 | 0.013 | 0.043 |
| ln(Y1*Y2) | -0.162 | 0.000 | -0.336 | 0.000 | -0.350 | 0.000 | -0.420 | 0.000 | -0.084 | 0.000 | -0.059 | 0.000 |
| ln(Y2*Y2) | 0.195 | 0.000 | 0.171 | 0.000 | 0.122 | 0.000 | 0.173 | 0.000 | 0.144 | 0.000 | 0.030 | 0.000 |
| ln(W1*W1) | -0.003 | 0.788 | -0.003 | 0.551 | -0.025 | 0.000 | 0.321 | 0.000 | 0.157 | 0.000 | 0.090 | 0.000 |
| ln(5Z) | 0.227 | 0.000 | -0.026 | 0.000 | -0.062 | 0.000 | -0.225 | 0.000 | 0.174 | 0.000 | 0.200 | 0.000 |
| ln(Y1*W1) | -0.082 | 0.000 | 0.012 | 0.000 | -0.032 | 0.000 | -0.079 | 0.000 | -0.003 | 0.763 | -0.117 | 0.000 |
| ln(Y2*W1) | 0.153 | 0.000 | 0.001 | 0.610 | -0.039 | 0.000 | -0.024 | 0.000 | -0.006 | 0.571 | -0.026 | 0.000 |
| ln(Y1*Z) | -0.104 | 0.000 | -0.006 | 0.038 | -0.016 | 0.000 | 0.184 | 0.000 | 0.026 | 0.001 | -0.026 | 0.001 |
| ln(Y2*Z) | -0.090 | 0.000 | 0.008 | 0.001 | 0.062 | 0.000 | 0.030 | 0.000 | -0.087 | 0.000 | 0.045 | 0.000 |
| ln(W1*Z) | -0.036 | 0.001 | -0.022 | 0.000 | 0.074 | 0.000 | 0.223 | 0.000 | -0.012 | 0.334 | 0.227 | 0.000 |
| T | -0.020 | 0.468 | -0.029 | 0.000 | -0.073 | 0.000 | -0.083 | 0.000 | -0.060 | 0.131 | 0.165 | 0.000 |
| T^2 | 0.000 | 0.832 | 0.000 | 0.881 | 0.001 | 0.000 | 0.005 | 0.000 | -0.005 | 0.003 | 0.002 | 0.000 |
| ln(Y1*T) | 0.012 | 0.000 | 0.004 | 0.000 | 0.010 | 0.000 | -0.044 | 0.000 | -0.009 | 0.031 | -0.030 | 0.000 |
| ln(Y2*T) | 0.004 | 0.190 | -0.002 | 0.020 | 0.004 | 0.000 | -0.019 | 0.000 | -0.015 | 0.000 | -0.015 | 0.000 |
| ln(W1*T) | 0.005 | 0.173 | -0.007 | 0.000 | -0.009 | 0.000 | -0.022 | 0.000 | -0.029 | 0.000 | 0.004 | 0.132 |
| ln(Z1*T) | -0.006 | 0.219 | -0.005 | 0.000 | -0.017 | 0.000 | 0.067 | 0.000 | 0.034 | 0.000 | 0.030 | 0.000 |
| Sigma | 0.873 | 0.000 | 0.253 | 0.000 | 0.129 | 0.000 | 0.595 | 0.000 | 1.601 | 0.000 | 0.178 | 0.000 |
| Lambda | 3.145 | 0.000 | 0.026 | 0.997 | 0.698 | 0.000 | 1.632 | 0.000 | 1.989 | 0.000 | 0.243 | 0.719 |
| Group membership probability | | | | | | | | | | | | |
| P | 0.088 | 0.000 | 0.378 | 0.000 | 0.534 | 0.000 | 0.486 | 0.000 | 0.251 | 0.000 | 0.263 | 0.000 |

Notes: 27,248 observations on 4,476 banks. See Table 2 for an explanation of the variable codes. l= $s_u$/ $s_v$; s= $s_u$+$s_v$.Country dummies included as group determinants (not reported).

**Appendix Table 2, List of industries included in this study**

| | *Industry name* | *NACE code* |
|---|---|---|
| 1 | Agriculture, forestry and fishing | AtB |
| 2 | Mining and quarrying | C |
| 3 | Food and beverages | 15t16 |
| 4 | Textiles, wearing apparel and leather products | 17t19 |
| 5 | Wood and wood products | 20 |
| 6 | Paper, printing and publishing | 21t22 |
| 7 | Coke, refined petroleum and nuclear fuel | 23 |
| 8 | Chemicals and chemical products | 24 |
| 9 | Rubber and plastics | 25 |
| 10 | Non-metallic mineral products | 26 |
| 11 | Basic metals and fabricated metal products | 27t28 |
| 12 | Machinery | 29 |
| 13 | Electrical and optical equipment | 30t33 |
| 14 | Transport equipment | 34t35 |
| 15 | Manufacturing, nec; recycling | 36t37 |
| 16 | Electricity, gas and water supply | E |
| 17 | Construction | F |
| 18 | Motor trade | 50 |
| 19 | Wholesale trade | 51 |
| 20 | Retail trade | 52 |
| 21 | Hotels and restaurants | H |
| 22 | Transport and storage | 60t63 |
| 23 | Post and telecommunications | 64 |
| 24 | Business services | 71t74 |
| 25 | Social and personal services | O |

## References


Aghion, P., G.M. Angletos, A. Bannerjee and K. Manova (2007), "Volatility and Growth: Credit Constraints and the Composition of Investment" *mimeo*, Harvard University.

Almeida, H. and D. Wolfenzon (2005), "The effect of external finance on the equilibrium allocation of capital" *Journal of Financial Economics* 75, 133-164.

Beck, T., R. Levine and N. Loayza (2000a), "Finance and the sources of growth" *Journal of Financial Economics* 58, 261-300.

Beck T., A. Demirgüç-Kunt and R. Levine (2000), "A New Database on Financial Development and Structure" *World Bank Economic Review* 14, 597-605.

Bekaert, G., Harvey, C. R., Lundblad, C. (2005), "Does financial liberalization spur growth?" *Journal of Financial Economics* 77, 3-55.

Benhabib, J. and M.M. Spiegel (2000), "The Role of Financial Development in Growth and Investment" *Journal of Economic Growth*, 5, 341-360.

Berger, A. N. (2008), "International Comparisons of Banking Efficiency" *Financial Markets, Institutions, & Instruments* 16(3), 119-144.

Berger, A.N. and D.B. Humphrey (1997), "Efficiency of financial institutions: International survey and directions for future research" *European Journal of Operational Research* 98, 175-212

Berger, A. N., I. Hasan, and L. F. Klapper (2004), "Further Evidence on the Link between Finance and Growth: An International Analysis of Community Banking and Economic Performance" *Journal of Financial Services Research* 25(2/3), 169-202.

Berger, A.N., W.S. Frame and N.H. Miller (2005), "Credit Scoring and the Availability, Price, and Risk of Small Business Credit" *Journal of Money, Credit, and Banking* 37(2), 191-222.

Bos, J. W. and H. Schmiedel (2007), "Comparing Efficiency in European Banking: A Meta Frontier Approach" *Journal of Banking & Finance* 31, 2081-2102.

Bos, J. W. B., M. Koetter, J. W. Kolari, and C. J. M. Kool (2008), "Effects of Heterogeneity on Bank Efficiency Scores" *European Journal of Operational Research*, forthcoming.

Calomiris, C. and J. R. Mason (2003), "Fundamentals, panics, and bank distress during the Depression" *American Economic Review* 93(5), 1615-1647.

Cetoreili, Nicola (2004), "Real Effects of Bank Competition" *Journal of Money, Credit, and Banking* 36, 543-558.

Casu, B. and P. Molyneux (2003), "A comparative study of efficiency in European banking" *Applied Economics* 35, 1865-1876.

de Serres, A., S. Kobayakawa, T. Sløk and L. Vartia (2006), "Regulation of financial systems and economic growth" *OECD Economics Department Working Papers*, no. 506.

Dietsch, M. and A. Lozano-Vivas (2000), "How the environment determines banking efficiency: A comparison between French and Spanish industries" *Journal of Banking & Finance* 24(6), 985-1004.

Fernández de Guevara, J. and Maudos J. (2007), "Banking competition, financial dependence and economic growth" Bank of Finland Conference Proceedings Financial Markets, Innovation and Growth.

Fisman, R. and I. Love (2003), "Trade Credit, Financial Intermediary Development, and Industry Growth" *Journal of Finance* 58(1), 353-374.

Fisman, R. and I. Love (2007), "Financial Dependence and Growth Revisited" *Journal of the European Economic Association* 5(2-3), 470-479.

Furstenberg, G. v. and U. von Kalckreuth (2006), "Dependence on external finance: an inherent industry characteristic?" *Open Economies Review*, 17, 541-559.

Greene, W. (2005), "Reconsidering Heterogeneity in Panel Data Estimators of the Stochastic Frontier Model" *Journal of Econometrics* 126, 269-303.

Griffith, R., S. Redding and J. van Reenen (2004), "Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries" *Review of Economics and Statistics* 86(4), 883-895.

Guiso, L., P. Sapienza, and L. Zingales (2004), "Does Local Financial Development Matter?" *Quarterly Journal of Economics* 119, 929 - 969.

Hartmann, P., F. Heider, E. Papaioannou and M. Lo Duca (2007), "The Role of Financial Markets and Innovation in Productivity and Growth in Europe" *ECB Occasional Paper Series*, no. 72.

Humphrey, D. B. and L. B. Pulley (1997), "Bank's Response to Deregulation: Profits, Technology and Efficiency" *Journal of Money, Credit, and Banking* 29(1), 73-93.

Inklaar, R., M. P. Timmer and B. van Ark (2008), "Market services productivity across Europe and the US" *Economic Policy* 23(53), 139-194.

Jorgenson, D.W., M. Ho and K.J. Stiroh (2005). 'Growth of US Industries and Investments in Information Technology and Higher Education', in C.A. Corrado, J. Haltiwanger and D.E. Sichel (eds.) *Measuring Capital in the New Economy*, Chicago: University of Chicago Press.

King, R. and R. Levine (1993a), "Finance and Growth: Schumpeter Might Be Right" *Quarterly Journal of Economics* 108, 717-737.

King, R. G. and R. Levine (1993b), "Finance, Entrepreneurship, and Growth: Theory and Evidence" *Journal of Monetary Economics* 32, 513-542.

Klapper, L., L. Laeven and R. Rajan (2006), "Entry regulation as a barrier to entrepreneurship" *Journal of Financial Economics* 82, 591-629.

Kumbhakar, S. C. and C. A. K. Lovell (2000), *Stochastic Frontier Analysis* Cambridge: Cambridge University Press.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer and R. W. Vishny (1997), "Legal Determinants of External Finance" *Journal of Finance* 52(3), 1131-1150.

La Porta, R., F. Lopez-de-Silanes and A. Shleifer (1998), "Law and Finance" *Journal of Political Economy* 106(6), 1113-1155.

Levine, R. (2005), "Finance and Growth: Theory and Evidence" in P. Aghion and S. N. Durlauff (eds.) *Handbook of Economic Growth*, North-Holland.

Lucchetti, R., L. Papi, and A. Zazzaro (2001), "Bank's Inefficiency and Economic Growth: A Micro-Macro Approach" *Scottish Journal of Political Economy* 48(4), 400-424.

Maudos, J., J. M. Pastor, F. Perez, and J. Quesada (2002), "Cost and Profit Efficiency in European Banks" *Journal of International Financial Markets, Institutions and Money* 12(1), 33-58.

Mester, L. J. (1997), "Measuring Efficiency at U.S. Banks: Accounting for Heterogeneity Matters" *Journal of Operational Research* 98(2), 230-242.

Orea, L. and S. Kumbhakar (2004), "Efficiency measurement using a latent class stochastic frontier model" *Empirical Economics* 29(1), 169-183.

Rajan, R. G. and L. Zingales (1998), "Financial Dependence and Growth", *American Economic Review*, 88(3), pp. 559-586.

Rioja, F. and N. Valev (2004). Does One Size Fit All? A Reexamination of the Finance and Growth Relationship. *Journal of Development Economics* 74, 429-447.

Robinson, J. (1952), *The Rate of Interest and Other Essays*, London: MacMillan.

Romero-Ávila, D. (2007), "Finance and growth in the EU: New evidence from the harmonization of the banking industry" *Journal of Banking & Finance* 31, 1937-1954.

Schumpeter, J. A. (1912), *Theorie der Wirtschaftlichen Entwicklung*. Leipzig: Dunker & Humblot.

Sealy, C.W. and J.T. Lindley (1977), "Inputs, Outputs, and a Theory of Production and Cost at Depository Financial Institutions" *Journal of Finance* 32(4), 1251-1266.

Timmer, M.P., M. O'Mahony and B. van Ark (2007a), "The EU KLEMS Growth and Productivity Accounts: An Overview" *mimeo*, University of Groningen & University of Birmingham, March.

Timmer, M.P., G. Ypma and B. van Ark (2007b). "Industry-of-Origin Prices and Output PPPs: A New Dataset for International Comparisons" *GGDC Research Memorandum*, GD–82 Groningen Growth and Development Centre, www.ggdc.net.

Wurgler, J. (2000), "Financial markets and the allocation of capital" *Journal of Financial Economics*, 58(1-2), pp. 187-214.