

# Finance and Growth in a Bank-Based Economy: Is it Quantity or Quality that Matters?

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## **Abstract**

With this paper we seek to contribute to the literature on the relation between finance and growth. Most studies use proxies on the size of financial systems and control at most for the ownership of intermediaries rather than measuring the quality of intermediation. Moreover, cross-country comparisons may suffer from the disadvantage that systematic differences between markedly different economies could drive the result that finance matters. Therefore, we suggest an alternative to measure the quality of banks' financial intermediation and focus on the regions of one economy only: Germany. To approximate the quality of financial intermediation we use bank-specific efficiency estimates. We find that this measure of intermediation quality has a significantly positive effect on growth. This result is robust also after excluding banks likely to operate in multiple regions, when distinguishing between different banking pillars active in Germany and when excluding the structurally weaker East from our analysis.

JEL classification: G21, O16, O47, O52, R11, R51.

Keywords: Finance-growth-nexus, intermediation quality, regional growth, efficiency.

# 1 Introduction

The notion that a sound financial system fosters economic growth has already been advocated by Schumpeter (1934, 1939). Since the seminal empirical work by King and Levine (1993) and important theoretical contributions (Pagano, 1993), the question if and to what extent financial development spurs economic growth experienced a renaissance. Numerous studies test Schumpeter's early hypotheses.<sup>1</sup> Given the available evidence, only few economists doubt that finance matters for growth today.

But in our view most studies suffer from two major shortcomings. First, in a Schumpeterian world it is the *quality* rather than the *quantity* of financial intermediation that influences economic growth. However, most studies specify proxies of financial systems' size, for example the credit to GDP ratio. Only few account for the quality of intermediation, mostly by controlling somewhat indirectly for the ownership of banks (La Porta et al., 2002; Dinc, 2005). But to our knowledge, hardly any study measures quality more directly at the microeconomic bank level. Second, most studies are of a cross-country nature, frequently sampling very different economies like the U.S. on the one hand and Thailand on the other. Then, significant financial indicators may partly be driven by excessively heterogeneous samples.<sup>2</sup>

We address these problems in the following manner. First, we grasp the quality of intermediation by using microeconomic technical efficiency measures derived at the bank-level to assess banks' abilities to convert inputs into financial products and services. We argue that financial intermediation can spur growth in those regions where banks are relatively more successful in maximizing their profits when selecting the most promising customers and monitoring their investments.<sup>3</sup> Second, we seek to reduce potential sample bias by focusing on the regions of one industrialized country only, namely Germany. Thereby, we ensure that many environmental factors identified as significant are fairly homogeneous in our sample. We hypothesize that in Germany's fragmented three-pillar system of private and public banks the quality of financial intermediation is not only different across regions but also of significant importance to promote growth.<sup>4</sup> Our study adds to the only two analyses that we are aware of that also seek to distinguish between the quality and the quantity of financial intermediation, namely Lucchetti et al. (2001) and Berger et al. (2004).

In this paper, we concentrate throughout on banks only. We do not investigate the relative merits of banks versus markets or other intermediaries for two rea-

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<sup>1</sup>For example, Rajan and Zingales (1998), Beck and Levine (2002) and Berger et al. (2004). Review studies are Levine (2004), Thiel (2001) and Dolar and Meh (2001).

<sup>2</sup>To some extent this is merely an omitted variable bias if factors influencing growth are not controlled for. For example, La Porta et al. (1998) show that the legal system and Garretsen et al. (2004) that cultural differences influence growth. However, beyond this potential omitted variable problem we may also face the conceptual problem entailed in the assumption of a homogeneous production function between, say, developed and less developed countries. Of course, a regional focus entails other caveats such as a potential lack of variation of GDP across regions. We discuss subsequently a number of these challenges in our results section.

<sup>3</sup>We hypothesize that profit efficiency is a suited proxy because, first, Koetter (2006) shows that banks' profit-maximizing abilities differ considerably across Germany's regions and because, second, there is evidence that bank efficiency significantly predicts the ultimate signal of (un)successful intermediation: bank failure (Wheelock and Wilson, 2000; Worthington, 2002; Koetter et al., 2006).

<sup>4</sup>Private banks are commercials and cooperatives and savings banks constitute the public sector.

sons. First, increasingly many scholars discard the view that banks and markets are substitutes (Merton and Bodie, 2004). Empirical evidence indicates that both markets and institutions are integral parts of a financial system that complement each other (Levine, 2002; Beck and Levine, 2002). Second, Germany is a role-model of a bank-based system. Hackethal (2004) examines inasmuch the German economy depends on banks, markets and other intermediaries to channel funds from savers to investors. His results confirm conventional wisdom: German banks were, still are and likely remain to be of paramount importance in Germany's financial system for the foreseeable future.

We structure the paper as follows. In section 2, we discuss the literature that links finance and growth theoretically and empirically. In section 3, we introduce our growth specification, the methodology to derive the quality of financial intermediation by banks and the data used. In section 4 we present and discuss our results. We conclude in section 5.

## 2 Financial Development and Growth

The question if and how financial development influences real economic growth is at the very heart of the finance-growth literature. Both the available evidence and remaining open issues are numerous and have been reviewed by Levine (2004) recently. Here, we focus on theoretical links between finance and growth and the available empirical evidence.

### 2.1 Theoretical Considerations

The importance of finance for real economic growth is not without debate. On the one hand, Robinson (1952) argues that financial services are provided as a reaction to the demand by corporate firms. In her view, finance follows entrepreneurial activity.<sup>5</sup> Similarly, Lucas (1988) regards finance an overvalued explanatory factor in growth theory. On the other hand, economists like Gurley and Shaw (1955), Gerschenkron (1963), Goldsmith (1969) and McKinnon (1973) find that neglecting financial development severely limits our understanding of economic growth.

Along the lines of the latter scholars there are two channels through which financial development can influence growth. The first is Hicksian in nature and emphasizes the enhanced accumulation of capital through higher savings (Hicks, 1969). The second represents a Schumpetrian point of view and centers on the improved ability of the financial sector to increase technological progress through an efficient selection, funding and monitoring of projects (Schumpeter, 1934, 1939).

Pagano (1993) employs a simple endogenous growth model to illustrate how financial development can influence growth through these two channels. On the one hand, larger volumes of financial funds saved promote growth as more savings are available to fund investment projects. This effect relates to the Hicksian view that better developed financial systems are those that channel higher quantities from

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<sup>5</sup>This point is also known as the reverse causality critique (Boyd and Smith, 1996).

savers to investors. On the other hand, an improved quality of intermediation can both enhance factor productivity and reduces the fraction of savings that are foregone due to suboptimal production plans of financial agents. Both effects resemble the Schumpetrian train of thought. Better intermediaries help to reduce slack in the financial system and foster capital productivity through investing in more profitable projects.

Both notions, Hicks as well as Schumpeter, imply that better developed financial systems reduce transaction and information costs. Levine (2004) distinguishes five ways how banks accomplish these reductions:<sup>6</sup> (i) information collection, (ii) project monitoring, (iii) risk management, (iv) channelling savings and (v) facilitate transactions of goods and services.

First, consider information collection. If it is costly to gather information when making investment decisions, studies in the vein of Allen (1990) show that financial intermediaries help to economize on search cost and thereby foster aggregate saving. According to Morales (2003), information gathering leads to learning effects. This implies that financial intermediaries are better suited to spot entrepreneurs with the highest potential to innovate on products, services and processes.

Second, consider monitoring. Better developed financial systems aid equity and debt holders of firms to scrutinize managers as to ensure that the latter act in the best interest of the former. If information asymmetries exist, managers may exploit free-rider considerations of investors in financial markets when individual investors rely on each other to conduct costly monitoring activities. The seminal model by Diamond (1984) illuminates how banks act as delegated monitors on behalf of investors, thereby solving the free-rider problem. De la Fuente and Marin (1996) find that banks help to enhance productivity as they are particularly suited to monitor opaque, and hence information cost intensive, innovative projects. In the vein of Schumpeter's constructive destruction argument, Bencivenga and Smith (1993) provide a model where banks ration credit in order to select the most profitable investments, which raises capital productivity.

Third, consider risk management. Better developed financial systems help savers and investors in three ways to enhance risk management: cross-sectional diversification, intertemporal diversification, and liquidity provision. The first issue follows straight from finance theory. Greenwood and Jovanovic (1990) argue that intermediaries foster productivity thanks to their ability to select profitable investments and to assemble portfolios that ameliorate project-specific shocks. While it may be too costly for an individual investor to diversify, Acemoglu and Zilibotti (1997) show how intermediaries facilitate the funding of more risky but innovative projects. The second issue highlights intertemporal risk-sharing (Allen and Gale, 1997). Especially in Germany's corporate culture of long-term relations between borrowers, lenders and owners (Elsas and Krahen, 2004) financial intermediaries may commit to a long-run perspective and help both savers and investors to prevent premature divestiture. The third issue refers to liquidity risk. The more difficulties savers have to convert real assets into means of exchange, the less inclined they are to give up

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<sup>6</sup>Note again that we focus here on banks. Obviously, all of these functions may be fulfilled by markets or non-bank financial intermediaries, too. For a complete review of the relative merits we refer to Levine (2004).

the direct control of their savings. This implies that either financial markets (Bencivenga et al., 1995), intermediaries (Diamond and Dybvig, 1983) or a mixture of the two (Fecht et al., 2005) can help to insure savers against liquidity shocks, thereby fostering investment in longer-run, illiquid and relatively risky projects.

Fourth, consider the collection and channelling of savings. Many projects require large, indivisible funding. Collecting funds from a multitude of investors is expensive for an individual project owner. Financial intermediaries can spread these fixed costs if they execute this collection function for many savers and investors (Sirri and Tufano, 1995). This increases aggregate savings and investment by matching different denominations between the two.

Fifth, consider the facilitation of exchanging goods and services. Financial development helps to establish an accepted medium of exchange. This reduces transaction and information costs since these are high if non-standardized goods have to be evaluated on a case-by-case basis in barter economies. According to Greenwood and Smith (1996), this allows for a higher number of transactions, which is necessary if an economy increasingly specializes. They argue that higher specialization favors productivity gains and thereby promotes growth.

In sum, all five functions of financial intermediaries affect growth via the volume of savings and an efficient allocation of capital to productive investments. We regard the former effect primarily as a quantity effect that financial development has on growth. In contrast, we regard the latter as a quality effect of the sector's ability to channel financial resources efficiently to those investment projects that maximize return. Let us turn next to the empirical evidence as how to measure financial development.

## 2.2 Empirical Evidence

Most empirical growth studies analyze if and how fast per capita income  $y$  converges to its steady state. Barro and Sala-i Martin (1995) show that the average growth rate of per capita output depends on the initial level of per capita output,  $Y_0$ .<sup>7</sup> On this basis, Lucchetti et al. (2001) denote what they call the reference model of the finance-growth literature as

$$\Delta y = \beta_1 y_0 + \beta_2 fd + \beta_3 x + \epsilon, \quad (1)$$

where lower case letters indicate the log of a variable,  $FD$  denotes a proxy of financial development,  $x$  is a vector of additional control variables and  $\epsilon$  is a random error term. In equation (1),  $\Delta y$  depicts the growth rate of per capita GDP. To our knowledge none of the studies on Germany's economic growth considers the financial sector in the analysis (Niebuhr, 2001; Dreger and Kosfeld, 2003; Kosfeld et al., 2005). This neglect is surprising because, to put it in terms of Levine (2004), the evidence in support of a positive relation between financial development and growth is remarkably robust across a whole range of alternative empirical methodologies.

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<sup>7</sup>See the discussion in chapters 11 and 12, in particular their equation (11.1).

With respect to the international evidence, the seminal contribution in the finance-growth literature is King and Levine (1993). Their empirical specification of the growth model is based on a single cross-sectional analysis under the assumption of identical aggregate production functions as depicted in equation (1). Their proxy for financial development  $FD$  equals liquid liabilities of the financial industry relative to gross domestic product (GDP).<sup>8</sup> Hence, King and Levine (1993) gauge primarily the quantity effect of financial development. Additionally, they acknowledge the importance of human capital accumulation, population growth, trade or government expenditure and specify according covariates to enter  $x$ . For 77 countries during the period 1960 and 1989 and three alternative measures of economic growth<sup>9</sup> they find significant and large relations between financial development and growth.

Many empirical studies of the growth-finance nexus (Demetriades and Hussein, 1996; Da Rin and Hellmann, 2002) proxy  $FD$  by a variation of these initially suggested measures. Levine et al. (2000) extend earlier studies regarding estimation techniques and data coverage. Their results confirm earlier findings: a significant and strong influence of financial development on growth. They conclude that the evidence on the importance of finance for growth is robust.

The available evidence is criticized by Lucchetti et al. (2001) primarily for the choice of proxies of financial development. They stress two issues. First, the volume of credit intermediated is only an indirect measure of the Schumpeter argument that better developed financial systems enjoy less frictions in the intermediation process and foster additionally the rate of return through better project selection and monitoring. Secondly, absolute measures of credit volume are subject to simultaneity problems, initially pointed out by Robinson (1952), to a much larger extent than a relative measure of the quality with which banks perform their intermediation task. In a nutshell, credit *volume* may simply be positively correlated with growth because in an expanding economy firms increase their demand for financial funds. Lucchetti et al. (2001) find indeed that both the quantity of credit and the quality of banks as measured by cost efficiency have significant influence on regional growth, respectively. The only additional study that we are aware of that also distinguishes more explicitly between the quantity and quality effect of financial development is Berger et al. (2004). For a sample of 49 nations they do find a positive and significantly different effect of bank efficiency on growth during 1993 and 2000. In sum, both studies suggest that the alternative channels as to how financial development matters for growth should be separated: quantity versus quality.

A second critique of most international evidence is related to the cross-country nature of these studies. Failure to account for systematic differences across countries leads to biased results. Intuitively, comparing growth rates and the volume of cumulative loans to GDP between developed and less-developed countries may yield spurious results (Rioja and Valev, 2004). While the identification of additional control variables is an important progress in the finance-growth literature, an alternative strategy is to compare regions with reasonably akin economic structures.

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<sup>8</sup>King and Levine (1993) construct two additional proxies: credit supplied by central versus commercial banks and funds lend to the private and the public sector. These two measures provide additional information about the sources and directions of financial funds.

<sup>9</sup>Mean rate of real GDP per capita growth, mean rate of per capita capital stock growth and total productivity growth.

One of the few studies embarking on this train of thought is Jayaratne and Strahan (1996). They examine the relation between branching deregulation in the U.S. and its impact on state growth. They find that deregulation improved the quality of lending, measured by individual banks' shares of non-performing loans, thereby fostering capital accumulation. With regard to European evidence we are only aware of Italian studies. Besides Lucchetti et al. (2001), Guiso and Zingales (2002) use survey data on loan applicants' success to receive a loan as a proxy for financial development. They find that higher financial development fosters entrepreneurial activity, enhances competition in the non-financial sector and results in higher corporate growth. These studies suggest that after eliminating a range of reasons for systematic differences between regions it is the quality of financial intermediation that spurs growth.

In sum, theory suggests that well-developed banks should spur growth via a quantity and a quality effect. However, the empirical literature did not yet address the issue as how to measure these two different channels more directly. We turn next to our methodology as how to measure regional growth in Germany.

### 3 Methodology

Our primary concern in this paper is perfectly in line with one agenda point for future research in Levine (2004): The necessity to develop better proxies for financial development. We begin with our specification of a growth model and subsequently discuss the measurement of bank efficiency as a proxy for intermediation quality.

#### 3.1 Growth Specification

A crucial assumption of cross-sectional growth studies in the vein of equation (1) is that production functions are supposed to be homogeneous across analyzed regions. In our view, it is most likely that such an assumption is overly heroic due to unobserved country-specific effects. While using alternative samples of more homogeneous regions within one country partly alleviates the problem, Islam (1995) suggests to approach the problem more directly. He advocates the use of panel estimators to relax the restrictive assumption of homogeneous production functions across regions. This approach avoids the bias of estimated coefficients when omitting unobservable region-specific effects if these are correlated with the error. Furthermore, Levine (2004) notes that cross-sectional estimation of mean growth rates neglects the information contained in the time variation and forgoes additional degrees of freedom, which are available when exploiting longitudinal data. Therefore, we use in this study panel data and estimation techniques.

Another decisive advantage of a panel approach relates to potential simultaneity problems of financial development indicators and growth. The use of endogenous regressors leads to estimations that suffer from inconsistency and bias, which requires the specification of suited instrument variables. Levine et al. (2000) stress that panel data enables us to control for endogenous explanatory variables insofar as dynamic panel data estimators in the vein of Arellano and Bond (1991) have been developed

to address the potential simultaneity bias directly. They exploit the information contained in panel data by choosing lagged level variables as instruments as to solve the issue. Moreover, they allow us to explicitly test the validity of chosen instruments.

We follow Islam (1995) and Levine et al. (2000) and specify the reduced form of a growth model in levels as a dynamic panel model. The regression equation is:

$$y_{i,t} = \alpha y_{i,t-1} + \beta f d_{i,t} + \gamma x_{i,t} + \mu_i + \epsilon_{i,t}. \quad (2)$$

As previously, all variables in lower cases are denoted in logarithms. We amend time indicators  $t$  and in addition,  $FD$  contains now two measures: the volume  $FD^V$  and the quality of financial development  $FD^Q$ . The former resembles the well-known specification of bank credit volume relative to GDP in the finance-growth literature. We deal with the measurement of the latter below in section 3.2. We specify a vector of further control variables,  $x$ , to contain human capital  $HC$  and the growth rate of the working population  $ETG$ .  $\mu_i$  is an unobserved region-specific effect and  $\epsilon$  represents the error term, where the latter is  $\epsilon_{i,t} \sim \text{iid}(0, \sigma_\epsilon^2)$ , independent of each other and among themselves.

Equation (2) cannot be estimated directly because the lagged endogenous variable is correlated with the unobserved group effects  $\mu_i$ . Thus, we have to eliminate the latter. To this end the Arellano-Bond estimator transforms equation (2) by taking first differences to yield:<sup>10</sup>

$$\Delta y_{i,t} = \alpha \Delta y_{i,t-1} + \beta \Delta f d_{i,t} + \gamma \Delta x_{i,t} + \Delta \epsilon_{i,t}. \quad (3)$$

The implementation of equation (3) is not straightforward because the differenced error term and lagged dependent variable,  $E[\Delta y_{i,t-1}, \Delta \epsilon_{i,t}] \neq 0$ , are now correlated by construction. Under the assumption that the  $\epsilon_{i,t}$  are not autocorrelated, Arellano and Bond (1991) suggest to employ lagged levels as instruments for  $\Delta y_{i,t-1}$ . The Arellano-Bond estimator is formulated as a GMM estimator with the moment conditions given by

$$E[W_i' \Delta \epsilon_i] = 0, \quad (4)$$

where  $W_i'$  denotes a matrix of instruments. If the lagged difference of the dependent variable can be instrumented sensibly with its own lagged levels, equation (4) holds and we can reject the presence of a correlation between differenced error terms and instruments.

In addition to the correlation problem of  $y_{i,t}$  prevalent by construction of the difference estimator, we have to address the concern that our explanatory variables  $FD^V$  and  $FD^Q$  are potentially also correlated with the error due to reverse causality. In principle, any measure of financial development is potentially endogeneous.

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<sup>10</sup>Note, that taking first differences does not affect estimated coefficients as these are identical in equations (2) and (3). We report below estimated coefficients with variable labels in levels according to equation (2).

Especially the volume of credit may well be explained by expanding economic activity rather than vice versa. Thus, we have to identify suitable instruments for  $FD^V$  and  $FD^Q$ .<sup>11</sup>

The appropriateness of the chosen instruments can be validated by a test on the validity of the moment restrictions. The Sargan test for overidentifying restrictions represents such a test on the moment conditions formulated in equation (4) with the null-hypothesis  $H_0$  that moment conditions are not systematically violated.

Specifying financial development as exogenous, predetermined or endogenous variables and using alternative instruments respectively, allows us to test which choice of instruments for financial development is appropriate.<sup>12</sup> Let us turn beforehand to our approach to measure the quality effect of financial development.

### 3.2 Intermediation Quality

Our approach to devise a measure of intermediation quality is inspired by Lucchetti et al. (2001) and Berger et al. (2004). We approximate the quality of banks to perform their intermediation function by the efficiency of banks to employ resources when generating financial products and services.

The intuition behind this proxy unfolds as follows. We regard the main task of a bank to channel funds from savers to investors, to allocate them to the most profitable projects and to act as a delegated monitor after investment. Therefore, we consider in line with Sealey and Lindley (1977) the monetary volume intermediated as output  $O$ . When conducting their intermediation function, we assume that banks minimize cost,  $C$ , and maximize profits  $\pi$ . This requires them to use input quantities,  $Q$ , such as labor and deposits, in optimal proportions to produce a portfolio of outputs, for example interbank versus corporate loans. Under the assumption that banks are price-takers in factor markets, optimal input proportions depend on relative input prices,  $P$ . Bank inefficiency arises when managers employ simply too much input quantities and/or allocate them in wrong proportions.

Let us illustrate the link between efficiency and the quality of financial services provided with an example. If banks are better developed, we would expect that they hire the optimal amount of risk managers and credit officers given their choice of a loan portfolio to supply and respective wages. Assume that a bank granted relatively many corporate loans, which we assume to be on average more risky compared to interbank loans. 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 labor costs in the short run. But if the bank consistently

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<sup>11</sup>If explanatory variables are correlated with past *and* contemporaneous errors  $E[X_{i,t}, \epsilon_{i,s}] \neq 0$  for  $s \leq t$ , we refer to the variable as endogenous. Then, using first differences requires us to use levels lagged by two periods or more as instruments. In contrast, predetermined variables are contemporaneously *uncorrelated* with the errors  $E[X_{i,t}, \epsilon_{i,s}] \neq 0$  for  $s < t$  and present realizations depend only on past shocks. Thus, it suffices to instrument predetermined variables with their levels lagged by one period.

<sup>12</sup>Note, however, that this tests cannot rule out the conceptual question of reverse causality. Ultimately, the decision to specify GDP to depend on financial development can only be rooted in theory.

underprices riskier loans, subsequent defaults will result in write-offs of bad loans, thereby increasing cost and ultimately leading to inefficiency.<sup>13</sup> As a second example, banks may simply employ too much of an input. Spending on buildings and other fixed assets may be too high if managers negotiate rents poorly or if they are more interested in prestigious offices. Such a bank is then identified as inefficient compared to the industry.<sup>14</sup>

Since it is not only the ability of banks to economize on cost but especially to provide an output vector that maximizes profits, we estimate (alternative) profit efficiency with stochastic frontier analysis. We assume that banks maximize profits and use the so-called alternative profit model by Humphrey and Pulley (1997). A bank produces four outputs: interbank and commercial loans,  $O_1$  and  $O_2$ , respectively, and securities,  $O_3$ . To account for the increasing importance of off-balance sheet activities, we additionally follow Clark and Siems (2002) and specify the former as a fourth output  $O_4$ . Banks demand three inputs subject to given factor prices,  $P$ , and a technology constraint,  $T(O, Q, Z)$ , which also contains equity,  $Z$ . A bank employs fixed assets,  $Q_1$ , labor,  $Q_2$ , and borrowed funds,  $Q_3$ . In line with the alternative profit model, we further assume that German universal banks possess some pricing discretion on the output side subject to a pricing opportunity set  $H(R, O, P, Z)$ , where  $R$  denotes output prices.  $H(\bullet)$  is another constraint next to  $T(\bullet)$ . Maximum profits  $\pi^*(O, P, Z)$  depend on given input prices, available equity and output quantities.

The alternative profit approach is in our view appropriate for three reasons. First, Koetter et al. (2006) note that around 80% of German universal banks are active on regionally confined markets. This simply reflects the three-pillar structure of the German banking market, where the vast number of banks are fairly small local cooperative and savings banks. Similar to U.S. banking markets prior to the Interstate Banking Efficiency Act of 1994, both banking groups are prohibited by their respective head organizations to branch out at will ("*Regionalprinzip*"). Second, Hempell (2004) and Fischer and Pfeil (2003) analyze regional competition and find evidence of some regional market power, especially outside the non-urban areas. Third, if efficiency has indeed a positive effect on growth, we expect that it is not only the ability to economize sensibly on cost but especially to choose output portfolios efficiently. Due to the frequent absence of adequate output prices in banking data (Mountain and Thomas, 1999), the alternative profit model is an established approach to also assess the ability of banks to convert production factors efficiently along both in- and output dimensions into financial services and products.<sup>15</sup>

Finally, we acknowledge that deviations from optimal profit may not entirely be due to inefficiency but systematic differences across banking groups' business mixes, location in structurally weak eastern regions or sheer size. Therefore, we control for bank-specific heterogeneity by specifying a vector  $h_k$  of dummy variables for banking group, location, size and time-fixed effects. We write the alternative profit frontier using the translog functional form as follows:<sup>16</sup>

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<sup>13</sup>Alternatively, if the bank consistently overprices, it will lose the business to competitors. This would imply comparatively high labor cost in relation to relatively small volumes of funds and, thus, high inefficiency, too.

<sup>14</sup>See Hughes et al. (2003) for evidence on bank manager's desire to build empires.

<sup>15</sup>See for example Amel et al. (2004) for a review of perfect and alternative profit studies.

<sup>16</sup>We impose the necessary homogeneity and symmetry restrictions as in Lang and Welzel (1999).

$$\begin{aligned}
\ln \pi_{kt} &= \alpha_k + \sum_{i=1}^3 \alpha_i \ln P_{ikt} + \sum_{m=1}^3 \beta_m \ln O_{mkt} + \delta_0 \ln Z_{kt} \\
&+ \frac{1}{2} \sum_{i=1}^3 \sum_{j=1}^3 \alpha_{ij} \ln P_{ikt} \ln P_{jkt} + \sum_{i=1}^3 \sum_{m=1}^3 \gamma_{im} \ln P_{ikt} \ln O_{mkt} \\
&+ \frac{1}{2} \sum_{m=1}^3 \sum_{n=1}^3 \beta_{mn} \ln O_{mkt} \ln O_{nkt} + \frac{1}{2} \delta_1 (\ln Z_{kt})^2 \\
&+ \sum_{i=1}^3 \omega_i \ln P_{ikt} \ln Z_{kt} + \sum_{m=1}^3 \zeta_m \ln O_{mkt} \ln Z_{kt} + \eta_0 h_{kt} + u_{kt} + v_{kt}.
\end{aligned} \tag{5}$$

In any year  $t$ , a bank  $k$  can deviate from optimal profit before tax,  $\pi_{kt}$ , due to random noise,  $v_{kt}$ , or inefficient use of in- and outputs,  $u_{kt}$ . To distinguish these two effects, we specify a composed total error,  $\varepsilon_{kt}$ . For a profit frontier, inefficiency leads to below frontier costs. Therefore, the total error is  $\varepsilon_{kt} = v_{kt} - u_{kt}$ . The random error term  $v_{kt}$  is assumed iid with  $v_{kt} \sim N(0, \sigma_v^2)$  and independent of the explanatory variables. The inefficiency term is *iid* with  $u_{kt} \sim N|(0, \sigma_u^2)|$  and independent of the  $v_{kt}$ . It is drawn from a non-negative distribution truncated at zero.

One important difference regarding efficiency estimation in comparison to, for example, Lucchetti et al. (2001) and Berger et al. (2004), refers to the estimation of efficiency over time. Most studies actually use pooled cross-sectional estimation to obtain time-varying efficiency scores per bank. This implicit independence assumption of bank production over time is not very realistic. Especially in the context of growth studies an important caveat is that resulting efficiency scores may merely reflect cyclical developments of both bank assets and liabilities. In turn, those studies that employ panel frontier estimation usually suffer from the drawback of imposing a priori substantial structure on the efficiency terms (Kumbhakar and Lovell, 2000).

Therefore, we employ a recently developed bank-specific fixed effects panel stochastic frontier model with time-variant inefficiency to estimate the parameters in equation (5). This model has two main advantages. First, efficiency can develop unrestrictedly over time (Greene, 2005).<sup>17</sup> Second, any systematic differences across banks that are neither due to inefficiency nor controlled for by  $h_k$  enter the bank-specific effect  $\alpha_k$ . Such systematic differences are likely to exist even within one economy only, let alone in cross-country studies like that of Berger et al. (2004). The  $\alpha_k$ 's are allowed to be correlated with  $O_{kt}$ ,  $W_{kt}$  and  $Z_{kt}$  (Greene, 2005). Subsequently, we obtain bank-specific efficiency measures with the method suggested by Jondrow et al. (1982). We use the conditional distribution of  $u$  given  $\varepsilon$  and a point estimator of technical efficiency is given by  $E(u_{kt}|\varepsilon_{kt})$ , i.e. the mean of  $u_{kt}$  given  $\varepsilon_{kt}$ . Profit efficiency ( $FD^Q$ ) is calculated as  $[\exp(-u_{kt})]$  and equals one for a fully efficient bank. Likewise,  $FD^Q$  of 0.9 implies that a bank realized only 90% of optimal profits that could have been realized with the identical production plan.

We argue that our  $FD^Q$  measure enjoys three major advantages compared to the traditional approaches in the finance-growth literature. First, it is a much more

<sup>17</sup>Inefficiency can vary over time but is not further specified to follow any particular (linear) trend over time as, for example, in the model of Battese and Coelli (1992).

direct measure of resources wasted during the intermediation process due to suboptimal allocation and use of input factors in the vein of Leibenstein (1966). It therefore resembles the inefficiency component of financial development mentioned in Pagano (1993) much closer compared to the intermediated credit volume employed traditionally.

Second, we estimate a long-run profit frontier, which also includes operational costs arising from writing off non-performing loans. Deviations from optimal profits therefore capture the long-run (dis-)ability of bankers to fulfil their intermediation task efficiently. We argue that this holistic assessment of bank performance captures the ability to gather information both *ex ante* and *ex post* more appropriately compared to a proxy of the volume intermediated. This is because systematic and sustained failure to optimize the production process in light of these core functions of successful bankers, will result in higher than industry cost and thus lower than industry profits. Hence, we think that our  $FD^Q$  measure also captures the influence of financial development on an economy's factor productivity to a better extent compared to the sheer size of the financial industry.

Third, the relative ability to convert inputs into outputs is less prone to critique regarding reverse causality. In section 3.1 we pointed out that cross-sectional estimation fails to distinguish whether large volumes of bank credit, that is bank size, cause economic growth or rather result from it. While the use of instruments in our dynamic panel model alleviates the problem,  $FD^Q$  enjoys the conceptual advantage that it is a *relative* measure. More specifically, we assume that the transformation technology  $T(\cdot)$  is identical for all banks operating in Germany. At the same time, we account simultaneously through  $\alpha_k$  and  $h_k$  for systematic differences across banks, such as size or banking sector. Our quality proxy of financial development,  $FD^Q$ , is therefore independent of the credit volume of an individual bank because the efficiency of a bank does not depend on how much output it produces but rather how well it does so. It therefore seems reasonable to assume that the sustained ability of individual banks to exploit its resources given the available technology as efficient as possible does not depend per se on whether the economy is contracting or expanding. Intuitively, the performance of bankers to minimize costs and maximize profits when supplying financial services should foster growth independent of the question whether the intermediated volume is small or large.

As noted earlier in our growth specification, the Arellano-Bond estimator allows us to test the validity of our empirical specification in the light of the potential endogeneity of the financial development indicators more formally below. Before turning to our results, we briefly discuss our data sources and defined variables.

### 3.3 Data and Variables

*Growth* Macroeconomic data per district ("*Kreis*") are obtained from State and Federal Statistical Offices, respectively.<sup>18</sup> These data are available on an annual basis between 1997 and 2003. The Federal Office for Building and Regional Planning ("*Bundesbehörde für Bauwesen und Raumordnung*") provided us with a key to

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<sup>18</sup>These regions corresponds to the NUTS 3 level of the data assembled by Eurostat.

map these political regions, namely districts, to economic planning regions ("*Raumordnungsregionen*, *ROR*") in Germany. The latter consist of multiple districts and represent the office's taxonomy. It is based on economic interdependencies as approximated by commuters within economic agglomeration areas.<sup>19</sup> Niebuhr (2001) argues that the use of economic planning regions is significantly superior due to their definition by economic criteria compared to political regions provided by the statistical offices.<sup>20</sup> Our data comprise all 97 ROR in Germany and we use GDP per worker,  $Y$ , as dependent variable.<sup>21</sup> Variable descriptions, sources and summary statistics are depicted in table 4 in the appendix.

*Controls* To control for the accumulation of human capital,  $HC$ , we use the ratio of student enrollment in the upper secondary school relative to total students. As in King and Levine (1993) we consider capital depreciation  $\delta$  to be constant at 5 percent and we specify population growth as the change of the employed population. We define the joint variable as  $ETG$  in our estimated regressions.<sup>22</sup> Finally, we amend control variables for the structure of local banking markets. In our results section we present estimations that use either the mean market share per ROR or the local Hirschman-Herfindahl-Index as proxies for competition. Summary statistics for control variables are also depicted in table 4 in the appendix.

*Financial development* We use balance sheet and profit and loss account data for all private and public banks that reported to the Bundesbank between 1993 and 2004. As noted earlier, we measure the quantity of financial development  $FD^V$  as the amount of loans and securities over GDP. The quality of financial intermediation  $FD^Q$  is approximated by profit efficiency, measured with stochastic frontier analysis. In addition to the regional aggregation of  $FD^Q$  depicted in table 4, we provide in table 5 in the appendix detailed summary statistics per banking group on bank production data used in the estimation of profit efficiency. As shown in table 6 most individual parameter estimates and especially  $\lambda$  are significantly different from zero. Hence, the specification of an alternative profit frontier is tested to be superior compared to an average response function without a composed error term (Kumbhakar and Lovell, 2000).<sup>23</sup> The resulting efficiency scores' development over time is depicted per banking group in table 7. In line with previous studies on German banks, especially large national banks suffer from the highest profit inefficiency (Altunbas et al., 2001). Furthermore, the development of  $FD^Q$  over time differs to quite some extent across banking groups. For example, while local cooperative banks exhibit a stable development over time, both local savings and especially national banks show more efficiency volatility over time. In addition to this different efficiency

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<sup>19</sup>We also employed data on the district and state level to check our estimations for robustness. While results are qualitatively similar, we consider our choice of RORs superior to other regions in order to minimize spatial correlations and poor asymptotic properties of our estimator for small cross-sections.

<sup>20</sup>An alternative regional dimension to analyze growth in Germany are labor market regions as in Kosfeld et al. (2005) and German Council of Economic Advisors (2004).

<sup>21</sup>Alternatively, we checked the robustness of our results using gross value added per worker. Furthermore, we also checked these dependent variables in terms of per capita.

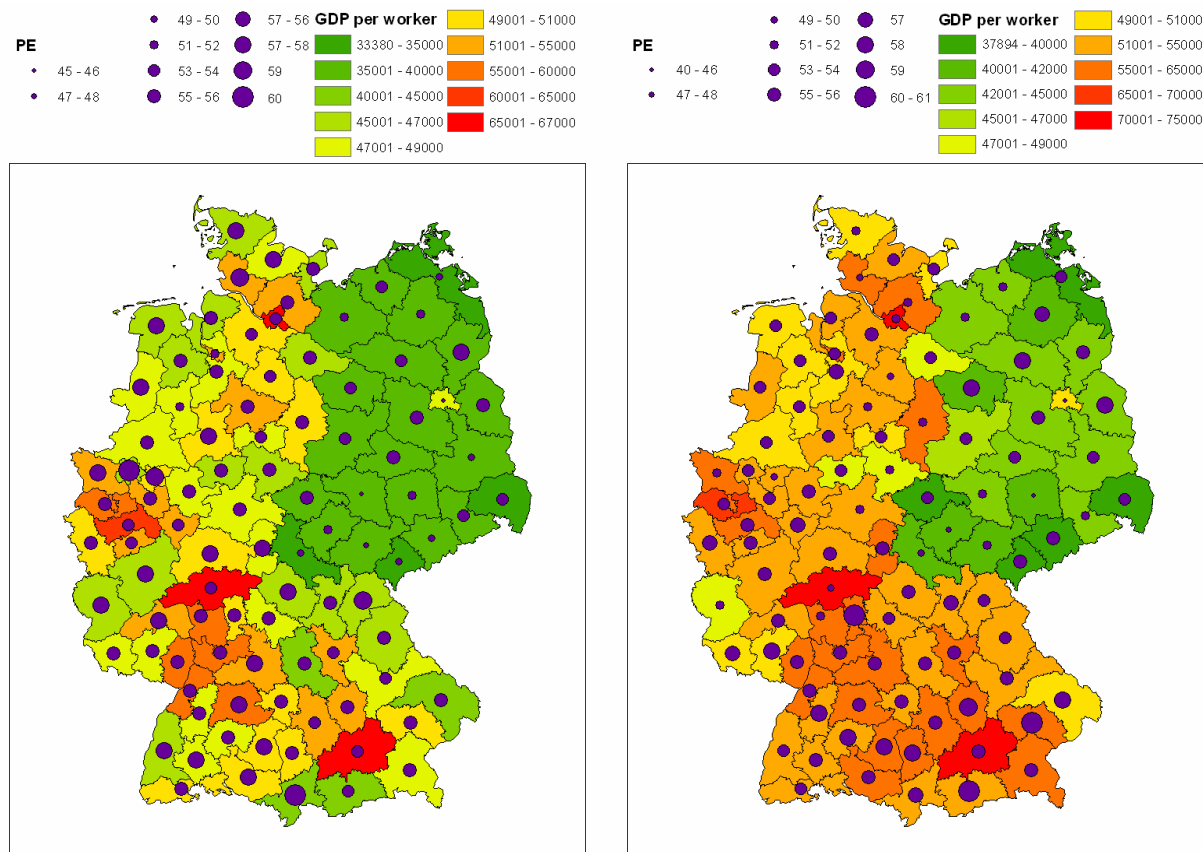
<sup>22</sup>In analogy to the specification of GDP per capita we also employed population growth here as well. We also checked the robustness of our results for alternative values for  $\delta$ , ranging in increments of 50 basis points between 2.5 to 7.5 percent. By and large, results were not qualitatively affected.

<sup>23</sup>We also tested by means of log-likelihood ratio tests whether the translog functional form is supported and if the vector of dummies accounting for heterogeneity  $h_{kt}$  is jointly significantly different from zero. Both hypotheses are accepted.

dynamics per banking group, figure 1 further illustrates that according to our proxy the quality of financial intermediation (and GDP per worker) differs considerably across Germany's regions, a result also reported by Koetter (2006).

In sum, the estimation results of efficiency are in line with previous findings in the financial economics literature. Profit efficiency as well as GDP per worker exhibit quite some variation both across time and regions.

Figure 1: GDP per worker and profit efficiency (PE) in Germany's ROR 1997 (lhs) and 2003 (rhs)



Source: Authors

After estimating  $FD^Q$  for each bank in every year, we allocate bank-specific variables to their respective ROR via the location of the head office of the bank. Given the *de jure* principle of regional demarcation of German public banks as well as the *de facto* regionally limited range of activity of small commercial and virtually all cooperative banks, bank specific indicators should accurately describe both quality and quantity of financial intermediation within a respective ROR. We conduct two plausibility checks regarding the defensibility of this approach. First, we use data on the large credit register of the Bundesbank ("*Millionenkreditevidenz*") to obtain the percentage share of loans larger than 1.5 million Euros granted within the regions ("*Ortsnummer*") classified by the Bundesbank. While not identical to

ROR this classification provides the closest alternative.<sup>24</sup> On average, local savings and cooperative banks grant 80 percent of their loan portfolio to customers within the Bundesbank regions. Even for commercial banks the local lending share is still at around 30 percent. This supports our approach to allocate banks on the basis of their head quarters. As a second check we use available information on bank branches to examine the regional activities of banks. Only very few banks maintain networks in more than one ROR. In fact, the branch network of savings and cooperative banks is highly concentrated within their respective ROR. While 93 percent of all cooperative banks' branches are located within the ROR of the head office, the branch network of saving banks is even more concentrated with 97 percent of all branches located within the same ROR. Despite these supporting indications we still consider national banks undertaking their business across ROR to present a difficulty since a precise allocation of their activities remains impractical. This is also confirmed by the branch distribution of nationally active banks. The share of branches within the same ROR of large commercial banks, small commercial banks and *Landesbanken* is 5, 31 and 45 percent, respectively.

Given this robustness check and due to prevailing efficiency differences across banking groups, we estimate below our preferred specification also after excluding all nationally active banks and according to further splits of local banks only.<sup>25</sup>

## 4 Results

*Specification Choices* We consider two specification choices most important when estimating the growth model as presented in equation (2). First, we investigate how to specify our quality and quantity measures of financial development with respect to the choice of instruments: as exogenous, predetermined or endogenous variables. This choice should be model driven and we use the Sargan test to validate whether the imposed moment conditions determined by the choice of instruments are systematically violated for each alternative.<sup>26</sup> Second, we are concerned with potential problems due to serial correlation and an adequate lag-structure of level variables used as instruments for our lagged endogenous variable  $y_{i,t-1}$ .

Consider first the Sargan test, which provides a mean to test the appropriateness of specified instruments for the lagged dependent and especially financial development indicators (Arellano and Bond (1991)). If financial development merely results from an increased demand for financial funds in an expanding economy, the specification of  $FD^V$  and/or  $FD^Q$  as exogenous variables yields biased and inconsistent estimates due to their contemporaneous correlation with the error term. Then, the Sargan test on the moment conditions in equation (4) is no longer fulfilled and financial development should be specified either as predetermined or endogenous

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<sup>24</sup>German banks have to report each loan beyond the mentioned size to the Bundesbank indicating the debtor and his geographical location.

<sup>25</sup>National banks are large commercial banks, *Landesbanken* and central cooperative banks.

<sup>26</sup>See footnote 11 for the choice of predetermined and endogenous instrument variables. Note that we do not claim that the Sargan test allows direct inference about the conceptual endogeneity of financial development. Testing all possible choices, however, allows us to test the statistical validity of chosen instruments and thus to draw inference on the economic robustness of our results.

Table 1: Comparison of Specification Choices

Quality	Quantity		
$\chi^2$ Sargan <sup>a)</sup>	Exogenous	Predetermined	Endogenous
Exogenous	49.4*** [24]	77.1*** [55]	72.6** [48]
Predetermined	70.2** [55]	93.9 [86]	88.7 [79]
Endogenous	68.8** [48]	90.4 [79]	85.3 [72]
$FD^Q$ Coefficient <sup>b)</sup>	Exogenous	Predetermined	Endogenous
Exogenous	0.036*** [0.012]	0.046*** [0.013]	0.042*** [0.013]
Predetermined	0.030 [0.019]	0.036* [0.020]	0.035* [0.019]
Endogenous	0.056** [0.024]	0.059** [0.025]	0.062** [0.024]
AR(2) z-value <sup>b)</sup>	Exogenous	Predetermined	Endogenous
Exogenous	-1.290 [0.197]	-1.430 [0.153]	-1.300 [0.192]
Predetermined	-1.230 [0.218]	-1.360 [0.175]	-1.310 [0.189]
Endogenous	-1.360 [0.173]	-1.490 [0.136]	-1.470 [0.142]

Notes: \*\*\*, \*\*, \* denotes significance at the 1, 5, 10 percent level.

<sup>a)</sup> Degrees of freedom in parentheses; <sup>b)</sup> p-values in parentheses.

variables using alternative lagged levels as instruments. If such a specification fulfills the notion that the expected correlation between contemporaneous errors and instruments is not systematically different from zero, we interpret the effect of financial development due to its direct effect on growth. In the predetermined case, an acceptance of the  $H_0$  under the Sargan test indicates that financial development is at least contemporaneously uncorrelated with the error term.

We therefore estimate the baseline model in equation (2) using the two-step GMM estimator.<sup>27</sup> Consider the nine respective Sargan test statistics in the top panel of table 1 that represent all possible combinations as how to specify the quality and the quantity of financial intermediation, respectively.<sup>28</sup> We depict the three possible specification choices of  $FD^V$  in columns and the respective options for  $FD^Q$  in rows.

The first line and column in the upper panel of table 1 indicate the five cases where at least one indicator of financial development is specified as exogenous variable, respectively. The according Sargan statistics reject any of these specifications on the basis of a systematic violation of the moment conditions. Consequently, neither measure of financial development is statistically independent of growth.

<sup>27</sup>In terms of table 4 the employed variables are:  $Y_1$ ,  $FD^Q$ ,  $FD^V$ ,  $HC$ ,  $ETG$  as well as year dummies to account for time-fixed effects.

<sup>28</sup>Test statistics are based on the two-step estimator since these are suited for specification choices (Arellano and Bond, 1991). Coefficients reported below are based on (consistent) one-step estimates to draw inference.

Results for the remaining options highlight that both of the two variables needs to be instrumented. Notably, it is statistically permissible to specify one or both indicators either as predetermined or as endogenous variable. For any combination, the Sargan test is insignificant and does not reject the set of instruments chosen.

Our prime conclusion regarding this result is to acknowledge that the use of estimators using suitable instruments is necessary. Inference from analyses that fail to instrument financial development indicators of either kind must be treated with great care.<sup>29</sup>

We show in the second panel of table 1 that these (remaining) specification choices are not driving our result that the quality of financial development influences growth positively. Consider to this end reported coefficients for  $FD^Q$  from one-step estimations for all nine combinations. In virtually all cases the coefficient for our quality proxy of financial development is significantly positive and of similar magnitude. We conclude that across specification choices the effect of the quality of financial development remains robust.<sup>30</sup> We opt here for the most conservative approach and specify both  $FD^Q$  and  $FD^V$  as endogenous variables.

Second, we consider briefly the issue of serial correlation. As discussed in section 3.1, taking first differences and rewriting equation (2) implies that the error term  $\Delta\epsilon_t$  suffers from serial correlation by construction, which is unproblematic given our difference estimator.<sup>31</sup> However, we must not observe any autocorrelation of higher order as to avoid inconsistent and biased estimates. For all possible combinations of  $FD^Q$  and  $FD^V$  discussed above, the bottom panel in table 1 reports according test statistics and p-values. The results provide evidence that second-order autocorrelation does not present a problem.

*Financial Development* We consider first if either proxy of financial development has an independent effect on growth. Table 2 presents results based on the one-step AB estimator with heteroscedasticity robust standard errors. The first three columns contain baseline regressions using GDP per worker as dependent variable. All estimations account for fixed time effects by means of annual dummy variables.<sup>32</sup>

In line with our expectations, the coefficient of  $FD^Q$  is significant and positive. An improvement of 1 percent of the quality of financial intermediation fosters economic growth by about 0.06 percent. With regard to  $FD^V$  we find that the coefficient is significant and negative. This stands in contrast to the evidence presented in the finance-growth literature. This result implies that merely increasing the amount of bank loans has no significant impact on growth. In contrast, an improvement of the ability to use these available funds efficiently in the sense of selecting and monitoring investment projects indeed helps to promote growth.

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<sup>29</sup>We also estimated the growth specification with alternative estimators, ranging from simple cross-sectional and pooled OLS to fixed effect panel estimators. These robustness checks further underpinned our conclusion that dynamic panel estimators using appropriate instruments are key to the analysis.

<sup>30</sup>We refrain at this stage from further interpretations since we concentrate first on our specification choices. Instead, we ask the reader to bear with us for a few more pages until we discuss individual estimates.

<sup>31</sup>This is confirmed by tests for an AR(1) process which we do not report here.

<sup>32</sup>Coefficients are by and large all significant and available upon request. We do not report time dummy estimates in any of our results presented here to conserve on space.

Both effects are robust when specified simultaneously.<sup>33</sup> The column labelled **Both** is our baseline regression. The coefficients for both  $FD^Q$  and  $FD^V$  exhibit identical directions compared to individual effects discussed previously. Consequently, our finding that improvements in the quality of financial intermediation significantly spur growth does not merely result from capturing effects of the traditionally specified quantity measure of financial development. Both the validity of instruments as well as the absence of second order autocorrelation support the specification. Moreover, the control variables for human capital ( $HC$ ) and the growth of the working population ( $ETG$ ) exhibit signs in line with theory and are statistically significant. The former exhibits a positive coefficient, which implies that faster accumulation of know-how feeds economic growth. The latter yields the result that higher working population growth leads, *cet. par.*, to reduced income per worker. The result for human capital is in line with previous findings in the literature. However, Kosfeld et al. (2005) fail to detect any effect with regard to the growth of the working population.<sup>34</sup>

The negative effect of an expansion of bank lending may merely reflect the maturity of the German economy. For example, studies that explicitly distinguish between different life cycle stages of developed and less-developed economies also find markedly different effects of financial development on growth (Rioja and Valev, 2004). An additional explanation relates to the findings of the German Council of Economic Advisors (2004), which reports in fact an excess supply of credit in Germany's mature economy. Put differently, the amount of funds provided by banks to finance investment projects does not seem to be in short supply at all. Instead, the economy may suffer from a fundamental shortage of innovative and profitable investment projects that are worthwhile to fund with the available volume of savings. Then, merely increasing the volume of loans and securities exerts per se no growth impetus.<sup>35</sup>

*Variable Choice* Second, we test in table 2 if alternative dependent variables  $y$  or additional control variables  $x$  affect our results. The results remain qualitatively similar for alternative variables. In the column labeled **GVA** results are based on the same regression using gross value added per worker as dependent variable. The coefficients remain largely unchanged while Sargan and autocorrelation tests support this specification, too. Thus, our results for  $FD^Q$  and  $FD^V$  are not due to the choice of alternative dependent variables. In the column labeled **HHI** we control for the structure of local banking markets. We augment our baseline growth model with the Herfindahl-Hirschman index on the basis of total assets per ROR. The coefficients for this proxy of market power is insignificant and has no effect on our result for financial development.<sup>36</sup>

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<sup>33</sup>The result of a significantly negative volume effect is robust across instrumentation choices, alternative estimators and a range of other volume proxies, such as deposits, interbank credit, and other bank data tested.

<sup>34</sup>We also run regressions using the growth of the total population and also found a significant and negative impact on growth of GDP per capita.

<sup>35</sup>Since most banks in Germany are either voluntarily or due to imposed regulation acting in confined regions only, this result may also indicate a lack of possibilities to diversify loan portfolios to customers outside their regions. If, for example, macroeconomic shocks are region-specific, there is little a bank obliged to lend only within it's region can do. Any increase of loan volumes is likely to be channeled to creditors more or less equally suffering from poor economic conditions.

<sup>36</sup>We also test the average market share of banks per ROR. Results are identical to the HHI

Table 2: Alternative dependent and additional control variables

	Quality	Quantity	Both	GVA <sup>a)</sup>	HHI <sup>b)</sup>	West	Centers
$\ln Y_{i,t-1}$	0.336**	0.287**	0.277**	0.277**	0.277**	0.491***	0.301**
	[0.145]	[0.136]	[0.133]	[0.133]	[0.133]	[0.091]	[0.134]
$\ln FD^V$		-0.049*	-0.035*	-0.035*	-0.036*	-0.029*	-0.042*
		[0.027]	[0.021]	[0.021]	[0.021]	[0.015]	[0.023]
$\ln FD^Q$	0.057**		0.062**	0.062**	0.064**	0.121***	0.065***
	[0.025]		[0.024]	[0.024]	[0.025]	[0.042]	[0.025]
$\ln ETG$	-0.009***	-0.011***	-0.008**	-0.008**	-0.008**	-0.008	-0.008**
	[0.004]	[0.003]	[0.003]	[0.003]	[0.003]	[0.007]	[0.003]
$\ln HC$	0.096***	0.114***	0.105***	0.105***	0.107***	0.059	0.106***
	[0.024]	[0.020]	[0.022]	[0.022]	[0.022]	[0.052]	[0.024]
$\ln HHI$					0.002		
					[0.003]		
Constant	0.010***	0.011***	0.011***	0.009***	0.011***	0.008***	0.010***
	[0.002]	[0.003]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Sargan [ $\chi^2$ ]:	68.61	73.31	85.33	85.33	84.91	67.78	83.36
AR2 [z-value]:	-1.84	-1.11	-1.47	-1.47	-1.44	-0.87	-2.09**

Notes: Robust standard errors in parentheses. AB One-Step Estimation. Sargan test from Two-Step Estimator.

Time dummies included (not reported). \*\*\*, \*\*, \* denotes significance at 1, 5 and 10 percent level.

<sup>a)</sup> Gross-value added per worker; <sup>b)</sup> Hirschman-Herfindahl Index based on gross total bank assets per ROR.

*East and West Germany* Third, we check the regional robustness of our results. One important motivation to focus on economic agglomeration areas within one country is our concern that identification of significant financial development indicators in international studies may be owed to excessive heterogeneity of sampled countries. Our suggested regional approach, however, bears caveats, too. One important potential shortcoming is that both GDP growth and financial development may not differ sufficiently in the first place. To this end we illustrated already in figure 1 that both key variables,  $FD$  and  $GDP$  vary considerably across the regions of Germany.<sup>37</sup> One may further argue that even seven years after the unification of East and West Germany our findings are primarily a reflection of persistent and significant differences between the structurally weaker regions in the East. In the column labeled **West** in table 2 we therefore estimate the baseline model for the 74 Western ROR only.<sup>38</sup> Sargan and AR tests support this specification and underline our earlier conclusion that it is the quality of financial intermediation that matters for growth. In fact, the effect of improving intermediation quality rather than quantity is twice as high as in the (economically) more mature West compared to the federal case: a 1 percent improvement in the ability to realize profits increases GDP per worker growth by 0.12 percent. In a slow growing economy such as Germany this contribution is not only statistically but also economically significant.

specification.

<sup>37</sup>Maps for additional years, compound annual growth rates as well as our quantity measure of financial development are available upon request. Low correlation coefficients of  $FD$  and  $GDP$  across ROR confirm that both measures vary considerably already within one country.

<sup>38</sup>We also estimate the model for the 23 Eastern ROR only. Results are qualitatively unchanged and available upon request from the authors. But given the prohibitively low number of cross-sections that are critical for the asymptotic behavior of our estimator, we do not depict them here since specification tests do not allow us to draw statistically firm inference.

*Regional versus national banks* Fourth, we analyze if the identified quality effect of financial development is driven by a potential failure to appropriately allocate the activities of national banks to separate regions. While the majority of German banks are small and undertake their business within a limited geographical area, some operate on a nation-wide basis (Koetter et al., 2006). As a first robustness check along these lines, we report in the column labeled **Centers** results from a sample that excludes the three ROR that host most of such nationally active banks. These are the regions hosting the cities of Frankfurt a.M., Munich and Stuttgart. Results are qualitatively identical and we conclude that our findings are not driven by these regional "banking centers". Intuitively, this is not too surprising if one realizes that even the five largest banks in Germany have together only a very small market share of around 17 percent.

*Private versus public banks* Related to the issue of nationally active banks we further investigate in table 3 to what extent the quality of banking services of private and public banks matters differently for regional growth. In the column labeled **Baseline** we reproduce for comparison purposes the specification with mean  $FD$  proxies including all universal banks.

In the second column, we include only local banks that operate in confined regions to construct our measure of intermediation quality. The banking sample comprise primarily savings and cooperative banks but also smaller commercial banks.<sup>39</sup> Thereby, we account for the unavailability of regional income distributions of all nationally active banks, i.e. also those not headquartered in Frankfurt, Munich or Stuttgart. The respective results in column **Local** of table 3 indicate the same positive and significant effect of  $FD^Q$  and the significantly negative effect of  $FD^V$  for local banks. Consequently, our results are not driven by the inclusion of large banks.

Table 3: Financial development across banking groups

	<b>Baseline</b>	<b>Local</b>	<b>Public</b>	<b>Coops</b>
$\ln Y_{i,t-1}$	0.277** [0.133]	0.282** [0.130]	0.271** [0.126]	0.287** [0.126]
$\ln FD^V$	-0.035* [0.021]	-0.035* [0.021]	-0.024 [0.018]	-0.039* [0.021]
$\ln FD^Q$	0.062** [0.024]	0.060*** [0.023]	0.076*** [0.023]	0.063*** [0.024]
$\ln ETG$	-0.008** [0.003]	-0.007** [0.003]	-0.006* [0.003]	-0.006** [0.003]
$\ln HC$	0.105*** [0.022]	0.107*** [0.023]	0.108*** [0.023]	0.093*** [0.024]
Constant	0.011*** [0.002]	0.011*** [0.002]	0.011*** [0.002]	0.011*** [0.002]
AR2 [z-value]:	-1.47	-1.47	-1.68*	-1.15
Sargan [chi2]:	85.33	91.08	92.84	91.04

Notes: Robust standard errors in brackets. AB One-Step Estimation.

Sargan test from AB Two-Step Estimation. Time dummies included

(not reported). \*\*\*, \*\*, \* denotes significance at 1, 5 and 10 percent level.

<sup>39</sup>Detailed statistics on both production and efficiency data across banking groups is depicted in tables 5 and 7, respectively.

Note that this specification still incorporates small commercial banks. One may object the assumption that the business of small commercial banks is limited to a geographical area similar to that of public and private banks from the cooperative sector. Since there is no possibility to verify the geographical scope of activity for the group of small commercial banks, we further reduce our sample to construct financial development indicators.

Consider to this end column **Public**, where we estimate our baseline specification with a quality measure of financial development that is derived for public savings banks only. Local savings banks are state-owned and they are active in all ROR in all years. As depicted in table 7 in the appendix, they are among the most profit efficient banks across banking groups in Germany, albeit mean efficiency exhibits quite more volatility over time compared to, for example, local cooperative banks. While the coefficient of  $FD^V$  is not significantly different from zero, the effect of improving efficiency of public savings banks on growth is even larger compared to the baseline specification. Hence, especially for this banking group improvements in the ability to provide financial products and services profit efficiently helps to increase economic growth. In turn, the frequent claim that savings banks are necessary to provide the society at large with access to credit has no statistically significant effect on growth. According to our results, local savings banks help to improve the society the most when further improving their profit efficiency.

Finally, we estimate our growth model with a separate measure for intermediation quality of cooperative banks in column **Coops**. Note that these are commercial banks as they are mutually owned by private agents of the economy. Our results resemble those of the baseline and underpin that, first, improving efficiency improves growth and, second, a sheer expansion of financial quantity is to the detriment of income per worker. Clearly, we neither model here nor elsewhere whether the observed volume of bank loans is supply or demand driven. Future research to further investigate the reasons for this negative effect of expanding bank credit and securities is certainly interesting in it's own right. Here, however, we consider the issue out of the present paper's scope. We limit ourselves to infer from our results that larger volumes of financial funds intermediated alone do not promote growth. Instead, an improvement in the quality of financial intermediation is the variable that indicates a positive effect on income per worker. This effect prevails across banks of different ownership, public or private.

## 5 Conclusion

We provide in this paper evidence on the finance-growth nexus for the regions of Germany. Using data for the 97 economic planning regions ("*Raumordnungsregionen, ROR*") and all banks operating in the Republic, we distinguish two different channels of financial development: a Hicksian volume effect  $FD^V$  and a quality effect  $FD^Q$  of financial development in the vein of Schumpeter. We introduce an improved measure for the latter: microeconomic profit efficiency measured for each bank individually. Our main results are the following six.

First, our evidence supports the notion that the quality of financial intermediation as measured by profit efficiency of individual banks significantly affects growth.

A one-percent increase in profit efficiency spurs GDP per worker by 0.06 percent.

Second, the traditional proxy of credit volume to GDP used in most finance-growth studies yields in virtually all specifications a significantly negative coefficient. As indicated in alternative studies (Rioja and Valev, 2004) the sheer volume effect of financial development may differ when taking into account different stages of an economy's life cycle. In Germany's fairly saturated economy, a mere expansion of credit alone may very well not be the bottleneck to more economic growth (German Council of Economic Advisors, 2004). However, further inference would require the explicit modeling of the credit market as to determine if the observed level of aggregate loans indeed reflects the equilibrium level or not. We deem the issue out of the present paper's scope and focus instead on suggesting an alternative measure to proxy the quality of financial intermediation.

Third, we find evidence that both measures of financial development must not be specified simultaneously as exogenous explanatory variable. We find that the use of instrumental variable estimators is necessary. However, by choosing suitable instruments we are able to obtain unbiased and consistent estimates.

Fourth, our results remain robust after a number of specification tests. Both the effect of  $FD^V$  and  $FD^Q$  are qualitatively identical when specified individually. Hence, these two proxies appear to capture indeed two conceptually different channels how financial development can influence growth.

Fifth, our measures of  $FD$  and  $GDP$  differ considerably both over time and across regions. Our significantly positive effect of quality rather than quantity not only persists when looking at West Germany only, it is even stronger in this economically more mature part of the Republic.

Sixth, we exclude those banks from the construction of our financial development indicator that operate nationally and can therefore not be allocated to single regions with complete certainty. The positive effect on growth due to improving bank efficiency persists across banking groups. In fact, it is largest for publicly owned local savings banks. Consequently, it seems most favorable for society if all banks improve their ability to provide financial products and services rather than merely expand their lending.

In sum, the positive effect of  $FD^Q$  on growth suggests that in a mature economy growth requires better but not necessarily more banking. We conclude that, first, the channels of financial development are conceptually different and, second, this difference can be taken into account by using efficiency as a more explicit proxy for the quality effects financial development has on growth.

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## 6 Appendix

Table 4: Mean growth and financial development variables per ROR 1997-2003

Variable	Description	Unit	Mean	SD	N	Source
$Y_1$	Gross domestic product per worker	€	49,438.7	7,650.9	679	FSO/SSO
$Y_2$	Gross value added per worker	€	46,092.4	7,102.2	679	FSO/SSO
$FD^Q$	Profit efficiency	%	54.6	3.0	679	BBK
$FD^V$	Bank loans and securities to GDP	%	100.8	130.3	679	BBK
$ETG$	Growth rate employed	%	0.25	1.44	679	FSO/SSO
$POPG$	Growth rate population	%	0.05	0.01	679	FSO/SSO
$HC$	Secondary school pupil to total pupil	%	22.1	4.0	679	FSO/SSO
$HHI$	Hirschman-Herfindahl-Index bank assets	Pts	200.3	316.3	679	BBK

Notes: €: Euros; %: percentages; FSO and SSO:

Federal and State Statistical Offices, respectively; BBK: Deutsche Bundesbank.

Table 5: Summary statistics for Stochastic Frontier Analysis by banking group

Variable	National banks		Local banks		Total
		Com'cial	Savings	Coops	
<i>Number of observations</i>	<i>227</i>	<i>1,372</i>	<i>6,428</i>	<i>21,593</i>	<i>29,620</i>
$O_1$ Interbank loans	34,200.0	760.0	133.0	32.0	349.0
	27,000.0	2,250.0	263.0	98.8	3,830.0
$O_2$ Customer loans	43,600.0	1,770.0	915.0	147.0	722.0
	44,200.0	5,970.0	1,430.0	382.0	5,610.0
$O_3$ Securities	22,200.0	701.0	400.0	53.6	329.0
	20,500.0	2,780.0	535.0	152.0	2,720.0
$O_4$ Off-balance sheet	18,800.0	521.0	95.2	15.7	200.0
	23,900.0	1,920.0	174.0	47.0	2,690.0
$W_1$ Price of fixed assets	27.6	11.8	15.5	16.4	21.0
	29.9	20.8	11.1	164.9	46.9
$W_2$ Price of labor	71.0	87.2	48.9	49.8	51.5
	18.3	558.6	229.3	15.8	161.6
$W_3$ Price of borrowed funds	4.7	8.0	3.8	3.6	3.8
	1.2	12.4	0.8	0.7	2.7
$Z$ Equity	3,200.0	169.0	66.7	11.9	55.5
	3,470.0	441.0	103.0	27.3	426.0
$TA$ Total assets	108,000.0	3,500.0	1,540.0	248.0	1,500.0
	91,400.0	10,200.0	2,230.0	617.0	12,600.0
$\pi$ Profit before tax	798.0	59.0	26.1	4.3	17.7
	859.0	170.0	37.1	9.5	111.0

Notes: Mean with standard deviation underneath. All variables measured in millions of Euro unless noted otherwise;  $W_1$  and  $W_2$  in percentages,  $W_3$  in thousands of Euro. Source: Deutsche Bundesbank

Table 6: Parameter estimates stochastic profit frontier estimation

Dependent variable			$\ln\pi$		
Log-likelihood			-46,482		
	$\beta$	P-value		$\beta$	P-value
$\ln W_1$	0.203	0.000	$\ln W_1 \ln Z$	0.100	0.000
$\ln W_2$	-0.018	0.673	$\ln W_2 \ln Z$	0.044	0.000
$\ln O_1$	0.185	0.000	$\ln Y_1 \ln Z$	0.038	0.000
$\ln O_2$	-0.042	0.174	$\ln O_2 \ln Z$	0.034	0.000
$\ln O_3$	0.327	0.000	$\ln O_3 \ln Z$	-0.011	0.000
$\ln O_4$	0.078	0.001	$\ln O_4 \ln Z$	-0.023	0.000
$\ln Z$	0.284	0.000	$0.5 \ln Z \ln Z$	-0.051	0.000
$0.5 \ln W_1 \ln W_1$	-0.027	0.000	National banks	-0.658	0.000
$0.5 \ln W_1 \ln W_2$	-0.032	0.002	Local commercial	0.039	0.000
$0.5 \ln W_2 \ln W_2$	0.238	0.000	Local savings	0.049	0.000
$0.5 \ln O_1 \ln O_1$	0.011	0.000	EAST	0.437	0.000
$0.5 \ln O_1 \ln O_2$	-0.078	0.000	Size group I	-0.065	0.000
$0.5 \ln O_1 \ln O_3$	-0.012	0.000	Size group II	-0.028	0.000
$0.5 \ln O_1 \ln O_4$	-0.008	0.026	Size group III	-0.013	0.011
$0.5 \ln O_2 \ln O_2$	0.079	0.000	1993	0.073	0.000
$0.5 \ln O_2 \ln O_3$	-0.053	0.000	1994	0.158	0.000
$0.5 \ln O_2 \ln O_4$	-0.033	0.000	1995	0.063	0.000
$0.5 \ln O_3 \ln O_3$	0.038	0.000	1996	0.064	0.000
$0.5 \ln O_3 \ln O_4$	0.001	0.639	1997	0.034	0.000
$0.5 \ln O_4 \ln O_4$	0.030	0.000	1998	-0.059	0.000
$\ln Y_1 \ln W_1$	0.001	0.601	1999	-0.004	0.641
$\ln Y_1 \ln W_2$	-0.018	0.000	2000	-0.082	0.000
$\ln Y_2 \ln W_1$	-0.031	0.000	2001	-0.179	0.000
$\ln Y_2 \ln W_2$	-0.079	0.000	2002	-0.098	0.000
$\ln Y_3 \ln W_1$	-0.016	0.000	2003	-0.027	0.000
$\ln Y_3 \ln W_2$	-0.029	0.000	$\sigma$	3.764	0.000
$\ln Y_4 \ln W_1$	-0.051	0.000	$\lambda$	20.725	0.000
$\ln Y_4 \ln W_2$	0.093	0.000			

Notes: Fixed effect frontier panel estimation with time variant efficiency. Maximization with BFGS algorithm, 76 iterations. N: 29,620; K:3,567;  $\sigma = \sigma_u + \sigma_v$ ;  $\lambda = \sigma_u/\sigma_v$ .

Table 7: Profit efficiency per banking group over time

Year	National banks		Local banks		Savings		Coops	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1993	0.508	0.150	0.548	0.135	0.534	0.088	0.551	0.091
1994	0.535	0.122	0.489	0.145	0.581	0.068	0.554	0.082
1995	0.504	0.082	0.491	0.135	0.567	0.085	0.557	0.079
1996	0.507	0.107	0.500	0.138	0.577	0.079	0.553	0.080
1997	0.531	0.075	0.517	0.134	0.567	0.074	0.554	0.075
1998	0.575	0.109	0.515	0.152	0.546	0.076	0.555	0.079
1999	0.489	0.095	0.479	0.146	0.546	0.072	0.552	0.081
2000	0.481	0.117	0.517	0.144	0.519	0.084	0.553	0.088
2001	0.510	0.131	0.502	0.159	0.553	0.076	0.545	0.083
2002	0.443	0.145	0.459	0.161	0.559	0.077	0.548	0.078
2003	0.500	0.143	0.463	0.179	0.523	0.082	0.558	0.089
2004	0.474	0.133	0.462	0.169	0.535	0.084	0.556	0.083
Pooled	0.507	0.119	0.496	0.151	0.552	0.081	0.554	0.082
N	227		1,372		6,428		21,593	

Notes: National banks comprise Deutsche Bank, Dresdner Bank, Commerzbank, Hypovereinsbank, Postbank, Landbanks and central cooperative banks.