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Regional growth and finance in Europe: is there a quality effect of bank efficiency?

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Iftekhar Hasan – Michael Koetter – Michael Wedow

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Regional growth and finance in Europe: Is there a quality effect of bank efficiency?

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Abstract

In this study, we test whether regional growth in 11 European countries depends on financial development and suggest the use of cost- and profit-efficiency estimates as quality measures for financial institutions. Contrary to the usual quantitative proxies for financial development, the quality of financial institutions is measured in this study as the relative ability of banks to intermediate funds. An improvement in bank efficiency spurs five times more regional growth than does an identical increase in credit. More credit provided by efficient banks exerts an independent growth effect in addition to the direct quantity and quality channel effects.

Keywords: bank performance, regional growth, bank efficiency, Europe

JEL classification numbers: G21, O16, O47, O52

Selittääkö pankkien tehokkuudella mitattu rahoitusjärjestelmän laatu alueellisia kasvueroja Euroopassa?

Suomen Pankin keskustelualoitteita 13/2009

Iftekhar Hasan – Michael Koetter – Michael Wedow
Rahapolitiikka- ja tutkimusosasto

Tiivistelmä

Tässä työssä tutkitaan empiirisesti rahoitusjärjestelmän kehittyneisyyden vaikutusta eri alueiden taloudelliseen kasvuun 11 maassa Euroopassa. Tutkimuksen kysymyksenasettelu korostaa rahoitusjärjestelmän laadun merkitystä talouskasvun kannalta ja puoltaa kustannustehokkuuteen ja voittoihin perustuvaa menettelyä mitattaessa rahoituslaitosten laatutasoa. Tavanmukaisista rahoitusjärjestelmän kehittyneisyyden kvantitatiivisista mittaustavoista poiketen rahoituslaitosten laatua mitataan tässä työssä pankkien suhteellisella tehokkuudella rahoituksen välityksessä. Tulosten mukaan pankkien tehokkuuden parantuminen kiihdyttää talouskasvua viisi kertaa voimakkaammin kuin vastaava luottojen määrän kasvu. Tehokkaiden pankkien luotonannolla on luottojen määrästä ja rahoitusjärjestelmän laadusta riippumaton lisävaikutus talouskasvuun.

Avainsanat: pankkien suorituskyky, alueellinen kasvu, pankkien tehokkuus, Eurooppa

JEL-luokittelu: G21, O16, O47, O52

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1 Introduction

Information asymmetries between lenders and borrowers tend to be lower in better developed financial systems because a better selection of productive investment projects, improved monitoring of borrowing, and a reduction in the amount of resources banks waste in the intermediation process (Pagano, 1993; Bertocco, 2007) facilitates growth and the accumulation of capital and growth. Many studies analyze this finance-growth nexus empirically and explain cross-country growth differentials by the volume of funds relative to economic output (Levine, 2005). This study addresses two concerns regarding this literature.

First, inference drawn from comprehensive cross-country studies covering very different economies possibly suffers from excessive sample heterogeneity.¹ Moreover, cross-country studies treat regions as ‘isolated islands’ (Quah, 1996) and usually neglect regional interdependencies. This can bias results, and studies such as Higgins et al (2006) therefore analyze economic growth and convergence at the regional level. However, few studies also assess the regional effects of the financial sector on economic growth.²

The second concern relates to the measurement of financial development in most studies in terms of (relative) credit volumes. A mere expansion of credit need not indicate a qualitative improvement of intermediaries’ abilities to channel scarce funds from savers to borrowers, which is of crucial importance (Romero-Ávila, 2007). We suggest a more direct measure of the quality of financial institutions, thereby addressing the issue of suboptimal empirical proxies for theoretical counterparts raised by Levine (2005).

We test whether better bank efficiency, estimated at the firm level, significantly spurs growth. This relative measure of bank performance gauges the quality of financial institutions relative to their peers instead of the *quantity* of funds intermediated.

We seek to contribute to the few regional studies on financial development in two respects.³ First, we present evidence of a positive relation between banking quality and economic growth in several regions within 11 countries of the

¹ Rousseau and Wachtel (2007) carefully point out that finance-growth nexus results are considerably weaker when assessing only industrialized countries, for example, and more recent periods. This does not necessarily imply the absence of a relation but merely that the inference requires careful sampling.

² Exceptions, such as Guiso et al (2004), provide indirect evidence given the focus on business establishment rather than growth but underpin the importance of regional differences.

³ See, for example, Lucchetti et al (2001), Valverde et al (2003), and Hasan et al (2009) on the relation between bank market competition, efficiency, legal and political indicators, and growth in Italian, Spanish and Chinese regions, respectively. In an extension of these studies, we suggest here a more explicit measure of bank’s intermediation quality.

European Union.⁴ Thus, we maintain a regional focus but cover a comprehensive sample of regions in an increasingly integrating financial system. To assess financial institutions, we employ bank-level data obtained from the Bankscope database and associate each bank with a specific European region.

Second, we hypothesize that the economic efficiency of banks converts scarce resources into financial products and services that produce growth. More specifically, Humphrey and Pulley (1997) point out that cost efficiency does not capture a bank's ability to convert inputs efficiently into outputs, because the measure focuses only on the cost aspects of banking businesses. Instead, they emphasize the skills needed to maximize profits for a given production plan by estimating profit efficiency. This study is, to our knowledge, therefore the first to analyze the relation between regional growth in Europe and banks' abilities to provide financial services and products efficiently from cost and profit perspectives.

The remainder of this paper is structured as follows. In Section 2 we introduce the empirical approach to test if higher regional bank efficiency fosters economic growth, and we describe the data. We discuss results in Sections 3 and 4 and conclude the study in Section 5.

2 Methodology

2.1 Regional growth

Different regions of Europe have significantly different growth patterns Quah (1996). Likewise, banks' ability to intermediate funds efficiently remains not only heterogeneous across the continent but regionally despite an ongoing harmonization of financial regulation in Europe (Bos and Kool, 2006). Given the importance of regional differences, we hypothesize that higher regional bank efficiency should promote regional growth, too. We specify a reduced-form growth model as a dynamic panel model (Levine et al, 2000)

$$\ln Y_{r,t} = \alpha \ln Y_{r,t-1} + \beta_1 \ln FV_{r,t} + \beta_2 \ln FQ_{r,t} + \beta_3 \ln X_{r,t} + \beta_4 \ln Z_{c,t} + \gamma \ln WX_{s,t} + \mu_r + \varepsilon_{r,t} \quad (2.1)$$

⁴ We avoid excessive heterogeneity and exclude recent members of the EU that still have significantly different financial systems. Results for a sample of 23 EU countries are available upon request.

where Y is the gross domestic product per worker, X is a vector of regional controls,⁵ t are time indicators, and r indexes European regions at Eurostat's 'NUTS 2 level'.⁶ To eliminate μ_r , an unobserved region-specific effect, we use the system GMM estimator (Blundell and Bond, 1998).

It is well known that financial development, especially volume-based measures, are prone to endogeneity problems because improving real economic conditions can trigger, for instance, an expansion in both credit demand and supply. Therefore, we follow Levine et al (2000) and employ lagged levels and differences as instruments for FV and FQ, respectively, to deal with this possible statistical endogeneity. In addition, we include control variables Z_c to control for banking system traits per country c , which we use in the microestimation of bank efficiency described in this section (Lozano-Vivas et al, 2002). Financial development is measured in two ways: by volume (FV) and by the quality of financial development (FQ). The former resembles a specification well known in the finance-growth literature: bank credit volume relative to GDP. Due to inherent aggregation problems for financial volumes at the regional level, we specify a measure based on national market capitalization that is used in most finance-growth studies.

A related challenge concerns the spatial allocation of both the volume and the quality of financial-development proxies. Ideally, we would weigh each bank's lending by local customer portfolios or the spatial distribution of branch networks. Unfortunately, neither is publicly available for European banks. We deal with this problem therefore primarily in a statistical way. Specifically, we also specify a spatial-lag model such that FV (FQ) of the neighboring regions can spill over to region r . Spatial lags are specified in X and account for the possibility that growth in region r depends systematically on financial development in neighboring regions $s \in R$, where R is the set of all regions (Anselin, 1988). We use a predetermined contiguity matrix W to weigh FV (or FQ) of all neighboring regions.⁷ In matrix notation, WX_{st} is the weighted average of financial-development proxies across R_r regions neighboring region r . The parameter γ measures whether regional growth benefits ($\gamma > 0$), suffers ($\gamma < 0$), or is independent ($\gamma = 0$) from the financial development of neighbors.

We have no theoretical precedent as to the spatial effects of financial development on regional growth. On one hand, better banking might enhance a region's growth by facilitating real economic interaction. On the other hand,

⁵ Regional controls are the growth rate of the working population and spatial lags of FV and FQ. Adequate regional controls for human capital were not available, but we specify patents per capita. We also include a direct and a squared time trend to control for time-specific effects.

⁶ NUTS: Nomenclature des unites territoriales statistiques. Descriptive statistics are provided in Section 3.

⁷ We used binary Queen contiguity as a weighting matrix to average financial development for all regions that either have a direct border with region r or have vertices.

superior financial services in neighboring regions may attract investors and therefore have a ‘pull’ effect of investment and growth.

Finally, we exclude regional banking centers and select further subsamples as robustness checks.

2.2 Banking quality

To assess the quality of financial intermediation more directly, we measure a bank’s *relative* efficiency in converting inputs into a production set while maximizing profits. This relative measure is conceptually less prone to reverse causality criticism. Banks’ ability to demand inputs at given prices in optimal proportions should influence growth positively independent of whether the economy is expanding or contracting. A region in which banks fulfill their project-selection and loan-monitoring functions is on average more efficient than other regions and should benefit in terms of growth because the ‘right’ projects receive funding at the ‘right’ cost of lending given risk.

We assume that banks demand labor, fixed assets, and borrowed funds at given factor prices w to produce customer loans y_1 and other earning assets y_2 subject to a technology constraint, which also depends on bank-specific and environmental controls z , and a pricing opportunity set such that total costs C are minimized and profits before tax PBT are maximized (Humphrey and Pulley, 1997).⁸ In the alternative profit model, we assume that banks possess some regional market power subject to a pricing opportunity set $H(p, y, w, z)$, where p denotes output prices. This model assumes that banks have some local market power. Therefore, both minimum cost $c^*(y, w, z)$ and maximum profits $\pi^*(y, w, z)$ depend on input prices, equity, and output quantities. A translog stochastic frontier is then

$$\ln \text{LHS}_{it} = \alpha_i + \sum_{j=1}^J \alpha_j \ln x_{ijt} + \frac{1}{2} \sum_{k=1}^K \sum_{j=1}^J \alpha_{jk} \ln x_{ijt} \ln x_{ikt} + \varepsilon_{it} \quad (2.2)$$

Where LHS is either cost or profit and x is short for y , w , and z , respectively. In addition to bank production data, we also specify a time trend t to account for technical change. We assume $\varepsilon_{it} = v_{it} - u_{it}$ for the profit frontier and $\varepsilon_{it} = v_{it} + u_{it}$ for the cost frontier, where v_{it} is i.i.d. and $v_i \sim N(0, \sigma_v^2)$. To identify the inefficiency component u_{it} , we re-parameterize $\lambda = \sigma_u / \sigma_v$.

Two issues are important to note in the efficiency estimation. First, despite ongoing integration, financial systems continue to differ across European

⁸ In line with the intermediation approach, we include interest expenses in total cost and specify the price of borrowed funds accordingly as a factor price.

economies. For instance, the Italian government began to privatize banks on a large scale during the 1990s, yet government-owned savings banks continue to constitute a sizeable portion of the German banking industry. Lozano-Vivas et al (2002) showed that failure to account for such systematic differences leads to contaminated inefficiency scores. Therefore, we specify country-specific controls in addition to banks' equity capital to capture regulatory, macroeconomic, and banking-market differences in z .⁹ These factors can influence optimal costs and/or profits as well as management's abilities to attain the optimal frontier, we specify z in the kernel of equation (2.2) and as a determinant of the inefficiency distribution. The latter we assume to be $u_i \sim N(\mu + dz, \sigma_u^2)$, where μ is the location parameter of the inefficiency distribution and d a vector of parameters to estimate. Any remaining unobserved heterogeneity across European banks is captured by bank-specific fixed effects α_i . A bank i can deviate from optimal profits PBT or optimal costs C due to random noise v_{it} or inefficiency u_{it} . Equation (2.2) is estimated with maximum likelihood methods as a fixed-effect panel frontier (Greene, 2005).¹⁰ Contrary to most frontier models, inefficiency is time-variant without imposing a monotonous trend.

Second, the use of the translog specification implies that we need to deal with banks incurring losses in the profit frontier, because the log of negative numbers is not defined. Most studies either dismiss observations with negative profits or inflate profits of all considered banks by adding the sample minimum plus one. However, Bos and Koetter (2009) suggest an alternative *negative indicator approach*, which is less likely to be biased. We set the dependent variable PBT for observations with negative profits to 1 but specify an additional indicator variable that takes the absolute value of losses if profits are zero or negative (before taking logs). It equals 1 for observations with positive profits. Thereby, we sample both profitable and loss-producing banks but explicitly include the latter information. Point estimates of efficiency are obtained as the conditional expectation of u given ε . For example, profit efficiency (PE) of 80% implies that the bank could have generated 20% more profit had it employed inputs and outputs efficiently.

⁹ We describe this data below in more detail. In an earlier version of this paper, we included country dummies instead.

¹⁰ We follow the conventions in the frontier literature regarding distributional assumptions and restrictions to identify the model (Kumbhakar and Lovell, 2000). Note, however, that the properties of the alternative profit frontier are theoretically not as well defined as in the standard profit frontier case. But Kumbhakar and Lovell (2000, p. 213) write that '[...] it is reasonable to assume that [the alternative profit function] is non-decreasing in the elements of y and non-increasing in the elements of w '. Therefore, imposing homogeneity of degree one on input prices for both cost and alternative profit frontiers seems reasonable.

2.3 Data and regional allocation

We use unconsolidated financial data for approximately 7,000 banks in 11 EU countries between 1996 and 2004. The banks are mapped to 147 NUTS 2 regions based on three regional identifiers provided in the Bankscope database: country, city, and zip codes.

Table 2.1 **Descriptive statistics per country on growth and financial development**

Country	GDP growth		Profit efficiency		Cost efficiency		Credit to GDP		N
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Austria	3.88	1.15	61.20	7.93	63.58	4.08	101.8	88.3	77
Belgium	3.57	1.12	54.96	17.02	68.20	11.20	102.4	165.1	52
Denmark	3.84	n/a	67.57	n/a	68.32	n/a	101.3	n/a	9
Finland	4.26	2.18	73.22	13.28	66.01	14.07	74.9	63.2	15
France	3.07	1.93	64.92	10.79	70.67	5.69	67.5	70.8	208
Germany	3.44	1.63	62.51	5.65	68.44	6.63	115.4	182.3	369
Ireland	5.18	1.23	46.17	0.00	54.36	0.00	156.8	0.0	8
Italy	1.80	1.68	63.36	7.25	70.33	5.21	85.8	72.5	183
Luxembourg	4.00	n/a	56.18	n/a	65.93	n/a	1433.4	n/a	9
Spain	3.02	1.80	68.22	10.18	73.29	4.76	160.0	228.0	150
Sweden	3.26	1.80	62.56	8.24	73.21	5.32	44.2	71.2	43
Total	3.11	1.67	63.44	8.40	69.49	6.02	113.6	135.7	1,123

Notes: All variables are denoted in percentages. GDP: Gross domestic product. SD indicates intracountry standard deviation across regions. N indicates observations. All variables averaged between 1996 and 2004.

German districts (*Regierungsbezirke*) correspond to NUTS 2 regions, and we match banks' postcodes to NUTS 2 regions using the so-called *Regionalschlüssel*. It enciphers German regions via a 12-digit code, and *Regierungsbezirke* are identified by the third digit. French NUTS 2 regions correspond to the 26 *departements*, which nest several postcodes available per bank in Bankscope. The first two digits of the French postcode identify the NUTS 2 region. Italian banks are also allocated to NUTS codes via their postcodes. Here, a range of postcodes corresponds to a NUTS code. NUTS 2 regions in Spain coincide with the 19 Spanish autonomic regions, which nest 50 provinces. The first two letters of the postcode identify the province and consequently the NUTS region of each bank. NUTS 2 regions in Austria match with the nine states (*Bundesländer*), which can be uniquely identified from zip codes.

All banks that could not be mapped via their zip codes are mapped manually. In this second step we use the city names provided in Bankscope to allocate banks

to NUTS 2 regions.¹¹ Denmark and Luxembourg comprise only one NUTS 2 region, which renders the allocation of banks to NUTS 2 regions straightforward.¹²

We aggregate point estimates of profit (and cost) efficiency to serve as our proxy for the regional quality of financial intermediaries FQ.¹³ Likewise, aggregate lending per region across banks relative to GDP serves as a volume proxy FV. The final dataset is an unbalanced panel comprising 147 different NUTS 2 regions in 11 EU countries. Descriptive statistics in Table 2.1 highlight that even across old EU member states productivity growth differed at times considerably between 1996 and 2004. Likewise, the depth of financial systems also differs considerably across nations.¹⁴ The dispersion of relative intermediation abilities is, however, much lower.

The comparison of efficiency levels across different samples, specifications, and methods is subject to caution because the former are relative measures. Therefore, efficiency levels depend crucially on how the benchmark is obtained (Bauer et al, 1998). Note nonetheless that alternative profit efficiency is relatively high compared to cross-country or US evidence reviewed in, for example, Berger and Humphrey (1997). Our use of a panel frontier estimator that accounts for bank-specific fixed effects might explain this. The latter might otherwise be identified as inefficiency. The few studies that also use this estimator to estimate PE among European banks find similar results.¹⁵ Mean cost efficiency of almost 70% is slightly lower than the mean indication of 75% to 80% mentioned in Berger and Humphrey (1997) but may simply reflect the more recent time period considered here. In sum, both cost and profit efficiency estimates are in line with previous evidence. Note that the intracountry standard deviation of growth and finance proxies is high and supports our focus on regions rather than nations.

To avoid efficiency measures that are contaminated when fitting one European frontier, we follow the suggestion of Lozano-Vivas et al (2002) and control for a number of country-specific traits in each of the respective banking systems. We show mean indicators per country in Table 2.2. To measure the regulatory framework, we specify the central banking independence index (CBI) suggested in Arnone et al (2007). This is a composite index of political and economic dimensions of central bank autonomy. Higher values indicate more

¹¹ We exclude overseas and offshore territories.

¹² Irish bank data is only available for one region.

¹³ The complete Bankscope sample includes unconsolidated financial accounts for 27,248 bank-year observations in 25 EU countries in 1994–2004. We also tested alternative aggregation measures such as median or higher moments per region without material changes to our main results.

¹⁴ For example, Luxembourg is a financial center. We control for such extreme observations.

¹⁵ For example, Koetter (2006) reports mean PE of 64.7% for a sample of German banks, which are by far most numerous in the European banking market. In addition, we follow Lozano-Vivas et al (2002) and specify environmental controls in the kernel, which further reduces unobserved heterogeneity otherwise identified as inefficiency.

autonomy, which is positively related to financial stability and should therefore spur economic growth. We also include the Index of Economic Freedom from the Heritage Foundation (HER), which measures the propensity of a country's policies to provide economic freedom. It is a composite index of ten indicators that rank policies in the areas of trade, government finances, government interventions, monetary policy, capital flows and foreign investment, banking and finance, wages and prices, property rights, regulation, and informal market activity. Higher values indicate more economic freedom.¹⁶ Although our sample is fairly homogenous, we note that both CBI and HER differ at times considerably, thus indicating the importance of specifying environmental controls in the efficiency estimation in order to avoid misidentification of such an effect in the growth regression.

Table 2.2 **Country-specific controls included in frontier estimation**

Country	Controls							N
	<i>CBI</i>	<i>HER</i>	<i>DD</i>	<i>IB</i>	<i>DB</i>	<i>BC</i>	<i>BD</i>	
Austria	0.94	66.85	2.49	2.86	46.33	0.56	0.05	77
Belgium	0.94	65.58	10.02	1.07	24.80	1.31	0.44	52
Denmark	0.75	69.30	18.37	24.85	373.96	0.40	0.05	9
Finland	0.94	68.27	0.18	3.37	49.24	0.24	0.00	15
France	0.94	59.18	1.90	2.71	39.83	0.44	0.05	208
Germany	0.88	67.92	6.14	2.60	56.15	0.48	0.11	369
Ireland	0.81	77.49	2.09	9.33	156.81	0.25	0.01	8
Italy	0.81	61.86	1.78	2.21	19.22	0.49	0.09	183
Luxembourg	0.94	76.12	81.03	467.11	14,000	0.04	0.01	9
Spain	0.88	65.38	1.25	0.90	16.20	0.95	0.08	150
Sweden	0.94	68.03	2.75	39.05	595.83	0.23	0.00	43
Total	0.89	64.95	4.38	7.63	175.62	0.56	0.10	1,123

Notes: CBI: central bank independence indicator (Arnone et al, 2007). HER: Heritage Foundation Index of Economic Freedom. DD: deposit density measured; IB: net income per branch; DB: deposits per branch; BC: branches per capita; BD: branch density (Lozano-Vivas et al, 2002, OECD 2008, World Development Indicators CD-ROM). All variables are averaged over 1996 to 2004. All monetary aggregates in thousands of deflated 2000 Euros.

To control for further environmental factors and banking industry traits per country, we closely follow Lozano-Vivas et al (2002) and construct five measures from the bank profitability data of the OECD (2008). We consider the value of aggregate deposits per inhabitant (*deposit density*, DD), the income per branch

¹⁶ In addition, we included income per capita levels as well as population density in the frontier estimation to control for further effects influencing the supply and demand of financial services (Lozano-Vivas et al, 2002).

(IB), aggregate deposits per branch (DB), branches per capita (BC), and branches per square kilometer (*branch density*, BD).

3 Results

Parameter estimates for the regional growth model in equation (2.1) are shown in Table 3.1. Because the volume of funds may not be independent of economic growth, we specify financial-development proxies as predetermined and endogenous variables, respectively, and use lagged levels and differences as instruments.

The individual volume effect is insignificant. This is in line with studies reporting that the exclusion of less developed countries or the consideration of more recent years yields no or weak evidence of a finance growth nexus (Rousseau and Wachtel, 2009). Quantity effects alone may be insufficient to spark growth in mature economies in recent years.

Table 3.1 **Financial development effects on regional growth**

	Quantity	Profit efficiency			Cost efficiency		
		<i>Quality</i>	<i>Both</i>	<i>Interaction</i>	<i>Quality</i>	<i>Both</i>	<i>Interaction</i>
Constant	1.117*** [0.358]	1.679*** [0.490]	1.061*** [0.345]	1.006*** [0.319]	1.715*** [0.477]	1.047*** [0.318]	0.954*** [0.273]
GDP _{t-1}	0.876*** [0.033]	0.826*** [0.046]	0.886*** [0.032]	0.893*** [0.029]	0.825*** [0.044]	0.890*** [0.029]	0.899*** [0.024]
FV	0.000 [0.002]		0.001 [0.002]	0.010*** [0.004]		0.002 [0.002]	0.005 [0.006]
FQ		0.023** [0.009]	0.020** [0.009]	0.048*** [0.018]	0.060* [0.032]	0.047* [0.028]	0.058 [0.036]
FV x FQ				0.018** [0.007]			0.009 [0.016]
Labor force growth	-0.148*** [0.023]	-0.125*** [0.022]	-0.128*** [0.021]	-0.134*** [0.020]	-0.115*** [0.024]	0.124*** [0.022]	-0.125*** [0.021]
Observations	1209	1123	1123	1123	1123	1123	1123
Regions	147	134	134	134	134	134	134
Sargan χ^2	125.82	122.45***	130.74*	131.32	121.38***	127.55*	131.84

Notes: GDP: Gross domestic product per region. FV: Financial volume measured as regional aggregate credit relative to GDP; FQ: Financial quality measured as regional mean bank efficiency. First-stage efficiency measures conditional on environmental controls (see Table 2.2). All variables measured in log levels. Standard errors in brackets. ***/**/* significant at 10%/5%/1%. In the system GMM estimation financial quality is specified as predetermined; financial volume and the interaction terms are specified as endogenous variables. Time trend included but not reported. Lagged levels and differences are used as instruments.

The individual profit-efficiency effect of financial quality on regional growth is in turn positive and significant. It is also possible that both bank efficiency and credit effects off-set each other. In line with casual evidence from the recent credit

crises, Marquez (2002) shows that increasing competition can induce banks to lend excessively to low-quality borrowers, thereby causing inefficiencies. Therefore, we specify in column three the quantity and the profit-efficiency channel of financial intermediation simultaneously. Though the insignificance of a mere deepening of credit markets remains in line with Rousseau and Wachtel (2009), our measure of financial institutions' quality, is statistically significant and positive. The absence of a volume effect might be due to our focus on mature economies in recent years. Another explanation could be that the provision of more credit by inefficient banks implies a poor selection of projects. High efficiency alone, in turn, may indicate that banks excessively scrutinize their supply of loans and avoid, for example, lending to more opaque small businesses that might bear future loan write-offs given difficult and costly assessments.

Therefore, we test if the interaction between bank quality and the volume of funds intermediated is significant. This model suggests that future finance-growth studies should account for three channels through which better banking can spur growth: a quantity, a quality, and an interaction effect of regional credit and bank efficiency. Each of these channels contributes significantly to output-per-capita growth in Europe's mature regions, even in recent years.

Estimated magnitudes especially emphasize that better banking fosters regional economic growth. A 1% increase in banks' ability to convert inputs into financial services spurs regional growth in total by almost 0.06%. Because regional mean PE is low (63%), this implies that an improvement in PE by approximately one standard deviation (8%) translates into 48 basis points of additional economic growth. In light of mean growth rates (Table 2.1), such gains are economically meaningful. This result corroborates policies that foster banks' profit efficiency in Europe. Also note that a 1% increase in the profit efficiency of banks has more than four times the effect on growth that a relative increase in lending volumes does.

In the right-hand panel of Table 3.1 we depict the results from specifications where we measure the quality channel via banks' relative ability to minimize cost. Cost efficiency is interesting to investigate because most bank-efficiency studies use this model to evaluate bank performance.

Our results show only a modest and at best weakly significant relation between cost efficiency and regional growth. This may indicate that financial intermediaries that are relative top performers in terms of operating cost in the industry need not necessarily be those banks that also manage to conduct the most profitable business. This may simply reflect the idea that although cost minimization is a necessary condition for the realization of optimal profits, it is not a sufficient one. Banks' ability to generate profits from their relations seems to especially stimulate regional economic growth.

In sum, the quality effect of better financial institutions is both economically and statistically significant when measured by using banks profit efficiency.¹⁷ We therefore focus henceforth on specifications using this measure of banks' relative ability to conduct their business. Because our study is subject to a number of possible caveats, we conduct next a series of robustness checks on this relation between regional growth and profit efficiency.

4 Robustness

4.1 Ordinary least squares

First, one may doubt whether using a panel of annual observations permits any inference on growth when in fact business-cycle developments drive our findings. We attempt to address this concern given the restrictions imposed by data availability and estimate the long-term relation between financial quantity and quality proxies using simple OLS with average data covering the entire nine-year period (1996–2004).

We show in Table 4.1 individual and joint specifications of PE as well as initial GDP per worker in 1996 on the growth rate of GDP per worker. This specification is also known as a convergence regression and is analogous to the dynamic panel model presented before.¹⁸ Larger, initial GDP per worker implies lower subsequent growth rates and therefore a negative coefficient is expected in this OLS specification. Our key interest here is to show that in both specifications the effect of profit efficiency on regional GDP per capita and on growth rates is significant and positive.

¹⁷ Coefficients of worker growth, the lagged endogenous variables, as well as the usual specification tests are in line with expectations, too.

¹⁸ The analogy to the dynamic panel estimation follows from simply rewriting $(\ln y_{it} - \ln y_{it-1}) = f(\bullet)_t + \epsilon_{it}$ with $t = 2004$ and $t-1 = 1996$ used in the present OLS specification as $\ln y_{it} = \ln y_{it-1} + f(\bullet)_t + \epsilon_{it}$, with annual observations such that $t = 1994, \dots, 2004$ in a panel context (Islam, 1995). As such, a positive coefficient below 1 in the dynamic panel model is analogous to the familiar negative coefficient for initial income in the OLS convergence regression shown in Table 4.1 (Blundell and Bond, 1998).

Table 4.1

**OLS estimates of profit efficiency on
GDP-per-worker growth**

	GDP per worker growth			
	Quantity	Quality	Both	Interaction
Constant	1.564** [0.603]	2.260*** [0.516]	2.486*** [0.503]	2.599*** [0.518]
GDP ₁₉₉₆	-0.171*** [0.050]	-0.216*** [0.046]	-0.237*** [0.043]	-0.239*** [0.043]
FV	0.002 [0.004]		0.007 [0.005]	0.03 [0.026]
FQ		0.089** [0.036]	0.082** [0.037]	0.140* [0.082]
FV x FQ				0.028 [0.031]
Labor force growth	-0.378** [0.162]	-0.267** [0.117]	-0.274** [0.117]	-0.243** [0.116]
Observations	109	102	102	102
R-squared	0.24	0.38	0.39	0.40

Notes: Dependent variable is annualized GDP per worker growth rate per region between 1996 and 2004. FV: Financial volume measured as regional aggregate credit relative to GDP; FQ: Financial quality measured as regional mean profit efficiency. First-stage efficiency measures conditional on environmental controls (see Table 2.2). All variables measured in log levels. Robust standard errors in brackets. ^{*/**/***} significant at 10%/5%/1%.

Both parameters for initial income and working population growth are line with theory and previous evidence. More important, individual and joint specifications of FV and FQ are in line with dynamic panel estimations and have statistically and economically positive growth effects. This suggests that our findings do not seem to be solely driven by business-cycle developments. Because simple OLS methods neglect the possibly endogenous nature of either measure of financial development and do not exploit the panel nature of our data, we use henceforth the dynamic panel specification to address further potential concerns.

4.2 Regional allocation and financial centers

Allocating banks to regions on the basis of headquarters location is inevitably heuristic to some degree. In a first set of robustness checks we therefore choose different samples to test the quality channel of financial development. Although the vast majority of banks in Europe continue to be small in size and regional in scope, some regions in Europe are financial centers of international relevance. We exclude these, but results reported in the first column of Table 4.2 remain

unaffected.¹⁹ Next, we exclude the largest three banks in each region when aggregating FQ and FV. Results in column two demonstrate the insensitivity of our main finding to this choice. Finally, most banks in Europe are located in Germany, most of which are very small, operate locally, and might therefore drive the findings in our European sample. The third column in Table 4.2 shows results excluding Germany with no qualitative changes either.

A second set of regressions concerns possible aggregation problems with spatially lagged regressions. Ideally, we would like to weigh banks' financial-development proxies depending on the spatial distribution of their customers, for instance the location of borrowers. Alternatively, one could use the regional branch distribution as a weighting scheme. Neither approach is feasible because such information is private and unfortunately unavailable to us at the European level.

Table 4.2 **Financial centers and regional allocation**

	Excluding fin. centers	Excluding 3 largest FI	Excluding Germany	FQ	FV	Spatial spillovers FV x FQ	Both	All
Constant	1.159*** [0.307]	0.910*** [0.295]	1.201** [0.520]	0.730*** [0.269]	1.134*** [0.338]	0.770*** [0.258]	0.813*** [0.272]	0.822*** [0.273]
GDP _{t-1}	0.877*** [0.029]	0.896*** [0.028]	0.875*** [0.050]	0.910*** [0.026]	0.881*** [0.031]	0.907*** [0.025]	0.903*** [0.026]	0.901*** [0.026]
FV	0.007* [0.004]	0.010* [0.006]	0.020*** [0.005]	0.013*** [0.005]	0.013*** [0.003]	0.011*** [0.004]	0.013*** [0.004]	0.015*** [0.006]
FQ	0.033*** [0.012]	0.033** [0.013]	0.047*** [0.013]	0.066*** [0.014]	0.071*** [0.015]	0.064*** [0.013]	0.077*** [0.017]	0.084*** [0.019]
FQ x FV	0.010* [0.005]	0.010* [0.006]	0.021*** [0.006]	0.026*** [0.007]	0.019*** [0.006]	0.022*** [0.007]	0.024*** [0.007]	0.027*** [0.009]
Spatial FQ				-0.003 [0.002]			-0.002 [0.002]	-0.004 [0.004]
Spatial FV					-0.024** [0.010]		-0.018* [0.011]	-0.028** [0.012]
Spatial FQ x FV						0.003 [0.002]		-0.003 [0.004]
Labor force growth	-0.132*** [0.020]	-0.157*** [0.022]	-0.141*** [0.025]	-0.151*** [0.019]	-0.131*** [0.021]	-0.148*** [0.019]	-0.146*** [0.020]	-0.146*** [0.020]
Observations	1078	1170	763	902	1123	902	902	902
Regions	129	144	96	122	134	122	122	122
Sargan	126.46	138	95.21	118.63*	130.77*	117.72*	118.12*	118.16*

Notes: First-stage efficiency measures conditional on environmental controls described in Table 2.2. Standard errors in brackets. *** ** * significant at 10%/5%/1%. In the system GMM estimation financial quality is specified as predetermined, financial volume and the interaction term are specified as endogenous variables. Time effects specified but not reported. Lagged levels and differences are used as instruments.

We therefore rely on statistical techniques suggested by Anselin (1988) to allow banks' profit efficiency and lending behaviors to affect growth outside the regions

¹⁹ These regions are Amsterdam, Frankfurt, Luxembourg, Madrid, Milan, and Paris.

in which they are headquartered. Specifically, we generate spatial lags of all three measures of financial development: quantity, quality, and their interaction. This permits financial development in neighboring regions to affect growth in region r to capture the notion that financial economic activity might not be spatially independent. A priori, the relation between spatially weighted financial development and regional growth remains unclear. For instance, borrowers may prefer to take out credit and consume in neighboring regions if banks process their savings there more efficiently. This would lead to a pull effect, which can have a negative spatial effect on economic growth. The effects of spatial lags of financial development proxies therefore remain an empirical question. Consider to this end the results in the five rightmost columns of Table 4.2.

Most important, we find that all five specifications of spatially weighted quantity and quality measures leave the positive direct effects on regional growth intact. In particular the individual and direct effect of financial quality as approximated by regional mean-profit efficiency increases considerably and is economically significant. Spatial lags of profit efficiency in neighboring regions are in turn always insignificant. Only the aggregate lending volume in adjunct regions exhibits a statistically significant negative coefficient. This suggests that deeper credit markets in the geographic vicinity exert a pull effect, perhaps by attracting some of the local investors. However, these centrifugal forces of economic activity are clearly compensated by economically (and statistically) significant direct effects through all identified channels of financial development on growth. Overall, these results demonstrate that spatial effects do not alter our main conclusions.

4.3 Alternative and additional growth determinants

The vast majority of finance-growth studies use data for financial development provided by the World Bank.²⁰ Therefore, we specify national financial market depth as a proxy for the volume of financial development FV in the first four columns of Table 4.3. This is in line with previous finance-growth studies (Levine et al, 2000) instead of the regional aggregates of bank credit used here. Both direct stock- and bond-market capitalization relative to national GDP are positive and statistically significant, but interaction effects are insignificant. The inclusion of traditional quantity measures that neglect the important spatial dispersion of credit within countries reduces but does not eliminate the quality effect, which we suggest to be of relevance here.

²⁰ Financial development and structure data are available at <http://www.worldbank.org>.

Table 4.3

Alternative and additional growth controls

	Stock market		Public bond market		Bank market structure		Environmental controls		
	Individual	Interaction	Individual	Interaction	CR 3	CR 5	Patents	Political	Banking
Constant	2.015*** [0.495]	1.618*** [0.499]	1.877*** [0.617]	3.208*** [0.557]	1.331*** [0.357]	1.295*** [0.353]	0.348 [0.350]	-0.277 [0.391]	-0.53 [0.335]
GDP _{t-1}	0.807*** [0.047]	0.838*** [0.047]	0.806*** [0.058]	0.683*** [0.053]	0.858*** [0.033]	0.861*** [0.032]	0.940*** [0.032]	0.960*** [0.034]	0.989*** [0.029]
FV	0.020*** [0.007]	0.034*** [0.008]	0.035*** [0.007]	0.060*** [0.015]	0.014*** [0.004]	0.012*** [0.004]	0.016*** [0.004]	0.020*** [0.005]	0.010** [0.005]
FQ	0.015** [0.007]	0.043** [0.021]	0.017** [0.007]	0.025** [0.013]	0.034*** [0.010]	0.033*** [0.010]	0.056*** [0.015]	0.062*** [0.016]	0.053*** [0.016]
FQ x FV		0.026 [0.018]		0.011 [0.015]	0.010** [0.005]	0.010** [0.005]	0.025*** [0.007]	0.028*** [0.008]	0.020*** [0.008]
Labor force	-0.117*** [0.025]	-0.156*** [0.022]	-0.150*** [0.017]	-0.134*** [0.020]	-0.131*** [0.022]	-0.130*** [0.022]	-0.168*** [0.022]	-0.167*** [0.021]	-0.185*** [0.021]
Growth									
Concentration					0.046*** [0.012]	0.052*** [0.015]	0.064*** [0.014]	0.069*** [0.014]	0.078*** [0.019]
Ratio									
Patents							0.000 [0.001]	0.000 [0.001]	-0.001 [0.001]
per capita									
Central bank								0.089 [0.074]	-0.303*** [0.102]
independence									
Heritage index								0.102*** [0.030]	-0.003 [0.033]
(HER)									
Income per									-0.076*** [0.011]
branch (IB)									
Deposits per									0.074*** [0.010]
branch (DB)									
Branches per									0.004 [0.017]
capita (BC)									
Branch density									-0.014*** [0.006]
(BD)									
Observations	1123	1123	1114	1114	1123	1123	973	973	973
Regions	134	134	133	133	134	134	133	133	133
Sargan	130.23**	120.67***	129.21**	123.57***	129.25	129.21	125.31*	123.37*	125.32*

Notes: First-stage efficiency measures conditional on environmental controls described in Table 2.2. Standard errors in brackets. * significant at 10%/5%/1%. In the system GMM estimation financial quality is specified as predetermined, financial volume and the interaction term are specified as endogenous variables. Time trend specified but not reported. Lagged levels and differences are used as instruments. Stock and public bond market capitalization are obtained from the World Bank and are measured relative to country GDP. Patents per capita at the NUTS 2 level are obtained from Eurostat. Other control variables are described in Table 2.2.

Levine et al (2000) emphasize the importance to include additional control variables in finance-growth regressions to avoid selection of a favored result. Therefore, we conduct some additional robustness tests. A first concern relates to the ambiguous relation between growth and competition. According to previous empirical evidence, changes in bank competition can influence growth very differently.²¹ Therefore, we include both the three- and five-firm concentration ratios, which are the aggregate market shares of the three (five) largest banks within a country, to control for a possible misspecification. Results in columns five and six show that concentration ratios are positively and significantly related to growth. This confirms Cetorelli's (2004) argument that especially large firms, which contribute substantially to economic growth, benefit from concentrated

²¹ For example, negatively by deterring new firm creation (Cetorelli, 2004) or increased (and excessive) risk-taking of banks (Boyd and De Niccolo, 2005) versus statistically not at all (Valverde et al, 2003).

banking markets. The result is also in line with Allen and Gale (2004) in that fewer banks imply a more stable banking system, which is easier to supervise effectively.²² Most important for our study is the result that market-structure proxies have an independent effect but leave coefficients for FQ and FV intact.

The three rightmost columns of Table 4.3 depict results after including one additional regional and more national environmental control variables. First, we specify patents per capita to control for differences in innovative capacity across regions but do not find a significant effect on regional growth. The identified effects of financial development on growth remain intact. Because we study the effect of financial development on regional growth, indicators of political and regulatory freedom as well as national banking-market traits, such as branch density and alike, may have direct effects on growth next to their influence on optimal costs, profits, and thus efficiency. Therefore, we use the same controls specified in the first-stage stochastic frontier analysis in the growth regression. The main finding is that both individual and interacted effects of regional financial quantity and financial quality proxies remain statistically and economically significant. Therefore, the positive effect of all three channels of financial development on regional growth seems fairly robust for our sample.

5 Conclusion

Traditional measures of financial development hinge on quantity proxies, which might not fully reflect the ability of financial systems to intermediate funds. We suggest an additional quality measure of financial intermediaries to explain regional economic growth in Europe. We measure European banks' profit efficiency and allocate both financial quality and quantity indicators to around 147 NUTS 2 regions in 11 EU countries. We show that regional economic growth in mature economies and recent time periods benefits significantly from more efficient banks.

Our results highlight the importance of specifying three distinct channels through which banks may foster productivity growth: more credit, more efficient intermediaries, and the interaction of the two. The efficiency effect is approximately three times as large as the quantity channel. Apparently, it is especially the quality of financial services that spurs economic prosperity in Europe's relatively mature economic regions.

Our results are robust to different empirical specifications as well as alternative, more frequently used measures of financial development. Future

²² Ideally, we would also test the regional market power of banks, for example by assessing the relation between lending margins or fees per branch on regional growth. Unfortunately this information is not available to us and we therefore use simple indicators at the national level.

research should aim to incorporate the quality effects of financial markets, competition among financial institutions, and regional interdependencies more explicitly into the analysis of (regional) growth in industrialized economies.

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