

Manganelli, Simone; Popov, Alexander

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EUROPEAN CENTRAL BANK

EUROSYSTEM

# WORKING PAPER SERIES

NO 1259 / OCTOBER 2010

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## FINANCE AND DIVERSIFICATION

by Simone Manganelli  
and Alexander Popov



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### FINANCE AND DIVERSIFICATION<sup>1</sup>

by Simone Manganelli<sup>2</sup>

and Alexander Popov<sup>3</sup>



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<sup>2</sup> European Central Bank, Kaiserstrasse 29, D-60311 Frankfurt am Main, Germany; email: [simone.manganelli@ecb.europa.eu](mailto:simone.manganelli@ecb.europa.eu)

<sup>3</sup> Corresponding author: European Central Bank, Financial Research Division, Kaiserstrasse 29, D-60311 Frankfurt am Main, Germany; e-mail: [Alexander.Popov@ecb.europa.eu](mailto:Alexander.Popov@ecb.europa.eu)

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**Address**

Kaiserstrasse 29  
60311 Frankfurt am Main, Germany

**Postal address**

Postfach 16 03 19  
60066 Frankfurt am Main, Germany

**Telephone**

+49 69 1344 0

**Internet**

<http://www.ecb.europa.eu>

**Fax**

+49 69 1344 6000

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## Abstract

We study how financial market efficiency affects a measure of diversification of output across industrial sectors borrowed from the portfolio allocation literature. Using data on sector-level value added for a wide cross section of countries and for various levels of disaggregation, we construct a benchmark measure of diversification as the set of allocations of aggregate output across industrial sectors which minimize the economy's long-term volatility for a given level of long-term growth. We find that financial markets increase substantially the speed with which the observed sectoral allocation of output converges towards the optimally diversified benchmark. Convergence to the optimal shares of aggregate output is relatively faster for sectors that have a higher "natural" long-term risk-adjusted growth and which exhibit higher information frictions. Our results are robust to using various proxies for financial development, to accounting for the endogeneity of finance, and to controlling for investor's protection, contract enforcement, and barriers to entry. Crucially, the observed patterns disappear when we employ "naive" measures of diversification based on the equal spreading of output across sectors.

**JEL classification:** E32, E44, G11, O16

**Keywords:** Financial development, Growth, Volatility, Diversification, Mean-variance efficiency

## NON TECHNICAL SUMMARY

There is ample empirical evidence that finance is conducive to country and industry growth, but its effect on the trade-off between growth and volatility has received limited treatment so far. Do higher levels of growth come at the cost of higher output volatility? How far is the country's actual industrial composition from the optimal growth-volatility trade-off? Are countries with more developed financial systems closer to the optimal trade-off? These are some of the questions that we address in this paper.

A country's GDP is made up of the contributions of its industrial sectors. A country's expected growth and volatility is therefore determined by its industries' growth, volatility and correlations, as well as by its industrial composition. If we think of a country's growth rate as the return on a portfolio, and its industries as individual assets in that portfolio, we can construct mean-variance efficient frontiers (optimally diversified benchmarks) and compare them across countries.

Using a sample of 28 OECD countries, we calculate for each year each country's distance to the efficient frontier over the 1970-2007 period. Next, we study how financial development affects the convergence to the frontier over time and across countries. To address causality issues, we apply a cross-country cross-industry empirical methodology and check whether industries with higher risk-adjusted growth rates (Sharpe ratios) and industries with higher natural information frictions converge faster to their implied output shares in countries with more developed financial systems. We also use policy measures aimed at liberalising credit markets instead of volume measures of financial development to address endogeneity issues.

In order to correct for the possibility that convergence is mainly driven by institutional factors, we allow our empirical procedure to account for the main legal and regulatory characteristics of the environment that might be correlated with financial development and thus bias our estimates. We also address concerns about the quality of our proxies for financial development. Finally, we test the hypothesis that a larger economic zone, like the euro zone, is a more suitable unit of observation than the country.

Our main findings are:

- 1) Efficient financial markets affect strongly and causally the speed with which economies converge to our measure of "optimal" diversification. Numerically, a two-standard deviation increase in our preferred proxy for financial development (private credit to GDP) results in a 3.5% higher annual speed of convergence to the optimally diversified benchmark. Alternative measures of financial development that are more designed for advanced financial systems, such as measures of equity market and bond market depth, give a similar picture.
- 2) While economies' risk-adjusted growth increases mechanically over time as fast-growing sectors become larger, we find that financial markets also tend to decrease the economy's

overall volatility of growth for the same level of long-term growth. This happens through a reallocation effect in which sectors with naturally lower volatility for the same level of long-term growth converge faster to their optimal share of output in the economy.

3) Financial markets have no effect on a set of measures that define diversification as the equal spreading of output across sectors ("naive" diversification). This result is easy to interpret if one bears in mind the U-shaped diversification pattern documented in the literature. Our finding that for a set of industrialized economies, output is spread as to maximize overall risk-adjusted growth, is fully consistent with a development pattern in whose later stages the economy specializes in order to exploit pecuniary externalities and economies of scale. At the same time, that economies with more efficient financial markets do not exhibit a more equal spreading of output across sectors is also consistent with a development path in which "naive" diversification does not evolve linearly over time.

The results are robust to various proxies of financial development, to different econometric procedures, and to different units of observation (country vs. euro zone). They also survive when we eliminate from the sample countries which liberalized their credit markets during the sample period, which may have induced a structural break in the efficient frontier itself. Most importantly, they do not go away after stringent procedures are used to address the potential endogeneity of finance and omitted variable bias.

Our findings have interesting and important policy implications. To cite just one, our paper inform policy-makers' understanding of the trade-off between efficiency and stability. Recent research has documented that various empirical proxies for financial development are associated with higher probability of recessions. This could happen because excessive financial development may foster herding behaviour, excessive risk-taking, and the potential to create bubbles. On the other hand, the findings in our paper suggest that countries with more developed financial markets tend to have better diversified economies, and so to achieve the same level of growth at a lower level of economic volatility. Whether the net effect of these two forces is positive or negative is an issue that deserves further attention.



## I. Introduction

This paper assesses the contribution of financial markets to sectoral diversification defined in the spirit of mean-variance portfolio theory. Using data on sector-level value added for a wide cross section of countries and for various levels of disaggregation, we construct a benchmark measure of diversification as the set of allocations of aggregate output across industrial sectors which minimize the economy's long-term volatility for a given level of long-term growth. We find robust evidence that efficient financial markets are associated with a higher speed of convergence of the actual allocation of output across industrial sectors to the optimal benchmark. By means of illustration, if in 1970 Greece had as deep credit markets as the U.S., in 2007 its economy would have exhibited a diversification pattern associated with a 18% lower volatility than the realized one.

Besides yielding new and robust results, our methodology provides an alternative way of thinking about the pattern of sectoral diversification over the development cycle. Diversification is expected to increase in the early stages of development as the expansion of markets enables a gradual allocation of investment to its most productive uses while reducing the variability of growth (Acemoglu and Zilibotti [1997]). It is then expected to decrease in later stages of the development path as pecuniary externalities and costly trade induce countries to specialize (Krugman [1991]). The resulting pattern is known as "U-shaped diversification" (Imbs and Wacziarg [2003]). However, thinking of diversification as the equal spreading of output across sectors ignores the interplay between the sectors' intrinsic growth and volatility, as well as the exact degree to which individual projects are correlated. If industries exhibit long-run growth-volatility patterns consistent with the characteristics of individual assets in an investment portfolio (Imbs [2007]), then it is logical to think of an optimally diversified economy as a combination of sectors' shares, maximizing a representative agent's utility from return and risk, and derived from the sectors' own long-term growth, growth correlations, and volatility.

What is the role of financial markets in the evolution of sectoral diversification defined in an optimal portfolio sense? We know that financial development may decrease the variability

of growth (Greenwood and Jovanovic [1990]), that it leads to a more efficient use of resources through sectoral reallocation from slow-growing to fast-growing sectors (Wurgler [2000]), and that it affects the industries' growth rates (Rajan and Zingales [1998]) and volatility (Raddatz [2006], Levchenko et al. [2009]). But how do efficient financial markets affect the economy's overall growth-volatility pattern? For example, financial markets are expected to help economies insure away idiosyncratic risk and exploit better their productive opportunities (Aiyagari [1994]), regardless of whether these arise from natural resources, investment in human capital, or the advent of new technologies. Consider now a representative investor who is embarking on such strategy by investing in a range of industrial sectors; institutional investors like pension funds or mutual funds would be good examples. The optimal diversification objective would then imply not that all investment is allocated to fast-growing sectors, or that it is spread equally across available projects to decrease overall volatility, but rather that it is allocated across sectors as to maximize the economy's overall long-term risk-adjusted return.

In calculating the economy's set of optimal allocations of aggregate output across industrial sectors which minimize the economy's long-term volatility for a given level of growth, we constrain investors to be unable to short a sector. Our calculations suggest that a number of sectors have very small optimal weights, close to zero. For example, three sectors in the SIC 1-digit industrial classification (Agriculture, hunting, forestry and fishing; Mining and quarrying; and Construction) account for less than 5% of the share of output in the "optimal" sectoral portfolio implied by long-term growth, volatility, and growth correlations. The sectors with the biggest weight in the optimal portfolio are Community, social and personal services (32.3%); Finance, insurance, real estate and business services (26.7%); and Transport, storage and communication (14%). The former two sectors of the last group also exhibit the biggest difference between actual and optimal share, 21.4% and 18.5% on average across countries and time, with their optimal share being higher than their actual one. On the other side of the spectrum, our estimates imply that on average, the actual share of manufacturing is higher than the optimal one by 14.5%. Another sector which is

suboptimally large is agriculture. The fact helps illustrate the way we think of "optimality": while agriculture and manufacturing are essential sectors, given their long-term growth, volatility, and correlations with the returns in other sectors, a large realized share of these two sectors may imply a sub-optimally diversified economy.

Our main finding is that efficient financial markets affect strongly and causally the speed with which economies converge to our measure of "optimal" diversification. Numerically, a two-standard deviation increase in our preferred proxy for financial development results in a 3.5% higher annual speed of convergence to the optimally diversified benchmark. At the same time, financial markets have no effect on a set of measures that define diversification as the equal spreading of output across sectors ("naive" diversification). This result is easy to interpret if one bears in mind the U-shaped diversification pattern established by Imbs and Wacziarg (2003). Our finding that for a set of industrialized economies, output is spread as to maximize overall risk-adjusted growth, is fully consistent with a development pattern in whose later stages the economy specializes in order to exploit pecuniary externalities and economies of scale. At the same time, that economies with more efficient financial markets do not exhibit a more equal spreading of output across sectors is also consistent with a development path in which a "naive" measure of diversification, such as the Gini coefficient, does not evolve linearly over time.

We address a number of concerns about the robustness of our findings. First, our results might be capturing the demand-driven move over the development cycle towards sectors with lower intrinsic volatility, like health provision, education, and government services (e.g., Koren and Terneyro [2007]). In that regard, an estimate of a positive effect of finance on convergence to frontier might be biased by a preference-driven global move away from volatility. We address this concern by employing a panel specification with time, country, and industry fixed effects which allows us to isolate the contribution of the time-varying country-specific component of finance to convergence.

Second, our results might be biased by left-out variables bias and reversed causality. For

example, unobserved entrepreneurial culture or households' propensity to save might be driving both optimal diversification and financial development. Alternatively, if financial services are a superior good, richer and better diversified economies would have a higher demand for them. We address these concerns by first employing a cross-country cross-industry regression analysis *a la* Rajan and Zingales (1998) in which we include country and industry fixed effects. These fixed effects control for any potential feedback from the level of diversification to finance, as well as for the effect of omitted variables that affect diversification and vary by countries and industries. In some specifications, we also include country-industry dummy interactions, to sweep away the effect of time-invariant unobservables that vary by *both* country and industry. This strategy allows us to study the differential effect of financial markets on sectors that are naturally more responsive to finance. Second, we replace our volume measures of finance with data on liberalization events in financial markets. This *de jure* measure is largely exogenous (Bekaert et al. [2005]) and so it should additionally address concerns about the endogeneity of financial development.

Third, in order to correct for the possibility that convergence is mainly driven by institutional factors, we allow our empirical procedure to account for the main legal and regulatory characteristics of the environment that might be correlated with financial development and thus bias our estimates. We also address concerns about the quality of our proxies for financial development. Finally, we test the hypothesis that a larger economic zone, like the euro zone, is a more suitable unit of observation than the country. Our main findings remain stubbornly robust to all these alternative specifications.

The rest of the paper is structured in the following way. Section 2 discusses related literature. Section 3 describes the construction of the allocative efficiency benchmark, our empirical methodology, and the data. Section 4 presents the empirical results together with a battery of endogeneity and robustness tests. Section 5 concludes with a discussion of the main results and of possible extensions.

## II. Related Literature

While there are two main theoretical arguments for why economies diversify along the development path - nonhomothetic preferences<sup>1</sup> and portfolio arguments - it is the latter that motivates our approach to linking finance and diversification. In particular, in Acemoglu and Zilibotti (1997) diversification occurs endogenously as a result of the agents' decisions to invest in a range of imperfectly correlated projects. Initial capital scarcity and the indivisibility of individual projects ensure that diversification is imperfect in the early stages of development. The number of open sectors grows with financial development, making it easier to reach a stage where idiosyncratic risk is removed by investing in all sectors. Consequently, diversification is a process that accompanies economic growth and financial development through a portfolio motive. Our paper is a direct test of whether efficient financial markets are indeed associated with a more optimal allocation of investment across industrial sectors in a portfolio sense, as well as with a lower overall volatility.

Our paper also relates to a growing body of literature which has focused on the link between economic growth and volatility of growth. From a theoretical point of view, the link is ambiguous. For example, endogenous growth is affected by business cycle volatility negatively in the presence of diminishing returns to investment, and positively in the presence of precautionary savings, creative destruction, liquidity constraints, or high-return high-risk technologies<sup>2</sup>. The combined evidence implies that growth and volatility tend to relate negatively at the country level (e.g., Ramey and Ramey [1995]), but positively at the industry level (Imbs [2007]). This apparent contradiction is resolved by noticing that the positive correlation between risk and return at the industry level is masked by aggregation, as aggregation only captures the covariance between sectoral growth and the country-specific component of aggregate variance, but not the sector-specific component of volatility. This approach of distinguishing between the country-specific and sector-specific elements of volatility is shared, among others, by Koren and Terneyro (2007), who show that in large part the reduction of country-specific volatility over the development cycle is due to the reallocation of output to sectors with intrinsically lower volatility. We take the insight that individual industries

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<sup>1</sup>See Imbs and Wacziarg (2003) for details.

<sup>2</sup>See Imbs (2007) for an exposition of these arguments



exhibit growth-volatility patterns much like individual assets in a portfolio one step further by studying the diversification side of this argument and the contribution of finance to it.

Our study also relates to various contributions to the literature on finance and growth spurred by King and Levine (1993)<sup>3</sup> that have looked at the effect on growth of credit markets (e.g., Rajan and Zingales [1998], Beck et al. [2000], Beck and Levine [2002], and Raddatz [2006]), of equity markets (e.g., Levine and Zervos [1998] and Beck and Levine [2004]), and of financial liberalization (e.g., Bekaert et al. [2005]), among others. This literature has generally found that financial development has a positive effect on the level of growth, especially in industrial sectors that rely on external finance for technological reasons. In addition to the level effect, and more relevant to our work, Wurgler (2000) brings evidence on the impact of finance on growth via the reallocation of output across industrial sectors.

This paper also informs the literature on finance and volatility (e.g., Beck et al. [2006], Bekaert et al. [2006], and Larrain [2006]). This literature broadly finds that financial development and liberalization lower the volatility of output and consumption. One possible theoretical motivation is provided by Carranza and Galdon-Sanchez (2004) who show that in economies with imperfect credit markets, output volatility tends to be higher due to the effect of strategic complementarities in the production sector. Nevertheless, taken individually, the increase in level growth, the reallocation of investment towards faster-growing sectors, and the decline in sectoral volatility recorded in the literature do not inform the question of the effect of financial markets on sectoral diversification as fully as our paper does.

Several recent contributions have aimed to study the link between finance, growth, and volatility in a more unified framework. For example, Levchenko et al. (2009) show that financial liberalization increases both the growth and volatility of output at the industry level, and that this effect is driven by greater capital accumulation, greater employment, and higher firm entry. Acharya et al. (2007)

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<sup>3</sup>The idea to link finance and growth in a causal way is usually attributed to Schumpeter (1911), with later contributions by Goldsmith (1969) and McKinnon (1973). For recent surveys, see Beck et al. (2001), Wachtel (2001), and Levine (2005).



use a mean-variance efficiency framework in order to study the effect of bank branching deregulation on optimal reallocation of output across sectors. They find that deregulation broadly accelerates convergence to the mean-variance efficiency frontier.

Our contributions relative to these studies is that we show how financial deepening affects sectoral growth and volatility patterns not individually, but by allocating investment across growth and risk patterns in an optimal portfolio sense, and that we study the international dimension of this phenomenon.

### III. Methodology and Data

#### *III.A. Constructing a Diversification Benchmark*

While there is a variety of possible benchmarks for sectoral diversification (e.g., Kalemli-Ozcan et al. [2003] and Imbs and Wacziarg [2003]), we focus on the concept of mean-variance efficiency. The idea is the following. A country's GDP is made up of the contributions of its industrial sectors. An individual economy's expected growth and volatility are therefore determined by:

- 1) its sectors' growth, volatility, and growth correlations;
- 2) its sectoral composition.

Thinking of a country's growth rate as the return on a portfolio, and its sectors as individual assets in that portfolio, we can construct mean-variance efficient frontiers *a la* Markowitz (1952) and compare them across countries. Each country's efficient frontier is composed of the set of minimum volatilities that can be achieved by optimally reallocating resources across sectors, for a given rate of growth.

Let  $y_{c,s,t}$  be the rate of growth of sector  $s$  in country  $c$  at time  $t$ , and  $w_{c,s,t}$  the corresponding sector's share of aggregate output. By construction, it must be that  $\sum_{s=1}^S w_{c,s,t} = 1$  for all  $c$  and  $t$ , where  $S$  denotes the number of sectors. Each country's rate of growth  $y_{c,t}$  can therefore be rewritten as:

$$y_{c,t} = \sum_{s=1}^S w_{c,s,t} y_{c,s,t} \quad (1)$$

Assuming that investors, citizens, and governments have preferences over growth and volatility, it is possible to find the optimal sector shares by maximizing a utility function which is increasing in return and decreasing in risk, in the same way an investor wishes to determine the utility maximizing portfolio from a given set of assets. Assuming a quadratic utility over growth and volatility, we can estimate expected utility as

$$\hat{U}_c(\mathbf{w}_c) = \hat{E}(\mathbf{w}_c' \mathbf{y}_{c,t}) - \lambda_c \hat{V}(\mathbf{w}_c' \mathbf{y}_{c,t}) \quad (2)$$

where  $\lambda_c$  is the risk aversion coefficient,  $\hat{E}$  and  $\hat{V}$  denote the estimated expected value and variance, and we format vectors in boldface.

In principle, it would be possible to compute a time-varying, conditional efficient frontier, for instance by modelling the variance covariance matrix with a multivariate GARCH model. However, since we are interested in the long-run growth and risk opportunities of the economy, it is more appropriate to use the unconditional means and variances. Both approaches rest on the implicit assumption that there are no structural breaks in the underlying stochastic process. Such an implicit assumption is common to the entire finance, growth and volatility literature.

For a given level of risk aversion, the optimal trade-off between growth and volatility is given by the solution to the following constrained optimization problem:

$$\left\| \begin{array}{ll} \max_{\mathbf{w}_c} & \hat{U}_c(\mathbf{w}_c) \\ s.t. & \mathbf{w}_c \geq 0 \\ & \sum_{s=1}^S w_{c,s} = 1 \end{array} \right. \quad (3)$$

The non-negativity constraint reflects the fact that in this context it is not economically meaningful to have negative weights for the industrial composition. The solution to such a problem

requires the knowledge of the coefficient of risk aversion. As this is unknown, we modify the optimization problem as follows:

$$\left\| \begin{array}{ll} \min_{\mathbf{w}_{c,t}} & \hat{V}(\mathbf{w}'_{c,t} \mathbf{y}_{c,t}) \\ s.t. & \mathbf{w}'_{c,t} \hat{E}(\mathbf{y}_{c,t}) \geq \tilde{\mathbf{w}}'_{c,t} \hat{E}(\mathbf{y}_{c,t}) \\ & \mathbf{w}_{c,t} \geq 0 \\ & \sum_{s=1}^S w_{c,s,t} = 1 \end{array} \right. \quad (4)$$

where we denote with  $\tilde{\mathbf{w}}_{c,t}$  the vector of observed weights for country  $c$  at time  $t$ . That is, we choose the point on the frontier which minimizes the country's output volatility for the realized level of growth. The distance between such a point and the actual levels of volatility can be interpreted as a measure of allocative efficiency, because it measures by how much a country could have reduced its macroeconomic volatility, while achieving the same level of growth, by simply allocating differently its resources across sectors.

Denoting the vector solution to this problem by  $\mathbf{w}_{c,t}^*$ , and by  $w_{c,s,t}^*$  the individual elements of this vector, we can construct the following measures of country's allocative efficiency:

$$\begin{aligned} D_{c,t} &= \sqrt{\sum_{s=1}^S (w_{c,s,t}^* - \tilde{w}_{c,s,t})^2} = \|\mathbf{w}_{c,t}^* - \tilde{\mathbf{w}}_{c,t}\| \\ D_{c,s,t} &= |w_{c,s,t}^* - \tilde{w}_{c,s,t}| \end{aligned} \quad (5)$$

where  $\tilde{\mathbf{w}}_{c,t}$  is the observed vector of actual allocations, and  $\tilde{w}_{c,s,t}$  denotes its individual elements. Therefore,  $D_{c,t}$  is the Euclidean distance between the optimal and actual vectors of weights,  $\mathbf{w}_{c,t}^*$  and  $\tilde{\mathbf{w}}_{c,t}$ , while  $D_{c,s,t}$  is the distance between optimal and actual weight for each component of those same vectors. We will interchangeably refer to both distances as "distance to efficient frontier" and "distance to an optimally diversified benchmark".

Figure I gives an illustration of how the average allocation of industrial output over the sample period relates to the so constructed distances to frontier for the U.S., the euro area, and Japan. Figures II-IV illustrate the diversification path several individual countries have followed over the

sample period. Clearly, while the U.S. has experienced a Pareto improvement both in the sense of reduced volatility and increased growth, Japan has moved towards the frontier only in the dimension of growth, and Spain has actually experienced a divergence between 1990 and 2007, with higher growth rates achieved at the cost of higher volatility. These figures illustrates an important point: while countries mechanically converge in the growth dimension - as the fastest growing sectors increase their weight over time - they may converge or diverge in the volatility dimension. To avoid the possibility that we are simply capturing a mechanical convergence in the growth dimension, the dependent variables in (5) measure the Euclidean distance between the weights associated with the actual and the corresponding efficient allocation along the volatility dimension.

### III.B. Empirical methodology

We study the link between finance and diversification using a standard convergence framework. Our first convergence test estimates the degree to which distance for country  $c$  converges to the efficient frontier following higher financial development. We estimate the convergence equation

$$D_{c,t} = \alpha D_{c,t-1} + \beta D_{c,t-1} \cdot Finance_{c,t} + \gamma Finance_{c,t} + \delta_c + \eta_t + \varepsilon_{c,t} \quad (6)$$

where  $Finance_{c,t}$  is equal to a standard measure of financial market development, and  $D_{c,t}$  is defined in Equation (5).<sup>4</sup> Our coefficient of interest is  $\beta$ : if  $\beta < 0$ , then greater financial development is associated with faster convergence to the optimal diversification benchmark.<sup>5</sup> The inclusion of country and year fixed effects allows us to purge our estimates from the effect of unobservable global

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<sup>4</sup>It's important to note that equation (6) can be rewritten as

$$D_{c,t} = \alpha D_{c,t-1} + (\beta D_{c,t-1} + \gamma) \cdot Finance_{c,t} + \delta_c + \eta_t + \varepsilon_{c,t}$$

and so the full effect of finance on distance to the allocative efficiency frontier is given by  $\beta D_{c,t-1} + \gamma$ . For example, if both  $\beta$  and  $\gamma$  are negative, then more finance decreases distance to frontier, but if  $\beta < 0$  and  $\gamma > 0$ , then the total effect of finance depends on  $D_{c,t-1}$ , and for low levels of  $D_{c,t-1}$ , finance could lead to divergence even if  $\beta < 0$ .

<sup>5</sup>As pointed out by Acharya et al. (2007), the frontier is estimated with an error, and hence there is an attenuation bias in estimating convergence. This works against finding an effect and hence what we see in the data should be interpreted as a lower bound for the true effect. In addition, as shown by Jagannathan and Ma (2003) in the context of mean-variance allocation, imposing non-negative constraints significantly reduces the impact of estimation error.

trends (like the "Great Moderation") and unobservable country-specific time-invariant institutional influences, and isolate the within-country effect of financial development.

The relationship between financial market size and diversification is illustrated in Figure V, which plots the reduction in distance to the optimal diversification benchmark over the sample period (calculated using data at the 2-digit level of disaggregation) against initial ratio of private credit to GDP for the cross section of OECD countries. Clearly, the correlation is strongly positive. Countries with initially more efficient credit markets - typically Anglo-Saxon - experience a larger reduction between actual and optimal diversification over the past 40 years than less financially developed countries (typically Mediterranean and transition economies). 12% of the cross-country variation in the speed of convergence to the diversification benchmark is explained by the size of financial markets.

Next, we perform the same test on the country-sector level disaggregated data, and define  $D_{c,s,t}$  as in Equation (5) above. This allows us to directly look into the issue of reallocation and examine which sectors move faster to their implied optimal weight following financial development. Formally, we estimate the convergence equation

$$D_{c,s,t} = \alpha D_{c,s,t-1} + \beta D_{c,s,t-1} \cdot Finance_{c,t} + \gamma Finance_{c,t} + \delta_c \cdot \phi_s + \eta_t + \varepsilon_{c,s,t} \quad (7)$$

As in the previous specification, the inclusion of country, sector, and year fixed effects allow us to purge our estimates from the effect of unobservable global trends and unobservable industry and institutional influences, and isolate the within-country-by-sector effect of financial development. Equation (7) estimates whether financial development accelerates the reallocation across sectors within a country in the direction of the implied optimal sectoral shares in this country. In comparison, while Equation (6) is a test of convergence of country-level aggregates towards the optimal diversification benchmark, Equation (7) estimates reallocation across sectors in the direction of the optimal weights.

We address the issue of the endogeneity of financial development in two alternative ways. First,

we replace our volume measures of finance with dummies equal to 1 after the year in which domestic financial markets were liberalized. It is commonly believed that policy decisions are more exogenous than volume measures of finance (Bekaert et al. [2005]). Second, we employ the Rajan and Zingales (1998) approach of interacting our measure of finance with a measure of each sector's natural characteristic, in this case, long-term industry-level benchmark Sharpe ratio, and benchmark share of small/young firms. By identifying one channel via which finance should speed convergence - that is, more so for sectors which naturally offer lower risk for the same level of return, and which are naturally more sensitive to external finance - we aim to purge the possible bias in our estimates induced by simultaneity.

Finally, we repeat our main exercise on aggregate euro zone data for the 1991-2007 period (due to the unification of Germany in 1991, prior data cannot be used). This gives us two additional insights. First, it allows us to ask whether the effect of finance on convergence holds in larger economic zones, given that a country might not be the most suitable unit of observation when studying diversification and allocation across industrial sectors. For example, Krugman (1991) points out that demand linkages and costly trade will rather lead to sectoral specialization not within one U.S. state, but between, for example, the East Coast and the U.S. mainland. The European analog of this argument would be differences in specialization patterns between the industrialized North and the agricultural South. Second, it allows us to instrument euro zone credit with an indicator variable equal to 1 after 1999, the year of the introduction of the euro. While the euro might not be such a good instrument for credit market development because it may also affect convergence through increased trade and reduced exchange rate risk, this exercise still allows us to address the endogeneity of financial market development from another angle.

### *III.C. Data*

Our main data on nominal value added - which we deflate to get real values - come from the STAN Database for Structural Analysis and cover 28 countries over the period 1970-2007<sup>6</sup>. The

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<sup>6</sup>For 6 countries - Czech Republic, Germany, Hungary, Poland, Slovakia, and Switzerland - coverage only starts



data are decomposed alternatively into 9 SIC 1-digit and 20 SIC 2-digit sectors. While it would seem natural to only focus on the finer disaggregation, as with 9 industries we lose substantial sectoral variation, disaggregating the data by SIC 1-digit industries serves two important purposes. For one, we thus make sure that we do not include sectors with negligible output share in the calculation of the diversification benchmark. Second, given the dimensionality restrictions involved, we are unable to construct diversification benchmarks for countries for which data start after 1987 if we only have the set of 20 2-digit industries. It is also worth noting that if anything, aggregation into a set of so coarsely defined industrial sectors makes it harder rather than easier to detect an effect of finance on the reallocation of resources across economic activities.

Two data clarifications are in order. First, disaggregated data tend to be arbitrary in the sense that some economic activities are classified more coarsely than others. If data on one type of economic activity are consistently collected in a more disaggregated fashion, convergence to the mean-variance efficiency frontier may emerge as a mechanical property of that process (Acharya et al. [2007]). We address this issue by employing data at different levels of disaggregation; however, given the dimensionality limitation imposed in calculating the mean-variance efficiency frontier, which requires that the number of years in the data exceeds the number of sectors, we resort to using the data at the SIC 1-digit and OECD 2-digit aggregation. Second, while the UNIDO has been the preferred dataset in the finance and growth literature, it only includes data on the manufacturing sector, and so STAN is more suited to studying optimal reallocation in the context of the major shift during the sample period from manufacturing towards services, for example.

The financial variables used in this paper come from two different sources. The main measure of financial markets development is  $\text{PRIVATE CREDIT} / \text{GDP}$ . What goes into the numerator is the value of total credits by financial intermediaries to the private sector (lines 22d and 42d in the International Financial Statistics), and so this measure excludes credits issued by the central banks. The reason for this exclusion is that in many cases it is likely to be determined by political

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in the early 1990s - see Table 1 for details.

rather than economic considerations. It also excludes credit to the public sector and cross claims of one group of intermediaries on another. Finally, it counts credit from all financial institutions rather than only deposit money banks. The data on this variable come from Beck et al. (2010) and are available for all 28 countries in the data set between 1970 and 2007.

While the main measure of domestic financial development considered in the paper is ubiquitous in empirical research, it is intrinsically likely to contain measurement error. For one, it is difficult to capture all aspects of financial development in one empirical proxy. Second, there are idiosyncratic differences across countries in the availability of unobservable sources of working capital, such as trade credit or family ownership. To confront these issues, we use in robustness tests data on equity market size (STOCK MARKET CAPITALIZATION / GDP), bond market size (PRIVATE + PUBLIC BOND CAPITALIZATION / GDP), as well as various measures of financial integration.

We also address the issue of the endogeneity of any volume measure of finance to economic development by employing a *de jure* measure of financial development in addition to the *de facto* one. In practice, we replace PRIVATE CREDIT / GDP with information on banking sector liberalization dates. This alternative indicator is constructed by assigning a value of 0 for the years in which the country's domestic credit market was not liberalized, and 1 for the years after it became liberalized. The indicator comes from Bekaert et al. (2005).

Table I summarizes the sectoral data, for both the SIC 1-digit and the OECD 2-digit classification used, along with initial date for which the sectoral data are available. Table II summarizes the data on both the *de facto* and the *de jure* measures of credit market development.

## IV. Empirical Results

This section is split into four subsections. The first (IV.A) investigates the effect of finance on diversification. The second (IV.B) addresses various simultaneity issues associated with faster convergence to the diversification benchmark. The third (IV.C) compares the effect of finance on

our optimal diversification benchmark and its effect on a number of "naive" measures of diversification. The fourth (IV.D) studies whether the main findings are affected by accounting for other characteristics of the business environment, by the choice of proxy for financial development, and by the choice of unit of observation.

#### *IV.A. Finance and Diversification*

The first empirical question addressed in this paper is whether finance accelerates the country's convergence to our diversification benchmark implied by its sectoral long-term growth, volatility of growth, and growth correlations across sectors. We study this effect in Panel A of Table III. Columns (1) and (3) report the estimates of Equation (6) for the 1- and 2-digit data, respectively. Only the countries for which the time dimension of the data is at least as large as the sectoral dimension are used to calculate distances to frontier; for the rest the variance-covariance matrix is singular.<sup>7</sup> The estimate of the direct auto-regressive coefficient on distance to frontier so defined,  $\alpha$ , implies a yearly reduction of between 5.5% and 9.5% in our sample. Importantly, the effect of finance interacts negatively with distance as implied by the estimate of the coefficient  $\beta$ . Therefore, our estimates suggest that financial development has a positive effect on the speed with which countries converge to their efficiency frontier. Numerically, a two-standard deviation increase in financial development results in a speed of convergence to the frontier by higher by about 3.5% annually. The magnitudes of the effect are roughly similar across 1-digit and 2-digit disaggregation of the data, and equally significant.

One immediate caveat is that our diversification benchmark itself may have been affected by financial development. If finance affects both growth and volatility, as the literature on finance and growth has argued, then initial financial underdevelopment will result in artificially low early growth and high early volatility. Structural breaks in financial development, therefore, will remove constraints to growth and lower volatility, and that would effectively contaminate our long-term

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<sup>7</sup>This results in the exclusion of the Czech Republic, Germany, Hungary, Poland, Slovakia, and Switzerland from the exercise on the 2-digit data, as for all 6 countries there are less than 20 years of data available.

benchmark. One solution is to calculate a "clean" frontier in which long-term growth, volatility, and growth correlations have not been affected by finance mid-cycle. In Columns (2) and (4) we do so by estimating Equation (6) on a restricted sample of countries which liberalized domestic credit markets before the beginning of the sample period. In that way we make sure that we are measuring convergence to an allocative efficiency benchmark based on unconstrained long-term growth and volatility, and not to one contaminated by the initial underdevelopment of financial markets. The statistical significance of our estimates remains unchanged, and the economic meaning of the coefficients is if anything higher than implied by the estimates on the full sample.

We next use the disaggregated nature of our data to study the effect of finance on the difference between actual and optimal output shares for each country-sector. This procedure is aimed at giving us a better idea of which sectors are primarily responsible for the speed of the convergence to a country-wide allocative efficiency frontier. For a start, we find that 6 sectors in the SIC 1-digit industrial classification account for 95% of the share of output in the "optimal" sectoral portfolio implied by long-term growth and volatility of growth. The sectors with the biggest weight in the optimal portfolio are Community, social and personal services (32.3% in the SIC 1-digit case); Finance, insurance, real estate and business services (26.7% in the SIC 1-digit case); and Transport, storage and communication (14% in the SIC 1-digit case). The former two sectors of the last group also exhibit the biggest difference between actual and optimal share, 21.4% and 18.5% on average across countries and time, with their optimal share being higher than their actual one. On the other side of the spectrum, our estimates imply that on average, the actual share of manufacturing is higher than the optimal one by 14.5%. This suggests that in a sample of industrialized countries at least, there is "too much" manufacturing across the board given the optimal share of manufacturing implied by our benchmark calculations.

Panel B of Table III reports the estimates of Equation (7). We essentially repeat the same procedure from the country tests: in Columns (1) and (3), we use the full sample of countries, and in Columns (2) and (4) we exclude countries which liberalized domestic credit markets dur-

ing the sample period. The regressions include time dummies to account for shifts associated with global unobservables, like the "Great moderation", for example. They also include a set of country-industry interaction dummies to account for the fact that low-volatility sectors may be a superior good (Koren and Terneyro [2007]). The effect of private credit on convergence survives the disaggregation. In this specification, we estimate that a two standard deviation increase in our proxy for financial market development accelerates the speed of convergence by about 1.5% annually.

In Table IV we repeat the empirical exercises from Table 3 using a GMM Arellano-Bond (1991) estimator rather than a OLS procedure. We do so in order to account for the presence of a lagged dependent variable in dynamic panel data. In unreported regressions, we also estimate the GMM estimator introduced by Blundell and Bond (1998) which corrects for the bias arising in fixed effects estimations in dynamic models. This correction is standard in panel estimation of the finance and growth nexus (e.g., Acharya et al. [2007] and Bonfiglioli [2008]). Our results continue to hold.

In all, Tables III and IV imply that part of the effect of finance is a re-structuring of output away from sectors with low optimal and high actual weight towards sectors with high optimal and low actual weight. This might be happening because the former have a negative long-term Sharpe ratio and so have to gradually disappear from an efficient portfolio. Hence, we partially capture the effect of finance on the natural disappearance of obsolete sectors. In theory it could be that the total effect depends on initial conditions, and so the overall effect of finance is confounded by a very inefficient initial sectoral allocation, limiting the effect of diversification as in Acemoglu and Zilibotti (1997). The effect of finance could also be confounded by other political economy forces, for instance, large inefficient sectors might be using lobbying tools to acquire government resources and continue existing while their implied weight might be zero. We investigate these possibilities later on.

It is important to point out that finance has a direct positive and statistically significant effect on the distance (for example, estimate of 0.002 in Column 1 of Table III, Panel B). This implies that close to the frontier, more finance is associated with a divergence rather than convergence to the frontier.<sup>8</sup>

#### *IV.B. Endogeneity of Finance*

We have so far established a positive correlation between financial development and convergence to an optimal diversification benchmark defined in the sense of mean-variance efficiency. However, the question of causality has been left largely unanswered. Given the evidence so far, the argument can still be made that financial development has simply increased in the wake of faster diversification, in itself driven by factors unobservable to the econometrician. For example, the observed pattern could be due to the fact that more optimally diversified economies consist of large capital-intensive sector, and so a large financial industry emerges to serve those. Alternatively, unobservable factors like entrepreneurial culture and propensity to save might be driving both the size of financial markets and diversification patterns. In this subsection, we describe how we deal with these issues.

##### *IV.B.1. The Nature of Reallocation*

We first address the issue of omitted variable bias by employing the methodology first introduced by Rajan and Zingales (1998). They document the significance of the interaction term between a country-level characteristic of financial development and an industry-level characteristic of financial dependence. The innovation of the method is in that they use a U.S. benchmark to construct an exogenous measure of financial dependence in their sample of countries which excludes the U.S. This empirical strategy alleviates concerns about the ability of financial development to anticipated growth. It also addresses questions about the joint determination of financial development and growth by a third, unobservable factor.

One natural channel via which we expect finance to exert a causal effect on convergence to frontier is the technological risk-adjusted growth of the sector. Movement towards the frontier is

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<sup>8</sup>However, that point is quite close to the frontier. For example, for the sample mean value of private credit to GDP, the distance beyond which more finance leads to divergence is 0.0024 in the MVE metric, a value attained by 1.7% of the country-sector-time observations in our sample.



associated with an increase in the Sharpe ratio<sup>9</sup> of the portfolio via reduction of volatility for the same level of return, or alternatively, an increase in return for the same level of volatility. Financial markets are looking for the best investment opportunities in terms of risk-adjusted growth. Therefore, the effect of financial development on sectoral reallocation within the portfolio of industrial sectors should work faster for those sectors that exhibit the highest Sharpe ratio for technological reasons. For instance, if the communications sector offers the lowest volatility for the same return, then finance will be expected to reallocate resources towards that sector faster than for sectors with lower Sharpe ratio (controlling for cross-sectoral growth correlations and for initial distance).<sup>10</sup>

Another sectoral characteristic, exploited widely in related literature, is a sector's natural dependence on external finance. If financial underdevelopment affects the allocation of output across business activities, that limitation will likely be most severe in sectors which naturally rely on external finance. Such sectors will likely have a high share of small as well as young firms (e.g., Aghion et al. [2007] and Acharya et al. [2007]). The share of small/young firms will therefore be a good proxy for the natural external finance need of the sector.

We investigate this channel in Table V. Of course, using the sectors' country-specific Sharpe ratios and share of young/small firms would make the estimation prone to the same endogeneity concerns as before. For that reason, we follow Rajan and Zingales (1998) and compute the Sharpe ratio for each of the 9 SIC 1-digit sectors and 20 OECD 2-digit sectors in the U.S. In addition, we instrument the U.S. industry-level Sharpe ratio with the predicted sample one interacted with U.S. average financial development (Ciccone and Papaioanou [2006]). This gives a measure of what the median sample risk-adjusted growth would be if it was observed in a country with the U.S. level of financial development. This approach addresses one of the main criticisms against the Rajan and Zingales methodology, namely that it uses a benchmark extracted from a specific industrial composition and thus a noisy measure of "true" risk-adjusted growth. Regarding the share of young

<sup>9</sup>The Sharpe ratio is defined as the sector's long-term growth rate divided by the standard deviation of the sector's long-term growth rate.

<sup>10</sup>The idea is similar to Wurgler (2000). However, he looks at growth only and doesn't take into account the growth volatility of the sectors.

firms, we calculate it for each sector using data from the Dun and Bradstreet database, averaged for the 1985-1995 period, and again instrument it for with the sample measure of that share, using data from Amadeus, interacted with the U.S. measure of financial development. Then, we interact these two industry benchmarks with the interaction term in Equation (7), and exclude the U.S. from the regressions that follow.

The estimates confirm the effect that we already found in Tables III and IV when we use the industries' "natural" long-term Sharpe ratios, for data at the 1-digit (Column (1)) and 2-digit (Column (3)) level of disaggregation. Namely, financial development as proxied by PRIVATE CREDIT / GDP increases the speed with which sectors' shares converge to the benchmark implied by mean-variance efficiency, and this effect is stronger for sectors that naturally have higher Sharpe ratios. The exact same results are obtained when we differentiate by the share of young firms (Column (2) for 1-digit and Column (4) for 2-digit data): sectors with a higher share of young firms (presumably, sectors with higher natural information frictions, which finance should affect more strongly) see a faster reallocation following financial development.

It should be noted that each sector's benchmark Sharpe ratio is measured for the same time period used for the sample countries - namely, a full 38 years. The first reason for doing so is that we want to calculate "natural" volatility over a relatively long period of time. The second reason is that we think of the US benchmark over the 1970-2007 period as a global ex-ante one given the technological opportunities of that sector. Then the question becomes one of how financial development affects sectoral reallocation given the *potential long-term* performance of the countries' sectors.

#### IV.B.2. Reversed Causality

We now proceed to address the issue of reversed causality. For example, countries that diversify faster may demand larger financial sectors if they derive a larger share of economic output from more capital intensive industries. For that reason, in Table VI, we account for the endogeneity of finance in an alternative fashion. Namely, we replace our preferred measure of financial devel-

opment with liberalization dates of domestic credit markets, as per Table II. We do so both for sectoral data at the 1-digit (Column (1)) and 2-digit (Column (3)) level of disaggregation. Although the argument has sometimes been made that liberalization may be endogenous as policy makers may be undertaking it at the times when the country is starting on the path of higher growth<sup>11</sup>, a policy measure is more exogenous to growth opportunities than the volumes measures we have used so far. Hence, we replace the financial proxy in Equation (7) with a dummy variable equal to 1 after the year in the country liberalized its credit markets. We continue to measure a positive effect of credit markets on the speed of convergence.<sup>12</sup>

Another issue with our tests so far is that the financial sector is included both in the left-hand side and the right-hand side of the estimation equation. To address this concern, in Columns (2) and (4) of Table VI we exclude the sector "Finance, insurance, real estate and business services" and "Financial intermediation" from the main tests using the data disaggregated at the SIC 1-digit and the OECD 2-digit level, respectively. As explained before, our previous results might be biased by the fact that the proxies for financial development we use increase simultaneously alongside the share of financial services on the left-hand side. The effect of credit market development, however, survives this procedure, with a largely undiminished magnitude.

Taken together, these tests point to the fact that the endogeneity of the volume measures of finance used so far may be inducing attenuation bias in our estimations, while the inclusion of the financial sector may be biasing the results upwards. In all, our measures of credit markets development continues to affect strongly the speed of convergence to the diversification benchmark in all tests.

#### *IV.C. Optimal vs. "Naive" Diversification*

The virtue of our measure of "optimal" diversification, based on the concept of mean-variance efficiency, is that it accounts simultaneously for sectoral growth, volatility, and cross-correlations.

<sup>11</sup>See Bekaert et al. (2007) for details.

<sup>12</sup>This result is reminiscent of Bekaert et al. (2007) who find that an exogenous measure of growth opportunities predicts faster growth than the endogenous one.

We now contrast our results with those obtained by assuming away the importance of cross-sector correlations, or of sectoral growth, volatility, and correlations. In the first case, we estimate a benchmark frontier in which all covariance terms are set to zero. This transforms a mean-variance efficiency argument into one in which finance targets sectors based solely on their individual Sharpe ratios. Such a framework fails to explain the full pattern of convergence of sector weights in country-level value added (Table VI, Column (1) of Panels A and B). This implies that the effect of finance on diversification is significant only when the covariance of returns is properly accounted for in an optimal portfolio sense.

More importantly, we contrast our measure of diversification based on allocative efficiency with measures which define diversification as an equal spreading of output across industrial sectors. One such "naive" measure is the Ogive index which is widely used in studies of geographic diversification (e.g., Conroy [1975]). For a set of  $i = 1, \dots, n$  individual sectors with corresponding shares  $s_i$ , the Ogive index is calculated as  $n \sum_{i=1}^n \left(s_i - \frac{1}{n}\right)^2$ . A second such natural measure is the Herfindahl-Hirschman index defined as  $\sum_{i=1}^n s_i^2$ . A third one is the Gini coefficient, defined as  $\frac{1}{2n(n-1)} \sum_{i=1}^n \sum_{j=1}^n |s_i - s_j|$ .<sup>13</sup> All measures are identical in the sense that they constitute a "naive" concept of diversification which ignores any considerations about growth, volatility, and cross-sector correlations.

Columns (2)-(4) of Table VII, Panels A and B, report the results of a set of tests in which the original measure of distance to our diversification benchmark is replaced with each of the "naive" measures of diversification just defined (which can also be understood as distance to an "absolute" diversification benchmark, as all three mechanical measures assign a value of 0 to equally spread output, and a value of 1 to output concentrated in one sector). The results suggest that finance has no significant effect on the speed with which the country allocation of output converges to a benchmark in which output is equally spread across the set of industrial sectors available. And while the coefficient on the measure of diversification implies that diversification increases over time, it does so at a much lower speed than our measure of allocative efficiency, and in the case of

<sup>13</sup>See Imbs and Wacziarg (2003) for details on implementation.

the Gini coefficient, for example, convergence is almost nonexistent.

#### *IV.D. Robustness*

Our empirical methodology so far has been very parsimonious: we have studied the effect of finance on the speed of convergence, accounting for natural convergence, global time trends, and country-industry unobservables. We have also addressed various simultaneity concern to strengthen the causality argument, and shown that finance exhibits no effect on "naive" measures of diversification which ignore the interplay of growth and volatility at the sectoral level. In this section, we perform additional robustness checks addressing the quality of our financial development proxies, alternative characteristics of the business environment, and alternative units of observation.

##### *IV.D.1. Alternative Measures of Financial Development*

So far we have relied exclusively on the time series of the ratio of private credit to GDP to capture the country-specific evolution in financial depth. Given the importance of access to increasingly international capital markets, especially for some industrial sectors, alternative measures of financial development that capture the international supply of capital beg to be considered. In the first two columns of Table VIII, we replace our proxy for financial depth with measures of stock and bond market capitalization to GDP. (For the sake of brevity, we do so only for country-industry distances to our diversification benchmark). The gist of the results remains unchanged (albeit the magnitude of the effects decreases and the statistical significance of the results is weakened): deeper financial markets are associated with faster convergence to frontier.

Next, we pay explicit attention to the fact that countries can also diversify abroad, both in terms of direct and portfolio investment, and this is likely to be especially important for small, open economies. While we have made it impossible for economies to "short" a sector by construction, we can still look at the financial side of cross-border diversification. In Columns (3)-(4) of Table VIII, we control for trade openness (using the ratio of exports plus imports to GDP), for integration in international financial markets (by using the ratio of total foreign assets and liabilities to GDP),

and for the share of net foreign assets to GDP in the country. All of these alternative measures of finance turn out to be significant in at least one specification and level of data disaggregation, and the sign of the estimates implies that they affect convergence in the same direction as credit market development. One can therefore confirm that measures of financial depth seem to affect the speed of convergence to allocative efficiency frontier alongside measures of international financial integration.

Finally, our data allow us to pay specific attention to financial services as a productive sector of the economy. In particular, some countries may have a comparative advantage in financial services due to specialization in a particular type of human capital, or due to early specialization in banking activities. One way to exploit this possibility is to test whether countries with initially relatively large financial sectors have different diversification paths than countries with initially relatively small financial sectors. We perform our main tests on these two sub-samples of countries, and report the results in Columns (5) and (6). The estimates imply that deeper financial markets speed up convergence to allocative efficiency frontier for both types of countries, however, the gain in speed of convergence is relatively higher for countries which initially specialized to a lower degree in financial services.

#### IV.D.2. Finance, Law, and Regulation

Another important issue to address is that finance may simply be proxying for other characteristics of the business environment. In particular, GDP growth rates tend to be positively related to a wide array of institutional factors (Barro [1991]) which tend to be correlated. For example, financially more developed countries tend to have better institutions, less rigid regulation of businesses, and better protection of investors and enforcement of contracts. To the extent that the degree of development tends to be similar across most dimensions of financial, regulatory, and legal development, those could all be capturing similar aspects of a favorable business environment. We therefore consider the effects of barriers to entry, investor protection, and contract enforcement on convergence to the diversification benchmark.



The reason we focus on these three dimensions of the business environment is that they have been found to explain variations in industry growth in previous studies. For example, Klapper et al. (2006) show that entry barriers are associated with lower firm entry in industries characterized by higher business churn. Entry barriers could thus result in slower convergence to the diversification benchmark if the industries with the highest optimal share are the naturally highest-entry ones. Djankov et al. (2008) show that a stricter enforcement of minority shareholders' rights results in a more dynamic economy, as measured by the number of active firms per population. To the extent that the number of active firms is a proxy for the optimal utilization of growth opportunities, low degree of investment protection may be hampering convergence to the optimal diversification benchmark by constraining industry growth. Finally, insufficient contract enforcement is argued to have been the main culprit in various countries' observed long-term decline (e.g., Clague et al. [1999]).

In Table IX, we repeat our previous estimations at the country and country-industry level in a horse race in which interactions of last period's distance to optimally diversified benchmark with the respective characteristic of the business environment have been included in the model. Data on entry barriers (number of days it takes to register a new business), investor protection (composite of transparency of transactions, liability for self-dealing, and shareholders' ability to sue officers and directors for misconduct), and contract enforcement (number of days it takes to resolve a contractual dispute in court) come from the Doing Business Database of the World Bank, and are averaged over the longest available period. We perform the analysis both at the country (Panel A) and industry (Panel B) level, as well as both on the 1-digit (Columns (1) and (2)) and 2-digit (Columns (3) and (4)) data. We find that industries converge more slowly to their optimal share in countries where it takes longer to register a business. We also find that better investor protection accelerates convergence to frontier. Finally, convergence is slower in countries where it takes longer to resolve contractual disagreements. The sum of these results suggests that legal and regulatory obstacles can slow down convergence to an allocative efficiency frontier - for example, by increasing

the marginal cost of investing in opaque high-growth sectors. Importantly, the effect of finance we observed in previous regressions survives this robustness exercise. It also holds when we exclude the countries which liberalized domestic credit markets during the sample period which may have induced a structural break in the MVE frontier (Columns (2) and (4)).

#### IV.D.3. Stages of Diversification

In Table X, we test how financial depth affects diversification for different initial stages of diversification. Imbs and Wacziarg (2003) show that diversification follows a non-linear pattern over the development cycle, so it is conceivable that our measure of "optimal" diversification will be affected by finance differently at various stages of diversification. We split the countries in subgroups based on initially "low" vs. "high" degree of diversification (essentially - the bottom vs. top half of the distribution of initial distances to the optimally diversified benchmark. Then, we test how credit and equity market development affects the speed of convergence for different degrees of initial diversification. While it is tempting to hypothesize that bank credit is more important at intermediate stages of diversification, while access to equity markets is more important for advanced stages of diversification, we find that bank credit tends to matter for convergence at all stages of diversification, and access to equity markets matters mostly for countries with low initial degree of diversification.

#### IV.D.4. Finance and Diversification: Larger Economic Zones

One final critical question to our approach is whether a national economy is a proper unit of observation. The literature on the geographic agglomeration of economic activity, pioneered by Krugman (1991), points out that demand linkages and costly trade will rather lead to sectoral specialization not within one U.S. state, but between, for example, the East Coast and the U.S. mainland. Kalemli-Ozcan et al. (2010) also emphasize that the euro area might be a more appropriate unit of observation to study intersectoral allocation than an individual euro area member country. In that sense, that the German region of Bavaria specializes in car production and the

German region of Rhineland specializes in wine production might be less important than the fact that Germany has a relatively large automobile industry while Portugal has a relatively large wine industry.

Our framework allows for an immediate test of this hypothesis. In Table XI, we report the estimates from revised versions of previous regressions where we have calculated distance to our diversification benchmark using aggregate sectoral data for the euro area starting in 1991<sup>14</sup>, and our main measure of finance is now the aggregate credit-to-GDP ratio for all euro area countries for each year starting in 1991. Given that we only have 17 years of observations, we only use disaggregation at the 1-digit SIC industry level to calculate the efficient frontier. Across the board of empirical tests, we confirm that deeper credit markets are associated with a faster convergence to an allocative efficiency frontier. As before, we use OLS and a GMM procedures (Columns (1) and (2), respectively), we account for "natural" industry characteristics, like information frictions and "natural" risk-adjusted growth (Columns (3) and (4), respectively), and we exclude the financial sector from the exercises (Column (5)). We also use the introduction of the euro in 1999 as an instrument for financial development (Column (6)). While the validity restriction is undoubtedly satisfied, the argument can be made that the introduction of the euro in 1999 may have shifted the frontier by allowing faster reallocation along other dimensions, like trade and the reduction of exchange rate risk, which invalidates the exclusion restriction. Therefore, this final test should be interpreted with caution.

## V. Conclusion

In this paper, we study whether international differences in financial market depth can be mapped into country variations in sectoral diversification. We construct a benchmark measure of diversification as the set of allocations of aggregate output across industrial sectors which minimize

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<sup>14</sup>The unification in 1991 of the largest economy in the euro zone, Germany, makes it impossible to use pre-1991 data.

the economy's long-term volatility for a given level of long-term growth. Our main finding is that more developed credit markets are associated with faster convergence to such an optimally diversified benchmark. We argue that overall economic efficiency is improved not just via the increase in size of high-growth sectors, but also via overall reduced volatility. Second, our allocative efficiency framework differs from "naive" measures of diversification derived from the relative size of any particular sector. Hence, our results do not imply that finance pushes countries to diversify away from their comparative advantage. What they do imply is that efficient financial markets reallocate investment in a way which takes into account both comparative advantage in terms of growth, and diversification in the sense of an overall volatility-minimizing portfolio. Finally, regulatory and legal institutions also contribute to this process of convergence without diminishing the independent role of finance. While parsimonious, our empirical strategy makes us fairly certain that our findings are not driven by left-out variable bias, the endogeneity of financial development, or global volatility-reducing reallocation effects, like the "Great Moderation". What theories are more relevant in explaining our results, and whether these results will stand the test of dynamic measures of allocative efficiency incorporating the idea of expanding technological frontiers *a la* Acemoglu et al. (2006) present themselves as exciting avenues of future research.

## References

- [1] Acemoglu, D., and F. Zilibotti, 1997. Was Prometheus unbound by chance? Risk, diversification, and growth. *Journal of Political Economy* 105, 709-751.
- [2] Acemoglu, D., Aghion, P., and F. Zilibotti, 2006. Distance to frontier, selection, and economic growth. *Journal of the European Economic Association* 4, 37-74.
- [3] Acharya, V., Imbs, J., and J. Sturgess, 2007. Finance and efficiency: Do bank branching regulations matter? CEPR Discussion Papers 6202, C.E.P.R. Discussion Papers.
- [4] Aghion, P., Fally, T., and S. Scarpetta, 2007. Credit constraints as a barrier to the entry and post-entry growth of firms. *Economic Policy* 22/52, 731-779.
- [5] Aiyagari, R., 1994. Uninsured idiosyncratic risk and aggregate saving. *The Quarterly Journal of Economics* 109, 659-684.
- [6] Arellano, M., and S. Bond, 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies* 58, 277-297.
- [7] Barro, R., 1991. Economic growth in a cross section of countries. *The Quarterly Journal of Economics* 106, 407-443.
- [8] Beck, T., Levine, R., and N. Loayza, 2000. Finance and the sources of growth. *Journal of Financial Economics* 58, 261-300.
- [9] Beck, T., Demirguc-Kunt, A., Levine, R., and V. Maksimovic, 2001. Financial structure and economic development: Firm, industry, and country evidence, in *Financial Structure and Economic Growth: A Cross-Country Comparison of Banks, Markets, and Development*, eds., Asli Demirguc-Kunt and Ross Levine (MIT Press, Cambridge, MA).

- [10] Beck, T., and R. Levine, 2002. Industry growth and capital allocation: Does having a market- or bank-based system matter? *Journal of Financial Economics* 64, 147-180.
- [11] Beck, T., and R. Levine, 2004. Stock markets, banks, and growth: Panel evidence. *Journal of Banking and Finance* 28, 423-442.
- [12] Beck, T., Lundberg, M., and G. Majnoni, 2006. Financial intermediary development and growth volatility: Do intermediaries dampen or magnify shocks? *Journal of International Money and Finance* 25, 1146-1167.
- [13] Beck, T., Demirgüç-Kunt, A., and R. Levine, 2010. A new database on financial development and structure. *World Bank Economic Review* 14, 597-605.
- [14] Bekaert, G. Harvey, C., and C. Lundblad, 2005. Does financial liberalization spur growth? *Journal of Financial Economics* 77, 3-55.
- [15] Bekaert, G. Harvey, C., and C. Lundblad, 2006. Growth volatility and financial liberalization. *Journal of International Money and Finance* 25, 370-403.
- [16] Bekaert, G., Harvey, C., Lundblad, C., and S. Siegel, 2007. Global growth opportunities and market integration. *Journal of Finance* 62, 1081-1137.
- [17] Blundell, R., and S. Bond, 1998. Initial conditions and model restrictions in dynamic panel data models. *Journal of Econometrics* 87, 115-143.
- [18] Bonfiglioli, A., 2008. Financial integration, productivity and capital accumulation. *Journal of International Economics* 76, 337-355.
- [19] Carranza, L., and J. Galdon-Sanchez, 2004. Financial intermediation, variability, and the development process. *Journal of Development Economics* 73, 27-54.
- [20] Ciccone, A., and Papaioannou, E., 2006. Adjustment to target capital, finance and growth. CEPR Discussion Papers 5969.

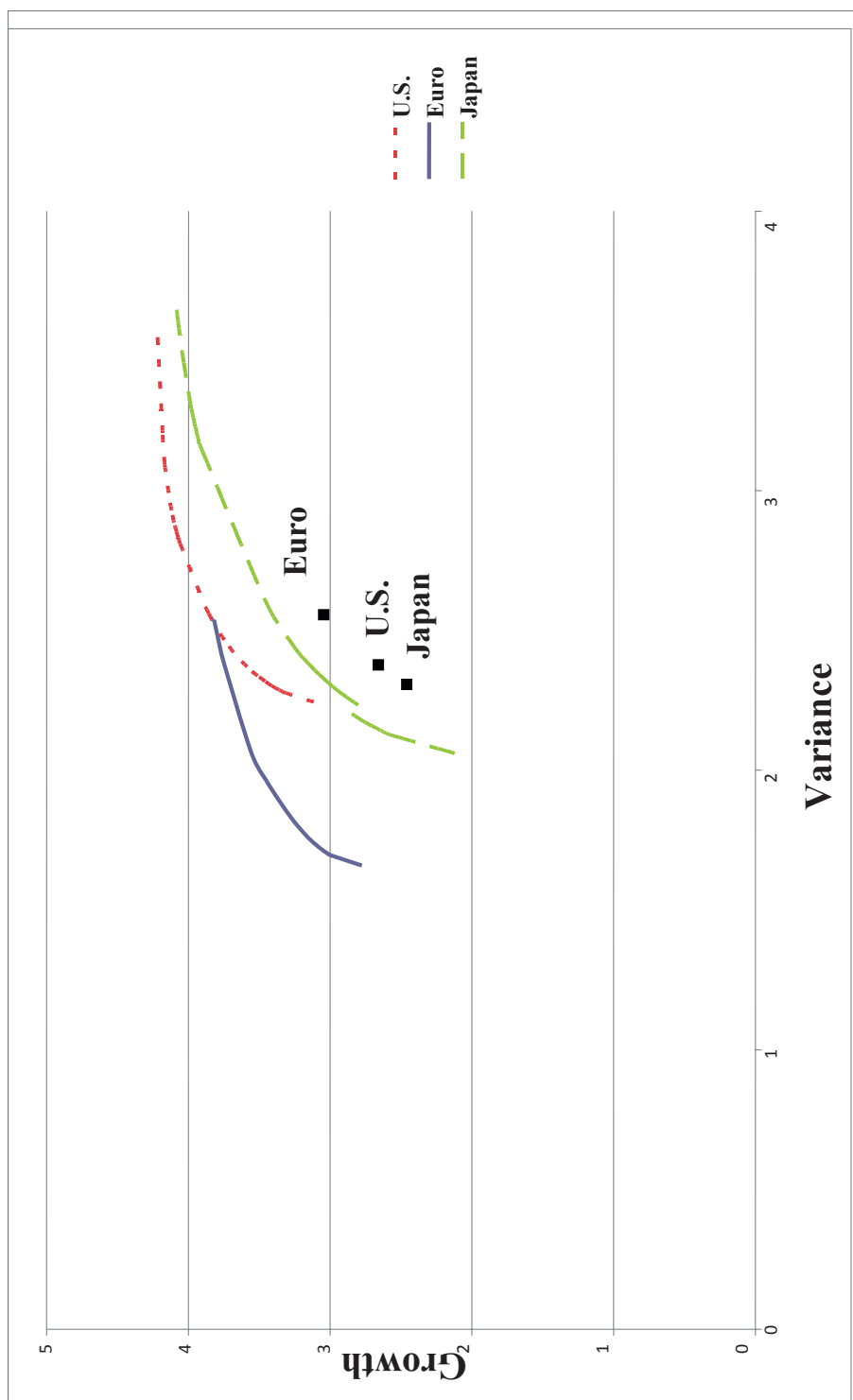
- [21] Clague, C., Keefer, P., Knack, S., and M. Olson, 1999. Contract-intensive money: contract enforcement, property rights, and economic performance. *Journal of Economic Growth* 4, 185-211.
- [22] Conroy, M., 1975. The concept and measurement of regional industrial diversification. *Southern Economic Journal* 41, 492-505.
- [23] Djankov, S., La Porta, R., Lopez-de-Silanes, F., and A. Shleifer, 2008. The law and economics of self-dealing. *Journal of Financial Economics* 88, 430-465.
- [24] Goldsmith, R., 1969. *Financial Structure and Development* (Yale University Press, New Haven, CT).
- [25] Greenwood, J., and Jovanovic, B., 1990. Financial development, growth, and the distribution of income. *Journal of Political Economy* 98, 1076-1107.
- [26] Imbs, J., 2007. Growth and volatility. *Journal of Monetary Economics* 54, 1848-1862.
- [27] Imbs, J., and R. Wacziarg, 2003. Stages of diversification. *American Economic Review* 93, 63-86.
- [28] Jagannathan, R., and T. Ma, 2003. Risk reduction in large portfolios: Why imposing the wrong constraints helps? *Journal of Finance* 55, 1651-1683.
- [29] Kalemli-Ozcan, S., Sorensen, B., and O. Yosha, 2003. Risk sharing and industrial specialization: Regional and international evidence. *American Economic Review* 93, 903-918.
- [30] Kalemli-Ozcan, S., Papaioannou, E., and J.-L. Peydro-Alcalde, 2010. What lies beneath the euro's effect on financial integration? Currency risk, legal harmonization, or trade. *Journal of International Economics* 81, 75-88
- [31] King, R., and R. Levine, 1993. Finance and growth: Schumpeter might be right. *Quarterly Journal of Economics* 108, 717-737.

- [32] Klapper, L., Laeven, L., and R. Rajan, 2006. Entry regulation as a barrier to entrepreneurship. *Journal of Financial Economics* 82, 591-629.
- [33] Koren, M., and S. Terneyro, 2007. Volatility and development. *The Quarterly Journal of Economics* 122, 243-287.
- [34] Krugman, P., 1991. Increasing returns and economic geography. *Journal of Political Economy* 99, 483-499.
- [35] Lane, P., and G. M. Milesi-Ferretti, 2007. The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970-2004. *Journal of International Economics* 73, 223-250.
- [36] Larrain, B., 2006. Do banks affect the level and composition of industrial volatility? *Journal of Finance* 61, 1897-1925.
- [37] Levchenko, A., Ranciere, R., and M. Thoenig, 2009. Growth and risk at the industry level: The real effects of financial liberalization. *Journal of Development Economics* 89, 210-222.
- [38] Levine, R., 2005. Finance and growth: Theory, evidence, and mechanisms, in *The Handbook of Economic Growth*, eds., Philippe Aghion and Steve Durlauf (North-Holland, Amsterdam, Netherlands).
- [39] Levine, R., and S. Zervos, 1998. Stock markets, banks, and economic growth. *American Economic Review* 88, 537-558.
- [40] Markowitz, H., 1952. Portfolio selection. *Journal of Finance* 7, 77-91.
- [41] McKinnon, R., 1973. *Money and Capital in Economic Development* (Brookings Institution, Washington, DC).
- [42] Raddatz, C., 2006. Liquidity needs and vulnerability to financial underdevelopment. *Journal of Financial Economics* 80, 677-722.



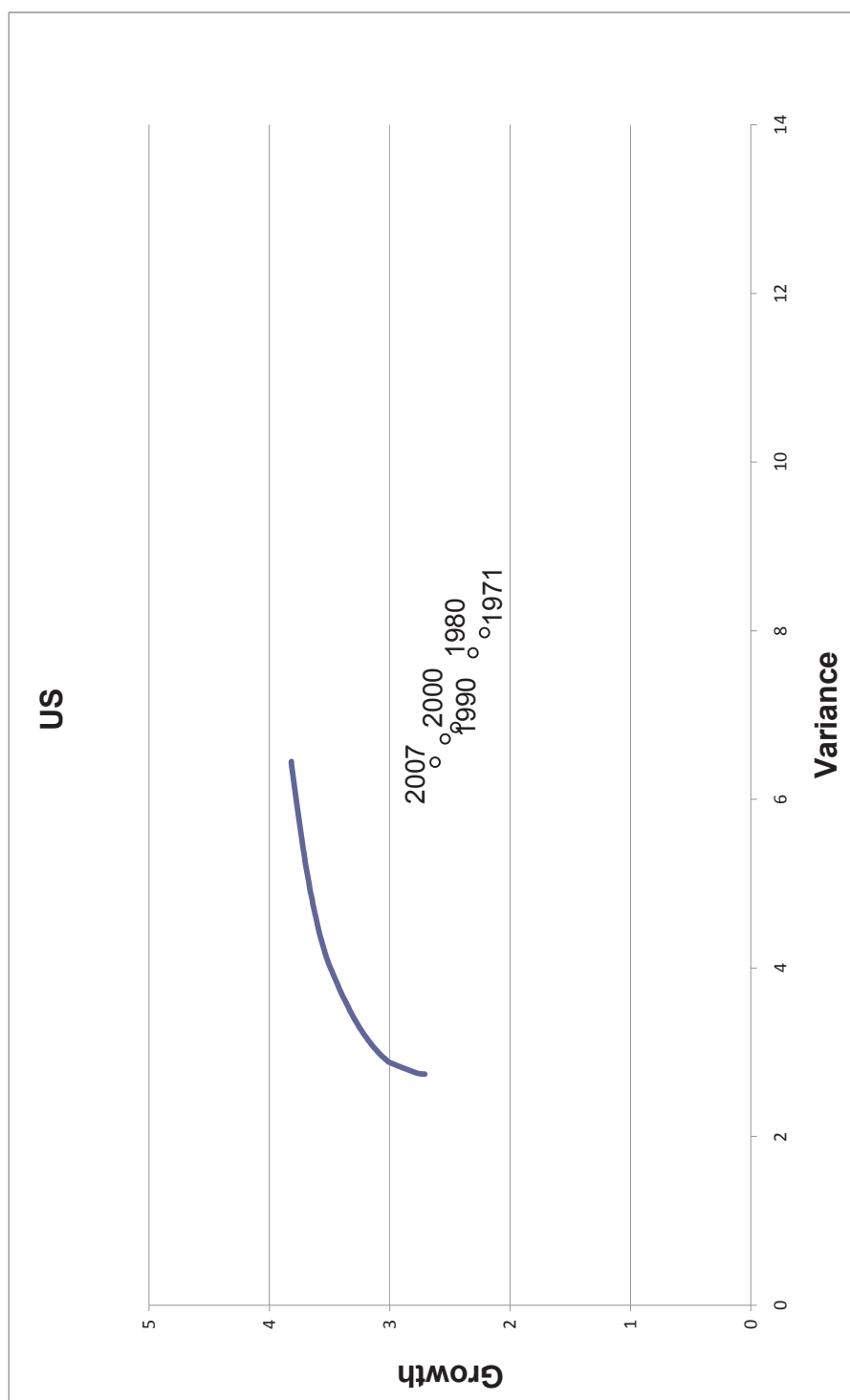
- [43] Rajan, R., and L. Zingales, 1998. Financial dependence and growth. *American Economic Review* 88, 559-586.
- [44] Ramey, G., and V. Ramey, 1995. Cross-country evidence on the link between volatility and growth. *American Economic Review* 85, 1138-1151.
- [45] Schumpeter, J., 1912. *The Theory of Economic Development*, published in 1934 (Harvard University Press, Cambridge, MA).
- [46] Wachtel, Paul, 2001. Growth and finance: What do we know and how do we know it?, *International Finance*, 4(3), 335-362.
- [47] White, H., 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica* 48, 817-838.
- [48] Wurgler, J., 2000. Financial markets and the allocation of capital. *Journal of Financial Economics* 58, 187-214

**Figure I.**  
**Diversification Benchmark and Actual Industrial Composition**



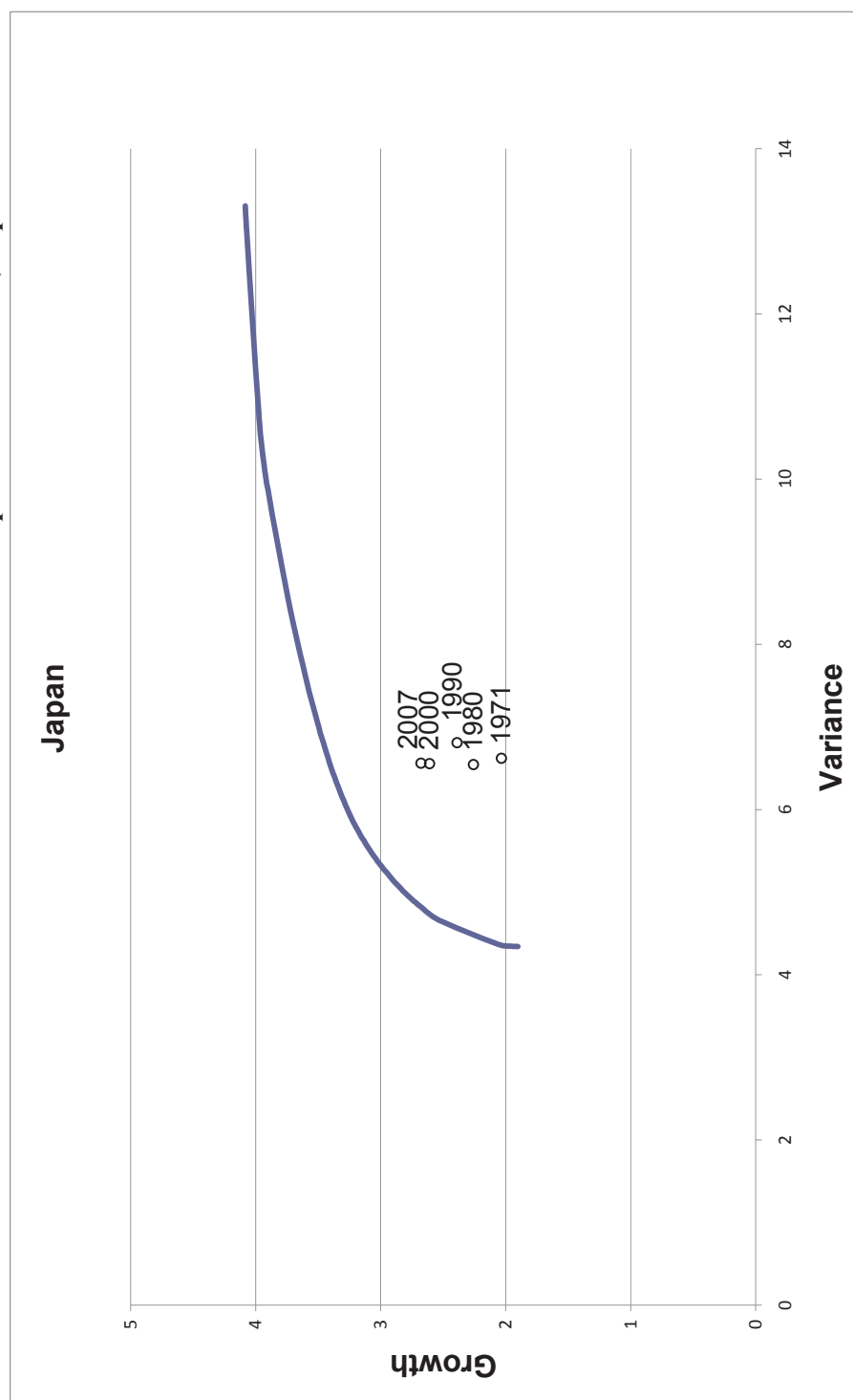
Note: The graph shows the benchmark diversification of industrial output, based on mean-variance efficiency and calculated using the countries' sectors' long-term growth, volatility, and correlations over the sample period, and the average actual realization of industrial output.

**Figure II.**  
**Diversification Benchmark and Actual Industrial Composition over Time, U.S.**



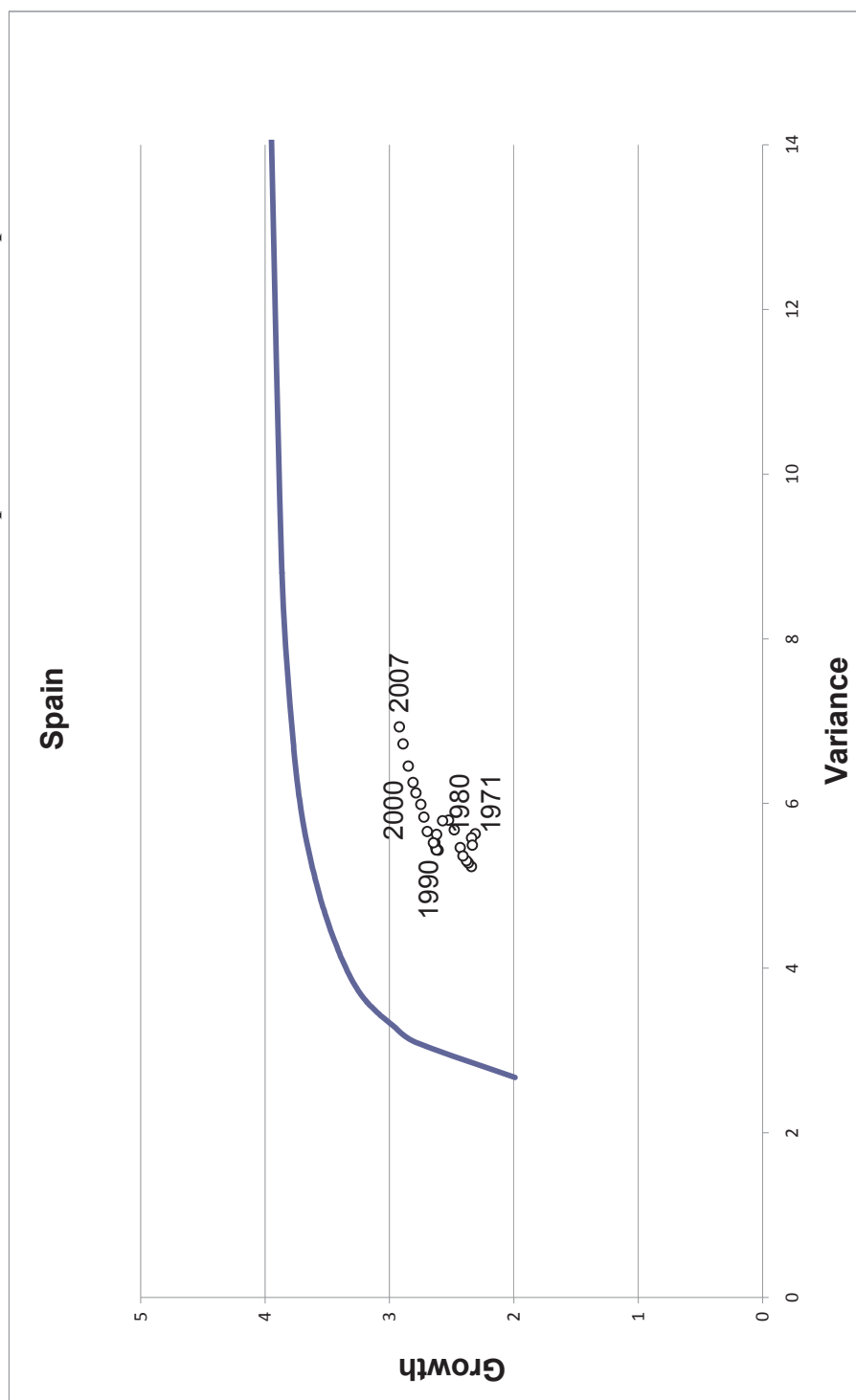
Note: The graph shows the benchmark diversification of industrial output, based on mean-variance efficiency and calculated using the sectors' long-term growth, volatility, and correlations over the sample period, and the evolution of the actual realization of industrial output over the sample period, for the U.S.

**Figure III.**  
**Diversification Benchmark and Actual Industrial Composition over Time, Japan**



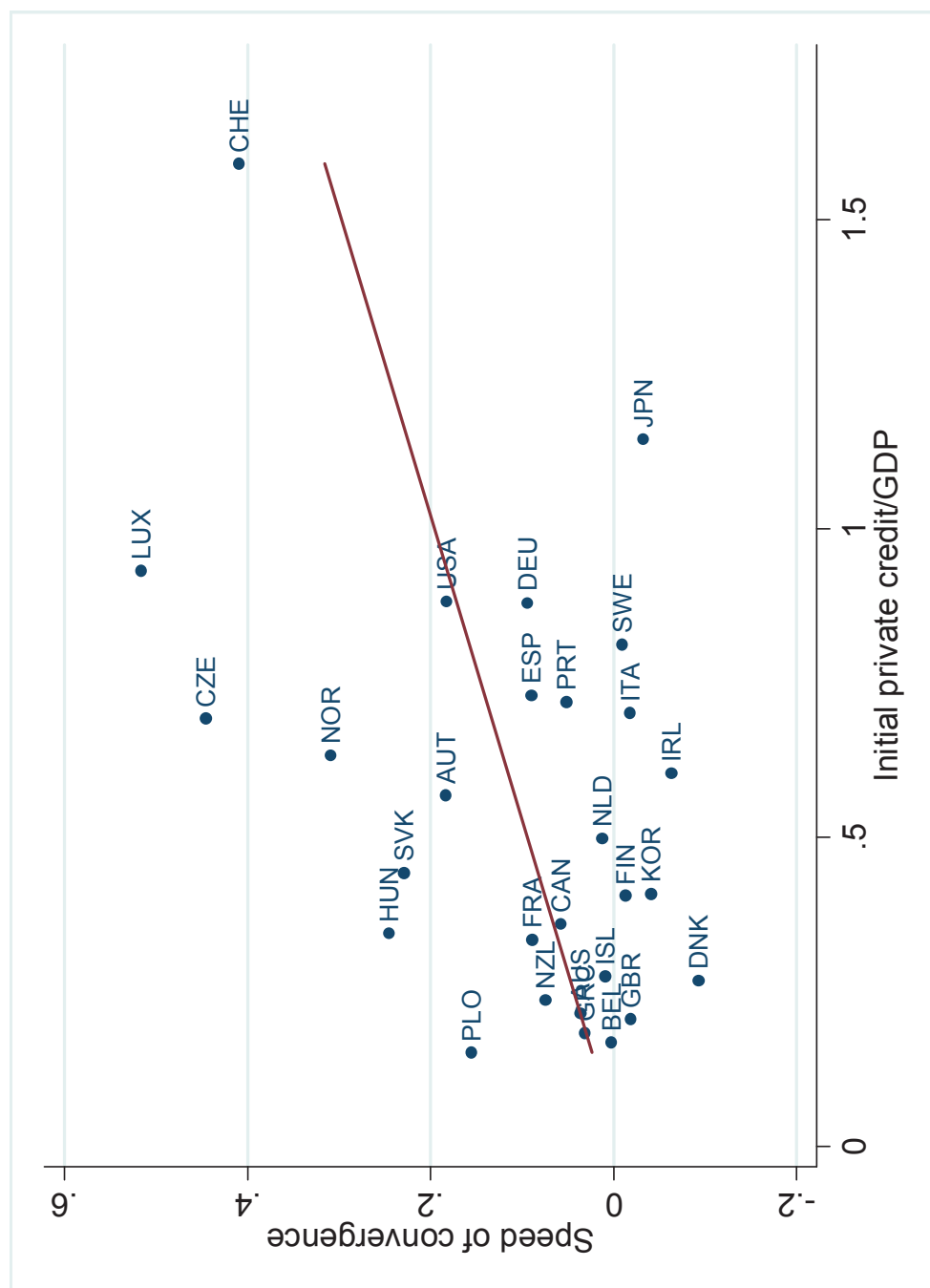
Note: The graph shows the benchmark diversification of industrial output, based on mean-variance efficiency and calculated using the sectors' long-term growth, volatility, and correlations over the sample period, and the evolution of the actual realization of industrial output over the sample period, for Japan.

**Figure IV.**  
**Diversification Benchmark and Actual Industrial Composition over Time, Spain**



Note: The graph shows the benchmark diversification of industrial output, based on mean-variance efficiency and calculated using the sectors' long-term growth, volatility, and correlations over the sample period, and the evolution of the actual realization of industrial output over the sample period, for Spain.

**Figure V.**  
**Speed of Convergence and Initial Private Credit/GDP**



Note: The graph shows each individual country's autoregressive speed of convergence over the sample period to a diversification benchmark based on mean-variance efficiency against beginning-of-sample period private credit to GDP.

**Table I.**  
**Value Added Growth, Volatility, and Distance to Diversification Benchmark**

Country	Average		SIC 1-digit industries		OECD 2-digit industries	
	growth	volatility	Initial distance	Final distance	Initial distance	Final distance
Australia	0.032	0.036	0.332	0.292	0.403	0.304
Austria	0.021	0.018	0.306	0.266	0.354	0.321
Belgium	0.022	0.026	0.541	0.427	0.407	0.347
Canada	0.030	0.035	0.388	0.350	0.341	0.275
Czech Republic	0.020	0.039	0.628	0.617	0.366	0.370
Denmark	0.018	0.024	0.384	0.360	0.350	0.298
Finland	0.029	0.052	0.550	0.533	0.463	0.327
France	0.023	0.025	0.455	0.374	0.298	0.258
Germany	0.006	0.013	0.423	0.377	0.382	0.353
Greece	0.026	0.051	0.467	0.444	0.312	0.272
Hungary	0.004	0.056	0.430	0.415	0.355	0.319
Iceland	0.028	0.087	0.312	0.397	0.417	0.469
Ireland	0.065	0.039	0.620	0.557	0.521	0.379
Italy	0.027	0.037	0.438	0.332	0.376	0.300
Japan	0.023	0.024	0.421	0.422	0.374	0.324
Korea	0.077	0.068	0.588	0.565	0.599	0.425
Luxembourg	0.054	0.035	0.471	0.522	0.357	0.380
Netherlands	0.023	0.025	0.438	0.392	0.400	0.367
New Zealand	0.032	0.036	0.533	0.514	0.318	0.262
Norway	0.034	0.045	0.575	0.709	0.472	0.546
Poland	0.029	0.032	0.422	0.386	0.524	0.503
Portugal	0.022	0.034	0.367	0.363	0.342	0.347
Slovakia	0.023	0.042	0.278	0.277	0.348	0.361
Spain	0.026	0.025	0.320	0.373	0.402	0.373
Sweden	0.021	0.036	0.609	0.503	0.564	0.471
Switzerland	0.006	0.017	0.485	0.467	0.437	0.431
UK	0.007	0.012	0.382	0.276	0.441	0.352
US	0.024	0.026	0.499	0.477	0.349	0.342

*Note:* The table describes the STAN database for structural analysis. The underlying industry data are at the SIC 1-digit level and OECD 2-digit level (See Appendix B for details). Column (1) lists the average country-level value added growth rate over the period that the country is observed, which is a simple average of the sectoral level growth rates. Column (2) lists long-term standard deviations of growth for each country, again averages across sectors. Columns (3)-(4) and (6)-(7) list our estimates of initial and final distance to the optimally diversified benchmark for each country, in a mean-variance efficiency metric, for SIC 1-digit and OECD 2-digit data, respectively. Columns (5) and (8) give the initial year for which data become available for each country. All data are available until 2007.

**Table II.**  
**Credit Markets: Volumes and Liberalization Events**

Country	Credit markets	
	Private credit / GDP	Liberalization date
Australia	0.513	1994
Austria	0.841	<1970
Belgium	0.433	<1970
Canada	0.783	<1970
Czech Republic	0.507	1994
Denmark	0.501	1994
Finland	0.571	<1970
France	0.713	<1970
Germany	1.077	<1970
Greece	0.371	1987
Hungary	0.299	1994
Iceland	0.541	<1970
Ireland	0.821	<1970
Italy	0.618	<1970
Japan	1.452	1985
Korea	0.827	1998
Luxembourg	1.054	<1970
Netherlands	1.069	<1970
New Zealand	0.558	1987
Norway	0.869	1985
Poland	0.236	1994
Portugal	0.856	1986
Slovakia	0.504	1994
Spain	0.811	<1970
Sweden	0.956	1985
Switzerland	1.601	<1970
UK	0.653	<1970
US	1.306	1985

*Note:* The table describes our main financial variable used in the text, private credit over GDP. Column (1) lists the country-level ratio of private credit by all financial institutions, excluding central banks, to GDP, averaged over the sample period. Column (2) lists the year in which the respective country liberalized its banking sector; '<1970' means that those countries' credit markets are open throughout the period. Data on private credit come from Beck et al. (2010). Data on banking sector liberalization events come from Bekaert et al. (2005).



**Table III.**  
**Finance and Convergence to Diversification Benchmark: OLS Estimation**

Panel A. Country distance to frontier				
	SIC 1-digit data		OECD 2-digit data	
	Full sample	Clean frontier	Full sample	Clean frontier
$D_{c,t-1} \cdot \text{Credit}$	-0.0564 (0.0274)**	-0.1172 (0.0506)**	-0.0661 (0.0271)**	-0.0980 (0.0610)*
$D_{c,t-1}$	0.9045 (0.0333)***	0.9467 (0.0552)***	0.9416 (0.0279)***	0.9438 (0.0547)***
Credit	0.0211 (0.0123)*	0.0415 (0.0231)*	0.0225 (0.0106)**	0.0347 (0.0239)
Observations	731	424	678	415
Panel B. Country-industry distance to frontier				
	SIC 1-digit data		OECD 2-digit data	
	Full sample	Clean frontier	Full sample	Clean frontier
$D_{c,s,t-1} \cdot \text{Credit}$	-0.0220 (0.0068)***	-0.0411 (0.0122)***	-0.0290 (0.0036)***	-0.0283 (0.0059)***
$D_{c,s,t-1}$	0.8806 (0.0084)***	0.8820 (0.0134)***	0.9201 (0.0045)***	0.8894 (0.0068)***
Credit	0.0024 (0.0012)**	0.0049 (0.0023)**	0.0013 (0.0004)***	0.0010 (0.0007)
Observations	6,579	3,816	13,560	8,300

*Note:* The Table reports estimates from fixed effects regressions where the dependent variable is  $D_{c,t}$  (Panel A) and  $D_{c,s,t}$  (Panel B), both calculated according to equation (5). The regressions are carried out on the sample of all countries for which the number of years with non-missing data is at least as large as the number of industries (Columns labeled “Full sample”), and on the sample of all countries for which the number of years with non-missing data is at least as large as the number of industries and which liberalized their credit markets during the sample period (Columns labeled “Clean frontier”). ‘Credit’ is the ratio of private credit to GDP. All estimates are from OLS regressions. Country and year fixed effects (Panel A) and country fixed effects interactions with industry fixed effects, as well as year fixed effects (Panel B) included in all regressions. White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table IV.**  
**Finance and Convergence to Diversification Benchmark: GMM Estimation**

Panel A. Country distance to frontier				
	SIC 1-digit data		OECD 2-digit data	
	Full sample	Clean frontier	Full sample	Clean frontier
$D_{c,t-1} \cdot \text{Credit}$	-0.0911 (0.0290)***	-0.1443 (0.0495)***	-0.0919 (0.0302)***	-0.0984 (0.0620)*
$D_{c,t-1}$	0.9025 (0.0320)***	0.9515 (0.0518)***	0.9540 (0.0283)***	0.9306 (0.0547)***
Credit	0.0347 (0.0132)***	0.0566 (0.0226)**	0.0262 (0.0117)**	0.0287 (0.0245)
Observations	697	402	650	395
Panel B. Country-industry distance to frontier				
	SIC 1-digit data		OECD 2-digit data	
	Full sample	Clean frontier	Full sample	Clean frontier
$D_{c,s,t-1} \cdot \text{Credit}$	-0.2005 (0.0139)***	-0.2091 (0.0243)***	-0.1750 (0.0077)***	-0.1460 (0.0128)***
$D_{c,s,t-1}$	0.8225 (0.0152)***	0.8661 (0.0246)***	0.8536 (0.0085)***	0.8052 (0.0130)***
Credit	0.0230 (0.0025)***	0.0232 (0.0044)***	0.0105 (0.0009)***	0.0067 (0.0016)***
Observations	6,273	3,618	13,000	7,900

*Note:* The Table reports estimates from fixed effects regressions where the dependent variable is  $D_{c,t}$  (Panel A) and  $D_{c,s,t}$  (Panel B), both calculated according to Equation (5). The regressions are carried out on the sample of all countries for which the number of years with non-missing data is at least as large as the number of industries (Columns labeled “Full sample”), and on the sample of all countries for which the number of years with non-missing data is at least as large as the number of industries and which liberalized their credit markets before the sample period (Columns labeled “Clean frontier”). ‘Credit’ is the ratio of private credit to GDP. All estimates are from a GMM procedure which implements the Arrelano-Bond estimator to account for the presence of a lagged dependent variable in a dynamic panel model. White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table V.**  
**Finance and Convergence to Diversification Benchmark:**  
**Which Sectors Converge Faster?**

	Benchmark = US industry Sharpe ratio	Benchmark = US industry share young firms	Benchmark = US industry Sharpe ratio	Benchmark = US industry share young firms
	SIC 1-digit industries		OECD 2-digit industries	
$D_{c,s,t-1} \cdot \text{Credit} \cdot \text{Benchmark}$	-0.0181 (0.0053)***	-0.2001 (0.0654)***	-0.0140 (0.0014)***	-0.2208 (0.0299)***
$D_{c,s,t-1}$	0.8794 (0.0086)***	0.8799 (0.0092)***	0.9231 (0.0045)***	0.9194 (0.0048)***
Credit	0.0014 (0.0011)	0.0024 (0.0013)*	0.0011 (0.0004)***	0.0011 (0.0004)**
Benchmark	0.0071 (0.0022)***	0.0110 (0.0061)*	0.0037 (0.0007)***	0.0122 (0.0067)*
Observations	6,273	6,273	12,880	12,880

*Note:* The dependent variable in all cases is  $D_{c,s,t}$  calculated according to Equation (5). ‘Credit’ is the ratio of private credit to GDP. ‘US industry Sharpe ratio’ is the ratio of long-term growth divided by long-term standard deviation of growth for US industries at the SIC 1-digit (Columns (1) and (2)) or OECD 2-digit (Columns (3) and (4)) level. ‘Share of young firms’ is the share of firms younger than 2 years out of the full population of firms for US industries at the SIC 1-digit (Columns (1) and (2)) or OECD 2-digit (Columns (3) and (4)) level. Both industry benchmarks are instrumented in all regressions by the predicted sample Sharpe ratio/share of young firms in a regression on country and industry dummies, interacted with the respective US measure of financial development. The US is excluded from all regressions. Country fixed effects interactions with industry fixed effects, as well as year fixed effects, are included in all regressions. White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table VI.**  
**Endogeneity of Finance**

	Credit = Bank liberalization date	Financial sector excluded	Credit = Bank liberalization date	Financial sector excluded
	SIC 1-digit industries		OECD 2-digit industries	
$D_{c,s,t-1} \cdot \text{Credit}$	-0.0330 (0.0053)***	-0.0141 (0.0050)***	-0.03714 (0.0030)***	-0.0292 (0.0036)***
$D_{c,s,t-1}$	0.8902 (0.0069)***	0.8669 (0.0076)***	0.9178 (0.0039)***	0.9188 (0.0046)***
Credit	0.0034 (0.0009)***	0.0019 (0.0009)***	0.0015 (0.0003)***	0.0014 (0.0004)***
Observations	6,930	5,848	14,140	12,882

*Note:* The dependent variable in all cases is  $D_{c,s,t}$  calculated according to Equation (5). ‘Credit’ is the ratio of private credit to GDP. ‘Bank liberalization date’ equals 1 for the years after the country liberalized its domestic credit market, and 0 otherwise. Data on those come from Bekaert et al. (2005). Financial sector (SIC industry #8, OECD industry #65-67) is excluded from the regressions in Columns (2) and (4). Country fixed effects interactions with industry fixed effects, as well as year fixed effects, are included in all regressions. White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table VII.**  
**Optimal vs. “Naive” Diversification**

Panel A. Country SIC 1-digit data				
	Corr=0	Ogive index	HHI	Gini coefficient
$D_{c,t-1} \cdot \text{Credit}$	-0.0317 (0.0243)	0.0224 (0.0192)	0.0159 (0.0194)	0.0020 (0.0182)
Observations	731	731	731	731
Panel B. Country OECD 2-digit data				
	Corr=0	Ogive index	HHI	Gini coefficient
$D_{c,t-1} \cdot \text{Credit}$	-0.0649 (0.0398)	-0.0229 (0.0179)	-0.0325 (0.0232)	-0.0421 (0.0263)
Observations	678	678	678	678

*Note:* The dependent variable is  $D_{c,t}$  in Column (1), calculated by setting correlations equal to 0 in Equation (5); the Ogive index in Column (2); the Herfindhal-Hirshmann index in Column (3); and the Gini coefficient in Column (4); See Section IV.C for details on how those are calculated. ‘Credit’ is the ratio of private credit to GDP. Country fixed effects and year fixed effects are included in all regressions. White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table VIII.**  
**Alternative Measures of Finance**

Panel A. SIC 1-digit data						
$D_{c,s,t-1} \cdot \text{Credit}$			-0.0221 (0.0078)***	-0.0185 (0.0078)***	-0.0366 (0.0154)**	-0.0141 (0.0032)***
$D_{c,s,t-1} \cdot \text{Stock}$	-0.0189 (0.0087)*					
$D_{c,s,t-1} \cdot \text{Bonds}$		-0.0207 (0.0118)*				
$D_{c,s,t-1} \cdot \text{Trade}$			-0.0001 (0.0001)			
$D_{c,s,t-1} \cdot \text{Gross}$ foreign assets				-0.0011 (0.0009)		
$D_{c,s,t-1} \cdot \text{Net}$ foreign assets				0.0204 (0.0085)**		
Observations	4,914	4,806	6,480	6,399	3,063	3,516
Panel B. OECD 2-digit data						
$D_{c,s,t-1} \cdot \text{Credit}$			-0.0149 (0.0043)***	-0.0248 (0.0042)***	-0.0311 (0.0057)***	-0.0195 (0.0034)***
$D_{c,s,t-1} \cdot \text{Stock}$	-0.0126 (0.0034)***					
$D_{c,s,t-1} \cdot \text{Bonds}$		-0.0066 (0.0040)*				
$D_{c,s,t-1} \cdot \text{Trade}$			-0.0005 (0.0001)***			
$D_{c,s,t-1} \cdot \text{Gross}$ foreign assets				-0.0171 (0.0053)***		
$D_{c,s,t-1} \cdot \text{Net}$ foreign assets				-0.0022 (0.0007)***		
Observations	13,760	13,380	13,560	13,380	7,427	6,133

*Note:* The dependent variable is  $D_{c,s,t}$ , calculated according to Equation (5). ‘Stock’ is the ratio of stock market capitalization to GDP. ‘Bonds’ is the ratio of private plus public bonds to GDP. ‘Trade’ is the ratio of exports plus imports to GDP. ‘Gross foreign assets’ is the ratio of foreign assets plus liabilities to GDP. ‘Net foreign assets’ is the ratio of foreign assets to GDP. In column (5), the analysis is performed on the countries which fall in the bottom half of the distribution of financial sector share of total value added in the initial year of data availability. In column (6), the analysis is performed on the countries which fall in the top half of the distribution of financial sector share of total value added in the initial year of data. Country fixed effects interactions with industry fixed effects, as well as year fixed effects, are included in all regressions. White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table IX.**  
**Finance, Law, and Regulation**

Panel A. Country distance to frontier				
	SIC 1-digit data		OECD 2-digit data	
	Full sample	Clean frontier	Full sample	Clean frontier
$D_{c,t-1} \cdot \text{Credit}$	-0.0607 (0.0304)**	-0.0613 (0.0317)**	-0.0387 (0.0143)***	-0.0603 (0.0283)***
$D_{c,t-1} \cdot \text{Entry time}$	0.0016 (0.0025)	0.0020 (0.0026)	0.0018 (0.0011)*	0.0007 (0.0017)
$D_{c,t-1} \cdot \text{Investor protection}$	-0.0176 (0.0246)	-0.0202 (0.0260)	0.0114 (0.0086)	0.0114 (0.0102)
$D_{c,t-1} \cdot \text{Contract enforcement}$	0.0003 (0.0001)***	0.0003 (0.0001)***	0.0001 (0.0001)	0.0001 (0.0001)
$D_{c,t-1}$	0.8818 (0.1803)***	0.8998 (0.1903)***	0.9428 (0.0564)***	0.9676 (0.0783)***
Observations	680	619	577	346
Panel B. Country-industry distance to frontier				
	SIC 1-digit data		OECD 2-digit data	
	Full sample	Clean frontier	Full sample	Clean frontier
$D_{c,s,t-1} \cdot \text{Credit}$	-0.0184 (0.0074)**	-0.0337 (0.0128)***	-0.0273 (0.0042)***	-0.0230 (0.0073)***
$D_{c,s,t-1} \cdot \text{Entry time}$	0.0020 (0.0009)**	0.0024 (0.0016)	0.0020 (0.0004)***	0.0018 (0.0009)***
$D_{c,s,t-1} \cdot \text{Investor protection}$	-0.0210 (0.0082)***	-0.0211 (0.0123)*	-0.0387 (0.0045)***	-0.0377 (0.0066)***
$D_{c,s,t-1} \cdot \text{Contract enforcement}$	0.0001 (0.0001)	0.0002 (0.0001)***	0.0002 (0.0001)*	0.0002 (0.0001)***
$D_{c,s,t-1}$	0.9610 (0.0502)***	0.9273 (0.0897)***	1.1162 (0.0306)***	1.0623 (0.0474)***
Observations	6,120	3,645	12,240	7,620

Note: The dependent variable is  $D_{c,t}$  (Panel A) and  $D_{c,s,t}$  (Panel B), both calculated according to Equation (5).

‘Entry time’ is the number of days necessary to start a business in the respective country. ‘Investor protection’ is an average of three indices of degree of protecting private investors. ‘Contract enforcement’ is the number of days necessary to settle a contractual dispute in court. Columns (1) and (3) report the regression estimates from the full unbalanced panel covering the period 1970-2006; Columns (2) and (4) report the regression estimates after excluding countries which liberalized their credit markets during the sample period. Country and year fixed effects are included in all regressions (Panel A). Country fixed effects interactions with industry fixed effects, as well as year fixed effects, are included in all regressions (Panel B). White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table X.**  
**Finance and Stages of Diversification**

Panel A. Country SIC 1-digit data			
	Low initial diversification		High initial diversification
$D_{c,t-1} \cdot \text{Credit}$	-0.0837 (0.0183)***		-0.0331 (0.0482)
$D_{c,t-1} \cdot \text{Stock}$		-0.0231 (0.0130)*	0.0927 (0.0612)
Observations	351	355	380 386
Panel B. Country OECD 2-digit data			
	Low initial diversification		High initial diversification
$D_{c,t-1} \cdot \text{Credit}$	-0.0464 (0.0169)***		-0.0997 (0.0599)*
$D_{c,t-1} \cdot \text{Stock}$		-0.0348 (0.0200)*	0.0235 (0.0476)
Observations	307	313	371 375

*Note:* The dependent variables is  $D_{c,t}$ , calculated according to equation (5). ‘Credit’ is the ratio of private credit to GDP. ‘Stock’ is the ratio of stock market capitalization to GDP. ‘Low initial diversification’ refers to the countries which are in the bottom half of the allocative-efficiency implied diversification distribution in the first year of data availability. ‘High initial diversification’ refers to the countries which are in the top half of the allocative-efficiency implied diversification distribution in the first year of data availability. Country fixed effects and year fixed effects are included in all regressions. White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.



**Table XI.**  
**Finance and Convergence to Diversification Benchmark in Larger Economic Zones**

	OLS	Arellano - Bond	Benchmark= US industry Sharpe ratio	Benchmark= US industry share young firms	Financial sector excluded	2SLS
SIC 1-digit data						
$D_{c,s,t-1} \cdot \text{Credit}$	-0.1147 (0.0239)***	-0.1729 (0.0247)***			-0.0966 (0.0239)***	-0.1619 (0.0359)***
$D_{c,s,t-1} \cdot \text{Credit}$ $\cdot \text{Benchmark}$			-0.0966 (0.0230)***	-0.7495 (0.1816)***		
$D_{c,s,t-1}$	0.9121 (0.0228)***	0.8694 (0.0219)***	0.8899 (0.0257)***	0.9214 (0.0229)***	0.9021 (0.0308)***	0.8989 (0.0243)***
Benchmark			0.0390 (0.0086)***	-0.0009 (0.0005)*		
Observations	135	126	135	135	120	135

*Note:* The dependent variable is  $D_{c,s,t}$ , calculated according to Equation (5), using aggregated data for the 12 original euro zone countries. ‘Credit’ is the ratio of private credit to GDP for the 12 original euro zone countries. Column (1) reports the OLS regression estimates from the full unbalanced panel covering the period 1991-2007. Column (2) reports the estimates from a GMM procedure which implements the Arellano-Bond estimator to account for the presence of a lagged dependent variable in a dynamic panel model. ‘US industry Sharpe ratio’ is the ratio of long-term growth divided by long-term standard deviation of growth for US industries at the SIC 1-digit level. ‘Share of young firms’ is the share of firms younger than 2 years out of the full population of firms for US industries at the SIC 1-digit level. Financial sector (SIC industry #8) is excluded from the regression in Column (5). In Column (6), the credit variable has been instrumented using an indicator variable equal to 1 after 1999 (the year of the introduction of the euro). Industry and year fixed effects included in all regressions. White (1980) standard errors appear below each coefficient in parentheses, where \*\*\* indicates significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

## Appendix A. Variables and sources

Value added	Country-industry estimate of real annual growth of value added. Available until 2007 for 9 SIC 1-digit and 20 OECD 2-digit industries for 28 OECD countries, at best starting in 1970. Constructed by deflating nominal growth rates. Source: STAN Database for Structural Analysis.
Share young firms	Share of firms younger than 2 years out of the total population of firms, for US corporations. Calculated for 1-digit SIC industries. Average for the years 1985-95. Source: Dun & Bradstreet.
Credit	The value of total credits by financial intermediaries to the private sector in each country, available with annual frequency. Excludes credit by central banks. Calculated using the following deflation method: $\{(0.5) * [F_t/P_{et} + F_{t-1}/P_{et-1}]\} / [GDP_t/P_{at}]$ where F is credit to the private sector, P <sub>e</sub> is end-of period CPI, and P <sub>a</sub> is average annual CPI. Source: Beck et al. (2010).
Stock	Value of listed shares to GDP, calculated using the following deflation method: $\{(0.5) * [F_t/P_{et} + F_{t-1}/P_{et-1}]\} / [GDP_t/P_{at}]$ where F is stock market capitalization, P <sub>e</sub> is end-of period CPI, and P <sub>a</sub> is average annual CPI. Source: Beck et al. (2010).
Bonds	Private domestic debt securities issued by financial institutions and corporations plus public domestic debt securities issued by government as a share of GDP, calculated using the following deflation method: $\{(0.5) * [F_t/P_{et} + F_{t-1}/P_{et-1}]\} / [GDP_t/P_{at}]$ where F is amount outstanding of private plus public domestic debt securities, P <sub>e</sub> is end-of period CPI, and P <sub>a</sub> is average annual CPI. Source: Beck et al. (2010).
Trade	The sum of exports and imports of the total economy over GDP. Available until 2007 for 9 SIC 1-digit and 20 OECD 2-digit industries for 28 OECD countries, at best starting in 1970, with annual frequency. Source: STAN Database for Structural Analysis.
Gross foreign assets	The sum of total foreign assets and liabilities over GDP, with annual frequency. Source: Lane and Milesi-Ferretti (2007).
Net foreign assets	Total foreign assets over GDP, with annual frequency. Source: Lane and Milesi-Ferretti (2007).
Bank liberalization	Dummy variable equal to 1 after the year in which domestic credit markets were open to foreign participation. Source: Bekaert et al. (2005).
Entry time	The time (in days) it takes to register a new business entity in the respective country. Data aggregated over the time period. Source: Doing Business Database.
Investor protection	Average of three indices of protection of investors: transparency of transactions, liability for self-dealing, and shareholders' ability to sue officers and directors for misconduct. Data aggregated over the time period. Source: Doing Business Database.
Contract enforcement	The time (in days) it takes to resolve a contractual dispute in the respective country. Data aggregated over the time period. Source: Doing Business Database.

## Appendix B. Sectoral coverage

### 1. SIC 1-digit Classification (9 sectors)

1. Agriculture, Hunting, Forestry, and Fishing
2. Mining and Quarrying
3. Manufacturing
4. Electricity, gas, and water supply
5. Construction
6. Wholesale and retail trade - restaurants and hotels
7. Transport, storage and communications
8. Finance, insurance, real estate, and business services
9. Community, social, and personal services.

### 2. OECD 2-digit Classification (20 sectors)

- 01-05. Agriculture, Hunting, Forestry, and Fishing
- 10-14. Mining and Quarrying
- 15-16. Food Products, Beverages, and Tobacco
- 17-19. Textiles, Textile Products, Leather, and Footwear
20. Wood and Products of Wood and Cork
- 21-22. Pulp, Paper, Paper Products, Printing, and Publishing
- 23-25. Chemical, Rubber, Plastics, and Fuel Products
26. Other Non-Metallic Mineral Products
- 27-28. Basic Metals and Fabricated Metal Products
- 29-33. Machinery and Equipment
- 34-35. Transport Equipment
- 36-37. Manufacturing Not Elsewhere Specified and Recycling
- 40-41. Electricity, Gas, and Water Supply
45. Construction
- 50-52. Wholesale and Retail Trade
55. Hotels and Restaurants
- 60-64. Transport, Storage and Communications
- 65-67. Financial Intermediation
- 70-74. Real Estate, Renting, and Business Activities
- 75-99. Community, Social, and Personal Services

