Why does financial sector growth crowd out real economic growth?

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Abstract

We examine the negative relationship between the rate of growth of the financial sector and the rate of productivity growth. Using a panel of 20 countries over 30 years, we establish that there is a robust correlation: the faster the financial sector expands, the slower the real economy grows. We then proceed to build a model in which this relationship arises from the fact that investment projects that are easier to pledge as loan collateral have lower productivity. As the financiers improve their ability to recover collateral in default, entrepreneurs expect credit to grow more quickly. As a consequence, they choose to invest in more pledgeable/less productive projects, reducing productivity growth. We take this theoretical prediction to the data and find that financial growth disproportionately harms industries the less tangible their assets or the more R&D intensive they are.

Keywords: Growth, financial development, credit booms, R&D intensity, asset tangibility

JEL classification: D92, E22, E44, O4

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1. Introduction

Finance and growth are intimately connected. Since the seminal work of Levine in the early 1990s, we have known that for economies to thrive, then required deep and broad financial systems.[1] But what is true from emerging and frontier economies may not be true in the advanced world. That is, finance could very well be a two-edged sword. When credit is relatively low, or the financial sector's share of employment modest, it adds to growth. But there is a threshold beyond which it becomes a drag. There is now considerable evidence that productivity grows more slowly when a country's government, corporate or household debt exceed 100% of GDP.[2]

In this paper, we examine the relationship between financial *growth* and real growth. And, unlike the level relationship, where finance is good for a while, in this case the result is unambiguous: the faster the financial sector grows, the worse it is for real growth. Using a panel of 20 countries over 30 years, we establish that there is a robust, economically meaningful, negative correlation between productivity and financial sector growth. And, that causality likely runs from financial sector growth to real economic growth.[3]

To understand the mechanism that lies behind this relationship, *how* the growth in finance detracts from real growth, we construct a model where entrepreneurs can choose among a set of projects which differ in their pledgeability and their productivity. Our model builds on two key assumptions. First projects that are easier to pledge as collateral, whose output is more tangible, display a lower return. This creates a trade-off between the projects that are easier to finance, and hence will be larger, on the one hand, and those that are more productive on the other. Second, we assume that entrepreneurs must choose a project and commit to it for more than one period. As a result, entrepreneurs' choice of project depends not only on their *current* ability to borrow, but on their *future* ability to borrow as well. In this environment, the faster the financial sector and credit grow, the more pledgeable and less productive the projects that are undertaken, and the slower the real economy grows.

We take our theoretical prediction to sectoral data. Focusing on manufacturing industries, we confirm that the less tangible an industry's assets, or the more R&D intensive it is, the more its growth is harmed by financial sector growth. That is, the less pledgeable an industries' inputs or outputs, the more it is damaged by financial booms.

[1] See Levine (1997) for a survey of this early work.

[2] See, for example, Reinhart and Rogoff (2010), Cecchetti, Mohanty and Zampolli (2011) and Cecchetti and Kharroubi (2012).

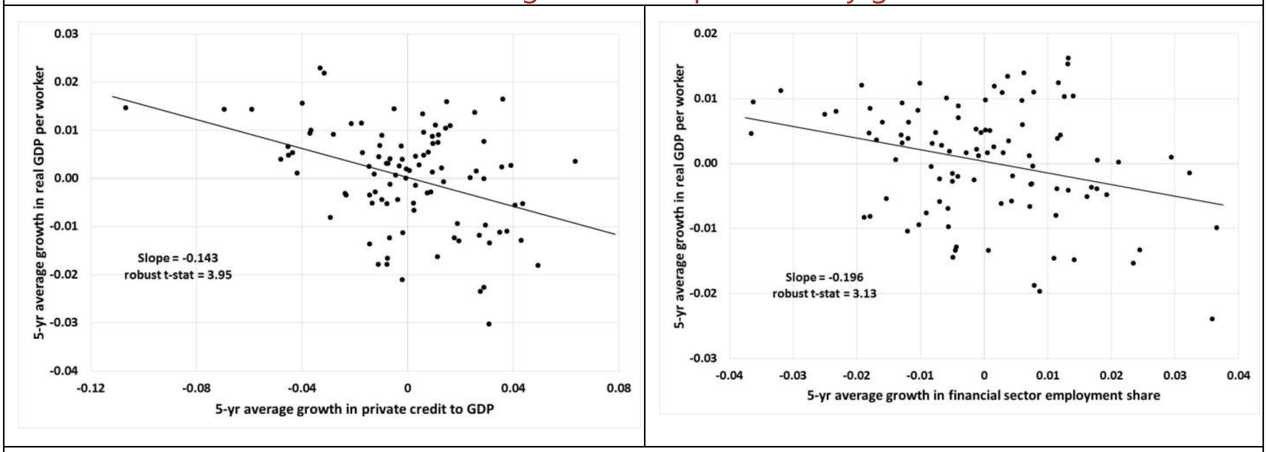
[3] Our findings are consistent with the negative correlation between changes in household debt and subsequent GDP growth documented more recently by Mian, Sufi and Verner (2015).

The remainder of the paper is divided into three parts, followed by a brief conclusion. In Section 2 we present the country-level results. This provides the motivation of our more detailed analysis. Then, in sections 3, we describe the model that guides our thinking about the relationship between growth in the financial sector and growth in the real sector. Section 4 presents the results of our industry-level analysis. Building on the seminal work of Rajan and Zingales (1998), we study 33 manufacturing industries in 17 advanced economies and provide unambiguous evidence for large effects of financial booms on industries that either have low asset tangibility or are R&D-intensive. Our estimates imply that a highly R&D-intensive industry located in a country with a rapidly growing financial system will experience productivity growth that is roughly 2 to 2.5 percentage points per year less than an industry that is not very R&D-intensive located in a country with a slow-growing financial system. The final section concludes.

2. Country-level data

We begin our analysis at the country-level. Graph 1 plots growth in real GDP per person employed on the vertical axis against two measures of financial sector growth on the horizontal: growth in private credit relative to GDP (left-hand panel) and growth in the financial intermediation sector share of total employment (right-hand). We use data on 20 advanced economies from 1980 to 2009.[4] In every case, data are averaged over five year periods and measured as deviations from the country mean. The figure shows a clear negative relationship between financial sector growth and real growth.

Graph 1
Financial sector growth and productivity growth



Graphs plot non-overlapping five year averages rates of deviation from country means for Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, the United Kingdom, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Sweden and United States over the period from 1980 to 2010. The right hand panel controls for beginning-of-period real GDP per worker.

[4] See the graph 1 for the list of countries. All data sources are describe in the appendix.

The line running through the scatter plot has a negative slope with a coefficient that is significantly less than zero at the 1% level in both cases. There are many reasons why this negative correlation could arise. To examine them, we turn to a slightly more sophisticated statistical analysis. And to anticipate our conclusion, the negative relationship is robust to the inclusion of a variety of controls. Moreover, to the extent that we can establish causality, it runs from financial sector growth to productivity growth.

2.1 The relationship between real growth and financial sector growth: the baseline case

Our analysis uses the following simple regression based on the existing growth literature[5]

(1) $y_{i,t+5} = \alpha_i + \beta_t + \gamma . f_{i,t+5} + \delta . e_{i,t+5} + \Lambda X_{i,t} + \varepsilon_{i,t}$,

where $y_{i,t+5}$ is the average growth of output per person employed in country *i* between year *t* and *t+5*, α_i is country fixed effect, β_t is a time fixed effect, $f_{i,t+5}$ is the average growth of financial sector size in country *i* between year *t* and *t+5*, $e_{i,t+5}$ is the average growth in the number of persons employed in country *i* between year *t* and *t+5*, $X_{i,t}$ is a vector of pre-determined control variables, and ε_{it} is a residual.

Table 1 reports the results of our baseline regression in which the controls are the beginning of period values for CPI inflation, government consumption to GDP, trade openness (computed as the half sum of imports plus exports relative to GDP) and the log level of productivity. We use non-overlapping five-year average for 20 countries over 30 years.

Table 1
Relationship between growth in GDP per person employed and growth in finance

Measure of growth in finance	(1)	(2)	(4)
Private credit relative to GDP	-0.0869*** *(0.0287)*		
Private credit relative to nonfinancial firms to GDP		-0.0734*** *(0.0267)*	
Financial sector employment share			-0.174*** *(0.0606)*
R-squared	0.741	0.611	0.551
Number of Observations	109	96	96

Results for equation (1): $y_{i,t+5} = \alpha_i + \beta_t + \gamma . f_{i,t+5} + \delta . e_{i,t+5} + \Lambda X_{i,t} + \varepsilon_{i,t}$, where y_{it+5} is average growth in output per person employed in country *i* between year *t* and year *t+5*, α_i is a country fixed effect, β_t is a time fixed effect, f_{it+5} is average growth in a measure of financial sector size in country *i* between year *t* and year *t+5*, e_{it+5} is average growth in the number of persons employed in country *i* between year *t* and year *t+5*, X_{it} is a vector of pre-determined control variables, and ε_{it} is the residual. The controls are the beginning of period values for CPI inflation, government consumption to GDP, trade openness measured as the half sum of imports plus exports relative to GDP and the log level of productivity. Robust standard errors in parentheses. Statistical significance at 1; 5 and 10% respectively denoted with ***/**/*. Data sources are described in the appendix.

[5] See, for example, Barro (1998).

These results confirm those of Graph 1. When we control for all of the established determinants of trend growth – inflation, population growth, the size of the government, trade – as well as catch-up effects (in the log level of GDP per person employed), the negative relationship between financial sector growth and real growth remains. It is worth emphasizing, however, that the result is likely driven by credit to firms, as growth in household credit to GDP is not significantly correlated with productivity growth.

We can get a sense of the size of the effect by looking at some specific examples. Consider the cases of Ireland and Spain. Starting with Ireland, from 2005 to 2010 the ratio of Irish private credit to GDP more than doubled, growing 16.9 percent per year. By contrast, over the five years from 1995 to 2000, it grew at a more modest average annual rate of 7.7 percent. The estimate in Table 1 (γ=-0.0869) implies that this 9.2 percentage point difference has resulted in a productivity slow-down over 2005-2010 of 0.8 percentage points per year compared to the period 1995-2000. This accounts for around 30 per cent of the 2.9 percentage point drop in productivity growth (from 3.3% a.r. to 0.4% a.r.) that occurred over this period.

Turning to Spain, from 1990 to 1995, the ratio of private credit to GDP was almost constant (-0.22 percent per year) while Spanish productivity was growing +1.7% per year. Fifteen years later, from 2005 to 2010, private credit to GDP grew 8.1 percent a year but productivity grew only 1 percent a year. Our estimates suggest that, if private credit to GDP had been constant instead of rising by 8.1 percentage points, then productivity growth in Spain over 2005-2010 would have the same as it was in 1990-1995 (+1.7 percent per year).

Of course changes in the growth rate of private credit to GDP or the financial sector employment share cannot account for most of the fluctuations in productivity growth rates. In particular, there are a variety of alternative factors that influence both productivity growth and financial sector growth.

2.2 The relationship between real growth and financial sector growth: robustness

To support our interpretation of the results in Table 1, we turn now to a more detailed investigation of alternative explanations. For example, if financial sector growth is negatively correlated with the level of financial development, which seems likely, then our regression could simply be picking up the standard result that financial deepening and growth are positively related (at least most of the time).[6]

Another possibility is that the result is a consequence of composition effects. If credit growth comes along with a shift in the share of credit going toward households relative to that going to firms, this could change the composition of production away from relatively high productivity investment goods to

[6] As Cecchetti et. al (2011) note, while low levels of debt are associated with higher real growth rates, as the ratio of debt to GDP rises, it can eventually become a drag on growth.

relatively low productivity consumer goods. Alternatively, if we assume that nonbank intermediaries and financial markets supply marginal credit, and that bank credit is more information intensive and more productivity enhancing, then a shift away from lending by banks could account for the reduction in productivity growth.[7]

Our results could also be due to changes in the distribution of employment across sectors. Here we can think of two cases. The first is the shift towards finance and real estate. It could be that growth in finance is really representing large construction and real estate services sectors– where productivity gains are relatively low. A second possibility is that growth in finance is really just a part of a secular trend in which employment is shifting away from manufacturing into services.

Yet another possible explanation is that the negative correlation we find is a consequence of financial crises. High growth in finance tends to presage financial crises. And, financial crises are associated with low growth.

Finally, we note the possibility of reverse causation. Low productivity growth could give rise to higher financial sector growth. Rajan (2011) has argued that credit expansion has been pushed by politicians to fill the gap between flat wage profiles and the expectation of ever-increasing living standards.[8] Although this could give rise to our results, it is important to bear in mind that the financial sector usually grows faster when the real economy grows more quickly.[9] Hence, excepting the most recent experience of some advanced economies, reverse causality from productivity growth to financial sector growth is likely to be positive, not negative.

Each of these possibilities leads us to either include a different control variable in the regression equation (1); or, in the case of reverse causation, to use instrumental variables. Table 2 summarizes the issues and the control variables used to address them.

We have examined the first 6 possibilities summarized in Table 2 by sequentially adding controls to baseline equation (1). And for the last case, we investigate the possibility of reverse causality by instrumenting for financial sector growth and employment growth in equation (1) as these two variables are measured contemporaneously to the dependent variable, while the other explanatory variables are all pre-determined. In all cases, the left-hand-side variable is the five-year average growth in GDP per

[7] Conversely, it could be that bank credit is less productivity enhancing if banks favour old credit relationship over new ones and the former finance lower productivity projects than the latter.

[8] Increased inequality may also have contributed to spur credit extension in particular to the poorest (see Rajan 2011).

[9] The view that financial development is a by-product of growth is discussed in Robinson (1952): "Where enterprise leads, finance follows". More recently, see Philippon and Reshef (2013) for a cross-country study of the long-run properties of the financial sector income share.

person employed and the right-hand-side variables include those in the baseline results reported in Table 1.

Table 2 Robustness Exercises	
What else might explain why financial sector growth can be a drag on real growth?	**Control variable added to equation (1)**
1. Financial sector size	Level of variable used to measure growth in finance
2. Composition of credit demand: firms vs households	Share of credit to firms
3. Composition of credit supply: banks vs nonbanks	Share of credit from banks
4. Real estate services	Construction & real estate employment share
5. Manufacturing vs. services	Manufacturing employment share
6. Financial crises	Crisis indicator
7. Reverse causality	Instrumental variables

We use three variables to instrument the ratio of private credit to GDP and employment growth variables: (1) the beginning of period level of the nominal long term interest rate, (2) a financial liberalisation index and a dummy variable which equals one if there is evidence of financial reform during the year prior to the one under consideration. (The dummy variable is constructed by looking to see if the financial liberalisation index increased.)[10] We base our choice of instruments on the view that a change in long term rates affects productivity growth essentially through credit and employment growth.[11] Similarly, we presume that credit and employment growth are the main channels through which financial liberalisation and financial reforms affect productivity growth.

Instrumenting the growth in financial sector employment share variable proves to be more difficult, although reverse causality may also be less of a concern. That said, we use four instruments: the financial liberalisation index, the dummy variable for financial reform, manufacturing share in total employment, and the bank share in total credit.

For the sake of brevity, we only report our estimate of the coefficient on growth in finance *(γ)* in equation (1). Table 3 summarizes these results. Our reading of Table 3 is that the aggregate results are very robust. To see this, note that when we use private credit relative to GDP based measure of growth

[10] Data on financial liberalisation and financial reforms are drawn from Abiad et al. (2008).

[11] It is surely possible that long term interest rates affect productivity growth independently of credit and employment. If this is the case, it would mean that a lower long term rate raises productivity growth by allowing credit-constrained firms with positive NPV projects to invest more. This would undermine the case for a negative relationship between credit and productivity growths and reinforce our findings.

in finance, the coefficient of interest in the OLS regressions ranges from -0.07 to -0.10.[12] And when we use the employment-based measure of growth in finance, the coefficient of interest ranges in the OLS regressions from -0.16 and -0.18. Furthermore, there is no case where the effect is not statistically significantly different from zero at the 5% level.

Table 3
Robustness

	Measure of growth in finance		
	Private credit relative to GDP	**Private credit to firms relative to GDP**	**Financial sector employment share**
Baseline	-0.0869*** *(0.0287)*	-0.0734*** *(0.0267)*	-0.174*** *(0.0606)*
Control added			
1. Level of variable used to measure growth in finance[a]	-0.101*** (0.0344)	-0.0774** (0.0341)	-0.183*** (0.0688)
2. Share of credit from banks	-0.0846*** (0.0282)	-0.0732*** (0.0267)	-0.166*** (0.0606)
3. Share of credit to firms	-0.0762** (0.0339)	-0.0734** (0.0316)	-0.176** (0.0688)
4. Const. & Real Estate employment share	-0.0698** (0.0298)	-0.0590** (0.0283)	-0.163*** (0.0607)
5. Manufacturing employment share	-0.0859** (0.0325)	-0.0697** (0.0288)	-0.170*** (0.0643)
6. Crisis indicator	-0.0880*** (0.0279)	-0.0690*** (0.0257)	-0.169*** (0.0591)
7. Instrumental variables[b]	-0.223*** (0.0769)	-0.172** (0.0673)	-0.353* (0.188)

[a] For example, in the regression that uses growth in private credit to GDP, we introduce the level of private credit to GDP, and so on. The coefficients are all on the growth in finance in an equation in which a control has been added. Variables are all defined in the appendix.
[b] Employment growth and credit measures of financial sector growth are instrumented using (1) the nominal long term interest rate, (2) an index for financial liberalisation and (3) a dummy variable which equals one if there is evidence of financial reform. Employment growth and employment measure of financial sector growth are instrumented using (1) an index for financial liberalisation, (2) a dummy variable which equals one if there is evidence of financial reform, (3) the manufacturing share in total employment and (4) the bank share in total credit. All instruments are measured using beginning of period values. In each of the three different estimations, the Hansen test cannot reject the null hypothesis is that the instruments are all valid.

Before continuing, it is interesting to note that the coefficient of interest in the baseline regression tends to be lower in absolute value to those obtained with IV estimation. This suggests that, if reverse causality is playing any role, it is in the opposite direction, i.e. that higher productivity growth leads to higher not

[12] The range is even narrower when growth in finance is measured using private credit to non-financial firms relative to GDP.

lower financial sector growth. Hence the baseline OLS regressions tend to provide a lower bound for the effect of financial sector growth on productivity growth.

The conclusion from the country-level data is clear: financial sector growth is a drag on real growth. The impression from Graph 1 at the beginning of this section is supported by a more careful statistical analysis. But what is behind this robust empirical regularity? What is the mechanism by which finance, something we know to be fundamental to the operation of the economy, is doing harm? To address this question, we turn first to theory and then return to empirics.

3. The model

To examine the possible sources of the relationship between financial sector growth and real growth we construct a model where entrepreneurs combine their own resources with borrowed funds to invest a project. Critically, we assume that entrepreneurs choose from a set of projects that differ in their return. And, mirroring the real world, higher-return projects are presumed to be inherently riskier and more difficult to finance. Specifically, the higher the return to a project, the more difficult it is to pledge its output to potential financiers. That is, entrepreneurs face a trade-off between return and size: high-return but difficult to finance projects on the one hand vs. low-return but easy to finance projects on the other. We introduce growth in finance by assuming that financier's technology for recovering debt in default improves over time. This, in turn, increases entrepreneurs' borrowing capacity. But the more rapidly entrepreneurs' borrowing capacity increases over time, the more profitable the lower return projects. The result is the negative relationship between financial sector growth and real growth that we documented in the previous section.

The remainder of this section presents the details of our model. We start with the general setup, before proceeding with the dynamics of the economy and finally showing how growth in the borrowing capacity affects output and TFP growth.

3.1 The general framework, returns and pledgeability

Consider a small open economy with overlapping generations of entrepreneurs who live for three periods. Entrepreneurs born at time t receive a bequest B_t from the generation born at time $t-1$. Generation t entrepreneurs combine this bequest with borrowing D_t obtained from financiers in order to invest in a project. For simplicity and without loss of generality, we normalize the cost of capital to one. At time $t+1$, the project produces output that is then used for three purposes: (i) repayment of the loan, D_t, (ii) bequeath B_{t+1} to the next generation who is just born and (iii) save S_{t+1}. Entrepreneurs born at time t can then combine savings S_{t+1} with some new borrowing D_{t+1} to invest in the same project at time *t+1*. Finally at time *t+2*, entrepreneurs reap the project's output and use it to for two different tasks: (i) pay back liabilities D_{t+1}, and (ii) consume C_{t+2}.

The key assumption in our setup is that once entrepreneurs choose a project type, they are committed to that same type for their entire productive life. This is consistent with the idea that entrepreneurs invest in technologies, skills and capital for more than a single period at a time.

To continue, denoting β a positive scalar, we write the utility function of an entrepreneur born at date *t* as

(2) $U_t = \log B_{t+1} + \beta \log C_{t+2}$.

Projects entrepreneurs can invest in, are indexed by the parameter ρ, which measures the degree to which the return to a given project is pledgeable. And, a project's total return is given by $R(\rho)$.[13] Realistically, higher-productivity projects are more difficult to pledge, so $\partial R/\partial\rho<0$; and we assume all available projects have positive NPV and are credit constrained, so that $R(\rho)>1>\rho$.[14]

3.2 The dynamics of the economy

Turning to the dynamics of this economy, we start by denoting the profit from the project of type ρ project undertaken in period *t* as $\pi_t(\rho)$. We are now able to write the utility maximization problem for an entrepreneur born at date *t* as

(3)
$$\max_{B_{t+1},C_{t+2}} U_t = \log B_{t+1} + \beta \log C_{t+2}$$
$$\text{s.t.} \begin{cases} B_{t+1} + S_{t+1} = \pi_t(\rho) B_t \\ C_{t+2} = \pi_{t+1}(\rho) S_{t+1} \end{cases}$$

We can solve this problem for the period *t+1* bequest and period *t+2* consumption. These are:

(4)
$$B^*_{t+1} = \frac{1}{1+\beta}\pi_t(\rho)B_t$$
and
$$C^*_{t+2} = \frac{\beta}{1+\beta}\pi_{t+1}(\rho)\pi_t(\rho)B_t .$$

[13] See Holmström and Tirole (1997) for a micro-foundation of the pledgeable return based on ex ante moral hazard.

[14] The assumption that total and pledgeable returns are negatively correlated can easily be justified on the basis of the fact that a higher pledgeable return allows for more borrowing, increasing the size of the project. With decreasing marginal returns to capital, this immediately implies a lower total return.

The first expression governs the growth rate of the economy for a given project pledgeability ρ. To see this, simply divide by B_t and note that bequests (and hence the economy) grow at the rate $\pi_t(\rho)/(1+\beta)$.

Next, we turn to the optimal project choice, which is related to the dynamics of entrepreneur's borrowing capacity.

3.3 Financial constraints and optimal project's choice

As we said at the outset, entrepreneurs borrow to finance investment. But they have the option to default strategically. To preclude this possibility, financiers impose a borrowing limit that ensures entrepreneurs will choose to repay.

To determine this no-default level of borrowing, consider an entrepreneur starting with a unit of own funds and investing $1+d$ in project of type ρ. Total output from this project is $(1+d)R(\rho)$. If the entrepreneur chooses to repay financiers, the profit is then $(1+d)R(\rho) - d$. (Recall that, since this is a small open economy the cost of capital is exogenous and normalized to one.) Alternatively, an entrepreneur who chooses to default earns the same revenue $(1+d)R(\rho)$ but then loses the pledgeable output $(1+d)\rho$.

Moreover, the financier can recover some claims in the case of default. We assume that the recovery rate varies over time and is given by $(1-1/\sigma_t)$, where $\sigma_t > 1$. Hence instead of paying back d, the entrepreneur can default on $(1/\sigma_t)d$ and pay only $(1-1/\sigma_t)d$, implying a profit in default of $(1+d)(R(\rho)-\rho) - (1-1/\sigma_t)d$. This expression embodies the intuition that defaulting is less desirable the higher either ρ or σ_t.[15]

Comparing the profit with and without default, we can derive the no-default constraint:

(5) $$d_t \leq \frac{\rho\sigma_t}{1-\rho\sigma_t}$$

For this constraint to be meaningful, we assume that the parameters ρ and σ_t are such that $\sigma_t\rho < 1$ is satisfied for all possible projects.[16] Let us now denote the right hand side of (5) as $d(\rho,\sigma_t)$. The function $d(\rho,\sigma_t)$ has several important properties:

(6) $$\frac{\partial d(\rho,\sigma_t)}{\partial \rho} \geq 0 \ , \ \frac{\partial d(\rho,\sigma_t)}{\partial \sigma_t} \geq 0, \text{ and } \frac{\partial^2 d(\rho,\sigma_t)}{\partial \rho \partial \sigma_t} \geq 0 .$$

[15] See Aghion et al. (1999) for a similar modelling approach to credit constraints

[16] If it were not, the inequality in (5) would always be strict. That is the entrepreneur would never default.

To summarize, ρ and $d(\rho,\sigma_t)$ move in the same direction – the more pledgeable a project, the higher the maximum level of borrowing. Furthermore, σ_t and $d(\rho,\sigma_t)$ also move in the same direction – as the financiers' ability to recoup their loan in the case of default σ_t increases, the maximum level of borrowing $d(\rho,\sigma_t)$ goes up.[17] And finally, the increase in $d(\rho,\sigma_t)$ for a given increase in σ_t will be larger, the larger is the pledgeable return ρ. So, in the event there is financial innovation that raises financiers' ability σ_t to recoup loans in case of default, this will drive up lending by more to entrepreneurs holding projects whose output is more pledgeable.[18]

Given that projects are all positive NPV, entrepreneurs always borrow as much as possible and (4) always binds. Hence the profit $\pi_t(\rho)$ for an entrepreneur investing in a project with pledgeable return ρ at time t satisfies

$$\text{(7)} \qquad \pi_t(\rho) = \pi(\rho,\sigma_t) = (1 + d(\rho,\sigma_t))R(\rho) - d(\rho,\sigma_t)$$

With this in hand, we can now write down the project choice problem. Substituting the optimal bequest and consumption B^* and C^* from (4) into the utility function (2), yields the indirect utility function:

$$\text{(8)} \qquad \max_{\rho} U_t = \Omega + (1+\beta)\log \pi(\rho,\sigma_t) + \beta \log \pi(\rho,\sigma_{t+1})$$

$$\text{where } \Omega = (1+\beta)\log(B_t) + \beta\log(\beta) - (1+\beta)\log(1+\beta)$$

Note that Ω is a constant with respect to the parameter of interest ρ.

In choosing a project of type ρ, entrepreneurs trade-off the return $R(\rho)$ against the borrowing ability $d(\rho,\sigma_t)$. That is, projects with a higher return are more difficult to finance because their output is more difficult to pledge. This choice is affected by financiers' ability σ_t to recoup their claims in case of default. And, as we noted earlier, when σ_t is high the borrowing ability $d(\rho,\sigma_t)$ is very sensitive to the project's pledgeability ρ (see equations (6)). As a result, choosing a high return project has a higher cost in terms of forgone borrowing ability. Moreover, given that entrepreneurs are tied to a unique type of project for their entire lifetime, they need to take into account not only the financiers' *current* ability (σ_t) to recoup claims in case of default, but the financiers' *future* ability as well (σ_{t+1}). For this reason, both the level and the growth rate of credit extended to entrepreneurs matters for the choice of the optimal project, and hence for output and growth.

[17] This effect is very consistent with the main findings of literature on finance and growth (See Levine 1997 for a survey)

[18] Here we take changes in financiers' ability to recoup claims σ to be exogenous. In practise, financial innovation which affects σ is endogenous and depends on how much innovation and how many innovators are in the financial sector. Philippon and Reshef (2012) show that financial deregulation has played a major role in raising the skill intensity and compensation for human capital in the US financial industry. Cahuc and Challe (2012) investigate theoretically the labour force allocation between the real and the financial sector in the presence of bubbles and rents in the financial sector.

To solve problem (8), we assume that $R(\rho)$ and $\pi(\rho,\sigma_t)$ are both concave in ρ for all values of σ_t and that there is a unique level of ρ *denoted* $\rho^*(\sigma_t)$ that maximizes the profit function $\pi(\rho,\sigma_t)$. Under these assumptions, we can show that $\rho^*(\sigma_t)$, the level of ρ such that $\partial\pi(\rho,\sigma_t)/\partial\rho=0$, is a positive function of σ_t. To see this, we can solve the equation $\partial\pi(\rho,\sigma_t)/\partial\rho = 0$, and obtain an implicit expression for $\rho^*(\sigma_t)$. Differentiating this implicit expression then yields:

$$(9) \qquad \frac{d\rho^*}{d\sigma_t} = \frac{\left[R(\rho^*)-1\right]^{-1}}{-R^{(2)}(\rho^*)}\left[\frac{R'(\rho^*)}{\sigma_t}\right]^2$$

Given that $R(\rho)$ is concave in ρ, and that all projects are positive NPV, the right hand side of (8) is always positive. The pledgeability level $\rho^*(\sigma_t)$ which maximizes the profit function $\pi(\rho,\sigma_t)$ is therefore always increasing of σ_t. This immediately implies that the higher σ_t, the more pledgeable-lower return, the projects entrepreneurs choose.

To continue, consider what happens when the financiers' ability to recoup loans grows over time, so that $\sigma_{t+1}>\sigma_t$. In this case, entrepreneurs' welfare, U_t, is strictly increases in ρ when $\rho < \rho^*(\sigma_t)$ and strictly decreases with ρ when $\rho > \rho^*(\sigma_{t+1})$.[19] This immediately implies that the welfare maximizing level of ρ , ρ^*, is such that $\rho^*(\sigma_t) < \rho^* < \rho^*(\sigma_{t+1})$. From (8), it is straightforward to compute the first-condition which determines ρ^*. Denoting $\pi'(\cdot)$ the derivative of the profit function with respect to ρ, the welfare maximizing level ρ^* satisfies

$$(10) \qquad \frac{\pi'(\rho^*,\sigma_{t+1})}{\pi(\rho^*,\sigma_{t+1})} = \frac{1+\beta}{\beta}\frac{-\pi'(\rho^*,\sigma_t)}{\pi(\rho^*,\sigma_t)}$$

Using (9), we can now derive the following result:

> *When the return $R(\rho)$ and the profit function $\pi(\rho,\sigma_t)=(R(\rho)-\rho\sigma_t)/(1-\rho\sigma_t)$ are concave in ρ and there is a unique level of ρ that maximizes $\pi(\rho,\sigma_t)$, entrepreneurs choose higher pledgeability projects when their borrowing capacity grows more quickly over time.*

To see this, start by noting that, given the necessary condition, $\rho^*(\sigma_t) < \rho^* < \rho^*(\sigma_{t+1})$, and given that $\pi(\cdot)$ is concave in ρ, the left hand side of the first order condition in (10) is positive and decreasing in ρ. Similarly, given the necessary condition $\rho^*(\sigma_t) < \rho^* < \rho^*(\sigma_{t+1})$ and given that $\pi(\cdot)$ is concave in ρ, the right hand side of the first order condition (10) is positive and increasing in ρ. Moreover, since the left hand side (10) is positive, it is necessarily increasing in σ_{t+1}. Entrepreneurs therefore choose at time *t* to invest in a project whose pledgeability ρ^* increases when financiers' ability to recoup loans is expected to grow more quickly.

[19] Remember the two properties that $\pi(\rho,\sigma_t)$ is increasing in ρ when $\rho < \rho(\sigma_t)$ and $\rho(\sigma_t)$ increases with σ_t.

The intuition of this result is straightforward. The larger (σ_{t+1}-σ_t), the more quickly entrepreneurs expect their borrowing ability to grow over time, increasing [$d(\rho,\sigma_{t+1})$ - $d(\rho,\sigma_t)$]. Because of the complementarity we noted earlier, entrepreneurs will take advantage of the prospect of higher *future* credit availability by investing in more pledgeable projects *from now*. But recall that these more pledgeable projects are also less productive. This means that as the growth rate in credit increases, total factor productivity growth decreases, given that it is represented by $R(\rho^*)$. As ρ^* goes up with a higher growth rate in credit, $R(\rho^*)$ goes down and so does TFP.

Moreover as the growth rate in credit increases and entrepreneurs choose more pledgeable projects, the growth rate of the economy given by

$$\frac{B_{t+1}}{B_t} = \frac{\pi(\rho^*, \sigma_t)}{1+\beta}$$

faces opposite effects since more pledgeable projects are less productive but allow entrepreneurs to run larger projects and hence earn larger profits. However the property that the pledgeability of the optimal project satisfies $\rho^* > \rho(\sigma_t)$ implies that as the pledgeability of the optimal project ρ^* increases, current profits $\pi(\rho^*, \sigma_t)$ necessarily decrease. Hence the growth rate of the economy given by equation (3) also decreases when the growth rate in credit increases.

We can now state our main result:

> *A higher growth rate of credit reduces the growth of both total factor productivity and aggregate output.*

Interestingly, contrary to changes in the *growth* of credit, changes in the *level* of credit have ambiguous effects on output growth in our model. To see this, consider an increase in σ_t, so financiers' *current* ability to recoup loans improves. This has two effects. On the one hand, there is a direct positive effect on output growth as entrepreneurs can raise more resources for investment. On the other hand, there is an indirect effect through optimal pledgeability which goes up. Higher pledgeability magnifies the increase in entrepreneurs' borrowing capacity which further contributes to raise output growth. Higher pledgeability however means at the same time that projects are less productive which reduces output growth.[20]

[20] This confirms the empirical finding of Cecchetti and Kharroubi (2012), that the relationship between output growth and the *size* of the financial sector can go both ways.

4. Industry-level data empirical investigation

Two main conclusions emerge from the model of the previous section. First, its predictions match the empirical results at the aggregate level reported in Section 2: financial sector growth is negatively correlated with productivity growth. Second, it implies that financial sector growth disproportionately benefits sectors with output or assets that are more tangible, something we are able to examine directly. The key to figuring out which sector are most likely to be damaged from financial sector growth requires that we look for the sectors where pledging of either assets or output is difficult. On the asset side, we can measure this directly from information on asset tangibility. For output, we use R&D intensity as a proxy. Our conjecture is that financial sector growth should harm industries the less tangible their assets or the higher their R&D intensity. Using these insights, we now provide a brief description of the data we use, before turning to the empirical specification, and finally to results which match the predictions of the model.

4.1 The data

To get some sense of which sectors are being harmed by financial sector growth, we require two types of detailed data. The first measures financial sector growth and the second quantifies the extent to which an individual industry owns tangible assets or output. We now examine each of these in turn. Starting with financial sector growth, we consider the ratio of total private credit relative to GDP, as well as private credit to non-financial corporations relative to GDPand private credit to households relative to GDP. In each case, we compute the average growth rate from 2000 to 2008 for each of these.[21]

Graph 2 plots the set of three indicators we examine for the 16 OECD countries in our sample. Note that Japan and Germany have experienced negative growth for all three indicators. Switzerland exhibits a virtually stable level of finance (remember that this is the growth rate, not the level of development). Unsurprisingly, Spain shows a strong boom that is invariant to the way it is measured. So far, this is as expected. What is surprising is the fact that there are the booms in Denmark and Sweden – larger, even, than those in the United Kingdom and the United States.[22]

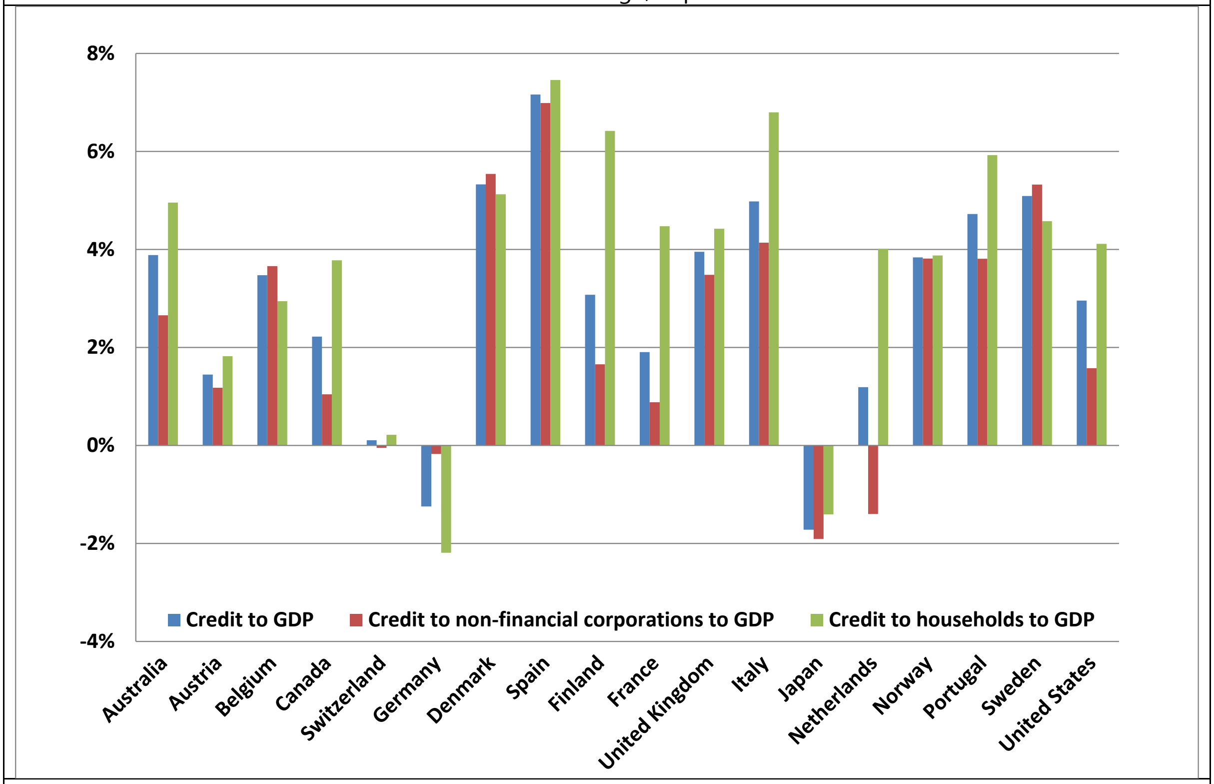
[21] Due to limited availability of industry value added and employment data, Portuguese credit growth is computed over 2000-2006, and for France credit growth it is from 2000 to 2007 for France.

[22] See Greenwood and Scharfstein (2012) for a detailed analysis of financial sector growth in the US.

Graph 2

Financial sector growth in advanced economies

2000–08 average, in per cent



Sources: BIS credit database; authors' calculations. Data for France are for the period 2000 to 2007. And for Portugal, data are for the period 2000 to 2006.

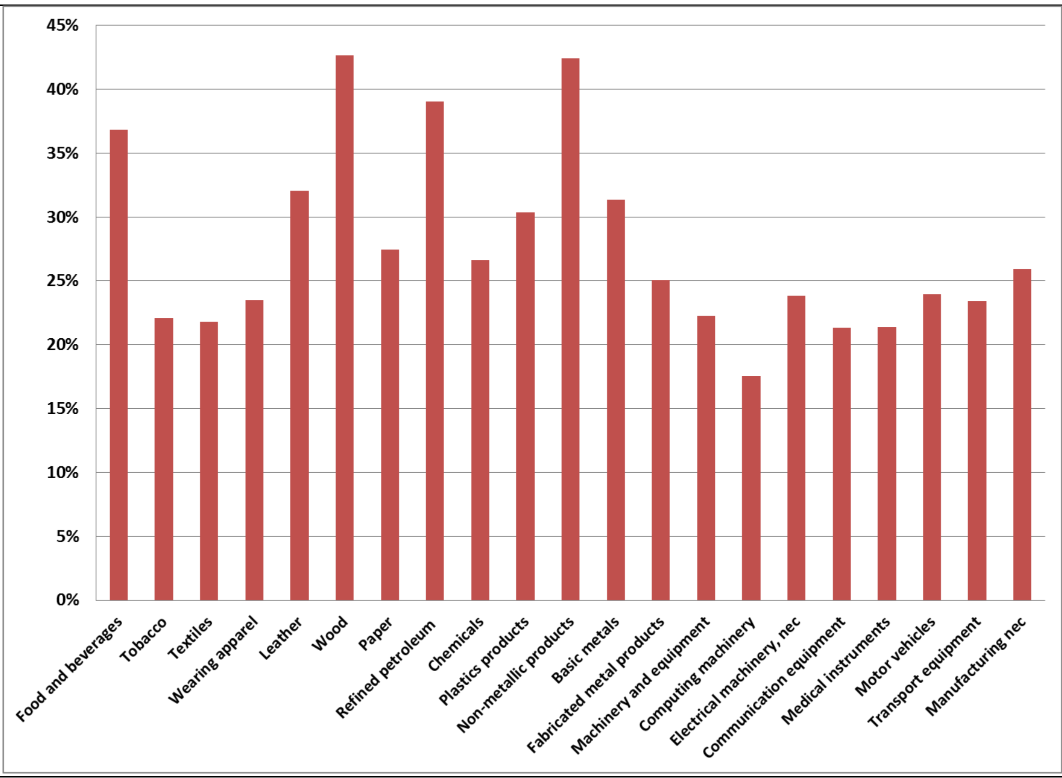
Turning to industry-specific characteristics, our asset tangibility data are taken from Braun (2005). We use the ratio of tangible to total assets. The former includes property, plants and equipment, while the latter adds goodwill, R&D, the human capital associated, organizational capital, accounts receivables, cash, and inventory levels. Braun calculates a given industry's tangibility level as the median for U.S. companies in the industry for the period from 1986 to 1995.

We compute R&D intensity analogously as the median ratio across firms belonging to the corresponding industry in the US of R&D expenditures to total value added. As we just mentioned, R&D intensity gives us an indication of the likely pledgeability of a firm's output. The more R&D intensive, the more likely the products will have a large intellectual property component. We follow Rajan and Zingales (1998) in measuring industry characteristics using US data. This approach, which is forced on us by data availability, assumes that differences across industries are driven largely by differences in technology that are the roughly similar in all countries. Given that our sample is for advanced OECD economies with substantial cross-border trade, this seems an innocuous assumption.[23]

Graph 3

Asset tangibility

(by industry in percent)



Sources: Braun (2005); authors' calculations.

Graphs 3 and 4 report the industry-level measures. Starting with asset tangibility in the first of the two graphs, unsurprisingly industries like petroleum refining, paper and products, and iron and steel have the highest levels of tangible assets. At the other end of spectrum is computing machinery, communication equipment and medical instruments.

Turning to R&D intensity in Graph 4, the picture is somewhat different. Here we plot the ratio of average R&D expenditure to value added for the period 1990–99. Looking at the graph, we can divide industries into two distinct groups: one with very low and one with very high R&D intensity. In the first group are tobacco, textiles, printing, basic metals and shipbuilding, while the second includes communications equipment, medical instruments and aircraft industries. In the latter group, R&D expenditures can be as large as one third of total value added. Note also that the size for these two groups is fairly different: out

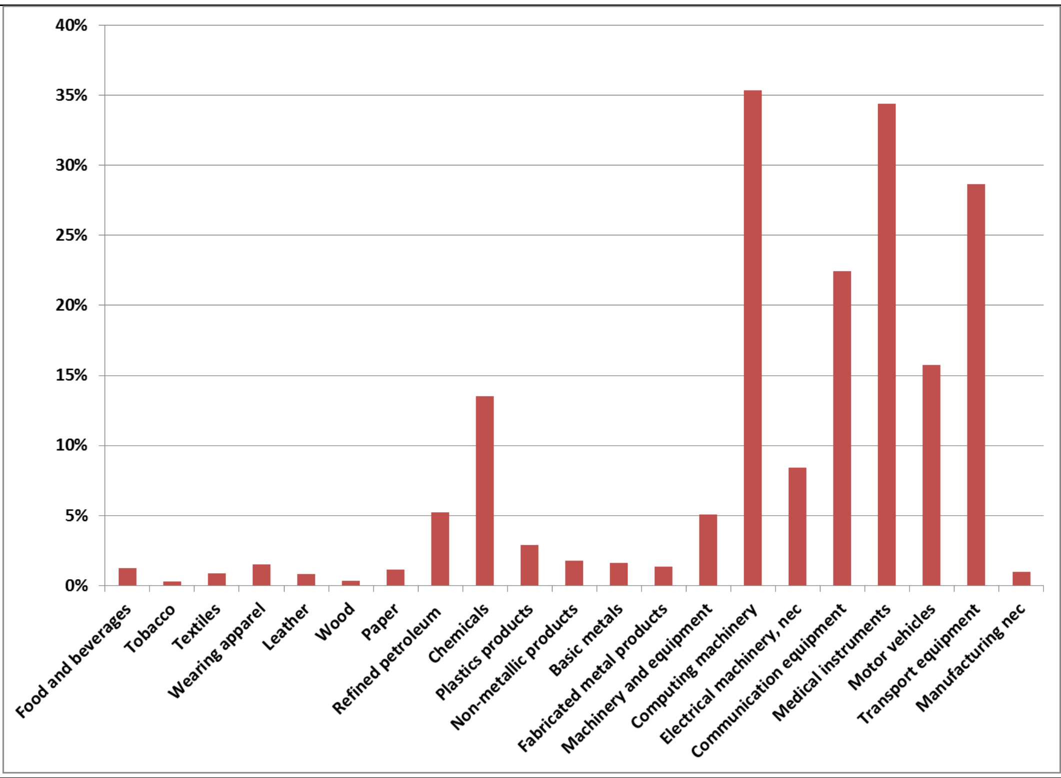
[23] More precisely, the working assumption is that the ranking of industries according to asset tangibility or R&D intensity is country-invariant.

of the 33 industries in our sample, 22 display R&D expenditures of less than 10% of value added. By contrast, only three industries devote more than 30% of their value added to R&D expenditures. (We note that the correlation between the measures plotted in Graphs 3 and 4 is less than -0.5.)[24]

Graph 4

R&D intensity in manufacturing industries[1]

In per cent



[1] Ratio of R&D expenditure to total value added.

Sources: OECD Structural Analysis database; authors' calculations.

4.2 The empirical specification and the results

Our sample is a panel of countries and industries over the period from 2000 to2008. For the countries, data limitations limit us to advanced OECD countries. And for industries, we are restricted to manufacturing sectors. Following Rajan and Zingales (1998), the following regression allows us to test for the effects of interest:

(11) $$y_{i,c} = \beta_i + \beta_c + \gamma.(p_i \times g_c) - \delta.z_{i,c} + \varepsilon_{ic},$$

where $y_{i,c}$ is the average growth rate of real value added (per person employed) in industry i in country c over the period 2000 to 2008 ; β_i and β_c are industry and country fixed effects; $p_i \times g_c$, the interaction

[24] Table A1 reports information on the external financial dependence and R&D intensity of the industries in the sample.

variable of interest, is the product between industry *i*'s measure of pledgeability p_i and country *c*'s financial sector growth g_c; over the period 2000 to 2008 and finally, we control for initial conditions: $z_{i,c}$ is the log ratio of value added (per person employed) in industry i in country c in year 2000 to manufacturing value added (per person employed) in country *c* in 2000.[25,26]

We estimate equation (11) using a simple ordinary least squares (OLS) procedure, computing heteroskedasticity-consistent standard errors. This brings up the possibility of simultaneity bias. As noted earlier, the variable representing industry characteristics – either asset tangibility or R&D intensity – is based entirely on US data. This reliance on the United States mitigates the possibility of reverse causation, as it seems quite unlikely that industry growth outside the US affects characteristics of industries in the US. In addition, as noted earlier, financial development growth is measured at the country level, whereas the dependent variable is measured at the industry level. Again, this reduces the scope for reverse causality as long as each individual industry represents a small share of total output in the economy. (For completeness, we also report IV estimates in section 4.3).

Table 4

Growth in industry value added and growth in finance

	(1)	(2)	(3)	(4)	(5)	(6)
Interaction of asset tangibility with						
Growth in Private Credit relative to GDP	5.962*** *(1.774)*					
Growth in Credit to Firms relative to GDP		4.928*** *(1.506)*				
Growth in Credit to Households relative to GDP			4.360*** *(1.626)*			
Interaction of R&D intensity with						
Growth in Private Credit to relative GDP				-4.174*** *(1.105)*		
Growth in Credit to Firms to relative GDP					-3.254*** *(1.006)*	
Growth in Credit to Households to relative GDP						-3.473*** *(0.994)*
Observations	420	420	420	395	395	395
R-squared	0.414	0.403	0.402	0.453	0.436	0.450

The dependent variable is the average annual growth rate in real value-added per person employed for the period 2000–08 for each industry in each country. Asset tangibility is the median for U.S. companies in the industry for the period 1986–1995. R&D intensity is the average for the ratio of R&D expenditures to value added for US industries for the period 1990–2000. The interaction variable is the product of variables. Robust standard errors are in parentheses. All estimations include country and industry dummies and the log of industry value added to total manufacturing value added in 2000. Significance at the 1/5/10% level is indicated by ***/**/*.
Country sample: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Italy, Japan, the Netherlands, Norway, Portugal and Sweden.
Sources: OECD Structural Analysis database; BIS database on credit; Braun (2005); authors' calculations.

Table 4 reports results using industry value added growth as a dependent variable. The estimated coefficient for the interaction term between industry asset tangibility and financial sector growth is

[25] The choice of this time period has no significant implications for the results. It is, however, useful in dealing with possible reverse causality issues, as industry characteristics are measured during time periods prior to 2000.

[26] This methodology has been used to study, for example, implications of financial sector composition, bank- versus market-based, on industry growth (Beck and Levine (2002)) and how financial (under)development affects industry volatility (Raddatz (2006)).

positive and significant. For the interaction between industry R&D intensity and financial sector growth, the coefficient is negative and significant. When the financial sector grows more quickly, value added tends to grow disproportionately faster in industries with either higher asset tangibility or lower R&D intensity. This confirms the mechanism highlighted in the model that financial sector growth benefits sectors whose assets are more tangible or whose output is easier to pledge.

Turning to industry productivity growth, the results in Table 5 are qualitatively similar to those in Table 4. Industry labour productivity growth is significantly negatively correlated with the interaction term, measured as the product of industry asset tangibility and either financial sector growth or industry R&D intensity and financial sector growth. Financial booms therefore disproportionately harm productivity growth for low asset tangibility or high R&D-intensive industries. Again, the results are robust to the measure of financial sector growth.

As for the quantitative implications of these estimates, we compute the difference in productivity growth between a sector with low asset tangibility (high R&D intensity) located in a country whose financial system is growing slowly and a sector with high asset tangibility (low R&D intensity) located in a country whose financial system is growing rapidly, all else equal. The row labelled "Difference-in-difference effect" in Table 5 reports the results from this experiment.[27] We find an effect of between 4½% and 5½% when industries are ranked according to asset tangibility. This means that productivity of an industry with high asset tangibility located in a country experiencing a financial boom tends to grow 4½-5½ percent a year more quickly than an industry with low asset tangibility located in a country not experiencing such a boom. This difference-in-difference effect is the same order of magnitude than the unconditional sample volatility of labour productivity growth, which is 4.2%.

Turning to industry R&D intensity, the difference-in-difference effect is estimated to be between –2 and –2½%. That is to say, the productivity of a sector with high R&D intensity located in a country with a rapidly-growing financial sector grows between 2 and 2½% a year more slowly compared to the productivity of a sector with low R&D intensity located in a country whose financial system is growing slowly. This supports the conclusion we reached for value added growth: financial sector growth benefits disproportionately more to sectors whose output is easy to pledge.

[27] We compute the difference-in-difference effect as the coefficient on the interaction term times the difference between the product of the 75th percentile of financial sector growth and the 75th percentile of either asset tangibility or R&D intensity and the product evaluated at the 25th percentile. That is, the difference-in-difference effect = $\gamma[p_i(75^{th}\ percentile) \times g_c(75th\ percentile) - p_i(25^{th}\ percentile) \times g_c(25th\ percentile)]$.

Table 5

Growth in industry productivity and growth in finance

	(1)	(2)	(3)	(4)	(5)	(6)
Interaction of asset tangibility with						
Growth in Private Credit relative to GDP	4.530*** *(1.660)*					
Growth in Credit to Firms relative to GDP		3.786*** *(1.377)*				
Growth in Credit to Households relative to GDP			3.053* *(1.563)*			
Interaction of R&D intensity with						
Growth in Private Credit relative to GDP				-3.640*** *(0.965)*		
Growth in Credit to Firms relative to GDP					-3.110*** *(0.887)*	
Growth in Credit to Households relative to GDP						-2.721*** *(0.913)*
Difference-in-difference effect (in pp)	5.59	4.68	4.49	-2.66	-1.87	-2.47
Observations	420	420	420	395	395	395
R-squared	0.346	0.339	0.334	0.385	0.375	0.375

The dependent variable is the average annual growth rate in real value-added per person employed for the period 2000–08 for each industry in each country. Asset tangibility is the median for U.S. companies in the industry for the period 1986–1995. R&D intensity is the average for the ratio of R&D expenditures to value added for US industries for the period 1990–2000. The interaction variable is the product of variables. Robust standard errors are in parentheses. All estimations include country and industry dummies and the log of industry value added per person employed to total manufacturing value added per person employed in 2000. Significance at the 1/5/10% level is indicated by ***/**/*. Country sample: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Italy, Japan, the Netherlands, Norway, Portugal, and Sweden.
Sources: OECD Structural Analysis database; BIS database on credit; Braun (2005); authors' calculations.

Comparing the results in Tables 4 and 5, it is fair to say that growth in credit to households relative to GDP has a weaker effect on productivity than growth in credit to firms or growth in overall private credit. One reason for this could be that growth in household credit affects firms only indirectly through demand shifts while the other measures of credit to GDP growth (credit to firms and overall credit) affect firms more directly.

4.3 Instrumenting credit growth

The industry level investigation is designed to isolate causality running from aggregate developments in credit to industry specific growth performance. But it is surely possible that credit growth is a policy decision that depends on country characteristics. For example, in countries where high tangibility or low R&D sectors are larger, there could be demands to expand credit more quickly as such sectors benefit disproportionately more from such expansion. Similarly, countries where such sectors are expected to grow more quickly could experience stronger credit growth. To address with this potential endogeneity, we instrument for credit expansion with the nominal short and long term interest rates in 2000, the level for financial liberalisation in 2000 and a financial reform dummy that takes a value one if the financial liberalisation index rose between 1999 and 2000.

Financial reforms are likely carried out with the idea to expand credit particularly to those credit constrained firms. Hence countries where high tangibility or low R&D sectors are either large or expected to grow quickly are unlikely to launch such reforms as such sectors would fear a crowding-out effect to the benefit of formerly credit-constrained sectors. Nominal interest rates are also useful as instruments because short- and long-term rates are positively correlated with subsequent credit to GDP growth in our sample, while the difference between them (which is a measure of growth opportunities) is not. Hence instrumenting credit growth with interest rates helps isolate the supply shock to credit growth which arguably does not depend on sectoral growth.

Table 6

Growth in industry productivity and growth in finance: IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Interaction of asset tangibility with						
Private Credit relative to GDP Growth	3.993*** (1.507)					
Credit to Firms relative to GDP Growth		4.216*** (1.636)				
Credit to Households relative to GDP Growth			3.416*** (1.302)			
Interaction of R&D intensity with						
Private Credit relative to GDP Growth				-4.260*** (1.083)		
Credit to Firms relative to GDP Growth					-4.335*** (1.193)	
Credit to Households relative to GDP Growth						-3.756*** (0.865)
Observations	420	420	420	395	395	395
R-squared	0.060	0.050	0.044	0.088	0.066	0.067
J-stat	3.974	3.656	4.578	3.835	4.286	4.155
(p. value)	*(0.264)*	*(0.301)*	*(0.205)*	*(0.280)*	*(0.232)*	*(0.245)*
LM-stat	26.78	26.26	33.34	28.84	26.71	30.56
(p. value)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*

The dependent variable is the average annual growth rate in real value-added per person employed for the period 2000–08 for each industry in each country. Asset tangibility is the median for U.S. companies in the industry for the period 1986–1995. R&D intensity is the average for the ratio of R&D expenditures to value added for US industries for the period 1990–2000. The interaction variable is the product of variables. Instruments for credit growth variables: short and long term nominal interest rate in 2000, financial liberalisation index in 2000, dummy for financial reform in 2000. Robust standard errors are in parentheses. All estimations include country and industry dummies and the log of industry value added per person employed to total manufacturing value added per person employed in 2000. Significance at the 1/5/10% level is indicated by ***/**/*. Country sample: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Italy, Japan, the Netherlands, Norway, Portugal and Sweden.
Sources: OECD Structural Analysis database; BIS database on credit; Braun (2005); authors' calculations.

The results of this IV procedure are reported in Table 6. The estimates are very close in magnitude to their OLS counterparts reported in Table 5, suggesting that our results are not driven by reverse causality. An interesting qualification is that, while the interaction term with growth in total credit relative to GDP has the largest effect on industry productivity growth in the OLS estimates, the interaction term with growth in credit to firms relative to GDP is now largest.

4.4 Robustness

There is a variety of plausible alternative interpretations for our industry-level results. We examine five in some detail. First, there is the possibility that the negative impact of financial growth on industry-level productivity growth arises from the level of financial development itself. If financial sector growth and the level of financial development are negatively related (larger financial sectors tend to grow more slowly) and the size of the financial sector is positively related to industry productivity growth, then we would mistakenly attribute to financial sector growth a negative effect that in reality reflects the positive effect of the financial development level. Second, we look at the impact of monetary policy. Financial sector growth is likely to be related to the stance of monetary policy and the cost of capital: the more accommodative monetary policy and the lower the cost of capital, the faster the financial sector will grow. Since monetary policy is most accommodative during periods when aggregate growth is low, this raises the possibility that what we are finding is essentially the effect of countercyclical monetary policy. Third, there is the potential impact of fiscal policy. If fiscal deficits crowd out credit extension to the private sector, then again we could be confounding an aggregate cyclical policy with what we believe to be a cross-sectional effect. Fourth, it may be important to control for the extent to which the economy is actually a net importer of both capital and goods, as this could influence the availability of resources and have a differential impact on the productivity performance of more financially constrained sectors.

Appendix tables A2 and A3 present a set of results that addresses these four possibilities. There, we report the coefficient on the interaction term in which a variety of variables are added to our baseline regression, equation (11). Overall, the results reported in the previous section are confirmed in terms of both statistical and economic importance. Financial sector growth is detrimental to industries that have more tangible assets or are more R&D-intensive. Taken together, this leads us to conclude that our results are quite robust.

5. Conclusion

In this paper, we study the real effects of financial sector growth and come to two important conclusions. First, the growth of a country's financial system is a drag on productivity growth. That is, higher growth in the financial sector reduces real growth. Financial booms are not, in general, growth-enhancing. Second, using sectoral data, we examine the distributional nature of this effect and find that credit booms harm what we normally think of as the engines for growth – those industries that have either lower asset tangibility or high R&D-intensity. This evidence, together with recent experience during the financial crisis, leads us to conclude that there is a pressing need to reassess the relationship of finance and real growth in modern economic systems.

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Data appendix

Data sources for country level-regressions:

OECD Economic Outlook database: Real GDP, Nominal GDP, Dependent employment, Private consumption expenditure deflator, Imports of goods and services, Exports of goods and services, Government final consumption expenditure.

IMF database: Financial Liberalisation index, financial reform indicator.

BIS database: Total credit to the private non-financial sector, Total credit to the private non-financial corporations, Bank credit to the private non-financial sector.

OECD STAN and EUKLEMS database: Employment in financial intermediation sector, Employment in financial intermediation and real estate service sector, Employment in construction sector, Employment in manufacturing sector.

Data sources for industry level-regressions:

OECD STAN database: Industry value added, Industry employment, Industry R&D intensity, Value added in manufacturing sector and employment in manufacturing sector.

Braun data: Industry asset tangibility.

BIS database: Total credit to the private non-financial sector, Total credit to the private non-financial corporations, Total credit to households.

IMF database: Financial Liberalisation index, financial reform indicator.

OECD Economic Outlook database: Nominal GDP, Nominal short term interest rate, Nominal long-term interest rate, Government fiscal balance, Government expenditures, Imports of goods and services, Exports of goods and services, Current Account balance.

Table A1
Industry characteristics

Code[1]	Description	Asset tangibility	R&D intensity[3]
1500	Food products and beverages	36.82%	1.25%
1516	Food products, beverages and tobacco	36.33%	1.18%
1600	Tobacco products	22.08%	0.26%
1700	Textiles	21.80%	0.88%
1718	Textiles, textile products, leather and footwear	20.94%	1.12%
1719	Textiles and textile products	28.79%	0.73%
1800	Wearing apparel, dressing and dyeing of furniture	23.49%	1.47%
1900	Leather, leather products and footwear	32.04%	0.80%
2000	Wood and products of wood and cork	42.67%	0.31%
2100	Pulp, paper and paper products	32.42%	0.00%
2122	Pulp, paper, paper products, printing and publishing	27.42%	1.14%
2200	Printing and publishing	21.30%	0.00%
2300	Coke, refined petroleum products and nuclear fuel	39.02%	5.21%
2325	Chemical, rubber, plastics and fuel products	27.14%	9.67%
2400	Chemicals and chemical products	26.61%	13.51%
2401	Chemicals excluding pharmaceuticals	29.68%	8.55%
2423	Pharmaceuticals	16.81%	25.58%
2500	Rubber and plastics products	30.38%	2.86%
2600	Other non-metallic mineral products	42.39%	1.79%
2700	Basic metals	31.35%	1.60%
2728	Basic metals and fabricated metal products	25.92%	1.43%
2800	Fabricated metal products, except machinery and equipment	25.05%	1.35%
2900	Machinery and equipment, nec	22.24%	5.06%
3000	Office, accounting and computing machinery	17.54%	35.34%
3033	Electrical and optical equipment	23.82%	23.13%
3100	Electrical machinery and apparatus, nec	23.82%	8.43%
3200	Radio, television and communication equipment	21.33%	22.45%
3300	Medical, precision and optical instruments	21.37%	34.38%
3400	Motor vehicles, trailers and semi-trailers	23.96%	15.73%
3435	Transport equipment	24.05%	20.75%
3500	Other transport equipment	23.44%	28.67%
3510	Building and repairing of ships	23.95%	0.00%
3529	Railroad equipment and transport equipment, nec	21.01%	11.56%
3530	Aircraft and spacecraft	23.37%	34.35%
3637	Manufacturing, nec, and recycling	25.92%	0.97%

[1] ISIC Rev 3 classification. [2] Tangible assets as a fraction of total assets. [3] R&D intensity is the ratio of R&D expenditures to value added.

Sources: OECD (2011);Braun (2005); authors' calculations.

Table A2

Industry productivity growth, asset tangibility and growth in finance

Interaction of asset tangibility with	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Private Credit to GDP Growth	4.530*** (1.660)	6.254*** (2.111)	4.123** (1.645)	4.203** (1.758)	5.842** (2.334)	6.027*** (2.224)	5.882** (2.968)	4.800*** (1.709)	4.677*** (1.717)	4.846*** (1.831)	5.048** (2.055)
Variable added to equation (11) is the interaction of asset tangibility with											
Initial credit to GDP (log of)		0.419** (0.189)									
Real short-term interest rate			-0.0508 (0.0428)								
Real long-term interest rate				-0.0349 (0.0663)							
Nominal long-term interest rate					-0.0697 (0.0495)						
Nominal short-term interest rate						-0.0741* (0.0388)					
Inflation							-4.794 (6.447)				
Fiscal balance to GDP								-0.670 (0.704)			
Fiscal expenditure to GDP									-0.276 (0.563)		
Trade Balance to GDP										0.481 (0.753)	
Current Account to GDP											0.535 (0.799)
Observations	420	420	420	420	420	420	420	420	420	420	420
R-squared	0.346	0.362	0.349	0.347	0.350	0.354	0.348	0.347	0.346	0.347	0.347

The table provides the estimation results from adding variables to regression equation (11) one at a time. The dependent variable is labour productivity measure as the average annual growth rate in real value-added per person employed for the period 2000–08 for each industry in each country. Initial relative labour productivity is the ratio of industry labour productivity per worker to total manufacturing labour productivity per worker in 2000. Asset tangibility is the median for U.S. companies in the industry for the period 1986-1995. Interaction variables are the product of interacted variables. Robust standard errors are in parentheses. All estimations include country and industry dummies. Significance at the 1/5/10% level is indicated by ***/**/*. Country sample: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Italy, Japan, the Netherlands, Norway, Portugal, and Sweden.
Sources: OECD Structural Analysis database; BIS credit database; Braun (2005); authors' calculations.

Table A3

Industry productivity growth, R&D intensity and growth in finance

Interaction of R&D intensity with	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Private Credit to GDP Growth	-3.640*** (0.965)	-4.021*** (1.167)	-3.529*** (0.952)	-3.436*** (1.014)	-3.583*** (1.281)	-3.586*** (1.246)	-3.062* (1.650)	-3.781*** (1.003)	-3.688*** (1.017)	-3.895*** (1.063)	-3.944*** (1.185)
Variable added to equation (11) is the interaction of R&D intensity with											
Initial credit to GDP (log of)		-0.0885 (0.114)									
Real short-term interest rate			0.0119 (0.0281)								
Real long-term interest rate				0.0203 (0.0395)							
Nominal short-term interest rate					-0.00338 (0.0281)						
Nominal long-term interest rate						-0.00310 (0.0239)					
Inflation							-2.146 (3.790)				
Fiscal balance to GDP								0.425 (0.687)			
Fiscal expenditure to GDP									0.0877 (0.340)		
Trade Balance to GDP										-0.367 (0.469)	
Current Account to GDP											-0.303 (0.477)
Observations	395	395	395	395	395	395	395	395	395	395	395
R-squared	0.385	0.387	0.386	0.386	0.385	0.385	0.386	0.386	0.386	0.387	0.386

The table provides the estimation results from adding variables to regression equation (11) one at a time. The dependent variable is the average annual growth rate in real value-added per person employed for the period 2000–08 for each industry in each country. Initial relative labour productivity is the ratio of industry labour productivity per worker to total manufacturing labour productivity per worker in 2000. R&D intensity is the average for the ratio of R&D expenditures to value added for US industries for the period 1990–2000. Interaction variables are the product of interacted variables. Robust standard errors are in parentheses. All estimations include country and industry dummies. Significance at the 1/5/10% level is indicated by ***/**/*.

Country sample: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Italy, Japan, the Netherlands, Norway, Portugal and Sweden.

Sources: OECD Structural Analysis database; World Bank Financial Structure and Development database; Braun (2005); authors' calculations.