NBER WORKING PAPER SERIES

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Working Paper 25079
http://www.nber.org/papers/w25079

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2018

We thank Claudio Borio, Dietrich Domanski, Barry Eichengreen, Andrew Filardo, Leonardo Gambacorta, Nobu Kiyotaki, Christian Upper and Fabrizio Zampolli for helpful discussions; and Garry Tang for valuable research assistance. The views expressed in this paper are those of the authors and not necessarily those of the BIS or the National Bureau of Economic Research.

At least one co-author has disclosed a financial relationship of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w25079.ack

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NBER Working Paper No. 25079
September 2018
JEL No. D92,E22,E44,O4

ABSTRACT

We examine the negative relationship between the rate of growth in credit and the rate of growth in output per worker. Using a panel of 20 countries over 25 years, we establish that there is a robust correlation: the higher the growth rate of credit, the lower the growth rate of output per worker. We then proceed to build a model in which this relationship arises from the fact that investment projects that are more risky have a higher return. As their borrowing grows more quickly over time, entrepreneurs turn to safer, hence lower return projects, thereby reducing aggregate productivity growth. We take this theoretical prediction to industry-level data and find that credit growth disproportionately harms output per worker growth in industries that have either less tangible assets or are more R&D intensive.

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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, they require 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 percent of GDP.[2]

In this paper, we examine the relationship between credit *growth* and real growth. And, unlike the level relationship, where finance is good before turning bad, in this case the result is unambiguous: the faster the growth in credit, the worse it is for real growth. Using a panel of 20 countries over 25 years, we establish that there is a robust, economically meaningful, negative correlation between output per worker growth and growth in real credit. And, that causality likely runs from finance to output.

To understand the mechanism that lies behind this relationship, *how* the growth in credit reduces growth in output per worker, we construct a model where entrepreneurs can choose among a set of projects which differ in their risk and average return. Our model builds on two key assumptions. First, as is standard, projects that are more risky yield a higher average return. Entrepreneurs are therefore confronted with the traditional risk-return trade-off. 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 growth in credit, the safer and less productive the projects that are undertaken, and the slower the real economy grows.[3] In addition when entrepreneurs are heterogeneous in their borrowing capacities, aggregate credit growth tends to affect disproportionately those with lower borrowing capacity.

We take this theoretical prediction to sector-level data. Focusing on manufacturing industries, we confirm that the less tangible an industry's assets, or the more R&D intensive it is (our proxies for the ability to borrow) the more credit growth harms productivity growth. That is, the less pledgeable an industries' inputs or outputs, the more damaging are financial booms.

The remainder of the paper is divided into three main 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

[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).

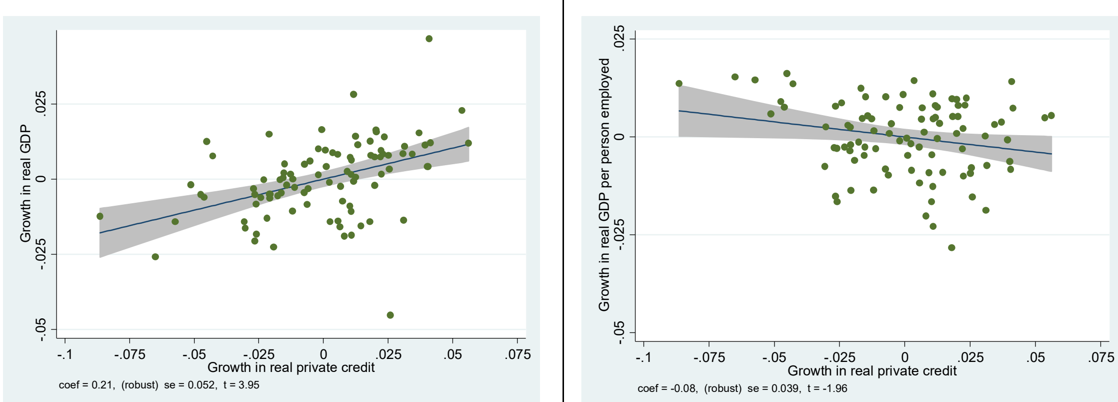
[3] In the model, the return on the projects undertaken by entrepreneurs directly affects the growth rate of total factor productivity.

sections 3, we describe the model that guides our thinking about the relationship between credit growth and productivity growth. 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 negative effects of credit growth 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 credit will experience growth in value added per worker that is roughly 2 to 2½ percentage points per year less than an industry that is not very R&D-intensive located in a country with a slow-growing credit. The final section concludes.

2. Country-level data

We begin our analysis at the country-level. In the left-hand panel of Graph 1 we plot growth in real GDP on the vertical axis against growth in real credit to the private sector on the horizontal axis. In the right hand panel, we examine growth in real GDP *per person employed* versus growth in real credit to the private sector. Our sample includes 20 advanced economies from 1985 to 2009.[4] In every case, data are averaged over five year non-overlapping periods and measured as deviations from the country mean. The results show that real GDP and real credit growths are correlated as would be expected, positively. But in the case of real GDP per worker, the correlation turns negative. As real credit grows faster, labour productivity growth declines. We note that the line running through the scatter plot has a negative slope with a coefficient that is significantly less than zero at standard confidence levels.

Graph 1: Growth in output and output per worker versus real credit growth

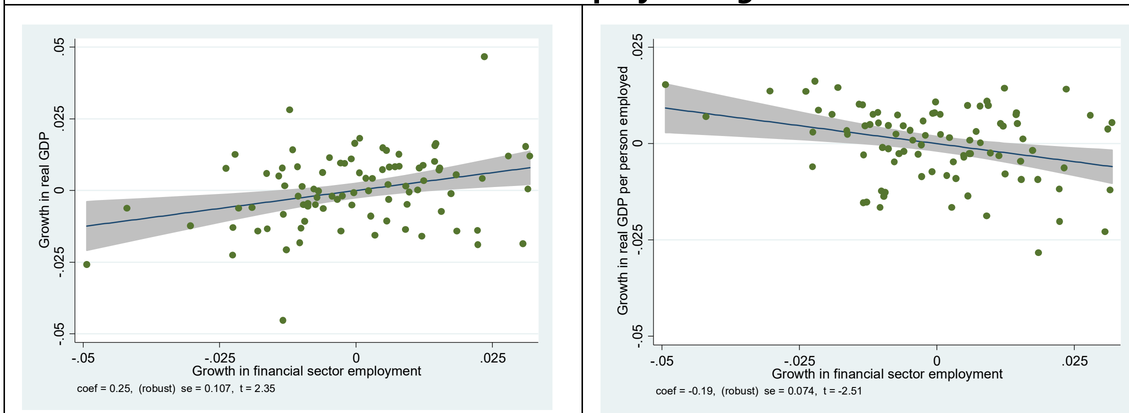


Graphs plot non-overlapping five year averages rates of deviation from country means for Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, the United Kingdom, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Sweden and United States over the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

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

Results using growth in the financial intermediation sector employment shown in Graph 2 are similar. Again, the right-hand panel shows a clear negative relationship between growth in output per worker and growth in financial sector employment.

Graph 2: Growth in output and output per worker vs. financial sector employment 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.

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 the financial sector to the real economy.

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]

$$(1) \quad y_{i,t+5} = \alpha_i + \alpha_t + \phi f_{i,t+5} + \omega X_{i,t} + \varepsilon_{i,t},$$

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 and α_t are country and time fixed effect, $f_{i,t+5}$ is a measure of growth in the financial sector (credit or employment) 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, and the log level of output per person employed. The data sample is again from 1985 to 2009.

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

Table 1:
Growth in GDP per person employed and growth in finance

Measure of growth in finance	**(1)**	**(2)**	**(3)**	**(4)**
Total real private credit	-0.084** *(0.036)*			
Real private credit to non-financial firms		-0.079*** *(0.032)*		
Real private credit to households			-0.027 *(0.029)*	
Financial sector employment				-0.158*** *(0.045)*
R-squared	0.781	0.776	0.755	0.797
Number of Obs.	90	81	81	87

Note: Results for equation (1): $y_{i,t+5} = \alpha_i + \alpha_t + \phi f_{i,t+5} + \omega X_{i,t} + \varepsilon_{i,t}$ where y_{it+5} is growth in output per person employed in country *i* between year *t* and year *t+5*, α_i and α_t are country and time fixed effect, f_{it+5} is a measure of growth of the financial sector (real credit, deflated by the GDP deflator, or financial sector employment) 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, and the log level of output per person employed. All regressions include country and time fixed effects. Robust standard errors in parentheses. Statistical significance at 1; 5 and 10% respectively denoted with ***/**/*. Data sources are described in the appendix.

These results confirm those of Graph 1. When we control for (some of) the established determinants of output growth – inflation, the size of the government– as well as catch-up effects (in the log level of GDP per person employed), the negative relationship between growth in the financial and growth in real GDP per person employed remains. Moreover, in the case of credit, the negative correlation is driven by credit to firms, as growth in household credit is not significantly correlated with output per worker growth (the estimated coefficient is negative, but with a t-stat less than minus one).

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, real credit to the private sector more than doubled, growing 15.1 percent per year. By contrast, over the five years from 1990 to 1995, it grew at a more modest average annual rate of 7.4 percent. The estimate in Table 1 ($\hat{\phi}$ =-0.084) implies that this 7.7 percentage point difference has resulted in a productivity slow-down over 2005-2010 of 0.65 percentage points per year compared to the period 1990-1995. This accounts for around 30 per cent of the 2.1 percentage point drop in productivity growth (from 2.5 to 0.4 percent at an annual rate) that occurred over this period.

Turning to Spain, from 1990 to 1995 financial sector employment fell by –0.4 percent per year, while Spanish productivity was growing +1.7 percent per year. Fifteen years later, from 2005 to 2010, financial sector employment grew 2.6 percent a year but productivity grew only 0.7 percent a year. Our estimates suggest that his change accounts for roughly half of the decline. That is, if financial sector employment had continue to decline modestly instead of rising, then productivity growth in Spain over 2005-2010 would have been 1.2 percent per year, roughly half a percentage point higher than it was.

Of course changes in the growth rate of private credit or in the growth rate of financial sector employment cannot account for all fluctuations in output per worker growth. In particular, there are a variety of alternative factors that influence both output per worker growth and each of our three financial sector growth variables. The next section looks at them more closely.

Before continuing, it is important to note the contrast between the results in Table 1, which emphasize the importance of credit to firms, and those reported in Mian, Sufi and Verner (2017), who focus on credit to households.[6] An important difference is that we are looking at contemporaneous effects, while Mian et al. examine lagged effects. That is, we find that the faster real credit to nonfinancial firms rises, the slower productivity grows. As we will discuss, we see this as largely a consequence of reallocation of resources in which finance is favouring relatively low productivity growth activities. Our supply-side perspective as complementary with the demand-side story that growing household debt is associated with lower future aggregate growth resulting an increased likelihood that consumers will face binding liquidity constraints and be forced to reduce their consumption.

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

To support our interpretation of the results in Table 1, we turn to a more detailed investigation of alternative explanations. For example, if credit 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).[7]

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 to households relative to that going to firms, this could change the composition of production away from relatively high productivity investment goods to 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.[8]

[6] See also the discussion in Mian and Sufi (2018).

[7] As Cecchetti, Mohanty and Zampolli (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.

[8] 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.

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.[9] Although this could give rise to our results, we note that since the financial sector is more likely to grow faster when the real economy grows more quickly, reverse causality is likely to give rise to a positive, not negative correlations.[10]

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 (IV). Table 2 summarizes the issues and the control variables used to address them.

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 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

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

[10] 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.

instrumenting for credit growth and financial sector 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 person employed and the right-hand-side variables include those in the baseline results reported in Table 1.

We use three variables to instrument private real credit 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.[11] We base our choice of instruments on the view that a change in long term rates affects productivity growth essentially through credit growth.[12] Similarly, we presume that credit growth is the main channel 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, ϕ 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 real credit growth, the coefficient of interest in the OLS regressions ranges from -0.07 to -0.10.[13] And when we use the financial sector employment growth, the coefficient of interest ranges in the OLS regressions from -0.15 and -0.18. Furthermore, there is no case where the effect is not statistically significantly different from zero at the 5 percent level.

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

[11] The dummy variable set to one if the financial liberalisation index increases. Data on financial liberalisation and financial reforms are drawn from Abiad et al. (2008).

[12] 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.

[13] The range is even narrower when using private real credit to non-financial firms.

Table 3: Robustness

	Measure of growth in finance		
	Private real credit	**Private real credit to firms**	**Financial sector employment**
Baseline	-0.084** *(0.036)*	-0.079*** *(0.032)*	-0.158*** *(0.045)*
Control added			
1. Level of variable used to measure growth in finance[a]	-0.0959** (0.0388)	-0.0932*** (0.0337)	-0.147** (0.0552)
2. Share of credit from banks	-0.0829** (0.0355)	-0.0778** (0.0323)	-0.154*** (0.0445)
3. Share of credit to firms	-0.0882** (0.0386)	-0.0830** (0.0323)	-0.171*** (0.0517)
4. Const. & Real Estate employment share	-0.0844** (0.0354)	-0.0738** (0.0322)	-0.177*** (0.0432)
5. Manufacturing employment share	-0.0743** (0.0368)	-0.0717** (0.0321)	-0.151*** (0.0508)
6. Crisis indicator	-0.0827** (0.0344)	-0.0776** (0.0322)	-0.156*** (0.0458)
7. Instrumental variables[b]	-0.187** (0.085)	-0.199*** (0.058)	-0.194** (0.088)

[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] Growth in private real credit and growth in private real credit by firms are instrumented using (1) the ratio of bank credit to total credit, (2) the ratio of credit to firms to total credit, (3) the ratio of financial sector employment to total employment, (4) a dummy variable which equals one if there is evidence of financial reform, (5) a dummy variable which equal one if there is evidence of a large financial reform. Financial sector employment growth is instrumented using (1) the ratio of bank credit to total credit, (2) the ratio of manufacturing employment to total employment, (3) the ratio of financial sector employment to total employment, (4) a dummy variable which equals one if there is evidence of financial reform, (5) a dummy variable which equal one if there is evidence of a large financial reform. All instruments are measured using beginning of period values. In each of the three different estimations, the Hansen test cannot reject the null hypothesis that the instruments are all valid.

The conclusion from the country-level data is clear: credit growth or financial sector employment growth is a drag on output per worker growth. The impression from Graph 1 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 total factor productivity growth.

3.1 The general framework, returns and borrowing constraints

Consider a small open economy with overlapping generations of entrepreneurs who live for three periods. Entrepreneurs born at time t receive a bequest E_t from the generation born at time $t-1$. Generation t entrepreneurs combine this bequest with borrowing B_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, B_t, (ii) bequeath E_{t+1} to the next generation who is just born and (iii) savings S_{t+1}. Entrepreneurs born at time t can then combine savings S_{t+1} with some new borrowing B_{t+1} to invest in the same project at time $t+1$. Finally at time $t+2$, generation t entrepreneurs reap the project's output and use it to for two different tasks: (i) pay back liabilities B_{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) $$U_t = \log E_{t+1} + \beta \log C_{t+2}$$

Projects entrepreneurs can invest in, are indexed by their first period return which we denote R_1. Entrepreneurs face a risk return trade-off: namely, projects with a higher first period return R_1 also face larger uncertainty during the second period return which we denote R_2. For simplicity we assume that the second period return can, with equal probabilities, be either high $R_2 = R + \sigma(R_1)$ or low $R_2 = R - \sigma(R_1)$, with $\sigma'(\cdot)>0$. Moreover we assume all available projects have positive average net present value (NPV), so that $R_1; R_2>1$. Finally an entrepreneur can borrow at most an amount b_t for each unit of own funds at date t.

3.2 The dynamics of the economy

Turning to the dynamics of this economy, we start by denoting the first and second period profit –per unit of own funds- from a project undertaken in period *t* respectively as $\pi_t(R_{1,t})$ and $\pi_{t+1}(R_{2,t})$. We are now able to write the utility maximization problem for an entrepreneur born at date *t* as

(3) $$\max_{E_{t+1};C_{t+2}} U_t = logE_{t+1} + \beta E logC_{t+2}$$

$$\text{s.t.} \begin{cases} E_{t+1} + S_{t+1} = \pi_t(R_{1,t})E_t \\ C_{t+2} = \pi_{t+1}(R_{2,t})S_{t+1} \end{cases}$$

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

(4) $$E_{t+1}^* = \frac{1}{1+\beta}\pi_t(R_{1,t})E_t$$
and
$$C_{t+2}^* = \frac{\beta}{1+\beta}\pi_{t+1}(R_{2,t})\pi_t(R_{1,t})E_t$$

The first expression governs the growth rate of the economy for a given project $(R_{1,t})$ chosen at date t. To see this, simply divide by E_t and note that bequests (and hence the economy) grow at the rate $\pi_t(R_{1,t})/(1+\beta)$.

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

3.3 Optimal project choice

Given that projects are all positive NPV, entrepreneurs always borrow as much as possible. Hence denoting b_t the amount of borrowing at date t per unit of own funds, the profit rates $\pi_t(R_{1,t})$ and $\pi_{t+1}(R_{2,t})$ for an entrepreneur investing at date t in a project with first period return $R_{1,t}$ satisfy

(5) $$\pi_t(R_{1,t}) = (1 + b_t)R_{1,t} - b_t \text{ and } \pi_{t+1}(R_{2,t}) = (1 + b_{t+1})R_{2,t} - b_{t+1}$$

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

(6) $$\max_{R_{1,t}} (1+\beta) log\pi_t(R_{1,t}) + \beta E log\pi_{t+1}(R_{2,t})$$
$$\text{s.t. } R_{2,t} = \begin{cases} R - \sigma(R_{1,t}) \text{ with probability } \frac{1}{2} \\ R + \sigma(R_{1,t}) \text{ with probability } \frac{1}{2} \end{cases}$$

Projects with a large return R_1 yield large first period profits, which fulfils two purposes as entrepreneurs can make a large bequest and can also enjoy large savings which will be used for the second period investment and will hence eventually help raise final consumption. However, projects with a large return R_1, while they contribute to raise second period consumption on average, also make it more volatile, which reduces agent's welfare. To find out how entrepreneurs trade-off higher bequest and average consumption against more volatile consumption, we can write the first-order condition: Denoting $\delta_t = b_t/(1+b_t)$, the debt to asset ratio, the optimal project entrepreneurs choose satisfies the following first order condition:

(7) $$\frac{R_{1,t} - \delta_t}{1+\beta} = \frac{1}{\beta} \frac{(R - \delta_{t+1})^2 - \sigma^2(R_{1,t})}{\sigma(R_{1,t})\sigma'(R_{1,t})}$$

Using (7), we can now derive the following result:

Entrepreneurs choose projects with lower average return $R_{1,t}$ when their borrowing capacity at date t+1 increases relative to their borrowing capacity at date t. That is, when credit grows more quickly, entrepreneurs undertake lower average return project, and so productivity grows more slowly.

To see this, we just need to differentiate the optimality condition (7) with respect to the return R_1 and the future borrowing capacity δ_{t+1}. Doing so yields:

(8) $$\left[1 + \frac{\beta}{2(1+\beta)} + \frac{(R-\delta_{t+1})^2 - \sigma^2(R_{1,t})}{2\sigma(R_{1,t})\sigma'(R_{1,t})}\left[\frac{\sigma'(R_{1,t})}{\sigma(R_{1,t})} + \frac{\sigma''(R_{1,t})}{\sigma'(R_{1,t})}\right]\right]\frac{dR_{1,t}}{d\delta_{t+1}} = -\frac{R-\delta_{t+1}}{\sigma(R_{1,t})\sigma'(R_{1,t_1})}$$

The term in bracket on the left-hand side in (8) is positive while the term on the right hand side is negative. Entrepreneurs therefore respond to an increase in future borrowing by choosing projects with a lower return R_1 and a lower variance σ.

The intuition for this result is straightforward. The larger is b_{t+1}, or equivalently δ_{t+1}, the more costly are risky projects for agents' welfare. The key point to note here is that the marginal utility of second period consumption increases with the amount of borrowing. Hence when borrowing is high, a negative shock further raises the marginal utility of consumption. Since entrepreneurs prefer to avoid the case of large marginal utility of consumption, they tend to invest in safer less productive projects when borrowing is larger. Note that the opposite is the case for current borrowing: an increase in current borrowing b_t raises the marginal utility of bequest and entrepreneurs respond by choosing more productive/more risky projects.

3.4 Credit growth and output growth

Denoting $R_{1,t}$ the first period return for projects started on date t, growth, given by the dynamics of the initial endowment E_t, is therefore a positive function of current borrowing but a negative function of future borrowing:

(9) $$\frac{E_{t+1}}{E_t} = \frac{\pi(R_{1,t})}{1+\beta} \text{ and } \frac{\partial E_{t+1}/E_t}{\partial b_{t+1}} < 0 < \frac{\partial E_{t+1}/E_t}{\partial b_t}$$

Note that entrepreneurs' project choice $R_{1,t}$ affects directly the total factor productivity growth of the economy. Similarly, output at date t+1 is the sum of the first period output for entrepreneurs starting their project at date t and the second period output for entrepreneurs who started their project at date t-1. Output at date t+1 satisfies:

(10) $$y_{t+1} = \frac{1+b_t}{1+\beta}\left(R_{1,t} + \beta R_{2,t-1}\right)\pi\left(R_{1,t-1}\right)E_{t-1}$$

And, we can write the growth rate of output between t and t+1 as

(11) $$\frac{y_{t+1}}{y_t} = \frac{R_{1,t}+\beta R_{2,t-1}}{R_{1,t-1}+\beta R_{2,t-2}}\frac{1+b_t}{1+\beta}\left(R_{1,t-1} - \delta_{t-1}\right)$$

We can now state our main result:

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

Interestingly, as was the case for the dynamics of initial endowment E_t, changes in the *level* of credit have positive effects on output growth in our model. To see this, consider an increase in b_t. This has two effects. On the one hand, there is a direct positive effect as entrepreneurs can raise more resources for investment. On the other hand, an increase in current borrowing has a positive effect on the returns $R_{1,t}$ and $R_{2,t-1}$ while it has a negative effect on the return $R_{1,t-1}$. These two forces hence go in the same direction: an increase in date-t borrowing raises the growth rate of output between date t and date t+1.

3.5 Heterogeneous entrepreneurs

Up to now, we have assumed that entrepreneurs are all the same. In practise however, they differ, especially in their borrowing capacity. Consider then the case in which entrepreneurs are indexed according to their borrowing capacity $b_{i,t}$ at time t, a higher index i corresponding to a larger borrowing capacity $b_{i,t}$.

Then assuming $\sigma(\cdot)$ is linear with $\sigma'(\cdot)=\sigma$, denoting $\delta_{i,t} = b_{i,t}/(1+b_{i,t})$, and defining $R_{i,1,t}$ at the project chosen by entrepreneurs with borrowing capacity $b_{i,t}$ at time t, the first order condition (8) simplifies to

$$\frac{\partial R_{i,1,t}}{\partial b_{t+1}} = -F\left(\delta_{i,t};\delta_{i,t+1}\right)\frac{\partial \delta_{i,t+1}}{\partial b_{t+1}} \tag{12}$$

where $\partial\delta_{i,t}/\partial b_t > 0$ and the function $F(\cdot, \cdot)$ is positive and decreasing in both arguments. Hence, as was the case with homogenous entrepreneurs, as future borrowing capacity b_{t+1} increases, entrepreneurs choose less productive, less risky projects. However this effect is dampened for entrepreneurs enjoying a larger borrowing capacity when

$$\frac{\partial}{\partial i}\frac{\partial R_{i,1}}{\partial b_{t+1}} = -\left[\frac{\partial \delta_{i,t+1}}{\partial b_{t+1}}\frac{\partial F\left(\delta_{i,t};\delta_{i,t+1}\right)}{\partial i} + F\left(\delta_{i,t};\delta_{i,t+1}\right)\frac{\partial}{\partial i}\frac{\partial \delta_{i,t+1}}{\partial b_{t+1}}\right] > 0. \tag{13}$$

When credit growth disproportionately benefits entrepreneurs with a lower borrowing capacity, i.e. $\frac{\partial}{\partial i}\frac{\partial \delta_{i,t+1}}{\partial b_{t+1}} \leq 0$, then condition (10) always holds.[14]

An increase in the rate of credit expansion therefore tends to generate a disproportionate drop in growth for entrepreneurs with a lower borrowing capacity relative to those with a larger borrowing capacity.

4. Industry-level data empirical investigation

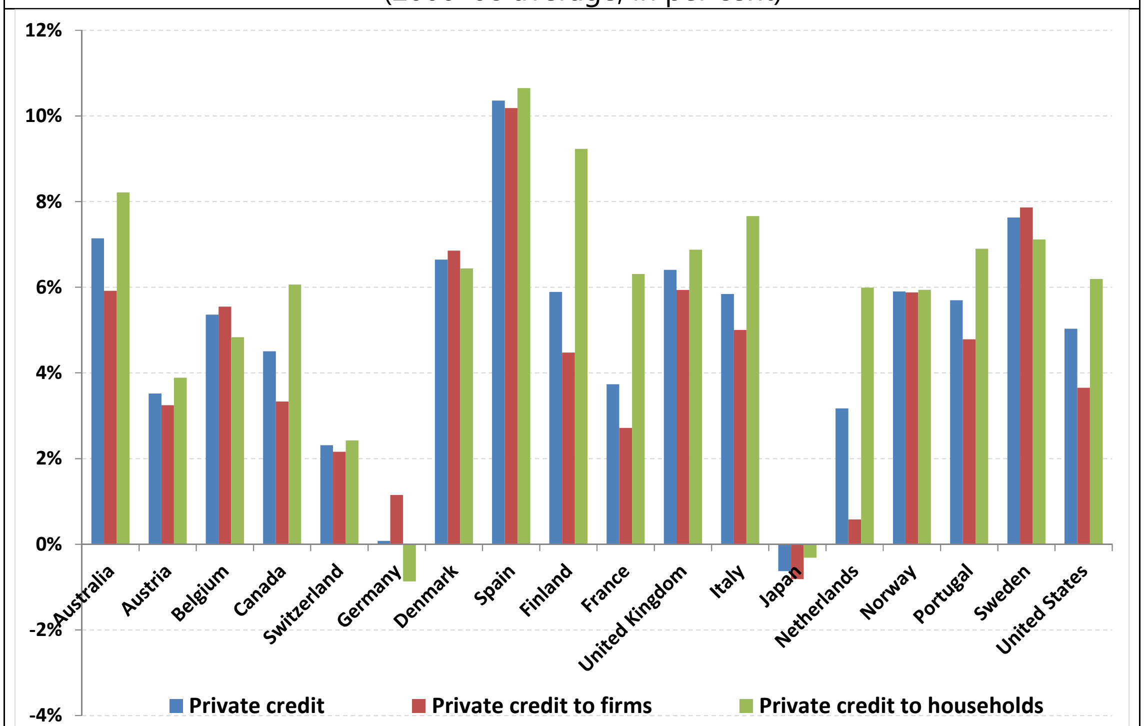
Two main conclusions emerge from the model of the previous section. First, the model's predictions match the empirical results at the aggregate level reported in Section 2: credit growth is negatively correlated with productivity growth. Second, the model shows that credit growth disproportionately harms entrepreneurs based on their ability to borrow. Specifically, the more tangible an entrepreneur's assets, or the easier it is for them to pledge their output, the less they will be harmed as credit growth increases. To figure out which sectors are these likely to be, we consider a measure of asset tangibility. And, we use R&D intensity as a proxy for the ability to pledge output.

[14] Note that the condition $\frac{\partial}{\partial i}\frac{\partial \delta_{i,t+1}}{\partial b_{t+1}} \leq 0$, is sufficient but not necessary to obtain the result that entrepreneurs with a lower borrowing capacity tend to reduce by more the productivity of the projects they pick up for a given expansion in credit. For instance when an expansion in credit affects all entrepreneurs' borrowing capacity equally, then our main conclusion still holds.

4.1 The data

We start with a brief description of data both on credit and on the extent to which an individual industry owns tangible assets or output. Graph 3 plots the average growth rate from 2000 to 2008 for three credit indicators in the OECD countries in our sample. Note that Japan and Germany have experienced zero or even negative real credit growth. Switzerland exhibits very balanced credit growth across firms and households (around 2 percent). Unsurprisingly, Spain shows a strong boom regardless of how it is measured. So far, this is as expected. What is surprising is the fact that there are the booms in Denmark and Sweden – close to or even larger than those in the United Kingdom and the United States.[15]

Graph 3: Real Credit 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, we construct the ratio of tangible to total assets using data from Braun (2005). Tangible assets include property, plants and equipment, while total assets adds goodwill, R&D, associated human capital, 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.

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

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.[16]

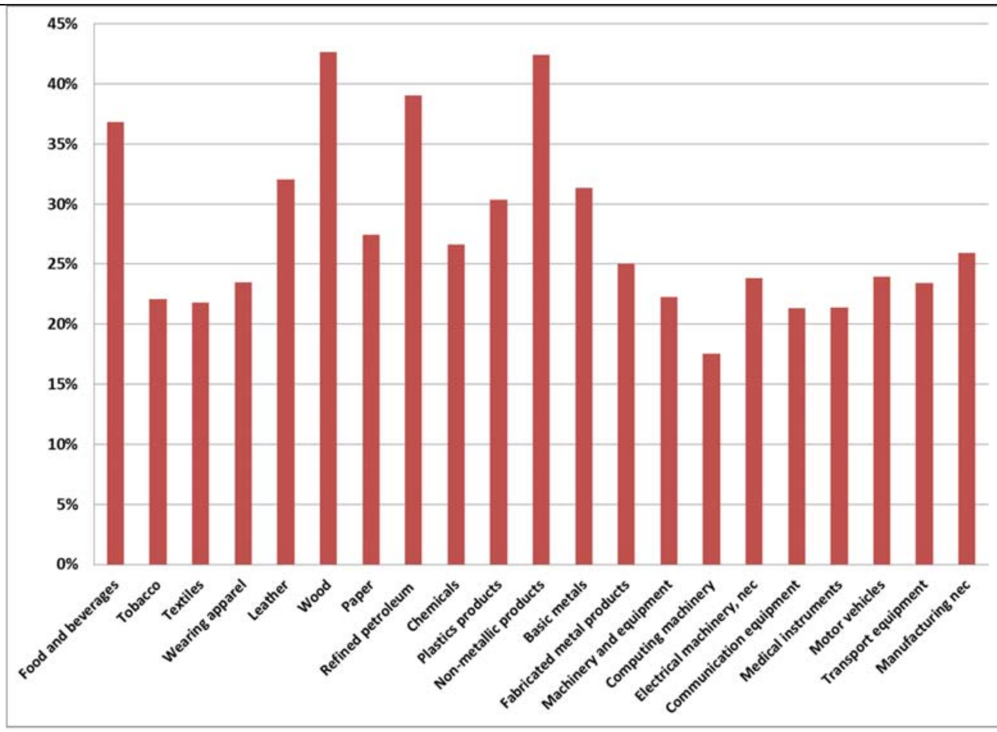
Graphs 4 and 5 report the industry-level measures. Starting with asset tangibility in Graph 4, unsurprisingly industries like petroleum refining, paper and products, and iron and steel have the highest levels of tangible assets. At the other end of spectrum is computing machinery, communication equipment and medical instruments.

Turning to R&D intensity in Graph 5, 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, we have 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 of the 33 industries in our sample, 22 display R&D expenditures of less than 10 percent of value added. By contrast, only three industries devote more than 30 percent of their value added to R&D expenditures. (We note that the correlation between the measures plotted in Graphs 4 and 5 – between our measures of asset tangibility and R&D intensity – is less than -0.5.)[17]

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

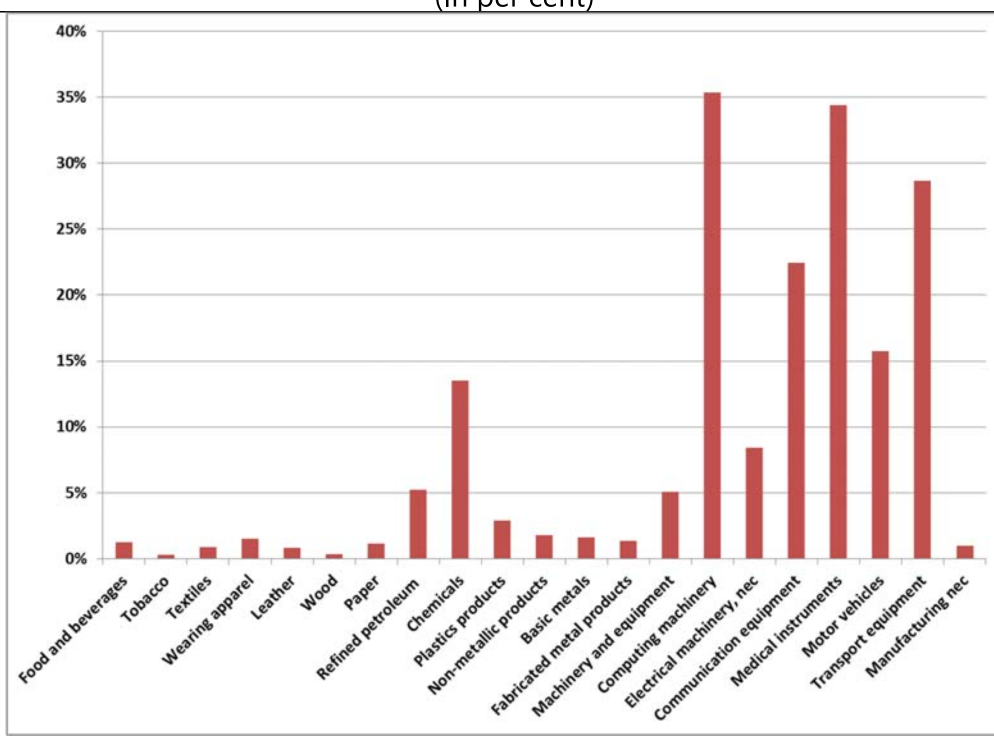
[17] Table A1 reports information on the external financial dependence and R&D intensity of the industries in the sample.

Graph 4: Asset tangibility
(by industry in percent)



Sources: Braun (2005); authors' calculations.

Graph 5: 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 to 2008. For the countries, data availability limits 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:

(14) $$y_{i,c} = \lambda_i + \lambda_c + \gamma(p_i \text{ x } g_c) - \theta z_{i,c} + \varepsilon_{i,c} \ ,$$

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 ; λ_i and λ_c are industry and country fixed effects; $p_i \times g_c$, the interaction variable of interest, is the product of industry i's measure of pledgeability p_i and country c's financial sector growth g_c. 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.[18,19]

We estimate equation (14) 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 for the essential industry characteristic – 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, growth in finance 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).

Our main results are in Table 4. Industry-level 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. When the financial sector grows more quickly, industry-level productivity 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. Furthermore, the results are robust to the measure of financial sector growth.

[18] 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 prior to 2000.

[19] 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)).

Table 4: Growth in industry productivity and growth in finance						
	(1)	(2)	(3)	(4)	(5)	(6)
Interaction of asset tangibility with						
Growth in Real Private Credit	3.860** *(1.513)*					
Growth in Real Credit to Firms		3.476*** *(1.318)*				
Growth in Real Credit to Households			2.621* *(1.408)*			
Interaction of R&D intensity with						
Growth in Real Private Credit				-3.211*** *(0.913)*		
Growth in Real Credit to Firms					-3.006*** *(0.854)*	
Growth in Real Credit to Households						-2.373*** *(0.866)*
Difference-in-difference effect (in pp)	4.44	4.42	3.59	-2.44	-2.18	-2.18
Observations	403	403	403	378	378	378
R-squared	0.361	0.356	0.349	0.399	0.394	0.386

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.

As for the quantitative implications of these estimates, we compare 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 4 reports the results from this experiment.[20] We find an effect of between 3½ and 4½ percent 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 3½-4½ 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 as the unconditional sample volatility of labour productivity growth, which is 4 percent.

Turning to industry R&D intensity, we estimate a difference-in-difference effect that is between –2 and –2½ percent. 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 percent a year more slowly than a sector with low R&D intensity located in a country whose financial system is growing slowly. This confirms the prediction of the model: financial sector growth benefits disproportionately more to sectors whose output is easy to pledge.

[20] 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*$)]$.

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-intensive 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 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 an eye toward expanding credit, particularly to 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 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.

The results of this IV procedure are reported in Table 5. The point estimates are slightly lower than their OLS counterparts reported in Table 4 for the interaction with asset tangibility but slightly larger (in absolute value) for the interaction with R&D intensity. All in all, this suggests that our results are not driven by reverse causality.[21]

[21] An interesting qualification is that, while the interaction term with growth in total real credit has the largest effect on industry productivity growth in the OLS estimates, the interaction term with growth in real credit to firms is now largest.

Table 5: Growth in industry productivity and growth in finance: IV estimates						
	(1)	(2)	(3)	(4)	(5)	(6)
Interaction of asset tangibility with						
Private Real Credit Growth	3.041** (1.332)					
Real Credit to Firms Growth		3.197** (1.432)				
Real Credit to Households Growth			2.709** (1.164)			
Interaction of R&D intensity with						
Private Real Credit Growth				-3.574*** (1.057)		
Real Credit to Firms Growth					-3.606*** (1.137)	
Real Credit to Households Growth						-3.351*** (0.870)
Observations	403	403	403	378	378	378
R-squared	0.063	0.058	0.048	0.094	0.085	0.067
J-stat	5.921	5.607	6.396	3.899	3.870	4.396
(p. value)	*(0.116)*	*(0.132)*	*(0.094)*	*(0.273)*	*(0.276)*	*(0.222)*
LM-stat	23.03	22.97	26.71	21.28	20.59	22.31
(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.

4.4 Robustness

There is a variety of plausible alternative interpretations for our industry-level results. We examine four 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, our results could be driving by changes in 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, the extent to which the economy is a net importer of both capital and goods 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 (14). 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)
Growth in Private Credit to Firms	3.476*** (1.318)	5.101*** (1.666)	3.225** (1.333)	3.201** (1.391)	4.294** (1.681)	4.675*** (1.694)	4.023** (1.927)	3.712*** (1.366)	3.505*** (1.329)	3.630** (1.427)	3.691** (1.543)
Variable added to equation (14) is the interaction of asset tangibility with											
Initial credit to GDP (log of)		0.491*** (0.173)									
Real short-term interest rate			-0.0623 (0.0446)								
Real long-term interest rate				-0.0451 (0.0676)							
Nominal long-term interest rate					-0.0573 (0.0391)						
Nominal short-term interest rate						-0.0733** (0.0331)					
Inflation							-2.742 (5.079)				
Fiscal balance to GDP								-0.566 (0.692)			
Fiscal expenditure to GDP									-0.0801 (0.544)		
Trade Balance to GDP										0.345 (0.757)	
Current Account to GDP											0.322 (0.753)
Observations	403	403	403	403	403	403	403	403	403	403	403
R-squared	0.356	0.380	0.362	0.358	0.360	0.366	0.357	0.357	0.357	0.357	0.357

The table provides the estimation results from adding variables to regression equation (14) 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)
Growth in Private Credit to Firms	-3.006*** (0.854)	-3.554*** (0.995)	-2.895*** (0.808)	-2.867*** (0.823)	-2.996*** (1.041)	-3.045*** (1.044)	-2.814** (1.108)	-3.040*** (0.911)	-2.959*** (0.893)	-3.230*** (0.878)	-3.223*** (0.933)
Variable added to equation (14) is the interaction of R&D intensity with											
Initial credit to GDP (log of)		-0.174** (0.0871)									
Real short-term interest rate			0.0166 (0.0302)								
Real long-term interest rate				0.0180 (0.0402)							
Nominal short-term interest rate					-0.000809 (0.0225)						
Nominal long-term interest rate						0.00298 (0.0207)					
Inflation							-0.991 (2.805)				
Fiscal balance to GDP								0.104 (0.803)			
Fiscal expenditure to GDP									-0.133 (0.344)		
Trade Balance to GDP										-0.422 (0.485)	
Current Account to GDP											-0.287 (0.450)
Observations	378	378	378	378	378	378	378	378	378	378	378
R-squared	0.394	0.401	0.395	0.395	0.394	0.394	0.395	0.394	0.395	0.396	0.395

The table provides the estimation results from adding variables to regression equation (14) 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.