Reassessing the impact of finance on growth

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January 2012

Conference draft

Abstract

This paper investigates how financial development affects growth at both the country and the industry level. Based on a sample of developed and emerging economies, we first show that the level of financial development is good only up to a point, after which it becomes a drag on growth. Second, focusing on advanced economies, we show that a fast-growing financial sector can be detrimental to aggregate productivity growth. Finally, looking at industry-level data, we show that financial sector growth disproportionately harms industries that are either financially dependent or R&D-intensive.

JEL classification: D92, E22, E44, O4.
Keywords: Growth, Financial Development, Credit Booms, R&D Intensity, Financial Dependence.

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1. Introduction

One of the principal conclusions of modern economics is that finance is good for growth. The idea that an economy needs intermediation to match borrowers and lenders, channelling resources to their most efficient uses, is fundamental to our way of thinking. And, since the pioneering work of Goldsmith (1969), McKinnon (1973) and Shaw (1973), we have had evidence to support our intuition that finance is good for growth. But recent experience has led many people to question whether this conclusion is definitive. Is it true regardless of the size and growth rate of the financial system? Or, like a person who eats too much, does the financial system become a bloated drag on the rest of the economy?

In this paper, we confront this question by first examining the impact of the size and growth of the financial system on aggregate economies, and then look at its impact on productivity at the level of individual manufacturing industries. We present three very striking conclusions. First, as is the case with many things in life, with finance you can have too much of a good thing. That is, at low levels, a larger financial system goes hand in hand with higher productivity growth. But there comes a point – one that many advanced economies passed long ago – where more banking and more credit lower growth.

Our second result comes from looking at the impact of growth in the financial system – measured as growth in either employment or value added – on real growth. Here we find evidence that is unambiguous: faster growth in finance is bad for aggregate real growth. One interpretation of this finding – one to which we subscribe – is that financial booms are bad for trend growth.

Finally, in our examination of industry-level data, we find that industries that are in competition for resources with finance are particularly damaged by financial booms. Specifically, we show that manufacturing sectors that are either R&D-intensive or dependent on external finance suffer disproportionate reductions in productivity growth when finance booms.

At first, these results may seem surprising. After all, a more developed financial system is supposed to reduce transaction costs, raising investment directly, as well as improve the distribution of capital and risk across the economy.[1] These two channels, through the level and composition of investment, are the mechanisms by which financial development improves growth.[2] But the financial industry competes for resources with the rest of the economy. It requires not only physical capital, in the form of buildings, computers and the like, but highly skilled workers as well. Finance literally bids rocket scientists away from the satellite industry. The result is that erstwhile scientists, people who in another age dreamt of curing cancer or flying to Mars, today dream of becoming hedge fund managers.

There is an important sense in which this description of the consequences of a financial boom is no different from those of the dotcom boom of the 1990s; or the impact of any other boom tied to more tangible output. While they are booming, these industries draw in resources at a phenomenal rate. It is only when they crash, after the bust, that we realise the

[1] See Pagano (1993) for a simple analytical model of financial development as a reduction in transaction costs in the context of an AK model. A more comprehensive approach is developed in Holmström and Tirole (1997), who provide a model for why different financial patterns (direct finance vs intermediated finance) may coexist altogether.

[2] Theoretical contributions relating the role of financial intermediaries to the composition of investment include: Acemoğlu and Zilibotti (1997), who look at how the presence of financial intermediaries affects the risk return profile of entrepreneurs' projects; Holmström and Tirole (1998), who examine how financial intermediaries can help save on liquidity hoarding; and Aghion et al (2010), who show how financial development helps reduce the growth cost of economic fluctuations.

extent of the overinvestment that occurred. Too many companies were formed, with too much capital invested and too many people employed. Importantly, after the fact, we can see that many of these resources should have gone elsewhere. Following the dotcom bust, for example, innumerable computers were scrapped, office buildings vacated and highly trained people laid off.

The remainder of the paper is divided into two parts, followed by a brief conclusion. In Section 2, we examine the impact of the level and growth rate of the financial system on productivity growth in a sample of 50 advanced and emerging countries over the past three decades.

Considering the level of financial development, we find that when private credit grows to the point where it exceeds GDP, it becomes a drag on productivity growth. Then, focusing on a set of advanced economies, we turn to growth in finance. There we find that, compared with a country where financial sector employment is stable, a typical financial boom – employment growth of 1.6% per year – reduces growth in aggregate GDP per worker by roughly one half of 1 percentage point.

In Section 3, building on the seminal paper by Rajan and Zingales (1998), we study 33 manufacturing industries in 15 advanced economies. We find unambiguous evidence for very large effects of financial booms on industries that either have significant external financing needs or are R&D-intensive. For example, we report estimates that imply that a highly R&D-intensive industry located in a country with a rapidly growing financial system will experience productivity growth of something like 2 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.

2. The country-level analysis

We begin by examining the simple relationship between the size of a country's financial system and its growth, proceeding in two steps to see whether there is a point where bigger is no longer better. First, we look at the impact of the level of financial development on productivity growth; and then we move on to examine the consequences of faster financial development for aggregate productivity growth.

2.1 The inverted U-shaped effect of financial development

A simple scatter plot of five-year non-overlapping averages for 50 advanced and emerging countries over the 1980–2009 period – some 300 data points in all – allows us to construct Graph 1. More specifically, we plot five-year average GDP-per-worker growth (our measure of productivity growth) on the vertical axis against five-year average private credit to GDP (our measure of financial development) on the horizontal axis, both as deviations from their country-specific means.

The relationship is clearly not monotonic. That is, at low levels of credit, more credit is good for growth. But there comes a point where the additional lending and a bigger financial system become a drag on growth.

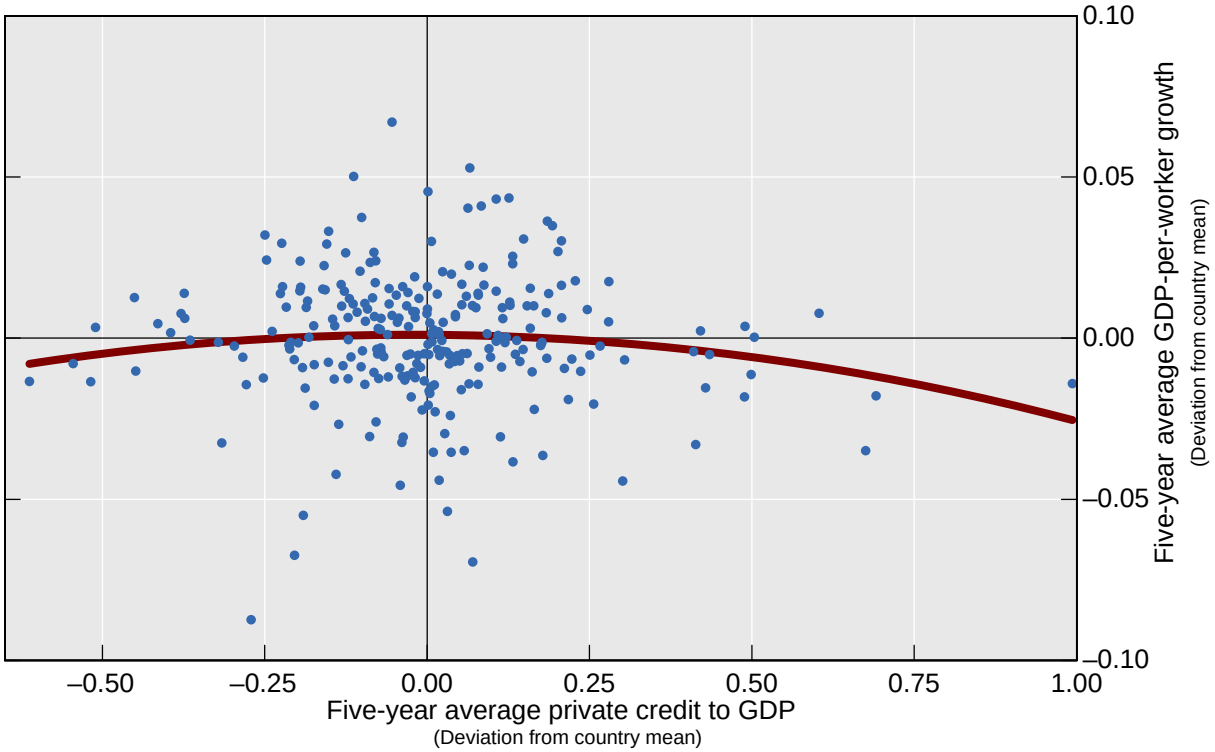
For a more precise sense of this relationship, and to test our hypothesis that the effects of finance on growth can go from good to bad, we turn to a simple regression.[3] The form of this regression is fairly simple. First, on the left-hand side we have the five-year average growth

[3] Our work in this section builds on an extensive body of research, especially the empirical literature relating growth to finance. Notable contributions on this topic include King and Levine (1993), Islam (1995), Levine and Zervos (1998), Beck et al (2000) and Cecchetti et al (2011). Comprehensive surveys can be found in Levine (1997, 2005).

in output per worker in a given country. We regress this on the following variables: the level of financial development; the squared level of financial development (looking for the parabola in Graph 1); and a series of control variables known to influence aggregate growth.

Graph 1

Financial development and growth[1]



[1] Graphical representation of $\Delta y_{k,t+5,t} = \alpha + \beta_k + \gamma_0 X_{k,t,t+5} + \gamma_1 (fd)_{k,t,t+5} - \delta y_{k,t} + \varepsilon_{k,t}$ for a sample countries over the period 1980–2009. Country sample: Argentina, Australia, Austria, Bangladesh, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Italy, Japan, Korea, Republic of, Luxembourg, Mexico, Morocco, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Philippines, Poland, Portugal, Russia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, United States, Venezuela, Vietnam.

Sources: Penn World Tables; World Bank Financial Structure and Development database; authors' calculations.

To fix ideas and notation, we write this as:

$$\Delta y_{k,t+5,t} = \alpha + \beta_k + \gamma_0 \left(fd_{k,t+5,t}\right) + \gamma_1 \left(fd_{k,t+5,t}\right)^2 + \gamma_2 X_{k,t+5,t} - \delta y_{k,t} + \varepsilon_{k,t} \quad (1)$$

where $y_{k,t}$ is the log of output per worker in country k in year t; $\Delta y_{k,t+5,t}$ is the average growth in output per worker in country k from time t to $t+5$; $fd_{k,t+5,t}$ is the average ratio of private credit to GDP in country k from time t to $t+5$, our measure of financial development; $X_{k,t+5,t}$ is a set of control variables averaged from time t to $t+5$, including working population growth, openness to trade measured by the ratio of imports and exports to GDP, the share of government consumption in GDP and CPI inflation; α is a constant and β_k is a vector of country dummies; and ε is the error term, which we allow for heteroskedasticity. Our hypothesis is that γ_0 will be positive and γ_1 negative.

Table 1 presents the results from this very simple exercise. The first column reports the result with no controls. Here we see the result that we expect – the relationship is parabolic.

Importantly, as we sequentially add control variables, this relationship very clearly survives. The linear term, γ_0, is around 0.035 and the quadratic term, γ_1, is always close to –0.018.[4]

Table 1

GDP-per-worker growth and private credit to GDP[1]

Dependent variable: five-year average real GDP-per-worker growth	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Five-year average private credit to GDP	**0.036***** *(0.011)*	**0.038***** *(0.011)*	**0.035***** *(0.011)*	**0.035***** *(0.011)*	**0.035***** *(0.011)*	**0.048**** *(0.021)*
Five-year average private credit to GDP squared	**–0.018***** *(0.005)*	**–0.018***** *(0.005)*	**–0.018***** *(0.005)*	**–0.017***** *(0.005)*	**–0.017***** *(0.005)*	**–0.022***** *(0.008)*
Log of real GDP per worker	**–0.742***** *(0.211)*	**–1.020***** *(0.210)*	**–1.110***** *(0.208)*	**–1.110***** *(0.207)*	**–1.160***** *(0.204)*	**–6.220***** *(1.200)*
Five-year working population growth		**–0.478***** *(0.162)*	**–0.480***** *(0.160)*	**–0.471***** *(0.163)*	**–0.501***** *(0.152)*	**–0.685***** *(0.162)*
Five-year average openness to trade			**0.010***** *(0.003)*	**0.010***** *(0.003)*	**0.009***** *(0.003)*	**0.054***** *(0.010)*
Five-year average government consumption share in GDP				**0.0106** *(0.046)*	**0.0107** *(0.045)*	**–0.145** *(0.331)*
Five-year average CPI inflation					**0.0378** *(0.036)*	**0.047** *(0.037)*
Turning point for the effect of private credit to GDP on real GDP-per-worker growth	**0.98**	**1.02**	**0.99**	**0.99**	**1.01**	**1.08**
Observations	270	270	270	270	270	270
R-squared	0.098	0.160	0.190	0.190	0.213	0.424

The dependent variable is the five-year average real GDP-per-worker growth for the period 1980–2009 for each country, which yields six observations for each country. Five-year averages for the independent variables are computed over the same period as the dependent variable. The log of real GDP per worker is the natural logarithm of real GDP per worker for the initial year of the period over which the averages are computed, divided by 100. All estimations include a non-reported constant. Estimation (6) includes country dummies. Robust standard errors are in parentheses. Significance at the 1/5/10% level is indicated by ***/**/*. The turning point for the effect of private credit to GDP on real GDP-per-worker growth is the level for private credit to GDP below (above) which an increase in private credit to GDP is estimated to raise (reduce) real GDP-per-worker growth.

[1] Sources: Penn World Tables; World Bank Financial Structure and Development database; authors' calculations.

To see what these numbers mean, we can look at a few examples. Starting with New Zealand, in the first half of the 1990s, private credit was below 90% of GDP. It rose steadily, reaching nearly 150% of GDP by the time of the crisis. The estimates in Table 1 suggest that

[4] We note that the results reported in Table 1 are robust to adding a variety of changes to equation (1). These include: (i) using GDP per capita instead of GDP per worker as the dependent variable; (ii) using alternative measures of financial development like private credit by banks to GDP, bank deposits to GDP, financial system deposits to GDP, or bank assets to GDP; and (iii) dropping certain countries, such as the former communist countries, from the sample.

this increase created a drag of nearly one half of 1 percentage point on trend productivity growth.

Thailand is another interesting example. In the run-up to the Asian crisis of 1997–98, the ratio of Thai private credit to GDP reached 150%. More recently, this measure of financial sector size has fallen to roughly 95%. This time, the result is a benefit of roughly one half of 1 percentage point in trend productivity growth.

Finally, take the example of the United States, where private credit grew to more than 200% of GDP by the time of the financial crisis. Reducing this to a number closer to 100% would, by our estimates, reap a productivity growth gain of more than 150 basis points.

Next, we use the results to compute an estimate of the peak of the inverted U – at the vertical line in Graph 1. These estimates are reported in the notes to Table 1 and are roughly 100% of GDP. This figure is close to the threshold of 90% computed in Cecchetti et al (2011) – a gap that is probably the result of differences in data and methods.[5]

We should be very clear that we do not in any way view these peak debt values as targets, and neither should any readers (or authorities). These are levels of debt that a country should only approach in extremis. And as discussed in more detail by Cecchetti et al (2011), under normal circumstances we would expect to see debt at much lower levels than these thresholds. Keeping debt well below 90% of GDP provides the room needed to respond in the event of a severe shock. Otherwise, should a crisis arise, the additional accumulation of debt would result in a drag on growth that would make recovery even more difficult than it already is.[6]

2.2 The real effects of financial sector growth

Having established that there is a point at which financial development switches from propelling real growth to holding it back, we now turn to an examination of the impact of the speed of development on productivity growth. Put another way, we examine how financial sector booms – periods when financial development is moving at a particularly fast pace – can affect growth.[7] To do this, we rely on a 21-country subset of the countries covered in the previous analysis.

Graph 2 summarises our main finding. Again, on the vertical axis we plot the five-year average GDP-per-worker growth. On the horizontal axis, we now plot the five-year average growth in financial sector employment.[8] (As in Graph 1, both variables are measured as deviations from their country-specific means.) The result is quite striking: there is a very clear negative relationship. The faster the financial sector grows, the worse it is for growth!

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[5] The current study uses a broader set of countries, while the latter employs a somewhat more sophisticated econometric model.

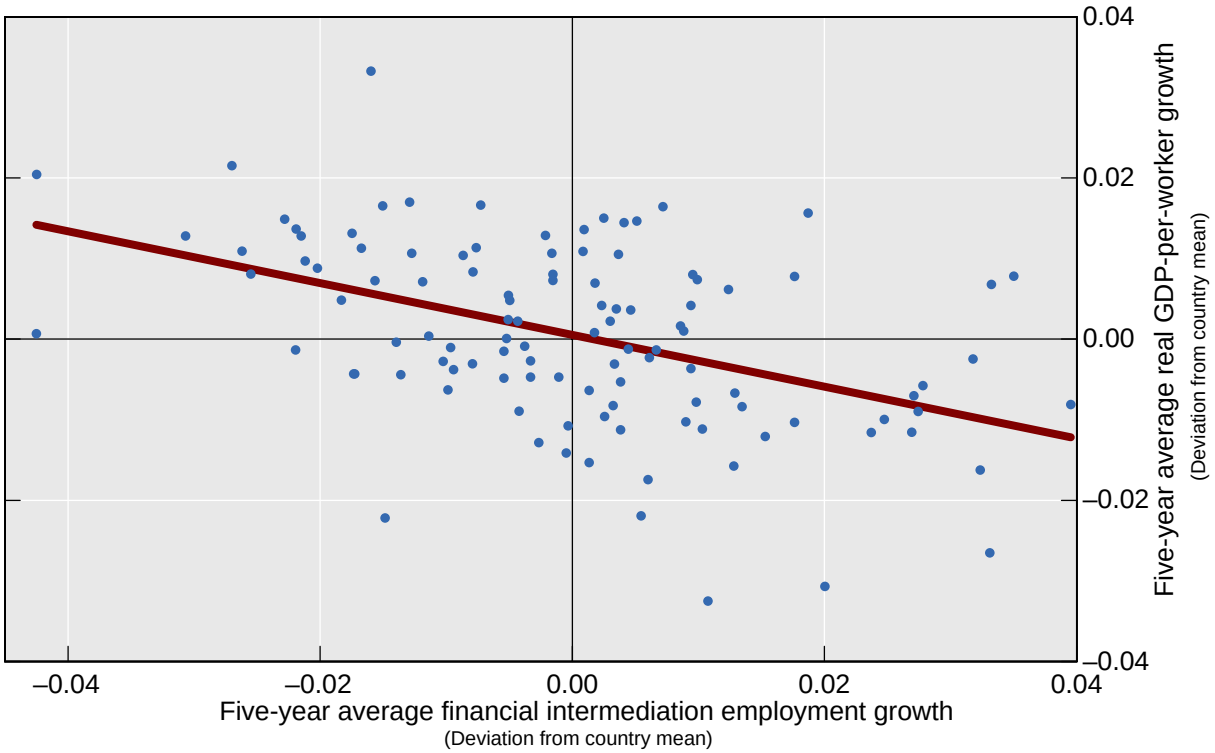
[6] This argument is consistent with the results of welfare maximisation, which would imply that, in normal times, debt should be maintained below the level at which borrowing constraints become binding.

[7] There is a large and well known literature on this financial accelerator and its quantitative implications for the business cycle (see Bernanke and Gertler (1989) and Bernanke et al (1999), for instance). Likewise, there is a significant body of research examining credit cycles (from Kiyotaki and Moore (1997) to more recent work by Caballero et al (2006) on the dotcom bubble or Lorenzoni (2008), who look at the normative implications of credit booms). We are, however, unaware of empirical studies on the implications of financial booms for long-run growth.

[8] The results reported in this section are robust to the use of financial sector value added, rather than employment.

Graph 2

Financial sector growth and productivity growth[1]



[1] Graphical representation of $\Delta y_{k,t+5,t} = \alpha + \beta_k + \gamma_0 \Delta fd_{k,t+5,t} - \delta y_{k,t} + \varepsilon_{k,t}$ for a sample of countries over the period 1980–2009, where $y_{k,t}$ is the log of output per worker in country k in year t; $\Delta y_{k,t+5,t}$ is the average growth in output per worker in country k from time t to $t+5$; $\Delta fd_{k,t+5,t}$ is the average growth in financial intermediation employment in country k from time t to $t+5$; β_k is a vector of country dummies; and $\varepsilon_{k,t}$ is a residual. Country sample: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Sources: OECD Structural Analysis database; Penn World Tables; World Bank Financial Structure and Development database; authors' calculations.

In order to verify that this relationship is robust, we follow the same procedure as before, estimating a panel regression with the five-year average annual growth rate in GDP per worker as the dependent variable. In addition to the controls used in equation (1), we now introduce financial sector growth. But, unlike in the earlier exercise, we cannot simply take the change in the ratio of private sector to GDP as the object of interest. If we were to do this, we would have GDP growth on the left-hand side of the regression and the inverse of GDP growth on the right-hand side, so finding a negative relationship would be wholly uninformative. It is for this reason that we now measure financial sector growth using employment growth and estimate:

$$\Delta y_{k,t+5,t} = \alpha + \beta_k + \gamma_0 \Delta fd_{k,t+5,t} + \gamma_1 X_{k,t+5,t} - \delta y_{k,t} + \varepsilon_{k,t} \qquad (2)$$

where all variables are defined as before, with the exception of $\Delta fd_{k,t+5,t}$, which is the average growth in financial sector employment in country k from time t to $t+5$. We note that the vector of controls in equation (2) includes the growth rate of the working population, trade openness measured as the ratio of imports plus exports to GDP, the share of government consumption in GDP, CPI inflation and the *level* of financial development.

Table 2 presents the results of estimating equation (2). The different regressions include the key variable of interest, here financial intermediation employment growth. The different columns reflect different measures of financial sector size.

Table 2

GDP-per-worker growth and private credit to GDP[1]

Dependent variable: five-year average real GDP-per-worker growth	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Five-year average financial intermediation employment growth	**–0.471***** *(0.083)*	**–0.327***** *(0.074)*	**–0.325***** *(0.073)*	**–0.328***** *(0.073)*	**–0.331***** *(0.074)*
Five-year working population growth	**–0.356*** *(0.204)*	**–0.275** *(0.186)*	**–0.286** *(0.183)*	**–0.270** *(0.188)*	**–0.259** *(0.191)*
Five-year average openness to trade	**0.007** *(0.0148)*	**0.022** *(0.0138)*	**0.023** *(0.0143)*	**0.022** *(0.0142)*	**0.022** *(0.0138)*
Five-year average government consumption share in GDP	**–0.762***** *(0.212)*	**–0.636***** *(0.219)*	**–0.626***** *(0.220)*	**–0.637***** *(0.220)*	**–0.635***** *(0.219)*
Five-year average CPI inflation	**0.021** *(0.018)*	**0.011** *(0.018)*	**0.011** *(0.018)*	**0.011** *(0.018)*	**0.011** *(0.018)*
Log of real GDP per worker	**–0.083***** *(0.014)*	**–0.073***** *(0.012)*	**–0.072***** *(0.012)*	**–0.074***** *(0.012)*	**–0.076***** *(0.012)*
Financial intermediation share in total employment	**–1.732***** *(0.529)*				
Private credit to GDP		**–0.001** *(0.005)*			
Private credit by banks to GDP			**–0.002** *(0.006)*		
Financial system assets to GDP				**–0.000** *(0.006)*	
Banking system assets to GDP					**0.002** *(0.005)*
Observations	104	110	110	110	110
R-squared	0.616	0.583	0.584	0.583	0.583

The dependent variable is the five-year average real GDP-per-worker growth for the period 1980–2009 for each country. Five-year averages for the independent variables are computed over the same period as the dependent variable. The log of real GDP per worker is the natural logarithm of real GDP per worker for the initial year of the period over which the averages are computed. The financial intermediation share in total employment is the share of the financial intermediation sector in total employment for the initial year of the period over which the averages are computed. Private credit (by banks) to GDP is the ratio of private credit (by banks) to GDP for the initial year of the period over which the averages are computed. Financial (banking) system assets to GDP is measured as the ratio of financial (banking) system assets to GDP for the initial year of the period over which the averages are computed. All estimations include country dummies. Robust standard errors are in parentheses. Significance at the 1/5/10% level is indicated by ***/**/*.

[1] Country sample: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Sources: OECD Structural Analysis database; Penn World Tables; World Bank Financial Structure and Development database; authors' calculations.

Our interest is in the first row of the table. There we see that the faster financial sector employment grows, the worse it is for productivity growth (measured as five-year average

growth in GDP per worker). Moreover, this effect survives regardless of the combination and definition of the controls.[9]

As for the magnitude of the effects, we start by comparing a country with constant employment in financial intermediation with one in which employment grows at 1.6 percentage points per year, the sample average for those with positive growth. The elasticity estimate of –0.33 implies that the first country will grow on average 50 basis points faster than the second country. Given that the sample average productivity growth rate is 1.3%, this strikes us as sizeable.

Turning to some country examples, we look at Ireland and Spain – admittedly extreme cases. During the five years beginning 2005, Irish and Spanish financial sector employment grew at an average rate of 4.1% and 1.4% per year, while output per worker fell by 2.7% and 1.4%, respectively. Our estimates imply that if financial sector employment had been constant in these two countries, it would have shaved 1.4 percentage points from the decline in Ireland and 0.6 percentage points in Spain. In other words, by our reckoning financial sector growth accounts for one third of the decline in Irish output per worker and 40% of the drop in Spanish output per worker.

Overall, the lesson of this section is that big and fast-growing financial sectors can be very costly for the rest of the economy. They draw in essential resources in a way that hurts other sectors of the economy. But which parts of the economy are harmed the most? We now turn to this question.

3. Which industries are hurt the most?

We have a sense that as the financial sector grows, some parts of the economy are likely to be hurt more than others. The key to figuring out which ones are most damaged requires that we look for the sectors that are competing with finance for inelastically supplied inputs. We do this in two, complementary ways. First, we note that finance is a skilled-labour-intensive industry.[10] With this in mind, we posit that skill-intensive sectors are also R&D-intensive. This leads us to the hypothesis that R&D-intensive industries – aircraft, computing and the like – will be disproportionately harmed when the financial sector grows quickly.[11] By contrast, industries such as textiles or iron and steel, which have low R&D intensity, should not be adversely affected.

Second, we note that finance requires financing. That is, financial intermediaries compete with non-financial intermediaries for financial resources. This leads us to conjecture that firms that rely more heavily on external finance will be in more direct competition with the financial intermediaries themselves for resources.

Using these insights, we now provide a brief description of the data we use, before turning to the empirical specification, and finally to some results.

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[9] Note that the effect of control variables is relatively different from what it was in the previous regression. In particular, government size now has a significant negative effect. This could be related to the fact that here we focus on advanced economies, where high government consumption is more likely to have detrimental effects on the private sector. The speed of convergence is also much higher (between 7 and 8% a year) than in the previous regressions, which is also probably related to sample difference.

[10] Philippon and Reshef (2009) provide empirical evidence that, over the past 30 years, the US banking industry has become relatively skilled-labour-intensive.

[11] See Philippon (2007) for a model where human capital is allocated between entrepreneurial and financial careers, and where entrepreneurs can innovate but face borrowing constraints that financiers can help to alleviate. Cahuc and Challe (2009) also develop an analytical model focusing on the allocation of workers between financial intermediation and production sectors in the presence of asset price bubbles.

3.1 The data

Our analysis focuses on disaggregated data on productivity in manufacturing from 15 advanced OECD countries.[12] To get some sense of which sectors are being harmed by financial booms, we require two types of detailed data. The first measures financial sector growth and the second quantifies the extent to which an individual industry is competing with finance for resources. We now examine each of these in turn.

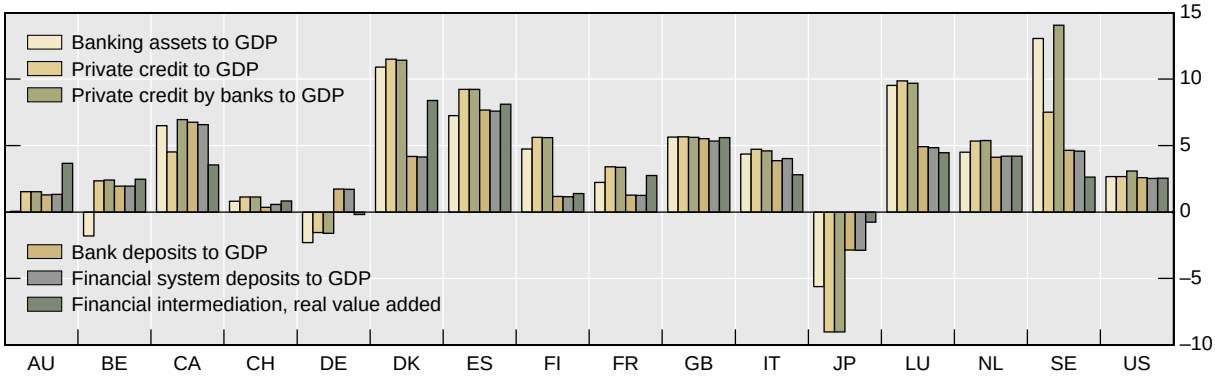
Starting with financial sector growth, we consider two types of indicators. The first focuses on banks alone – the ratio of banking assets to GDP, for example – and the second on the financial system more broadly – including measures such as total private credit to GDP. In each case, we compute the average growth rate from 2000 to 2008 for each of these.[13]

Graph 3 plots a set of six indicators for the 16 countries in our sample. Note that Japan has experienced negative growth for all the indicators considered. For Germany, growth is weak, with some indicators showing a modest rise and others a modest fall. 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 are the booms in Denmark and Sweden – larger, even, than those in the United Kingdom and the United States.

Graph 3

Financial sector growth in advanced economies

2000–08 average, in per cent



AU = Australia; BE = Belgium; CA = Canada; CH = Switzerland; DE = Germany; DK = Denmark; ES = Spain; FI = Finland; FR = France; GB = United Kingdom; IT = Italy; JP = Japan; LU = Luxembourg; NL = Netherlands; SE = Sweden; US = United States.

Sources: OECD Structral Analysis database; World Bank Financial Structure and Development database; authors' calculations.

Turning now to industry-specific characteristics, we concentrate on two different indicators: industry external financial dependence and industry R&D intensity. We measure external

[12] The list comprises Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Importantly, we exclude the United States because, given our methodology, described below, its inclusion would become a source of reverse causation.

[13] Contrary to the previous specification, using financial variables as a ratio of GDP to compute financial sector growth is not an issue here. The reason is that the empirical setup we use now is designed to capture the relative effect of financial sector growth on different industries. Taking an example, this approach tells, for instance, whether the tobacco industry suffers more than the pharmaceutical industry from higher financial sector growth, irrespective of the absolute macro level effect, which is captured in the specification by the country dummies. Yet, as a confirmation, we also use Financial Intermediation Real Value Added Growth to ensure that our results go through.

financial dependence as the median ratio across firms belonging to the corresponding industry in the United States of capital expenditures minus current cash flow to total capital expenditures. And R&D intensity is the median ratio across firms belonging to the corresponding industry in the US of R&D expenditures to total value added.

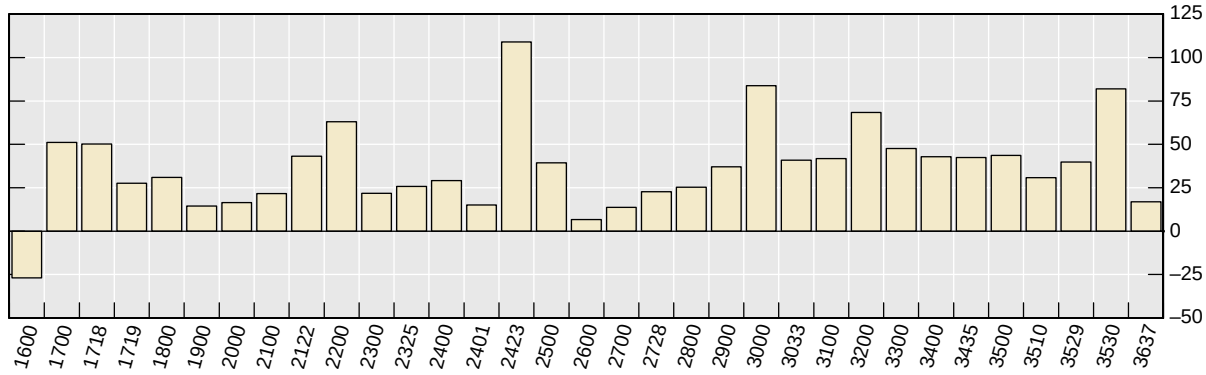
The financial dependence measure gives an indication of an industry's needs (or difficulties) in raising external finance and as such can be considered as a proxy for the borrowing constraints the industry could potentially face. By contrast, R&D intensity gives us an indication of reliance on skilled labour. For example, assets in more R&D-intensive industries are more likely to consist of labs filled with highly trained researchers and specialised equipment. Put differently, R&D-intensive industries demand highly skilled labour.

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.[14]

Graph 4

Financial dependence in manufacturing industries[1]

In per cent



[1] Capital expenditure in excess of internal cash flows as a percentage of capital expenditure. For the meaning of the industry codes, see Appendix Table A1.

Sources: Raddatz (2006); authors' calculations.

Turning to R&D intensity in Graph 5, the picture is somewhat different. (The correlation between the measures plotted in Graphs 4 and 5 is less than 0.7.) 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 (1800), textiles (1700), printing (2200), basic metals (2700) and shipbuilding (3510), while the second includes communications equipment (3200), medical instruments (3300) and aircraft industries (3530). 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% of value added. By contrast, only three industries devote more than 30% of their value added to R&D expenditures.

Graphs 4 and 5 report the industry-level measures. Starting with external finance in the first of the two graphs, we measure financial dependence as the fraction of investment financed

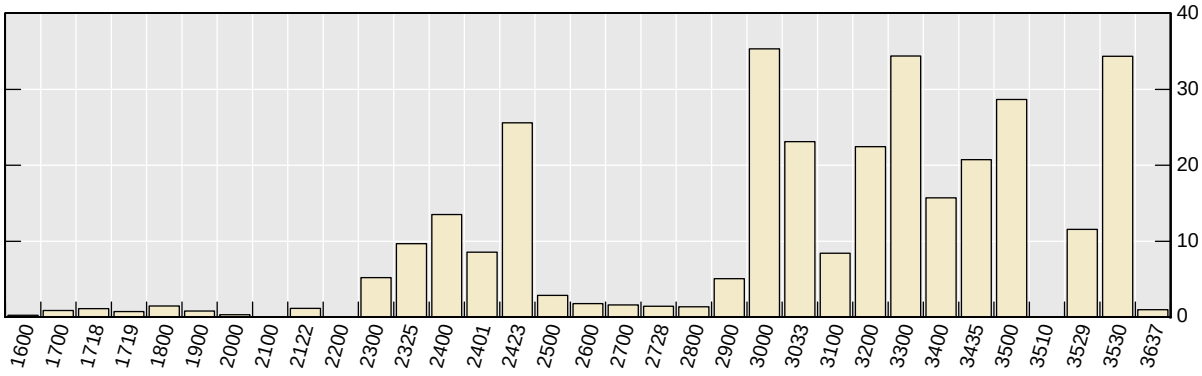
[14] More precisely, the working assumption is that the ranking of industries according to financial dependence or R&D intensity is country-invariant.

from external sources over the 1980–89 period. With the exception of tobacco (industry 1600), all the industries have internal cash flow that is insufficient to finance capital investment. And in only one other case, pharmaceuticals (industry 2423), is there investment in the presence of negative cash flow. For most of the remaining 31 manufacturing industries in our sample (listed in Appendix Table A1), financial dependence is less than 50%, meaning that the majority of capital expenditures is financed using internal funds.

Graph 5

R&D intensity in manufacturing industries[1]

In per cent



[1] Ratio of R&D expenditure to total value added. For the meaning of the industry codes, see Appendix Table A1.

Sources: OECD Structural Analysis database; authors' calculations.

3.2 The specification and the results

As in the previous two cases, our sample forms a panel. While there is a time dimension to our data – we use averages for the 2000–08 period[15] – the variation comes across countries and industries. For the countries, data limitations mean sticking with the OECD. 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:[16]

$$\Delta y^{j}_{k,2008,2000} = \alpha_j + \beta_k + \gamma\left(ic_j\right)\times\left(\Delta fd_{k,2008,2000}\right) - \delta\left(y^{j}_{k,2000} - y_{k,2000}\right) + \varepsilon_{jk} \qquad (3)$$

where $\Delta y^{j}_{k,2008,2000}$ is the average growth rate in labour productivity over the eight years from 2000 to 2008 in sector k of country j, measured as the ratio of industry real value added to industry total employment; α_j and β_k are industry and country fixed effects; $(ic_j)\times(\Delta fd_{k,2008,2000})$, the interaction variable of interest, is the product between industry j's intrinsic characteristic and country k's financial development growth; and finally, we control for initial conditions by including the log difference between labour productivity in industry j in country k and labour productivity in the overall manufacturing sector in country k at the beginning of the period $\left(y^{j}_{k,2000} - y_{k,2000}\right)$.

[15] 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. Data availability forces us to focus on manufacturing.

[16] 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)).

We estimate equation (3) 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 – financial dependence 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 is caused by the 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.

Turning now to the results themselves, Tables 3 and 4 report estimates of equation (3) using financial dependence and R&D intensity, respectively. Starting with financial dependence, we note that industry productivity growth is significantly negatively correlated with the interaction term (this is the first row of the table). This means that when private credit to GDP grows more rapidly, more financially dependent industries suffer more. The remainder of the results confirm this result. Regardless of how we choose to measure financial sector growth, industry productivity growth is always negatively correlated with the interaction term. In other words, faster-growing financial sectors hurt rather than benefit industries facing tighter financial constraints.

We also note that the coefficient on the initial condition, the level of productivity growth relative to manufacturing in 2000, is roughly –2.7%. This means that industries with productivity higher or lower than the manufacturing average close the gap at a rate of roughly 2.7% per year. That is, consistent with decreasing returns to scale, there is regression to the mean.[17]

As for the quantitative implications of these estimates, we ask what the difference in productivity growth is between a sector with low financial dependence located in a country whose financial system is growing slowly and a sector with high financial dependence located in a country whose financial system is growing rapidly, all else equal.[18] The row labelled “Difference-in-difference effect” in Table 3 reports the results from this experiment. The estimates are roughly –2.5%, meaning that productivity of a financially *dependent* industry located in a country experiencing a financial boom tends to grow 2.5% a year slower than a financially *independent* industry located in a country not experiencing such a boom. This is quite a large effect, especially when compared with the unconditional sample mean and volatility of labour productivity growth of 2.1% and 4.3%, respectively.

With regard to R&D intensity, the results in Table 4 are quite similar to those in Table 3. Again, industry labour productivity growth is significantly negatively correlated with the interaction term, this time measured as the product of industry R&D intensity and financial sector growth. Financial booms disproportionately harm highly R&D-intensive industries. Again, the results are fairly robust to the measure of financial sector growth, and the coefficient on the catch-up term is negative and close to that in Table 3.

Comparing the results in Tables 3 and 4, it is fair to say that the latter are less robust. While all estimates of the coefficients on the interaction terms are clearly negative, in the case of R&D intensity the magnitude varies by a factor of more than 3 depending on the measure of financial sector growth. One reason for this could be the distribution of R&D intensity across industries. Because quite a few industries engage in virtually no R&D, the discriminatory power of the interaction term is likely to be low.

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[17] The corresponding estimated half-life of convergence is roughly 25 years.

[18] More precisely, the difference in productivity growth is computed comparing an industry at the first quartile of the distribution for the industry-specific characteristic located in a country at the first quartile of the financial sector growth distribution with another industry at the third quartile of the distribution for the industry-specific characteristic located in a country at the third quartile of the financial sector growth distribution.

Table 3

Industry productivity growth, financial dependence and financial development growth[1]

Dependent variable: labour productivity growth	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Interaction (financial dependence and private credit to GDP growth)	**–1.145***** *(0.366)*					
Interaction (financial dependence and financial system deposits to GDP growth)		**–1.511***** *(0.524)*				
Interaction (financial dependence and private credit by banks to GDP growth)			**–1.004***** *(0.312)*			
Interaction (financial dependence and banking system deposits to GDP growth)				**–1.424***** *(0.510)*		
Interaction (financial dependence and banking assets to GDP growth)					**–-0.982***** *(0.339)*	
Interaction (financial dependence and growth in financial intermediation value added)						**–2.030***** *(0.555)*
Log of initial relative labour productivity	**–0.027*** *(0.014)*	**–0.026**** *(0.013)*	**–0.027*** *(0.014)*	**–0.026**** *(0.013)*	**–0.028**** *(0.014)*	**–0.027**** *(0.012)*
Difference-in-difference effect	**–2.53%**	**–2.63%**	**–2.83%**	**–2.53%**	**–2.74%**	**–2.81%**
Observations	335	335	335	335	335	349
R-squared	0.357	0.346	0.360	0.344	0.354	0.360

The dependent variable is the average annual growth rate in labour productivity per worker 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. Financial dependence is the median fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980–89. The interaction variable is the product of variables in parentheses. Robust standard errors are in parentheses. All estimations include country and industry dummies. Significance at the 1/5/10% level is indicated by ***/**/*.

[1] Country sample: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom.

Sources: Raddatz (2006); OECD Structural Analysis database; World Bank Financial Structure and Development database; authors' calculations.

Table 4

Industry productivity growth, R&D intensity and financial development growth[1]

Dependent variable: labour productivity growth	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Interaction (R&D intensity and private credit to GDP growth)	**–1.753***** *(0.590)*					
Interaction (R&D intensity and financial system deposits to GDP growth)		**–2.794***** *(0.937)*				
Interaction (R&D intensity and private credit by banks to GDP growth)			**–1.327***** *(0.502)*			
Interaction (R&D intensity and banking system deposits to GDP growth)				**–2.665***** *(0.912)*		
Interaction (R&D intensity and banking assets to GDP growth)					**–1.104*** *(0.568)*	
Interaction (R&D intensity and growth in financial intermediation value added)						**–3.560***** *(1.117)*
Log of initial relative labour productivity	**–0.032**** *(0.014)*	**–0.029**** *(0.013)*	**–0.030**** *(0.014)*	**–0.029**** *(0.013)*	**–0.030**** *(0.014)*	**–0.030**** *(0.012)*
Difference-in-difference effect	**–2.05%**	**–2.49%**	**–1.91%**	**–2.41%**	**–1.43%**	**–2.87%**
Observations	312	312	312	312	312	323
R-squared	0.349	0.347	0.344	0.345	0.334	0.359

The dependent variable is the average annual growth rate in labour productivity per worker 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. The interaction variable is the product of variables in parentheses. Robust standard errors are in parentheses. All estimations include country and industry dummies. Significance at the 1/5/10% level is indicated by ***/**/*.

[1] Country sample: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom.

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

As far as the quantitative implications of these results are concerned, excluding the estimates in column 5, the difference-in-difference effect is estimated to be between –1.9 and –2.9%. That is to say, a sector with high R&D intensity located in a country whose financial system is growing rapidly grows between 1.9 and 2.9% a year slower than a sector with low R&D intensity located in a country whose financial system is growing slowly. This supports the conclusion we reached using the financial dependence variable: the effect is large.

3.3. Robustness

There are 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, 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 monetary policy acting countercyclically.

Third, there is the potential impact of fiscal policy. If fiscal deficits crowd out private credit extension, then again we could be confounding an aggregate cyclical policy with what we believe to be a cross-sectional effect.

Lastly, 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 estimates for the coefficient on the interaction term in which a variety of variables are added to our baseline regression, equation (3). 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 face tighter financial constraints or are more R&D-intensive. That said, we note several interesting secondary results: the productivity of industries with higher financial dependence has grown disproportionately faster in countries with tighter monetary policy (Appendix Table A2, column (3)); a higher cost of capital (Appendix Table A2, column (4)); or a more restrictive fiscal policy, measured as the ratio of the fiscal deficit to GDP (Appendix Table A2, column (8)). Likewise, the productivity of industries with higher R&D intensity has grown disproportionately faster in countries with tighter fiscal policy (Appendix Table A3, column (6)); or higher trade or current account balance (Appendix Table A3, columns (8) and (9)).

4. Conclusion

In this paper, we study the complex real effects of financial development and come to two important conclusions. First, both the size and growth of a country's financial system can be a drag on productivity growth. That is, there comes a point where further enlargement of the financial system can reduce real growth. And, because the financial sector competes with the rest of the economy for resources, 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 that are more R&D-intensive. 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. More finance is definitely not always better.

Data appendix

Graph 1 and Table 1: Time period: 1980–2009

List of countries: Argentina, Australia, Austria, Bangladesh, Belgium, Brazil, Canada, Chile, China, Colombia, the Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Morocco, the Netherlands, New Zealand, Nigeria, Norway, Pakistan, the Philippines, Poland, Portugal, Russia, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, the United Kingdom, the United States, Venezuela and Vietnam.

Data sources: Penn World Tables for real GDP per worker, working population, ratio of imports and exports to GDP, ratio of government consumption to GDP and CPI; World Bank Financial Structure and Development database for private credit to GDP.

Graph 2 and Table 2: Time period: 1980–2009

List of countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Data sources: Penn World Tables for real GDP per worker, working population, ratio of imports and exports to GDP, ratio of government consumption to GDP and CPI; World Bank Financial Structure and Development database for private credit to GDP, private credit by banks to GDP, financial system assets to GDP and banking system assets to GDP; OECD STAN for financial intermediation employment growth and financial intermediation share in total employment.

Tables 3 and 4 and Tables A2 and A3: Time period: 2000–08

List of countries: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom.

List of industries: Tobacco products; Textiles; Textiles, textile products, leather and footwear; Textiles and textile products; Wearing apparel, dressing and dyeing of furniture; Leather, leather products and footwear; Wood and products of wood and cork; Pulp, paper and paper products; Pulp, paper, paper products, printing and publishing; Printing and publishing; Coke, refined petroleum products and nuclear fuel; Chemical, rubber, plastics and fuel products; Chemicals and chemical products; Chemicals excluding pharmaceuticals; Pharmaceuticals; Rubber and plastics products; Other non-metallic mineral products; Basic metals; Basic metals and fabricated metal products; Fabricated metal products, except machinery and equipment; Machinery and equipment, nec; Office, accounting and computing machinery; Electrical and optical equipment; Electrical machinery and apparatus, nec; Radio, television and communication equipment; Medical, precision and optical instruments; Motor vehicles, trailers and semi-trailers; Transport equipment; Other transport equipment; Building and repairing of ships; Railroad equipment and transport equipment, nec; Aircraft and spacecraft; Manufacturing, nec, and recycling.

Data sources: Penn World Tables for real GDP per worker, working population, ratio of imports and exports to GDP, ratio of government consumption to GDP and CPI; World Bank Financial Structure and Development database for banking assets to GDP, financial system deposits to GDP, banking system deposits to GDP, private credit by banks to GDP and private credit to GDP; OECD STAN for industry labour productivity growth, initial relative labour productivity, financial intermediation value added and R&D intensity; Raddatz (2006) for financial dependence; OECD *Economic Outlook* for real short-term interest rate, real long-term interest rate, CPI inflation rate, fiscal balance to GDP, government expenditures to GDP, trade balance to GDP and current account to GDP.

Table A1
Industry characteristics

Industry code[1]	Description	External financial dependence[2]	R&D intensity[3]
1600	Tobacco products	–27.00%	0.26%
1700	Textiles	51.08%	0.88%
1718	Textiles, textile products, leather and footwear	50.20%	1.12%
1719	Textiles and textile products	27.61%	0.73%
1800	Wearing apparel, dressing and dyeing of furniture	30.99%	1.47%
1900	Leather, leather products and footwear	14.50%	0.80%
2000	Wood and products of wood and cork	16.39%	0.31%
2100	Pulp, paper and paper products	21.64%	0.00%
2122	Pulp, paper, paper products, printing and publishing	43.18%	1.14%
2200	Printing and publishing	63.08%	0.00%
2300	Coke, refined petroleum products and nuclear fuel	21.80%	5.21%
2325	Chemical, rubber, plastics and fuel products	25.82%	9.67%
2400	Chemicals and chemical products	29.15%	13.51%
2401	Chemicals excluding pharmaceuticals	15.07%	8.55%
2423	Pharmaceuticals	109.10%	25.58%
2500	Rubber and plastics products	39.32%	2.86%
2600	Other non-metallic mineral products	6.68%	1.79%
2700	Basic metals	13.63%	1.60%
2728	Basic metals and fabricated metal products	22.73%	1.43%
2800	Fabricated metal products, except machinery and equipment	25.26%	1.35%
2900	Machinery and equipment, nec	37.04%	5.06%
3000	Office, accounting and computing machinery	83.78%	35.34%
3033	Electrical and optical equipment	40.87%	23.13%
3100	Electrical machinery and apparatus, nec	41.80%	8.43%
3200	Radio, television and communication equipment	68.33%	22.45%
3300	Medical, precision and optical instruments	47.62%	34.38%
3400	Motor vehicles, trailers and semi-trailers	42.94%	15.73%
3435	Transport equipment	42.50%	20.75%
3500	Other transport equipment	43.69%	28.67%
3510	Building and repairing of ships	30.81%	0.00%
3529	Railroad equipment and transport equipment, nec	39.87%	11.56%
3530	Aircraft and spacecraft	82.03%	34.35%
3637	Manufacturing, nec, and recycling	16.91%	0.97%

[1] ISIC Rev 3 classification. [2] External financial dependence is the ratio of capital expenditures minus cash flows to capital expenditures. [3] R&D intensity is the ratio of R&D expenditures to value added.

Sources: OECD (2011); Raddatz (2006); authors' calculations.

Table A2

Industry productivity growth, financial dependence and financial development growth[1]

Dependent variable: labour productivity growth	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log of initial relative labour productivity	**–0.027*** *(0.014)*	**–0.027**** *(0.013)*	**–0.027*** *(0.014)*	**–0.027*** *(0.014)*	**–0.026*** *(0.014)*	**–0.024**** *(0.011)*	**–0.027*** *(0.014)*	**–0.027*** *(0.014)*	**–0.027*** *(0.014)*
Interaction (financial dependence and private credit by banks to GDP growth)	**–1.004***** *(0.312)*	**–1.581***** *(0.436)*	**–1.056***** *(0.320)*	**–1.102***** *(0.338)*	**–0.964***** *(0.356)*	**–1.544***** *(0.364)*	**–1.058***** *(0.344)*	**–1.016***** *(0.310)*	**–0.988***** *(0.318)*
Interaction (financial dependence and initial private credit by banks to GDP)		**0.108*** *(0.058)*							
Interaction (financial dependence and average real short-term interest rate)			**0.027*** *(0.016)*						
Interaction (financial dependence and average real long-term interest rate)				**0.046*** *(0.026)*					
Interaction (financial dependence and average CPI inflation rate)					**–0.005** *(0.017)*				
Interaction (financial dependence and average fiscal balance to GDP)						**0.023**** *(0.011)*			
Interaction (financial dependence and average government expenditures to GDP)							**0.001** *(0.002)*		
Interaction (financial dependence and average trade balance to GDP)								**0.239** *(0.248)*	
Interaction (financial dependence and average current account to GDP)									**0.001** *(0.002)*
Observations	335	335	335	335	335	335	335	335	335
R-squared	0.360	0.375	0.366	0.369	0.360	0.382	0.361	0.362	0.361

The dependent variable is the average annual growth rate in labour productivity per worker 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. Financial dependence is the median fraction of capital expenditures not financed with internal funds for US firms in the same industry for the period 1980–89. The interaction variable is the product of variables in parentheses. Robust standard errors are in parentheses. All estimations include country and industry dummies. Significance at the 1/5/10% level is indicated by ***/**/*.

[1] Country sample: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom.

Sources: Raddatz (2006); OECD, *Economic Outlook* and Structural Analysis database; World Bank Financial Structure and Development database; authors' calculations.

Table A3

Industry productivity growth, R&D intensity and financial development growth[1]

Dependent variable: labour productivity growth	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log of initial relative labour productivity	**–0.030**** *(0.014)*	**–0.030**** *(0.014)*	**–0.031**** *(0.014)*	**–0.030**** *(0.014)*	**–0.031**** *(0.013)*	**–0.027**** *(0.012)*	**–0.030**** *(0.014)*	**–0.027**** *(0.013)*	**–0.030**** *(0.013)*
Interaction (R&D intensity and private credit by banks to GDP growth)	**–1.327***** *(0.502)*	**–1.616*** *(0.825)*	**–1.301**** *(0.554)*	**–1.221**** *(0.608)*	**–1.046*** *(0.606)*	**–2.185***** *(0.675)*	**–1.187*** *(0.611)*	**–1.468***** *(0.508)*	**–1.287**** *(0.510)*
Interaction (R&D intensity and initial private credit by banks to GDP)		**–0.052** *(0.106)*							
Interaction (R&D intensity and average real short-term interest rate)			**0.036** *(0.031)*						
Interaction (R&D intensity and average real long-term interest rate)				**0.057** *(0.054)*					
Interaction (R&D intensity and average CPI inflation rate)					**–0.040** *(0.031)*				
Interaction (R&D intensity and average fiscal balance to GDP)						**0.035*** *(0.020)*			
Interaction (R&D intensity and average government expenditures to GDP)							**–0.003** *(0.005)*		
Interaction (R&D intensity and average trade balance to GDP)								**1.220**** *(0.496)*	
Interaction (R&D intensity and average current account to GDP)									**0.008*** *(0.005)*
Observations	335	335	335	335	335	335	335	335	335
R-squared	0.360	0.375	0.366	0.369	0.360	0.382	0.361	0.362	0.361

The dependent variable is the average annual growth rate in labour productivity per worker 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. The interaction variable is the product of variables in parentheses. Robust standard errors are in parentheses. All estimations include country and industry dummies. Significance at the 1/5/10% level is indicated by ***/**/*.

[1] Country sample: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom.

Sources: OECD, *Economic Outlook* and Structural Analysis database; World Bank Financial Structure and Development database; authors' calculations.

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