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Finance and productivity: A literature review

Mark Heil

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FINANCE AND PRODUCTIVITY: A LITERATURE REVIEW

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By Mark Heil

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ABSTRACT/RÉSUMÉ

Finance and productivity: A literature review

This paper surveys a broad range of studies and highlights the main findings of the empirical literature regarding business finance and productivity. Numerous studies analyse the productivity effects of financial development and frictions. The results suggest: 1) Financial development likely has favourable effects on productivity growth; 2) financial frictions that impede the efficient flow of finance can mitigate the positive effects through a variety of channels; and 3) the magnitudes of productivity costs of financial frictions generally appear modest in financially developed economies but are considerably larger in developing economies. The paper also reviews studies of the influence of specific mechanisms on productivity, such as human capital, corporate finance, financial sector efficiency, equity finance and venture capital. Some policies that hamper productivity growth include inefficient insolvency regimes that impede exit of low-productivity firms, poorly developed contract monitoring and enforcement systems between banks and firms, collateral constraints that impair resource reallocation and imperfect bank supervisory practices that diminish productive capital reallocation through distorted lending practices.

JEL codes: D2; G2; G3; J2; O4

Keywords: Finance, productivity, financial development, financial friction, insolvency regime, human capital, venture capital, business cycle

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Finance et productivité : analyse des travaux antérieurs

Nous examinons dans ce document un large éventail d'études et mettons en lumière les principales conclusions des travaux empiriques publiés sur le financement des entreprises et la productivité. Dans de nombreuses études sont analysés les effets induits sur la productivité par les évolutions et les frictions financières. Leurs résultats laissent à penser que : 1) les évolutions financières ont probablement des effets favorables sur la croissance de la productivité ; 2) les frictions financières qui font obstacle à la circulation efficiente des ressources financières peuvent atténuer ces effets positifs *via* divers canaux ; et 3) l'ampleur des coûts de ces frictions financières en termes de productivité semble généralement modeste dans les économies financièrement développées, mais elle est nettement plus importante dans les économies en développement. Nous examinons également dans ce document les études de l'influence exercée sur la productivité par certains éléments tels que le capital humain, le financement des entreprises, l'efficience du secteur financier, le financement sur fonds propres et le capital-risque. Certaines caractéristiques du cadre d'action publique entravent la croissance de la productivité, notamment les procédures d'insolvabilité inefficaces faisant obstacle à la sortie du marché des entreprises peu productives, les systèmes de suivi et d'exécution des contrats conclus entre les banques et les entreprises laissant à désirer, les contraintes de garantie d'emprunt qui nuisent au redéploiement des ressources, et les pratiques imparfaites de surveillance des banques qui affaiblissent le mécanisme de réaffectation du capital productif en faussant les pratiques de crédit.

Classification JEL : D2 ; G2 ; G3 ; J2 ; O4

Mots clés : finance, productivité, évolutions financières, friction financière, procédure d'insolvabilité, capital humain, capital-risque, cycle économique

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FINANCE AND PRODUCTIVITY: A LITERATURE REVIEW

By Mark Heil[1]

Executive summary

1. Research on productivity and finance has been evolving rapidly in the current decade, due in part to the heightened priority ascribed to productivity analysis on the policy research agenda and the greater availability of firm-level and plant-level data that are harmonised across countries. This evolution has allowed researchers to analyse inter-firm dynamics and the channels that drive them. In turn, the recent empirical literature provides fresh insights that may inform policy development to help enact finance related measures that more effectively promote productivity growth.

2. *Finance and productivity.* Mounting empirical evidence demonstrates that finance is an important contributor to productivity growth, but there are also productivity losses due to financial frictions (7 direct analyses reviewed). Both single-country and cross-country studies agree that a range of different financial frictions can hinder productivity growth by impeding optimal resource allocation. The channels through which this result occurs vary depending on the country and type of financial friction considered. These frictions can reduce competition, impair capital investment, diminish advanced technology adoption and distort incentives to efficient capital allocation. There is some evidence that suggests that financial frictions can explain a sizeable share of the differences in productivity between developed and developing countries (2 studies reviewed).

3. *Insolvency regimes and productivity.* When firm insolvency policies result in high costs for exiting firms, low productivity firms may be less likely to leave the market, thereby tying up resources that could be reallocated to more productive uses. Recent firm-level analyses of firm exit policies show the direct productivity effects of firm exit may be exceeded by the indirect impact of spillovers to factor and product prices. These spillovers can stifle new firm entry, and impede shifts in market shares to more efficient competitors, resulting in missed opportunities for productivity growth. These findings lend further support for reforms of firm exit policies (3 quantitative insolvency studies reviewed).

4. *Transmission channels.* The limited direct research on channels suggests that a primary driver of productivity growth is knowledge production, which can have sustained effects on productivity through positive scale effects (4 studies on transmission reviewed). Increased human capital through education and training is closely linked to higher labour productivity, yet evidence that the availability of financing facilitates higher educational attainment is tenuous (8 quantitative human capital studies reviewed).

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1. Mark Heil is an economist at the US Treasury. At the time of writing this paper, he was seconded by the US Treasury to the Economics Department. The thoughts expressed in this paper do not necessarily reflect the views of the US Treasury. He is grateful to Boris Cournéde, Oliver Denk, Priscilla Fialho, Yvan Guillemette, Peter Hoeller, Catherine Mann, Valentine Millot, Paul O'Brien (Economics Department) and Sebastian Schich (Directorate for Financial and Enterprise Affairs) for comments and suggestions on earlier drafts. Special thanks go to Celia Rutkoski for assistance in preparing this document.

5. *Mergers and acquisitions and productivity.* On the whole, merger and acquisition activity is associated with gains in productivity. This result comes mainly from higher investment, matching of labour to productive uses, and closures of less productive plants after completion of the merger or acquisition (6 studies reviewed).

6. *Direct contributions of the financial sector to productivity improvement.* Efficiency improvements in the US financial sector during the late 1990s were substantial enough to contribute measurably to economy-wide productivity growth. However, these outsized improvements have not persisted and appear tied to the internet stock market bubble (4 studies reviewed). More broadly, recent research on bank economies of scale is mixed and does not necessarily support the view that the largest banks realise efficiency gains after controlling for implicit subsidies (2 studies on scale economies reviewed).

7. *Equity finance and productivity.* The research suggests that availability of equity financing is particularly valuable for the growth of young and small enterprises and it remains the primary external source for funding research and development. More broadly, equity finance is associated with economic growth while debt financing beyond a certain threshold is linked to declining growth, and equity can improve firm and systemic stability by reducing leverage rates. These characteristics strengthen the case for enacting measures that would help to develop equity markets and removing policies such as debt bias in taxation that favour debt financing (3 analyses reviewed).

8. *Alternative finance and productivity.* A central purpose of risk finance is to provide financial and mentoring support to the type of young, developing enterprises that can yield sizeable productivity gains through new products or production approaches considered too risky by many creditors. Recent evidence shows that the presence of venture capital (VC) investors improves opportunities for young firms to access capital in a marketplace that otherwise may deny them financing, likely due to limited risk appetite among intermediaries and lack of access to capital markets. Firms receiving VC finance have substantially higher post-VC finance productivity growth than similar firms not receiving VC, and this effect is amplified when initial VC flows occur at an early stage of firm development (3 studies reviewed).

9. *Business cycles and productivity.* Recent studies of both periods of economic decline and booms suggest that business cycle influences on productivity are inconclusive. There is evidence of both pro-cyclical and counter-cyclical influences on productivity, with the effects of economic cycles flowing through different mechanisms. One common factor among the studies shows that the presence of financial frictions during cycles can alter the direction and strength of a cycle's productivity impacts. The recent Great Recession saw less productivity enhancing reallocation than did earlier recessions (5 studies reviewed).

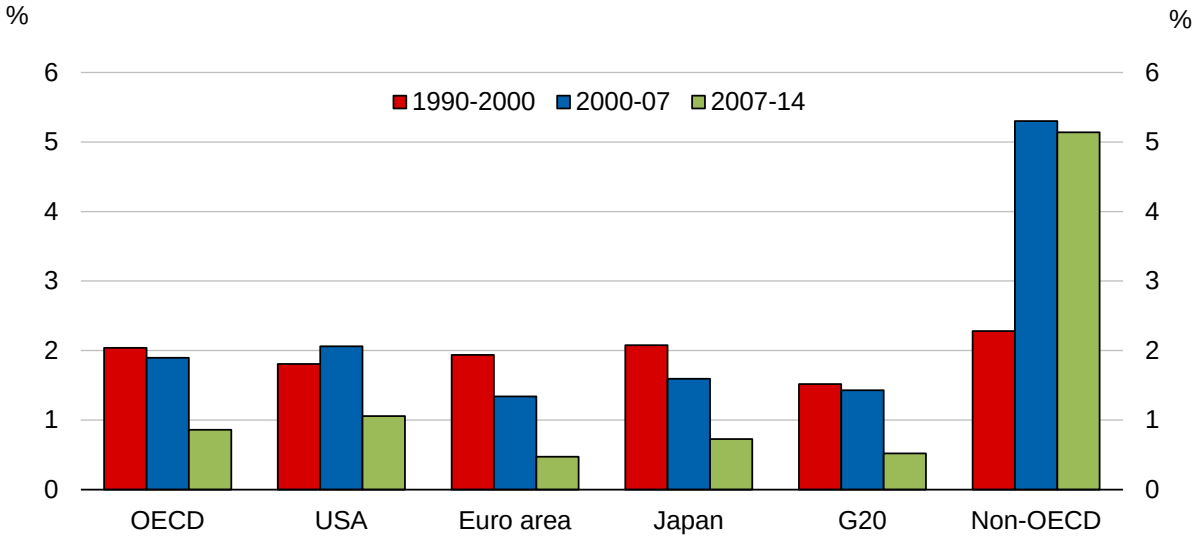
10. The preceding summary highlights some recent areas where the productivity and finance literature has sharpened its focus and improved the understanding of the current conditions and their policy linkages. These studies offer stronger guidance for policy development than did previous generations of research. Nonetheless, this work has not answered all the questions, and ample opportunities for deeper analysis remain, in particular to document how, across countries, financial policies and structures shape the capacity of firms to enhance productivity. Much of the existing research focuses on one or a few countries. For policy advice, it will hence be important to identify empirical regularities, as well as, differences across countries.

1. Introduction

11. Productivity growth is the main contributor to rising prosperity. When productivity rises, economies produce more output for a given level of input, generating gains that increase incomes and improve living standards. However, productivity growth has slowed considerably. Figure 1 shows the evolution of labour productivity growth. In the 1990s, hourly labour productivity growth per year averaged more than 2.0% across OECD countries, and the rate diminished slightly to 1.9% in the 2000-07 period. Yet these aggregate figures conceal the changes across regions. In 2000-07, the euro area and Japan saw substantial drops in their labour productivity growth, which were offset to some degree by increased productivity growth in the United States. However, in the 2007-14 period, sharp declines in all three regions prompted a more than halving from the previous period in the OECD-wide productivity growth rate to less than 0.9% per year.

Figure 1. Productivity growth has declined since the 1990s

Annualised growth of labour productivity (output per hour worked)



Note: OECD, Euro area, G20 and non-OECD are aggregated using GDP-PPP weights. OECD includes all OECD countries except Estonia. Euro area includes all euro area countries except Estonia. G20 includes all G20 countries except South Africa. Non-OECD is Argentina, Brazil, China, Colombia, India, Indonesia, Latvia, Lithuania, Russia and Saudi Arabia. Data for several countries begin between 1991 and 1995, not in 1990. Labour productivity for non-OECD countries is measured per worker, not per hour worked.

Source: OECD (2016a), "Promoting Productivity and Equality: A Twin Challenge." in *OECD Economic Outlook,* Vol. 2016/1, OECD Publishing.

12. In general, the declining productivity growth pattern in developed countries has persisted since the 1970s (OECD, 2015). However, the sharp decline in the latest period raises the stakes for policy makers seeking to support the growth needed for long-run improvements in their residents' quality of life. While the 2007-14 period coincides with the global financial crisis and sovereign debt crisis in Europe, research suggests that the slowdown in productivity growth reflects both cyclical and long-term structural components (OECD, 2016a).

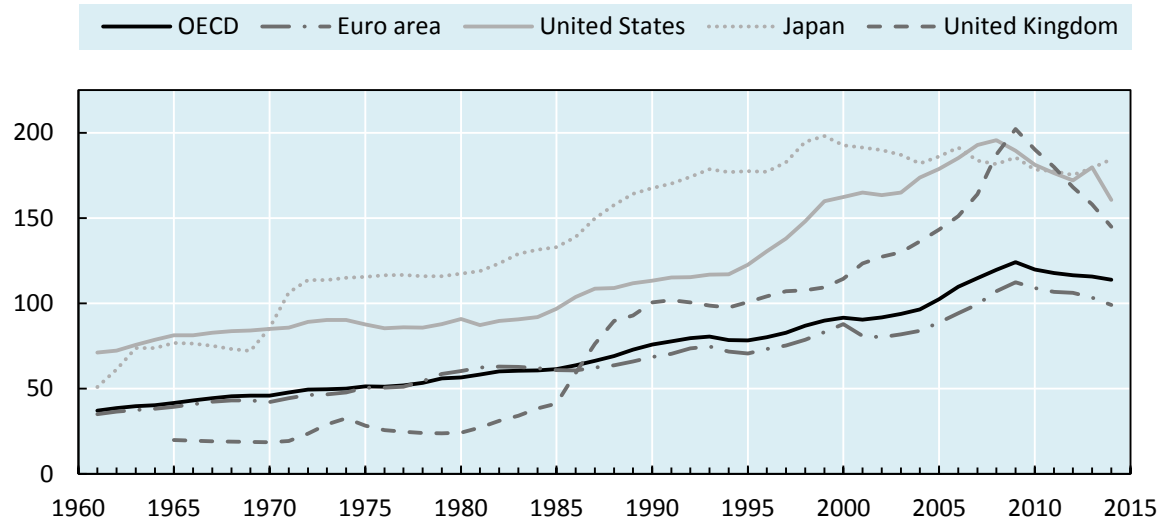
13. Long-term financial activity has climbed substantially in developed economies. Figure 2 shows that credit from financial institutions grew over three times as fast as real output in the more than four decades preceding the global financial crisis. Stock market capitalisation expanded nearly six times as fast as real output over the three decades before the crisis.[2] The upward trend of private credit was steady until

2. The private credit growth trend refers to the period 1961 to 2007, and the stock market capitalisation trend covers 1975-2007. Both are based on OECD averages across member countries.

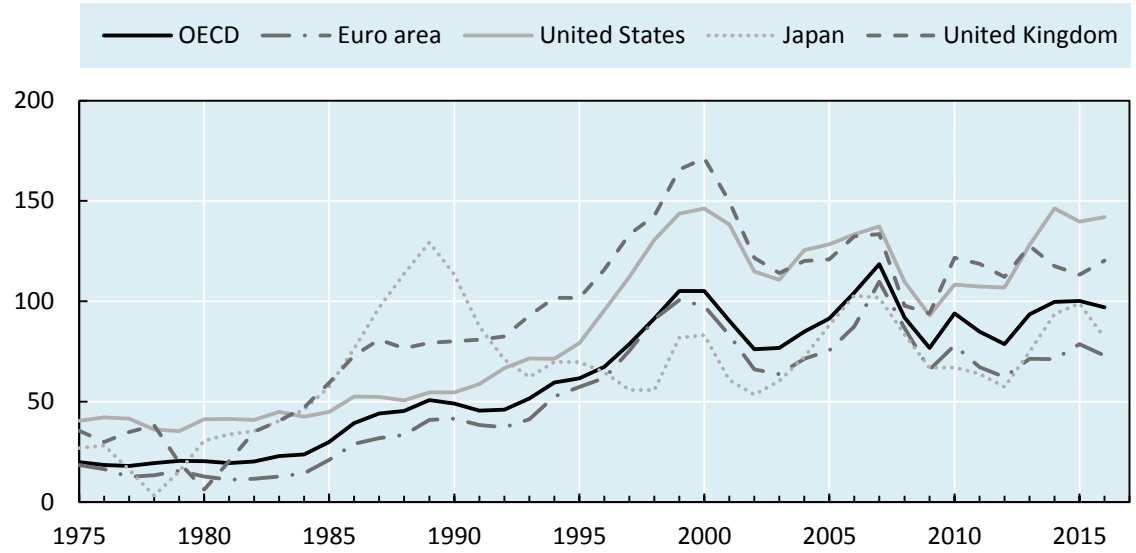
the financial crisis. Stock market capitalisation's growth path, on the other hand, has been more volatile, as expected, but continues to be well above the levels experienced prior to the internet bubble of the 1990s. Internationally, the expansion of bank cross-border claims continued unabated in real terms until the financial crisis downturn, but in 2016 claims still stand at more than eight times the level in 1980. Overall, these types of financing have shown remarkable historic growth, and demonstrate that finance has played an ever increasing role in the economy.

Figure 2. Historic expansion of financial activity

A. Financial institution private credit, % of GDP



B. Stock market capitalisation, % of GDP

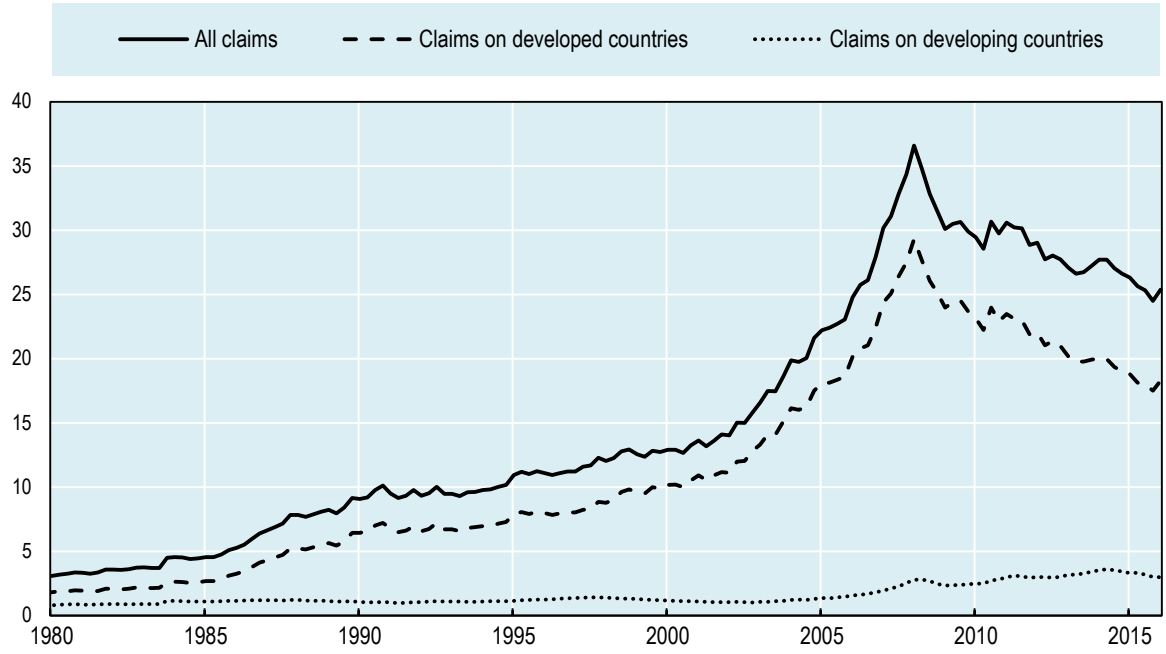


Note: Financial institution credit refers to credit by depository money banks and other financial institutions to the non-financial private sector. Stock market capitalisation is the value of all listed shares through 28 September 2016. OECD is the simple average of OECD countries for which data are available. Euro area is the simple average of OECD countries that belong to the euro area.

Source: Cournède, B., O. Denk and P. Hoeller (2015), "Finance and Inclusive Growth", *OECD Economic Policy Paper,* No. 15, OECD Publishing, Paris.*(*updated 2016).

Figure 2. Historic expansion of financial activity *(cont.)*

C. Cross-border bank claims, Trillions of 2010 USD



Note: The data cover all cross-border bank claims as reported in the BIS locational banking statistics. They include claims on all sectors of recipient economies. Descriptions of the BIS developing and developed country groupings are available from www.bis.org/statistics/a3_1.pdf. Data for developed and developing countries do not add to all claims because offshore financial centres and international institutions make up separate categories and some claims cannot be allocated. The BIS statistics are converted to 2010 US dollars using the US all-items CPI.

Source: BIS locational banking statistics, Thomson Reuters Datastream and OECD calculations.

14. Taken together, declining productivity growth and the rising role of finance represent two powerful, long-standing forces that shape economic life in OECD countries. Investigating the nexus between productivity and finance, and the policies that influence them, will improve the understanding of researchers and policy makers interested in harnessing potential mechanisms to stimulate productivity growth.

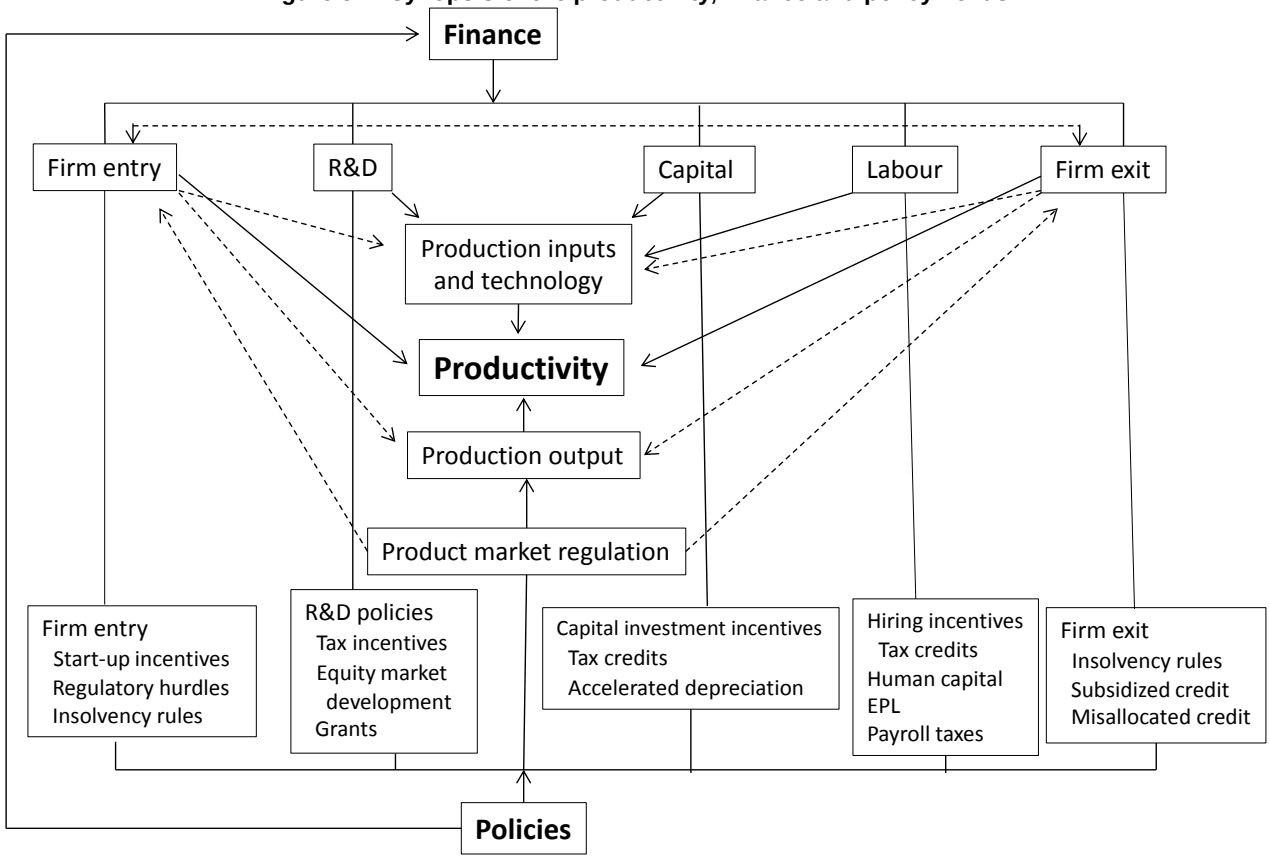
15. This survey of the literature assesses several facets of this nexus, and intends to help inform practitioners so that they may target their future research efforts to extend the current body of work in fruitful directions. It summarises the current state of understanding addressed by empirical studies about how financial factors influence the productivity of non-financial firms and the aggregate economy. It provides a framework for the analysis in the following section. Then, in Section 3, it reviews the literature on finance and growth, which represents an overarching precursor to studies that more specifically focus on productivity. The survey proceeds to review core studies on finance and productivity in Section 4, distinguishing between indirect and direct evidence and specifically discussing interactions with business cycle conditions.

2. A framework for the analysis

16. This section offers two views to help frame the literature on productivity and finance. The first outlines flows of finance to production inputs and their interactions with policies. The second provides a broad view of the range of potential financing sources for firms and the effects of financing frictions.

17. Figure 3 shows key policy mechanisms that affect financial institutions and the financing structure of non-financial firms, which together influence productivity.[3] The solid lines represent direct paths from one element to another and the dashed lines reflect indirect influences between elements. Starting at the centre, by definition, the combination of production inputs, production technology and outputs co-determine productivity. Production inputs consist of capital and labour, and R&D is an input that shapes production technology. All three may be supported by finance of any appropriate type shown below in Figure 4. Finance also supports new firm entry and incumbent firm exit, as both activities incur expenses and influence aggregate productivity. The productivity effect of firm entry may work both through the direct presence of new firms and through their effects on other firms via competitive pressure and potential innovation diffusion, if the entry introduces an innovative production technology or new product. Entering firms may also influence factor and output markets. Likewise, firm exit decisions directly affect productivity and may indirectly influence other firms' productivity through spillover effects on factor and output prices or crowding out (if stagnant incumbent firms remain in the market). Financial market policies will be discussed below.

Figure 3. A synopsis of the productivity, finance and policy nexus



3. This snapshot diagram is in no way an exhaustive explanation of productivity and finance dynamics. To maintain simplicity, it omits several potential influences and linkages between the existing elements. Its intent is to highlight some key interactions between productivity, finance and policy.

18. Public policies influence each of the potentially credit-financed elements of production, sometimes with unintended consequences for productivity. Firm entry policies may encourage (start-up incentives) or discourage (regulatory hurdles) entry, and entry rates may be affected by policies aimed at other objectives (e.g., insolvency rules and product market regulations). R&D policies such as tax incentives aim to encourage the activity, but may favour some types of firms over others in ways that affect productivity gains. Capital investment incentives can encourage investment, but they may also distort incentives and cause overallocation in some areas at the expense of others, if not carefully designed. A range of labour market incentives intended to encourage new hires or worker mobility can influence labour input and productivity, but such marginal incentives can be counteracted by other policies such as permanent payroll taxes. Employment protection legislation (EPL) and employer labour use flexibility may bear substantially on the effect of labour on productivity. Similarly, product market regulations can influence production directly, and indirectly through discouraging new firm entry and reducing competition. Finally, insolvency rules influence firm exit by shaping the costs to be incurred by insolvent firms.[4] When insolvency costs are high, low productivity firms may choose to remain in the market instead of shutting down, impeding reallocation of resources to more productive firms and creating a barrier to entry. At the same time, insolvency regimes that place high burdens on businesses may discourage innovation or new entries, thereby reducing dynamism.

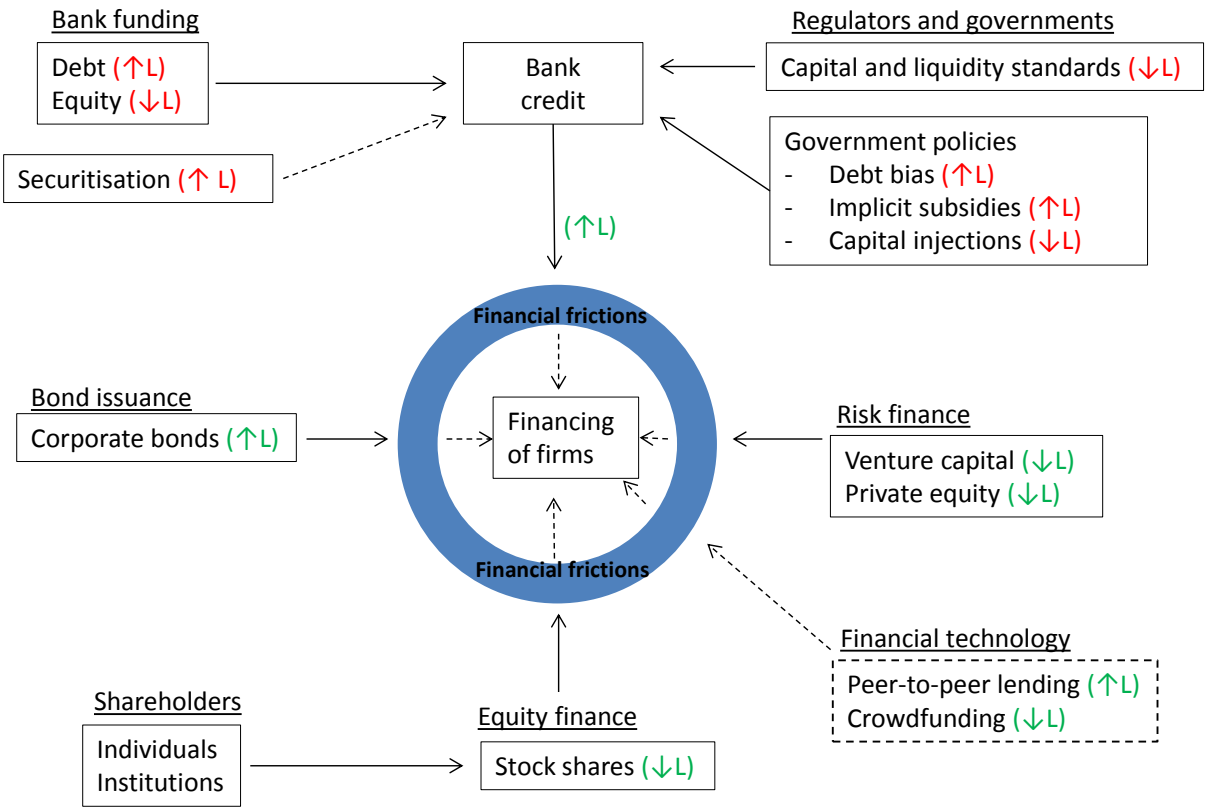
19. Figure 4 outlines some basic features of a financial system. It illustrates the sources and pathways of capital that ultimately flows toward businesses. Each of the distinct types of finance must penetrate a set of financial frictions in order to become available to firms. The solid arrows indicate direct flows of capital and the dashed arrows show potentially intermittent or diminished flows. The diagram shows that while, in principle, businesses have a range of financing options available to them, in practice a number of frictions can impede their ability to access finance. The characteristics of financiers and the characteristics of businesses seeking finance combine with market and regulatory conditions to influence the availability and terms of finance. In well-functioning systems, financial frictions are low, and finance is more likely to flow toward productive uses. Conversely, when frictions are high or financial development is low, the financial flows become distorted, and in the worst cases, may be systematically misallocated.

20. The figure shows that regulators and government policies may be influential in credit provision.[5] While an interconnected financial system may have numerous types of effects on the real economy, the diagram highlights the direct effects of policies and finance on leverage. Borrowing and leverage are an inherent part of finance and can help businesses to invest, operate, and grow. Leverage is a central feature of financial systems and the subject of ample attention during the post-recession financial regulatory reform process. Like banks, other firms can become leveraged by acquiring debt, and must monitor their leverage ratios. The red arrows and "L" symbols depict the direction of influence of the listed items on bank leverage. The green arrows and "L" symbols depict the same for other firms seeking financing. For example, debt bias in taxation tends to increase leverage among banks (and other businesses) and equity finance reduces leverage. For banks, the specific components of the array of potential funding sources and regulations can increase or decrease leverage. Other firms also have a range of financing options which can push leverage in either direction. Both banks and other firms seek a mixture of funding types that balance their need for capital while limiting leverage to sustainable levels. Optimising the funding mix itself requires sound analysis, and overleveraging may produce a form of financial friction for banks and firms, that could impede the productivity-enhancing effects of finance.

4. Related factors such as the efficiency of the judicial system may amplify or counteract the effect of insolvency rules depending on their directions of influence, but this illustrative discussion focuses on the latter for simplicity.

5. Regulation and policies also influence other forms of financing but those effects are omitted from the diagram for brevity.

Figure 4. Firm financing sources and leverage effects



21. Potential financial frictions are numerous and may be market-wide (e.g. poor market conditions for initial public offering stock issuances due to heightened risk aversion), internal to a financier (e.g. a policy of avoiding lending to specific sectors), or originate from a prospective borrower firm (e.g. a young firm that lacks the collateral value required by lenders for secured credit). Firms facing frictions impeding their access to capital may have more options now with the emerging crowd-funding, peer-to-peer lending, and other online venues, although these remain minor players in the market (therefore financial technology is shown in a dashed box). Each source of capital shown in the diagram has characteristics that may better suit some firms than others, so firms may seek to access the best funding mix available to them by accounting for such factors. For example, a young technology firm with high investment in human capital and a volatile but growing revenue stream may be considered a poor risk for a conventional business loan due to difficulty in providing collateral and a stable revenue history. Yet the same firm might be an appealing investment for a venture capital firm.

22. The main message of Figure 4 is that even well-developed and functioning financial systems face barriers to the optimal allocation of capital to its most productive uses. The literature suggests that efficient resource allocation contributes to productivity growth. Addressing frictions by removing distorting policies and addressing market failures would thus contribute to the efficiency of the financial system and productivity growth.

23. A small number of the studies reviewed herein offer insights on the incentives and decision making of financial firms, but it is not a primary focus of this paper. A future review of research that highlights these insights may be useful. Such a review may consider both historic and current influences on financial firm behaviour and their effects on non-financial firms.

24. From a historic perspective, the amount and type of finance available to businesses likely depend in part on the financial structure that emerges from the context of social development. One line of discussion compares the relative merits of bank-based versus market-based financial systems and links their development to the prevailing legal origins of countries. For example, countries with common law traditions are considered more likely to have market-based systems than are countries with civil law origins. These alternative legal traditions treat debt and equity contracts in distinct ways, which influence the development of securities markets and financial institutions (Demirguc-Kunt and Levine, 2001). In turn, the financial development path taken can affect economic growth.

25. The incentives created by current (and pending) regulations and policies influence the operating dynamics of financial institutions in more immediate ways. Generally, when regulatory environments are sound and free of distorting features, banks have incentives to allocate capital efficiently. However, when regulations or policies create distorted incentives – as in the case of Japan in the 1990s – credit flows may not be productivity-enhancing (Peek and Rosengren, 2005). This systematic misallocation can result in a large group of unprofitable firms that remain in the marketplace and impede productive reallocation (Caballero et al., 2008). More common examples of distortionary policies include the debt bias in taxation and implicit subsidies of systemically important financial firms. Thus, the characteristics of financial firms, influenced by historic factors and current regulations, have bearing on their investment decisions, the provision of finance, and ultimately on growth and productivity.

3. Financial development and economic growth

26. A large number of economic studies have probed the effects of finance and growth, rather than productivity directly, but they provide a useful context as long-term economic growth is largely a reflection of rising productivity. This literature helped to spawn the finance and productivity studies that followed, and one would expect to see effects of finance that are consistent across both bodies of work.[6]

3.1. Conceptual priors about finance and growth

27. Economic theory suggests that financial development from low levels provides structure and institutions that help to mitigate financial information costs and transactions costs between agents, and facilitates savings, investment and intermediation. This fosters capital accumulation that allows for the development of improved production technologies and feeds economic growth. At higher levels of financial development, capital is more readily available, but its provision may become inefficiently high. Positive and negative channels include the following (Cournède et al., 2015):

- More financial development can support higher economic growth through many channels including:
  - Reducing the need for financing projects from own funds;
  - Allocating capital to more productive uses;
  - Monitoring investments more professionally;
  - Providing more insurance, boosting innovation;
  - Facilitating the transmission of monetary policy; and
  - Generating productivity gains within the financial sector.

[6] This survey adopts the original terminology used by each paper reviewed and therefore includes both the terms "multifactor productivity" and "total factor productivity", although they are conceptually equivalent.

- On the negative side, too much finance can slow economic growth, particularly by:
  - Misallocating capital by funding projects with too low profitability, for instance, when distortions exist in the tax system or in the form of effective public support for too-big-to-fail banks;
  - Magnifying the distortionary costs of inefficiencies in financial intermediation such as financial sector wage premia (Denk, 2015a);
  - Heightening the risks of regulatory capture.

The direction of the net effect is therefore an empirical question.

3.2. Empirical evidence

28. The evidence presented suggests that financial development from a low level helps improve economic growth by reducing capital constraints and allocating it to productive enterprises (Table 1). This positive growth effect holds for countries with lower levels of financial development but diminishes as the provision of finance increases. Beyond a certain threshold, additional credit finance can slow economic growth (Table 2 below).

Table 1. Summary of studies on finance and growth

Authors (year)	Analytic approach	Main results
King and Levine (1993)	Cross-section and time-series OLS using initial values of FD and controls at start of decadal periods.	FD can spur economic growth by raising capital accumulation and improving capital allocation. Direction of causality may be a problem.
Rajan and Zingales (1998)	Sector-level growth models with interacted explanatory variables. Stock market, bank credit and accounting standards proxy FD. Reverse causality tests.	Greater FD increases value added growth rates of sectors more dependent on external financing by economically meaningful margins.
Beck et al. (2000)	Cross-sectional and dynamic panel regressions with “policy conditioning” controls.	Financial intermediaries have a large positive effect on TFP, which feeds GDP growth.
Manning (2003)	Re-examines data from Rajan and Zingales (1998) using sector-level growth model and bank credit for FD (alt models include stock market liquidity).	Strong positive link between lending to firms and growth applies to non-OECD countries. No significant link for OECD nations.
Pagano and Pica (2012)	Sector-level growth models using bank credit or stock market capitalisation for FD. Endogeneity tests use accounting standards as instrument.	FD increases growth of value added and employment in external finance dependent sectors of non-OECD countries, but not in OECD.
Law and Singh (2014)	Multistep dynamic panel estimation using Kremer et al. (2013) method. Bank credit and liquidity proxy FD.	Nonlinear relationship between finance and FD. Private sector credit beyond 88% of GDP has negative effect on output growth.
Cournède and Denk (2015)	Country-level growth models using value added, credit and equity finance for FD. Country-specific linear time trends and year fixed effects are included in baseline model.	Expansion in financial activity from a low base is related to strong increases in GDP growth, but the link turns negative at a threshold of about 100% of GDP for credit and equity finance.
Madsen and Ang (2016)	2SLS models using agriculture sector share of total income and unionization as instruments for FD. Data averaged over 5-year intervals.	FD operates through four channels: knowledge production, savings, investment and schooling. Knowledge is the main FD channel of growth.

Note: OLS is ordinary least squares; FD is financial development; TFP is total factor productivity; FF is financial friction; 2SLS is two-stage least squares; AE is allocative efficiency; MFP is multifactor productivity; IV is instrumental variable; GMM is generalized method of moments; VC is venture capital.

Table 2. Summary of non-linear studies between finance and growth

Authors	Sample countries	Type of data and period	Methods	Results
Deidda and Fattouh (2002)	119 developed and developing countries	Cross-sections, 1960-89	Hansen (2000) threshold regression	Nonlinear relationship between finance and economic growth. Finance is determinant of growth in high-income but not in low-income countries.
Rioja and Valev (2004a)	74 developed and developing countries	Panel (1961-95) averaged over 5 year intervals	Dynamic panel GMM. 3 regions: low, medium, high financial development	Finance has large positive effect on growth in medium financial development region, smaller positive effect in high financial development region.
Rioja and Valev (2004b)	74 developed and developing countries	Panel (1961-95) averaged over 5 year intervals	Dynamic panel GMM. 3 groups: low, medium, high income	Finance has strong positive influence on productivity growth in more developed economies. In low income economies, the effect of finance on output growth occurs through capital accumulation.
Shen and Lee (2006)	48 developed and developing countries	Panel (1976-2001)	Pooled OLS	Nonlinear inverse U-shaped link between finance and economic growth; Bank development is weak inverse U.
Ergungor (2008)	46 developed and developing countries	Cross-sections (average 1980-95)	2SLS with heteroscedasticity consistent SEs	Nonlinear contingent relationship between finance (banking sector) and growth.
Huang and Lin (2009)	71 countries	Cross-sections (average 1960-95)	Caner and Hansen (2004) IV threshold regression	Nonlinear positive relationship between finance and growth. Positive effect is more pronounced in low income countries than in high income countries.
Cecchetti and Kharroubi (2012)	50 developed and emerging countries	Panel (5 year non-overlapping 1980-2009)	Pooled OLS with robust SEs	Financial sector has inverted U-shaped effect on productivity growth. Financial sector growth is a drag on productivity growth.
Arcand et al. (2012)	>100 developed and developing countries	Cross-sections and panel (1960-2010)	Semi-parametric estimations	Finance starts having a negative effect on output growth when credit to private sector reaches 100% of GDP.
Cournède and Denk (2015)	44 developed and developing countries of OECD and G20	Panel (1965-2015)	OLS with country fixed effects	Finance beyond 100% of GDP is linked to slower growth for both bank credit and equity capital. Most OECD countries lie above the threshold for credit but below it for stock market capitalisation.

Source: Adapted from Law, S. and N. Singh (2014), "Does Too Much Finance Harm Economic Growth?" *Journal of Banking and Finance,* 41: 36-44, which provides the bibliographic references for the listed studies.

3.2.1. Early studies finding a strong positive link

29. A cross-country study by King and Levine (1993) found strong positive contemporaneous and predictive relationships between financial development and both economic growth and an allocative efficiency indicator. The analysis covers 77 developed and developing countries from 1960 to 1989 and includes four alternative indicators of financial development. Its outcomes are consistent with the view that financial development can help foster economic growth through boosting the rate of capital accumulation and improving its allocation. However, while the results are robust to a range of sensitivity analyses, the direction of causality of the relationships is not addressed and has been questioned.

30. Later studies using panel data found evidence that causality runs from finance to economic growth. Incorporating sector-level data to account for differences in the degree to which sectors depend on external financing, a seminal study of 41 countries, 1980-90 examined how financial development may influence the growth of industries. While it does not speak to productivity directly, its methods and outcomes are broadly related to it. Rajan and Zingales (1998) use a range of alternative indicators of financial development and find that higher development raises value added growth rates of sectors that are

more dependent on external financing by economically meaningful margins. The model yields a 1.3% increase in real annual growth rates for an industry at the 75th percentile of dependence on external financing in a country at the 75th percentile of financial development compared to a sector at the 25th percentile in a country at the 25th percentile. On average, in the three industries most dependent on external financing, mean residual growth rates were 1.1% in countries above the median level of financial development and -1.1% in those below the median. Reverse causality, whereby financial markets develop in response to the financing needs of industries, particularly when a country has a resource endowment that fosters development in financing intensive industries, has been a concern in the literature. The study addresses potential reverse causality by limiting the sectoral coverage to manufacturing and using accounting standards as an instrument with variables uncorrelated with omitted variables that influence finance dependent industry growth rates. It also tests for reverse causality by limiting the sample to small industries that are not large enough to be drivers of financial development, and finds the results are unchanged. The authors conclude that the positive effect of financial development on growth may work in part by facilitating the growth of new enterprises since they are more likely to need external funds than do incumbent firms.

31. Beck et al. (2000) assess the effects of financial development on economic growth and its drivers using cross-country and panel data models applied to up to 77 countries from 1960 to 1995. They find strong evidence of positive relationships between financial development and real per capita GDP growth and TFP growth. These relationships are economically significant and are robust to alternative financial development metrics and model specifications. For example, Mexico's productivity growth rate would have increased by almost 0.3% per year if its financial development level (proxied by the private credit to GDP ratio) had risen to the sample median ratio. However, the analysis finds limited evidence of a positive linkage between financial development and private savings rates, signalling that financial development induced economic growth may work through higher productivity growth rates rather than the scale effect of higher volumes of credit availability.

3.2.2. Recent studies questioning the presence of a positive link or finding a hump-shaped relationship

32. One study cautions that the finance and growth literature may have failed to find sufficiently stable results to inform policy on the timing, the means, and the conditions under which finance affects growth. Manning (2003) re-examines the data of Rajan and Zingales (1998) and shows that the strong positive linkage between aggregate lending to industrial sectors[7] and growth[8] between 1980 and 1990 applies to the sample of non-OECD countries, but not to the sample of OECD countries, which has a negative and statistically insignificant coefficient estimate. This result supports the view that financing is an important contributor to economic growth at low levels of financial development, but not at high levels of development. The author believes omitted variables correlated with both financial development and growth (e.g. finance may be correlated with other institutional factors or high human capital development that encourages growth) may have biased previous results. An alternative interpretation is that finance might have particularly fruitful effects on growth at just the stage of development experienced by the "Asian Tiger" countries during the period of analysis, and have an outsized impact on the regression results. The author suggests that the empirical question is not yet resolved, and further research should focus on long-run analysis, and modelling of more detailed dynamics. Pagano and Pica (2012) similarly use the Rajan and Zingales (1998) model with industry-level data from 1970 to 2003 and find financial

7. Lending is measured as domestic credit to the private sector divided by GDP.

8. Growth is measured directly by the annual compounded growth rate of real industry value added, and instrumented in separate regressions by accounting standards. Accounting standards signal the potential for obtaining finance based on the notion that higher financial disclosure requirements facilitates firms' abilities to raise funds. Accounting standards data are an index constructed by the Center for International Financial Analysis and Research.

development is positively related to employment growth in the non-OECD country sample, but show they are unrelated in the OECD sample. The model using the full sample of countries show positive links between financial development and employment growth, which conceals the differences between OECD and non-OECD countries until the study runs the split sample models.

33. More recent country-level studies demonstrate that the positive relationship between financial development and economic growth has limits. Law and Singh (2014) develop a dynamic panel threshold regression to study the non-linear relationship between credit and economic growth using data on 87 developed and developing countries from 1980 to 2010. Using three alternative indicators of financial development and a range of control variables, they confirm the finance and growth relationship resembles an inverted-U, with a positive link at lower levels of credit, which reaches a peak and then diminishes with additional credit. In their preferred model, the authors estimate the threshold value wherein the marginal unit of private sector credit elicits the maximum economic growth equals 88% of GDP. Of the sample countries, 29% (mainly OECD countries) have private sector credit ratios beyond the threshold level, signalling their aggregate credit levels may be slowing growth at the margin. This threshold estimate is roughly consistent with other estimates in the literature, which provides a range of 90 to 100% of GDP, despite the difference in sample countries and period of analysis (Arcand et al. 2012, and Cecchetti and Kharroubi 2012). Further analysis that divides the sample into separate regressions for developed and developing countries finds the outcomes are broadly consistent with the main results, but the threshold value for the developed countries is considerably higher than that for the developing ones. The study excludes consideration of equity finance, which it identifies as an area ripe for future research.

34. Cournède and Denk (2015) provide a long-run analysis of finance and economic growth using samples of all OECD countries and OECD plus G-20 nations from 1960 to 2011. They find that expansion of financing in countries with low levels of financial development helps fuel higher growth rates, but the growth effect of more finance shows diminishing marginal returns. For example, an increase in the level of intermediated credit from 20 to 30% of GDP is associated with more than a 1 percentage point rise in economic growth. However, the growth returns to additional finance begin to shrink and then become negative, such that an increase from 100 to 110% of GDP is linked with a 0.25 percentage point decline in economic growth. In contrast to intermediated credit, they find stock market capitalisation is positively related to growth, suggesting that transforming some finance from debt into equity, with no net change in aggregate finance, would tend to increase growth. Cournède et al. (2015) point towards several potential channels that might explain this plateau effect of finance, including misallocation of capital by funding low profit projects, increased economic costs associated with the distortions from implicit and explicit subsidies of financial institutions and susceptibility to financial shocks and contagion.

35. The finding that financial development is an important factor in boosting economic growth, but at higher levels, additional finance can impart a dampening effect on growth is well established in recent studies using developed and developing country samples (Arcand et al. 2012, Cecchetti and Kharroubi 2012, Sahay et al. 2015). Table 2 summarises studies finding non-linear relationships between finance and growth, adapted from Law and Singh (2014).

3.2.3. Summary of the evidence on finance and growth

36. To sum up this sub-section, studies from the 1990s and early 2000s found monotonic positive linkages between financial development and economic growth. However, subsequent research suggested that some of them used misspecified models, which generated biased outcomes. More recent empirical work using developed and developing country data find a threshold in the positive economic growth effects of credit finance beyond which additional finance can reduce economic growth. This threshold effect may be associated with a range of potential channels, including declining efficiency of capital allocation. The limited research on equity finance suggests the relationship is more stable and positive, so that a shift away

from credit toward equity appears associated with increased growth rates in more financially developed countries.

4. Finance and productivity

37. The research reviewed here suggests that inefficiencies in finance (present in countries with low financial development or through financial frictions) are key factors in explaining the large differences in productivity across countries. The estimated magnitude of the effect of financial frictions on allocative efficiency and productivity growth varies widely in the literature, which is unsurprising given the differences in methods, indicators, sample countries and time periods covered by the studies. This section reviews indirect and direct analyses of the relationship between finance and productivity.

4.1. Indirect analyses of the effect of finance on productivity

38. Several country-level studies assessing the relationship between finance and economic growth also provide indirect evidence on resource allocation and productivity. This survey briefly summarises a set of them, touches upon research and development (R&D) and includes an analysis of potential influences of corporate finance on productivity. Table 3 summarises the studies in this section.

Table 3. Summary of indirect evidence on finance and productivity

Authors (year)	Analytic approach	Main results
Rajan and Zingales (1998)	Sector-level growth models with interacted explanatory variables. Stock market, bank credit and accounting standards proxy FD. Reverse causality tests.	Greater FD increases value added growth rates of sectors more dependent on external financing by economically meaningful margins.
Wurgler (2000)	Estimated elasticities of manufacturing investment to value added.	In countries with high FD, investment growth is more responsive to rising value added (growth opportunities).
Benhabib and Spiegel (2000)	GMM regressions of GDP growth on FD metrics and income distribution.	Different elements of FD have positive influences on TFP growth and factor accumulation rates.
Brown et al. (2012)	GMM regressions of R&D spending on financial and endogenous liquidity smoothing variables.	Internal finance and external equity finance are important drivers of R&D spending.
Demeulemeester and Hottenrott (2015)	Cost of debt regressed on lagged R&D subsidies and controls, including firm age. Considers grant applications, rejections and subsidy rates.	Firms receiving R&D subsidies have lower cost of subsequent debt on average, which can help to augment R&D activity for financially constrained firms.

Note: FD is financial development; TFP is total factor productivity; GMM is generalized method of moments.

4.1.1. Studies providing indirect evidence on finance and productivity

39. The Rajan and Zingales (1998) study cited previously notes that a mechanism for the higher growth rates of financially dependent industries in more financially developed countries may be the lower cost of finance to firms in these industries. Lower financing costs facilitate more investment. In addition to the direct productivity gain from reducing the cost of a key production factor (capital), the associated potential incremental investment may also improve returns and boost productivity indirectly in the medium or long run.

40. A key factor highlighted in Section 2 whereby finance can boost productivity is by promoting a more efficient allocation of capital. A number of studies found evidence corroborating this hypothesis. Wurgler (2000) shows that investment growth responds more strongly to value-added growth in more

financially developed countries, in a study covering 65 developed and developing market economies over the period 1963-95. The results offer evidence that financially well-developed countries tend to allocate capital more efficiently than do less developed nations. Financial development is linked to both reducing investment in declining sectors and raising investment in growing ones. The author cites three potential mechanisms for this dynamic: effective management incentives to pursue productive investment strategies (which can be muted in state-owned enterprises), clear signalling of investment opportunities through informative stock prices, and strong shareholder rights (which tend to limit investment in declining sectors).

41. The literature has also specifically pinpointed effects on TFP. A study using country-level panel data from 1965 to 1985 attempted to assess the economic growth effects of financial development and identifies the main channels through which growth is influenced. Benhabib and Spiegel (2000) offer suggestive evidence that two financial variables in their growth model are positively related to economic growth, after accounting for disparities in factor accumulation rates. These financial variables, a metric of the overall size of the banking sector and a proxy for the share of credit flowing to the private sector, imply that these aspects of financial development fuel economic growth through improvements in TFP. A one standard deviation increase in these metrics increases annual growth by 0.5 and 0.7 percentage points, respectively in the median sample country.

4.1.2. Effect of finance on productivity through research and development

42. One channel through which finance can influence productivity is through the funding of R&D. R&D consists of long-run investments with expected positive future returns, features which call for external financing to play a role in their funding. Brown et al. (2012) provides empirical support for this hypothesis, based on panel data of 16 European countries from 1995 to 2007. They find that access to equity finance is closely linked to R&D, in a model that includes stock issues and changes in cash holdings to control for endogenous R&D smoothing. This result overturns previous work on the topic that omitted stock issues and cash holdings from the models.

43. Alternative policies that consider the positive spillover effects of private research to warrant public grants to firms for R&D may generate additional favourable impacts to grant recipients. Demeulemeester and Hottenrott (2015) show that public R&D grants to firms tend to lower the cost of private finance for recipients. The study examines nearly 1 700 Belgian firms covering 2000-12 using the average cost of debt as the variable of interest. It finds that firms receiving R&D grants subsequently have lower cost of debt by about 5% on average in the following year. The authors identify three potential channels through which this effect operates. They rule out the "resource effect" (improved liquidity of firms receiving grants) as a major factor, but find the "certification effect" (a firm receiving a grant sends favourable signals to credit markets) and the "preparation premium" for young firms (that the act of applying for grants improves credit outcomes by helping them become more prepared for the loan acquisition process). The study suggests the results offer support for R&D subsidy programmes targeting financially constrained firms. Although the study does not state it, to the extent that firms conducting R&D can obtain financing at lower cost due to participating in public grant programs, one may expect an incremental rise in R&D activity, which can help promote productivity gains, all else equal.

4.2. Direct analyses of finance and productivity

44. A large set of theoretical and empirical research examines the relationship between finance and productivity in a more direct fashion than those reviewed above. The selected studies reviewed here reflect seminal work and trace the evolution of the field's knowledge. Table 4 provides a brief summary of the studies discussed in this section.

Table 4. Summary of direct analyses of finance and productivity

Authors (year)	Analytic approach	Main results
Effects of financial development		
Levine and Zervos (1998)	Models test transmission channels as dependent variables regressed on separate credit and equity variables.	Productivity growth is the main channel linking FD (both credit and equity) to growth.
Andrews and Cingano (2014)	Allocative efficiency (AE) models using DD and instruments where applicable.	Banking regulation and FD are not significantly linked to AE, but less stringent bank regulation and FD are associated with higher productivity.
Bravo-Biosca et al. (2013)	IV regressions of MFP growth on external finance dependent sectors interacted with FD (5 separate regressions each with distinct FD metric).	No significant effects of FD on MFP in any model. Indirect evidence that FD is associated with more dynamic firm growth distributions in sectors more dependent on external finance.
Effects of financial frictions		
Obstacles to contract monitoring and enforcement		
Erosa and Hidalgo Cabrillana (2008)	Theoretical comparison of lending with poor contract enforcement and optimal contracts, and effects on productivity.	Endogenous financial intermediation theory helps explain use of inefficient technologies and low aggregate TFP.
Cole et al. (2016)	Theoretical model linking finance, technology adoption and productivity. Simulations use country-specific labour and monitoring efficiencies.	FD helps determine the type of production technology used, which influences productivity growth.
Collateral constraints		
Buera et al. (2011)	Theoretical 2-sector (small-scale, services and large, manufacturing) model and simulations with alternative values of FF parameter.	FF distort entrepreneurs' decisions and explain national differences in labour productivity, aggregate TFP and capital accumulation.
Midrigan and Xu (2014)	Theoretical 2-sector (traditional and modern) model and simulations of 3 countries with different levels of FF.	FF can reduce TFP and output considerably, by distorting agent decisions to enter modern sector and technology adoption.
Insolvency regimes and credit supply		
Bergthaler et al. (2015)	Qualitative review of insolvency law in Europe and assessment of policy reforms.	Weak insolvency regimes in Europe limit the ability to restructure viable SMEs and liquidate nonviable ones. More policy reforms are needed.
Bravo-Biosca et al. (2013)	IV models with MFP growth regressed on creditor rights interacted with capital intensity and creditor rights interacted with inverse of average firm size.	More pro-creditor bankruptcy regimes are associated with lower MFP growth in capital intensive industries and in industries with smaller efficient scale.
Andrews et al. (2014)	Capital regressed on firm-level patent stock and patent stock interacted with policy variables.	Costly bankruptcy regimes are associated with less favourable responses of firm capital to patenting.

Table 4. Summary of direct analyses of finance and productivity *(cont.)*

Authors (year)	Analytic approach	Main results
Insolvency regimes and credit supply (cont.)		
Adalet McGowan et al. (2017)	Method of testing spillovers mirrors Caballero et al. (2008). Capital reallocation analysis regresses capital growth on lagged MFP and lagged MFP interacted with zombie resource shares.	Zombies reduce average productivity and impair growth of productive firms. A higher share of capital stock held by zombies is linked to reduced productive capital reallocation.
Arnold and Flach (2017)	Regressions of TFP on log employment, initial firm productivity interacted with reform dummy, and controls. Industry-level decomposition of AE.	Pro-creditor reform in Brazil relaxed credit constraints for high-productivity firms and improved allocative efficiency.
Imperfect bank regulation		
Peek and Rosengren (2005)	Probit estimates of the probability that a bank increases lending to a firm, controlling for bank and firm characteristics.	Evidence of "evergreening" loans and balance sheet cosmetics among banks provided distorted incentives resulting in credit flowing to unproductive firms.
Caballero et al. (2008)	Productivity regressed on industry characteristics including zombie firms and share of capital sunk in sick firms.	Negative spillovers from rising sector shares of zombie firms harm healthy firms and contribute to lower productivity.
Adalet McGowan et al. (2017)	Method of testing spillovers mirrors Caballero et al. (2008). Capital reallocation analysis regresses capital growth on lagged MFP and lagged MFP interacted with zombie resource shares.	Zombies reduce average productivity and impair growth of productive firms. A higher share of capital stock held by zombies is linked to reduced productive capital reallocation.
Financial frictions measured through borrowing rates		
Gilchrist et al. (2013)	Accounting framework linking firm bond price spread dispersion (FF) to TFP changes, applied to US manufacturing.	Small TFP losses due to FF related distortions in US manufacturing, but potentially much larger in emerging economies.
Financial frictions measured through accounting ratios		
Levine and Warusawitharana (2016)	Dynamic productivity growth model with 4 alternative FF, estimated using GMM.	The sensitivity of future productivity growth to finance increases with the level of FF.

Note: DD is difference-in-differences; FD is financial development; TFP is total factor productivity; FF is financial friction; AE is allocative efficiency; MFP is multifactor productivity; IV is instrumental variable; GMM is generalized method of moments.

4.2.1. Productivity effects of financial development

45. Studies concentrating on periods when the financial sector was less developed tend to uncover stronger productivity benefits of more finance (than studies using more recent data or countries where finance is more developed). An early study of the ties between financial development and economic growth also includes analysis of productivity growth: Levine and Zervos (1998) use banking and stock market data as measures of financial development for 47 countries from 1976 to 1993. Running separate models with the dependent variables of output growth and productivity growth the authors test the influence of financial development by including banking and stock market variables in each model, along with control variables. The results show that both banking and stock market characteristics are positively linked to output and productivity growth, suggesting a complementarity between these forms of financing. The magnitudes of the effects appear substantial. For example, a one standard deviation increase in initial stock market liquidity and initial banking development would accumulate over the period of analysis to yield 24% higher productivity. One caveat is that the authors acknowledge the direction of causality is not established, which is not unusual for studies from this period.

46. Studies that directly link financial development and productivity generally find that it works through firm dynamism rather than allocation across existing firms. Andrews and Cingano (2014) find that

more financial development and lower bank regulation stringency are linked with higher average productivity. The authors interpret this result as working through the mechanism of net firm entry (also known in reallocation studies as the extensive margin), meaning finance helps to improve productivity by reducing the share of lower productivity firms in the economy, consistent with the findings of Midrigan and Xu (2014). Indeed, Andrews and Cingano (2014) detect no clear evidence of a relationship between allocative efficiency and either financial development (using a credit metric) or bank regulation. They consider the potential effects of misallocation of resources linked to a range of policy frictions in 21 OECD nations in 2005 using a difference-in-differences model. They find that some policies, especially employment protection laws, reduce the efficiency of allocation of resources between existing firms.[9]

47. There is additional indirect evidence of firm-dynamics-related productivity benefits of greater financial development. Bravo-Biosca et al. (2013) find such effects in firm-level data covering 10 OECD countries from 2002 to 2005.[10] In industries dependent on external finance, more developed financial institutions are associated with a more dynamic growth distribution of firms (fewer stable firms and more shrinking and growing firms), facilitating the reallocation of capital through the firm churning process. However, they fail to find a significant effect of financial development on MFP in sectors highly dependent on external finance.

4.2.2. Productivity implications of financial frictions

48. A strand of research investigates the impact of financial frictions on productivity or related outcomes (financial frictions are illustrated in Figure 4) using firm-level data. These studies explore the importance of external financing by testing the effects of borrowing constraints like borrowing ceilings, imperfect contract enforcement, and collateral constraints. This literature suggests that financial frictions can slow economic growth and reduce productivity growth, and may be a key determining factor in cross-country productivity differences. They can take different forms:

- Limits to contract monitoring and enforcement;
- Collateral constraints;
- Incentives created by insolvency regimes;
- Adverse effects of bank regulatory or supervisory practices.

The rest of the section reviews the literature relating to these sources of financial frictions, before turning to the assessment of their effects that are measured indirectly through:

- Differences in borrowing rates;
- Accounting ratios.

Obstacles to contract monitoring and enforcement

49. Difficulties in monitoring or enforcing contracts are a potentially powerful source of financial frictions. A theoretical model put forth by Erosa and Hidalgo Cabrillana (2008) outlines how poor contract enforcement in developing countries may create a pernicious dynamic that results in persistently low aggregate TFP and wide-spread misallocation of resources, marked by the use of low productivity technologies and an unequal distribution of labour productivity across industries. The stylised model

9. Allocative efficiency is the within-sector covariance between a firm's size and its productivity level.

10. Here financial development is measured by an index consisting of the sum of stock and bond market capitalisation plus private bank credit all divided by GDP. The metric captures both debt and equity.

suggests that entrepreneurs borrowing from financial intermediaries have little incentive to provide accurate information about the value of their investment projects (due to limited enforcement), and general equilibrium price impacts (inflated output prices and low wages) make it profitable to operate low productivity businesses. Limited contract enforcement impedes factor mobility so that it fails to flow to higher productivity sectors, causing overallocation to less productive industries. Therefore the financial friction described in the paper has far-reaching effects that distort incentives and results in slow growth and low productivity, which is consistent with the empirical data in some emerging economies.

50. On the empirical side, a recent study by Cole et al. (2016) models firm technology adoption decisions in India, Mexico and the United States with external financing as a critical determinant. They show that a financial system with long-term contracts and efficient performance monitoring promotes the adoption of advanced technologies that fuel higher productivity. Advanced production technologies entail high up-front investment costs (calling for external finance) and generate earnings late in the firm development cycle (requiring careful monitoring by financiers). Thus, only countries with efficient financing institutions and mechanisms can fund advanced technologies. India and Mexico's systems allow adoption of entry-level and intermediate-level technologies, which have lower financing needs and shorter pay-off horizons than does advanced technology. These technology choices help to explain the differences in TFP between these countries. The authors estimate that if India and Mexico had a financial system as well-developed as that of the United States, their TFP would jump by 46% and 43%, respectively, a result of adopting more advanced technologies.

Collateral constraints

51. A widely cited study by Buera et al. (2011) reveals that financial frictions can account for a large part of the cross-country variation in economic development by increasing gaps in labour productivity, aggregate TFP, and capital to output ratios.[11] These frictions create distortions that misallocate capital and skew firm entry and exit decisions, which contribute to low TFP. The authors develop a stylized two-sector model of the effect of poor contract enforcement (financial friction) in developed and developing countries. The quantitative results show that frictions can have substantial effects, potentially reducing labour productivity by half and cutting TFP by one-third on average, relative to a perfect credit benchmark. Consistent with previous studies (e.g. Rajan and Zingales 1998), it finds that sectors with better-developed financing needs are more vulnerable to financial frictions. For example, manufacturing's high fixed costs and large efficient operating scales mean new entries require a large amount of external finance. When availability of finance is distorted through frictions, firm entry and exit diverge from the efficient path, in the more financially dependent manufacturing sector, but less so in the service sector, which has low fixed costs. By acting as a barrier to entry into manufacturing, financial frictions can raise prices of manufactured goods and lower productivity, a symptom of too few firms (therefore less competition and less production) and too little exit (low productivity firms remain in the market) and entry. This extensive margin dynamic illustrates why the resource misallocation problem in the more financially dependent sectors is greater than in the less financially dependent ones. Misallocation of capital occurs mainly at the intensive margin (between firms) in the service sector, but almost entirely at the extensive margin in manufacturing. Therefore, the frictions are more likely to prevent new enterprises from entering the market when fixed costs are high, and tend to impede between-firm reallocation when fixed costs are lower.

52. Another study looks at misallocation at the intensive margin and at the extensive margin associated with financial frictions in the emerging country context, but finds generally smaller effects. Midrigan and Xu (2014) develop a two-sector model calibrated to China, Colombia, and South Korea to examine the effects of financial frictions in the form of collateral constraints on TFP. The model includes a

11. The paper models financial frictions as endogenous collateral constraints based on imperfect enforceability of contracts.

traditional sector marked by low barriers to entry and low productivity, and a modern sector with high fixed costs and high productivity. In their model, businesses can self-finance investment from their earnings. However, traditional sector producers are unable to self-finance entry into the modern sector because their low margins preclude saving sufficient funds to meet the high start-up costs of the modern sector. Thus, financial frictions constrain entry into the more profitable modern sector. At the same time, earnings among enterprises in the modern sector are sufficient to self-fund some productive investment when financial frictions impede the acquisition of debt or equity funding. The analysis finds that financial frictions cause relatively modest 5 to 10% TFP losses in the modern sector through capital misallocation (intensive margin). In contrast, the frictions bite much harder in the traditional sector mainly by impeding entry into the more productive modern sector (extensive margin), with productivity losses of up to 40%.

Insolvency regimes, credit supply and productivity

53. The insolvency regime can generate financial frictions and affect productivity by imposing high costs on shutting down a business. Insolvency costs may take several forms and may have the ex-ante effect of complicating the funding of fast-growing-but-risky firms and ex-post effects of slowing the exit of low productivity firms and tying capital in low-productivity firms. This mechanism may be particularly important in the post-financial crisis environment due to the large volume of non-performing business debt held by financial institutions and the slow pace of resolution in many countries. At the same time, insolvency regimes with strong creditor protections can increase the supply of credit which may augment productivity enhancing investment, so the net effect on firm productivity remains an empirical question.

54. Bergthaler et al. (2015) recommend a set of additional insolvency regime reforms to move European countries toward international best practices.[12] Such policies would improve incentives for firms and banks to resolve bad debt, which, if successful, can clear a path for viable firms to implement efficiency-improving restructuring and allow new lending from banks. Effective policies could help to increase resource reallocation and spur new investment, which can contribute toward enhanced productivity over time. The authors place particular emphasis on the need to address legal, financial, and regulatory challenges to restructuring among small and medium-sized enterprises.

55. Bravo-Biosca et al. (2013) use firm-level data on 10 OECD countries from 2002 to 2005 to assess the effects of bankruptcy laws on productivity and find suggestive evidence of a negative relationship. They measure the stringency of bankruptcy laws with an index of creditor rights that incorporates four dimensions of creditors' rights in the event of a debtor's insolvency. Their direct analysis of the effects on productivity by firm characteristics finds that more stringent bankruptcy frameworks are associated with a decline in MFP growth in capital intensive industries and MFP reduction in sectors with smaller minimum efficient production scales. Additional analysis offers indirect evidence on productivity effects based on firm growth distributions by firm characteristics. Firm growth distributions with relatively large shares of stable firms and small shares of shrinking and growing firms (e.g. Austria) are associated with low dynamism and limited reallocation of resources, whereas distributions with relatively modest shares of stable firms and substantial shares of shrinking and growing firms (e.g. US) tend to reallocate resources more readily. This reallocation supports productivity growth if, on net, it shifts resources from less efficient firms to more efficient ones.[13] Generally, European countries have larger shares of stable firms than the does the United States, but smaller shares of shrinking and growing firms. The study reports differences-in-differences between the 90th percentile (water transport) and 10th percentile (textiles) capital-intensive industries in the countries with the most protective (UK) and the least protective (US) creditor rights regimes. It shows the difference in the share of high growth firms in the UK between these two

12. The authors list a sizeable set of reforms that have been enacted since 2010 in Europe.

13. This is the case in the absence of offsetting firm-internal MFP growth.

sectors is roughly a third smaller than in the US, and the difference in the share of stable firms is about 20% higher than in the US, suggesting a less dynamic growth distribution of capital intensive firms in countries with stronger creditor protections in their bankruptcy regulations.

56. Andrews et al. (2014) provide evidence that bankruptcy law can materially affect capital flows to firms holding patents, a proxy for innovative firms. Using firm-level data for 23 OECD countries from 2002 to 2010, their simulation results show a decrease in the cost of the bankruptcy process from the high point (Italy) to the sample mean (France) would yield a 30% greater capital allocation to firms with patents. The results support the view that expectations of costly bankruptcies can discourage entrepreneurs' experimentation with higher-risk, higher-potential-return investments, and can sequester resources in older, low-productivity firms. These effects help slow growth and dampen firm turnover rates that contribute to productive reallocation in dynamic economies. At the same time, the authors caution that stronger protections for creditors reduces their risk exposure and may increase credit supply, so the net impact of stringent bankruptcy laws is uncertain.

57. Adalet McGowan et al. (2017) show evidence that exit barriers contribute to higher industry shares of lagging firms. Using data on 17 European and Asian OECD countries from 2000-02 to 2012-14 they find that countries with high firm exit costs tend to have larger shares of financially unhealthy firms. Likewise, countries with slow commercial courts tend to have more weak firms than do countries with efficient judicial systems. These results suggest that policies and practices that impede firm exit may trap resources in existing low productivity firms and hinder the entry of more productive firms.

58. While stronger creditor protections may raise insolvency costs for firms, they may also stimulate credit supply by lowering creditor risk, making the net effect on aggregate productivity an empirical question. In contrast to the preceding studies, Arnold and Flach's (2017) analysis focuses on the credit supply response of stronger creditor protections. It examines the 2005 policy reform in Brazil that strengthened creditor protections to test the impacts on allocation of resources across firms. Their model of the determinants of TFP growth includes log employment, initial productivity interacted with the reform, and controls. The study covers 1 700 firms from 2000 to 2010. First, the policy reform increased the supply of credit, as predicted by Andrews et al. (2014). Second, the results show that firms that were initially more productive have larger post-reform productivity gains than do less initially productive firms, suggesting that the improved access to finance flows toward more productive firms. Third, decomposition of industry-level productivity shows that industries with high dependence on finance saw larger improvements in allocative efficiency (compared to those less dependent on finance) after the reform. The latter two results suggest that the growth in credit supply has productivity enhancing effects. However, the authors do not analyse the potential impacts of the policy reform on bankruptcy costs, which might be less favourable for firm productivity, as outlined by the preceding studies in this section.

Imperfect bank regulatory or supervisory practices

59. Financial frictions can also arise from imperfect bank regulation or supervision and result in lending practices that reduce productivity. Peek and Rosengren (2005) analyse the misallocation effects of poor regulatory practices and perverse incentives among Japanese banks in the 1990s that caused misallocation through an oversupply of credit to financially troubled firms. Using bank-level and firm-level data from 1993 to 1999, they build a probit model to predict the likelihood of bank lending to firms, while controlling for an array of bank and firm characteristics such as loan demand and firm capital structure. During this period, many Japanese banks faced internal and external incentives to continue lending to financially troubled firms with elevated default risk and low productivity. The internal incentive was to provide more credit to these firms so they could service their existing loans and avoid non-performing loan (NPL) status, which strengthened as a bank's risk-based capital ratio approached its required ratio. External incentives included government permission or encouragement to lend to troubled

firms to avoid potential firm bankruptcies (or bailouts) and the associated unemployment, and strong expectations that banks would continue to lend to firms within their "*keiretsu*" corporate groups even when uncreditworthy. Results show robust evidence that supports the influence of each incentive. First, banks were more likely to provide additional funds to financially weaker firms (measured by return on assets and net working capital metrics) than to financially healthier ones, and this effect was more pronounced among lenders with capital ratios within 2% of their capital requirement thresholds, and among banks with higher credit exposure to the firm. Second, firms that were *keiretsu* members were more likely to receive additional loans generally, and were likelier still to receive more credit from banks in the same *keiretsu* group. Third, government-controlled banks were also more likely to increase lending the more financially troubled the borrower firm was, which is suggestive of government complicity in this practice. Interestingly, unaffiliated non-bank financial institutions behaved differently from banks, as they were less likely to lend more to the financially stressed firms. The study does not estimate the magnitude of the economic costs of this practice. Overall, the analysis demonstrates the systematic channelling of lending to the firms that were the least likely to put the funds to productive use. This dynamic probably delayed the necessary restructuring of both weak firms and weak banks and fed large scale capital misallocation that likely fuelled the stagnation of productivity growth in Japan.

60. Studies have documented the negative productivity effects that arise when financial systems allow unprofitable firms to hog capital and labour:

- Caballero et al. (2008) find that the substantial market shares of persistently unprofitable Japanese firms ("zombie" firms) that were kept afloat by bank loans in the 1990s dampened productivity growth through two channels.[14] First, these low productivity firms' continued existence in the marketplace directly curtailed aggregate productivity. Second, spillover effects of their presence reduced the entry of more productive firms. Regressions show that higher industry shares of unprofitable firms are associated with lower investment and employment growth rates among healthy firms in the sector. The difference in productivity between zombie and healthy firms increases substantially as the share of former rises. For industries with high shares of zombie firms, the authors estimate the cumulative losses of investment attributable to their presence. For a typical healthy firm in the wholesale industry over 1993-2002, the cumulative forgone investment compared to the 1981-92 average ranged between 17 and 43% of capital, or up to 3.5 years of investment. Therefore, the evidence suggests that unprofitable firms that remained in business with support from banks crowded out the normal dynamic process of job and firm turnover that promotes productive reallocation. The distortions caused by these firms functioned in part through depressed prices for their products and increased wages, which together reduced incentives for new firm entry.

- Adalet McGowan et al. (2017) obtain similar findings when analysing firm-level data for nine European nations from 2003 to 2013.[15] They confirm the existence of spillover effects from zombie firms to healthy ones and find evidence that higher industry shares of zombie firms are linked to greater divergence in MFP between these firms and stronger firms (especially young ones). In a separate cross-sectional analysis of 13 European countries in 2013, the response of firm capital growth to lagged MFP shows more capital investment flows to higher productivity firms, but the flow is abated when industry shares of zombie firms are high, suggesting that resource reallocation may become less efficient.

14. Caballero et al. (2008) define zombie firms as those that receive subsidized credit.

15. Adalet McGowan et al. (2017) define zombie firms as those more than 10 years old with an interest coverage ratio under one for three consecutive years. Their robustness analysis experiments with alternative time periods and age thresholds.

Financial frictions measured indirectly through borrowing rates

61. Borrowing rate differentials, especially when they cannot be accounted for by observable risk factors, can serve to measure financial frictions and assess their impact on productivity. Gilchrist et al. (2013) develop an accounting framework calibrated to US manufacturing firms to assess empirically how financial frictions affect their factor input decisions and drive resource misallocation. The sample covers 496 firms with access to the corporate bond market from 1985 to 2010, which comprised half of domestic manufacturing sales over the period. Using dispersion in interest rate spreads of publicly traded firm debt to proxy financial frictions, the results suggest that US manufacturing TFP losses due to financial market distortions lie in a relatively modest range between 1.7% and 3.5%, assuming the distortions apply to both capital and labour markets. When the effect of the financial frictions are restricted to distort only capital input decisions, the TFP loss estimates decline by roughly 0.35 percentage points. A simulation wherein the authors increase by ten-fold the dispersion in firm-level borrowing costs yields a nearly 20% loss of TFP due to the associated financial distortion, a level that may be observed in only the least developed countries. The authors also analyse alternative firm structures, factor substitutability scenarios, and how widely applicable the distortions are. They find that TFP losses due to financial market distortions are greater when the capital share in the production function is high, when substitutability between capital and other inputs is low, and when the financial frictions apply to all production inputs.

Financial frictions measured indirectly through accounting ratios

62. Accounting ratios, such as book leverage, can provide indications about the cost of external financing and be related to productivity performance. In this vein, a recent study on financial frictions and productivity growth using firm-level data of four European countries from 2000 to 2010 yields a more nuanced finding. Levine and Warusawitharana (2016) estimate the effects of financing frictions on TFP growth due to investments in innovation using a generalised method of moments approach. First, they show that firm-level debt growth (their financing metric) has a positive link with future TFP growth, consistent with previous findings. Next, using the deviation of book leverage from the industry median as a proxy of the cost of debt and lagged deviation of a firm's cash holdings from the industry medians[16] interacted with debt growth to assess the effects of frictions, they find economically meaningful differences. For example, the difference in future productivity growth for a firm at the 25th percentile of financial frictions versus one at the 75th percentile varies from 0.1 to 1.6 percentage points, depending on the exogenous friction metric used. An alternative model using debt growth plus equity growth to proxy financing yields similar results, suggesting that the differences between debt and equity may not be readily discernible in this configuration (the share of capital funded by debt growth far exceeds equity growth in this sample and period).

Summary of the literature on financial frictions and productivity

63. To summarise this subsection, the evidence is consistent with the view that financial frictions applied to different samples of countries and periods of analysis consistently tend to reduce productivity. The evidence is particularly well developed for the manufacturing sector but it appears to hold for the service sector as well. In broad terms, productivity losses due to financial frictions in a country with a relatively efficient financial system like the US appear modest (less than 5% of TFP). However, when policies and practices create inefficient incentives in finance, like in Japan in the 1990s, the associated misallocation can exert sharper downward pressure on productivity. In developing countries, financial

16. As these firm-level financial friction indicators are endogenous to firms' choices, the authors also use the sovereign debt spread between a country's 10-year sovereign bond and the 10-year German bond as a metric that is exogenous to individual firms.

frictions appear to explain a considerable portion of the productivity gap with developed nations, implying large and persistent productivity losses.

4.3. Studies investigating channels other than firm-level frictions through which financial development influences productivity

64. A few studies explicitly examine the underlying channels, beyond firm-level frictions, through which financial development influences the productivity level or growth. Growth theory holds that in steady state, diminishing returns to the capital stock preclude this factor from functioning as the main channel of financial development's influence on long-run rising productivity. Possibly, the innovation channel has constant returns, making it a candidate for the channel that drives the persistent positive effect of financial development on growth and productivity (Madsen and Ang, 2016). Table 5 summarizes the studies in this section.

Table 5. Summary of studies of other channels through which finance influences productivity

Authors (year)	Analytic approach	Main results
Direct analyses of potential channels		
Levine and Zervos (1998)	Models test transmission channels as dependent variables regressed on separate credit and equity variables.	Productivity growth is the main channel linking FD (both credit and equity) to growth.
Beck et al. (2000)	Cross-sectional and dynamic panel regressions with "policy conditioning" controls.	Financial intermediaries have a large positive effect on TFP, which feeds GDP growth.
Benhabib and Spiegel (2000)	GMM regressions of GDP growth on FD metrics and income distribution.	Different elements of FD have positive influences on TFP growth and factor accumulation rates.
Madsen and Ang (2016)	2SLS models using agriculture sector share of total income and unionization as instruments for FD. Data averaged over 5-year intervals.	FD operates through four channels: knowledge production, savings, investment and schooling. Knowledge is the main FD channel of growth.
Human capital		
Harmon et al. (2000)	Literature review.	There is a large private return from one additional year of schooling on earnings. Evidence for social returns is scarce.
Vignoles et al. (2004)	(i) OLS and IV on a first-differences equation where the unobserved individual fixed-effect cancels out. Instruments are lagged values of work related training; (ii) Two-step Heckman selection model.	Work related training has a large positive impact on earnings, but only for some individuals. Firms train only those workers who will gain the most from the training.

Table 5. Summary of studies of other channels through which finance influences productivity *(cont.)*

Authors (year)	Analytic approach	Main results
Human capital (cont.)		
Lynch (1992)	Two-step Heckman selection model. First step is a probit on the probability of receiving training. Second step estimates a wage equation including the inverse Mills ratio from the probit on training.	Formal employer provided training increases earnings by 7%. Previous off-the-job training increases earnings by 5%. Apprenticeship increases earnings by 13%. Previous employer provided training has no impact on current wage.
Black and Lynch (1996)	Data from National Center on the Educational Quality of the Workforce (EQW) National Employers' Survey. OLS on a standard Cobb-Douglas production function.	A 10% increase in average education in the establishment leads to an increase in productivity between 4.9% and 8.5% in manufacturing and 5.9% and 12.7% in nonmanufacturing. For manufacturing, the greater the proportion of time spent in formal off-the-job training, the higher the productivity.
Blundell et al. (1999)	Literature review.	There is considerable amount of knowledge and consensus regarding the private economic return to education and training for the individual, and, to a lesser extent, on the contribution of education to economic growth. Lack of suitable data and methodological issues have prevented an adequate assessment of the impact of human capital on firm performance.
Lochner and Monge-Naranjo (2011)	Descriptive statistics using the NLSY79 and NLSY97.	The college attendance gap between the highest and lowest ability quartiles from the lowest family income and wealth quartiles is 47%, compared to a 37% gap for those from the highest quartiles.
Lochner and Monge-Naranjo (2012)	Literature review and theoretical model.	Increases in college costs have pushed more youth up against their credit limits. Borrowing constraints may be more harmful for investment in young children. Recent studies are pessimistic about the benefits of additional subsidies for higher education; new efforts to help finance earlier investments offer more promise.
Keane and Wolpin (2001)	Structurally estimate a dynamic optimisation model of the joint schooling, work, and savings decisions of young men, using NYSY79.	Borrowing constraints exist and are tight. But, relaxing them has no significant impact on completed schooling. Hence, intergenerational correlation in schooling cannot be explained by capital market constraints.

Table 5. Summary of studies of other channels through which finance influences productivity *(cont.)*

Authors (year)	Analytic approach	Main results
Human capital (cont.)		
Cameron and Taber (2004)	Develop a schooling choice model with heterogeneous borrowing rates and explore theoretical predictions. Predictions are tested using NYSY79-94 and with the IV estimation of a random coefficient wage equation. The instrument for schooling is the presence of a college in the county of residence at age 17.	None of the methods produces evidence that borrowing constraints generate inefficiencies in the market for schooling. They conclude that additional policies aimed at improving credit access will have little impact on schooling attainment.
Rothstein and Rouse (2011)	Use a natural experiment: the introduction of a "no-loans" policy in a highly selective university (replacement of loans by grants). The average treatment effect is estimated by DD.	Debt causes graduates to choose substantially higher-salary jobs and reduces the probability that students choose low-paid "public interest" jobs.
Corporate finance		
OECD (2016b)	Analysis of financial drivers of productivity growth, ranking firms by deciles over alternative time horizons.	Certain characteristics of four main finance areas are associated with higher firm productivity growth: sustained R&D investment, stable equity finance, stable free cash flow, and M&A activity.
Li (2013)	DD comparing plants after a takeover with similar plants that have not changed ownership. Uses plant-level data from the U.S. Census Bureau.	Target plant's TFP experiences net improvement relative to comparable plants following a takeover. Increases in productivity stem primarily from a more efficient use of inputs, while output remains constant.
Siegel and Simons (2010)	Use data for all Swedish manufacturing firms and employees over 14 years to estimate an OLS equation for TFP. Control for labour, capital and materials used in production, as well as, age dummies, industry and time fixed-effects.	M&As enhance plant productivity, although they also result in the downsizing of establishments and firms. Increases in productivity stem from improved matching of workers and managers to firms and industries that best suit their skills.
Bruner (1988)	Uses data from the acquisition history of firms in the Fortune 1000 list of 1979. Histories were checked for the 25 year period between 1955 and 1979. Draws a control sample from the Compustat Industrial File. Empirical methodology consists in statistical analysis of variance (ANOVA).	Before the merger, bidders are significantly less levered than the control sample of firms. Within the first year of merger, the bidders' leverage rises significantly.
Clayton and Ravid (2002)	Use data from the FCC website between 1994 and 1995, which lists all bids in all auctions. OLS regression with market debt-equity ratio to represent leverage as dependent variable. Controls for firm size and bankruptcy risk, among other firm characteristics.	As debt increases, firms tend to reduce their bids.

Table 5. Summary of studies of other channels through which finance influences productivity *(cont.)*

Authors (year)	Analytic approach	Main results
Corporate finance (cont.)		
Uysal (2011)	Uses firms covered in Compustat and the Center for Research in Security Prices (CRSP) from 1990 to 2007 to estimate the target leverage ratio in a first step. These are estimated with annual regressions of the leverage ratios on the main determinants of capital structure. Leverage deficits are defined as actual leverage minus predicted leverage. Next, OLS is used to analyse if leverage deficit affects acquisitions decisions.	Managers take deviations from their target capital structure into account when planning and structuring acquisitions. Firms that are overleveraged relative to their target debt ratios are less likely to make acquisitions and are less likely to use cash in their offers. They also acquire smaller targets and pay lower premium.
Finance sector efficiency gains		
van Ark et al. (2003)	Sector decomposition into differences in contribution of industry i to aggregate productivity growth due to national productivity levels and growth rates, and employment shares and growth rates.	Financial securities industry is the largest contributor to the US-EU productivity growth differential, 1995-2000. The broad ICT using services sector is the main driver of this gap.
van Ark et al. (2008)	Sector decompositions of productivity growth for EU and US, based on EU KLEMS database.	Contribution of the knowledge economy to labour productivity growth in the US was much larger than in the EU, 1995-2004.
Gordon (2004)	Qualitative analysis of productivity differences between US and Europe.	Some studies exaggerate the effect of high ICT investment in the US. Retail and wholesale trade is a key US productivity driver, along with others.
Hartwig (2008)	Qualitative synthesis of potential drivers of US-EU productivity growth gap. Labour productivity growth calculations.	Productivity measurement differences are a minor source of the US-EU gap. The dot com bubble caused a spike in US productivity.
Productivity within the finance sector		
Davies and Tracey (2014)	Assessment of bank implicit subsidies based on ratings uplifts.	No evidence of scale economies for large banks when controlling for implicit subsidies.
Denk (2015a)	Wage regressions with many employer, employee and job control variables using micro-data.	In Europe, the financial sector wage premium is 25% on average. It rises along the earnings distribution and reaches 40% for top-paid workers.
Denk (2015b)	Descriptive statistics using micro-data.	In Europe, finance is the industry most disproportionately represented among the top 1% earners.

Note: OLS is ordinary least squares; FD is financial development; DD is difference-in-differences; TFP is total factor productivity; 2SLS is two-stage least squares; MFP is multifactor productivity; IV is instrumental variable; GMM is generalized method of moments; M&A is mergers and acquisitions; ICT is information and communications technology.

4.3.1. Direct analyses of potential channels

65. Some studies have investigated the effect of financial development on TFP versus the accumulation of physical or human capital, with contrasting results:

- Levine and Zervos (1998) find positive effects of bank credit and stock market finance on capital accumulation and productivity growth.

- Beck et al. (2000) find that the main channel through which financial development influences economic growth is by fuelling higher TFP.[17] The authors arrive at this conclusion because they find a positive link from finance to growth but not to capital accumulation. Benhabib and Spiegel (2000) report evidence that financial development works through physical capital accumulation but not TFP growth.

66. One recent paper examines four potential transmission channels using long-run country-level data: knowledge production; savings; investment; and education. Madsen and Ang (2016) use data of 21 OECD countries (over 1870-2009) to estimate four sets of models, each using a potential channel as the dependent variable to test the effect of financial development. They find that financial development is strongly positively related to each of the four channels. The central finding is that knowledge production is the main driver of financial development's positive effect on growth, contributing 0.43% to the annual average productivity growth rate for sample countries over the full period, compared to 0.18% for savings and 0.02% for tertiary education. The outcomes are robust to alternative metrics of financial development, alternative estimators, a longer time interval period to consider the possible effect of business cycles, and allowing for disequilibrium in the housing market. The paper maintains the result is consistent with endogenous growth theory, which holds that long-run productivity growth depends on technology improvement. The authors suggest the policy should place emphasis on knowledge development, given its substantial role on transmitting the effect of financial development to productivity growth.

67. In summary, there are only few studies that directly examine the potential channels through which financial development influences economic or productivity growth. Broadly, the papers reviewed suggest that financial development boosts economic growth by facilitating productivity improvements. In turn, knowledge production and capital accumulation help fuel productivity. This survey places greater weight on the study by Madsen and Ang (2016) because of its OECD country sample, long time horizon and recent publication.

4.3.2. Further evidence on the human capital channel

68. Another mechanism through which finance might influence productivity is by facilitating access to higher education. While studies on the effect of education financing on firm or aggregate productivity are scarce, the empirical research shows positive linkages between education and productivity, but evidence of the relationship between finance and education appears mixed.

69. Both the theoretical and empirical literature suggests that formal education increases the earnings of individual workers. Even when controlling for the potential selection of individuals with higher ability and earnings capacity into higher education, the so-called "ability bias", empirical studies still find a positive return to education. Harmon et al. (2000) reviews studies estimating the return to education on

17. Their main financial development measure is "private credit" which is the aggregate value of financial intermediary credit to the private sector as a share of GDP. Additional metrics used include "liquid liabilities" (liquid liabilities of the financial system) and "commercial-central bank" which measures the scope of commercial banks in the economy. The study does not use an indicator of equity finance.

earnings, using different methodologies and data sets. The literature that studies the causal impact of training on earnings is scarcer and may also be affected by selection bias. Nonetheless, some empirical studies have found a positive impact of lifelong learning on labour income. For example, Vignoles et al. (2004) found a positive link between work-related training and earnings in the United Kingdom, using an instrumental variable approach with a model in first-differences to cancel out potential individual fixed-effects. Previously, Lynch (1992) estimated positive returns on earnings from formal employer provided training, previous off-the-job training and apprenticeships in the United States, controlling for the non-random assignment of individuals. To the extent that wages reflect the marginal productivity of workers, a differential in earnings between high-skill and low-skill individuals would indicate a gap in individual productivities.

70. Among the studies that directly investigate the relationship of education and training with measures of productivity, Black and Lynch (1996) present evidence using establishment-level survey data for the United States. They find that, depending on the econometric specification, a 10% increase in average education of the workforce in the establishment, may lead to an increase in productivity between 4.9% and 8.5% in the manufacturing sector, and between 5.9% and 12.7% in the non-manufacturing sector. They also find evidence on the positive impact of formal off-the-job training on productivity, measured as the dollar value of sales and controlling for the total number of labour hours. Blundell et al. (1999) provides a non-technical summary of the evidence on the returns to education for the individual, the firm and the economy at large, mainly for the United Kingdom. Amongst the returns for the firm, they consider the impact on firm productivity. Finally, for the overall economy, they summarise the macroeconomic evidence on the positive impact of education on aggregate productivity growth.

71. Another strand of the literature, starting with Becker (1967), argues that financial constraints hinder investment in human capital accumulation. This idea relies on the observation that, conditional on ability, college attendance is strongly correlated with family income and wealth, as documented in Lochner and Monge-Naranjo (2011). Lochner and Monge-Naranjo (2012) review studies of the impact of credit constraints on the education decision. They show that incorporating credit constraints in a simple two-period model of human capital investment helps explain observed borrowing, schooling and default patterns in the United States. Nevertheless, there is some ambiguity in the literature about the impact of borrowing constraints on formal education investment. Keane and Wolpin (2001) find that, while youth seem to be severely financially constrained in their consumption decisions, the relaxation of borrowing constraints would barely affect college attendance decisions. The same conclusion emerges in Cameron and Taber (2004) who find no evidence that borrowing constraints generate inefficiencies in the market for schooling. More recently, using a macroeconomic data set for 21 OECD countries over the period 1870 to 2009 and a reduced form approach, Madsen and Ang (2016) find that financial development, measured by the ratios of credit to GDP, bank assets to GDP and monetary stock to GDP, has a positive impact on gross enrolment rates in secondary and tertiary education. The authors control for life expectancy, the real interest rate, real per capita income, country and time fixed-effect. Although financial development may be correlated with lower financial constraints, it should be noted that these are different concepts. As previously mentioned, frictions in a highly developed financial system may still result in significant credit constraints.

72. Formal education is not the only component of human capital accumulation. However, absent from the literature is research on the potential impact that financial constraints and financial development may have on post-education or lifelong training investment, which has also been shown to positively affect productivity.

73. Another related issue concerns the impact of student debt on occupational choices and whether this could have an indirect effect on productivity. For instance, Rothstein and Rouse (2011), using a natural experiment in the United States, find that high levels of student debt causes graduates to choose higher-

salary jobs as opposed to low-paid public sector jobs. Assuming that wages partly reflect the productivity of different occupations, higher levels of student debt could work as an incentive to look for highly productive jobs.

4.3.3. Potential influences of corporate finance on productivity

74. The literature reported above strongly suggests that the structure of corporate finance has a systematic bearing on firm productivity outcomes. A recent analysis of 11 000 multinational firms covering the period 2002 to 2015 by the OECD (2016b) uses descriptive assessments (not regression based) of firms ordered by deciles of labour productivity growth to consider their relationship with key corporate finance characteristics in order to illustrate some mechanisms through which finance may link to productivity. It finds suggestive evidence that the following practices are associated with firms that have higher productivity growth in advanced economies.

- *Sustained research and development investments.* Firms with higher productivity growth have more sustained growth in their R&D investments than do lower productivity growth firms. The authors regard R&D as an important engine of technological progress and product innovation. Although the study does not make an explicit link, the availability of financing is likely to facilitate R&D spending.
- *Stable equity financing.* Maintaining stable equity financing ratios in the face of external shifts like the financial crisis is a sign that firms concentrate on long-run investment and returns. In advanced economies, the lower productivity growth decile firms substantially increased their debt-to-capital ratios in the post-crisis period, while higher productivity growth firms kept their debt and equity ratios steady across the two periods.
- *Stable free cash flow*. Higher productivity growth firms tend to have greater and more stable free cash flow ratios, than do lower productivity growth firms. Free cash flow can serve as a buffer for firms when short-run fluctuations occur, and allow them to concentrate on their long-run objectives. It may also reduce the need for short-term external financing and thereby limit taking on new debt to cover short-term needs.
- *Merger and acquisition (M&A) activity.* M&A activity was highest among the lowest productivity growth firms and the highest productivity growth firms. While specific M&A deals may be either productivity-enhancing or productivity-inhibiting depending on the market structure and intentions of the acquiring firm, on the whole, this activity is associated with higher productivity growth. An example of a potentially productivity-enhancing merger may be when a large firm acquires a small, productive technology company and invests in expanding its reach into new markets while simultaneously shedding a low productivity unit within the corporate entity. M&A activity frequently requires external financing to execute, so the availability of finance may be a critical factor in realising these potential productivity gains.

75. The literature provides evidence supporting the favourable productivity effects of M&A activity found by OECD (2016b). There is a vast literature suggesting that M&As create value for the acquirer and target stockholders. These positive returns reflect the market's expectations that mergers will generate efficiency gains, market power gains, or both. Surprisingly, however, there is little evidence on whether such expectations materialise (Kaplan, 2000). A recent study by Li (2013) shows that acquiring firms increase the productivity of targets through more efficient use of investments and labour, as well as through the closure of inefficient plants. The author finds that the target firm's TFP increases relative to comparable firms following the takeover. A similar conclusion is reached by Siegel and Simons (2010), who find that M&As improve the sorting and matching of plants and workers to more efficient uses, using a linked employer-employee data set that covers all Swedish manufacturing firms and employees.

76. Since the financial structure of businesses seems to impact the probability that a takeover succeeds, it may indirectly affect productivity gains at the plant level through its impact on M&As. There is evidence that highly leveraged firms are less successful at acquiring targets, starting with Bruner (1988), Clayton and Ravid (2002), and later Uysal (2011). A potential mechanism through which financial structure influences the likelihood of a successful acquisition is the degree to which a potential acquirer firm is leveraged. Less leveraged firms may be able to pay higher premiums than other bidders. Figure 4 shows the directional impact of different types of firm financing on the recipient firm's leverage ratio (see green arrows and "L" symbols).

4.3.4. Studies of contributions from efficiency gains within finance to aggregate productivity

77. Financial development can also contribute to aggregate productivity through the efficiency gains it may generate within the financial sector itself. Some studies have considered that, in the late 1990s, the financial sector improved its own efficiency so much that it contributed substantially to economy-wide productivity growth. Van Ark et al. (2003) reckon that the securities-trading industry contributed 0.37 percentage points (and the rest of the financial sector 0.07 percentage points) to the 2.5% per annum increase in labour productivity that the US economy experienced between 1995 and 2000. Van Ark et al. (2003, 2008) attribute this strong contribution, which was not observed in the EU economy during the same period, to the deployment of efficiency-enhancing information and communication technologies (ICT) by US brokers and securities dealers. This more efficient use of ICT in securities trading as well as in retail trade was an important driver of the productivity gap between Europe and the United States (Gordon, 2004; van Ark et al., 2008).

78. However, the huge estimated labour productivity growth within the US brokerage industry in 1995-2001 (9.1% per annum according to Triplett and Bosworth, 2004) seems to owe much to the dotcom bubble and measurement issues (Hartwig, 2008). In particular, the key role played by the number of trades when measuring the US securities industry's output volume strongly boosted volume growth in a period characterised by a rapid rise in trading activity.

4.3.5. Studies about productivity within the financial sector

79. The rise of very large banks and resulting high concentration in banking has raised questions about whether the cost of weaker competition might be offset by scale economies. Studies on bank economies of scale offer some insight on the productivity implications of bank size.[18] This issue has high salience in the post-recession era as regulatory reform processes may consider placing requirements on large banks that directly or indirectly limit their operating scale. If policy measures lead to the break-up of large banks or effectively limit their size, costs could arise through the loss of economies of scale in the banking sector, but much of the empirical literature finds that financial activities involve no significant economies of scope or scale beyond a relatively small size (see Amel et al. 2004, for a survey). Recent research casts doubt on the apparent economies of scale at very large banks and finds they disappear when adjusting for too-big-to-fail subsidies (Davies and Tracey, 2014), although the evidence is not unanimous.[19] This result suggests that systemic risk associated with the failure of large banks can be reduced without efficiency effects from the loss of scale economies of large banks.

18. This discussion draws on Cournède, Denk and Hoeller (2015).

19. Hughes and Mester (2013) also adjust for too-big-to-fail subsidies, and continue to find economies of scale. The contrasting results may be due to distinct methods and substantial differences in the composition of sample banks (banks with assets over $100 billion make up over half of the sample observations of Davies and Tracey (2014), but just 2% of Hughes and Mester (2013).

80. Another channel through which too-big-to-fail subsidies arguably have found their way into the real economy, with potential consequences for productivity, is overly high pay in finance. In Europe, the financial sector wage premium (or how much financial employees receive in excess of what similar workers are paid in other industries) is 25% of average earnings (Denk, 2015a). It rises across the earnings distribution, reaching nearly 40% for top-paid workers. High wage premiums are one reason why finance is the industry most disproportionately represented among the top 1% earners (Denk, 2015b). Such financial rents are a symptom of excessive returns to the conduct of banking activities and are likely to reduce productivity, not least considering the importance of banking services as inputs for other industries.

4.4. Non-debt finance and productivity[20]

81. As identified in previous empirical work, a substantial presence of younger firms in a market tends to contribute to dynamism both through their high turnover rates and the relatively rapid growth of the survivors among them. Young firms tend to be more dependent on external financing than are older firms as they establish their place in the market and attempt to grow. However, accessing debt financing can be challenging for younger firms for several reasons. For example, they often lack a sufficient capital stock to serve as loan collateral, they typically have volatile revenue histories, and the probability of adverse selection problems may be elevated. These conditions elevate the level of uncertainty and risk to potential lenders and may be a barrier to credit provision. In principle, young firms may be better suited to access equity and other forms of non-debt capital. Equity does not add to the firm's leverage (and insolvency risk), it avoids the adverse selection issue, does not require collateral, and may allow closer investor monitoring of firm actions and performance (Brown et al., 2009). Table 6 provides a summary of the studies covered in this section.

20. Alternative finance here refers mainly to non-debt finance, and includes equity and risk finance, as depicted in Figure 4.

Table 6. Summary of studies of non-debt finance and productivity

Authors (year)	Analytic approach	Main results
Studies of an indirect link between equity and productivity		
Brown et al. (2009)	R&D model with financing constraints. First-difference GMM estimation for dynamic panels with lagged dependent variables.	For young firms, equity finance is positively linked to R&D spending. Shifts in supply of equity finance in 1990s drove the US R&D boom.
Brown et al. (2012)	GMM regressions of R&D spending on financial and endogenous liquidity smoothing variables.	Internal finance and external equity finance are important drivers of R&D spending.
Levine and Warusawitharana (2016)	Dynamic productivity growth model with 4 alternative FF, estimated using GMM.	The sensitivity of future productivity growth to finance increases with the level of FF.
Studies of a direct link between non-debt finance and productivity		
Levine and Zervos (1998)	Models test transmission channels as dependent variables regressed on separate credit and equity variables.	Productivity growth is the main channel linking FD (both credit and equity) to growth.
Chemmanur et al. (2011)	Firm-level TFP changes regressed on dummies showing differences in pre-financing TFP between firms receiving and not receiving VC, and TFP differences after VC financing.	On average, VCs finance firms with higher TFP in the 5 years before getting financing. VC-backed firms improve TFP by more than non-VC-backed firms in the 4 years after VC.
Andrews et al. (2014)	Firm-level TFP regressed on patent stock interacted with policy and sector exposure to policy, using a long difference specification.	Patent stock is positively associated with TFP. Results are sensitive to model specification.
Davis et al. (2014)	Plant-level DD model combined with decompositions to estimate effects of private equity buyouts on TFP relative to control firms.	Private equity buyouts facilitate productivity enhancing reallocation. Over two-thirds of TFP gains among target firms come from employment shifts from plant entry and exit.

Note: FD is financial development; FF is financial friction; TFP is total factor productivity; FF is financial friction; GMM is generalized method of moments; VC is venture capital; DD is difference-in-differences.

4.4.1 Studies of an indirect link between equity finance and productivity

82. There are few empirical studies looking directly at equity finance and productivity. In order to increase the volume of available studies this survey widens its scope to include those that may offer indirect insights.

83. An indirect perspective examines the potential role of equity finance on R&D investment and finds a positive role:

- Brown et al. (2009) develop a model consistent with the endogenous growth literature for US technology firms from 1990 to 2004, a period that witnessed dramatic growth, then downturns, in both equity market capitalisation and R&D investment. In this sector, equity finance dominates debt finance by a large margin. Regression outcomes differ by firm age. Among young (up to 15 year old) firms, internal and external equity finance are significant drivers of R&D, but no such link exists for older firms. The authors suggest this contrast may be due to the facts that younger firms largely drove the expansion and subsequent contraction in R&D, and that the younger firms may be substantially more financially constrained than older firms, which rely more on internal funding. The study estimates that the deviations from predicted trends in young technology firms' cash flow and stock issuances explain more than 70% of the boom and bust in R&D investment over the period. The authors state that the observed increase in non-farm labour productivity growth beginning two to three years after the R&D run-up started suggests these equity-aided investments provided a boost to productivity.

- Brown et al. (2012), find that stock issuances are consistently positively related to R&D in 16 European countries. The relationship is particularly strong among young firms and small enterprises, which may be more innovative than other firms and in greater need of financing.

84. One study would tend to find no specific role of equity finance, though it is not fully developed in this regard. Levine and Warusawitharana (2016) find that financial frictions increase the sensitivity of future productivity growth to debt growth in individual sample countries and in the aggregate. An alternative model using debt plus equity growth to proxy financing yields similar results, suggesting that the differences between debt and equity may not be readily discernible in this configuration (the share of capital represented by debt growth far exceeds equity growth in this sample and period). The authors do not report running the model using equity growth alone to proxy finance.

4.4.2. Studies of a direct link between non-debt finance and productivity

85. One study uses both equity and debt indicators of financial development in models that assess potential influences on economic and productivity growth. Levine and Zervos (1998) use stock market capitalisation and liquidity indicators in their models. Capitalisation over GDP shows the size of the stock market and is a common metric for financial development, although the authors note large markets may not always function effectively. Liquidity is measured by turnover (value of trades of domestic shares divided by value of listed domestic shares) and value traded (value of trades of domestic shares on domestic exchanges divided by GDP).[21] Including both banking and stock market indicators in their models, the results show that bank credit and stock market liquidity and value traded are positively related to GDP and productivity growth (stock market liquidity is the most robust of the equity metrics). A characteristic of stocks is that they allow investors to easily buy or sell shares, and the paper notes that this liquidity may improve efficient allocation of resources, capital formation, and growth. The significance of both banking and stock market variables in the regressions signals that both types of financial development may facilitate productivity.

86. Venture capital (VC) appears to have positive effects on firm productivity, especially for young firms. Chemmanur et al. (2011) research the effects of VC on productivity among more than 187 000 US private manufacturing firms from 1972 to 2000. Their analysis offers insights on the effects of VC and the channels through which they operate. The study provides strong evidence that firms receiving VC have better productivity performance both before and after the capital infusions than do firms not receiving it, suggesting that VC firms impart both a "screening" effect (investing in more efficient firms) and a "monitoring" effect (assisting and monitoring post-investment performance). On average, over the five years prior to the start of the VC finance, firms receiving VC had 7% higher TFP than non-VC recipient firms (screening effect). In each of the five years after receiving initial VC financing, these firms' TFP growth rates exceeded those of non-VC firms by between 5.5 and 14 percentage points (monitoring effect). Both the estimated screening effect and the monitoring results are economically meaningful and may roughly translate into 24% and 42% higher profits, respectively, according to the study. When dividing the sample into firms receiving initial VC finance at an early start up stage and those receiving it at a later stage, the evidence shows that while both groups had screening effects of similar magnitudes, the former group shows a substantially greater monitoring effect. This suggests that VC engagement of firms early in their development cycles may yield greater productivity gains later. Further analysis of the full sample sheds light on the mechanisms driving productivity growth. The authors find that growth in total sales revenue among VC-supported firms is a primary source of TFP growth. An observed rise in salaries in the four years after initial VC investment suggests the firms may improve the quality of their workers and managers, which contributes to higher productivity growth.

21. The authors caution that rising stock prices due to expectations of higher earnings can inflate the value traded and capitalisation indicators but remedy this by including both together in their regressions.

87. Research suggests a positive link between innovation and productivity growth. For example, a simulation analysis using a 2009-2003 long difference model by Andrews et al. (2014) shows a 10% rise in the patent stock is associated with a roughly 2% increase in TFP.[22] More resources flow to firms holding patents in countries with better developed financial markets than to firms without patents in those countries. This is consistent with the previous research (which does not distinguish between firms with and without patents) showing that financing plays an important facilitating part in helping capital constrained firms establish themselves in the marketplace. Andrews et al. (2014) find that access to VC may be particularly valuable for young firms with patents, wherein patents serve as proxies for firm innovation. Their simulation analysis shows that capital flows to firms with patents would increase by one-third if the country with the lowest VC supply in the sample of 23 OECD countries were lifted to the sample average level. As young firms may be seen by lenders as less creditworthy than older firms due to their limited histories and smaller size on average, they may be constrained in their ability to provide collateral. Innovative young firms in particular may develop uncommon new products with little earnings histories or invest heavily in research and knowledge, which are difficult to collateralise, making them seem risky to creditors but perhaps more appealing to equity investors or venture capitalists.

88. While equity financing in the form of stock market issuances and VC are well known, private equity financing may also influence firm productivity growth. Private equity entities often aim to acquire control of target firms, implement restructuring plans, and then sell or take them public, in an effort to raise the value of the target firm and earn returns for investors. A study by Davis et al. (2014) constructs a large data set of 3 200 US firms (target firms) acquired through buyouts between 1980 and 2005 consisting of 150 000 domestic plants and compares them with similar non-acquired firms (control firms) across a wide range of characteristics to assess the potential effects of private equity on productivity. In the two years after a buyout, the study finds that private equity buyouts increase TFP by 2.1 log points among target firms, while baseline TFP growth among control firms is slightly negative. Compared with control firms, target firms are roughly twice as likely to shut down low productivity plants and twice as likely to open new highly productive plants, and this accounts for three-quarters of these TFP gains among target firms.

4.5. Business cycles, finance and productivity

89. The early empirical research on business cycles and productivity, which to a large extent left financial market imperfections aside, concluded that recessions had favourable net effects on resource allocation, supporting Schumpeter's notion of "creative destruction". These periods of economic stress were seen as facilitating the process of productivity-enhancing reallocation, in part by sweeping away the least efficient producers, allowing resources to be shifted to more productive uses (for example see Davis and Haltiwanger (1990) and Caballero and Hammour (1994)). Table 7 summarises the studies discussed in this section.

22. Similarly, Égert (2016) finds higher innovation intensity is positively associated with increased MFP.

Table 7. Summary of studies on business cycles, finance and productivity

Authors (year)	Analytic approach	Main results
Barlevy (2003)	Theoretical general equilibrium model of lending. Firm-level regressions of output per worker on new debt, lagged net worth and industry year dummies, 1984-94.	Higher new debt is associated with increased labour productivity. Supports view that more productive firms borrow more and hypothesis that recessions may harm them.
Ouyang (2009)	Stylized two-state model calibrated to US manufacturing with stochastic demand shocks and learning by firms.	Recessions have net long-run productivity reducing effects. Exit of young firms include those that may have become high productivity firms.
Osotimehin and Pappada (2015)	Simulation model of firm dynamics with credit market imperfections, calibrated in part to US economy 1994-2012.	FFs may reduce the cleansing effect of recessions by leading to exit of some productive firms.
Foster et al. (2014)	Firm growth rates and exit rates regressed on TFP, unemployment, and interaction terms incorporating GR.	GR differed from prior recessions and saw less productivity enhancing reallocation.
Borio et al. (2015)	Productivity growth regressed on private credit and controls. Allocation and common component are regressed on same variables. Allocation component is further decomposed into productivity- and employment-driven elements.	Credit booms are associated with lower concurrent productivity growth rates, driven by the allocation component where employment moves toward low productivity sectors.
OECD (2016a), Denk and Kastrop (2016)	Trend productivity estimates based on OECD method. See Ollivaud and Turner (2015) and Johansson et al. (2013) on the method.	Half of the productivity growth decline since 2007 is due to cyclical factors and the other half to reduction in trend productivity growth.

Note: FF is financial friction; TFP is total factor productivity; GR is Great Recession.

90. Subsequent analyses reveal a more complex view of business cycle and productivity dynamics by incorporating financial-market imperfections into models. These studies find that under the conditions prevalent during recessions, distortions in credit market incentives can have counterintuitive effects and hamper rather than boost reallocation:

- Barlevy (2003) uses a general equilibrium model to show that well-functioning credit markets during recessions can foster productivity-enhancing *reallocation*. However, in the presence of market frictions, recessions can result in increased *misallocation*. This result emerges from a stylised condition marked by severe liquidity constraints such that creditors have incentives to lend to businesses that require smaller loans, even if they are less productive than businesses seeking larger loans, because lenders perceive their losses in the event of default would be smaller.

- When external funders are imperfectly informed, recessions can have negative effects on reallocation by depriving promising firms of sufficient time to develop and signal their potential. A simulation model by Ouyang (2009) calibrated to the US manufacturing sector uses data on firm entry, exit and productivity to estimate the potential opposing effects of "cleansing" and "scarring". The cleansing effect of recessions is the notion that recessions improve resource allocation by accelerating the exit of low productivity firms and redirecting their resources to more productive uses. The scarring effect is the idea that recessions induce responses by firms that reduce average productivity. Recessions may force young firms to exit before the firms have sufficient time to learn by doing and reveal themselves to external funders as being potentially efficient. This implies that some share of exiting young firms during a recession would have become high productivity firms had they remained in the market, but the opportunity for them to

become productive vanishes when they exit.[23] The model proxies recessions as negative demand shocks causing a drop in prices that shifts firm exit margins leftward. Simulation outcomes show that the long run scarring effects dominate the cleansing effects, signalling that recessions contribute to net *reductions* in productivity.

91. The debate is not settled, as other analysis suggests that the positive effects may dominate the negative ones, even in the presence of financial frictions. Osotimehin and Pappada (2015) develop a model calibrated to the United States from 1994 to 2012 to illustrate firm dynamics with credit frictions and endogenous firm entry and exit to test the cleansing hypothesis of recessions. The model simulates a productivity shock and a financial crisis shock, both with and without financial frictions. The simulations show that in the absence of financial frictions, both types of shocks lead to increased exit rates of lower productivity firms, resulting in higher average productivity among surviving firms and confirming a cleansing effect. The presence of financial frictions modifies the exit and entry decisions of firms by including their net worth (which is not always well aligned with their productive efficiency) in the equation, but both types of shocks still impart a cleansing effect, although a diminished one. Financial frictions alter the steady state productivity distribution of firms, which influences the magnitude of the overall average productivity improvements. One influential factor in the simulations is that more productive firms tend to be larger and therefore need more financing, which makes them more sensitive to the effects of financial frictions than less productive firms. However, this sensitivity is insufficiently strong to overturn the general prevalence for less productive firms to exit before more productive firms. Therefore, this study contrasts with the conclusions reached by Barlevy (2003), who shows that financial frictions compel more efficient firms to exit.

92. In contrast to the effect of liquidity *constraints*, finance might also influence productivity growth through rapid *expansion* of credit provision. Analogous to the previously cited results of Cournède and Denk (2015) and others showing that aggregate credit levels above a certain threshold are associated with lower economic growth, recent research examines the effect of credit booms on aggregate productivity growth. Borio et al. (2015) use one digit sector-level data of 21 developed economies from 1969 to 2009 to shed light on the relationship between credit booms, aggregate productivity and financial crises. The results show that on average, credit booms[24] tend to reduce contemporaneous aggregate labour productivity growth by roughly one-quarter percentage point annually, an economically meaningful decrease. This decline in productivity growth is driven mainly by reallocation of labour to lower productivity sectors during the credit boom period.[25] In combination, employment expansion in the relatively low productivity construction sector and employment shrinkage or slower job growth in the relatively high productivity manufacturing sector account for most of this productivity loss from reallocation. The study also assesses the effect of financial crises after credit booms on labour productivity, and shows that the misallocation effects of boom periods intensify and become considerably more persistent when the credit boom is followed by a financial crisis. In such cases, the credit boom induced losses in productivity growth can continue to drag on for eight years after the start of a financial crisis, according to one simulation. Results are robust to different credit metrics, instrumental variable estimation, and alternative model specifications.

93. Analysis contends that both cyclical and long-term structural factors have contributed to the slowdown in productivity growth, with each type of factor accounting for half of the decline since the global financial crisis (OECD, 2016a; Denk and Kastrop, 2016). An important cyclical driver for the

23. The model provides no clear mechanism for a firm or its constituent resources to return to the market after exit.

24. The study proxies credit boom periods by the growth rate of private credit to GDP ratio.

25. The analysis does not account for within-sector or within-firm reallocation.

slowdown in productivity has been very weak investment. Investment rates have yet to recover and remain a drag on productivity growth, especially in Europe. Besides poor demand and world economic growth prospects and a slowing of pro-competitive policy reforms, high financing costs in some markets are a reason why investment remains low.

94. To sum up this subsection, the literature on business cycles and productivity appears inconclusive, with both evidence to support a cleansing effect of recessions and contrary evidence suggesting that frictions during recessions counteract the cleansing effect. The extent to which these frictions impede improvements in overall productivity depend in part on idiosyncratic characteristics of the models used to identify them. Some of these models use calibrated simulation methods based on limited empirical data. Fuller empirical cross-country analysis would be helpful in determining how much financial frictions affect the potential productivity improvements generated during periods of recession.

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