WPZ
Wirtschaftspolitisches Zentrum
Ein Kompetenzzentrum der FGN-HSG, Universität St. Gallen

RESEARCH FRONTIER NO. 1

WPZ · Wien · St. Gallen
www.fgn.unisg.ch/wpz
www.wpz-fgn.com
office@wpz-fgn.com

The core mission of WPZ is to provide economic policy advice based on rigorous empirical evidence and cutting edge theoretical research. To promote the knowledge transfer from the frontier of academic research to policy advice, we invite leading academics from international elite universities to summarize policy relevant insights of their empirical and theoretical research agenda.

Philippe AGHION
Robert C. Waggoner Professor of Economics
Department of Economics
Harvard University
paghion@fas.harvard.edu

Competitiveness and Growth Policy Design

This essay investigates the process of creative destruction from a firm perspective, contrasts the nature of productivity growth in advanced countries and emerging economies, and discusses the design and governance of industrial policy for innovation based growth.

Moving to the Innovation Frontier

Edited by Christian Keuschnigg

Contents

About the Contributors *v*
Foreword *ix*

Editorial **1**
Christian Keuschnigg

1 Competitiveness and Growth Policy Design **5**
Philippe Aghion

2 R&D Policies and Economic Growth **31**
Ufuk Akcigit

3 Innovation and Business Growth **41**
William R. Kerr

4 Regional Variation in Venture Capital: Causes and Consequences **55**
Ramana Nanda and Matthew Rhodes-Kropf

5 Patent Rights and Cumulative Innovation: Causal Evidence and Policy Implications **73**
Mark Schankerman

1 Competitiveness and Growth Policy Design

Philippe Aghion
Harvard University

1.1 Introduction

After decades during which governments in developed countries would privilege domestic demand as a main driver of economic growth, the advent of globalisation has forced governments to increasingly turn their attention to the competitiveness of the domestic economy, i.e. the extent to which a country can export its production abroad and thereby "exchange goods and services in which it is abundant for goods and services that it lacks" (Altomonte et al., 2012).[1]

Meanwhile, trade economists have themselves evolved with regard to how the issue of competitiveness should be approached. Thus, as clearly explained by Bernard et al. (2011), while theories of international trade used to emphasise inter-industry trade and therefore the view that international competition is between countries, with each country playing on the industries where it has a comparative advantage, recent theories emphasise firm-level competition worldwide and intra-industry trade. As well put by Altomonte et al. (2012), "it is not really the country that exchanges [...] goods and services, but rather its firms". According to this view, what makes a country competitive is primarily what makes its individual firms competitive.

And what makes an individual firm competitive on the world market are both its productivity and its size. Here, the seminal theoretical contribution is by Melitz (2003), who develops a model of intra-firm trade with heterogenous firms where only firms that are sufficiently productive can become exporters, as being more productive allows firms to secure a market share that covers the fixed cost of exporting.[2]

This prediction is confirmed by cross-country firm-level evidence (see, for example, Altomonte et al., 2012) and it has important policy implications for how to enhance competitiveness of the domestic economy. In particular, in a departure from 'vertical' or 'top-down' policies that would emphasise national comparative advantage based on current national factor endowment, the new theories call for more horizontal policies to favour productivity growth and size growth of individual firms in the country.

1 The recent fiscal devaluation in France through the introduction of the Credit d'Impot Competitivite (CICE) gave rise to a heated debate between the advocates of demand-driven policies and those who emphasise the need to increase the country's competitiveness.

2 In practice, credit constraints, labour regulations and other types of market imperfections may prevent more productive firms from growing in size sufficiently to become viable exporters.

This chapter is organised as follows. Section 2 summarises the main arguments in the recent trade literature in favour of a firm-level approach to competitiveness. Section 3 links firm-level competitiveness to productivity. Section 4 discusses potential determinants of firm-level productivity and productivity growth. Section 5 considers potential barriers to the growth in firm size. Section 6 revisits the role for vertical targeting (or sectoral policies). Section 7 draws on our discussion to propose some elements of a new growth strategy for China. Section 8 concludes.

1.2 From industry-level to firm-level competitiveness

Until Melitz's seminal contribution to trade economics (Melitz, 2003), mainstream theories of international trade would commonly rely on the assumption of a representative firm in each domestic economy. These include both the Heckscher-Ohlin model emphasising comparative advantage under perfect competition as the main driver of international trade, and the more recent theories of Krugman (1980) and Helpman (1981) focusing instead on increasing returns and consumers' preference for variety as drivers of trade. However, recent evidence shows both that there is a high degree of heterogeneity across firms in a same domestic industry, and that this heterogeneity is in firm-level productivity, in firm size, in firm-level skills and wages, and in capital intensity. Moreover, as predicted by Melitz (2003), this heterogeneity with regard to productivity in particular is a key determinant of whether and to what extent firms are involved in international trade and of how well they perform as exporters.

First, the extent of intra-industry differences is shown, for example, by Syverson (2004). Within an average US sector, the top 10% of firms in terms of productivity are twice as productive as the bottom 10%. More recently, Hsieh and Klenow (2009) show that intra-industry differences are even bigger in emerging economies: in China and India, the top 10% produce more than five times as much as the bottom 10% in the average industry.

Moreover, the distribution of firm-level performance – whether it is measured by productivity or by firm size – tends to be highly skewed (typically Pareto distributed rather than normally distributed), with many low performing firms and only few high performing firms. This in turn implies that intra-industry firm heterogeneity is much greater than the heterogeneity in average performance across industries across countries. In other words, ignoring firm heterogeneity within industries and looking instead directly at industry-level or country-level averages introduces a significant 'aggregation bias' (Altomonte et al., 2012). And it may lead to inappropriate policy prescriptions if the heterogeneity in firm performance within an industry is mirrored by a heterogeneity in firms' ability to export on the world market.

Now suppose, as in Melitz (2003), that only firms above a given performance level cut-off are able to export. Then, as explained well by Altomonte et al. (2012), any policy that would simply aim at increasing average industry-level productivity without affecting the distribution of firm performance within the industry, and in particular without affecting the number of firms that pass the export threshold, will have no effect on the industry's overall exports, and therefore on its competitiveness. And indeed, as we will see in the next section, there is evidence of a 'happy few' phenomenon, i.e. that only few firms above

a given performance threshold are able to become exporters or more generally 'internationalised'. Hence the importance of looking directly at firm-level differences and of understanding how firm-level characteristics affect firms' ability to export,[3] in other words, not just their individual productivity levels but also whether those levels exceed the export threshold.

One remark to conclude this section. We have tried to explain here why more productive firms are more likely to engage in international activities, but there is also the reverse causality from trade openness to firm-level productivity growth. For example, using a new firm-level panel data across twelve European countries over the period 1996-2007, Bloom et al. (2011) show that increased competition from Chinese imports has spurred technical change within firms in those countries (whether technical change is measured by IT diffusion, R&D expenses, TFP growth or improvements in management practices).

1.3 Productivity and other key characteristics of exporting firms

Table 1.1 from Bernard et al. (2011) is based on 2002 data from the US Census of Manufactures. It regresses the various firm characteristics (size, productivity, skills, etc.) on a dummy variable indicating whether the firm is an exporter or not. The results summarised in the table (the first column includes no fixed effect, the second column includes industry fixed effects, and the third column includes industry fixed effects plus log firm employment as an additional control) point to an 'exporter premium' in terms of firm size, productivity, skill and capital intensity.

3 For example, by appealing to the heterogeneity in firm performance within industries, Antras et al. (2010) account for the so-called 'Spanish paradox', i.e. the fact that Spain increased its overall degree of competitiveness (measured by its share of world exports) over the decade 2000-2009 even though average productivity (measured by unit labour costs) deteriorated over that period. What happened is that productivity improved for firms already beyond the export threshold, but it underwent significant deterioration for firms below that threshold. Thus the same number of firms kept exporting and they exported more due to their increased productivity.

Table 1.1 Regression of various firm characteristics on a dummy variable indicating whether the firm is an exporter or not

	(1)	(2)	(3)
Log employment	1.19	0.97	-
Log shipments	1.48	1.08	0.08
Log value added per worker	0.26	0.11	0.10
Log TFP	0.02	0.03	0.05
Log wage	0.17	0.06	0.06
Log capital per worker	0.32	0.12	0.04
Log skill per worker	0.19	0.11	0.19
Additional covariates	None	Industry fixed effects	Industry fixed effects. Log employment

Note: OLS regressions.

Source: Bernard et al. (2011).

More recently, Altomonte et al. (2012) have gone somewhat further by looking at the relationship between firm characteristics and firm-level openness over multiple countries and considering several dimensions of openness. In order to perform a reliable comparative analysis, with the support of the Bruegel think tank the authors carried out a large cross-country, firm-level survey (European Firms in a Global Economy, or EFIGE). To construct the EFIGE dataset, the authors selected seven countries – Germany, France, Italy, Spain, the UK, Austria and Hungary – and for each of these countries they selected a large number of firms to which they sent a survey questionnaire. The overall sample included 3,000 firms in each of the first four countries, more than 2,000 firms in the UK, and around 500 firms in Austria and in Hungary. All of the firms had more than ten employees. Based on the answers to the questionnaire, the authors constructed 'openness' indicators reflecting the nature or extent of the firms' international involvement. Thus, a firm would be called "exporter" if it provided a positive answer when asked if it sold abroad. Similarly, binary indicators were constructed for importing versus non-importing firms and to distinguish between firms that were involved in foreign direct investment (FDI) or outsourcing from firms that were not.

Table 1.2, from Altomonte et al. (2012), provides interesting descriptive statistics on the mapping between various dimensions of firm performance and various indicators of firms' degree of openness. In particular, we see that larger or more capital-intensive firms tend to be more 'open' along the various openness scales. Moreover, the export performance threshold appears to be lower than the FDI threshold. Table 1.3 shows that the same conclusion applies when looking at firm-level productivity (whether measured by TFP, by unit labour costs, or labour productivity): more productive firms tend to be more open, and again the export performance threshold appears to be lower than the FDI threshold.

Table 1.2 Descriptive statistics of firm performance and indicators of firms' degree of openness

	No. of firms	Avg. turnover per firm (in €1,000)	Avg. no. of employees	Avg. capital stock per employee (in €1,000)
Non-active abroad	3,402	4,443.33	31.44	152.16
Active abroad	11,357	19,273.46	139.85	196.4
Of which				
Exporter	9,849	20,494.12	151.42	199.03
Importer of services	3,449	38,659.98	332.12	223.57
Importer of materials	7,298	24,976.44	191.17	200.36
Global exporter	4,016	24,777.71	103.43	222.93
Passive outsourcer	5,799	17,052.42	83.96	204.98
Active outsourcer	590	24,657.11	119.55	225.28
FDI	719	77,637.20	334.13	239.55
Whole sample	14,759	15,589.29	114.52	189.59

Source: EFIGE dataset; Altamonte et al. (2012).

Both the fact that better performing firms tend to be more open and the ranking between the thresholds associated with the different measures of openness appear even more clearly when looking at performance deciles. Altomonte et al. (2012) thus show that around 85% of firms within the top TFP decile in the corresponding industry are exporters, around 45% of firms in the same decile are global importers, fewer than 15% are involved in FDI, and around 5% are involved in outsourcing.

Table 1.4, again from Altomonte et al. (2012), reports the results from the OLS regression of TFP on the various openness dummies. First, we see that the correlations between TFP and the various openness indicators are all positive and significant. Second, being involved in FDI commands a higher TFP premium than being an exporter, which is again consistent with the notion that the fixed cost of FDI involvement is higher than that of exporting.

Table 1.3 Descriptive statistics of firm performance and indicators of firms' degree of openness including firm level productivity

	No of firms	Avg. turnover per firm (in €1,000)	Avg. no. of employees	Avg. capital stock per employee (in €1,000)	Total factor productivity	Unit labour cost (in euros per unit of added value)	Labour productivity (added value per employee in €1,000)
Non-active abroad	1,514	5,298.51	31.67	156.14	0.872	0.77	50.71
Active abroad	5,921	26,104.12	152	200.01	1.024	0.78	57.55
Of which:							
Exporter	5,201	26,104.12	164.41	203.19	1.033	0.77	58.09
Importer of services	1,900	50,004.76	372.81	230.61	1.159	0.84	61.81
Importer of materials	3,939	31,647.82	208.25	203.31	1.058	0.79	58.43
Global exporter	2,211	38,345.27	104.42	224.77	1.094	0.79	62.56
Passive outsourcer	2,965	20,763.66	84.31	208.06	1.06	0.79	59.86
Active outsourcer	306	32,991.62	127.39	224.94	1.066	0.76	56.03
FDI	387	98,554.23	359.7	238.08	1.293	1.05	63.35
Whole sample	7,435	20,303.82	125.6	190.39	0.991	0.78	56.05

Note: Numbers are weighted averages. TFP is the Solow residual of the production function.

Source: EFIGE dataset; Altamonte et al. (2012).

Table 1.4 Results from the OLS regression of TFP on the various openness dummies

Dep. Variable: TFP	(1) OLS	(2) OLS	(3) O.Probit	N
Active abroad	0.0906*** (0.0132)	0.0353*** (0.0128)	0.261*** (0.0290)	7,259
Exporter	0.0999*** (0.0136)	0.0399*** (0.0131)	0.272*** (0.0298)	6,563
Importer of services	0.171*** (0.0171)	0.0626*** (0.0171)	0.620*** (0.0531)	3,334
Importer of materials	0.118*** (0.0142)	0.0449*** (0.0138)	0.394*** (0.0332)	5,320
FDI	0.257*** (0.0329)	0.0980*** (0.0357)	0.750*** (0.0750)	1,862
Passive outsourcer	0.122*** (0.0151)	0.0558*** (0.0150)	0.329*** (0.0342)	4,372
Active outsourcer	0.134*** (0.0309)	0.0477 (0.0306)	0.364*** (0.0755)	1,777
Global exporter	0.156*** (0.0168)	0.0699*** (0.0167)	0.425*** (0.0368)	3,652
Country fixed effects	Yes	Yes	Yes	-
Sector fixed effects	Yes	Yes	Yes	-
Firm size	No	Yes	No	-

Source: Altamonte et al. (2012).

A key issue raised by the above tables is of course that of the direction of causality – in particular, whether the above correlations reflect the impact of firm-level performance on firms' ability to become more 'open', or the fact that increased openness raises firms' productivity growth. Melitz (2003) models the performance-to-openness causality, whereas we have developed models that capture the reverse causality from openness to productivity growth by including both a reallocation effect (towards more productive firms) and an 'escaping competition through innovation' effect. Both effects contribute to increasing average productivity in the domestic economy. That both causalities should be at work comes out clearly from the recent empirical literature on trade, reallocation and firm heterogeneity.[4]

1.4 Enhancing productivity

This section looks at the determinants of productivity growth, based on two questions: How can we enhance productivity growth in advanced versus emerging market economies? Is there something to learn from observing the big technological waves and their diffusion patterns across different countries? We first present a simple framework to think about the sources of productivity growth. We then look at the sources of productivity growth in advanced countries, before turning our attention to the sources of productivity growth in emerging market

4 In particular, see Sections 2.3 and 2.4 in Bernard et al. (2011).

economies. Finally, we analyse the technological waves and draw a few lessons from a comparison of the differences in their diffusion patterns across countries.

1.4.1 A framework for thinking about the sources of productivity growth

In 1956, Robert Solow developed a model to show that in the absence of technical progress, there can be no long-run growth in GDP per capita (Solow, 1956). On the other hand, historical evidence suggests that productivity growth is an increasingly important component of growth (see, for example, Helpman, 2004). But what are the sources of productivity growth?

A useful framework for thinking about productivity growth and its determinants is the so-called 'Schumpeterian paradigm', which revolves around four main ideas.

First idea: productivity growth relies on profit-motivated innovations. These can be process innovations (i.e. to increase the productivity of production factors such as labour or capital), product innovations (introducing new products), or organizational innovations (to make the combination of production factors more efficient). Policies and/or institutions that increase the expected benefits from innovation should induce more innovation, and thus faster productivity growth. In particular, better (intellectual) property rights protection, R&D tax credits, more intense competition, and better performing schools and universities are all policies that foster productivity growth.

Second idea: creative destruction. New innovations tend to make old innovations, old technologies and old skills obsolete. This underlies the importance of reallocation in the growth process.

Third idea: innovations may be either 'frontier' innovations, which push the frontier technology forward in a particular sector, or 'imitative' or 'adaptive' innovations, which allow the firm or sector to catch up with the existing technological frontier. The two forms of innovation require different types of policies and institutions.

Fourth idea: Schumpeterian waves. Technological history is shaped by the big technological waves that correspond to the diffusion of new 'general purpose technologies' (the steam engine, electricity, information and communication technologies (ICT), etc.) to the various sectors of the economy.

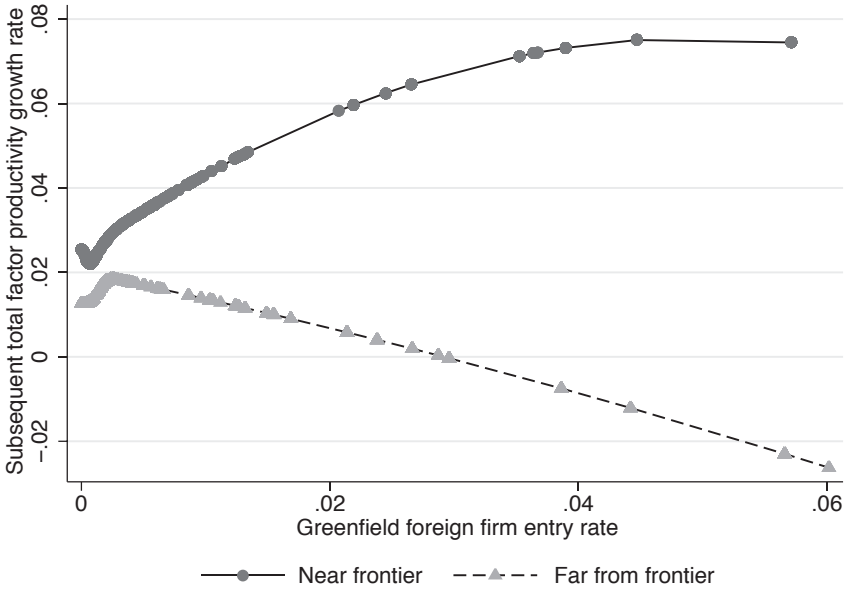
1.4.2 Enhancing productivity growth in advanced countries

To enhance productivity growth in advanced countries, where growth relies more on frontier innovations, it helps to invest more in (autonomous) universities, to maximize the flexibility of product and labour markets, and to develop financial systems that rely heavily on equity financing.

Figure 1.1 (from Aghion et al., 2009a) shows how competition (here measured by the lagged foreign entry rate) affects productivity growth in domestic incumbent firms. The upper curve shows the average TFP growth among domestic firms that are closer than the median to the worldwide technological frontier in their sector. We see that, on average, productivity growth in those firms responds positively to more intense competition. This reflects an 'escape competition effect', i.e. such firms innovate more to escape the more intense competition. In contrast, productivity growth in firms that are farther below the worldwide

technological frontier in their sector than the median reacts negatively to more intense competition. This reflects a discouragement effect. The closer a country is to the world-leading productivity level, the higher the fraction of 'above median' firms, and therefore the more productivity-enhancing product market competition is.

Figure 1.1 Total factor productivity growth and lagged foreign firm entry rate

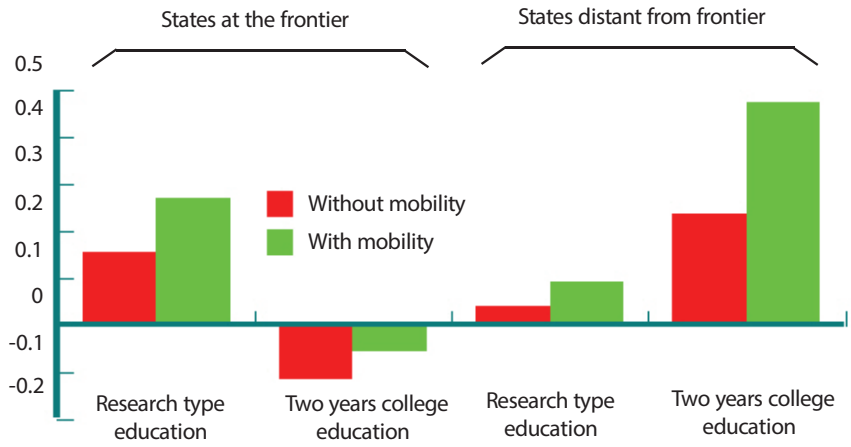


Source: Aghion et al. (2009a).

Similarly, one can show that more flexible labour markets (which facilitate the process of creative destruction) foster productivity growth more in more advanced countries.

A third lever of productivity growth in advanced countries is graduate education; indeed, frontier innovation requires frontier researchers. Figure 1.2, drawn from Aghion et al. (2009b), shows that research education enhances productivity growth more in US states that are closer to the frontier – i.e. in states with higher GDP per capita (California, Massachusetts, etc.) – whereas a two-year college education is what enhances productivity growth more in less-advanced states (Alabama, Mississippi, etc.). The same is true across countries: higher (and especially graduate) education enhances productivity growth more in countries with higher GDP per capita.

Figure 1.2 Long-term growth effects of spending $1,000 per person on education in US states



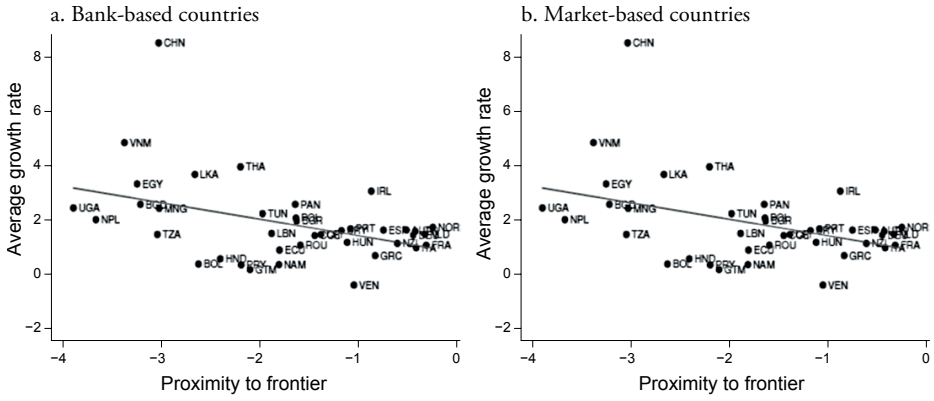
Source: Aghion et al. (2009b).

A fourth lever of productivity growth is the organisation of the financial sector. As shown in Figure 1.3 (drawn from Koch, 2014), a bank-based financial system enhances productivity growth more in less-advanced countries, whereas a more market-based financial system enhances productivity growth more in countries closer to the frontier.

Aghion et al. (2009c) performed cross-country panel regressions of productivity growth on the share of ICT in total value added and found a positive significant coefficient. But interestingly, once they control for product market regulation, the coefficient on ICT becomes non-significant. This in turn suggests that liberalising product markets is key to enhancing productivity growth in developed economies, also because they facilitate the diffusion of the ICT wave throughout the various sectors of the economy. This result is confirmed by Cette and Lopez (2012); Figure 1.4, taken from their paper, shows that the Eurozone[5] and Japan suffer from a lag in ICT diffusion compared to the United States.

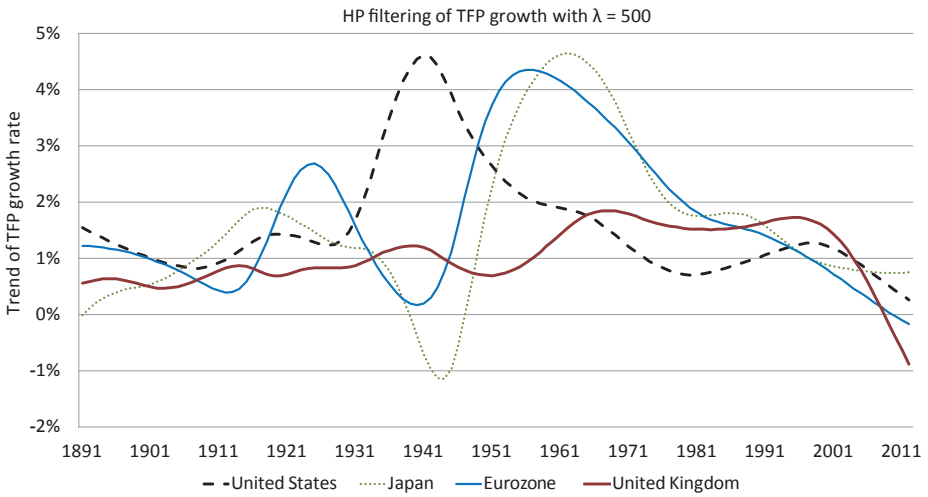
5 The Eurozone here is the aggregation of Germany, France, Italy, Spain, the Netherlands, Austria and Finland. These seven countries together represented in 88.5% of the total GDP of the Eurozone in 2012.

Figure 1.3 Average growth rate and proximity to the frontier for bank-based (left panel) and market-based (right panel) countries (growth rate of GDP per capita)



Source: Koch (2014).

Figure 1.4 Delayed productivity growth waves in other countries



Source: Cette and Lopez (2012).

Through an econometric analysis, Cette and Lopez show that this lag in ICT diffusion in Europe and Japan in comparison to the US is explained by institutional aspects: a lower average level of education of the working-age population, and more regulations on labour and product markets. This implies that by implementing structural reforms, these countries could benefit from a productivity acceleration linked to a catch-up to the ICT diffusion level in the United States.

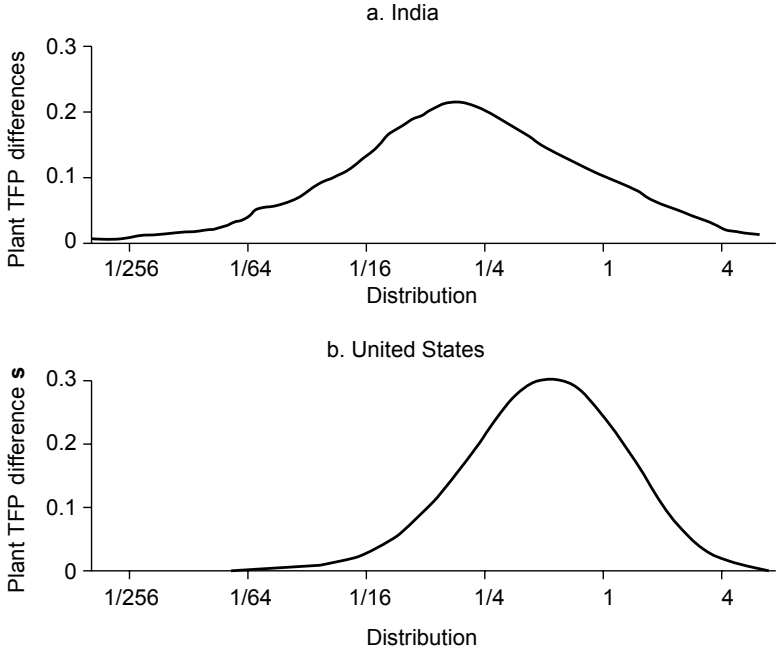
More recently, Cette et al. (2013) analyse the impact of anticompetitive regulations in upstream (service industry) sectors on productivity growth in downstream industries that are using inputs from those upstream sectors. Using

an unbalanced country-industry panel dataset covering 15 OECD countries over the period 1987-2007, the authors find that anticompetitive upstream regulations have a significant detrimental effect on productivity growth downstream, and that this effect operates in part (but not entirely) through R&D and ICT investments in downstream industries.

1.4.3 Productivity growth in emerging market economies

Turning now to the sources of productivity growth in emerging market economies, where adaptive innovation and factor accumulation are the main sources of growth, Hsieh and Klenow (2009) have emphasised the importance of input reallocation effects. In particular, if we compare the distribution of firm productivity in India and the United States (see Figure 1.5), we see that the United States has a thinner tale of less productive plants and a fatter tail of more productive plants than India. In other words, it is harder for a more productive firm to grow but also easier for a less productive firm to survive in India than in the United States; the creative destruction process operates more efficiently in the United States.

Figure 1.5 Distribution of plant TFP differences in US vs India



Notes: US mean=1; Higher US TFP due to reallocation – thinner 'tail' of less productive plants. Source: Hsieh and Klenow (2009).

This difference can be attributed to various potential factors, in particular, more rigid capital markets and labour/product markets in India, the lower supply of skills in India compared to the United States, the lower quality of infrastructure in India, and the lower quality of institutions to protect property rights and enforce

contracts in India compared to the United States. These factors in turn operate on productivity growth through several potential channels. One particularly interesting channel is that of management practices. Recent work (for a review, see Bloom and Van Reenen, 2010) shows that management practices are far worse in India than in the United States, and that the average management scores across countries are strongly correlated with levels of GDP per capita.

1.5 Technological waves

1.5.1 Two productivity growth waves

Using annual and quarterly data on labour productivity and TFP for 13 advanced countries (the G7 plus Spain, the Netherlands, Finland, Australia, Sweden and Norway) plus the reconstituted Eurozone over the period 1890-2012, Bergeaud et al. (2014) show the existence of two large productivity growth waves during this period.

The first wave, which culminated in 1941, corresponds to the second industrial revolution (in electricity, internal combustion and chemistry) (Gordon, 2000). The second wave, which culminated in 2001, is the ICT wave. The second wave is of a smaller magnitude than the first, and a big question is whether this second wave has now ended in the United States.

1.5.2 Diffusion patterns

Bergeaud et al. (2014, Figure 1.6) show that Japan, the UK and the Eurozone have benefited from both waves, although with delays in both cases. Thus the first wave fully diffused to the current Eurozone, Japan and the UK only after World War II. As for the second productivity wave, so far it has not shown up in the Eurozone or in Japan. Market rigidities contribute to explaining such delays; the lower quality of research and higher education appears to also matter.

5.3 Global breaks

One observes several global breaks in the evolution of productivity growth over the period 1890-2012. Bergeaud et al. (2014) show that there are have been types of global break: 1) the global breaks associated with the two World Wars; 2) the global breaks attributable to the two financial crises of 1929 and 2008; and 3) the break corresponding to the global oil supply shock.

Several interesting observations are proposed by Bergeaud et al. (2014) from observing these breaks. First, the global war shocks affected different countries differently; more precisely, they were downward shocks for countries such as France, Germany and Japan where battles were waged, but they correspond to an upward shock for the United States, which was not directly submitted to the confrontations. Second, the rebound from the Great Depression was stronger in the United States and Canada than in other developed countries. Also, most countries exited the Depression through World War II. Third, the impact of the global oil supply shock was generalised, although the United States got in and out of it earlier than the other countries, partly through deregulating its markets.

1.5.4 Country-specific shocks and the role of reforms

Bergeaud et al. (2014) show, in Figure 7 of their paper, a positive break in labour productivity and in TFP growth in Sweden after 1990. This stands in contrast with the case of Japan shown in their Figure 8, where we see no such break but instead decelerating labour productivity and TFP growth since 1980. Our explanation is that Sweden implemented sweeping structural reforms in the early 1990s; in particular, a reform of the public spending system to reduce public deficits, and a tax reform to encourage labour supply and entrepreneurship. No significant reform has taken place in Japan over the past 30 years.

Consider the four countries from Bergeaud et al.'s study that are commonly presented as lead reformers over the past three decades. The reforms initiated in Sweden in the early 1990s saw the rate of TFP growth increase from an average of 0.4% over the period 1976-1992 to an average of 1.9% over the period 1992-2008. Similarly, a 1982 reform in the Netherlands (the Wassenaard Agreement) is associated with an increase from an average TFP growth rate of 0.5% over the period 1977-1983 to an average TFP growth rate of 1.5% over the period 1983-2002. The reforms initiated in the early 1990s in Canada are associated with a break from an average TFP growth rate of 0.3% over the period 1974-1990 to an average rate of 1.1% over the period 1990-2000. Finally, the reforms initiated in the early 1990s in Australia are associated with a break from an average TFP growth rate over the period 1971-1990 of 0.4% to an average growth rate of 1.4% over the period 1990-2002.

These findings are in line with cross-country panel regressions suggesting that structural reforms play a key role in speeding up the diffusion of technological waves.

1.6 Obstacles to firm growth

In Section 3, we reported on recent theoretical and empirical work pointing to the importance of firm size for competitiveness. More precisely, we are after policies that emphasise productivity growth to an extent that should allow firms to eventually reach and pass the thresholds required to become 'open' (i.e. to first become an exporter and then to become involved in FDI and/or outsourcing activities).

There exists an entire literature on firm dynamics and its impact on aggregate productivity growth. On the theory side, the state of the art on the interplay between growth, reallocation and firm dynamics is represented by the recent papers by Klette and Kortum (2004), Acemoglu et al. (2012) and Akcigit et al. (2014). These papers build on the Schumpeterian growth paradigm (see Aghion and Howitt, 1992; and Aghion et al., 2013a) to model firms as multi-line producers and innovators. Innovations improve a firm's productivity in producing a particular intermediate input, and they allow an incumbent firm to expand its scope, i.e. the number of product lines it operates in. If the incumbent firm innovates on a new line, the firm drives out the previous producer on that line through Bertrand competition, as it outcompetes the previous producer on that line. Also, a successful innovation by an outsider on a product line currently covered by an incumbent firm eliminates that line from the incumbent firm's

range of products, thereby shrinking the number of product lines covered by that firm.

This framework generates an ergodic steady-state firm size distribution that depends upon the innovation technology, upon government policy towards incumbent firms and/or towards potential entrants, and upon regulatory or credit market characteristics, which will also affect firms' ability to enter and/or grow post-entry.

In particular, this framework can account for various stylised facts about firm dynamics and firm size distribution, including: (i) the firm size distribution is highly skewed; (ii) firm size and firm age are highly correlated (in this framework new firms are one-line firms, and to become large with a sufficient number of lines, a firm needs to have innovated on all these lines and also have survived creative destruction on a sufficient number of lines it used to operate on); (iii) small firms exit more frequently (it takes only one outside innovation to eliminate a one-line firm, whereas it takes several successful outside innovations to eliminate an initially multi-line firm), but the ones that survive tend to grow faster than average (the firm is more likely to be an efficient innovator, and also it can exploit R&D synergies across its multiple lines); (iv) a large fraction of R&D in the United States is done by incumbents; and (v) reallocation of inputs between entrants and incumbents is an important source of productivity growth.

The framework can also explain why factors that inhibit firm size growth in developing countries also inhibit aggregate productivity growth. For example, Akcigit et al. (2014) argue that in developing countries, contractual frictions become more dramatic as firms grow in size – it becomes increasingly hard to avoid hold-up by firm managers as the number of product lines controlled by the firm increases. This in turn inhibits the growth of most efficient firms (i.e. of firms with higher innovation capabilities); such firms have lower incentives to grow as firm owners want to mitigate the hold-up problem with their manager. But this in turn enables less efficient firms to remain active for a longer period before being replaced by more efficient firms.

While contractual incompleteness and lack of trust are obvious obstacles to firm growth, previous studies have also emphasised (a) adjustment costs induced by the R&D and/or advertising of incumbent firms; (b) the administrative costs of creating a new firm; and (c) labour market regulations.

Aghion et al. (2007) present empirical evidence on the effect of financial development on the entry of new firms of different size and on the post-entry growth of successful entrants. They use harmonised firm-level data on entry and post-entry growth by industry, size class and over time for a sample of industrialised, transition and Latin American countries (see Bartelsman et al., 2004). They consider two main indicators of financial development: the ratio of private credit, and stock market capitalisation. They instrument these financial development variables using a detailed set of regulatory indicators that characterise the banking and securities markets. Also, following Rajan and Zingales (1998), to minimise problems of omitted variable bias and other miss-specifications, they interact different indicators of financial development with the relative dependence on external financing of the corresponding sector in the United States.

The main results in the study by Aghion et al. (2007) are as follows. First, higher financial development enhances new firm entry in sectors that depend more heavily upon external finance. Second, the entry of the smallest firms benefits

the most from higher financial development, whereas financial development has either no effect or a negative effect on entry by larger firms. Third, financial development enhances post-entry growth of firms in sectors that depend more upon external finance, even when controlling for labour market regulations.[6]

The effect of regulations on firm dynamics and firm size is itself a fascinating topic that has barely been touched upon. An interesting paper by Garicano et al. (2013) analyses the static welfare effects of the 50 employee regulatory threshold in France, and points to a significant source of allocative inefficiency (namely, the inefficient concentration of firm size just below the threshold). Yet, how such a threshold or other types of regulations more generally affect the size distribution of firms and aggregate productivity growth remains an open question.

1.7 Do we still need vertically targeted policies?

1.7.1 The debate

The change of emphasis from industry-level to firm-level competitiveness, the evidence on the relationship between firm-level competitiveness and firm-level productivity, and finally our discussion of the determinants of productivity growth and policies to enhance it – all this points towards giving priority to 'horizontal targeting', i.e. policies (competition, labour market liberalisation, patent and R&D policy, etc.) that enhance productivity growth in all sectors, instead of focusing on 'vertical targeting', i.e. policies aimed at promoting particular industries in the worldwide competition with similar industries in other countries.

Vertical targeting used to be popular in the aftermath of World War II. For example, the World Bank and other international financial institutions would welcome the import substitution policies in Latin American countries whereby local industries would more fully benefit from domestic demand. Similarly, they would support East Asian countries such as Korea or Japan when they engaged in export promotion, for example through tariffs and non-tariff barriers and partly through maintaining undervalued exchange rates. For at least two or three decades after World War II, these policies – which form part of what is commonly referred to as 'industrial policy' – remained fairly uncontroversial, as both groups of countries were growing at fast rates.

However, vertical targeting has come under increasing criticism since the early 1980s among academics and policy advisers in international financial institutions. In particular, it has been criticised for allowing governments to pick winners and losers in a discretionary fashion, and consequently for increasing the scope for capture of governments by local vested interests. Empirical studies by Frankel and Romer (1999) and Wacziarg (2001) pointing to a positive effect of trade liberalisation on growth would, of course, reinforce the case against vertical targeting, as would recent work on competition and growth (see, for example, Aghion et al., 2005; and Aghion et al., 2008).

6 Previous work on the subject includes Beck et al. (2004a) who find that financial development is more growth-enhancing for industries that rely more on small firms (this is measured by the share of small firms in the respective US industry). In the same vein, Beck, Demirgüç-Kunt and Maksimovic (2005) use a firm survey to assess firms' perception of financial constraints. They find that small firms tend to be more affected by financial as well as legal and corruption issues than larger firms.

However, three phenomena that have occurred in the recent period invite us to rethink the issue. The first is climate change and the increasing awareness of the fact that without government intervention aimed at encouraging clean production and clean innovation, global warming will intensify and generate all kinds of negative externalities (droughts, deforestations, migrations, conflicts) worldwide. The second is the recent financial crisis, which revealed the extent to which laissez-faire policies has led several countries – especially in southern Europe – to allow the uncontrolled development of non-tradable sectors (in particular, real estate) at the expense of tradable sectors that are more conducive to long-term convergence and innovation. The third is the emergence of China, which has become so prominent on the world economic stage in large part thanks to its constant pursuit of industrial policy. Also, we now see an increasing number of scholars (in the United States in particular) denouncing the danger of laissez-faire policies that lead developed countries to specialise in upstream R&D and in services, while outsourcing all manufacturing tasks to developing countries where unskilled labour costs are lower. They point to the fact that countries such as Germany or Japan have managed to maintain intermediate manufacturing segments of their value chain better through pursuing more active industrial policies, and that this in turn has allowed them to benefit more from outsourcing the other segments.

As mentioned above, the most recurrent counter-argument to industrial interventionism is the 'picking winners' argument. True, industrial policy is to some extent always about 'picking winners', but as Vince Cable, the former UK Secretary of State for Business, Innovation and Skills, points out, "the 'winners' in this sense are the skills we judge we will need for the future, and the sectors they support". However, we will argue below that the 'picking winners' argument loses bite first when the government chooses to pick sectors rather than particular firms, and second when it 'governs' its sectoral interventions in such a way that preserves or even enhances competition and Schumpeterian selection within the corresponding sectors. A second criticism of traditional industrial policy is the risk of capture and rent-seeking behaviour that it involves. Here again, setting clear principles for the selection of sectors and for the governance of support to these sectors (competitiveness, exit mechanisms, etc.) should help address this criticism.

More fundamentally, a main theoretical argument supporting growth-enhancing sectoral policies is the existence of knowledge spillovers. For example, firms that choose to innovate in dirty technologies do not internalise the fact that current advances in such technologies tend to make future innovations in dirty technologies more profitable. More generally, when choosing where to produce and innovate, firms do not internalise the positive or negative externalities this might have on other firms and sectors. A reinforcing factor is the existence of credit constraints which may further limit or slow down the reallocation of firms towards new (more growth-enhancing) sectors. Now, one can argue that the existence of market failures on its own is not sufficient to justify sectoral intervention. On the other hand, there are activities – typically, high-tech sectors – that generate knowledge spillovers to the rest of the economy and where assets are highly intangible, which in turn makes it more difficult for firms to borrow from private capital markets to finance their growth. Then there might indeed be a case for subsidising entry and innovation in the corresponding sectors, and for doing so in such a way that guarantees fair competition within the sector.

Note that the sectors that come to mind are always the same four or five sectors: energy, biotech, ICT and transportation.

1.7.2 Rethinking the design and governance of industrial policy

To our knowledge, the first convincing empirical study in support of properly designed industrial policy was by Nunn and Trefler (2010). These authors use micro data on a set of countries to analyse whether – as suggested by the 'infant industry' argument – the growth of productivity in a country is positively affected by the extent to which tariff protection is biased in favour of activities and sectors that are 'skill-intensive', i.e. that use more highly skilled workers. They find a significant positive correlation between productivity growth and the 'skill bias' due to tariff protection. Of course, such a correlation does not necessarily mean there is causality between the skill bias due to protection and productivity growth; the two variables may themselves be the result of a third factor, such as the quality of institutions in the countries considered. However, Nunn and Trefler show that at least 25% of the correlation corresponds to a causal effect. Overall, their analysis suggests that adequately designed (here, skill-intensive) targeting may actually enhance growth, not only in the sector which is being subsidised but also in the country as a whole.

More recently, Aghion et al. (2012a) argue that sectoral policy should not be systematically opposed to competition policy. First, they develop a simple model showing that targeted subsidies can be used to induce several firms to operate in the same sector, and that the more competitive the sector, the more firms will be induced to innovate in order to 'escape competition' (see Aghion et al., 2005). Of course, a lot depends upon the design of industrial policy. Such policy should target sectors, not particular firms (or 'national champions'). This in turn suggests new empirical analyses in which productivity growth, patenting or other measures of innovativeness and entrepreneurship are regressed over some measures of sectoral intervention interacted with the degree of competition in the sector, and also with the extent to which intervention in each sector is not concentrated on one single firm, but rather distributed over a larger number of firms.

Unfortunately, data showing how much state aid each sector receives are not available for EU countries. Thus, to look at the interaction between state subsidies to a sector and the level of product market competition in that sector, Aghion et al. (2012a) use Chinese firm-level panel data. More precisely, they look at all industrial firms from the Chinese National Business Survey, an annual survey of all firms with sales of more than 5 million RMB. The sample period is 1988-2007, and the survey contains information on inputs and outputs, firm-level state subsidies, and so on. Product market competition is measured by 1 minus the Lerner index, which in turn is calculated as the ratio of operating profits minus capital costs over sales. The authors show that TFP, TFP growth and product innovation (defined as the ratio between output value generated by new products to total output value) are all positively correlated with the interaction between state aid to the sector and market competition in the sector. Thus, the more competitive the recipient sector, the more positive the effects of targeted state subsidies to that sector on TFP, TFP growth and product innovation in that sector. In fact, the authors show that for sectors with a low degree of competition the effects are negative, but the effects become positive in sectors

with a sufficiently high degree of competition. Finally, the authors show that the interaction between state aid and product market competition in the sector is more positive when state aid is less concentrated. In fact, if one restricts attention to the second quartile in terms of degree of concentration of state aid (this refers to sectors where state aid is not very concentrated), then state aid has a positive effect on TFP and product innovation in all sectors with an above-median level of product market competition.

1.7.3 Climate

Firms in a laissez-faire economy may innovate in 'the wrong direction', for example in polluting energy activities just because they have acquired expertise in such activities, not taking into account the environmental and also the knowledge externalities that their choice entails. Aghion et al. (2010) explore a cross-country panel data set of patents in the automotive industry. They distinguish between 'dirty innovations' that affect combustion engines and 'clean' innovations, such as those relating to electric cars. Then they show that the larger the stock of past 'dirty' innovations by a given entrepreneur, the 'dirtier' the current innovations by the same entrepreneur. This 'path dependence' phenomenon, together with the fact that innovations have been mostly dirty so far, implies that in the absence of government intervention, our economies would generate too many dirty innovations. There is therefore a role for government intervention to 'redirect technical change' towards clean innovations.

As argued in Acemoglu et al. (2012), delaying such directed intervention not only leads to further deterioration of the environment. In addition, the dirty innovation machine continues to strengthen its lead, making the dirty technologies more productive and widening the productivity gap between dirty and clean technologies even further. This widened gap in turn requires a longer period for clean technologies to catch up and replace the dirty ones. As this catching-up period is characterised by slower growth, the cost of delaying intervention, in terms of foregone growth, will be higher. In other words, delaying action is costly.

Not surprisingly, the shorter the delay and the higher the discount rate (i.e. the lower the value put on the future), the lower the cost will be. This is because the gains from delaying intervention are realised at the start in the form of higher consumption, while the loss occurs in the future through more environmental degradation and lower future consumption. Moreover, because there are basically two problems to deal with – the environmental one and the innovation one – using two instruments proves to be better than using one. The optimal policy involves using (i) a carbon price to deal with the environmental externality, and, at the same time, (ii) direct subsidies to clean R&D (or a profit tax on dirty technologies) to deal with the knowledge externality. This again calls for vertical targeting.[7]

7 Of course, one could always argue that a carbon price on its own could deal with both the environmental and the knowledge externalities at the same time (discouraging the use of dirty technologies also discourages innovation in dirty technologies). However, relying on the carbon price alone leads to excessive reduction in consumption in the short run. And because the two-instrument policy reduces the short-run cost in terms of foregone short-run consumption, it reinforces the case for immediate implementation, even for values of the discount rate under which standard models would suggest delaying implementation.

1.7.4 Summarising

Overall, our discussion in this section suggests that adequately targeted sectoral intervention, for example to more skill-intensive or more competitive sectors, can be growth enhancing. Also, we have argued in favour of not concentrating subsidies across firms in a sector. However, this is just the starting point for what we see as a much broader research programme on how to govern industrial policy so as to make it more competition friendly and more innovation enhancing. In particular, how can industrial policy be designed so as to ensure that projects that turn out to be non-performing will not be refinanced? How should governments update their doctrines and competition policy practices so as to factor in renewed thinking industrial policy design and implementation? The conjunction of the debates on climate change, the recent financial crisis and the new dominance of China in the world market reinforce our conviction that while market competition is certainly a main engine of growth, specialisation cannot be left entirely to the dynamics of laissez-faire. Also, one increasingly realises that the specialisation model, whereby the most advanced countries focus on upstream R&D and services and outsource everything else to emerging market economies, may not be sustainable in the long run.

1.8 Implications for policy design in emerging markets: The example of China

China is deservedly admired worldwide for its outstanding growth performance over the past three decades; this forces modesty and humility on people like me who are asked to provide economic advice. Yet, the growth in China so far has largely been a 'catch-up' growth, i.e. growth based on imitating or adapting technologies introduced elsewhere.

This catch-up growth has been spurred by the market reforms under the dual track approach as of the early 1980s, and by the establishment of a system of growth-based yardstick competition between provincial leaders. This in turn has favoured the reallocation of resources and investment from agriculture to industry, and from state-owned enterprises to (credit-constrained) new private enterprises. And technological catch-up has been further enhanced by encouraging foreign direct investment.

While more catch-up or reallocation-based growth can be achieved by improving management practices in existing firms (see our discussion above), by further liberalising labour flows from rural to urban areas, by further developing the financial sector, and by liberalising capital flows (as China already plans to do), there are several reasons to believe that this will not be sustainable in the long run. In particular, (i) the efficiency gains from reallocating resources from agriculture to industry and from absorption of imported technologies will be exhausted once the reallocation is complete; and (ii) wage increases will reduce China's comparative advantage in what it currently exports to the rest of the world.

Then the questions naturally arise: How can China avoid the middle-income trap and make a successful transition from catch-up growth to innovation-led growth? And how can China achieve higher quality growth in this process? The above discussion on firm-level productivity growth as the ultimate source of

competitiveness, as well as on the drivers of productivity growth, suggests five pillars of an innovation-based economy:

1) Competition and creative destruction. Frontier innovation is fostered by competition and free entry to a much larger extent than imitation. The reason for this is both that incumbent firms at the technological frontier can escape competition and the threat of entry by innovating, and that most path-breaking innovations are made by new entrants. Checks and balances are necessary to guarantee free entry and full competition, because this helps minimise the scope for collusion between (local) politicians and (large) incumbent firms.

2) Top research universities, i.e. universities with very high Shanghai rankings. Recent work on the subject suggests that to achieve such rankings, one needs not only to invest more in the university system, but also to grant universities autonomy on budget management, wage policy, hiring/firing decisions and the design of programmes. This autonomy has to come hand-in-hand with more effective competition between universities as well as between researchers. Thus, as for other sectors of the economy, here also less upward accountability has to be replaced by more downward accountability and competitive pressure.

3) A dynamic labour market system which combines (i) flexibility for firms to hire and fire; (ii) a good training system to help workers rebound from one job to another; and (iii) a good social safety net, i.e. with well-developed portable social security and pension rights from job to job, and also with a generous unemployment benefit system (conditional upon the unemployed worker training and then accepting a new job). A 'flexsecurity' system such as this makes creative destruction, and therefore innovation-led growth, work at greater speed.

4) A financial system that relies more on venture capital, private equity and stock markets; the reason being that innovative investments are riskier and therefore investors require both to obtain a share of the upside returns and to obtain control rights.

How can one ensure that innovation-led growth will be high-quality growth? My feeling is that the Chinese leadership has been concerned by two negative by-products of growth so far: the deteriorating environment, and the very fast increase in inequality. In other words the challenge is to achieve inclusive and sustainable innovation-led growth! As it turns out, implementing the above pillars helps achieve these objectives, in particular: (i) the combination of competition, education and 'flexsecurity' enhances social mobility; and (ii) the checks and balances (at the local level) which guarantee full competition should also help improve the environment.

A natural question then arises: Which organisational and/or institutional changes (if any) does China need to introduce in order to move toward full-steam innovation-led growth? Obviously, we do not have the answer to this question at hand because we lack knowledge on how the current institutional system is organised and how it works in practice.

Yet, empirical and casual evidence suggests that a smart state can stimulate its innovation-led machinery by: (i) setting up a fiscal system which achieves the triple goal of (a) raising revenue to make innovation-enhancing investments in education, universities infrastructure, (b) being redistributive to avoid excessive inequality and poverty traps, and (c) encouraging innovation by not expropriating innovators; and (ii) setting up adequate institutional mechanisms to strengthen checks and balances on the different levels of government to make sure both that

competition is fully enforced (as argued above) and that state investments aimed at enhancing innovation are properly targeted and monitored.

It would appear somewhat paradoxical to recommend that China move from imitation-led to innovation-led growth by simply imitating the institutional arrangements of existing innovation-led economies. Instead, China must find its own way to reform its state institutions so as to make the above pillars work fully. It must find its own answers to questions such as the following. How can we set up fully effective competition policy instruments and mechanisms starting from the current Chinese institutional context? Which contractual, organisational or institutional changes should we introduce, in particular at the regional/local level, in order for China to reach full steam in implementing sustainable and inclusive innovation-led growth? How can we factor in environmental and social (i.e. inclusiveness) dimensions in addition to GDP growth when evaluating regional or local leaders and organising the yardstick competition among them? How can we improve the tax and welfare system to achieve best standards and practices among innovating countries, and in particular to reconcile the need for redistribution and the need to finance good public infrastructure and services with innovation incentives.

1.9 Conclusion

In this chapter we have taken on board modern trade economics, and in particular the idea that a country's competitiveness boils down to the competitiveness of its individual enterprises. We have then reported on recent empirical work showing that firm-level competitiveness is related to firms' productivity and their ability to grow. We have looked at determinants of firm-level productivity, and also at potential obstacles that may inhibit firm size growth. Finally, we have argued that while enhancing firm-level productivity growth calls first for horizontal policies (product and labour market liberalization, trade liberalisation, more education investment, etc.), there may yet be a case for vertically targeted (sectoral) policies provided they are properly designed and governed.

To conclude our discussion, we would like to touch upon the delicate issue of macroeconomic policy. Recent studies (e.g. Aghion, Hemous, and Kharroubi, 2014; Aghion et al., 2012b) performed at the cross-country/cross-industry level show that more counter-cyclical fiscal and monetary policies enhance growth. Fiscal policy counter-cyclicality refers to countries increasing their public deficits and debt in recessions, and reducing them in upturns. Monetary policy counter-cyclicality refers to central banks letting real short-term interest rates fall in recessions, and having them increase again during upturns. Such policies can help credit-constrained or liquidity-constrained firms to pursue innovative investments (R&D, skills and training, etc.) over the cycle in spite of credit tightening during recessions, and it also helps maintain aggregate consumption, and therefore firms' market size, over the cycle, as argued in the previous section (see Chapter 13 in Aghion and Howitt, 2009). This suggests that an innovation-based economy would benefit from more counter-cyclical macroeconomic policies – with higher deficits and lower real interest rates in recessions, and lower deficits and higher real interest rates in booms – in order to help credit-constrained, innovative firms maintain their R&D and other types of growth-enhancing investments over the business cycle.

References

Acemoglu, D., P. Aghion, L. Burszty and D. Hemous (2012), "The Environment and Directed Technical Change", *American Economic Review* 102(1), pp. 131-166.

Aghion, P. and P. Howitt (1992), "A Model of Growth through Creative Destruction", *Econometrica* 60(2), pp. 323-351.

Aghion, P. and P. Howitt (2009), *The Economics of Growth*, Cambridge, MA: MIT Press.

Aghion, P., N. Bloom, R. Blundell, R. Griffith and P. Howitt (2005), "Competition and Innovation: An Inverted-U Relationship*", Quarterly Journal of Economics* 120(2), pp. 701-728.

Aghion, P., T. Fally and S. Scarpetta (2007), "Credit Constraints as a Barrier to the Entry and Post-Entry Growth of Firms", *Economic Policy* 22, pp. 731-779.

Aghion P., R. Burgess, S. Redding and F. Zilibotti (2008), "The Unequal Effects of Liberalization: Evidence from Dismantling the License Raj in India", *American Economic Review* 94(4), 1397-1412.

Aghion, P., R. Blundell, R. Griffith, P. Howitt and S. Prantl (2009a), "The Effects of Entry on Incumbent Innovation and Productivity", *Review of Economics and Statistics* 91(1), pp. 20-32.

Aghion, P., L Boustan, C. Hoxby and J. Vandenbussche (2009b), "Exploiting States' Mistakes to Identify the Causal Effects of Higher Education on Growth", mimeo, Harvard University, Cambridge, MA.

Aghion, P., P. Askenazy, R. Bourles, G. Cette and N. Dromel (2009c), "Education, Market Rigidities and Growth", *Economics Letters* 102(1), pp. 62-65.

Aghion, P., M. Dewatripont, C. Hoxby, A. Mas-Colell and A. Sapir (2010), "The Governance and Performance of Universities: Evidence from Europe and the US", *Economic Policy* 25, pp. 7-59.

Aghion, P., M. Dewatripont, L. Du, A. Harrison and P. Legros (2012a), "Industrial Policy and Competition", mimeo, Harvard University, Cambridge, MA.

Aghion, P., E. Farhi and E. Kharroubi (2012b), "Monetary Policy, Liquidity and Growth", mimeo, Harvard University, Cambridge, MA.

Aghion, P., U. Akcigit and P. Howitt (2013a), "What Do We Learn from Schumpeterian Growth Theory?", mimeo, Harvard University, Cambridge, MA.

Aghion, P., A. Dechezlepretre, D. Hemous, R. Martin and J. Van Reenen (2013b), "Carbon taxes, Path Dependence and Directed Technical Change: Evidence from the Auto Industry", mimeo, Harvard University.

Aghion, P., D. Hemous and E. Kharroubi (2014), "Cyclical Fiscal Policy, Credit constraints and Industry Growth", *Journal of Monetary Economics* 62(C), pp. 41-58.

Akcigit, U., H. Alp and M. Peters (2014), "Lack of Selection and imperfect Managerial Contracts: Firm Dynamics in Developing Countries", mimeo, University of Pennsylvania.

Altomonte, C., T. Aquilante and G. Ottaviano (2012), "The Triggers of Competitiveness: The EFIGE Cross-Country Report", Bruegel Blueprint No 17, Brussels.

Antràs, P., R. Segura-Cayuela and D. Rodríguez-Rodríguez (2010), "Firms in International Trade (with an Application to Spain)", SERIEs Invited Lecture at the XXXVth Symposium of the Spanish Economic Society, 16-18 December, Madrid.

Bartelsman, E., J. Haltiwanger and S. Scarpetta (2004), "Microeconomic Evidence of Creative Destruction in Industrial and Developing Countries", IZA Discussion Papers No. 1374, Bonn.

Beck, T., A. Demirguc-Kunt, L. Laeven and R. Levine (2004), "Finance, Firm Size and Growth", World Bank Research Working Paper No. 3485, Washington, DC.

Beck, T., A. Demirguc-Kunt and V. Maksimovic (2005), "Financial and Legal Constraints to Firm Growth: Does Size Matter?", *Journal of Finance 60*, 137-177.

Bergeaud, A., G. Cette and R. Lecat (2014), "Productivity Trends from 1890 to 2012 in Advanced Countries", Banque de France Working Paper No. 475, Paris.

Bernard, A., J. B. Jensen, S. Redding and P. Schott (2011), "The Empirics of Firm Heterogeneity and International Trade", NBER Working Paper No. 17627, Cambridge, MA.

Bloom, D., M. Draca and J. Van Reenen (2011), "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity", CEP Discussion Paper No. 1000, London.

Bloom, D. and J. Van Reenen (2010), "Why Do Management Practices Differ Across Firms and Countries?", *Journal of Economic Perspectives* 24(1), pp. 203-224.

Cette, G. and J. Lopez (2012), "ICT Demand Behavior: An International Comparison", *Economics of Innovation and New Technology*, *Taylor and Francis Journals* 21(4), pp. 397-410.

Cette, G., J. Lopez and J. Mairesse (2013), "Upstream Product Market Regulations, ICT, R&D and Productivity", NBER Working Paper No. 19488, Cambridge, MA.

Frankel, J. and D. Romer (1999), "Does Trade Cause Growth", *American Economic Review* 89(3), pp. 379-399.

Garicano, L., Lelarge, C. and J. Van Reenen (2013), "Firm Size Distortion and the Productivity Distribution: Evidence from France", NBER Working Paper No. 18841, Cambridge, MA.

Gordon, R. (2000), "Interpreting the 'One Big Wave' in U.S. Long-Term Productivity Growth", NBER Working Paper No. 7752, Cambridge, MA.

Helpman, E. (1981), "International Trade in the Presence of Product Differentiation, Economies of Scale and Monopolistic Competition: A Chamberlin-Heckscher-Ohlin Model", *Journal of International Economics* 11(3), pp. 305-340.

Helpman, E. (2004), *The Mystery of Economic Growth*, Cambridge, MA: Harvard University Press.

Hsieh, C.-T. and P. Klenow (2009), "Misallocation and Manufacturing TFP in China and India", *Quarterly Journal of Economics* 124(4), pp. 771-807.

Klette, T. and S. Kortum. (2004), "Innovating Firms and Aggregate Innovation", *Journal of Political Economy* 112, pp. 986-1018.

Koch, W. (2014), "Bank-Based Versus Market-Based Finance as Appropriate Institution", Mimeo, Université du Québec à Montréal (UQAM).

Krugman, P. (1980), "Scale Economies, Product Differentiation and the Pattern of Trade", *American Economic Review* 70(5), pp. 950-959.

Melitz, M. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica* 71(6), pp. 1695-1725.
Nunn, N. and D. Trefler (2010), "The Structure of Tariffs and Long-Term Growth", *American Economic Journal: Macroeconomics* 2(4), pp. 158-94.
Rajan, R. and L. Zingales (1998), "Financial Dependence and Growth", *American Economic Review* 88(3), pp. 559-586.
Solow, R. (1956), "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics* 70(1), pp. 65-94.
Syverson, C. (2004), "Market Structure and Productivity: A Concrete Example", *Journal of Political Economy* 112(6), pp. 1181-1222.
Wacziarg, R. (2001), "Measuring the Dynamic Gains from Trade", *The World Bank Economic Review* 15(3), pp. 393-429.

Wirtschaftspolitisches Zentrum WPZ

Top level research and communication for politics, economics and society

WPZ (Wirtschaftspolitisches Zentrum) is an initiative of the Institute of Economics (FGN-HSG) of the University of St. Gallen and is committed to the goals of

- cutting-edge research with policy relevance
- knowledge transfer to the policy community
- supporting upcoming research talents
- informing the public audience

Our activities range from fundamental research studies in cooperation with internationally leading scientists to regular commentaries on topical policy issues. We aim to stimulate the policy debate with insights form academic research and to contribute to a consistent reform agenda for Austria. To gain more relevance in the political decision making process, the insights and results of modern economic theory and empirical analysis shall be translated into widely accessibly formats and communicated to policymakers and the general audience.

We are grateful for your support and hope that you will recommend the initiatives of WPZ to friends and potential supporters. Please stay informed about our activities on www.wpz-fgn.com and get in touch via office@wpz-fgn.com.

Wirtschaftspolitisches Zentrum | www.wpz-fgn.com | office@wpz-fgn.com