

Explaining Productivity and Growth in Europe, America and Asia

This report explores a difficult question central to economic and social development in Europe and beyond: can productivity growth be achieved in concordance with other goals of society, and particularly environmental goals? Through an innovative exploration of the foundations of economic growth at the level of individual firms, Tobias Kretschmer identifies significant factors to help explain large-scale economic phenomena. Some of the complex interactions between drivers of economic growth are revealed, providing interesting new contexts for policy-makers looking to achieve sustainable, long-term productivity growth without compromising environmental performance and aims.

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The findings of *creating sustainable growth in europe* are summarised in four reports, together with an accompanying volume of *reflections*:

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Explaining Productivity and Growth in Europe, America and Asia

Tobias Kretschmer

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for the Study of Industrial Society**

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Foreword

For over 35 years, the Anglo-German Foundation for the Study of Industrial Society has promoted study and discussion of the processes of wealth generation and social development in the United Kingdom and Germany. Over this time, it has made a significant contribution to our understanding of modern industrial society, and has been instrumental in establishing focused comparative research as an essential component of evidence-based policy development.

Towards the end of 2004, the Foundation's Trustees recognised a need to draw together the various strands of work funded over the preceding three decades. They were increasingly concerned that the traditional organisation of research into distinct academic disciplines and associated policy domains was leading to a damaging compartmentalisation in government, so that policies adopted by one department often ran counter to the objectives of policy in other departments. The pressing need, the Trustees believed, was for a broader, more integrative approach, rather than for ever more detailed and specialised knowledge.

The Foundation therefore decided to launch a major project designed to counter-act that tendency while building on the comparative knowledge and expert networks established in its traditional priority areas. The title of the new initiative – *creating sustainable growth in europe* – confronts the central challenge facing both countries over the coming decades: how to reconcile the desire for growth with environmental and social sustainability.

An international Academic Advisory Board was convened under the chairmanship of Professor Sir Tony Atkinson, the distinguished economist and former Warden of Nuffield College Oxford, to advise the Foundation on the structure and content of the initiative. It was decided that the research should be organised in linked but largely autonomous programmes, each addressing one or more core themes within the general topic. The themes chosen were:

- innovation, productivity and growth
- environment and resources
- welfare, employment and social justice.

The initiative was formally launched in spring 2005 with a call for proposals. The research communities in Germany and the UK were invited to submit bids for programmes lasting up to three years and addressing one or more of the three core themes. The budget for the initiative was over £4 million. At the end of a rigorous selection process, the Foundation awarded grants to four programmes:

- Explaining Productivity and Growth in Europe, America and Asia (based mainly at LSE London, ZEW Mannheim and LMU Munich, and led by Professor Tobias Kretschmer, Ludwig-Maximilians-Universität Munich)
- Resource Productivity, Environmental Tax Reform and Sustainable Growth in Europe (based at six centres: King's College London (KCL); GWS Osnabrück; FU Berlin; Cambridge Econometrics; the University of Economics, Prague; and SERI, Vienna, and led by Professor Paul Ekins, then at KCL, now at University College London)
- The Economics and Politics of Employment, Migration and Social Justice (based at WZB Berlin, the Universities of Frankfurt and Hannover, and UCL and LSE London, and led by Professor Christian Dustmann, University College London)
- Sustainable Welfare and Sustainable Growth (based at Queen's University Belfast and FU Berlin and the Universities of Bremen, Edinburgh, Göttingen, Kent, Oxford and Southampton, and led by Professor Jochen Clasen, University of Edinburgh).

Meeting the challenge of sustainability will require far-reaching changes in institutions, processes and lifestyles. In launching its initiative, the Foundation wished to demonstrate the key role research could play in defining those changes and in identifying a fair division of the costs and burdens they would impose. Behind the innovative structure of the initiative lay the intention that each programme's distinctive contribution to knowledge and policy within its own academic and political area would be informed by contact with ideas and approaches from other disciplines and policy domains; and that the four programmes when viewed as a whole would add up to more than the sum of their parts. Their contribution would extend to how policy-makers think of their task – the breadth of data and knowledge to be drawn upon, and the nature and range of the implications to be considered.

The economic and political assumptions prevalent when *creating sustainable growth in europe* was launched have now been severely shaken. Many commentators argue that the present unprecedented conjuncture of financial, economic and ecological crises represents a crucial moment in the trajectory of capitalism. Many also argue that these crises represent an urgent call, and also a unique opportunity, for systemic rethinking, of a kind that happens only once in a generation. The findings of *creating sustainable growth in europe*, as summarised in the Foundation's series of four reports and in the accompanying set of *Reflections* by Tony Atkinson, are thus even more relevant and urgent than was originally foreseen. Taken together, they represent the essence of a generation's work by the founders, Trustees, staff and researchers associated with the Anglo-German Foundation, and the key component of its legacy.

Ray Cunningham
Director, Anglo-German Foundation
September 2009

Executive Summary

What are the determinants and consequences of productivity growth? This question was at the heart of the *csge* research programme *Explaining Productivity and Growth in Europe, America and Asia* and is of fundamental importance for firms in Europe (and of course in the rest of the world), governments, policy-makers and societies as a whole. It is also a multi-faceted question and one that has been difficult to approach, except perhaps piecemeal and at a purely national level, largely because of a lack of robust data. So the building of an unprecedented database of information about management, environmental and technological practices – across firms, industries and countries – was essential for the successful shaping of the programme.

Using this information to look at the foundations of economic growth at the level of individual firms, differences and factors appeared clearly enough to be used to explain large-scale economic phenomena at the level of countries and industries. And an analysis of these differences and factors also allowed an exploration of ever-important questions such as how much weight productivity growth should be given against other, potentially conflicting, goals, and whether productivity goals can be achieved in concordance with other goals of society.

For 50 years after the end of World War II, Europe's productivity growth outstripped that of the United States by approximately one percentage point each year, a process that most commentators assumed would continue until Europe eventually caught up with the US. But from the mid-1990s, to the surprise of economists and politicians on both sides of the Atlantic, US productivity growth accelerated past Europe's just as European growth started to fall back. This unexpected reversal in trends was what many observers call the 'US productivity miracle' and supplied the first big question to address in this programme: what accounts for Europe's slower growth in productivity and what can be done to improve it?

Of course, conventionally measured growth is not always desirable, and there may be damaging consequences for the environment. Indeed, increased industrialisation may have exacerbated a number of unsustainable environmental trends including climate change, increased industrial waste, and excessive exploitation of natural resources. This raised a second central question: what policies can help to foster productivity growth in an environmentally sensitive way? It is particularly interesting to see if there are significant trade-offs between economic and environmental performance – that is, does a business have to ignore the environment to some extent to be economically successful? – or if there can be 'win-win' policy scenarios in which environmental efficiency can be combined with productivity improvements.

Seeking answers to these questions and exploring the various drivers of productivity growth produced a number of significant findings. First, **productivity growth is not necessarily in conflict with environmental and societal growth**. A number of levers for productivity growth, most notably good management practices, can achieve economic growth at a low, or even no, cost to environmental goals. This implies that policies aimed at securing sustainable growth – that is, growth that allows both the economic and the environmental spheres to prosper – could be as simple as encouraging the use of productive and all-round resource-saving management practices. Such policies should at least contain an element of these practices, rather than distorting a production process towards methods that may save on one isolated input, but may be harmful otherwise, or simply not economically efficient.

Second, **there exist multiple interactions between different determinants of productivity growth**. In many cases, it may not be useful to study single factors of productivity growth and derive implications for firms and policy-makers from them. For example, the ability to reap returns from information and communications technologies (ICT) depends on the quality of a firm's management and organisational practices and how the two mesh together with effective selection and use of ICT systems. Policies aimed solely at promoting the adoption of a particular ICT application or piece of infrastructure are unlikely to be as effective as granting subsidies for training and reorganisation measures in conjunction with offering firms a choice of which ICT system they want to implement.

Third, **international differences in productivity depend on the differences in the 'typical' firm in a country as much as on the differences between the best and the worst firms in an economy**. Average figures at the level of an entire economy will conflate individual characteristics within a country. Different countries will have different industrial compositions, which in turn may be reflected in significant differences at the macroeconomic level. Also, some countries may have a significant proportion of badly run firms; this may pull down the average level of productivity in a country despite the fact that these countries also have a large number of firms that are as well managed as those anywhere else in the world. It is also the case that firms in a particular sector may be run with less skill in some countries than others. Investigating both the average and the distribution within countries will help governments to develop policies that are either aimed at improving the lower tail of the distribution or targeting the 'typical' firm in an economy.

These findings, while by no means the only conclusions to be drawn from the research programme, are particularly important for future policy-makers: they do not simply provide pointers towards individual policies but provide new contexts to shape policy-making in this area.

1 Management Practices – Drivers of Productivity Growth

Economists have long puzzled why there are such astounding differences in productivity levels between firms and countries (Hall and Jones 1999; Foster et al. 2008). Solow called these productivity differences ‘a measure of our ignorance’: a representation of inexplicable gaps in output. Worryingly, these ‘measures of our ignorance’ often account for more than half the performance variation between firms and countries.

One explanation for these productivity differences is that they reflect variations in management practices. This is something business schools, policy-makers and the media have long argued. As early as 1776, the father of economics, Adam Smith, emphasised the importance of management practices in his example of the operation of a pin factory, and by extension to other organisations. And it is common to hear reports that blame Britain’s relatively low productivity on bad management. This view is now so common in the United Kingdom (UK) that it has generated a vibrant export industry of television shows that rely on bad British management as a rich source of comedy: think of ‘The Office’ and ‘Fawlty Towers’.

Empirical work in economics to measure differences in management practices across firms and countries has been limited. But despite a lack of robust data the core theories in many fields such as international trade, industrial organisation and macroeconomics are starting to take into account such differences. This research project (Bloom et al. 2009a) set out to systematically measure management practices across firms and countries. Nine of the main findings so far are:

- There is a basic set of ‘good’ management practices. These involve systematically monitoring performance, setting appropriate targets and providing incentives for good performance.
- These good management practices appear closely associated with superior performance across a wide range of firms, countries and industries. In particular, they are linked with higher productivity and growth in manufacturing and higher patient survival rates in hospitals (Bloom et al. 2009b). On smaller samples they appear to be related to better productivity in retailing and superior exam grades in schools.
- Good management is not a homogeneous notion. Firms adapt different styles of management depending on their environment. For example, incentive management is particularly important for industries that have large workforces.
- Management practices vary across countries. Many of the average differences across countries are due to the size of the near-ubiquitous ‘long tail’ of badly managed firms. For example, the United States and northern Europe have fewer very badly managed firms than Brazil, China and India.

- Countries also display different styles of management. The Japanese, for example, are better at monitoring while the Americans are better at incentives.
- Multinational organisations are well managed in every country. They also partially transplant abroad the management styles of their home countries. Exporting firms are better managed than domestic non-exporters, but not managed as well as multinationals (Bloom et al. 2008b, 2009c).
- Inherited, family-owned firms that appoint a family chief executive officer (CEO) are, on average, badly managed. Firms managed by their original founder are also usually badly managed.
- Government-owned firms are typically extremely badly managed. Publicly quoted and private-equity-owned firms are typically well managed (Bloom et al. 2009d).
- Strong competition in the product market is associated with good overall management. Weak labour market regulation is associated with good management of incentives.

Measuring management

A new survey methodology, based on Bloom and Van Reenen (2007), was developed for this study. It uses an interview-based evaluation tool that defines and scores 18 basic management practices from 1 ('worst practice') to 5 ('best practice'). Management practices are assessed in three broad areas:

- **Monitoring.** How well do companies track what goes on inside their firms, and use this for continuous improvement?
- **Target-setting.** Do companies set the right targets, track the right outcomes and take appropriate action if the two do not tally?
- **Incentives.** Are companies promoting and rewarding employees based on performance, and systematically trying to hire and keep their best employees?

To obtain accurate responses, production plant managers are interviewed using a 'double-blind' technique. Managers are not told they are being scored or shown the scoring grid. They are only told that they are being interviewed about management practices for a research project.

Open questions – 'Tell me how you monitor your production process', rather than closed questions such as 'Do you monitor your production daily?' – are used. The scoring grid for the performance tracking aspect is shown in Table 1.1 as an example.

The other side of the double-blind technique is that interviewers are not told in advance anything about the firm's performance. They are only given the firm's name, telephone number and industry. Medium-sized firms (employing between 100 to 10,000 workers)

Table 1.1
Management practice dimension 4 ('performance tracking')

	Score 1	Score 3	Score 5
Scoring grid	Measures tracked do not indicate directly if overall business objectives are being met. Tracking is an ad-hoc process (certain processes aren't tracked at all).	Most key performance indicators are tracked formally. Tracking is overseen by senior management.	Performance is continuously tracked and communicated, both formally and informally, to all staff using a range of visual management tools.
Example firm	<i>A manager tracks a range of measures when he does not think that output is sufficient. He last requested these reports about eight months ago and had them printed for a week until output increased again. Then he stopped and has not requested anything since.</i>	<i>At a firm every product is bar-coded and performance indicators are tracked throughout the production process. However, this information is not communicated to workers.</i>	<i>A firm has screens in view of every line, to display progress to daily target and other performance indicators. The manager meets daily with the shop floor to discuss performance metrics, and monthly to present a larger view of the company goals and direction. He even stamps canteen napkins with performance achievements.</i>

were randomly sampled. Interviewers generally have not heard of these firms before, so have no preconceptions.

The survey was targeted at plant managers, managers senior enough to have an overview of management practices but not so senior as to be detached from day-to-day operations. A series of 'noise controls' on the interview process itself – like the time of day, day of the week, characteristics of the interviewee and the identity of the interviewer – were collected. Taking these factors into account when analysing results typically helps to improve the precision of the survey.

To ensure high sample response rates and skilled interviewers, MBA students were hired. Government endorsements were obtained for the surveys in each country covered. Most importantly, the survey was positioned as a 'piece of work on lean manufacturing', never using the word 'survey' or 'research'. Interviewees were never asked for financial data. Finally, the interviewers were encouraged to be persistent – so they ran about two interviews a day, at 45 minutes each on average, with the rest of the time spent repeatedly contacting managers to schedule interviews. These steps helped to yield a 45 per cent response rate which was uncorrelated with the (independently collected) performance measures.

Before presenting the results of the management scores it is worth discussing two steps undertaken to validate the management data.

First, for 5 per cent of the sample a second MBA student surveyed a second plant manager in the same firm. This was to see if management practices were measured consistently.

On a sample of 222 second interviews the correlation between the independently run first and second interview scores was 0.51. Hence, while the management score is clearly 'noisy' it is consistently picking up differences across firms.

Second, a series of performance equations were established for productivity, profitability, growth rates, survival rates and product mix for our survey firms. These data are taken from independently collected company accounts. This provides a check as to whether the measure of management practices is associated with a firm's performance. For our sample of manufacturing firms, higher management scores are robustly associated with better performance, measured in various ways. The key performance measure, however, was the level of total factor productivity (TFP). In recent work on almost 200 UK hospitals the management score is also associated with improved patient health outcomes.

Interestingly, better management practices at a business level are strongly associated with much lower energy use. Going from the 25th to 75th percentile of management practices (that is, from 'bad' to 'good' management) is associated with a 17.4 per cent reduction in energy use. The reason is that better-managed firms operate higher productivity, lean manufacturing techniques. Better-managed firms also appear to treat their employees better: they give them more work flexibility, leading to higher self-assessed employee satisfaction scores (Bloom et al. 2008).

The results of this survey cannot be used to confirm that firms which implement work-life balance practices show improved performance, as the *csge* report *Sustainable Welfare and Sustainable Growth* by Jochen Clasen (2009) demonstrates.

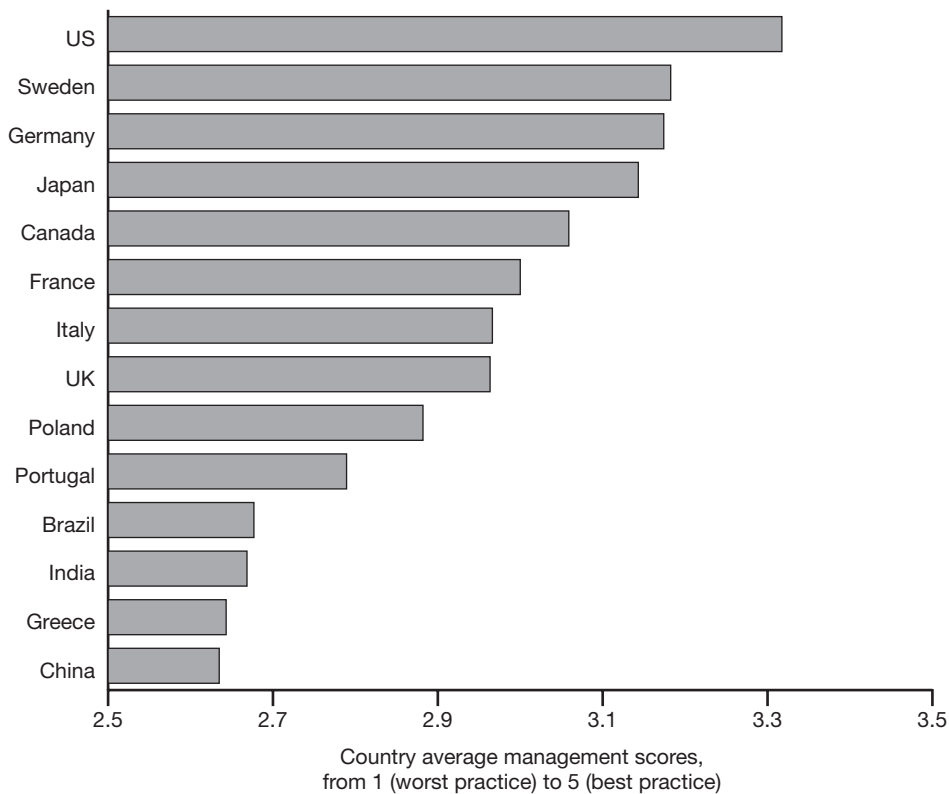
Management across firms and countries

Figure 1.1 plots the average management practice score across countries from the 6,000 interviews carried out in survey waves between 2004 to 2008 (mostly in 2006). The US has the highest management practice scores on average, with Germany, Japan and Sweden below, followed by a block of mid-European countries (France, Italy, the UK and Poland), with southern European and the developing countries of Brazil, China, Greece and India at the bottom.

In one sense, this cross-country ranking is not surprising. It approximates the cross-country spread of productivity or GDP per capita, as the countries with the highest GDP per capita also tend to have the highest average management scores in the sample. But in another sense it suggests that management practices could play an important role in determining this cross-country productivity spread.

Of course the key question is: *Why* do average management practices differ across countries? Figure 1.2 plots the firm-level histogram of management practices (solid bars) by country, and shows that management practices display tremendous within-country

Figure 1.1
Average management practice scores, 2004–2006

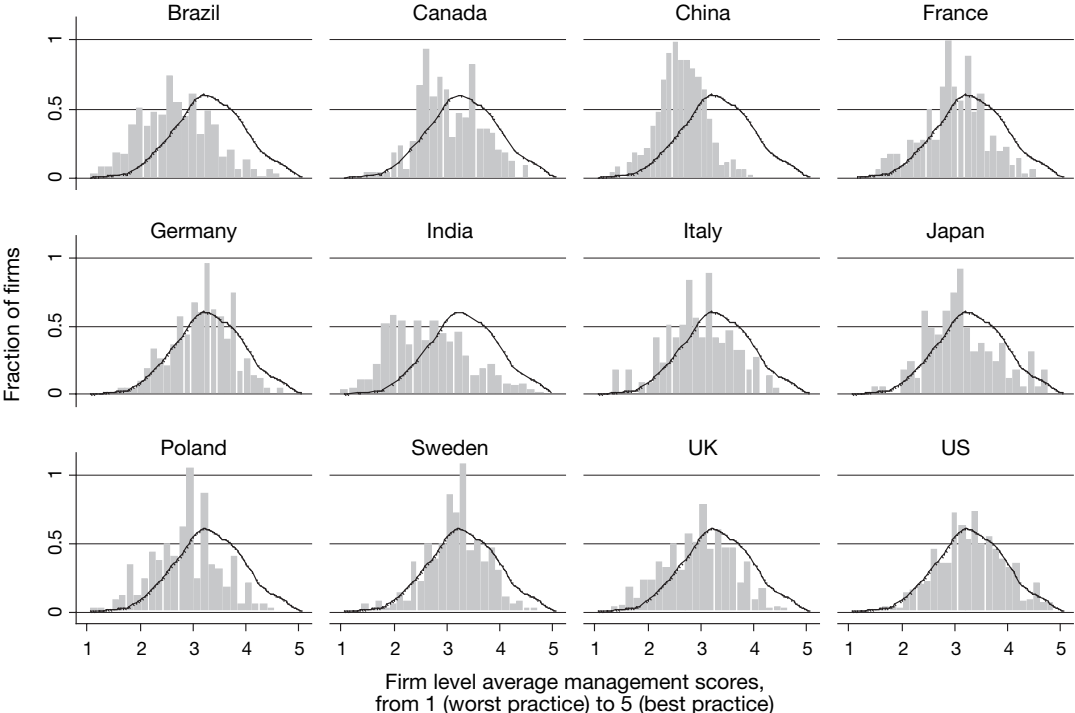


Note: Averages taken across all firms within each country. 5606 observations in total.

variation. So, much like productivity figures, within-country variation is far greater than cross-country variation. Also plotted is the kernel fit for the US so that each country can be compared with the US. This highlights that India has lower management scores than the US because of its large density of badly run firms (scores of 2 or less). Figure 1.3 provides this plot for just Germany and the UK to facilitate the direct comparison. The UK is the block level distribution and Germany is the solid line for comparison. Comparing the two countries it is clear that German management distributions are better than the UK's across the whole distribution, particularly at the lower tail of management practices.

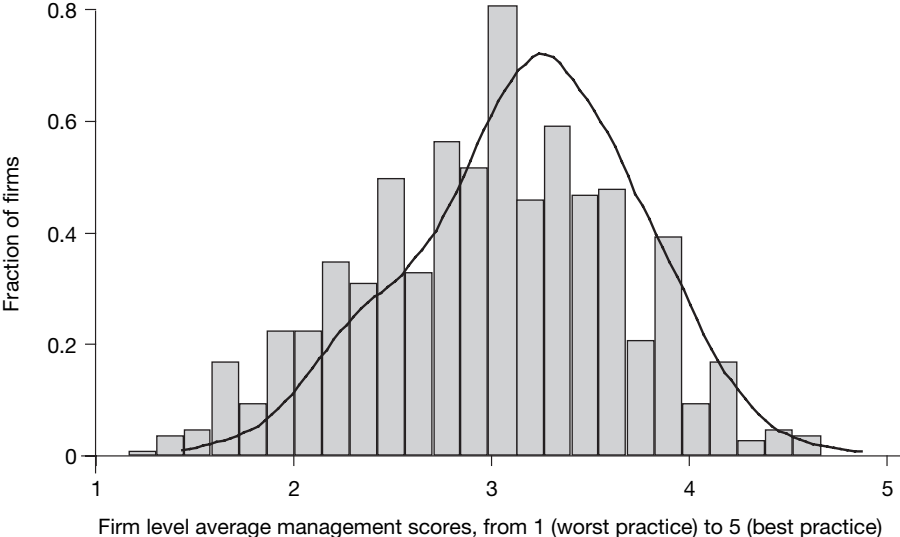
Figure 1.4 plots the relative scores by country for monitoring and target-setting (in light shade) and incentives (dark shade). Figure 1.5 shows that, overall, Sweden, Italy, Germany and Japan have the highest relative advantage in operations management (defined as monitoring and target-setting) while China, India and the US have the highest relative advantage in incentives management. This is consistent with countries having relative strengths in different types of management practices. This may help explain why, for example, the Japanese and Germans are stronger at physical-capital intensive manufacturing – such as automobiles and heavier industry – and the US is stronger in human-capital intensive manufacturing such as pharmaceuticals and hi-tech industries.

Figure 1.2
Firm-level management practices by country



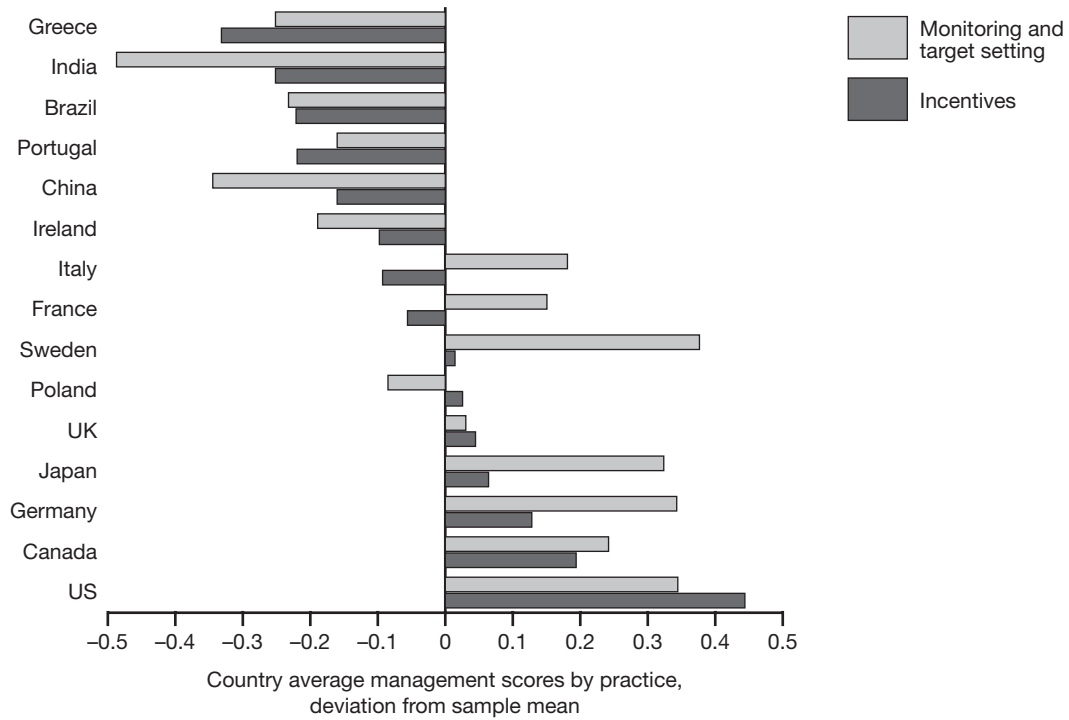
Note: Bars are the histogram of the actual density. The line is the kernel of the US density for comparison.

Figure 1.3
Firm-level management practices for the UK compared with Germany



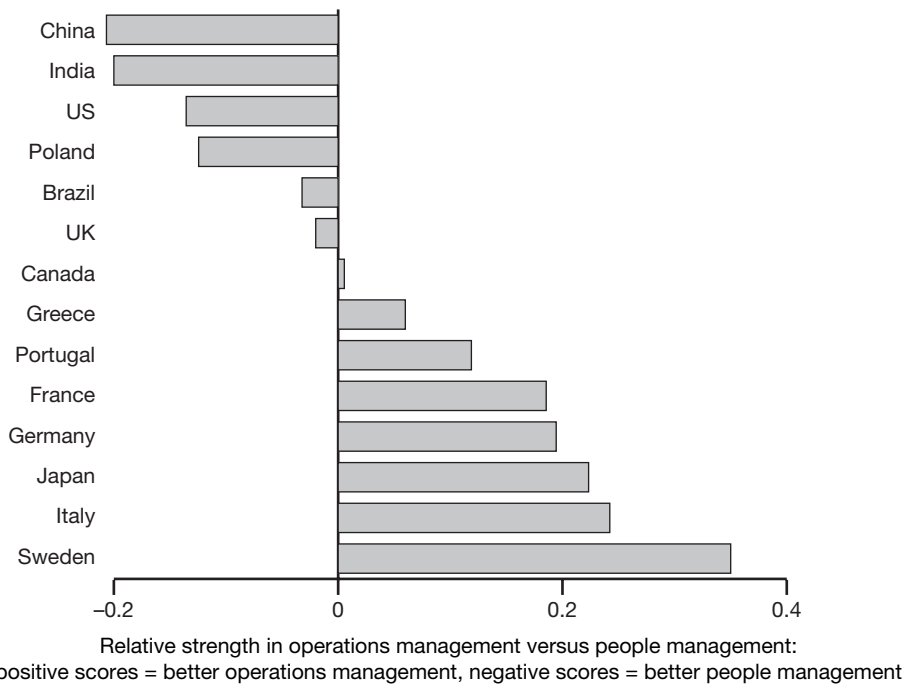
Note: Bars are the histogram of the actual density for the UK. The line is the kernel of the Germany density for comparison.

Figure 1.4
Relative management scores by country for monitoring/target-setting and incentives



Note: Averages taken across all firms within each country. 5606 observations in total.

Figure 1.5
Relative management scores for operations management



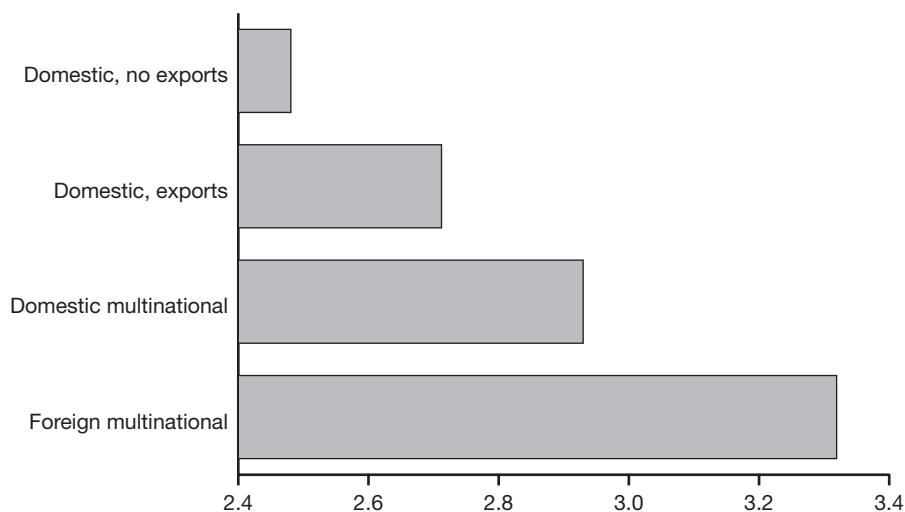
Note: Averages taken across all firms within each country. 5,747 observations in total. Scores defined as averages for monitoring and targets management (which we call 'operations management') less averages for people management

Figure 1.6 splits the firms along another dimension, namely by domestic, exporting and multinational firms. Consistent with the predictions of papers such as Grossman et al. (2006) there is a pecking order from multinational, to exporting, to domestic firms. Among multinationals, foreign multinationals (with establishments located outside their home country) are better managed than domestic multinationals (establishments located in the home country of the multinational). This is consistent with the idea that the very best firms tend to have multinational plants around the world, while less good multinationals tend to have fewer plants, which are more domestically orientated. As a result, management practices in a domestic plant are likely to be worse than those in foreign multinationals.

Figure 1.7 plots a firm-level histogram by ownership category. The bars display the distribution of management practices within each ownership group. The dotted line is the kernel density for dispersed shareholders – which is the most common ownership category in the US – for comparison. One interesting group are the family firms. Those that are family owned and family managed (Family, family CEO) have a large tail of badly managed firms, while the family owned but externally managed (Family, external CEO) look very similar to dispersed shareholders. Government-owned businesses are clearly badly managed, while private equity firms appear well managed.

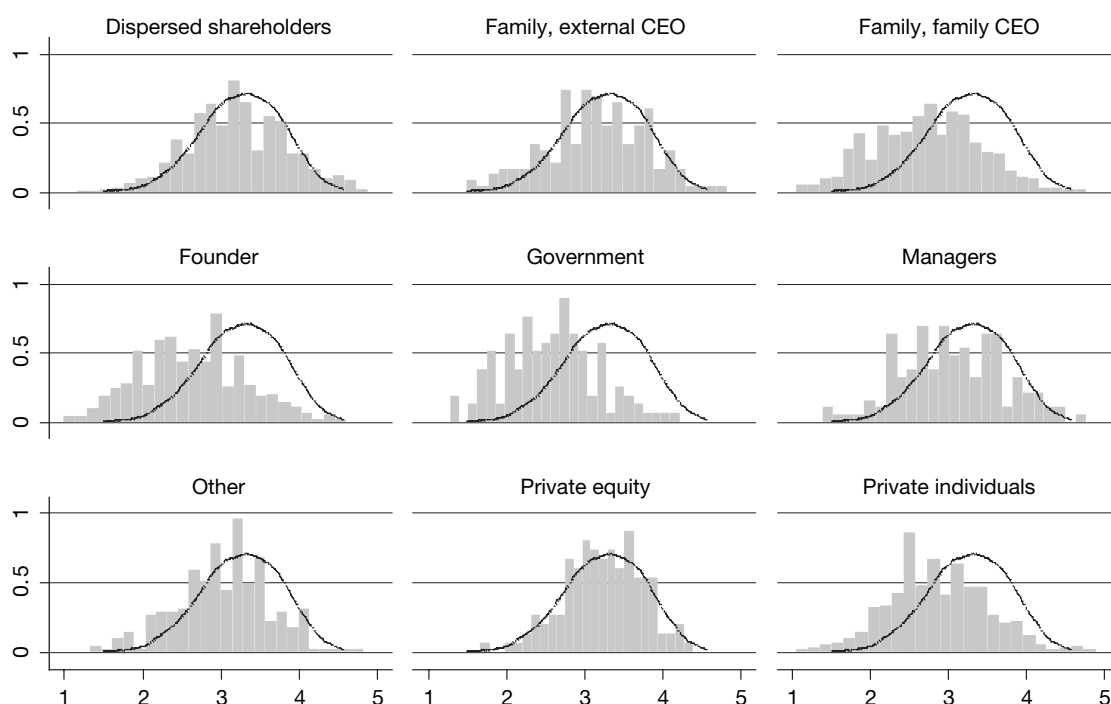
The results suggest correlation, not causality. It is possible that well-run firms simply attract good managers – and that the opposite holds true. But the correlations are intriguing and suggest that management practices are likely to play a tangible role in determining an economy's wellbeing. Field experiments running in India suggest that management practices indeed *cause* firms to become more productive, which further supports our theory.

Figure 1.6
Management scores by type of firm



Note: 'Domestic' is the establishment of a firm with no overseas production. 'Exports' means the establishment exports abroad. 'Domestic multinational' is the domestic establishment of a firm with overseas production (e.g. Toyota in Japan), and 'Multinational' is the overseas establishment of a multinational (e.g. Toyota in the US).

Figure 1.7
Management scores by ownership category



Distribution of firm management scores by ownership. Overlaid dashed line is the kernel density for dispersed shareholders, the most common US ownership type

Policies to improve management

Product market competition

The results provide strong evidence that competitive product markets are associated with better management practices. One route may be through selection, with badly run firms not lasting long in competitive markets. Another route may be through incentives to improve practices, which may be sharper when competition raises the stakes (either because efficiency improvements have a greater impact on shifting market share or because managers are more fearful of losing their jobs). Finally, to the extent that competition is associated with a greater number of firms, learning from competitors could be a third mechanism, as a firm with many competitors has a greater pool of firms from which to draw good practice. Whatever the reason, encouraging tougher competition should improve average management practices.

Business education

There are wide variations in management practices across firms, with many firms appearing to adopt practices associated with very low productivity. More, basic business education – for example in areas of capital budgeting, data analysis and standard human resources (HR) practices – could help improve management practices in many countries. This is

particularly true in developing countries where many firms do not even adopt standard management practices. Recent fieldwork with firms in India has provided much more supportive evidence on this. Such policies, if adopted, could be strongly complementary to the implications from the parallel *csg* programme *Inequality, Education and Comparative Political Economy* (Dustmann et al. 2009), who find that heterogeneity in basic skills is closely correlated to the wage penalty for unskilled workers. Reducing the differences in basic business skills could help moderate the wage gap in emerging economies.

Free trade and foreign direct investment

Foreign multinational ownership seems strongly associated with better management practices. One reason is that multinationals appear to export their best practices around the world. Good management is akin to an innovative process, which multinationals can take abroad within their firms. Exporting potential helps as well, since in many countries like Brazil, China and India exporters have to meet management practice standards embodied in ISO9000, which ensure they adopt various basic operations and HR practices.

Non-distortionary taxation

Family firms are on average badly managed in every country in the study. The reason appears to be that family firms often adopt family CEOs, who presumably go through a much less stringent selection process for that position than an externally chosen manager. As Warren Buffet famously joked, "If the US Olympic team of 2020 picked its members based on the eldest sons of the 2000 team we wouldn't win a thing." Unfortunately, many governments around the world provide strong tax subsidies for family firms. In the UK, for example, family firms are exempt from inheritance tax. Tax distortions like this are favouring activities associated with below-average management practices and governments should consider eliminating them.

Public ownership

Government-owned firms have strikingly bad management practices around the world. Given the lack of business experience of most bureaucrats this may not be surprising. Other things being equal, having ownership in the public sector is not a desirable state of affairs. This is a growing concern given the increasing government intervention in business in the wake of the current global financial crisis. In other words, it is possible that the short-term remedy of government taking control of private enterprises to prevent them failing may lead to poorer management practices in the future.

2 Innovation

Many commentators have argued that, while Europe's institutions and firms were well suited to the post-war period of 'imitation', when innovations from the US were diffused internationally, Europe is now closer to the technology frontier and must grow through innovation – pushing the frontier out rather than simply adopting and updating US innovations (Sapir, 2004; Acemoglu et al., 2006). This suggests that a second important determinant of economy-wide and firm-specific productivity is the degree to which firms can persistently innovate by improving processes or products, that is, by pushing out the technological frontier. In recent years, the innovation strategies used by firms have become increasingly sophisticated. This section investigates some of the more intricate elements of innovation strategies and policies to form a more nuanced picture of the contribution innovation makes to productivity.

Technology sourcing

Companies benefit from knowledge created in other companies or institutions. These knowledge spillovers are attributable to the idea that knowledge is a 'public good'. Knowledge spillovers do have geographic boundaries, however, so that to gain access to tacit or non-codified knowledge, a local presence is necessary. Companies may thus benefit from locating research and development (R&D) activities abroad. Harhoff et al. (2009) investigate how successful different types of R&D activity abroad are for sourcing technology and accumulating a stock of knowledge. Researchers may simply be based in other countries, or they may work with local companies on common projects, and R&D activities may or may not be technologically advanced. The investigation focuses on R&D activities by German firms in the US. Information about the location of researchers and the nature of co-operation with local firms is obtained from their patent applications and direct surveys.

The study finds it is beneficial for firms to have researchers located abroad. German firms with inventors located in the US benefit from the knowledge there in the form of higher productivity levels. Co-applications with US firms show an even greater benefit. The type of co-operation partner matters as well. Co-operation with suppliers, competitors and research institutions has a positive influence on the firms' productivity, but co-operation with customers has no measurable effect.

The results have implications for economic policy. Specifically, it can be positive if firms do not perform all their research in their home country but either send researchers abroad or maintain R&D facilities in other countries. A controlled, specific form of brain drain can

therefore be advantageous for the home country; it will lead to more knowledge being created, some of which will return to the home country.

Aschhoff and Sofka (2008) study collaboration between German manufacturing and services firms and universities. This provides a detailed perspective on how firms can design their interactions with universities to acquire knowledge and apply it successfully, using concepts of breadth (diversity of interactions) and depth (intensity of interactions) to categorise the channels used by firms to acquire knowledge from universities. Firms engaging in a wide range of interactions (breadth) and highly developed interactions (depth) are more successful innovators, both in terms of new product generation and the sales share of new products. Broadening a firm's interaction approach with universities (breadth) has stronger performance effects on innovation success than strengthening the intensity of existing ones (depth). This implies that firms should explore new types of interactions with universities instead of strengthening existing ones.

These results suggest that supporting technology transfer from universities to private firms politically should be considered as a tailored, multi-step process. While formal types of interactions, such as joint research, should remain the ultimate goal, such formal links probably overstretch firms' willingness and ability to engage deeply with universities right away.

Competition, innovation and productivity

It is often argued that competition fosters innovative activities that allow firms to survive or to escape competition. The outcome of such innovation activities is, however, rarely this clear cut, and the degree of uncertainty may affect decisions to undertake innovation projects. Uncertainty about levels of demand typically reduces the incentive to start R&D projects and delays innovation investment because a firm would rather take its time to gather new information about future market demand. Those firms faced with competition that wait to invest run the risk, however, that a competitor might innovate first and drive out the firm. Hence, competitive pressure can affect the value of waiting.

Dobbelaere et al. (2008) have developed a model to study the effect of market and technical uncertainty on the decision to start an R&D project, taking competition into account. The circumstances under which a change in demand or the cost of continuing R&D positively or negatively affects the probability of starting R&D are identified. The model is tested using German Community Innovation Survey (CIS IV) data on demand and technical uncertainty as well as perceived entry threat: under competitive pressure, both types of uncertainty affect the R&D decision.

Policy-makers will have to make sure that such degrees of uncertainty do not deter firms from investing – for example, if there were sufficient market or technical uncertainty to deter firms from undertaking socially desirable R&D, governments could consider measures, such as loss-sharing agreements or guarantees, to mitigate these sources of uncertainty.

Peters (2009) investigates whether one explanation for persistent productivity differences between firms is that firms display continued differences in innovation. Using panel data (1994-2005) from the German CIS survey reveals that better prior innovation performance substantiates further innovation success. In other words, the results confirm the 'success breeds success' axiom. First, successful product innovators are more likely to introduce new products in the future. Second, these firms also achieve a higher share of sales with these new products.

The results have important implications for the evaluation of technology and innovation policy. Since innovation performance shows true state dependence, measures to stimulate innovation, such as government support programmes, are likely to have a profound effect because they not only affect current innovation activities but are also likely to induce a permanent change in favour of innovation and hence stimulate productivity.

Evaluation of innovation policies

In imperfect capital markets, financial constraints may be a major reason for under-investment in innovation. Especially for R&D projects involving sunk costs, lenders demand a significant risk premium. Thus, firms with limited internal funds face financing constraints and may have to shelve innovation projects, given this risk premium. Policy-makers need to identify firms that might face such constraints and design policy instruments to alleviate potentially damaging under-investment. Policies should, however, particularly avoid 'crowding out' effects, that is, avoid firms replacing their own (available) resources with subsidies. Hottenrott and Peters (2009) employ a direct measure to identify firms facing financial constraints. In the German CIS survey, firms were asked how they would spend additional cash of about 10 per cent of the firm's last year's turnover. Firms that wanted to invest the additional cash in innovation projects felt they faced financial constraints that held back such investment. These financial constraints do not depend solely on the availability of internal funds but are driven by the firm's innovation capacity. That is, firms with small internal funds are not necessarily constrained if their innovation ambitions are low, but will be if their innovation capacity is high. Conversely, even financially sound firms face constraints and have to shelve some of their ideas if they have a high innovation capacity. Any policies to stimulate innovation in financially constrained firms needs to consider such multiple factors.

The efficiency of R&D subsidies

In most OECD countries, governments financially support R&D activities in the private sector to improve and secure innovative strength and competitiveness. For example, the German Federal Government runs a direct R&D project-funding scheme (DPF), a cost-sharing

scheme where up to 50 per cent of the R&D project costs are subsidised. Aschhoff (2008) investigates persistence in funding decisions, and compares the actual participants with the scheme's target group. Merging the German CIS survey with the DPF database produces a firm's subsidy status in each year, and detailed grant information allows two types of subsidy persistence to be identified. The first is simply due to the fact that funded projects may run for more than one calendar year (three on average). The other is due to newly approved projects.

The proportion of innovating firms that enter the funding scheme is very low. But if a firm has made it into the DPF scheme, the probability of it receiving subsidies for new projects in the following year is higher than that of dropping out of the scheme again. Overall, participation in the funding scheme is quite stable. Experience in the same scheme matters more than the subsidy status in the preceding year for the probability of getting new projects approved. The results do not appear to support the government's aim of supporting small and medium-sized enterprises (SMEs). Rather, firms with higher knowledge capabilities are more likely to enter and stay in the scheme.

Related to this study, Aschhoff (2009) analyses the role of a firm's subsidy history in the effectiveness of the subsidies granted: specifically, the effects of subsidies on R&D activities of frequent DPF participants. The size of the effects are compared with those of new participants in the scheme. There is no indication that the subsidy replaces, in full or in part, R&D expenditures that firms would have made themselves. Those firms that often receive DPF subsidies are likely to increase their own R&D spending. The subsidy has little effect on the self-funded R&D of first-time participants: although private R&D spending is higher for these firms, the increase is not significant. The results give no indication that frequent DPF participants exploit the support opportunity and that this makes the support instrument less effective. In terms of R&D output, the two groups use the grant, and the effects of the grant, equally efficiently in terms of generating new products and services. The results suggest that supporting the same firms over time does not alter the effectiveness of the grants.

3 Information and Communication Technologies

A large part of the European Union (EU)-US difference in labour productivity growth can be linked to ICT use (Stiroh 2002; Jorgenson 2001; Oliner and Sichel 2001). EU countries have designed and implemented policies aimed at encouraging ICT uptake because the received wisdom was that the US had a productivity advantage because it was faster in adopting and using ICT. However, the speed at which countries adopt ICT is unlikely to tell the full story. For example, even within Europe, the subsidiaries of US multinationals appear to make more effective use of ICT than either domestic European firms or non-US multinationals (Bloom et al. 2008). Previous research (Bresnahan et al. 2002) suggested that this gap in effectiveness may be linked to organisational and regulatory factors across Europe.

The relationship between ICT uptake and productivity is not as simple as is generally assumed. On a general (economy-wide) level, the direct effect of ICT use on average productivity is negligible. Using firm-level data, however, shows that some firms can use ICT very productively. Three new studies shed further light on the relationship between ICT use and performance of firms.

US multinationals and ICT use

What impact has ICT had on productivity? This has been a burning question for policy-makers and business leaders for several decades. Examining the use of ICT by global businesses shows that multinational enterprises in general, and US multinationals in particular, appear to have higher productivity that seems to be linked to a distinct pattern in their use of ICT. It may be that US firms have organised their management structures in a way that makes better use of ICT than their European counterparts. This confirms what business leaders have long known: the returns for using ICT are extremely variable; what makes the key difference is the management and organisation of the firm into which the ICT is placed.

The existing literature on ICT and productivity has generated a number of general findings. First, on average, ICT appears to be associated with higher productivity at firm level. Second, the magnitude of the association between ICT and firm productivity is substantial. Previous studies find that a doubling of the ICT stock increases productivity by 5 per cent, which suggests that there are some special features of ICT compared with other forms of capital. Third, there is a huge variation around the average impact of ICT on

firm productivity between different studies and firms. Investigating technology as well as other features of a firm helps in understanding this heterogeneity.

An important reason why the returns to ICT vary across firms is that different firms have very different organisational structures into which ICT is placed. Skills are also important. There is a great deal of evidence that skilled workers tend to be much better at coping with the uncertainties of new ICT systems than less skilled workers. Other organisational factors such as decentralisation of decision-making and the steepness of the managerial hierarchy have been found to be important. In several studies, researchers found some evidence that these factors do indeed affect the link between ICT and productivity.

One empirical regularity emerging from the study of within-firm productivity is that establishments owned by multinational firms are more productive than establishments owned by wholly domestic firms. It is especially interesting that US-owned multinationals are more productive than non-US multinationals. This productivity advantage by US firms is partially linked to greater use of assets: US establishments use about 10 per cent more materials and 4 per cent more non-ICT capital than non-US multinationals. However, ICT capital may also be an important factor: US firms use 40 per cent more ICT capital per worker than average whereas non-US multinationals use only 20 per cent more. Even after controlling for these factors, US establishments operating abroad are 8.5 per cent more productive than domestic firms in their home country. That is, nationality alone appears to create a gap between otherwise identical firms. A doubling of the ICT stock is associated with an increase in productivity of 5 per cent for a US firm but only 4 per cent for a non-US firm. US firms simply get more productivity out of the same amount of ICT (and this does not seem true of non-ICT capital).

A second interesting finding is that the bigger returns to ICT use for US firms are only found in certain sectors of the economy. These are exactly the same ICT-using sectors of wholesale, retailing and, to a certain extent, finance that account for the US productivity miracle. Of course, given the recent economic downturn in precisely these sectors, it has to be questioned whether earlier statistics have overstated the extent of the US productivity advantage. But why are the returns so much higher for US firms? None of the wide variety of existing hypotheses – e.g. that US firms simply have more skilled workers or better software – can fully explain the difference. The main reason may lie in the managerial structure of US firms. Apart from general differences in managerial quality, US subsidiaries are more likely to allow greater autonomy to employees, a factor associated with higher returns from ICT. This suggests that what gives US firms their advantage is that their organisational and managerial structures are conducive to getting the most out of ICT. It could be that a reason for the slower growth in productivity in European ICT-using sectors is that US firms have better internal organisation that gets more from their ICT.

So why do European firms not adopt more US-style forms of business organisation? Some are doing so. For example, the Wal-Mart system of supply chain management has been explicitly copied by Tesco, the UK's largest supermarket. It has also been transplanted

directly as Wal-Mart has acquired Asda, now the UK's second largest supermarket. Organisational changes such as this are large-scale and costly events so change is often slow and difficult. Further, there are regulatory and cultural constraints to adopting US business practices in Europe – although US multinationals like Starbucks and McDonald's appear to be able to do as well in their European outlets as they do back home. A deeper question is whether European firms really should change so radically. The older organisational forms served Europe well during the post-war catching-up period and it may be that, as the new technologies bed down, these traditional organisational forms will again prove themselves reliable. On the other hand, if the world's economies have genuinely entered a new phase of development where individual performance, flexibility and decentralisation are needed, such complacency could be fatal.

The rebound of US productivity growth over the last decade seems to be linked to ICT as the productivity acceleration was particularly strong (and much stronger than in Europe) in those sectors that used ICT intensively. While the recent economic downturn suggests that US productivity may have been overstated, especially in the ICT-intensive service industries that have been hit hardest, it is undisputed that, to take advantage of new technologies to support business processes, European firms may have to adopt some of the organisational innovations widely used in US firms, in tandem with the technological innovations.

Do older workers lower IT-enabled productivity?

The role of ICT as a driving force for productivity and competitiveness is well established. At country level, however, the contribution of ICT capital to GDP growth diminished considerably between 2000 and 2005, compared with the period 1995 to 2000, in almost all OECD countries. During the same time period, the participation of older people in the labour market has increased owing to demographic changes.

But is the productivity of a workforce using ICT affected by the age structure of that workforce? It appears not. Firm-level data from German manufacturing and services industries shows that workers older than 49 are not significantly less productive than workers aged between 30 and 49, whereas workers younger than 30 are significantly less productive than those aged between 30 and 49. Older workers using a computer are significantly more productive than older non-computer users. Moreover, the proportion of older workers in a workforce has no effect on the significantly positive relationship between labour productivity and IT intensity.

Some may question whether firms might employ only the best or most productive older workers while less productive employees leave the labour market either actively or passively – through early retirement programmes, for example. Even taking this into account, the finding that the percentage of older workers is not significantly related to labour productivity is supported.

The policy implications of this result are significant. Most of all, it suggests that protecting older workers from an increasingly ICT-intensive working environment is misguided, as they are unlikely to suffer from this trend. This is especially so as future older workers will have been exposed to ICT earlier in their working life. Instead, it is important to recognise that unskilled workers of all ages are likely to be the ones suffering the most, which may be further exacerbated by trends in off-shoring and globalisation which will further reduce demand for unskilled workers. This implication is made more salient by the results from Dustmann et al. (2009), in their related *csge* programme, that the wage penalty for unskilled workers is more severe in countries with strong differences in basic skills. Consequently, policies aimed at developing ICT skills alongside basic education for unskilled workers are likely to be more beneficial than ones targeted at older workers and are likely to have the dual impact of reducing the wage penalty on the one hand and counteracting the decrease in demand for unskilled workers on the other.

Complementarities between ICT, organisation and strategy

The literature on returns to ICT unanimously finds that firms differ significantly in their ability to achieve better performance through ICT. One explanation is that firms are not equally good at exploiting complementarities that exist between ICT and the internal organisation and management of a firm. Previous work has found that ICT is especially profitable if combined with giving decision-making rights to employees at a lower level and adopting human resource (HR) management practices that support this decentralisation of decision-making with proper motivation, information and opportunities for learning. These findings have important implications for (technology) managers, as they provide clues on how to unlock ICT's full potential for performance enhancement by aligning it with organisational and management practices.

Nevertheless, it appears unrealistic that there is a single best way to achieve such alignment. It appears much more likely that the external and internal characteristics of a firm will play a significant part in the process. It would seem of particular importance to consider the firm's organisational structure (in particular the level of centralisation) and the firm's strategy as typified by its model of organisational learning. Both possible forms of complementarities between ICT and organisational/HR practices (that is, ICT/decentralisation and ICT/centralisation) may be beneficial, depending on what model of organisational learning a firm adopts. A firm's strategic direction may focus on the continuous exploration of new products and markets (exploration) or the constant improvement of existing products and markets (exploitation). As each learning model, exploration and exploitation, is best realised through different organisational designs, the complementarities between ICT and organisational/HR practices may take a different form under each model.

In a unique sample of German manufacturing firms, the learning model indeed affects the interaction between ICT adoption and the degree of (de)centralisation. Specifically,

under an explorational learning model a decentralised organisation and ICT are complementary, while firms with an exploitative learning model benefit from coupling ICT with a centralised organisation.

These results depart from existing empirical findings that the only combination worth pursuing is that of decentralising the organisation alongside adopting ICT. Instead, they support the argument that allows for complementarities between ICT and centralisation. The findings also offer new insights for practitioners on how to align ICT with organisational and HR practices according to a firm's strategic orientation. This is highly relevant for managers, as it appears realistic that a firm will only be able to exploit the full potential of ICT for performance improvement if the firm's efforts to align ICT with organisational and management practices are fitted to the firm's circumstances.

For policy-makers, these findings imply that unless firms are encouraged to use ICT in keeping with their overall set-up (in terms of strategy and organisational structure), such incentives may not produce the desired impact. That is, policies should offer incentives for a wide range of ICT specifications rather than a single technology that may not be suited to all organisational circumstances.

4 Globalisation

The investment decisions of multinational firms are critical for productivity, but our understanding of outsourcing and offshoring is limited. Competition for 'footloose' multinational investment exists within Europe between countries like Poland and the richer EU nations (such as Germany), but it also operates between Europe as a regional bloc and the US, Japan and emerging nations such as India and China. More generally, globalisation and the flow of goods, capital and technology across national borders have unleashed explosive growth in the operations of multinational firms, as evidenced by dramatic increases in the levels of foreign direct investment (FDI) and international trade. Our research on globalisation has concentrated on two main areas. A first line of research has examined the organisation of multinational firms' economic activities across national borders. A second line has focused on the impact of international financial integration and other public policies on entrepreneurship and growth.

The global organisation of business activity

Two questions framed our consideration of the global organisation of business activity:

- Which stages of production or processes should be located overseas?
- Should overseas production or processes occur within the firm (FDI) or in a separate firm (outsourcing)?

Much of the recent debate about multinationals has focused on offshoring and the outsourcing of call centres, consultancy, IT support, and manufacturing assembly to low-wage locations in eastern Europe, India and China. These are examples of vertical multinational activity, which involves slicing up the value-added chain and relocating some of these slices abroad. Existing academic research has mostly concentrated on horizontal multinational activity, where firms replicate their production process abroad to serve local markets. Alfaro and Charlton (2007) used a new firm-level dataset provided by Dun & Bradstreet that reports the location, ownership, and activity of 650,000 multinational subsidiaries – this is close to a comprehensive picture of global multinational activity. FDI does occur between rich countries, and existing research has substantially underestimated the importance of vertical FDI, largely because of the lack of detailed information on the industries of the parent company and foreign subsidiary. At the level of detail usually available to researchers (that is, defining industries by their two-digit Standard Industry Classification), most vertical subsidiaries would simply appear to be in the same industry as the parent company. For example, a supplier assembling modules to go into a car would be in automobile manufacturing, just as its parent company. From

existing research it was also thought that firms were likely to locate low-skill aspects of their business in low-skill countries in order to take advantage of lower costs. Instead, it appears that multinationals overwhelmingly locate vertical subsidiaries geographically close to the production of their final goods. Therefore, despite reductions in transport costs and policy barriers to multinational activity, distance continues to exert a powerful influence on the organisation of production within firms. While countries clearly cannot alter their geographical location, they can control policy barriers to multinational activity. The elimination of artificial barriers to multinational activity that can render countries more remote from global centres of production is an important policy consideration.

Much of the traditional literature on multinational firms examines a firm's decision whether to serve a foreign market through exporting or local production. This literature assumes that, when local production occurs, it takes place within a multinational subsidiary rather than a stand-alone firm. Recent research suggests, however, that using a subsidiary rather than a stand-alone firm is itself a choice determined by the quality of the contracting environment. Using data on individual trade transactions collected by US customs provides empirical evidence on the determinants of whether international trade occurs within or between firms. A key feature of this data is that it reports whether each trade transaction takes place at arms length between stand-alone firms or instead occurs between related parties, where partners are 'related' if either party owns, directly or indirectly, 10 per cent or more of the other party. For imports, the ownership cut-off is 6 per cent. As recent theories suggest, the protection of property rights plays an important role in determining the share of trade between firms. On the one hand, countries with weak protection of property rights are less likely to have US-owned affiliates. Stronger property rights protection in a country therefore increases the share of US trade that is intra firm, because US firms are more likely to locate foreign affiliates in the country (the extensive margin). On the other hand, once US firms have affiliates in the foreign country, stronger property rights protection makes them more willing to engage in arm's-length transactions with foreign firms, which reduces the share of US trade that is intra firm (the intensive margin). On balance, stronger property rights protection increases the share of intra-firm trade because the extensive margin effect dominates the intensive margin effect. These findings have important policy implications in so far as they highlight the role of institutions in promoting economic development. Improvements in institutions can both enable developing countries to attract foreign multinationals and also encourage these foreign multinationals to outsource more of their economic activities to local firms.

Capital flows and production structures

Our research in this area examined two dimensions of how public policy can influence entrepreneurship and growth. A first study focuses on the role of international financial integration and foreign capital in promoting domestic entrepreneurship. A second examines more broadly how public policies can influence aggregate productivity and

growth through the allocation of resources across firms and plants with heterogeneous productivities.

The first study (Alfaro and Charlton 2006) explores the relationship between international financial integration and the level of entrepreneurial activity in a country. Using a unique firm-level dataset of approximately 24 million firms in nearly 100 countries between 1999 and 2004 gives both cross-country and industry-level evidence. Robust cross-country correlations are found between increased international financial integration and the activity of entrepreneurs – using various proxies for entrepreneurial activity, such as when a firm was set up, its size and that size relative to the distribution of all sizes, and specific measures of international capital market integration. These factors are examined in the context of the channels through which foreign capital may encourage entrepreneurship and show that entrepreneurial activity is disproportionately affected by international financial integration in industries that are more reliant on external finance. This suggests that international financial integration may improve access to capital either directly or through improved domestic financial intermediation. Second, entrepreneurial activity is higher in industries with a large share of foreign firms, which suggests that FDI creates opportunities for new firms as potential suppliers to foreign firms. Taken together, these findings make it clear that domestic entrepreneurial activity is an important channel through which international financial integration promotes growth and development.

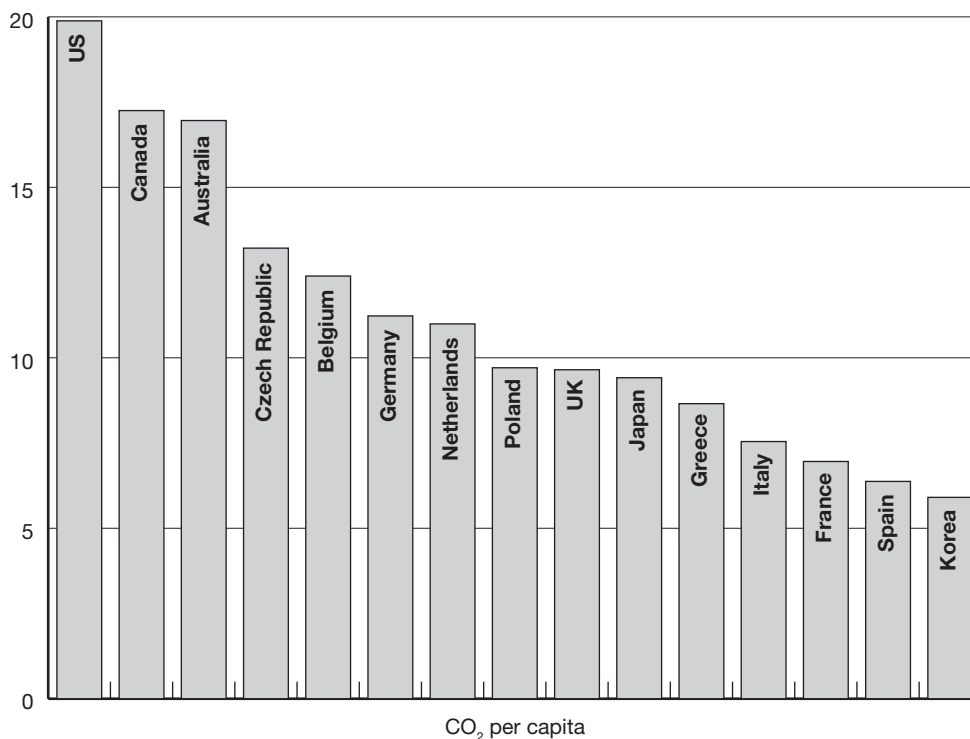
The second study (Alfaro et al. 2008) uses firm-level data for 79 developed and developing countries to investigate whether differences in the allocation of resources across heterogeneous plants are a significant determinant of cross-country differences in income per worker. A standard neoclassical model without productivity differences across plants accounts for some 42 per cent of the variance of income per worker across countries. Extending the model to incorporate productivity differences makes things much clearer: 58 per cent of the variance of income per worker across countries can now be accounted for. This suggests that public policy can affect the level of aggregate economic activity in the way that it provides for allocating resources across firms. Deregulation and other policies that allow resources to flow from less to more productive firms have an important role to play in enhancing aggregate productivity and growth.

5 Environmental Consequences

A key motivation for the csge initiative is the persistent productivity gap between the US and many European countries. Of course, the global public perception of the US as an economic powerhouse suffered a blow in 2007-08. It is now clear that many economic values were not quite what they seemed. It is, however, unlikely that this will lead to a revision of the verdict on productivity. The most advanced productivity comparisons, for example by the EU KLEMS Project (<http://www.euklems.net/>), are based on a careful comparison of the ratios of inputs and outputs of past production activities between countries. These facts should not be affected by financial uncertainties like stock market values. It is even clearer that the evidence on the environmental performance of the US does not need to be revised. Among large industrialised countries, the US is the leading emitter of greenhouse gases, both in absolute terms but more importantly in relative terms, as Figure 5.1 illustrates.

One might suspect that much of this is driven by a specific American taste for fuel-guzzling cars or air-conditioned homes. Interestingly, as can be seen in Figure 5.2, in a comparison with the UK, relative energy intensity – and, in turn, emission intensity – is higher across all demand categories, including industrial energy demand.

Figure 5.1
Per capita CO₂ pollution of major industrialised countries, 2000



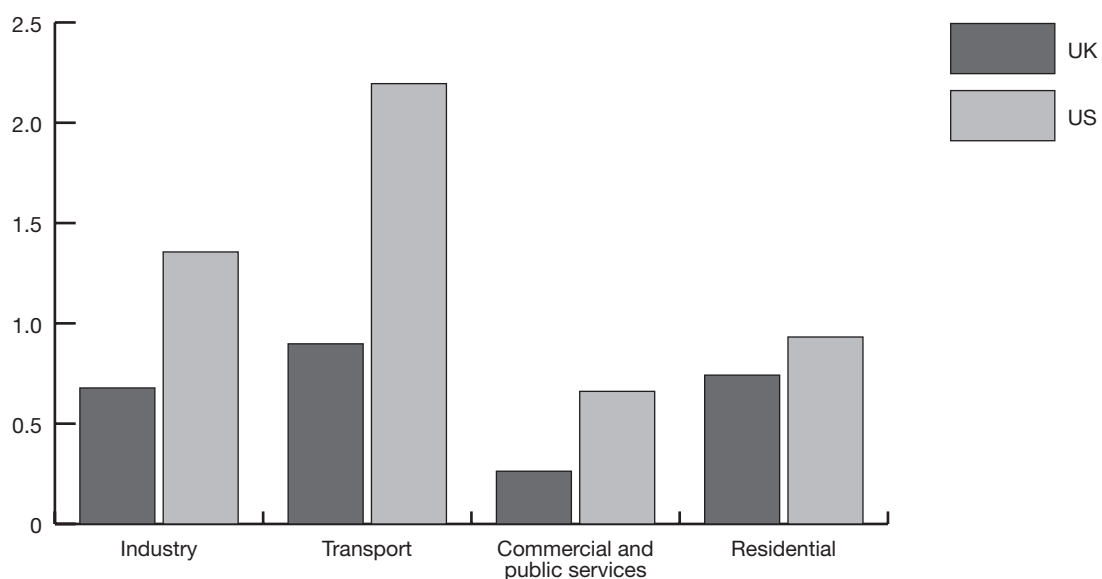
Source: IEA

The question that now arises is this. If higher industrial productivity and higher energy use of American firms are two sides of the same coin – that is, if American firms are using a production technology that is more economically productive but also more energy intensive – would efforts in Europe to increase productivity to US levels inexorably lead to higher energy intensity as well? What could drive such a connection? As other parts of this research have shown, advanced management techniques and well-conceived use of ICT are important drivers of high productivity, and potentially complementary. Clearly, having an abundance of computers is not useful if they are not plugged in and running. This, however, requires power and leads to emissions. So it would not be surprising if more productive companies, such as American ones, would end up more energy intensive.

Results from this research point in a different direction, however. Several pieces of evidence suggest that US firms are not more productive because of their higher energy intensity but despite it. First, more economically productive firms tend to be less energy intensive, both in the UK and the US. That is, more productive firms spend a smaller proportion of their budget on energy and materials, but a larger proportion on capital and labour. Thus, if higher productivity is indeed driven by ICT it must be that the additional power used by computers and other ICT equipment is more than compensated for by savings in other types of energy use. For example, ICT might allow better monitoring of business and production processes, thereby reducing wasted energy inputs and other intermediates. ICT might also require more high-skilled labour such as IT administrators, which might explain the increased labour share in more efficient companies.

A second piece of evidence is the performance of US multinationals in Britain. If the productivity advantage of US firms is driven by production technologies that are more energy intensive, we would expect to see an energy intensity gap between US firms

Figure 5.2
Per capita energy intensity across major usage categories, US vs UK, 2003

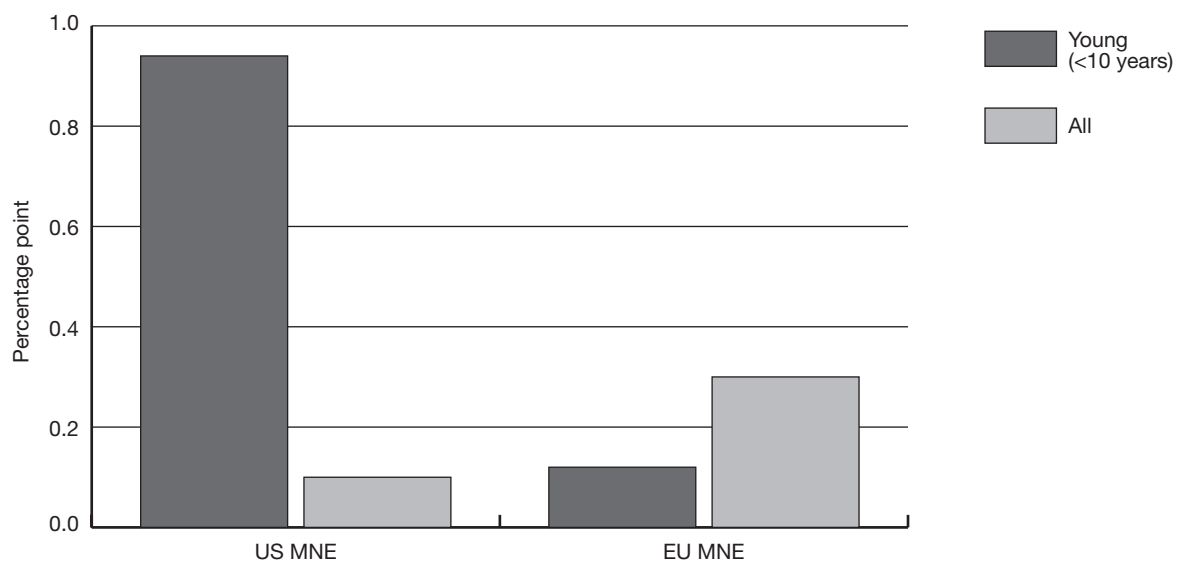


and other firms in any country where they are operating. On average, such a gap does not appear when comparing subsidiaries of US firms in the UK with those of the UK and other multinational enterprises (MNEs). There is, however, a gap when looking at US subsidiaries of firms that have only recently established themselves in the UK market (see Figure 5.3). In other words, the energy intensity gap vanishes over time as US MNEs stay longer in the UK. This is consistent with US firms learning more about more energy-efficient technologies.

So the answer to the original question of whether US-style productivity means US-style pollution is a negative – but it is positive for the environment. The key message for economic policy is that policy-makers should not be worried about compromising environmental efficiency when trying to increase productivity. Rather, environmental efficiency will improve as well to a substantial degree. For example, top UK firms (as measured by the management score described in Chapter 3) are 17 per cent less energy intensive than firms at the bottom.

A caveat with this argument is that an improvement in environmental efficiency – that is, usage of an environmental resource per unit of output – does not necessarily translate into an improvement in environmental performance if the increased efficiency is associated with an even higher increase in output. Figure 5.4 illustrates this by reporting the share of aggregate energy (in our sample) accounted for by different quartiles of the management quality distribution. Firms in both the top and the third quartile of the management score distribution account for a disproportionate share of the aggregate energy usage. This is not because they are more energy intensive but because these firms are typically larger. Policies aimed at productivity, therefore, must be combined with

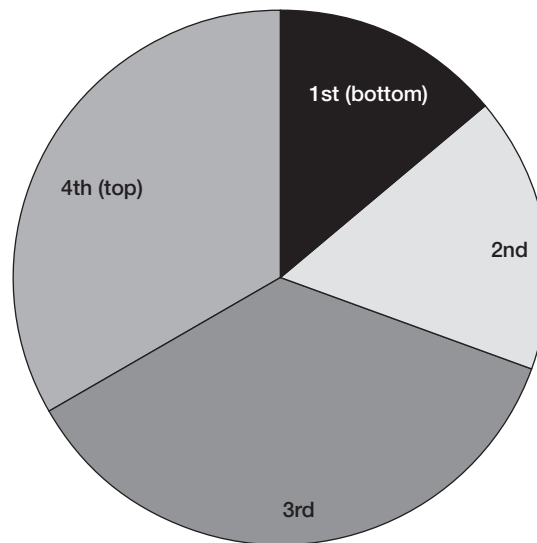
Figure 5.3
Average energy intensity of multinational enterprises (MNEs) in the UK



Notes: UK MNEs are normalised to zero. The bars report the difference in percentage points of energy expenditure over gross output. Thus young US MNEs energy intensity is almost 1 percentage point higher than that of UK MNEs.
Source: Martin (2009a)

Figure 5.4

Shares in aggregate energy of firms in different quartiles of the management score distribution



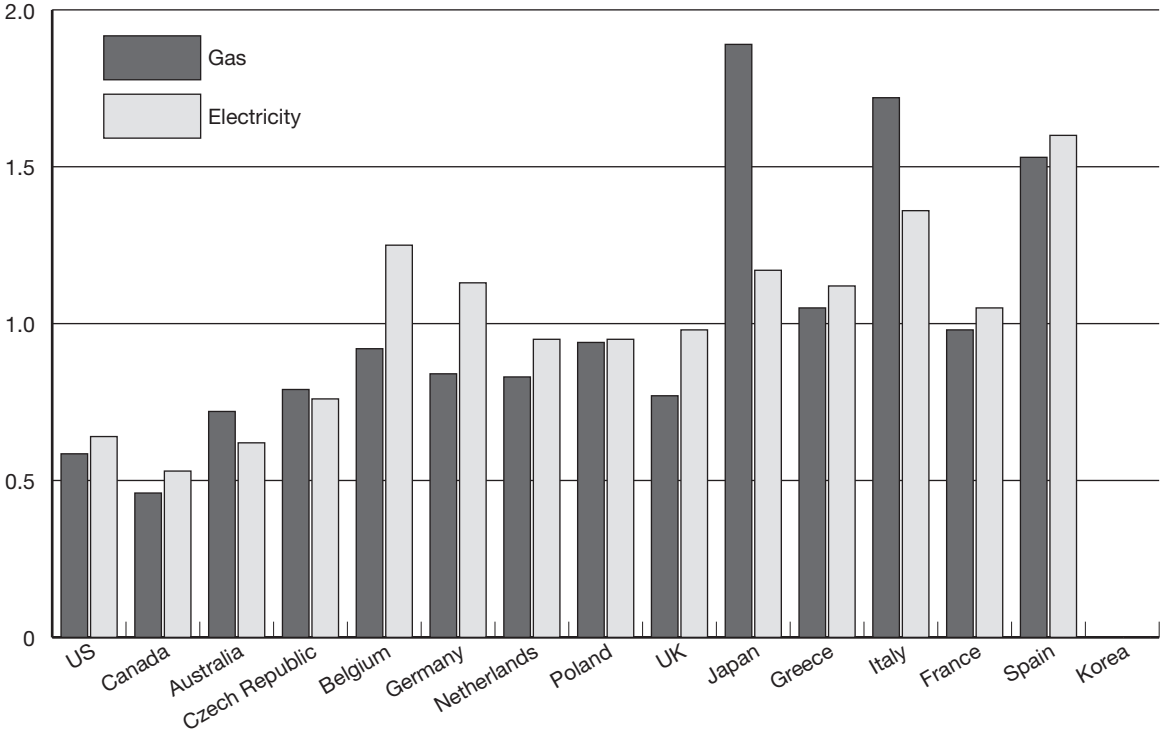
Source: Martin (2009b)

classic policies to limit pollution, such as energy or carbon taxes or carbon trading. The good news is that this can be done in such a way that there is a window of opportunity allowing economic growth while bringing down emissions.

Why is the US so energy intensive?

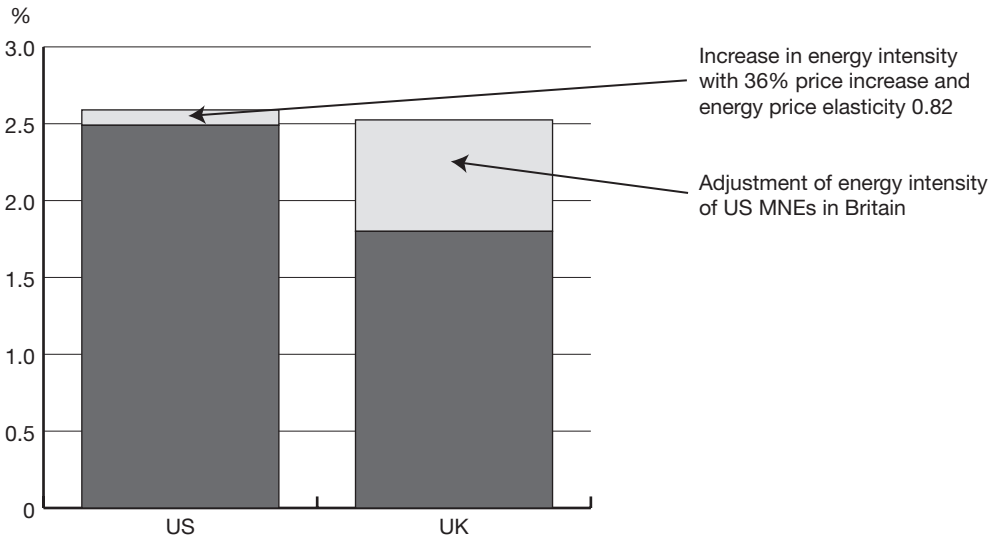
Our results suggest that there is not necessarily a technological link between the higher productivity and the higher energy intensity of US firms. The question however remains why the US uses so much energy compared with the UK. An obvious alternative explanation for the gap derives from persistent and strong differences in energy prices between the two countries, shown in Figure 5.5. On average, energy prices are approximately 36 per cent higher in the UK. Interestingly, common assumptions about energy price elasticities are not sufficient to explain the gap on the basis of price alone. For example, Roy et al. (2006), surveying a number of studies, report energy price elasticities of about 0.8 for manufacturing as a whole. In his *csg*e report, Ekins (2009) reports a number of 0.6. Indeed in value terms (energy expenditure over gross output) one might expect that energy intensities in the UK are higher than in the US because energy demand would not decline enough to make up for the increased price. Figure 5.6 illustrates this by showing the actual average energy intensities for the UK and the US and then the level of US energy intensity one would expect on the basis of common energy price elasticity estimates. The figure also displays the reduction in energy seen among US MNEs in Britain. This suggests that, quantitatively, the adjustment process could account for much of the

Figure 5.5
Average energy prices, 2000–2003



Notes: PPP US dollar price over mean of price across countries, average 2000–2003
 Source: Own calculations based on IEA data

Figure 5.6
Average manufacturing energy intensity in the US and the UK, 2002



gap. This suggests two further implications: first, common estimates of energy price elasticities (typically derived from within country or sector price fluctuations) are probably too low to capture the real business reaction to a sustained large price gap, such as the gap between the UK and US. Translating the US adjustment process into an elasticity leads to a value in the order of 1.8 rather than 0.6 or 0.82 as often suggested. Second, this adjustment process is not immediate. Our results suggest that it could extend over several years, reflecting the slow diffusion of knowledge about energy-saving technology and practices that environmentalists widely recognise. Policies to facilitate this process – for example, the Carbon Trust in the UK (<http://www.carbontrust.co.uk>) providing free energy advice to businesses – should be considered.

Can the US learn something from Europe?

US MNEs in the UK appear to undergo a process of technological learning. This raises the question of whether there is scope for such learning for US firms in the US itself. There are certainly indications that US firms in the US could learn from Europe and the UK if energy prices there were to increase to European levels as a consequence of climate change policies. This lends weight to policy-makers who seek to assist knowledge transfer between firms.

But is there scope to reduce energy consumption in the US based on UK/US knowledge transfer even given current energy prices? We explore this by looking at the response to economic productivity (TFP) as US firms reduce their energy intensity. The idea is that if the reduction in energy intensity goes along with a strong reduction in productivity this would be a sufficient (while not necessary) condition for US firms to adopt the new technologies, irrespective of energy prices. The effects are not clear enough, however, to draw any firm conclusions.

Can climate change policies help to increase productivity?

A popular narrative among politicians who promote stringent climate-change policies is the idea that such policies are not only good for the environment but that they are also a vehicle for job creation and productivity growth (<http://www.number10.gov.uk/Page13791>). This turns an earlier debate on its head – namely that climate change policy is endangering competitiveness and productivity.

A related idea in academic literature has often been referred to as the Porter hypothesis (Porter and van der Linde 1995). The suggestion is that environmental regulation forces firms to adopt new perspectives which can lead to new discoveries so, rather than being a cost burden, regulation can turn out to be a source of productivity growth.

Two new pieces of evidence add to these debates. First, Boehringer et al. (2008) examine the relationship between productivity and spending for German manufacturing sectors, as well as investment for environmental purposes. As with the results on productivity and energy intensity there are potential problems with reverse causality; that is, simply finding a strong relationship between productivity and environmental spending might imply that the first causes the second, or the second the first, or both. The availability of time series data allows the problem to be dealt with like this: if environmental spending goes up before productivity goes up it is indicative that spending causes the productivity increase. From this kind of analysis it emerges that long-term investments classified as environmental have a positive effect on productivity whereas short-term environmental expenditure does not. This by itself is not a proof of the Porter hypothesis or related ideas because environmental investments could either be made in response to regulations or simply voluntarily.

A more direct examination comes from evidence for the UK (Martin et al. 2009). Here an actual policy measure, the 2001 introduction of the so-called climate change levy, a tax on various fuel types for businesses, is examined. Its effect on business performance is measured by comparing firms that had to pay the levy with firms that were granted an exemption. The levy had a strong impact on energy intensity and power consumption of firms but no significant effect on productivity or indeed other economic variables such as employment. On the negative side this means no evidence for Porter-style effects. On the positive side, it also means there are no negative effects on economic performance, as some might have feared.

Summarising the facts

The US leads the world both in economic productivity and greenhouse gas intensity. Does this mean that high economic productivity is inevitably linked with high environmental pollution? Using firm-level data for both the UK and the US we find the opposite: more productive and better-managed firms are less energy intensive, suggesting that efforts to improve productivity also help to advance an environmental agenda by reducing energy use and therefore pollution intensity.

Looking at the performance of US MNEs in the UK it seems that the response to sustained and significant energy price rises is probably higher than assumed on the basis of conventional estimates. Second, there might be scope for transferring knowledge about energy-saving technologies from the UK – or more broadly Europe – to the US in the event of rising energy prices stimulating climate change policies in the US.

The finding of a positive relationship between energy intensity and productivity could inspire the hypothesis that efforts by firms to reduce their environmental impact, and indeed environmental regulation by governments, could lead to productivity gains. Because of the implied win:win situation such a hypothesis is very popular with policy-makers at the

moment. Looking at this hypothesis using sector-level data for Germany and in the light of a concrete policy measure in the UK, the 2001 introduction of the climate change levy, does not produce any positive evidence for such productivity effects. Neither, however, do moderately stringent climate change policies negatively affect productivity or employment, a hypothesis often put forward by opponents of climate change policies.

6 Conclusions

The research programme *Explaining Productivity and Growth in Europe, the US and Asia* was very ambitious, both in terms of employing a unified and challenging methodology across all its sub-programmes (see pages 42–44), and in terms of the scope of topics covered in the various sub-programmes, investigated at different locations. Without dwelling on the methodological advances made in the course of this project, it is worth noting that none of the key conclusions derived would have been possible without a strict focus on micro-level data and without combining primary and secondary sources to arrive at empirically robust and representative results. Future researchers may find it useful to note our research approach (outlined in more detail on pages 47–48) and to adapt parts of it for their needs.

The key aims were to explain why productivity growth in Europe was disappointingly slow compared with the US, and to identify possible interactions across drivers of productivity growth as well as side effects resulting from the struggle for higher productivity and economic well-being.

Headline findings

The study of differences in management practices across firms and countries found that the management of firms is an important element in determining an economy's productivity. Moreover, while the management and organisation of firms has an effect on productivity in its own right, perhaps more importantly it also facilitates the effective use of other levers of economic growth such as good use of ICT or product and process innovations. Conversely, improving the quality of management quality appears to come with fairly few 'side effects' in terms of other, less desirable outcomes.

The degree of heterogeneity across firms, not just economies, is considerable. That is, there are wide-ranging differences in the characteristics of firms (including the productivity drivers studied). Specifically, the following sources of heterogeneity appeared across firms (some of them documented for the first time):

- cross-country differences in management quality
- the structure of the industry in which the firm operates
- its location on the value chain
- differences in skill levels and composition
- differences in the level of sophistication in adopting and using new technologies.

The implications here are important. Policies will have different overall effects on firms: a policy aimed at increasing the use of ICT, for example, will not be successful in an economy with few skilled users of ICT, while it will have a great impact on productivity in an economy where good ICT skills are common.

It is important to recognise how several of the drivers and consequences interact. For example, management, organisation and ICT are interdependent in that, to use ICT most productively, appropriate organisational and managerial practices have to be in place. Further, innovative performance and international location are linked; being located abroad enables firms to absorb some of the spillovers and knowledge created there so that co-location plays a role even in times of advanced communication technologies. This resonates with another important result of the work, which finds interdependencies between the degree of globalisation of a firm, its management quality and its environmental performance. Multinationals are on average better managed than their domestic counterparts and tend to learn quickly about ways to improve their environmental performance. Again, looking at these interdependencies offers a picture that goes beyond simple statements such as 'globalisation is good or bad' or 'well-managed firms consume less or more energy'. Rather, it illustrates the complex and multi-dimensional issues that exist when trying to explain industrial production processes across countries and firms, and with multiple (intended and unintended) outcomes.

Good management and resource efficiency are not in conflict with each other. Well-managed firms are also less energy intensive, which contradicts the received wisdom that, to be economically productive, other aspects of a firm's impact on society (such as environmental performance, or the work-life balance of employees) have to be sacrificed. Given that lower energy intensity translates into a lower energy bill this finding may not seem surprising, but it supports the view that there is no point in penalising multinational industrial firms pre-emptively for their supposed inferior environmental performance, as these are the ones likely to be better managed and therefore more resource-efficient.

Lessons for policy-making

The question is: how can policy-makers use this new knowledge to shape policies that can help lift groups of firms, regions, or entire economies to achieve sustainable growth? Sustainable in this context means not only that investments in capabilities and skills are not sacrificed in favour of short-term exploitation of existing resources, but also that the growth is not in conflict with other goals of society such as sustainable use of energy, or out of tune with the existing skills and demographic structure of an economy. Further, 'sustainable' also implies that it has to take into account the likely trend towards more extensive cross-border trade of physical and intangible goods, which will present additional challenges for firms that are not (yet) exposed to international competition. Policy-makers may wish to consider the following:

Moving levers to improve management practices. Management practices are not typically seen as part of the policy arena but have an important impact on the productivity and consequently the economic well-being of an economy. Some of the factors found to be associated with good management, such as product market competition, facilitating foreign direct investment and privatisation of publicly owned firms, are already part of the policy repertoire of liberal industrialised economies. Other more direct measures, such as providing basic business education to a large portion of the population or removing tax advantages for certain forms of ownership, have not yet entered the policy discussion, in the case of tax breaks because of their controversial nature; nor has business education previously been clearly linked to economic growth. The results from this programme strongly suggest that these levers should be considered as key elements of a forward-looking set of policies to secure economic well-being.

Facilitating international mobility of goods, employees and services. An international dimension can improve productivity by enabling firms to make use of innovative knowledge generated abroad, by putting pressure on domestic firms to improve their management practices, or by letting firms focus on activities in which they possess a comparative advantage. Protectionist policies and erecting 'hidden' trade barriers like national product standards may well have the short-term effect of allowing a country to stabilise its existing industry structure and composition, but it will eventually distance it from the improvements made possible by internationalised markets. Sustainable growth also implies an economy's ability to restructure and reshape, which will be aided by the impetus coming from firms or employees located abroad.

Promoting policies to improve environmental performance and evaluating them on their primary aims. Policies designed to improve environmental performance are sometimes dismissed because they are perceived to stand in the way of unfettered productivity growth. An alternative school of thought considers such policies a panacea for all sorts of societal issues including job growth and innovative performance. In this way of thinking, the expectation is that the right incentives will encourage firms to invest in energy-saving technologies and implement them, leading to job creation in future growth industries and the widespread adoption of process innovations. Neither view should be considered key in the implementation of environmental policies: the fact that firms will respond to incentives such as the 2001 climate change levy in the UK by shifting their energy consumption to less expensive types of energy illustrates this. It appears that well-managed firms are better at spotting such opportunities, but there is no immediate side-effect that encourages firms to 'go green' across the board and invest heavily in other (non-incentivised) energy-saving technologies. Setting appropriate incentives for reduced energy consumption is difficult enough, so hoping for additional shifts in behaviour is unrealistic and puts an undue burden on the policy in question. If a policy achieves its main aim – a reduction in the consumption of a particular energy type, for example – that policy should be considered a success.

Recognising interactions across productivity drivers. Interactions and interdependencies occur across the different drivers of productivity growth. Policies, on the other hand, have

typically addressed just a single dimension – tax credits for research and development, broadband subsidies and technology transfer initiatives, to name just a few. Future policies aimed at securing sustainable growth need to reflect such interdependencies and should be designed accordingly. For example, incentives for firms to adopt ICT must be complemented by subsidies for training in the skills needed to use ICT effectively. Further, such incentives will have to take into account that ‘not all ICT is equal’ and that firms will benefit from different ICT systems depending on their strategies and organisational structure. For instance, incentives to adopt Open Source (OS) software may benefit firms that frequently change and adjust their ICT systems because their environment and structure demands it, while firms with centralised decision-making power may be encouraged to adopt software that does not match the rest of their organisation.

These four areas are those in which policy-making has urgently to catch up with scientific evidence. Some drivers of growth have been ignored so far (business education, for example); some policies, including those on environmental incentives, are evaluated on the wrong criteria; some, such as the opening of markets, are resisted in favour of short-term domestic gains; and many policies are treated in isolation (innovation or ICT policies, for example). Policy-making has to be kept up to speed with the demands of globally connected economies striving for sustainable growth: the additional dimensions uncovered in this research programme will help policy-makers shape their policies accordingly.

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Programme Structure and Participants

Management and organisational practices

This sub-programme concentrated on understanding and explaining management and organisational practices in firms across Europe, the US and Asia. This was the first attempt to build a comprehensive international dataset on management practices, making it possible to analyse for the first time their contribution to international growth and productivity differences. We collected international management data to address questions such as: How do management and organisational practices vary across Europe, US and Asia? How much do these practices matter for productivity and growth? What determines the spread of these practices across firms?

The researchers were:

- Nicholas Bloom, sub-programme leader (Stanford University/ Centre for Economic Performance [CEP], London School of Economics and Political Science [LSE])
- Raffaella Sadun (LSE/CEP)
- Christos Genakos (University of Cambridge/CEP)
- John Van Reenen (LSE/CEP).

Innovation

Many commentators have argued that while Europe's institutions and firms were well suited to the post-war period of 'imitation', when innovations from the US diffused internationally, Europe is now closer to the technology frontier and must grow through innovation – pushing the frontier out rather than simply adopting and updating US innovations. This sub-programme, in contrast to existing single-country efforts, took an integrated international perspective to address questions such as: Can European firms adapt their practices and structures to become more innovative? How can international technology transfer be accelerated? Are tax-based or grant-based innovation policies more cost effective?

The researchers were:

- Elisabeth Müller, sub-programme leader (Zentrum für Europäische Wirtschaftsforschung [ZEW])

- Georg Licht (ZEW)
- Bettina Peters (ZEW)
- Birgit Aschhoff (ZEW).

Information and communications technologies (ICT)

A large part of the EU-US difference in labour productivity growth can be linked to ICT use. Further, even within Europe, the subsidiaries of US multinationals appear to make more effective use of ICT than either domestic European firms or non-US multinationals. This may be linked to organisational and regulatory factors across Europe. We collected firm-level ICT data for Europe and the US and matched it to firm-level performance – and to the new management and organisational data gathered in the management sub-programme – to rigorously address questions such as: Why are US firms so much better at deploying ICT both domestically and through their European subsidiaries? To what extent do managerial and organisational practices contribute to this? What is the significance of an ageing workforce for firms' adoption of ICT and for firm performance?

The researchers were:

- Tobias Kretschmer, sub-programme leader (Ludwig-Maximilians-Universität [LMU] Munich/CEP)
- Mirko Draca (LSE/CEP)
- Irene Bertsekas (ZEW)
- Ferdinand Mahr (LMU Munich).

Globalisation

The investment decisions of multinational firms are critical for productivity, but our understanding of outsourcing and offshoring is limited. Competition for 'footloose' multinational investment operates within Europe between countries like Poland and the richer EU nations (such as Germany), but it also operates between Europe as a regional bloc and the US, Japan and emerging nations such as India and China. This sub-programme, addressed many questions related to these aspects such as: What are the specific patterns of vertical disintegration and their impact on the productivity of the European and US firms? Will capital mobility and financial openness foster countries' specialisation on more productive industries and/or entrepreneurship?

The researchers were:

- Stephen Redding, sub-programme leader (LSE/CEP)
- Andrew Charlton (CEP)
- Daniel Sturm (LSE/CEP).

Economic growth and environmental consequences

Rather than postulating that 'all growth is good', we recognise the trade-offs involved between basic productivity growth and other dimensions of human well-being. We built up a database on international environmental practices and linked this to detailed firm and environmental outcome data to address questions such as: What is the environmental performance of well-managed firms? How difficult is the trade-off between a firm's financial performance and its environmental 'friendliness'? What are firms' incentives to adopt environmental innovations as a function of regulatory and firm-specific circumstances?

The researchers were:

- Ralf Martin, sub-programme leader (Imperial College, London/CEP)
- Ulrich Oberndorfer (ZEW).

Many of the researchers were involved in more than one sub-programme and, especially towards the end of the project, studies spanned several sub-programme boundaries.

Programme Publications

Acemoglu, D. et al. 'Technology, Information and the Decentralization of the Firm', *Quarterly Journal of Economics*, 122 (4), 1759–1799.

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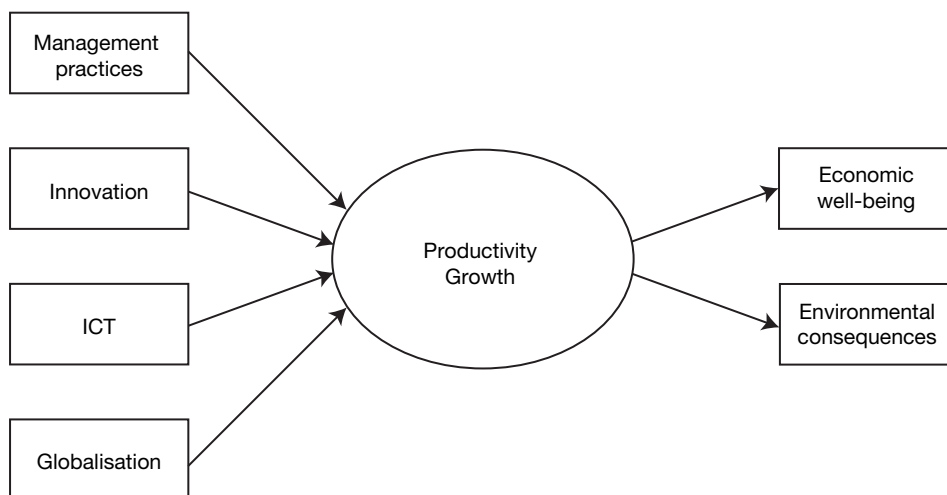
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Methodology

At the centre of our research programme was productivity growth and its consequences for economic well-being. The US productivity miracle had real economic consequences, and economic growth was put at the top of EU policy-makers' agenda. Nevertheless, we believe that looking at the drivers and other consequences was necessary to avoid coming to one-sided and potentially biased conclusions. Our investigation of both the determinants and consequences of productivity growth is intended to help establish whether the US can serve as an unambiguous role model in achieving high economic performance, or if there is only a select set of practices (and if so, which) that European firms can and should strive to emulate.

Figure A.1 illustrates our approach to the programme as a whole and the report that came out of it. The four drivers of productivity growth and the environmental consequences of productivity growth were dealt with in sub-programmes. Note that, although each section of the report focuses on a particular sub-programme, interdependencies and interactions with other drivers or consequences of productivity growth are highlighted in each of the chapters. This is important as we discovered during the course of our research that one of the reasons that earlier attempts to explain productivity growth were unsatisfactory has been that these efforts were compartmentalised or piecemeal. Allowing for interdependencies among different drivers and their consequences and actively seeking them out is especially useful when deriving implications for policy-makers who will be interested in the overall impact of their policies rather than an isolated effect on one partial aspect.

Figure M.1
Structure of the research programme



To answer the questions posed in our research programme, we needed an advanced methodological toolbox and the corresponding data. Specifically, by using the latest large-scale econometric techniques that enabled us to move beyond mere statements of correlation to investigations of causality – that is, what really is a driver of economic performance and what is a contemporaneous phenomenon – we needed a sufficiently large high-quality dataset covering the countries and industries we were interested in studying. As we were interested in the micro-foundations of macro-economic developments, we needed to generate primary data at the firm (or individual) level for many of the questions we were interested in. By tailoring these original sources of data precisely to our research questions and matching the data to an extensive set of additional data on matters such as firm performance (in multiple dimensions), we were eventually able to form a comprehensive picture of the international differences in the drivers and consequences of productivity growth.