Joint OECD-NBER Conference
Paris, 25-26 September 2014

PRODUCTIVITY GROWTH AND INNOVATION IN THE LONG RUN

PROCEEDINGS

NBER
National Bureau of Economic Research

OECD
BETTER POLICIES FOR BETTER LIVES

TABLE OF CONTENTS

**PRODUCTIVITY AND INNOVATION IN THE LONG RUN:
PROCEEDINGS FROM THE OECD-NBER CONFERENCE**

1.   On 25-26 September 2014, leading international academic experts and policy makers from OECD member countries participated in a high-level conference on the future of productivity and innovation at OECD. The conference – which was jointly organised with the National Bureau of Economic Research (NBER) – covered a breadth of approaches in order to better understand the factors that may shape prospects for long run productivity growth. The conference yielded many valuable insights, which will provide immediate benefit to the ongoing WP1-CIIE project on Long Run Productivity, but also takes on broader significance to the extent that it shapes future research on productivity at the OECD and the NAEC agenda.

2.   In her opening remarks, **Catherine Mann (OECD)** highlighted the centrality of research on productivity to the OECD's NAEC agenda and the likely benefits to empirical and theoretical research that would arise from collaboration between the OECD and NBER. Indeed, making the case for research on productivity requires little motivation, given the important contribution of multifactor productivity to explaining cross-country differences in the level and growth rate of per capita incomes. Mann also highlighted recent OECD research on the determinants of resource allocation across firms and the increasingly important contribution of knowledge-based capital to productivity growth. Mann concluded by identifying some potential sources of the productivity slowdown and highlighted a number of interesting questions for future research. The remainder of this note summarises the key messages from each session.

1.   Long-term patterns in global productivity

3.   The first session provided a long-term and cross-country perspective on productivity outcomes. **Francesco Caselli** (LSE) explored the sources of large and persistent cross-country income gaps in the context of a development accounting framework. Caselli demonstrated that the majority of cross-country income gaps reflects differences in the efficiency with which inputs are used – *i.e.* multifactor productivity (MFP) – rather than differences in human (h) and tangible capital (k) accumulation. More specifically, when looking at the contribution of human capital and its components to cross-country productivity differences, Caselli showed – contrary to other existing evidence – that the role of cognitive skills was relatively small. He explained this surprising result in terms of the fact that, unlike most studies, he simultaneously controlled for health and years of schooling, which seemed to explain most of the gap attributable to h. While the decision to use PISA scores for children aged 15 as a proxy for the cognitive skills of the entire population largely reflected the fact that these data were available for a wide set of countries, Caselli admitted that this measure was not ideal and recognised that the new OECD PIAAC data represented an attractive alternative. Finally, Caselli noted that investments in h and k are likely to be endogenous to MFP, implying that low MFP is likely to feedback into low investment in tangible and human capital in developing countries. Hence in a general equilibrium setting, the importance of MFP could be even higher.

4.   **Diego Comin** (Dartmouth) explored the contribution of the adoption and penetration of new technologies to the growth experiences of developed and developing economies, which have diverged significantly since around 1800 (*i.e.* the Great Divergence). Using a dataset containing 25 major technologies (from ring spindles to the internet), Comin showed that the lag between the time it takes for new technologies to be introduced in developed and developing countries has diminished, while cross-country differences in the speed of within-country penetration of the adopted technologies have become increasingly significant over time. While Comin argued that these patterns could explain up to 80% of the Great Divergence, the question of why gaps in the penetration of new technologies increased has remained. To the extent that the most obvious candidate explanations have either not changed (e.g. geography) or

converged (e.g. institutions) over the past 200 years, Comin emphasised the role of technological knowledge – that is, "knowledge about technology and how to use it productively". Put differently, knowledge is accumulated by using new technologies but using new technologies is what facilitates the absorption of technological knowledge. Comin noted that the industrial revolution brought new opportunities, which arrived sooner in some countries than others, and in those economies where the contemporary technologies were exploited marginally more intensively, technological opportunities grew faster. This in turn led to a gradual divergence in penetration rates, despite a convergence in the adoption lag.[1]

2.   Inequality, immigration and productivity

5.   This session discussed how to best harness the existing and potential talent pool to support productivity growth in the long run, with a particular focus on the role of immigration and equality of opportunity. **William Kerr** (Harvard Business School) discussed the impact of migration on productivity, noting that migrants account for about two-thirds of the net increase in the STEM (Science, Technology, Engineering and Mathematics) workforce in the United States since 1995, half of total doctorates, and are disproportionately represented amongst "star" scientists. Migrants also have a higher incidence of patenting and entrepreneurship, but this is mainly explained by their education levels. To measure the overall consequences for US innovation, Kerr presented evidence on the immigrants' impact on non-migrants in terms of wages, employment and innovation. Studies have found mixed evidence with a positive impact when analyzing local areas, and a negative impact, or crowding-out effects, when analyzing student enrollment in particular majors. Kerr also noted that the structure of migration programs matter greatly, particularly with respect to whether it is points-based or employer driven. For example, the H-1B visa program has become increasingly focused on STEM workers – particularly computing – over time due to more intense lobbying activity by firms. Kerr noted that the impact of immigration on inequality can vary across locations and is shaped by the capacity of firms to expand and whether the skills of the non-migrant workforce are complements or substitutes with respect to the migrant labour. From a global point of view, research has found that location matters, as it has an impact on: research productivity, benefits for the immigrants, and economic benefits that flow back to origin countries, particularly with respect to technology diffusion.

6.   **Andrew Leigh** (ex-Australian National University) argued that the lack of intergenerational mobility has the potential to undermine future productivity growth through three main channels: *i*) the misallocation of human capital investments; *ii*) less entrepreneurship from talented but poor individuals through the resulting interaction with capital market imperfections; and *iii*) labour market mismatch arising from intergenerational persistence in occupational choice. Estimates of the intergenerational income elasticity (IGE) for the United States are converging to around 0.5 and most other OECD countries are somewhat more mobile than the US (i.e. IGE<0.5).[2] According to Leigh, intergenerational mobility is driven by four factors: i) inequality: more unequal societies tend to have lower intergenerational mobility; ii) family structures: richer families can provide more educational enrichment, in particular children in richer families get more educational time from their parents despite the fact that they work longer hours; iii) schooling: countries that have higher dispersion in test scores also display higher income inequality, so the gaps observed at school seem to be persistent over time; and iv) the progressivity of social welfare systems: there is significant variation across countries in the ratio of transfers to low versus high income families. While analysis of the impact of policies on intergenerational mobility is constrained by a number

---

1   An alternative explanation put forth by Chad Syverson (Chicago Business School) in the subsequent discussion was that the increased complexity of technologies have led to an increased amount and sophistication of complementary investments.

2   An IGE of 0.5 implies that parents with income 10% above the mean could expect their children to have incomes 5% above the mean.

of factors, a recent natural experiment in Finland estimated that raising the tracking age[3] in school from 10 to 16 years was associated with a reduction in the IGE(i.e.) from 0.3 to 0.23 (Pekkarinen et al., 2006[4]). This increase in intergenerational mobility can be explained by the significant reduction in the heterogeneity in the quality, and to a lesser extent quantity, of primary and secondary education arising out of the reform.

3.   Environmental sustainability and productivity

7.   **Michael Greenstone** (Chicago) noted that the baseline path of rising global temperatures reflects sharp increases in predicted energy consumption and the fact that electricity generation from fossil fuels is relatively inexpensive due to abundant supply and relatively low extraction costs. Reliance on fossil fuels has been reinforced by recent innovations (e.g. in shale gas). Accordingly, limiting the increase in temperatures over coming decades requires fossil fuel prices sufficient to encourage stocks of fossil fuel resources to be left in the ground untouched. To achieve this all important emitting countries would need to participate in climate change mitigation, particularly China. Greenstone noted that the productivity consequences of climate change needs to be understood in the context of a situation where market factors are currently driving societies to choose fossil fuels. At the same time, evidence from China and India documenting a strong adverse effect of high temperature days on agricultural yields, real wages and life expectancy highlight the potential costs to long run productivity from not acting to curb fossil fuel emissions. The health consequences of pollutants which are produced jointly with greenhouse gases (particularly particulate matter) were also underscored. In this regard, Greenstone identified three main issues for policymakers: *i)* low rates of payment for electricity which restrict energy supplies; *ii)* large and poorly targeted (i.e. regressive) energy subsidies; and *iii)* lack of internalization of externality costs in energy consumption, implying that the private cost advantages delivered by fossil fuels should be weighted against the social costs associated with environmental damage.

8.   **Federick van der Ploeg** (Oxford) argued for a third way with respect to climate policy which combined two existing policy tools. First, a massive upfront subsidy for green innovation designed to overcome sunk costs and trigger favourable learning by doing effects (Acemoglu et al. 2012[5]) that eventually gets phased out. Second, a gradually increasing carbon tax along the lines suggested by Nordhaus and in the Stern Review. A policy focusing on generous and increasing green subsidies may have the unintended consequence of encouraging fossil fuel companies to exploit their reserves more quickly than would otherwise be the case in an effort to capture rents before they are priced out of the market. Van der Ploeg also drew attention to the potentially catastrophic but fundamentally uncertain consequences of climate change in the long-run. He concluded by arguing that a narrative which framed the issue in terms of a climate catastrophe at high temperatures, as opposed to smaller damages at lower temperatures, was easier for politicians to grasp.

4.   Long-run productivity: the state of the debate

9.   This session featured two prominent economists that have taken polar positions in the debate on the future of productivity growth. **Robert Gordon** (Northwestern) argued that the recent productivity slowdown is a permanent phenomenon and that the types of innovations that took place in the first half of the 20th century (e.g. electrification, internal combustion, etc.) are far more significant that anything that has taken place since then (e.g. ICT), or indeed, is likely to transpire in the future. Gordon also identified a number of head-winds that could act as a significant drag on economic growth in the United States in the

---

3   This is the age at which students select (or are selected for) either academic track or a vocational track.

4   Pekkarinen, T., R. Uusitalo and S. Pekkala (2006), "Education Policy and Intergenerational Income Mobility: Evidence from the Finnish Comprehensive School Reform", IZA Discussion Paper, No. 2204.

5   Acemoglu, D et al (2012), "The Environment and Directed Technical Change", American Economic Review, 102(1): 131–166

period ahead. These include: demography, education, inequality, globalization, energy/environment, and the overhang of consumer and government debt. Gordon conducted a provocative exercise in subtraction, and concluded that even if innovation was to proceed at the pace of the last 20 years, economic growth in the United States could slow from a long term average of 2% to around 0.2%, with two-thirds of the slowdown reflecting headwinds and the remaining one-third reflecting slowing innovation that occurred 40 years ago.[6]

10.   **Joel Mokyr** (Northwestern) argued that if the patterns of the past hold, there is good reason to expect the rate of technological change to accelerate over coming decades. Indeed, in contrast to the techno-pessimist view that all of the low-hanging fruits of invention have been picked, Mokyr noted that economic history shows no evidence of diminishing returns with respect to technological progress. In fact, science and technology's main function in history is to make taller and taller ladders to get to the higher-hanging fruits (and to plant new and possibly improved trees). With respect to future developments, Mokyr emphasised three key factors that have loomed large in the past: *i*) artificial revelation (i.e. technological progress provides the tools that facilitate scientific advances, which then feedback into new technologies in a virtuous cycle); *ii*) access costs; and *iii*) a good institutional set-up for intellectual innovation. For instance, Mokyr argued that advances in computing power and information and communication technologies have the potential to fuel future productivity growth by making advances in basic science more likely (i.e. via artificial revelation) and reducing access costs, but warned of the potential for bad institutions and policies to interfere. In this regard, Mokyr identified a number of key risks: *i*) outright resistance by entrenched interests or well-meaning ideologies suspicious of innovation which could lead to excess regulation and lack of entrepreneurial finance; *ii*) a poor institutional set up of research funding which favours incremental as opposed to radical innovation; *iii*) new forms of crime and insecurity (e.g. cyber insecurity).

5.   Organisational change and other firm-level factors

11.   This session examined factors driving productivity internal to the firm, with a particular focus on organisational change and ICT. **Catherine Mann** (OECD) explored the links between the intensity of investment in ICT and productivity and employment in the United States, showing that the productivity slowdown over the 2000s was characterised by a pattern of convergence whereby the leading sectors came back to the pack in terms of the contribution of ICT to labour productivity growth, while some laggard sectors improved somewhat. Mann also noted that net job growth in ICT intensive sectors is more pro-cyclical than in other sectors, possibly reflecting tighter employment management to business cycle demand in those sectors.

12.   **Nick Bloom** (Stanford) focused on the links between managerial quality and firm productivity, using data from the World Management Survey that measure core managerial practices in the areas of monitoring, targets and incentives (based on interviews with middle management from a randomly drawn sample of firms). A number of key messages emerged:

- Cross-country differences in managerial practice are significant, with the left tail of poorly managed firms much longer in many countries than in the United States, where heightened competitive pressure makes it difficult for poorly managed firms to survive.

- Managerial quality is higher in manufacturing than in the health care and education, which are less exposed to competitive pressures.

---

6   See also Gordon, RJ. (2012) "Is U.S. Economic Growth Over? Faltering Innovation and the Six Head-Winds," NBER Working Paper 18315.

- While standard regression analysis can only indicate a positive correlation (and not causation) between management scores and firm performance indicators (e.g. productivity, R&D and patenting), evidence from randomised control experiments from Indian textiles suggest a causal impact of management on productivity.

- Differences in managerial quality can account for (on average) one-quarter of MFP gaps between the United States and other countries.

- Bloom identified four proximate drivers of managerial quality: *i*) ownership structure (managerial quality is highest in MNEs and lowest in family managed firms); *ii*) competition; *iii*) education; and *iv*) regulations affecting product and labour markets.

13.   **Luis Garicano** (LSE) argued that the poor productivity performance of Spain and Italy, reflected slow ICT adoption which was partly due to a distorted firm size distribution – i.e. too many small firms owing to size contingent regulations – coupled with inadequate management practices. Using a case study of the New York Police Department's use of ICT to combat crime, Garicano stressed the important complementarities between ICT and management: the adoption of ICT only boosts productivity when organisations change to exploit the flexibility of the new technology. Furthermore, the required organizational change is non-trivial and often occurs in subtle and unexpected ways. For example, information technology (IT) decentralizes and empowers more junior workers because it reduces the costs of acquiring information, while communication technology (CT) centralizes decision making because it reduces the costs of communication, and thus making delegation unnecessary.

6.   Agglomeration and network issues

14.   **William Kerr** (Harvard Business School) discussed clusters of entrepreneurship and innovation and showed that long-run city (employment) growth is stronger in cities where the initial share of start-up firms in local employment is higher. The most convincing evidence on the link between city growth and innovation has been found for disruptive innovation and high growth entrepreneurship linked to venture capital (VC) financing, as opposed to innovation and entrepreneurship more broadly. A key trait of this special kind of innovation and entrepreneurship is active (trial and error) experimentation, because the success of such firms is impossible to predict *a priori*, even amongst the savviest VC investors. This highlights the dangers for governments using activist industrial policies to "pick winners", and the importance of well-designed framework policies that can reduce the costs of experimentation on the entry (regulations affecting product and financial markets) and exit (EPL and bankruptcy law) margins. Kerr also identified three main rationales for policy intervention to nurture entrepreneurial clusters: *i*) real externalities over firms and with respect to the local tax base; *ii*) fighting spatially concentrated poverty; and *iii*) credit market imperfections that limit start-ups. While governments have a number of policy tools at their disposal, Kerr warned that successful clusters had a number of unique characteristics (e.g. skills, age) which may prove difficult to replicate and that policy interventions should not stifle the dynamics that characterise high growth entrepreneurship.

15.   **Giles Duranton** (Pennsylvania – Wharton) discussed the two-way link between cities and growth. In his summary of the literature, Duranton noted that we know: *i*) quite a bit about what causes cities' population growth; *ii*) less about the relationship between urbanization and growth; and *iii*) close to nothing about the causal impact of cities on economic growth. Duranton cited amenities, transport infrastructure, and human capital as the main known drivers of city population growth across highly urbanised OECD countries. By contrast, while it is clear that modern economic growth is largely taking place in cities, the evidence on whether cities drive growth is less convincing. Cities can mildly foster the accumulation of physical capital, but they can have a relatively large effect on human capital accumulation. The latter reflects a virtuous cycle whereby agglomeration economies in cities make human capital more productive, which in turn fosters human capital accumulation and as human capital in cities become more

productive, this makes cities grow in population (and human capital). At the same time, innovative activity (e.g. R&D labs, patenting activity) tends to be geographically concentrated and we observe proportionately more innovations in larger and denser cities. However, it is unclear how much less innovation there would be in a world without cities. Duranton identified some important urban policy dilemmas: i) tension between the durability of urban structures and the flexibility required for innovation; ii) tension between the need to keep cities balanced and manageable and accommodating the diversity that underpins urban dynamism; and iii) tension between local policies that want to anchor specific economic activities and national efficiency that requires the most productive activities to expand irrespective of their location.

7. Technical progress, diffusion and resource reallocation

16. The final session explored the contribution of resource reallocation and technical progress to aggregate productivity growth. **Chad Syverson** (Chicago Business School) used a case study of the Japanese cotton spinning industry around the turn of the twentieth century to highlight the important contribution of resource reallocation – via mergers and acquisitions activity – to aggregate productivity growth. Interestingly, it was not a case of more productive firms acquiring less productive firms but acquisitions were instead characterized as "higher profitability buys lower profitability". More specifically, prior to acquisition the target plants had newer and better capital but this capital was being used sub-optimally, which meant that they were less profitable. Indeed, Syverson argued that leading firms were set apart by better demand management and superior use of productive capital rather than market power and higher prices, and after acquisition the new management raised both the productivity and profitability of the acquired plants.

17. **Ufuk Akcigit** (Pennsylvania) explored the impact of industrial policy on firm dynamics, reallocation and aggregate productivity growth. A number of key messages emerged:

- Policies which may appear attractive in partial equilibrium might have totally different general equilibrium impacts due to: *i)* aggregate price effects; *ii)* competition effects; and *iii)* composition and reallocation effects. For example, R&D tax subsidies are only truly effective when policy-makers can also encourage the exit of "low-type" incumbent firms, in order to free-up R&D resources; otherwise the subsidy will be fully capitalised into the R&D wage rate, without a concomitant rise in innovation output and aggregate productivity.

- Developing economies tend to be less productive than developed economies due to less efficient resource reallocation and lower post-entry growth potential. This partly reflects contractual frictions and lack of trust: for instance, in many developing and emerging countries (e.g. India), owners of firms are unwilling to delegate managerial responsibility outside their family due to fear of expropriation. Lack of delegation is estimated to account for around 50% of the gap in factor reallocation between the United States and India.

- The efficient reallocation of ideas via sales of patents in the secondary market can have non-trivial impacts on aggregate productivity growth, raising important issues for policies (e.g. treatment of Intellectual Property Rights or bankruptcy).

- In order to continue to provide useful and robust policy guidance in this area of research, additional micro-data is essential, and this is where the OECD can provide a significant contribution.

18. The Secretariat has made available the presentations and background papers of all presentations on the conference website at http://www.oecd.org/economy/productivity-growth-and-innovation-in-the-long-run.htm. In addition, webcasts of the conference are also available at the same web address. Finally, an abridged version of this summary will be included in the NBER bulletin, circulated to the NBER mailing lists and published on the NBER website www.nber.org.