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ZEW policy brief

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Falling Productivity Growth, Widening Productivity Gaps

Germany, in common with other industrial nations, has in recent years witnessed a decline in productivity growth despite sustained economic growth, falling unemployment and strong technological dynamics. A workshop held in Berlin at the beginning of 2018 examined this phenomenon.

KEY FINDINGS //

- The decline in productivity growth is not a measurement problem. However, the difficulty in measuring productivity has increased as digitalisation has spread and dynamic innovation activities have shifted into the services sector.
- In many sectors of the economy, the gap between highly productive and less productive firms is now widening more sharply than at the start of the millennium. More and more firms are no longer able to keep pace with the productivity growth achieved by leading firms. At the same time, there are differences between individual sectors when observing the development of intra-industry productivity divergences.
- The levels of innovation spending by large firms on the one hand and by small and medium-sized enterprises (SMEs) on the other have been diverging for years.
- As digitalisation has spread, many firms – especially SMEs – are facing considerable problems in adopting new technology. Both the public and private sectors in Germany are laggards compared with other countries when it comes to investing in these technologies.
- The number of business start-ups has been falling for years. This slowing entrepreneurial activity is both a symptom and a cause of the fact that financial and human resources are tied up for too long in established firms with low (productivity) growth.
- Economic and innovation policies are facing three major challenges: stimulating the adaptation of new technologies by investing in research and development (R&D) to foster firm innovation; promoting digitalisation; and improving the digital infrastructure. Tax incentives for R&D, indirect specific programmes to stimulate the diffusion of digital innovations, and adjustments to the regulation of markets for goods, services and factors of production would be sensible options to address these challenges.

INTRODUCTION

Many Western industrialised countries have for years now been witnessing falling growth rates in their productivity. The exact beginning, evolution and magnitude of this decline vary from country to country. However, this slowdown in productivity growth has been clearly visible in virtually all Western countries since at least the time of the financial and economic crisis. The reasons for this decline have been the subject of intensive debate around the world (Andrews et al. 2015, 2016; Bloom et al. 2017). Even Germany's productivity growth is falling despite its strong economic performance and its strong technological dynamics in the wake of digitalisation, which should yield higher productivity. However, attempts to address this phenomenon in terms of economic and innovation policies are still at the initial stages. This ZEW policy brief places productivity growth trends within an international context, discusses various possible explanations and illustrates these by providing data for Germany.

„Productivity isn't everything, but in the long run it is almost everything"
Krugman (1997, p. 11)

The productivity of a country's economy over time is one of the key factors determining its economic growth and prosperity. Productivity growth is a precondition for rising incomes and improving living standards and is determined by a number of factors. These include investment in capital equipment, the diffusion of innovations, new strategies for the (international) division of labour, and the entry and growth of highly productive firms that displace less productive ones.

This ZEW policy brief starts by presenting the latest empirical findings on the growth of macroeconomic productivity and analysing parallels between the relevant trends in Germany and other countries. It then focuses on approaches that are often used to explain this phenomenon at an international level. Here it looks closely at the extent to which these approaches can help to explain the trends observed in Germany. It concludes by outlining a few potential policy options in the fields of research and technology.

THE DECLINE IN PRODUCTIVITY GROWTH

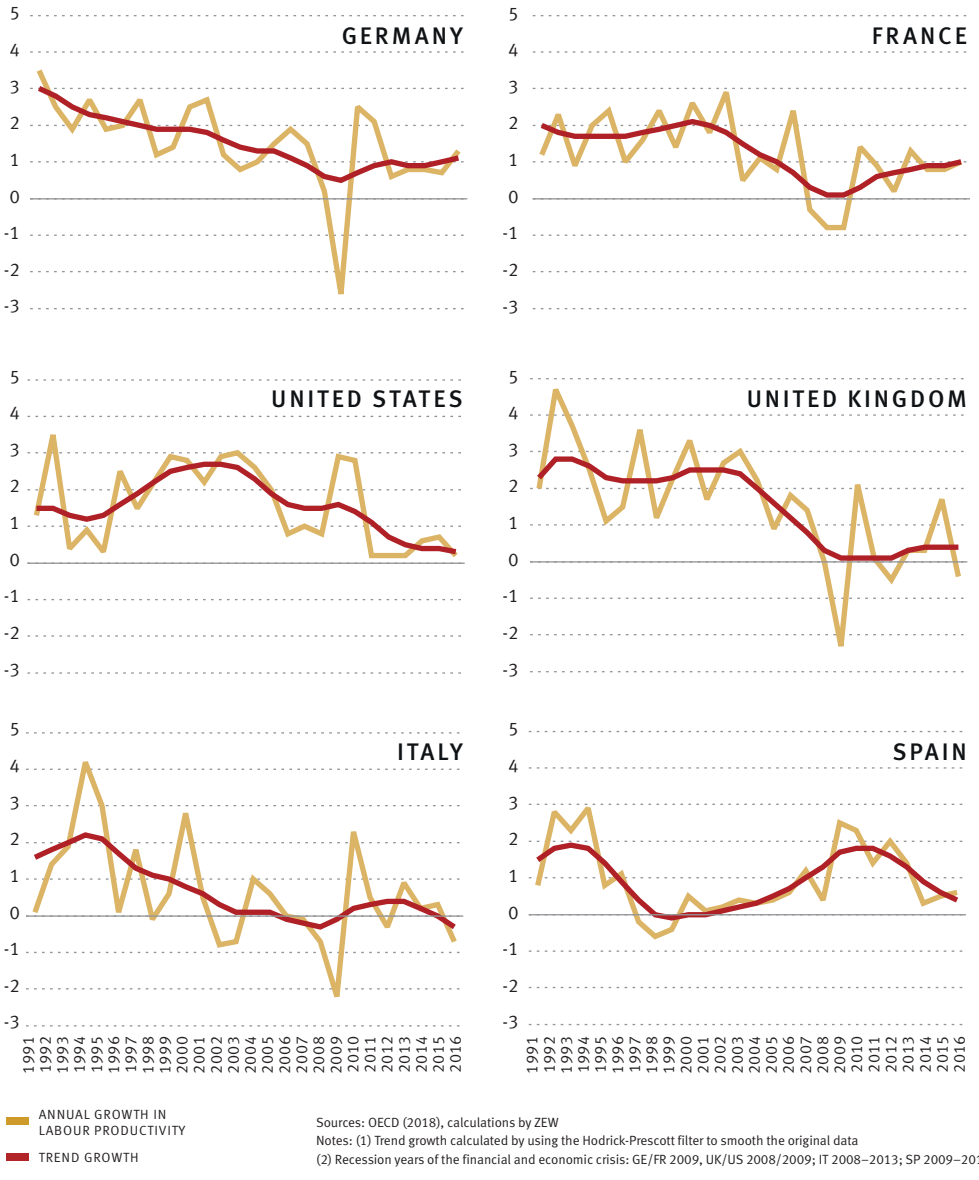
Jones (2017, p. 313) describes the slowdown in productivity growth as "perhaps the most remarkable fact about economic growth in recent decades [...] that occurred around the year 2000. This slowdown is global in nature, featuring in many countries throughout the world." Data from the Organisation for Economic Co-operation and Development (OECD) on the levels of macroeconomic productivity over time illustrates the slowdown in productivity growth. Figure 1 outlines the levels of growth in labour productivity in six selected countries based on individual annual figures and their trend growth. If we look at the relevant trends since the year 2000, we can clearly see a slowdown in productivity growth in all countries except for Spain. The financial and economic crisis had a severe short-term impact on productivity growth. Whereas Germany and France managed to raise their productivity growth marginally following the crisis, the relevant growth rates in the United States, the United Kingdom and, to an even greater extent, Italy settled at a low level close to zero. Productivity growth today is much lower than it was in the first half of the 2000s and well below where it was in the 1990s. The crisis had a long-term effect on productivity growth in Spain and Italy, of which the consequences are still visible in the present day. The trends shown for Italy and Spain underline the enormous challenges which these countries will face over the next few years.

The measurement of productivity growth – in this case the change in inflation-adjusted gross value added divided by labour input – is subject to various error sources. For example, it is not always sufficiently possible to separate output price rises into an inflation component and a quality component. Also, it is often not possible to accurately capture the inputs into a production process, such as the hours worked. Ademmer et al. (2017) argue that the underestimation of quality

improvements within the context of using new information and communication technologies has caused growth in labour productivity to be undervalued. They conclude, however, that the discussed measurement problems resulting from free digital services (see Ahmad et al. 2017; Byrne et al. 2016; Syverson 2017) – such as search engines and social media – do not significantly distort measurement because, among other things, they account for only a modest share of gross domestic product (GDP). Despite the existence of measurement errors, the observed decline in labour productivity growth is therefore not merely a statistical phenomenon. Consequently, the following chapter discusses the real-economy factors causing the slowdown in productivity growth.

POSSIBLE EXPLANATIONS FOR THE SLOWDOWN IN PRODUCTIVITY GROWTH

FIGURE 1:GROWTH RATES FOR REAL LABOUR PRODUCTIVITY 1991–2016 (PER CENT)



Sources: OECD (2018), calculations by ZEW
Notes: (1) Trend growth calculated by using the Hodrick-Prescott filter to smooth the original data
(2) Recession years of the financial and economic crisis: GE/FR 2009, UK/US 2008/2009; IT 2008–2013; SP 2009–2013

Low investment in tangible and intangible assets

Investment gap in spending on capital equipment

Based on the latest statistics, Ademmer et al. (2017) have identified a gap in German firms' spending on capital equipment as a possible reason for their weak productivity growth. They show that new jobs created by firms – especially since the wage restraint imposed in Germany in the mid-2000s – have less capital equipment, which has caused labour productivity to fall. In addition, the authors and the German Council of Economic Experts (2015) find that German firms – compared with those in other countries – invest less in advanced information and communication technologies (ICT). This, they argue, means that there is less stimulation of productivity growth by digitalisation. The authors suggest two potential reasons for the lower amount of investment in digitalisation technologies: first, the relatively strong regulation of Germany's markets for goods and labour, which reduces the pressure to compete and innovate; and, second, the large number of small and medium-sized enterprises (SMEs), which are potentially less able than large firms to make effective use of new digital technologies owing to the high implementation costs involved.

Productivity effects of digitalisation

Innovations in ICT caused the prices of ICT hardware to fall in the 1990s and early 2000s. Adjustments to the methodology used to calculate price indices for ICT goods enabled the effects of this price decline to be fairly adequately captured in productivity statistics. These prices have no longer been falling since about 2008. Nowadays, innovations in ICT take place primarily in the services sector. This poses a challenge to our ability to adequately capture the potential of new digital technologies (such as the Internet of Things, Industry 4.0).

Insufficient complementary investment to exploit the productivity potential of digitalisation

Brynjolfsson and McAfee (2014) argue that the actual digital revolution has yet to happen and that productivity growth will not start to accelerate until this revolution takes place. They point to necessary complementary investment in new business processes and human capital as well as the opportunities for new business models. A related analogy is the era of the electrification of industry at the end of the 19th century when productivity effects did not fully materialise up until four decades later once industrial manufacturing processes had been redesigned (see David 1990). Back in those days, too, the productivity potential was initially underestimated, and the slow diffusion of the new electrical system simultaneously brought about delayed productivity gains in manufacturing. Hence, technological paradigm shifts require a certain amount of time for their potential to be recognised and technological innovations to become widely established, so that productivity gains can subsequently be achieved.

In Germany there are adoption problems with exploiting the opportunities of digitalisation, too. In this respect Weber (2018) sees room for improvement in manufacturing (e.g. mechanical engineering, chemicals, automobiles) and a number of service sectors such as transport, logistics, and healthcare. Across various industries the potential to cut costs and tap new customer groups and markets through product innovation too often remains unutilised. Looking at the mechanical engineering sector, Gernandt (2018) identifies further obstacles such as the inability to charge higher prices for quality improvements, given a still fairly low willingness to pay for the added benefit of digital modules as well as difficulties in implementing Industry 4.0 technologies. The issue at the heart of this argument is therefore once again that the productivity-enhancing effects of digitalisation will not materialise for another few years.

Digitalisation also raises the question of whether it is becoming increasingly difficult to identify productivity growth on the basis of typically used indicators. Varian (2017) illustrates this point by giving the example of smartphones. Only cameras, film and photo development are included in the photography price index, even though the vast majority of the 1.6*1018 photos now created each year are taken, stored, and distributed using smartphones. The same applies to pocket calculators, GPS and so on. This technological value added is not adequately reflected in price

indices and so does not show up in the latest productivity statistics either (see Schmalensee 2018).

Technological potential exhausted

Declining research productivity only evident in individual sectors

A further key hypothesis used to explain the fall in productivity growth is a decline in research productivity. This hypothesis is based on the assumption that technological potential has increasingly been exhausted. Consequently, more and more time and effort are needed to devise new ideas and to turn them into innovative products, processes and business models. A few prominent publications such as those by Bloom et al. (2017) and Gordon (2012) provide evidence of a decline in research productivity. Malerba and Orsenigo (2015) point to the differences between individual sectors. Their investigation of the pharmaceutical industry highlights the fact that although the number of newly approved drugs has remained almost constant since the early 1980s, R&D spending has risen by a factor of 30 over the same period. We can therefore say that in this case there has been a fall in research productivity. On the other hand, Mohnen (2018) argues, based on a comprehensive study of the pertinent literature, that there is no evidence of any systematic decline in the rate of return on research and development (R&D) at the country level since the 1960s (see Peters et al. 2018). Consequently, there is no compelling evidence of an across-the-board decrease in research productivity as an explanation for the declining growth in multi-factor and labour productivity.

Increasing productivity gaps between firms

Growing divergence in innovation spending between large firms and SMEs

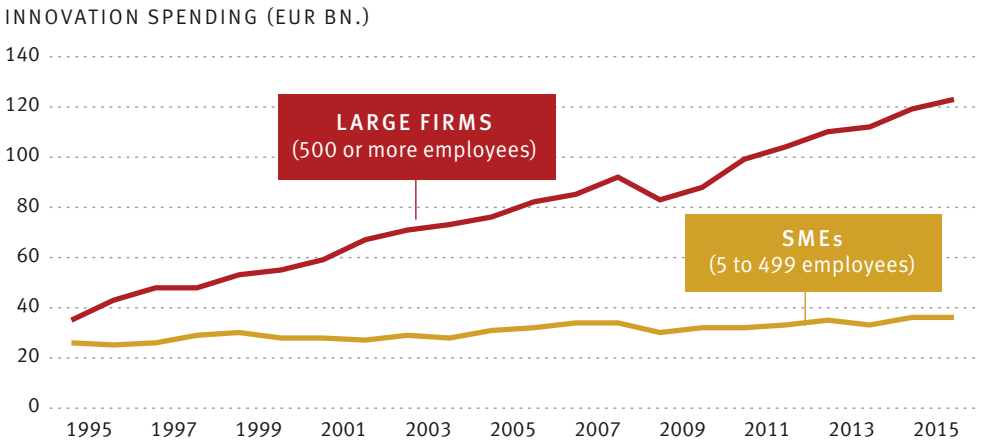
Although most countries report positive growth rates in R&D spending, over time this is increasingly being driven by large firms. Germany also exhibits a significant widening of the gap in innovation spending between SMEs and large firms since 1995 (Figure 2). The findings of Rammer et al. (2018) also imply that, overall, growing numbers of SMEs in Germany are withdrawing from innovation activities, whereas a small number of successful SMEs ('hidden champions') are stepping up their innovation activities. Consequently, the divergence in productivity levels within the SME segment itself is increasing. Possible reasons for this trend are the relatively low returns on innovation activities combined with the significant cost of expanding and permanently maintaining innovation capacities of SMEs.

Widening productivity gaps are illustrated by data from other countries as well. The persistence of firms belonging either to the group of productivity leaders or to the group of productivity laggards has also increased over time (see Andrews et al. 2015, 2016). It will furthermore become increasingly difficult for laggards to catch up with the most productive firms. This trend is said to have two potential causes. First, the growing complexity of new technologies means that the diffusion of innovations from leaders to laggards is declining or, at least, slowing down because only the most productive firms can make efficient use of such complex technologies within a short time frame. And, second, the economies of scale and scope offered by new digital technologies are providing productivity leaders with a monopoly-like market position that is hampering the laggards' development.

Growing productivity differentials in most industries

However, the differentials between productivity leaders and productivity laggards are not increasing to the same extent in all sectors. Although evaluations across all sectors reveal that there are generally growing divergences in German labour productivity as well, Figure 3 shows that this trend differs considerably in selected sectors. It presents five sectors of the R&D-intensive manufacturing industry in which Germany is a traditional leader. Whereas these intra-industry differentials are widening in the chemical, electrical engineering and mechanical engineering sectors, they remain largely constant in the automotive sector. Productivity gaps are narrowing in the optics, measurement and control technology, and medical equipment sectors. The reasons for this divergence in

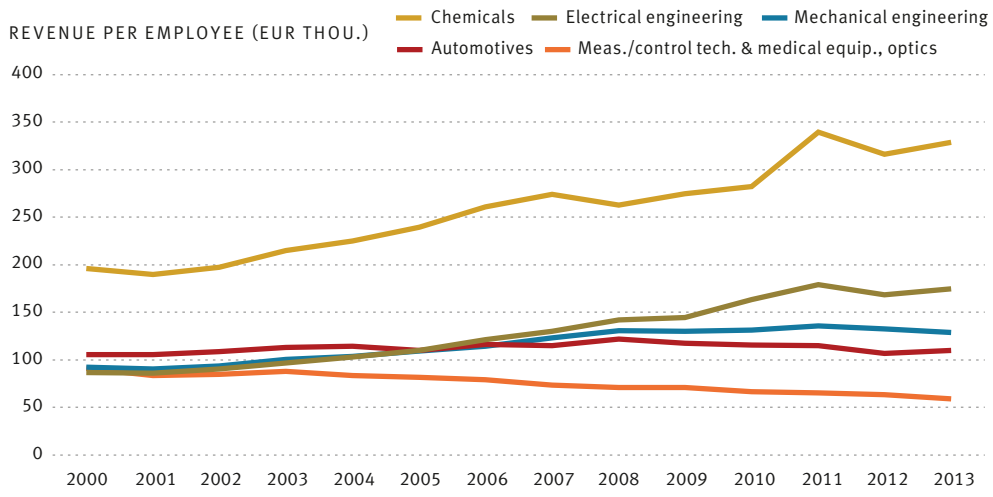
FIGURE 2: INNOVATION SPENDING OVER TIME



Source: Mannheim Innovation Panel (MIP), calculations by ZEW

productivity within individual industries are still largely unknown. One explanation, however, is significant differences in the intra-industry diffusion of innovative products, processes and business models. In the chemical industry, for example, there are ordinarily strong firm-specific economies of scale and scope that make it more difficult to transfer innovations to other firms in the industry. By contrast, it is easier for firms in the measurement and control technology and medical equipment sectors to benefit from their competitors' innovations.

FIGURE 3: CHANGES IN INTRA-INDUSTRY PRODUCTIVITY DIFFERENTIALS BETWEEN HIGHLY PRODUCTIVE AND LESS PRODUCTIVE FIRMS



Note: Changes in the differential between the 75% and 25% percentiles of the revenue-per-employee ratio in selected R&D-intensive sectors.
Explanation: In the chemical industry the productivity differential between the 75% and 25% percentiles of the revenue-per-employee ratio rose from EUR 200,000 to roughly EUR 350,000 per employee between 2000 and 2013.

Productivity growth and the economic crisis

The development of productivity growth in Italy and Spain over time (Figure 1) illustrates the negative impact of the financial and economic crisis on productivity growth. Productivity has hardly grown in either country in recent years. Gopinath et al. (2017) and Andrews et al. (2015, 2016) provide evidence to show that the productivity growth of the most productive and less productive firms in southern European countries has increasingly diverged since the economic crisis. This trend was intensified by the expansionary monetary policies pursued during the post-crisis years, because loans were provided even to firms with below-average productivity which, without this injection of fresh funds, would have gone out of business. Gropp et al. (2018) demonstrate that less restrictive banking regulation during times of crisis makes it easier for firms to survive a crisis. Although this enabled job losses to be avoided, it led to lower productivity growth in the wake of the crisis. The crisis also saw funding provided to unprofitable firms – also known as 'zombie' firms – at the expense of efficient firms (McGowan et al., 2017; Marin, 2018). While zombie firms can survive on modest profit margins, highly productive firms cannot achieve their full potential and new businesses are hampered in their development and expansion because urgently needed resources are tied up in zombie firms. In the medium term this has an adverse impact on productivity growth because resources are consumed by old, stagnating firms instead of being used more productively by young businesses, which would help boost productivity growth. Low productivity growth is therefore the 'price' paid for the fact that the cleansing effect of the crisis did not materialise. Schivardi et al. (2017) have analysed Italian banks' lending during the financial crisis. Their findings demonstrate that the effects of the misallocation of credit on aggregate productivity growth only become evident in the medium term and only occur when a large proportion of zombie firms impact on economic growth.

Cleansing effect of the crisis did not materialise

An additional factor is that the economic crisis affected firms' productivity growth to varying degrees. For example, firms that had invested more heavily in information and communication technologies proved to be more resilient to crises. Bertschek et al. (2017) have analysed the innovativeness of firms before and during the financial and economic crisis based on a sample of seven industries from twelve European countries. ICT-intensive firms in particular managed during the crisis to implement process innovations and, consequently, to achieve higher productivity growth and greater resilience to crises. These positive effects of ICT investment were especially evident in service sectors.

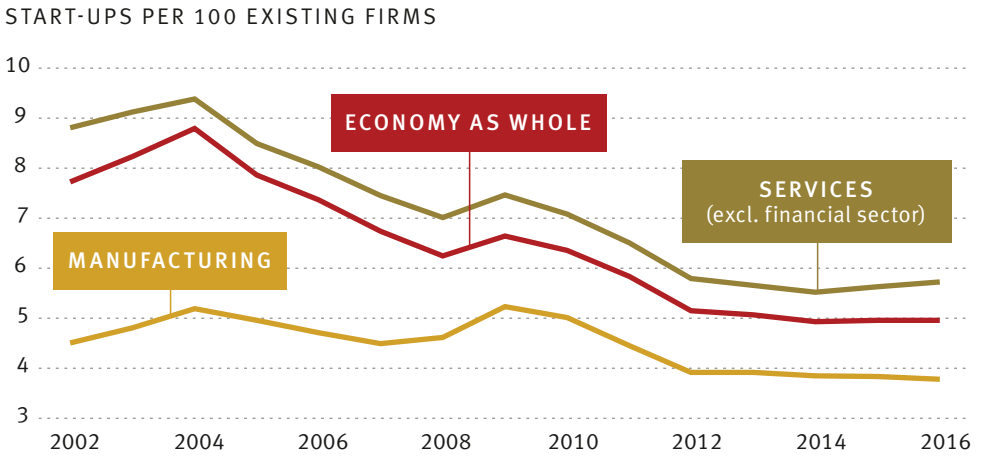
Insufficient dynamism in the corporate landscape

Decline in the number of business start-ups

Vibrant economies reallocate resources from unproductive firms to productive ones through market entries and exits. This reallocation stimulates productivity growth both directly through the economic activity of the new businesses and indirectly through their competitive effect on the productivity growth of established firms. Foster et al. (2018) argue that innovation spurts are accompanied by increasing start-up activity and widening productivity differentials and that only as a consequence of this does rising productivity growth occur. They back up their arguments with data from the US dotcom boom. By contrast, the process of dynamic selection in the corporate sector of Western industrial nations has been weakening for years now (Decker et al., 2016).

Germany too has been witnessing a declining number of business start-ups for years now. In 2016, for example, Germany saw 30 per cent fewer high-tech firms and 43 per cent fewer ICT firms being set up than in 2003. Figure 4 shows the changes in the numbers of business start-ups as a proportion of existing firms. Whereas eight new enterprises per 100 existing firms were set up in 2002, this figure had fallen to only five start-ups by 2016. In manufacturing this figure is now down to only four new firms. The competitive pressure of business start-ups has therefore declined significantly in Germany as well.

FIGURE 4: NUMBER OF BUSINESS START-UPS
AS A PROPORTION OF EXISTING FIRMS

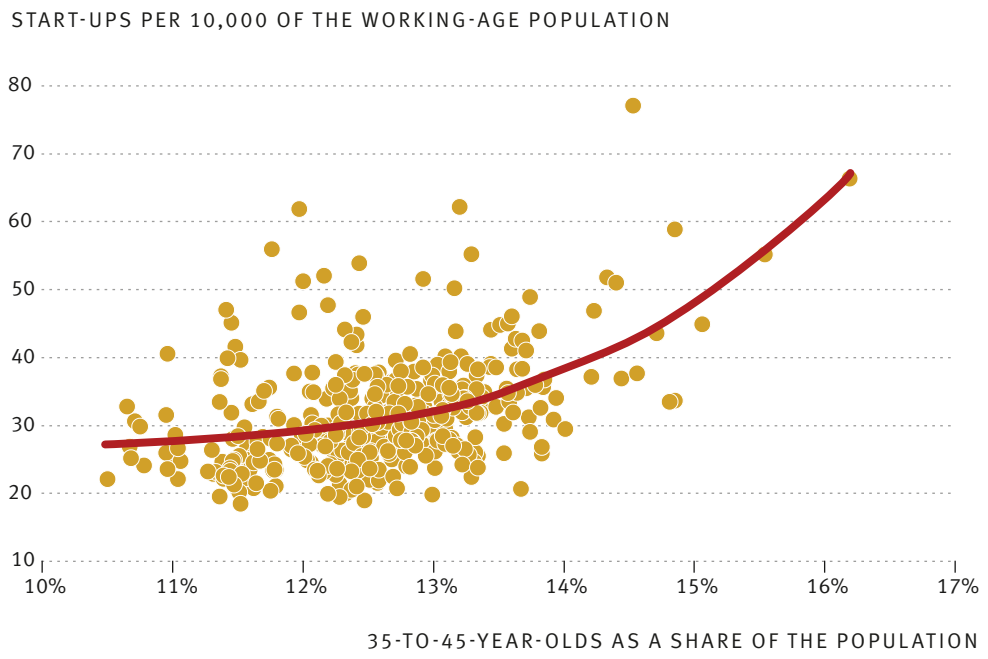


Sources: Mannheim Enterprise Panel (MUP), calculations by ZEW

Demography is reflected in falling numbers of start-ups

One possible explanation for the falling numbers of business start-ups are the demographic trends in many industrial nations. Karahan et al. (2016), for example, attribute the declining start-up rates in the US to the slowing growth in the working-age population. There is evidence that the same applies to Germany. The age group of 35-to-45-year-olds, which has the highest start-up rate in Germany, has been contracting for years. And the age group of 45-to-55-year-olds, which is the cohort with the second-highest start-up propensity, has also been shrinking for some years now. As these groups become smaller, then – assuming that individuals' start-up propensity remains unchanged and the institutional framework remains the same – the absolute number of business start-ups will fall. At the same time, the opportunity cost of setting up a business is rising in the age cohorts with the highest start-up rates. Figure 5 shows the relationship between start-up activity and the age structure of the population. It demonstrates that regions with a higher proportion of their population in the cohort with the highest start-up rate – i.e. the 35-to-45-year-olds – also have a comparatively higher level of start-up activity. In addition, Alon et al. (2017) indicate that the productivity effects of the falling number of start-ups are not solely attributable to the consequent weakening of the selection effect. A declining proportion of young firms as a share of the total firm population also reduces the direct effect of fast-growing, productive young firms on aggregate productivity growth. Given the empirical evidence available, it is therefore not unreasonable to conclude that demographic trends – in terms of both the human and firm populations – are one factor that explains the slowdown in productivity growth.

FIGURE 5: START-UP ACTIVITY AND AGE STRUCTURE AS A CROSS-SECTION OF URBAN AND RURAL DISTRICTS IN GERMANY, 2010–2015



Each dot represents an urban or rural district.

Sources: Mannheim Enterprise Panel (MUP), INKAR online, calculations by ZEW

POTENTIAL POLICY OPTIONS FOR STIMULATING PRODUCTIVITY

The global long-term decline in productivity growth, which further intensified around the turn of the millennium, stands in stark contrast to the current debate on the huge technological potential of digitalisation. Reducing this productivity potential to technological developments, however, would be an over-simplification of this phenomenon. This ZEW policy brief therefore provides a very succinct insight into the multifaceted web of productivity drivers. Closer inspection of these factors makes it clear that policies on research, technology and innovation need to be proactive in the face of the current trend of declining productivity growth. Here are a few potential policy options:

Review the regulatory density

- Integrating the technological potential of digitalisation into new products, processes and business models and ensuring their rapid diffusion provides opportunities to reverse the adverse productivity growth trend of recent years. Although high levels of investment in the expansion of network infrastructure is a necessary precondition for exploiting these opportunities, this on its own is nowhere near enough. It is equally important to constantly review and, where necessary, adjust the rules governing markets for goods, services and factors of production. As it is impossible to know in advance what kind of regulatory framework will yield the best results, experimental clauses should be adjusted so that instruments such as living labs and pilot schemes can be used to enable ex-ante evaluations of reform (options) to be conducted.

Use indirect specific programmes to stimulate the diffusion of digitalisation

- The diffusion of new forms of digitalisation requires firms to invest large amounts in equipment, expertise and skills. The situation today is similar to the integration of information technology and automation into manufacturing processes in the 1980s. Diffusion-based support programmes were often used back in those days. In the current situation we should build on this experience when launching new programmes.

R&D tax incentives for SMEs

- Given that many firms are withdrawing from innovation activities, the widely demanded introduction of tax incentives for R&D activities could provide a key stimulus in attempts to persuade small and medium-sized enterprises to continue to invest strategically in innovation.

Venture capital for fast-growing young firms

- The various causes and effects of the low number of business start-ups are a complex issue. Instead of tying up resources (such as financial and human capital) in fairly unproductive firms in order to protect jobs in the short term, these resources should be channelled into new, potentially more productive firms. An expansion of venture capital financing for growing firms as well as further measures to promote the scalability of new business models could support this redistribution process. In order to revitalise business start-up activity effectively, however, it is not sufficient to improve the financing facilities available. Given that the number of start-ups has been declining for years, existing approaches to promote new businesses should be reconsidered and new approaches should be devised.

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NOTE ON THIS ZEW POLICY BRIEF //

A workshop entitled 'The Productivity Paradox from the Perspective of Innovation Economics – Symptoms, Causes and Potential Cures' was held at the Allianz Forum in Berlin on 29 and 30 January 2018. This ZEW policy brief summarises selected findings from the workshop and supplements the lectures and discussions held at this event by placing them in the context of the wider international academic debate.

The workshop was jointly devised and organised by the boards of academic advisers to the R&D survey and the innovation survey, the research statistics arm of Stifterverband, and ZEW. The organisers of this conference were Uwe Cantner (Friedrich Schiller University Jena), Alexander Gerybadze (University of Hohenheim), Georg Licht (ZEW) and Gero Stenke (Stifterverband). The event received financial support from Germany's Federal Ministry of Education and Research.

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