The Impact of Population Ageing on Innovation and Productivity Growth in Europe

(Report for Tender VT/2004/454)

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Executive summary

When we try to answer the question **what an ageing workforce will mean for the future European productivity growth**, we have to start with the question about what productivity is. In this report we follow the common convention and use **value added based labour productivity**, the single most frequently computed productivity statistic. Applying growth accounting methods, one can show that the growth rate of labour productivity depends on capital deepening and the growth rate of total factor productivity, the latter often being referred to as a "measure of ignorance". In this report we argue that productivity is a **system attribute** rather than a property in the individual inputs. In particular, since capital and labour are value-weighted aggregates of a great number of fundamentally different humans, objects and services, combined in a great number of ways, there is no unique specification how workforce ageing will influence productivity. Our main argument is that individual productivity cannot be separated from its **social context**. Productivity growth is closely related to investment in research and development that underlies technological growth. Since the **composition of human capital** will determine the growth potential of technology (in particular innovation versus imitation) we discuss the educational composition in the past and its development in the future together with past and future projections of the age composition of the workforce as central explanatory factors of productivity growth.

Reviewing trends in EU aggregate productivity growth over the period 1979-2001 indicates that the EU productivity growth fell behind US growth rates in the second half of the 1990s and at the same time within-EU disparities of productivity growth increased. Productivity growth was highest in **ICT producing** manufacturing and service industries. Productivity growth was lower in both sectors of **ICT using** industries (i.e. the manufacturing and service sector) while **non-ICT sectors** clearly evidenced a downward trend in labour productivity. Since the latter group accounts for about two thirds of economy-wide value added in most countries of the EU, the gains in the former two groups (ICT producing and ICT using) were more than offset by declines in non-ICT industries. Various hypotheses are put forward to explain why the EU has gained less than the US in terms of ICT productivity and why the non-ICT part of the economy has performed much worse as compared to the US. These include regulations in product, labour, and financial markets, lacking efficiency of knowledge production, low capital deepening, low growth rates of total factor productivity, a declining supply of labour, demographics, etc. The focus of our report is to revisit in particular the latter hypothesis (the role of demographics) by performing a study on the relation between productivity and the age and educational composition of the workforce at the plant (Sweden)

and firm level (Austria). The **main original contribution of our study is therefore a micro-meso analysis at the firm/plant level** of the relation between productivity and the age and educational composition of the workforce in Sweden and Austria.

We are aware that the micro-meso link through which population ageing will affect productivity is only one among a set of various channels how labour force ageing will affect the economy wide productivity development. At the **macro level**, the link between population ageing and key driving factors of productivity such as technology, research and development, the efficiency of economic systems, etc. constitute important though not fully explored research areas. It is the feedback between the micro and macro level interrelationships and general equilibrium effects that will ultimately determine how population ageing shapes future economic productivity. By offering an in-depth study of the micro-meso level relation of population ageing and economic productivity, our report contributes a step towards such a multi-level analysis in the study of productivity and population ageing.

Since the Lisbon target not only relates to productivity growth but also aims to raise employment rates and to improve labour market performance, our report also summarises **trends in labour force structure** in the past and discusses future projections of productivity growth as they will depend on alternative projections of the labour force. Our study on five OECD countries (France, UK, Germany, Spain and US) clearly indicates that decreases/increases in the crude labour force rate (the total labour force divided by the population of working age) for males/females between 1985 and 2000 were dominated by changes in age-specific labour force participation rates (as opposed to changes in the age distribution of the total population). For males we have shown that mainly changes in labour force participation rates at younger and older ages explain the change in the crude labour force rate. For females, increases in the labour force participation rates at ages between 25 and 55 years account for most of the overall change in the crude labour force rate. Though our study only refers to past changes in labour market indicators and cannot assess the future impact of population ageing on the labour market, our results indicate that there is scope for dampening the effects of labour force ageing and labour force shrinkage through policy interventions aimed at changing labour force participation rates. Of course, **for countries where labour force participation rates for women and men are already high the margin for such behavioural changes is smaller than for countries still faced with low female and male participation rates**. As a recent study by the Commission of Europe shows however, the Lisbon target of an overall employment rate of 70%, a female employment rate of 60% and an employment rate for older people of 50% by 2010 will be hard to fulfil for all countries although some have already achieved one or more of the goals. Regarding the EU-15 as a whole, the largest potential to raise overall employment lies within those countries with lower employment rates and/or larger working age population. Low employment rates in the new member states strengthen the challenge towards the Lisbon target while their larger growth potential may facilitate these aims.

While a static comparative analysis implies that employment and productivity growth are negatively related (arguing that less productive and less skilled people are integrated in the workforce) the long-run effect of boosting employment is argued to be positive, not least from a fiscal perspective since it broadens the tax base.

Before presenting plant and firm level analysis of the age and educational composition on productivity we survey **theoretical and empirical evidence** at the macro and micro level that has discussed the relation between demographic structure and economic productivity. While the relation between age and individual productivity is less clear-cut, there has been recent evidence of a significant relation between changes in the adult population and aggregate productivity at the **macro level**. Based on recent empirical findings which have shown that input accumulation cannot explain the majority of cross-country differences in output per

worker and hence total factor productivity (TFP) must account for the differences, various studies have tested whether demographics do exert an influence on TFP. Empirical evidence based on pooled cross-country data over the period 1960-1990 indicates that **workers aged 40-49 have a large positive effect on productivity** (as measured by the Solow residual). A study based on Japanese industries, however, indicates that the positive effect of educated workers older than 40 on technological progress turned from positive in the 1980s to negative in the 1990s. **The higher rate of technological change and capital-biased technological change during the 1990s may have shifted the productivity peak towards younger ages**.

Understanding the age productivity profile at the individual and firm level (i.e. **micro level**) is central to understand retirement incentives at the individual and firm level. Strategies of encouraging older workers to remain longer in the workforce need to be evaluated in tandem with the productivity profile of older workers. It is well known that workers of different ages may have different levels of productivity (as well as capacities of learning), although the exact shape is still highly disputed and strongly dependent on the occupation, technological progress and possible cohort effects that work through schooling levels. Studies that estimate the influence of age on individual productivity are based on different indices, including supervisors' evaluations, piece-rate studies, analyses of **employer-employee datasets**, age-earnings profiles and entrepreneurial activity. Most piece-rate studies, measuring the quantity and quality of the workers' output, and analyses of employer-employee datasets, where companies' productivity is measured, suggest that productivity follows an **inverted U-shaped profile** where significant decreases are found after the age of 50. A problem with most estimates of how productivity varies by age is that older individuals who remain in the workforce are positively selected and have a higher productivity than those leaving the workforce, which might bias the estimates. Although supervisors' evaluations on average show little or no relationship between the assessment score and the age of the employee, subjective opinions may be biased, where for example the management's opinions of older employees may be inflated due to loyalty reasons. Since the relation between individual performance and wages is often distorted, age-earnings profiles cannot replicate the age-productivity profiles. Most commonly the latter profiles peak earlier than the former ones.
An important **cause of age-related productivity declines** is likely to be age-specific reductions in **cognitive abilities**. Some abilities, such as perceptual speed, show relatively large decrements already from a young age, while others, like verbal abilities, exhibit only small changes throughout the working life. **Experience** in a firm or plant boosts productivity up to a point beyond which, however, additional tenure has little effect. Older individuals learn at a slower pace and have reductions in their memory and reasoning abilities. In particular, senior workers are likely to have difficulties in adjusting to new ways of working.

Earlier studies tend to neglect the causes of age-related job performance differences and the impact of **changing labour market demands**, when measuring age differences in productivity. In the present report we estimate the productivity potential by weighing age-specific ability levels against the labour market demand for these abilities. Evidence from both employment shifts between industries and changes caused by relative wage levels of unskilled and skilled employees suggests that there has been an increase in the demand for cognitive abilities over a long period of time. Physical strength and bodily co-ordination have lost much of their importance, while analytic, numerical and interpersonal abilities are increasingly in demand. Basing the estimates on the causes of productivity differences allows an assessment of the impact of structural changes in the labour market. The **age-productivity profile** is found to vary over time, in accordance with changing labour market needs. Assuming a reasonably strong effect of experience, we estimate that **productivity peaks for the 35-44 year old age group**. If the demand for experience falls, the productivity peak shifts towards younger ages. Conversely, if the minimum ability requirement should drop over time,

age differences in productivity would decrease. The estimations of the productivity profile reflect that job performance on average tends to decrease in the second half of the working life, given almost any calibration of the model. The only exception to this would be if an individual's productivity gains from experience continue for several decades and if this effect more than outweighed the functional decreases with respect to other job-related factors. Given available empirical evidence on how additional work experience affects productivity, this may seem unlikely. Hence, these findings support the theory of delayed payment contracts, where the relatively high wages of older workers create loyalty to the firm and represent a compensation for high productivity earlier in the career.

Continuous increases in life expectancy have raised the concern that the number of years one should spend in the labour market in order to maintain old-age social security need to increase both from an individual as well as social point of view. Understanding how health develops over the life cycle is crucial to understanding individuals' work potential at older ages. **Health effects of age** represent a particularly important issue if frail health makes it difficult to work or if employment represents a health hazard for older individuals. As one grows older, blood circulation deteriorates, maximum oxygen uptake decreases, muscle strength and endurance are lowered, and bone mass decreases (particularly among women), hearing and eyesight decline with age and individuals are more likely to fall sick. Older individuals' work capacity can therefore in many occupations be lower, although adjusted working environments, technical aids and ergonomic equipment can improve the situation. Moreover, physical exercise, less smoking and alcohol and a healthier lifestyle with better nutrition would improve the working capacity of older individuals, and presumably this also holds true for younger individuals.

As these various studies on age-productivity differentials show, productivity is a system attribute and cannot be understood in isolation of its social context. However, the hump-shaped pattern of age-productivity differentials seems to be ubiquitous across various studies. To investigate **the relation between age and productivity**, taking into account firm-level-specific factors, we refer to **two matched employer-employee data sets** (a longitudinal one in Sweden and a recently generated cross-sectional one in Austria).

Summing up the micro evidence from **Swedish mining and manufacturing**, we find a hump shape in the age effects on productivity with some indications that the **peak of the hump may lie around the ages 30-49**. We are, however, unable to achieve any final resolution to estimation problems like the specification of functional form, simultaneity between explanatory variables and productivity, and the thorny issue of identifying cohort effects distinguished from age effects. Our results are therefore primarily exploratory ones and subject to revision as research on these issues develop. It is especially puzzling that we have great difficulties in distinguishing any stable and substantial effects from the increasing shares of employees with tertiary education. Our attempt at estimating education-specific age effects do indicate that secondary education is more important than tertiary education for productivity in mining and manufacturing.

Nevertheless **education** quite clearly has substantial effects on productivity and for the purpose of this report indicates that even if an ageing workforce were to become less productive this can very likely be compensated in the long run, 15-40 years into the future, by increasing the education level of the future workforce. The result that productivity is enhanced by large groups of 50-59 year old persons on the **local labour market** level, as well as the weak relation between productivity spread and wage cost spread, are strong indications that labour market mechanisms and flows play an essential role in the determination of productivity at more aggregated levels in the economy. The group of the 50-59 year olds is, according to previous research, also associated with higher unemployment and creation of

fewer vacancies. Our understanding of the dynamics here is still very weak, but differences between the matching of jobs to individual abilities for the young and the old seems crucial for achieving these results. Thus another tentative conclusion with respect to the purpose of the report is that well-functioning **labour markets** may be just as crucial as education for maintaining productivity especially with an ageing workforce. More research is, however, needed at the meso-levels (both regionally, over detailed industries and quite possibly also in the interactions of firms of different sizes) of the economy in order to define what is meant by well-functioning labour markets in this respect. Results on **worker and job flows** for manufacturing establishments with 50 or more employees between 1986/87 to 1995/96 show that many more jobs were created and destroyed than needed to match the net change in employment. This indicates that considerable economic resources are spent on the **matching process**, and our tentative conclusion is that this would provide an explanation for the phenomenon of "jobless growth". When the labour force is young there is a high degree of matching going on inducing a very **fluid labour market** with high rates of job and worker reallocation which stimulates employment growth. However, this high rate of reallocation is costly and tends to dampen the value added growth per employee. Hence **an older workforce is more efficiently matched** to the available jobs stimulating productivity growth but making employment growth sluggish.

To understand the restructuring process more closely which took place in the manufacturing industry during the period from 1986 to 1996 we considered how job and worker flows are distributed among workers in different ages and with different educational levels. We found a **sharp decline in employment for those with lowest education while net employment on average rose for those with a university degree**. Similarly, job creation rates for those with higher education were more than twice as high as for those with only a pre-upper secondary educational level. Job and worker flows by age groups indicate that employment among the oldest workers fell rather dramatically during the whole period and almost no jobs were created for oldest workers. Although a direct comparison to American data is marred by definition problems, the available evidence indicates that levels of reallocation of jobs are similar to the Swedish data we analysed, while worker reallocation is likely to be higher in the American economy. There are at least two possible interpretations of this. One is the conventional Eurosclerosis hypothesis that regulations and insider power makes European labour market less flexible. However, the local labour market age effects on productivity and the similarity of reallocation levels suggest another possibility. The Swedish labour market may be more efficient than the American in allocating youngsters to their most productive employment. High churning rates may be good for productivity if they lead to better matches, but there is also the possibility that the benefit of this is offset by excessive adjustment costs. While this remains only an interesting conjecture within the scope of this study it seems a most worthwhile focus of future research.

The cross-sectional firm level analysis for **Austrian mining and manufacturing** enterprises showed—just like for Sweden—that productivity dispersion is much wider than wage dispersion and it is almost impossible to see any relation between firm productivity and wage level. Regression of value added per worker on age and gender shares indicates a hump-shaped pattern for the age variable, i.e. firms in which the share of younger or older workers is higher; have a lower productivity compared to firms where the share of the middle age group is higher. By adding firm-specific factors like the size and age of the firm, etc. we still find a hump-shaped pattern of the age profile. Peak productivity is still found in the 30-49 year old age group. However, once we include the occupational structure and the part-time share of workers in firms as additional control variables, the hump-shaped pattern of age on productivity is dampened suggesting that age effects may be working through these variables since they are clearly correlated. Splitting the sample into two sub samples of **small** (less than

50 employees) versus **large firms** (50 or more employees) yields different conclusions than found for Sweden. For small-sized firms the results on the age pattern and other covariates are similar as for the whole sample. By contrast, age variables become all but insignificant in the sample containing only large firms. This means that no clear pattern of age can be observed in large firms. From these results it seems that in Austria the theory that larger-sized firms are more flexible to adjust the age structure of workers is not valid to the same degree as in Sweden. The results could rather indicate that large-sized firms can afford a workers council which protects employees' rights and worker flows are consequently more restricted. Another reason could be that large-sized firms, because of their market power, are not that much forced to minimise costs by optimising the age structure of their staff compared to small-sized firms. To test whether age structure effects are different between industries who belong to different categories of **ICT industries**, we perform separate regressions for the manufacturing sector distinguishing between ICT producing, ICT using and the rest of industries. We find no age pattern on productivity for ICT producing industries, a weak age pattern for ICT using industries and a hump-shaped age profile for all remaining industries. These results lend support to the hypothesis that other factors of production (e.g., ICT capital) are more important than the age structure of employees for ICT producing firms.

Based on our analysis of plant data for the Swedish manufacturing (which showed that both age structure and educational structure of the workforce have statistically significant effects on the productivity), we conduct a **prospective analysis** on workforce change and productivity in the last part of the report. The analysis is carried out in two steps. First, the model is calibrated on an out-of-sample data set of 14 EU countries. Then, for the 2005-2040 period, the model is combined with population projections, educational assumptions and assumptions of activity rates in order to produce scenarios for the EU-25 economies. It is important to note the limitations of this exercise. The projections do not account for any behavioural policy responses to the age effects, nor do they account for other factors affecting productivity growth such as technological change. The projections therefore must be interpreted as an assessment of how productivity would develop in the absence of any other changes than the projected population, labour force and education changes that are assumed. Our analysis does include, however, the important feedback of labour force participation rates and educational attainment for the long-run economic development. Put differently, an increase in educational level may compensate a decline in productivity more likely the longer people work and therefore the longer returns of education will last.

Our conclusion from the first calibration step is that the model we have developed using plant-level data on the relation between labour force structure and productivity can be used to reproduce movements in GDP at the aggregate level that are caused by variations in age structure and education levels. This provides us with a mechanism whereby assumptions about future changes in the structure of the active labour force can be transformed into different scenarios for GDP, GDP per worker, and GDP per capita scenarios. Our projection results indicate that the average prospects for **productivity growth** are not bad for the next 15 years. After 2025, though, there is a potential risk for stagnation if current participation rates and current education enrolment rates remain constant. Rising enrolment rates alone are not enough to secure long-run growth in GDP per capita since the high growth rate of the non-working age population dominates. Only by increasing labour force participation rates can negative effects on productivity growth of the ageing workforce be avoided. On average our **results** indicate that between 2005 and 2025 projected growth rates of labour productivity may rise from slightly below one per cent to over two per cent by raising participation rates to the best-practice level. To maintain growth after that requires raising education rates also to the best-practice levels. The effect will be even stronger on per capita income growth since also the number of employed in relation to the total population will increase in addition to

rising productivity levels. Depending on current participation rates and educational attainment rates, and on differences in age structure, the national trends will differ. For instance, in **Sweden** the increase in educational levels will help to increase GDP per capita during the next years but this may not be enough for continued increase. Labour force participation rates are already high in Sweden and the growth potential that operates through increased labour force participation is therefore more difficult to achieve for Sweden. Note, however, that according to the model the negative trend in Sweden is not due to an ageing workforce but to the rejuvenation that will take place as the baby boomers from the 1940s retire. On the other extreme, **Austria** has a very high educational level but labour force participation rates of older workers are among the lowest in the EU. The growth potential with respect to labour market reforms aimed at increasing the participation rates is therefore high for Austria. For **Italy**, both policies (increasing educational levels and labour force participation) are timely and would help to increase GDP per capita over the next decades.

While many questions are still unanswered this study points out some clear directions for future policy in this area. **First**, it confirms the common belief that **raised education levels** are important for maintaining growth in ageing economies, but it also indicates that for reasonable levels of education to be attained the delay in productivity effects is quite substantial, as in most cases appreciable effects do not occur until twenty years after such efforts have been initiated. In many countries **labour force participation rates** are historically low and could be raised which would offer a much faster road to increased productivity growth.

Second, the study shows that productivity growth is a more complex phenomenon than just adding up the individual capacity of the available labour supply. Individual productivity age profiles vary with the technological context and content of the work. Industrial restructuring and reallocation of labour within the current social context is quite likely to be quantitatively much more important than the age composition of labour per se. Matching properties of the labour market that depends to a very high degree on idiosyncrasies of national labour market institutions most likely are important in order to explain differences between the Swedish and Austrian results. The Swedish results indicating positive ageing effects at the local labour market level also indicate that such properties may be directly crucial for the explanation of "jobless growth" and, combined with macro evidence, indicate that ageing may enhance productivity growth at the national level in spite of individual productivity peaking at middle age.

While there are many questions left to resolve by future research these results indicate that **heterogeneity within the EU** is pervasive with respect to what measures different member states need to take in order to ensure future productivity growth. **In this perspective the achievement of common targets along the Lisbon agenda will clearly depend on the implementation of nationally specific policies that are tailored to the specific institutional and demographic circumstances of the individual countries**.

In summary, however, the **results** of this study indicate that the problem of an ageing workforce may have been somewhat exaggerated. **The effects of ageing per se are not particularly strong and can be ameliorated by largely rather modest changes in labour force participation and raised education levels.** For some countries this may be more difficult than for others, especially when policy at the same time must deal with the fiscal problems associated with rising dependency burdens. A sober assessment from this study is, however, that the latter problem is likely to overshadow the problem of an ageing workforce. Thus the **problem of how to organise increasing redistribution within an ageing population seems more pressing than how to deal with an ageing workforce**, even though success in the latter aspect will make the former problem easier to deal with.

If, as this study indicates, reallocation of jobs and workers across industries, firms, plants and places are crucial to the productivity performance of the population in ageing economies, then serious issues are raised with respect to current EU policies for social, industrial and regional protection. Alleviating the problems caused by declining industries or regions by subsidies preventing such reallocation may then carry a very high cost for the future sustainability of European welfare. Lock-in mechanisms in the labour market designed for social security today may undermine the social security of the future. From our results we can only raise this issue and not prescribe how to avoid it. Due to a lack of data on previous labour flows, the workings of these reallocation mechanisms are still uncharted research territory, where knowledge is scarce and opinions are many.

Comparative research in this area is still underdeveloped but attracting more and more attention. Our study demonstrates that a better understanding of the matching processes at the labour market is crucial for the formulation of sustainable industrial and labour market policies.