Summary for non-specialists
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ICT, Reallocation and Productivity

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Despite the current economic worries, medium- to long-run growth prospects for the EU are quite favorable. Owing to the potential boost to productivity from the adoption of currently available knowledge based technologies and the continuing development of information and communication technologies, a growth rate of 2.5 percent per year on average for the next 20-30 years appears attainable. The main question is how the EU policy environment can help to increase the probability that such a high productivity growth scenario will materialize. In the paper, we argue that this growth scenario depends on an economic environment with the proper incentives for entrepreneurs and incumbent firms to commit resources to R&D and other knowledge-based capital investments. Further, the environment must be accommodative to the processes of resource reallocation required for diffusion of new technology throughout the economy. Finally, the characteristics of current and prospective technology, with high fixed costs of creation and low marginal costs of use, may cause increases in income fluctuations and further skewing in income distribution. These outcomes could require renewed policy attention.

The paper starts with a critique of recent productivity and output growth forecasts. Fernald (2012) and Gordon (2012) provide projections of total factor productivity (TFP) growth and potential GDP growth for the USA that lie well below those experienced in the period 1995-2007 and below our optimistic case. Fernald is concerned with medium-term potential GDP growth, and does not provide much argumentation for why he assumes that the exogenous future TFP growth will lie between the rates seen for the periods 1973-1995 and 1995-2007. Gordon builds an interesting narrative about the three industrial revolutions seen in the past 150 years. His main points are that the productivity implications of the most recent revolution, ICT, do not compare in depth and breadth with the earlier revolutions, and that the main impact of ICT already is behind us. His view of exogenous future TFP growth already is quite low, and he lowers his forecast further owing to six growth-reducing 'headwinds' in order to arrive at long-run growth of consumption per capita of 1/4 percent per year. We dismiss many of these headwinds on theoretical grounds, but we concur that some indeed are cautions about policy that will be needed to allow for growth, for example policy in the areas of education, inequality, and energy.

Our forecast for future productivity growth starts with Moore's Law, the rule of thumb stating that the number of components on an integrated circuit can double every 18 months to 2 years. Economically, this results in the price of ICT capital goods relative to other goods being halved every 5 to 7 years. Brynjolfsson and McAfee (2011) foresee an acceleration in TFP as the contribution of ICT rises through the high growth rates of ICT capital that are leveraged by the increasingly large economic importance of installed ICT and related intangible capital. We provide some empirical evidence that the contribution of knowledge based capital to output growth indeed may be growing. To generate our optimistic forecast, we make a guess about the hours spent at present tasks that could be substituted away in the next generation, say 25 years, using technology currently in the pipeline. We consider the impact of just three technologies: driverless cars, universal multi-jointed robots, and data-driven expert systems. We think that in the future, current output can

be produced in half the time using these technologies, resulting in labor productivity growth of 2.5 percent per year. Achieving output growth, however, will require massive reallocation of workers.

The paper reviews empirical evidence related to reallocation, namely indicators of the output, employment and productivity developments derived at the firm level. The indicators are collected by a Eurostat project that makes use of a network of researchers and statisticians at 15 national statistical offices. While the paper provides a wealth interesting patterns that have not been published before, some main findings stand out. Finland and Sweden have the highest measures of efficiency of resource allocation (the covariance between productivity and size) and the highest measures of output market reallocation. Also these countries stand out in moving employment away from firms with low productivity towards firms with high productivity. Other notable findings are that in the UK a relatively large share of workers are employed in low productivity firms and that in France and Germany, the pace of reallocating workers from low to high productivity firms is rather slow. A novel finding, that is pertinent in understanding which policies can help boost adoption of ICTs, is the fact that ICT use at the firm level is associated with higher dispersion of output and productivity growth and that higher ICT intensity at the industry level also is correlated with a higher productivity dispersion.

Increases in measures of churn or higher contributions of reallocation to productivity may not in and of themselves be indicative of a proper policy stance. Using a firm-level perspective of ICT, reallocation and productivity, the paper discusses theoretical and empirical research that uncovers the drivers of knowledge-based capital investments, including intangibles. The models reviewed show how incentives for investment in innovative activities and knowledge-based capital interact with frictions and the policy environment. Using these models, it may become possible to evaluate particular policies. Indeed, recent empirical exercises using cross-country firm-level data have found links between various policy indicators and measures of reallocation. Related work provides some early evidence on the causal path from the policy environment and resource reallocation to incentives for investment in intangible assets.

Given the nature of ICT, and the changes it brings to the production technology of firms and to the interaction of firms in markets, the paper presents arguments for appropriate policy. First, policy suggestions are provided that would improve incentives to adopt ICT and increase productivity for innovative firms, technology adopters, and less productive firms. Next, a discussion is provided for problems on the labor market, related to reallocation, but also to incentives for schooling and considerations of wage inequality and possibilities that rewards may no longer be tightly related to effort. Finally, the paper argues that policy related to adoption incentives in public services, such as health care and education, may not only increase aggregate productivity directly, but may aid in providing new areas in which to absorb displaced workers.

This paper opens up the discussion of how economies can become ready to embrace the technological changes that are available to increase productivity and welfare in the coming decades. The paper further has presented puzzle pieces needed for researchers to complete the picture of how to evaluate the efficacy of labor and product market policies. These pieces include cross-country indicators derived from firm-level data as well as theoretical advances in heterogeneous agent models. Future research will be needed to put these together, starting with simple empirical methodologies, but going on with more recently developed methods of taking the models to the data.