Box 4.3

THE EFFECTS OF DEMOGRAPHIC AND TECHNOLOGICAL CHANGES ON LONG-TERM GROWTH

The demographic changes which will accelerate population ageing are going to happen along with a new wave of technological progress arising from developments in robotics and artificial intelligence. Questions arise in this scenario about the relationship between demographics and technology and its consequences for long-term economic growth.

An assumption which should be considered is that, as a result of technological progress, productivity gains will offset the reduction in the working-age population so that per capita GDP growth will rise as the population ages. Acemoglu and Restrepo (2017)[1] find evidence of a positive association between per capita income growth and the ratio of the population over 50 to the population between 20 and 49 in a broad sample of countries (including less developed countries) during the last 25 years. However, Aksoy *et al.* (2019),[2] who analyse a panel of OECD countries, reach the opposite conclusion (see Chart 1). They attribute the negative impact of demographic change on economic growth to the fact that the effectiveness of technological innovation is affected as the young working-age population decreases.

To analyse the mechanisms possibly relating demographics, innovation and economic growth in the long term, Basso and Jimeno (2019)[3] use an overlapping generation model with two stages in the life cycle (working life and retirement). In this model the technological innovation sector has two components: the production of new products/tasks and the automation of these tasks through the introduction of robots which replace human labour in the production of certain goods and services, whose relative weight is determined on the basis of their individual rates of return on investment.

The model has three characteristics which make the analysis especially important: i) a demographic structure which determines the labour supply and saving rate of the economy and, therefore, the available resources for capital accumulation, the production of new ideas and the robotisation of production; ii) a production function where certain tasks are performed exclusively through the combination of capital and robots (without human labour); and iii) a relationship of subsidiarity between technological innovation (whose efficiency decreases as the population ages) and robotisation. Accordingly, in the long term the productivity gains from the robotisation of production can only continue insofar as new products are created, i.e. it is assumed that before a production task can be performed by robots, it has to be invented and performed by humans.

Chart 2 shows the results of feeding into the model the demographic projections of the United States and Europe (understood as the aggregation of Germany, Italy, France and Spain), relative to the projected paths of per capita GDP growth and other macroeconomic variables.[4] First, it is interesting to highlight that, since population ageing will occur more quickly in Europe than in the United States, the results of the simulations predict that robotisation will grow more rapidly in Europe. Consequently, the decreases of the weight of labour in production and of the share of wages in GDP are estimated to be higher in Europe than in the United States. In any event, in this simulation, in which the technological innovation sector does not experience any efficiency improvement and it is assumed that the economy converges on a path where the weights of the labour-intensive and robot-intensive production sectors remain constant, long-term economic growth would be affected in both areas due to the ageing effect. In short, the potential productivity gain from automation would not be sufficient, based on these simulations, to offset the lower economic growth associated with demographic decline.

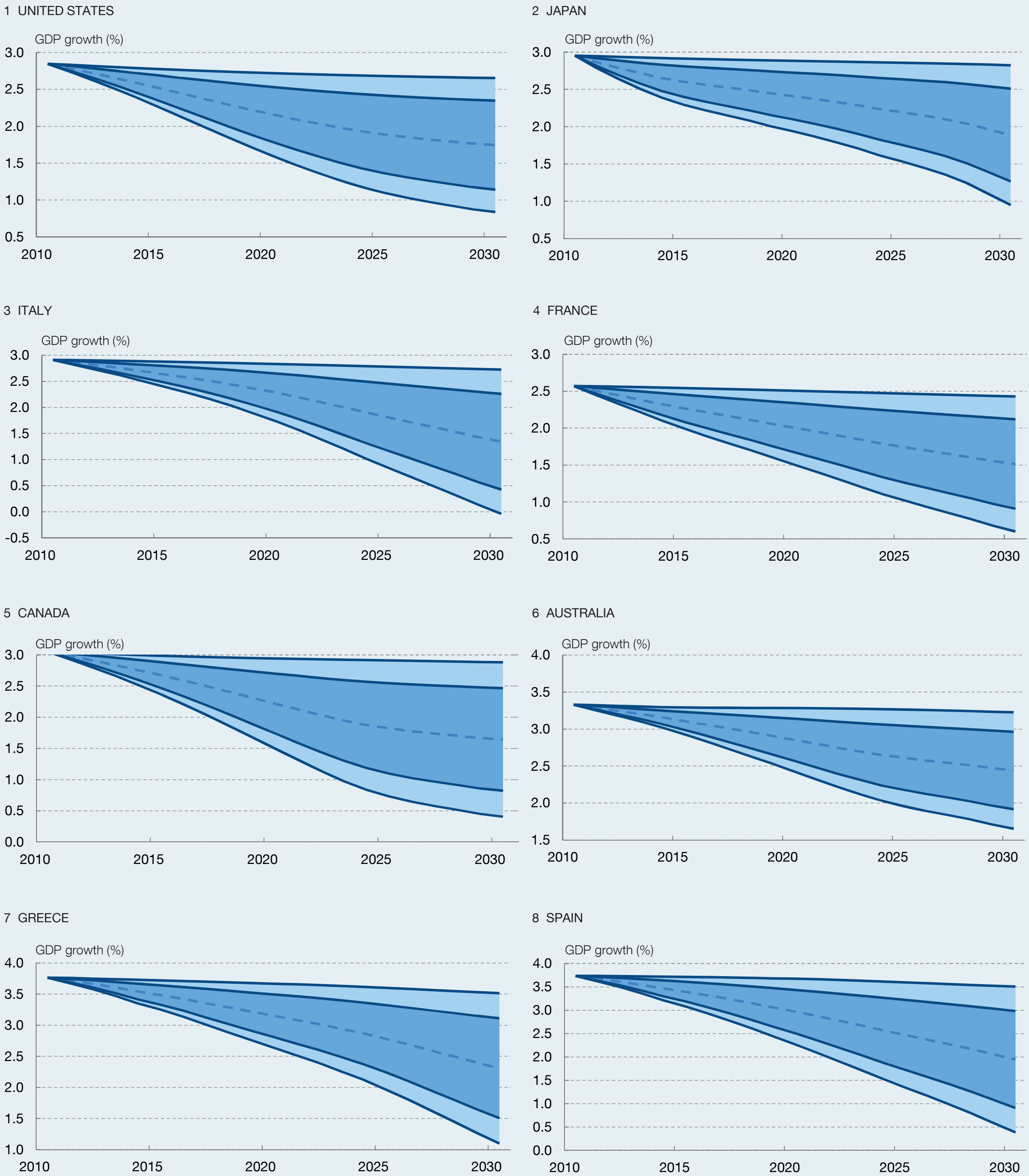
1 D. Acemoglu and P. Restrepo (2017), “Secular Stagnation? The Effect of Aging on Economic Growth in the Age of Automation”, *American Economic Review,* 107(5), pp. 174-179.

2 Y. Aksoy, H. S. Basso, R. P. Smith and T. Grasl (2019), “Demographic Structure and Macroeconomic Trends”, *American Economic Journal: Macroeconomics,* Vol. 11, No 1, January, pp. 193-222.

3 H. Basso and J. F. Jimeno (2019), *From Secular Stagnation to Robocalypse? Implications of Demographic and Technological Changes,* Banco de España Working Paper, forthcoming.

4 The demographic projections of the United Nations Population Division are used.

Chart 1
EFFECTS OF DEMOGRAPHIC AND TECHNOLOGICAL CHANGES ON GDP GROWTH, CALCULATED WITH HISTORICAL DATA

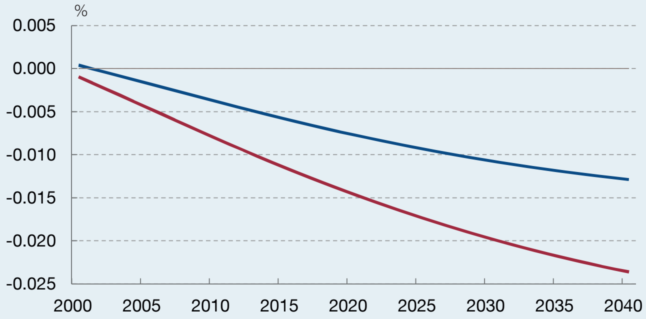


SOURCE: Aksoy, Basso, Smith and Grasl (2019).

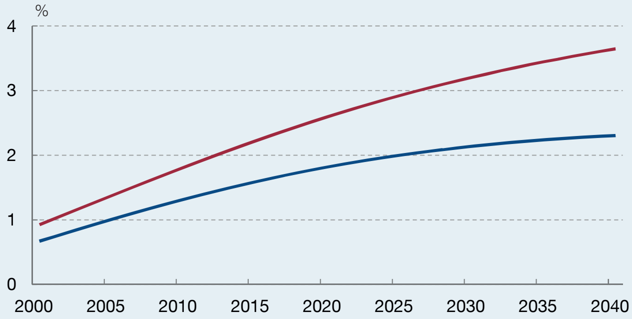
a The two confidence bands in Charts 1.1 to 1.8 refer to the statistical significance of the estimates with a confidence level of 60% and 80%.

Chart 2
SIMULATIONS OF SOME MACROECONOMIC VARIABLES BASED ON DEMOGRAPHIC PROJECTIONS

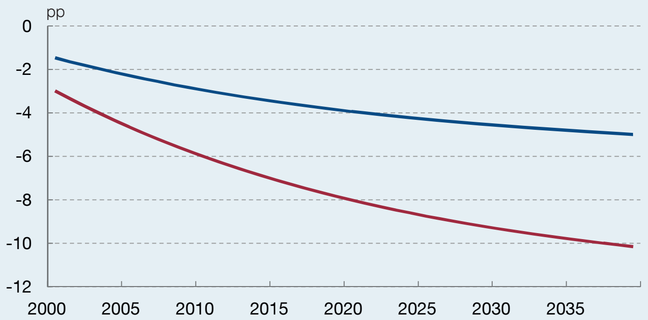
1 CHANGE IN GDP GROWTH PER CAPITA



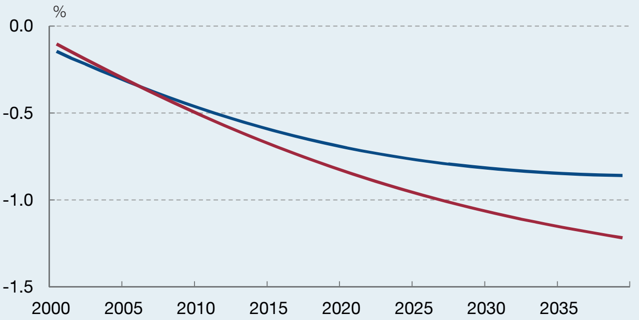
2 CHANGE IN RELATIVE WEIGHT OF ROBOTICS SECTOR



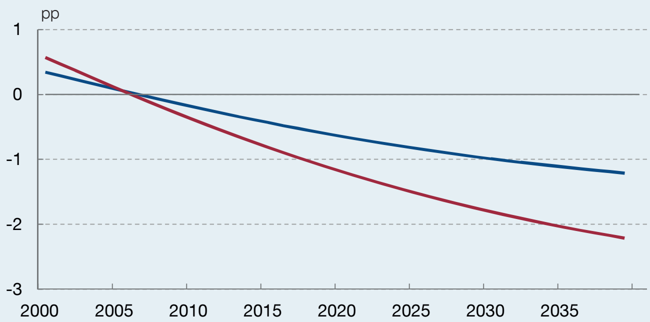
3 CHANGE IN EMPLOYMENT RATE (a)



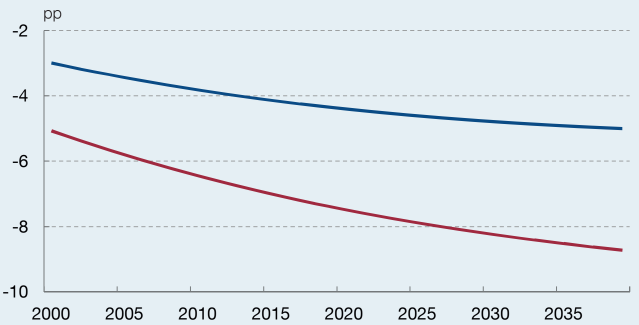
4 RELATIVE CHANGE IN WAGE SHARE OF GDP



5 CHANGE IN REAL WAGE GROWTH



6 CHANGE IN RELATIVE WEIGHT OF CONSUMPTION IN GDP



CORE EUROPE (b) — UNITED STATES

SOURCE: Basso and Jimeno (2019).

a Defined as the ratio of persons employed to the working-age population.
b Aggregation of Germany, Spain, France and Italy.