TECHNICAL APPENDIX

A.1 IDENTIFYING THE IMPACT OF AN ADVERSE DEMOGRAPHIC SHOCK ON THE REAL ECONOMY: A SEMI-STRUCTURAL (SVAR) MODEL-BASED APPROACH

Economic variables are influenced by many temporary and long-term disturbances, with demographics being only one of these shaping factors. Recent examples include the pandemic and energy crises resulting from the Russian-Ukrainian conflict, which had significant economic consequences for the euro area (EA). It is, therefore, important to carefully determine the impact of demographic trends on the real economy, avoiding either underestimating or overestimating their effects.

Macroeconomic shocks are unobserved, making their identification an extraordinarily challenging and highly controversial task as there is no unique method to accomplish it. In this note, we utilise a medium-size multivariate time series model to analyse data dynamics and apply qualitative and quantitative restrictions to identify a permanent negative demographic shock (i.e., SVAR analysis). The EA series considered in this study are the 1) dependency ratio, 2) population, 3) real wage, 4) GDP, 5) employment, 6) investment, 7) long-term (10y) government bond yield, 8) private savings (% of disposable income) and 9) patent applications. The identified shock permanently reduces population and employment below their trends while it increases the dependency ratio above its trend, with these restrictions also holding in the medium term.[1] The model is estimated using data between 1994Q4 and 2019Q4.[2] It is essential to recognise that while qualitative (i.e., sign) restrictions have been imposed on three variables, the remaining six are unconstrained.[3]

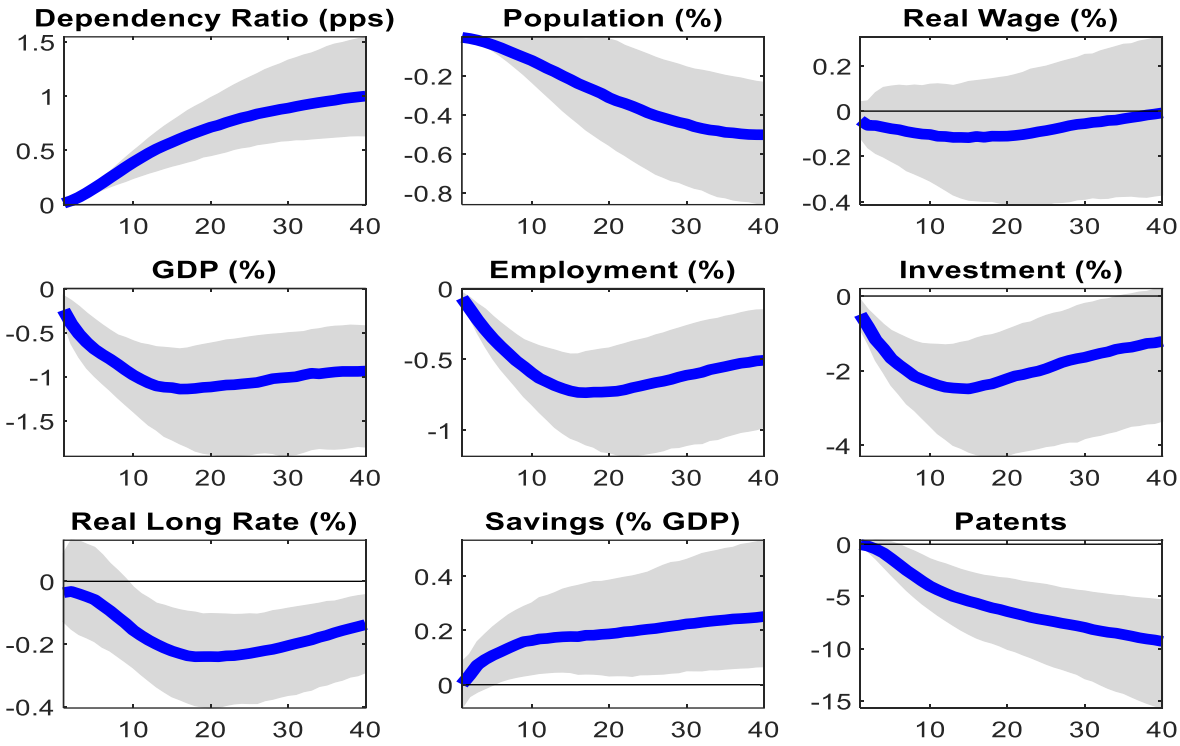
Figure 1 displays the economic transmission of the identified adverse demographic shock that increases the dependency ratio by 1pp. As discussed in the main text, the shift towards the new equilibrium is a process that unfolds only gradually, as several economic frictions influence it. The figure displays the responses of all variables in the VAR (i.e. not all of those are discussed in the main text), which are also left "unrestricted". The responses of these additional variables, such as savings, long-term interest rates and investment, serve as a "check" to assess the plausibility of the identified shock.

[1] Furthermore, the identified shock has been selected to maximise its forecast variance contribution on the dependency ratio and population in the medium run. The identification scheme employed in this study is a modification of Uhlig's (2005) penalty function approach, also used in Mumtaz et al. (2018), Mumtaz and Theodoridis (2020) and Mumtaz and Theodoridis (2024), among others.

[2] The VAR model is estimated using Bayesian econometrics techniques, prior information is incorporated into the estimation of the empirical through Minnesota-type priors, while the lag order of the VAR is set equal to two. The results remain roughly unchanged when the Wide Area Model database is used to extend (for most of the variables) the historical sample or when a model with four lags is considered.

[3] The empirical approach undertaken in this study is inspired by the work of Aksoy et al. (2019), who use a panel VARX model to identify the effects of demographics on a very similar set of variables but for an extended set of (21 OECD) countries.

Figure 1: Transient Dynamics



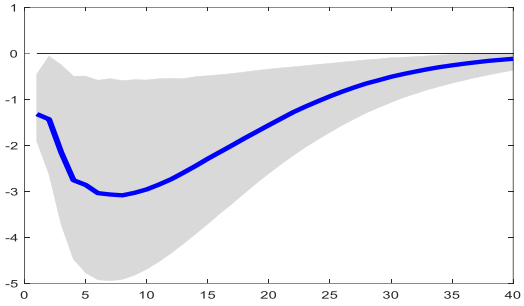
***Notes**: The shock has been normalised to increase the dependency ratio by 1pp in year 10. X-axis denotes quarters. The blue solid line and shadow illustrate the pointwise median and the 16th-84th percentiles of the posterior response distribution to an adverse demographic shock.*

A.2 DEMOGRAPHICS AND LABOUR MARKET TIGHTNESS: FEWER WORKERS LEAD TO FEWER VACANCIES BOTH IN SHORT AND LONG RUN

EA labour market tightness measures "hover" around historically high levels, triggering concerns about "wage-price spirals" due to high inflation induced by the energy crisis. Despite the rapid and substantial increase in the monetary policy rate, labour demand remains exceptionally high, and unemployment has reached historically low levels. In the absence of an increase in participation (already at historically high levels) or/and migration, the new vacancies posted will probably be filled by firms offering a higher wage. This may cause a second wave of inflationary pressure and higher policy rates that could harm the recovery of the economic activity, ongoing since the end of the pandemic crisis and interrupted by the Russian-Ukrainian conflict. The question that naturally arises is whether adverse demographic dynamics enhance the relationship between tight labour markets and higher wages.

A permanent adverse demographic shock reduces labour market tightness significantly for a protracted period (Figure A.2.1).[4] While not immediately intuitive, a lasting upsurge in the dependency ratio substantially diminishes labour market tightness over a prolonged span. This observation aligns with the preceding section's discussion, wherein real downward rigidity hinders an adequate decline of the real wage to counterbalance the decrease in labour productivity. This outcome detrimentally impacts firm profitability, curtails vacancy posting, and results in elevated unemployment rates due to job separation.

Figure A.2.1: Labour Market Tightness Response to an Adverse Permanent Demographic Shock (%)



***Notes**: The blue solid line and shadow illustrate the pointwise median and the 16th-84th percentiles of the posterior response distribution to an adverse demographic shock. X-axis denotes quarters.*
***Source**: Haver Analytics and ESM Calculation*

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[4] The series that proxies the EA labour market tightness (vacancy rate to unemployment rate ratio) is available only after 2006. We use local projection techniques (Jorda 2005) to infer the effects of a demographic shock on the labour market tightness to avoid jeopardising the estimation and the identification of the VAR model by including the latter series in the empirical model. Specifically, local projections, several controls and the VAR-identified demographic shock are employed to derive Figure 4.

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