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Leonarda Srdelić and Marwil J. Dávila-Fernández

Demographic transition and economic growth in 6-EU member states

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Demographic transition and economic growth in 6-EU member states*

Leonarda Srdelić[†a] and Marwil J. Dávila-Fernández[b]

[a] *Croatian National Bank, Croatia*
[b] *Department of Economics, Bucknell University, United States*

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Abstract

Europe is experiencing a dramatic shift in its demographic structure, ending three centuries of unprecedented population growth. However, there are few empirical estimates of the realised effect of such a process on economic performance. The present article attempts to fill this gap in the literature by assessing the impact of demographic transition in six European countries between 1971 and 2019. Unlike most studies in the field that rely on Cobb-Douglas production functions, we adopt an open-economy approach under the premise that, in the long-run, growth is balance-of-payments constrained. Applying time-varying-parameter estimation techniques, we compute the rate of growth compatible with equilibrium in the balance-of-payments (y_{BP}) and show it is a good predictor of output growth trends. We proceed by investigating the importance of population dynamics as one of its determinants. The obtained effects are moderate, and there is significant heterogeneity between countries. In Italy, for instance, a 10-points increase in the old-age dependency ratio is associated with a 3% lower y_{BP}, while in France, we have the opposite effect. Moreover, population decline effects are conditional to controlling for migration, with Germany and Austria differentiating themselves from their Southern Europe counterparts.

Keywords: Demographic transition; Long-run growth; Thirlwall's law; Europe.

JEL: J11; O41; O52.

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† *Corresponding author*
Email address: `leonarda.srdelic@hnb.hr`

1 Introduction

After three centuries of unprecedented population growth, Europe rediscovered the fear of demographic decline. Years of below-replacement fertility rates suggest that the negative population momentum has set in (e.g. Lutz et al., 2003; Reher, 2007). Decline and ageing share a common cause in low birth rates, with a reduction in mortality exacerbating the latter (Coleman and Rowthorn, 2011). Whether these trends should be regarded as a problem is a controversial matter. There are few empirical estimates of the realised effect of such a process on economic growth. Among alternative theories of growth and distribution, even fewer analyses have investigated the issue. The present article contributes to this literature by assessing the impact of the demographic transition on the long-run economic performance of six European countries between 1971 and 2019.

However, contrary to most studies in the field that heavily rely on Cobb-Douglas type of production functions (for a recent critique, see Zambelli, 2018; Gechert et al., 2021), we adopt an open economy approach under the premise that what is bought and sold in international markets reflects the economy's fundamentals. The relationship between trade performance and economic growth has been for a long time subject to considerable interest in economics (e.g. Dixon and Thirlwall, 1975; Feder, 1983; Feenstra and Romalis, 2014). Among the powerful reasons why exports matter, there is the fact that they are the only component of demand that can pay for import requirements, especially those of capital goods. International financial markets impose a limit to current-account imbalances beyond which they are not willing to continue lending. In this context, trade directly affects demand, but it is also related to the provision of international currency and the capacity of the domestic economy to access modern production techniques.

With these considerations in mind, the present paper explores a novel link between demographic transition and economic performance, referring to the so-called dynamic Harrod trade-multiplier. Frequently referred to as Thirlwall's (1979) law or Krugman's 45° rule, it states that a country trading in a foreign currency cannot sustain persistently and increasing current account imbalances. Thus, its long-run growth rate can be well-approximated by the rate of growth of exports divided by the income elasticity of imports. Empirical evidence supporting the trade-multiplier is available for a range of developed and developing countries (e.g. Bagnai 2010; Bagnai et al., 2016; Gouvêa and Lima, 2013; Kvedaras et al., 2020; Srdelic and Dávila-Fernández, 2022), including China (see Felipe and Lanzafame, 2020). On the other hand, the literature on export-led growth has consistently estimated price and income elasticities in export functions as well as investigated growth effects associated with exports (see, for example, Berg et al., 2012; Freund and Pierola, 2012; Tang et al., 2015). We bring new evidence on the macroeconomic effects of changes in the population age structure and uneven development in the European Union.

Our exercise is divided into two parts. First, we show that the rate of growth compatible with equilibrium in the balance-of-payments provides a fair approximation of long-run growth trends in Italy (IT), Spain (ES), Portugal (PT), Germany (DE), France (FR), and Austria (AT). These countries virtually represent two different institutional arrangements in the continent: Southern and Western Europe. The respective income elasticities of exports and imports were obtained by applying time-varying parameter estimation techniques (as in Felipe et al., 2019; Felipe and Lanzafame, 2020; Srdelic and Dávila-Fernández, 2022). Finally, our initial estimates are employed to investigate the importance of population dynamics to the productive structure, as captured by the ratio between the elasticity of exports over imports. Existing effects are moderate, and there is significant heterogeneity between countries. In Italy, for instance, 10 points increase in the old-age dependency ratio (OADR) is associated with a 3% lower y_{BP}, while in France, we have a slightly smaller opposite effect. Moreover, the consequences of population decline are conditional to controlling for migration, with Germany and Austria differentiating themselves from their Southern Europe counterparts. Such last result could reflect the more complex productive structure in the two Western countries, where "good jobs" have been created in a proportion that has allowed immigrants to be absorbed in sectors related to higher long-run growth.

These findings join existing studies on the macroeconomic effects of demographic transition and the possible implications in terms of innovation or savings behaviour (e.g. Prettner, 2013; Sheiner, 2014). By referring to Thirlwall's law, we explore an alternative mechanism that offers a unique framework to combine demand and supply constraints to explain international growth rate differences and structural change. We also confirm some previous insights that ageing and population decline might not *always* be a problem (see Coleman and Rowthorn, 2011). One should consider to what extent population (de)growth is driven by internal or migration dynamics.

Demographic transition and the fundamentals of the productive structure, as captured by trade elasticities in the trade-multiplier, might be connected by labour productivity. We argue that two main mechanisms operating in opposite directions are involved. First, a reduction in the population size indicates the prospect of declining demand. Firms respond to shrinking markets by reducing investment plans. As the average plant age increases and its correspondent competitiveness decreases, one should expect a reduction in the ability to explore dynamic economies of scale, damaging labour productivity (an argument that finds an echo in the Kaldorian literature, see Kaldor, 1966; 1967). On the other hand, a reduction in the labour force size can potentially increase workers' bargaining power. To save profit margins, firms may increase their search for labour-saving production techniques, raising productivity and non-price competitiveness (e.g. Manfredi and Fanti, 2006; Rada, 2012). The interaction between such contrasting forces could explain why the net final effects of the demographic transition on long-run growth seem moderate, and there is significant heterogeneity between countries.

The remainder of the paper is organised as follows. In the next Section, we revisit some stylised facts regarding the process of demographic transition in our sample of six European nations. Section 3 presents the fundamentals of the dynamic Harrod trade-multiplier and our estimates of the trade equations. Section 4 combines a Bayesian Model Averaging (BMA) and Weighted Averaging Least Squares (WALS) techniques to investigate the correspondence between a set of demographic variables and the productive structure. Some final considerations follow.

2 Some stylised facts

As mentioned at the beginning of this article, the potential macroeconomic implications of population ageing and eventually decline have gained attention in academic circles and the public debate. Our purpose in this Section is to provide a general overview of the ongoing demographic changes in six countries that virtually correspond to two different institutional arrangements. On the one hand, we have Italy, Spain, and Portugal representing Southern Europe. On the other hand, Germany, France, and Austria stand for the Western part of the continent.

Using data from Eurostat, Fig. 1 presents the main trajectories of a set of seven demographic variables in our first group of economies. On panels (a), (c), (e), we have for each country the population share up to 14 years old, those between 15 and 64, and above 65 years old. While it is already possible to see a marked increase in the importance of the last group, we use the same data to compute the OADR, defined as the population ages 65-plus divided by the population ages 15-64. OADRs have increased from 15 to 30 in the past four decades. Such trajectories are in line with broad trends in developed countries. According to OECD (2017), they are expected to more than double in the next 50 years, ranging in between 70 and 80. Moreover, the increase in dependency ratios is projected to continue, and demographically younger countries are expected to age even more rapidly.

The evolution of dependency ratios is contingent on mortality rates, fertility rates and migration. Not by surprise, ageing has followed a dramatic decrease in fertility rates, especially during the 1980s, as reported by the World Bank Development Indicators. The Total Fertility Rate (TFR) consists of the total number of children that would be born to each woman if she were to live to the end of her child-bearing years and give birth to children in alignment with the prevailing age-specific fertility rates. It fell from close to 3 to 1.5, way below replacement rates. These dynamics, of course, are very much related to the fact that fertility decisions have become conscious and individual, women participation in the labour market has increased over the past decades, and we have experienced a revolution in contraceptive technologies (for a detailed discussion, see Reher, 2007).

Specifically, in what concerns population growth, we can see that the population started to decline somewhere between the great financial crisis and the European debt crisis if we disregard migration. The modern form of population reduction is novel because now it is accompanied by ageing. Before the Industrial Revolution, effects on birth rates were transient, with the decline being provoked by wars and epidemics. Over the past century, low birth rates and an increase in life expectancy have been the keys. Panels (b), (d), (f) show that all three Southern countries currently register in between 0.1 and 0.3% annual population reduction. The introduction of migration changes the picture dramatically. Italy and Spain experienced a long-wave of net immigration that increased the growth rate of their populations up to 1.6% before the financial crisis. The case of Portugal is somehow different, with two immigration waves in between an episode of people leaving the country in the 1980s. Still, a general negative trend is quite evident in all three countries.

Western Europe is not an exception to these trends. Fig. 2 presents the same set of variables for Germany, France and Austria. The increase in the OADR is perhaps less pronounced, but only because fertility rates started to fall a decade before. In fact, in the case of Germany, the population growth rate without migration has been consistently negative, fluctuating around -0.1 and -0.2%. Contrary to Southern Europe, the population has been growing thanks to immigration. In this respect, France is an outlier. Fertility rates have stabilised around 2 in the 1980s, allowing the population to grow at a stable rate of 0.4% without migration, or slightly above once we take immigrants into account. Such trajectories tell us something about the centre-periphery dynamics inside the European Union, and no doubt they are subject to economic as well as political constraints.

France has never reported a natural population decline, indicating that the underlying relationship between demography and growth in this country might differ from the rest of our sample. The country has a comprehensive family policy with explicit pro-natal goals. However, it combines those elements with high female labour force participation rates and aims to guarantee significant income redistribution as well as an all-encompassing public

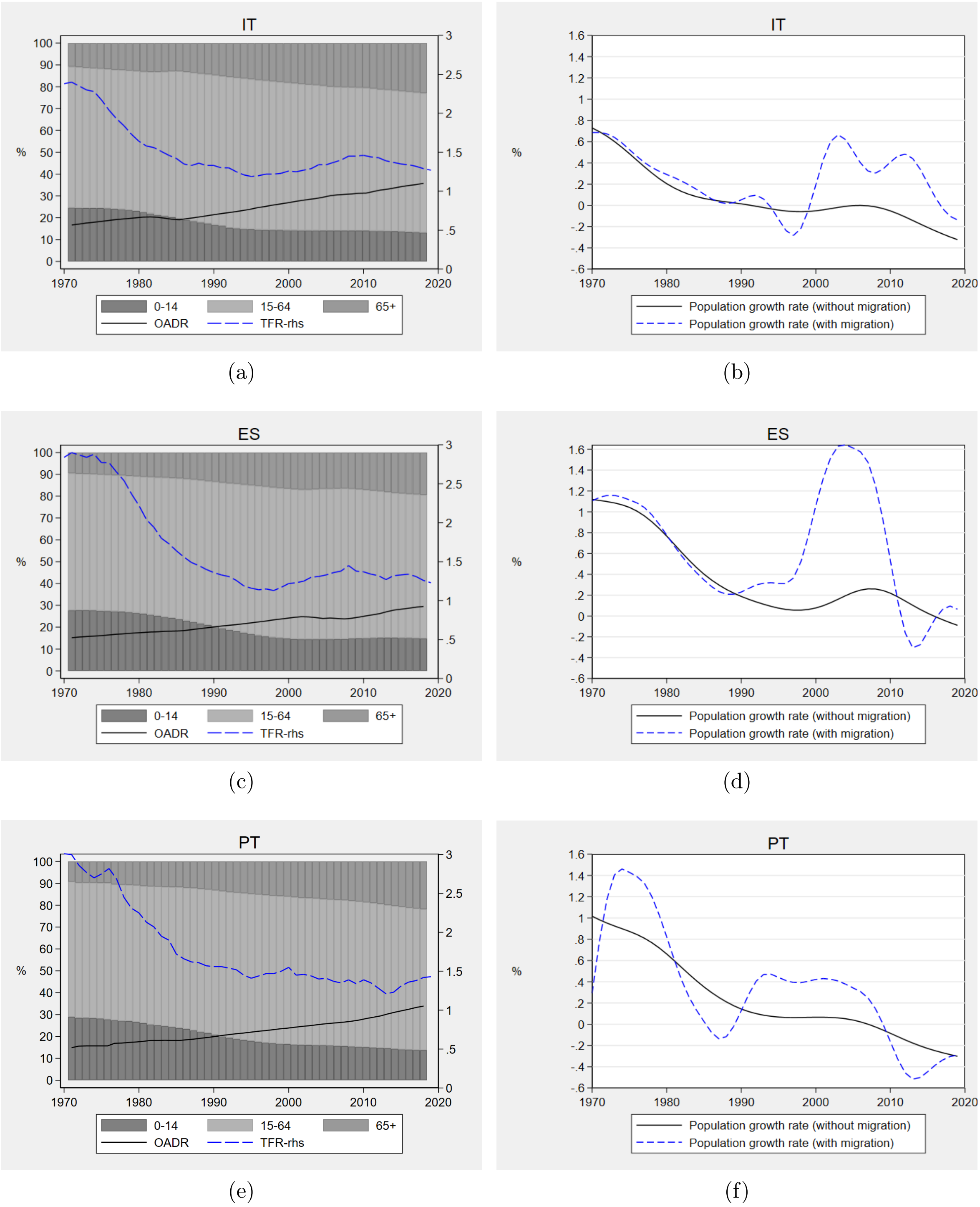
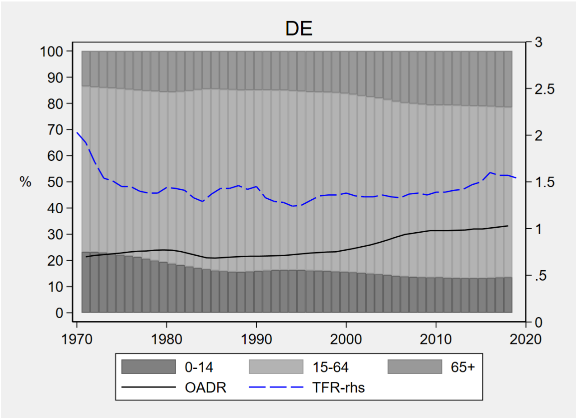


Figure 1: Demographic structure in Italy, Spain, and Portugal, 1971-2020.



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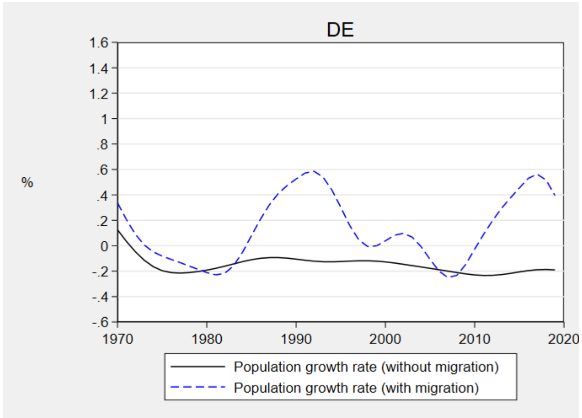

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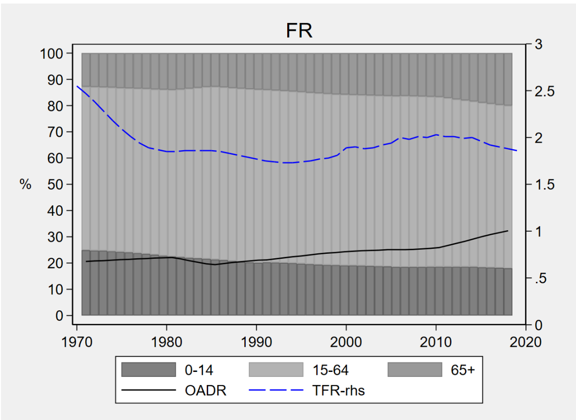

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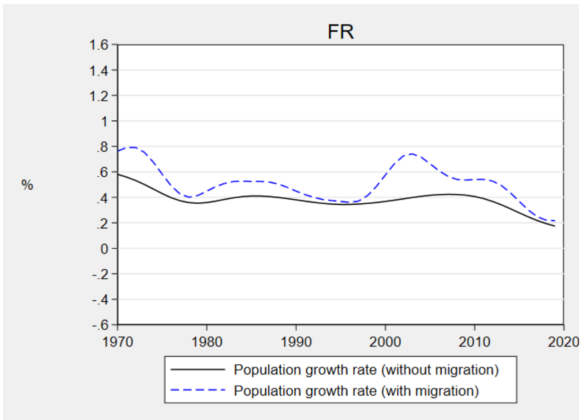

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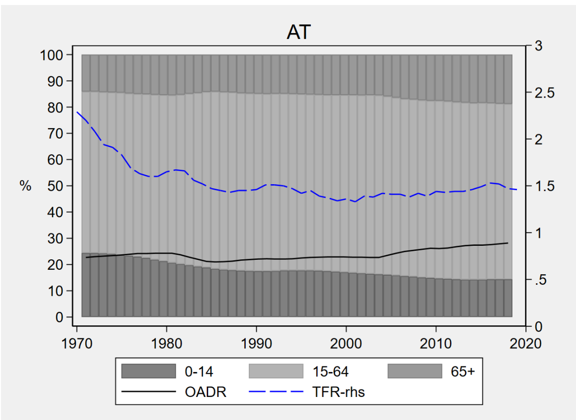

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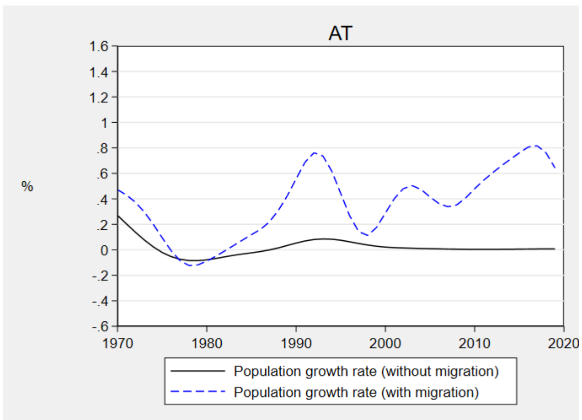


(f)

Figure 2: Demographic structure in Germany, France, and Austria, 1971-2020.

system of child-care facilities (see, for example, Lechevalier, 2019). The policies that were put in place to encourage three-children families include:

1. Nearly minimum-wage cash incentives for a mother to stay off work for one year following the birth of her third child.

2. Large reductions in train fares.

3. Income tax based on the principle the more children, the less tax.

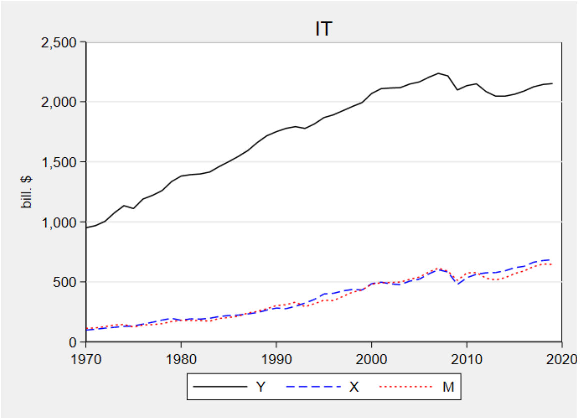
4. Three years paid parental leave that both parents can use.

5. Full-time schools.

Overall, differences in the population growth rate with and without migration also indicate distinct implications in terms of growth. In this paper, we are interested in exploring a novel link between demographic transition and economic performance, referring to the so-called dynamic Harrod trade-multiplier. The main idea is that the income elasticity of exports and imports reflect reflect the fundamentals of the productive structure (e.g. Araújo and Lima, 2007; Cimoli et al., 2019; Dávila-Fernández and Sordi, 2020). While we leave a formal exposition to the next Section, Fig. 3 depicts the main trends of output (Y), exports (X), and imports (M), using data from the World Bank Indicators.

We want to highlight some crucial differences between the two regions in terms of those three variables. In Southern Europe, the 2007 financial crisis and the subsequent debt crisis were followed by a pronounced reduction in production. In Italy, the economy has stagnated afterwards, while Spain and Portugal could recover pre-crisis production levels only in the last two years of our sample. It is possible to see the rise in trade deficits that preceded Spain and Portugal's collapse in 2010. Equilibrium in trade was eventually recovered, and Spain has registered a surplus ever since. Authors such as Panico and Purificato (2013) had argued that, before 2007, the flaws in the institutional organisation of the process of coordination between monetary and fiscal policy affected the cyclical and growth operation in those countries. There is a certain consensus that the adoption of the Euro was a shortcut for catching-up countries to gain access to international finance that later led to baking, sovereign, and foreign debt crisis, in that order (e.g. Bordo and James, 2013; Reinhart, 2015; from a comprehensive account, see Cesaratto, 2017).

While in Southern Europe, credit money creation by local and foreign banks was directed to construction and consumption bubbles that fuelled imports and inflation; in Western countries, this was followed by current account surpluses. Fig. 3 depicts the well-known trade surpluses in Germany and Austria after the full adoption of the Euro. Overall, trajectories in this last set of economies are smoother, with minor effects on levels or trends. Under the premise that economies grow by upgrading the products they produce and export (Hidalgo et al., 2007), the subsequent Section presents the dynamic trade-multiplier as a possible connecting bridge between long-run economic performance and demographic change.



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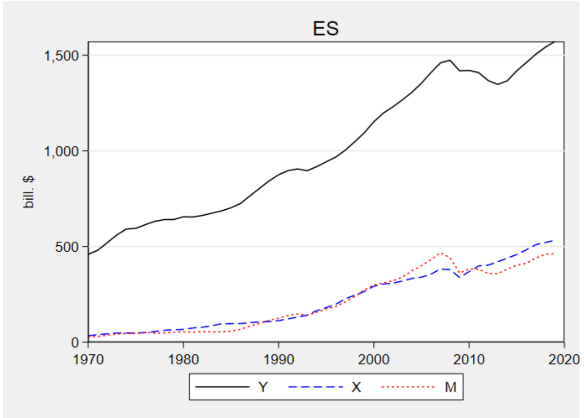

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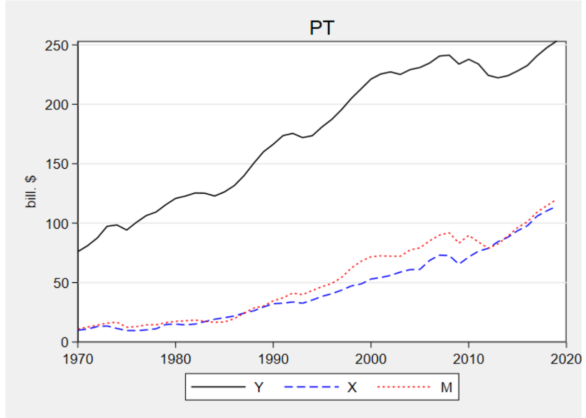

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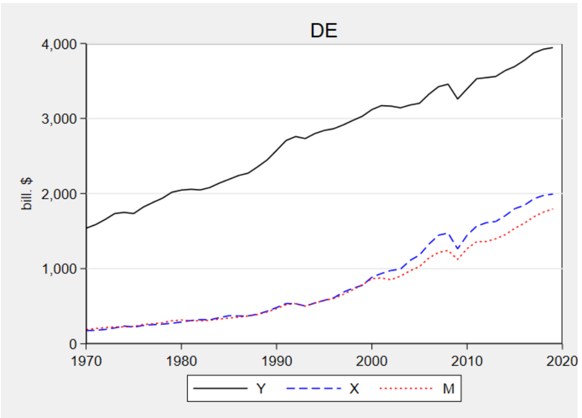

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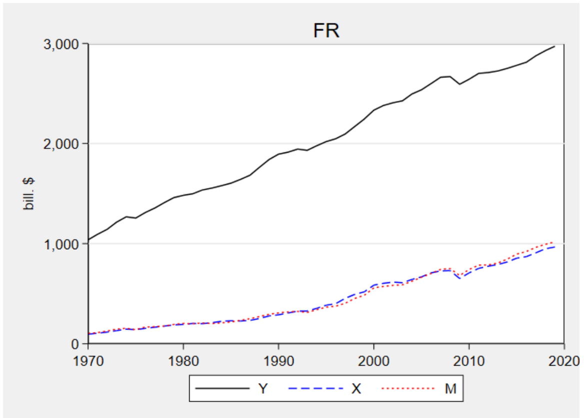

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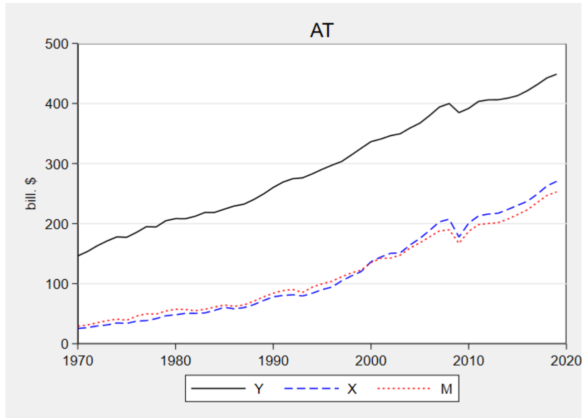


(f)

Figure 3: International trade in 6-EU selected countries (2010 US dollars).

3 The dynamic Harrod trade-multiplier

The idea of a balance-of-payments constraint on growth stands as one of the most powerful empirical regularities among alternative theories of growth and distribution (for a review, see Thirlwall, 2011; a discussion of new advances and controversies in this framework can be found in Blecker, 2021). It states that a country that trades in foreign currency cannot sustain persistently and increasing current account imbalances. As output rises, imports usually increase to satisfy investment and consumption requirements. This stylised fact stands even if a significant part of the economy is not exposed to trade. However, international financial markets limit current-account imbalances beyond which they are not willing to continue lending. If the economy does not obtain enough export earnings to pay for the import content of the other expenditure components, demand will have to be constrained. Such a boundary does not necessarily apply in the short-term, and the country may grow faster or slower than the rate compatible with equilibrium in the balance-of-payments. This is especially the case when international conditions are favourable. Nonetheless, in the long-term, imbalances cannot be persistently increasing. The central proposition of the dynamic trade-multiplier is that the balance-of-payments does not adjust through prices but rather through income.

The model has been generalised in several directions, including the incorporation of multi-sectoral issues by Araújo and Lima (2007). Countries in the European Union fit well this framework, given that they either trade in US dollars or Euros. The latter is managed by the Frankfurt-based European Central Bank (ECB) and has substituted national currencies. In this representation, suppose a small open economy divided into n sectors. The rate of growth of aggregate exports (x) and imports (m) are given by:

$$x_t = \sum_{i=1}^{n} \theta_{i,t} x_{i,t} \tag{1}$$

$$m_t = \sum_{i=1}^{n} \Omega_{i,t} m_{i,t} \tag{2}$$

where θ_i and Ω_j are the shares of each sector i in international trade, while x_i and m_i are the respective sectoral magnitudes. They are such that:

$$\begin{aligned} x_{i,t} &= x_i\left(rer_t, z_t\right),\ x_{i\ rer} > 0,\ x_{i\ Z} > 0,\ x_i(0,0) = 0 \\ m_{i,t} &= m_i\left(rer_t, y_t\right),\ m_{i\ rer} < 0,\ m_{i\ Y} > 0,\ m_i(0,0) = 0 \end{aligned} \tag{3}$$

where rer stands as variations in the real exchange rate, z is the rate of growth of output in the rest of the world, and y corresponds to the domestic rate of growth.

Equilibrium in trade, which for our purposes stands as *proxy* for equilibrium in the balance-of-payments, rules out the possibility of ever-increasing trade deficits or surpluses:

$$x_t = rer_t + m_t \tag{4}$$

Substituting (3) into Eqs. (1) and (2), inserting the resulting expressions into Eq. (4) and rearranging, we obtain the rate of growth of output compatible with equilibrium in the balance-of-payments (y_{BP}). Under Purchasing Power Parity (PPP), $rer = 0$. Assuming for simplicity that $x_i(\cdot)$ and $m_i(\cdot)$ are linear, it follows:

$$y_{BP,t} = \rho_t z_t \tag{5}$$

where

$$\rho_t = \frac{\sum_{i=1}^{n} \theta_{i,t}\phi_{i,t}}{\sum_{i=1}^{n} \Omega_{i,t}\pi_{i,t}} \tag{6}$$

with $\phi_i = \partial x_i/\partial z$ and $\pi_i = \partial m_i/\partial y$ standing as the sectoral income elasticities of exports and imports, respectively.

In the simplest aggregate case, when $i = 1$, we have:

$$\rho_t = \frac{\phi_t}{\pi_t} \tag{7}$$

For values of $\rho > 1$, the economy grows faster than the rest of the world, falling behind when $\rho < 1$. That is the reason why such a variable is frequently considered to capture the non-price competitiveness conditions of a country or region (see Cimoli and Porcile, 2014). It has proved to help explain international growth rate differences. Income elasticities are assumed to capture non-price factors that affect trade. For example, the supply characteristics of goods and services, such as their technical sophistication or quality, are behind their ratio (see McCombie and Thirlwall, 1994).

Still, for a long-time, ρ has maintained the status of a "measure of our ignorance", being somehow equivalent to the Solow residual in standard growth theory. Thus, even though occupying a central position in the model, it remains exogenously determined. Only recently, Felipe et al. (2019) and Felipe and Lanzafame (2020) have provided groundbreaking evidence on the determinants of non-price competitiveness in this framework. Their work refers to Indonesia and China but has a distinct feature: estimating time-varying trade elasticities based on the Kalman filter. In what follows, we will adopt a similar estimation strategy to obtain time-varying estimates of ρ and, in a second step, investigate the possible relevant correlations with population dynamics:

$$\rho = \rho\,(Dem)\,, \quad \partial\rho/\partial Dem \gtreqless 0$$

where Dem is a vector capturing the process of demographic transition.

3.1 Estimation strategy

State-space modelling using Bayesian methods has a long history and shares several features with many of the non-parametric models, with the notable distinction that they define the evolution of the time-varying parameters, or states, in the direction of time (for a recent review, see Chan and Strachan, 2020). We specify our system consisting of two sets of equations, namely, *measurement* and *state*. Imports are given by:

$$\begin{aligned} m_t^T &= \eta rer_t + \pi_t y_t^T + \varepsilon_{m,\,t} \\ \pi_t &= \pi_{t-1} + \varepsilon_{\pi,\,t} \end{aligned} \tag{8}$$

while for exports:

$$
\begin{aligned}
x_t^T &= \sigma rer_t + \phi_t z_t^T + \varepsilon_{x,\ t} \\
\phi_t &= \phi_{t-1} + \varepsilon_{\phi,\ t}
\end{aligned}
\tag{9}
$$

where η and σ are the price elasticities of imports and exports while ε are independent normally distributed errors with zero mean and constant variance.

This approach allows us to separate the effects of price from non-price competitiveness. The superscript T indicates that series have been purged from short-run fluctuations using two different techniques: the Christiano-Fitzgerald (CF) and the traditional Hodrick-Prescott (HP) filter.[1] The former is a band-pass (frequency) method that takes a two-sided weighted moving average of the data where cycles in a "band", given by a specified lower and upper bound, are "passed" through or extracted, and remaining cycles are "filtered" out. We adopted the full sample asymmetric version of the filter, where the weights on the leads and lags are allowed to differ. It is assumed a low cycle period of 2 and a high one of 20. On the other hand, we applied the HP filter using a smooth parameter $\lambda = 200$. Given the small-time dimension of our database and that we are not interested in price elasticities, we do not allow the latter to change over time.

We have the choice to report either filtered or smoothed estimates. Each of them serves different purposes and have a distinct economic meaning. As pointed out by Sims (2001), smoothed estimates tell us something about the difference between the best estimates made at the time t and *ex-post* estimates that use all available data today. We shall report them in what follows.

3.2 Data and empirical analysis

In this first stage of our analysis, we rely on annual data between 1971 and 2019. Output, exports, and imports series come from the World Development Indicators measured at constant 2010 US dollars. Exports and imports correspond to the value of all goods and other market services traded with the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. On the other hand, they exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Income of the rest of the world is computed as the difference between global and domestic Gross Domestic Product (GDP) at constant 2010 US dollars.

Fig. 4 reports the estimated income elasticity of imports and exports for Italy, Spain, and Portugal. They are not constant over time, thus justifying the relevance of our estimation strategy. Both CF and HP filters deliver similar results, though some differences are worth stressing. In Italy, for example, we observe an increase in π from the 1970s until the

[1] The issue of how or even whether it is possible to separate trend and cycle in macroeconomic series is as old as the profession itself. The flaws of HP have been known for a while. Alternative strategies include Christiano and Fitzgerald (2003) and, more recently, Hamilton (2018). While the issue continues to be open, there is some evidence indicating that Hamilton dominates HP in basic time series. Still, in more complex models, the reverse is true (e.g. Hodrick, 2020). For this paper, we maintain a conservative position and assess the robustness of our estimates to the use of two different filters: the Christiano-Fitzgerald and the well-known HP.

beginning of the 2000s. Afterwards, however, HP indicates relative stability of the income elasticity of imports, between 2.5 and 3, while CF suggests a reduction to 2. The income elasticity of exports, on the other hand, present the opposite behaviour. It was relatively stable until the end of the 1990s, depicting a negative trend afterwards that is only slightly reverted after 2010. In Spain, we have an inverted U for both elasticities. The 2010 European debt crisis seems to have left a significant mark, especially regarding π. The response of imports to changes in domestic demand fell sharply from 1.5 to 0.5 in those years. When it comes to Portugal, trajectories are relatively similar to Italy. The elasticity of imports has been stable since the 1990s, fluctuating around 2.5, while ϕ fell from the 1980s until 2010.

Of course, such preliminary insights remain incomplete unless we consider the ratio between ϕ and π. Fig. 4, panels (c), (f), and (i), report the behaviour of ρ over time. Two different moments are worth highlighting. Until the 1990s, Southern Europe was growing more or less at the same pace as the rest of the world, $\rho \approx 1$. Nonetheless, such a trajectory has changed in the last 30 years of our sample. Italy and Portugal have been growing consistently less, $\rho < 1$.[2]

Some differences and similarities to the previous region are worth stressing when it comes to Western Europe. As reported in Fig. 5, we have an inverted-U shape function in Germany and France again. Both elasticities increased up to a certain point and fell afterwards. In the case of Germany, the peak was in the 2000s. For France, π peaked in 2010, but ϕ did it in the mid-1990s. On the other hand, Austria presents itself as somehow a unique case. The income elasticity of imports has been relatively stable, with a slightly positive trend over the whole period. Two waves can be identified for ϕ, but the elasticity of exports has fluctuated around 1.5. If we take the ratio between them into account, see panels (c), (f), (i), it is possible to separate the sample again in two different moments. Before the 1990s, Germany, France, and Austria grew more or less at the same pace as the rest of the world. After that, all three countries have been growing proportionally less.

On the other hand, Fig. 6 compares the respective growth trends, as obtained with the CF filter, and the estimated rate of growth compatible with equilibrium in the balance-of-payments using the same filter. The dotted light line stands as the actual rate of growth. The continuous black line and the dotted blue one are very close. Such findings indicate that the trade-multiplier provides a fair prediction of the actual long-run rate of growth. In the Appendix A.1, we present a set of tests indicating that the trade-multiplier works as a centre of gravity of the economy. It is shown that the difference between y and y_{BP} is a zero-mean reverting process, suggesting the economy fluctuates around the external constraint. Appendix A.2 provides an additional visualisation and comparison between estimated y_{BP} and growth rate trends of the global economy.

That, of course, has happened in the context of at least two significant changes in the international arena. First, we have the consolidation of the European Union and the introduction of the Euro that has unified monetary policy without doing the same in terms of fiscal and industrial policies. There are ongoing rearrangements in the productive structure of the continent, with countries from Eastern Europe engaging in the process of catching-up. Western and Southern Europe have grown proportionally less as several regional value chains

[2]Perhaps the most surprising result comes from the spike in non-price competitiveness in Spain around 2010. We explain it as an artificial outcome from the dramatic decrease in π during those years. Given the macroeconomic context, Spain was forced to reduce its imports strongly. Such a decrease implies that the balance-of-payments constraint growth rate significantly deviates from the long-run trend. The findings of this study have to be seen in the light of the limitation mentioned above.

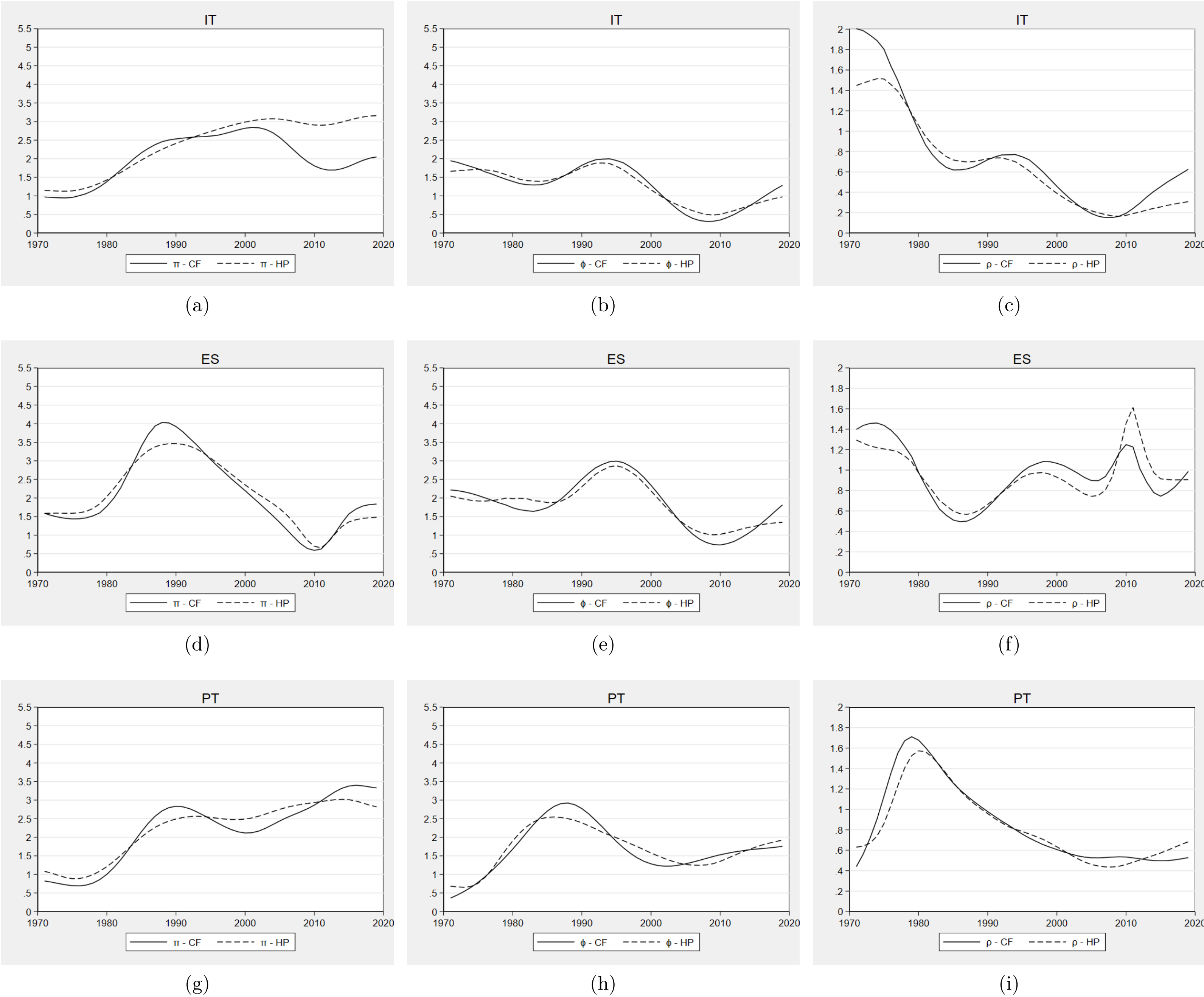


Figure 4: Time-varying estimates of non-price competitiveness and y_{BP} in Italy, Spain and Portugal, 1971-2019.

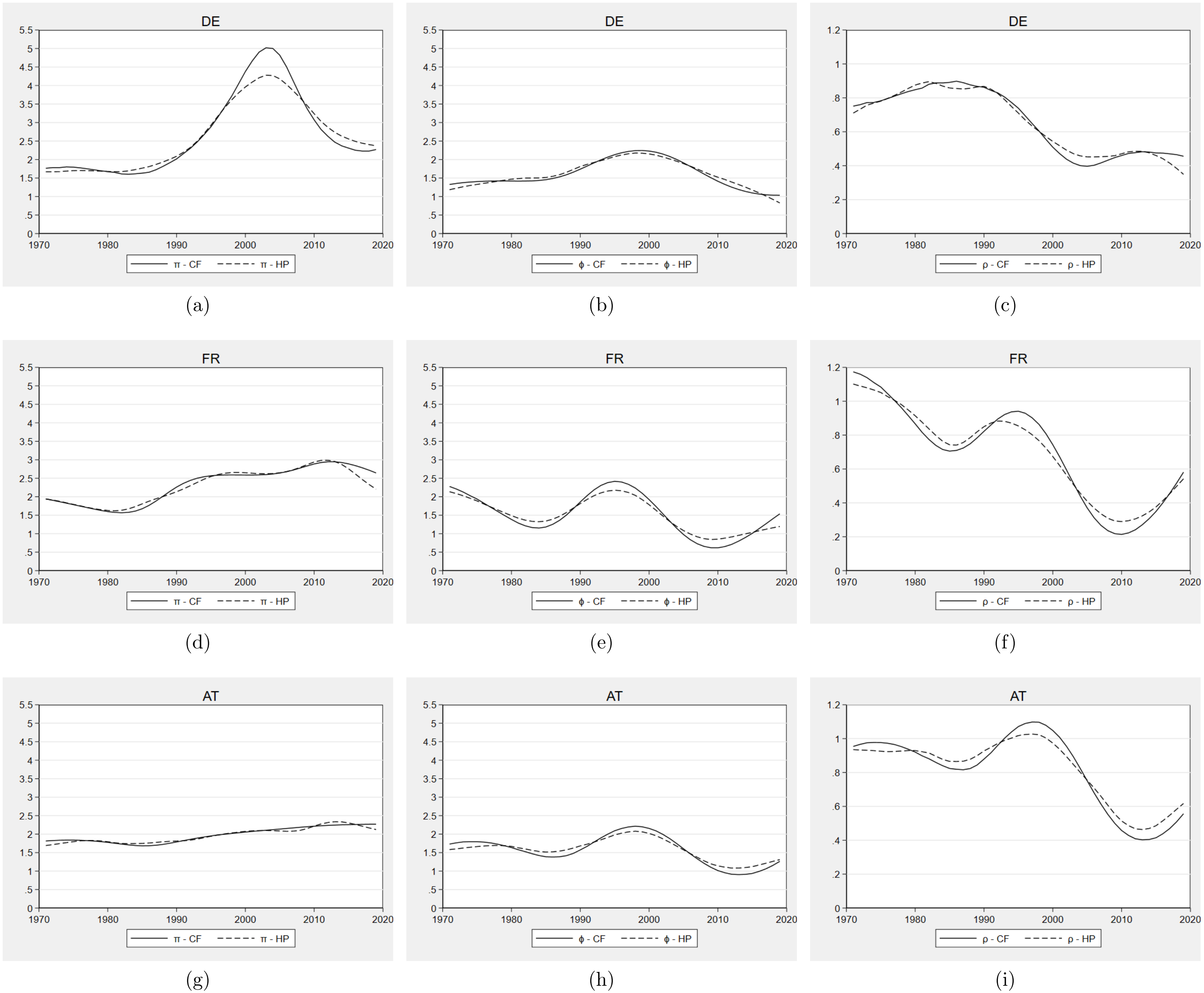


Figure 5: Time-varying estimates of non-price competitiveness and y_{BP} in Germany, France and Austria, 1971-2019.

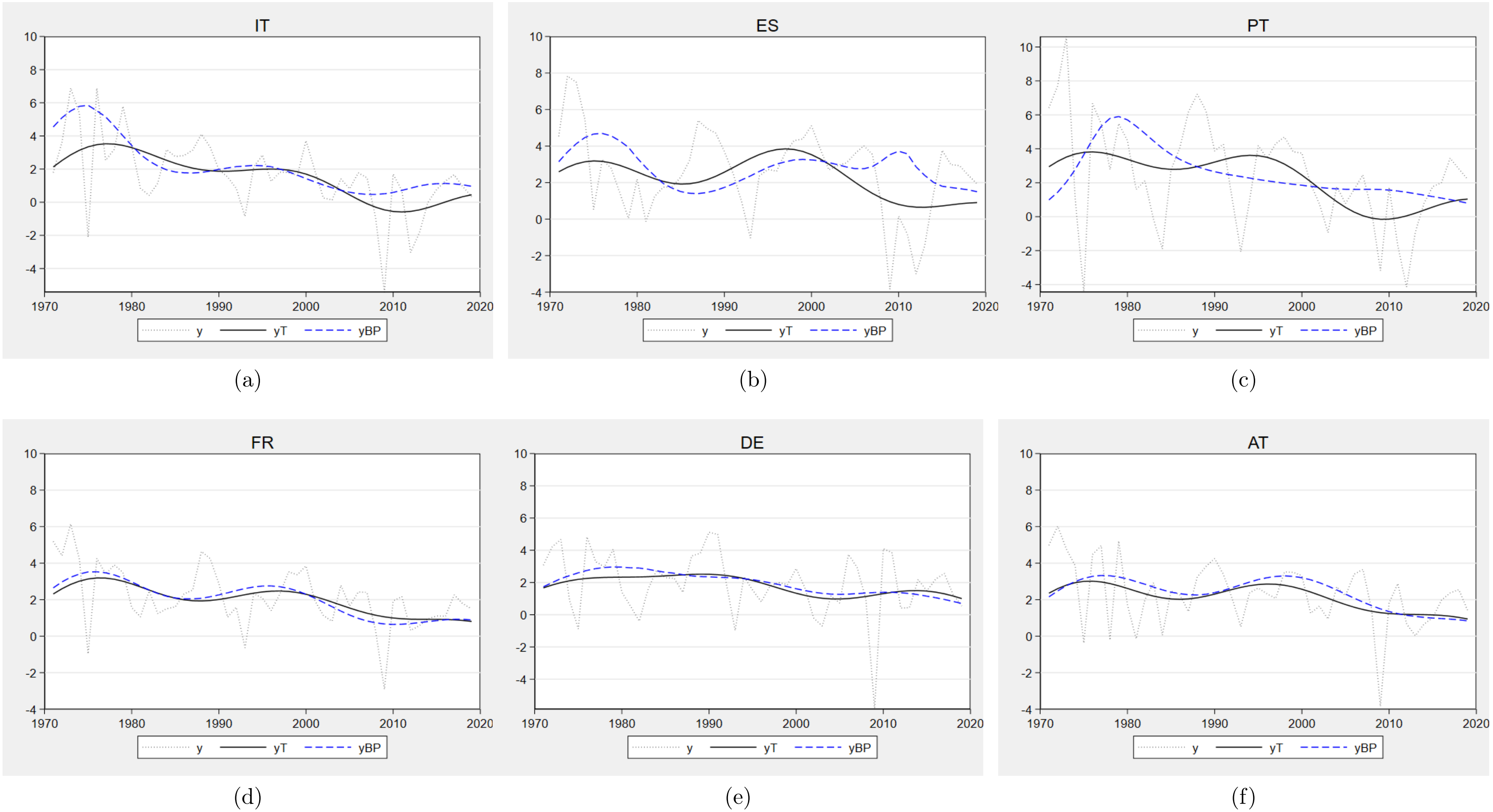


Figure 6: Time-varying estimates of y_{BP}, 1971-2019. The rate of growth compatible with equilibrium in the balance-of-payments was obtained using $\rho - CF$ estimates. Growth trends were also obtained using the CF filter.

have moved towards the East. Furthermore, China has emerged as a leading economy over the past thirty years, changing productive relations globally. Asia initially competed only in price terms, but the continent has increasingly improved its produced goods' technical sophistication and quality. As the region accelerated its growth rate, our sample of 6-EU countries grew proportionally less. Our estimates suggest that Italy, Portugal, Germany, France, and Austria currently have a growth rate of half the rest of the world. Spain is still growing less but maintains a position relatively close to the average global behaviour.

4 Demographic transition and non-price competitiveness

The economic performance of a country or region crucially depends on how the respective productive structure responds to foreign and domestic demand changes. A crucial question remains to be answered: What are the determinants of non-price competitiveness? More importantly, for the present paper, is whether variables capturing demographic transition are relevant to explain the dynamics of ρ. Following Felipe and Lanzafame (2020), we shall rely on the BMA estimator to answer this issue. Still, we differentiate ourselves from their seminal contribution in two ways. First, we focus our analysis on ρ instead of y_{BP}. We believe this is preferable because the former corresponds to a proper measure of catching-up and falling-behind dynamics. A country will be growing faster or slower than the rest of the world conditional to this variable being $\gtrless 1$. Finally, we explore the robustness of our results to the WALS estimator.

4.1 Estimation strategy

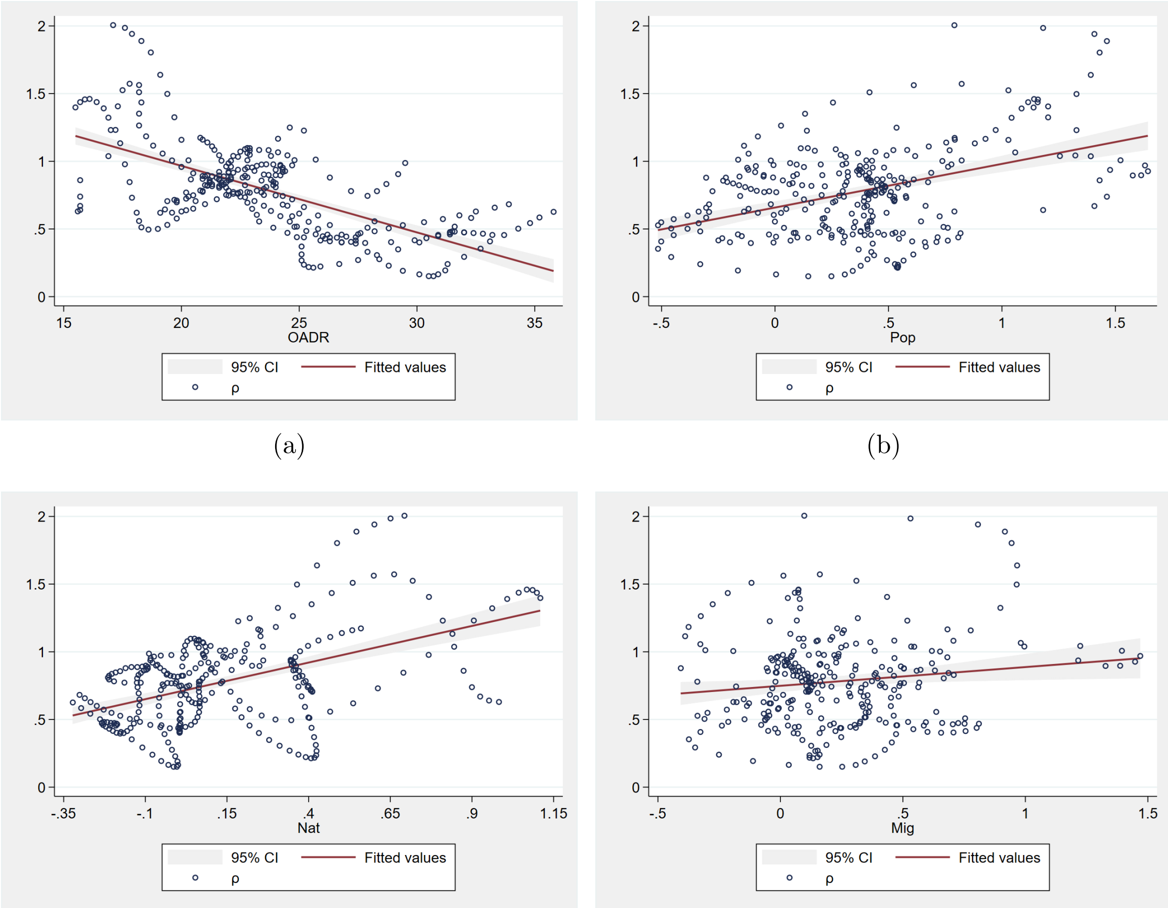
A useful set-up for investigating the relationship between non-price competitiveness, population dynamics, and a vector of control variables (W) is as follows:

$$\ln \rho_{t+1} = \psi Dem_t + \gamma W_t + \varepsilon_{\rho,t} \tag{10}$$

where ψ and γ are the coefficients associated with Dem and W; and ε_ρ represents the error term.[3]

Our immediate interest is to evaluate the role of a set of demographic variables on long-run growth through non-price competitiveness. Decline and ageing share a common cause in low fertility rates. However, one does not implies the other (Coleman and Rowthorn, 2011). Hence, to differentiate between these two mechanisms, we make use of the OADR, the growth rate of the population with (PoP) and without (Nat) migration, and the net migration growth rate (Mig). The latter is defined as the difference between immigration and emigration. Of course, introducing considerations on migration opens the door to a series of questions on the determinants of a person's decision to move to another country. They include the intrinsic heterogeneity in immigration profiles, as well as possible interactions with ageing (e.g. Bettio et al., 2006). A comprehensive assessment of those issues

[3]Given that $y_{BP} = \rho z$, the reader might notice some similarities between Eq. (10) and conventional estimations of the so-called growth equation. Our approach, nonetheless, comes with two important differences. First, we are dealing with the rate of growth compatible with equilibrium in the balance-of-payments, that was showed to be very closed to actual growth trends. In fact, as shown in the Appendix A.1, the difference between y and y_{BP} is a zero-mean reverting process. Second, we are assessing the impact of a set of explanatory variables on long-run growth through non-price competitiveness effects as in the dynamic Harrod trade-multiplier.



(a) (b)

(c) (d)

Figure 7: Scatter plots of the correlations between non-price competitiveness (ρ) and OADR, population growth with (Pop) and without (Nat) migration, and net migration (Mig).

goes beyond the scope of the paper. The findings of this study have to be seen in the light of the limitation mentioned above.

Since:

$$Pop = Nat + Mig$$

for each country, we run two different sets of regressions. First, considering only Pop as an explanatory variable. Later on, we used Nat and Mig instead. Time series are annual and come from Eurostat. Fig. 7 shows the scatter plots between ρ against OADR, Pop, Nat, and Mig when we pooled data. At first glance, we have a negative correlation between ageing and non-price competitiveness. We can also infer that population decline is negatively related to long-run growth through ρ. Nonetheless, these initial insights mask significant heterogeneity among countries and further require controlling for different confounding effects.

We select a number of additional potential determinants of non-price competitiveness, dividing them into three main groups:

1. Factors of production.

2. Aggregate demand and inequality.

3. The real exchange rate

The set of controls capturing the role of production factor accumulation comes from the Penn World Table (PWT 10.0). More conventional approaches have highlighted that human capital is an essential explanatory variable of economic prosperity (Lucas, 1988; Klemp and Weisdorf, 2018). Different measures and indexes of human capital have been built over the years. Here we limit ourselves to include the growth rate of the human capital index (HC), as reported by the PWT. In line with a long tradition emphasising that technical progress is to some extent capital embodied (e.g. Kaldor, 1980; Romero, 2019), we include the rate of growth of capital accumulation (K), from the PWT, and the Economic Complexity Index (ECI), as reported by the Atlas of Economic Complexity. In addition, we have incorporated the ratio between total factor productivity in the domestic economy and the technological frontier (TFP), i.e. the United States. This indicator has some similarities with the technological gap approach. It has been argued that it plays a role in explaining the non-price competitiveness of a given country or region (e.g. Verspagen, 1993; Cimoli and Porcile 2014; Cimoli et al., 2019).

One of the main findings of Felipe and Lanzafame (2020) was that the composition of aggregate demand matters to determine the rate of growth compatible with equilibrium in the balance-of-payments. Hence, we include the investment rate (I/Y) and government expenditures (G/Y) as a proportion of GDP in our regressions. This last set of controls also includes the degree of openness of the economy ($Open$) measured as the sum of exports and imports over GDP. Data comes from the PWT. Using the Macro-History Database from Jordà et al. (2017), we included the public debt to GDP ratio (D/Y), except Austria, for which time series were not available.

Given the existing evidence indicating that the level of the exchange rate appears to influence resource allocation and thus might impact non-price competitiveness, especially in developing countries (Rodrik, 2008; for a review see Demir and Razmi, 2021), we control for this effect including the natural logarithmic of the real exchange rate (RER) from the Bruegel datasets. Notice that our estimates of the trade equations already included price effects, which are not statistically significant. Still, we need to explore the possibility of a development channel from price to non-price competitiveness. A more depreciated exchange rate directly affects trade, making exporting easier and importing more challenging. Therefore, a country or region may start to substitute imports or promote exports because it is cheap. In that case, however, production is likely to be of low quality. Our results so far consider such an effect. The development channel gives one step forward and suggests that an RER depreciation sustained over time might compensate for asymmetric information problems and allow for processes of learning-by-exporting. In that case, quality is expected to improve slowly, and the exchange rate level might influence ρ.

Finally, we control for the share of income going to the so-called top 1%. In this case, series were obtained from the World Inequality Database. We apply the CF filter to all growth rates to remove the cyclical component of the series. In the Appendix A.3, we report robustness checks using $\rho - HP$ and applying the Hodrick-Prescott filter to the remaining growth rates among our explanatory variables. One should point out that growth rates are in the scale $[0, 100]$, which allows a more straightforward interpretation of the estimated coefficients.

4.2 WALS and BMA estimates

Even though economic theory provides valuable information on the empirical model specification, it offers little guidance about the *true* data-generating process. This fact creates a fundamental problem of model uncertainty, given that it is not clear *a priori* which explanatory variables must be included or which functional forms are appropriate. For instance, the choice of excluding a subset of regressors comes with a trade-off between bias and precision. To tackle such an issue, we apply the WALS and BMA estimators developed by Leamer (1978) and Magnus et al. (2010), relying on the implementation package in De Luca and Magnus (2011). These model-averaging techniques provide a coherent way of making inference on the regression parameters by considering the uncertainty due to both the estimation and the model selection steps.

The basic idea of BMA is that we need first to estimate the parameters of interest conditional on each model in the model-space, later computing the unconditional estimate as a weighted average of the former. Its key ingredients are the sample likelihood function and the prior distributions on both the regression parameters of the model and the model-space. On the other hand, WALS relies on preliminary orthogonal transformations of the auxiliary regressors and their parameters. It dramatically reduces the computational burden and allows a more transparent concept of ignorance about the role of the auxiliary regressors (see also Danilov and Magnus, 2004).[4]

We begin reporting in Tables 1 and 2 our WALS estimates of the determinants of non-price competitiveness in Southern and Western Europe. A regressor is considered robust if the t ratio on its coefficient is greater than one in absolute value. Alternatively, Masanjala and Papageorgiou (2008) indicated that a posterior inclusion probability (pip) > 0.5 stands as an equivalent condition. Recall that, as a dependent variable, we have taken the natural logarithm of the ratio between the income elasticities, $\ln \rho$. Given that $y_{BP} = \rho z$, as in Eq. (A.2), this allows us to interpret the obtained coefficients as percentage changes of the long-run rate of growth.

In Italy and Spain, an increase in the OADR is associated with reducing ρ. The estimated coefficient ranges from -0.06 to -0.32. They mean that ageing harms long-run economic growth perspectives. Germany and Austria also present a negative coefficient but a lower magnitude that sometimes is not statistically significant. Results are inconclusive in the case of Portugal. A 10-points increase in the OADR is associated with a 3% lower y_{BP} in Italy. Still, in France, we found the opposite effect, in line with the idea that whether ageing itself should always be regarded as a problem is a controversial matter. A 10-points increase in the French OADR is related to 1-2% higher y_{BP}. Differentiating between population growth with and without migration, coefficient magnitudes in France and Italy is similar, though with the opposite sign. Indeed, the two countries are in very different moments in the process of demographic transition. While Italy shows a clear negative trend in population growth (without migration) and a fertility rate below 1.5, France has experienced a steady demographic expansion with fertility rates below 2.

As pointed out at the beginning of the paper, France never reported a natural population decline. Instead, this country has adopted an explicit set of pro-natal policies that,

[4]Based on a classical linear regression framework, these estimators divide explanatory variables into two subsets: focus and auxiliary. The former consists of regressors with solid theoretical support, while the latter corresponds to additional variables whose inclusion is less certain. The number of possible models to be considered is equal to 2^k, where k is the number of auxiliary regressors. We assume all variables are auxiliary for completeness, resulting in a model-space up to 8192 models.

Table 1: WALS estimates of the determinants of non-price competitiveness in Southern Europe

	Dependent variable: ln ρ_{t+1}											
	Italy				Spain				Portugal			
Explanatory	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
OADR_t	-0.3239104	-3.48	-0.1779249	-2.97	-0.0610007	-1.51	-0.2064358	-4.13	0.0945807	5.30	-.0397226	-2.91
Pop_t	-1.154448	-2.44	–	–	-0.1570261	-0.37	–	–	0.6997513	5.57	–	–
Nat_t	–	–	7.279481	5.86	–	–	-2.769414	-3.55	–	–	1.055696	20.44
Mig_t	–	–	-5.195095	-7.94	–	–	-1.085395	-2.42	–	–	-1.03749	-6.51
HC_t	-14.946	-3.73	-7.991907	-3.22	-3.411898	-3.06	-8.221735	-5.22	1.050384	16.64	.0979182	1.11
K_t	-0.0097834	-0.11	-0.5944816	-5.98	-0.0089699	-0.10	-0.043101	-0.55	0.1071401	4.14	-.1066565	-5.03
TFP_t	-0.0093819	-0.63	0.0332468	2.91	-0.002624	-0.35	0.0009475	0.16	-0.0013005	-0.62	-.0005255	-0.66
ECI_t	-0.5917236	-0.88	0.3314771	0.67	0.8083374	3.85	0.3278926	1.59	0.0931058	1.36	.0572322	2.19
I_t/Y_t	-0.0191972	-0.48	-0.0343302	-1.30	0.0267396	1.78	-0.0092722	-0.59	0.0029822	1.17	.0028126	2.95
G_t/Y_t	-0.09536	-1.22	-0.1361973	-2.53	-0.0074215	-0.23	-0.0176613	-0.66	-0.0043862	-0.73	-.0121326	-5.20
Open_t	-0.0403579	-3.31	-0.0198912	-2.18	-0.0192779	-3.11	-0.0172929	-3.53	-0.0010806	-1.18	-.0014149	-4.16
D_t/Y_t	-0.0399365	-2.78	0.004981	0.44	0.0107831	2.87	-0.0047951	-0.96	-0.0005113	-0.75	-.0017232	-5.98
ln RER_t	-1.755668	-1.88	-0.6740962	-1.13	1.247787	3.10	0.8303679	2.44	-0.0932245	-0.75	.2237972	4.31
Top $1\%_t$	-0.3034523	-3.09	-0.1668503	-2.51	-0.0178356	-0.26	-0.0238382	-0.43	-0.0197386	-1.56	.0035908	0.73
Const.	40.3211	4.18	18.1387	2.78	-2.406644	-1.08	9.739825	2.67	-3.690815	-4.48	.3826602	0.78
k_1	1		1		1		1		1		1	
k_2	12		13		12		13		12		13	
q	1.0000		1.0000		1.0000		1.0000		1.0000		1.0000	
c	0.6931		0.6931		0.6931		0.6931		0.6931		0.6931	
kappa	74.0		86.6		68.5		106.6		77.9		194.3	

Table 2: WALS estimates of the determinants of non-price competitiveness in Western Europe

	Dependent variable: ln ρ_{t+1}											
	Germany				France				Austria			
Explanatory	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
OADR_t	-0.009638	-0.98	-0.0135389	-1.45	0.1111791	3.04	0.1949957	8.29	-0.0443817	-4.65	-0.0271306	-3.08
Pop_t	0.6791929	11.93	–	–	4.538136	2.87	–	–	0.1389893	0.50	–	–
Nat_t	–	–	-0.038277	-0.05	–	–	14.55643	9.11	–	–	-16.97719	-3.68
Mig_t	–	–	0.6607606	11.43	–	–	-2.459178	-1.76	–	–	12.74896	3.81
HC_t	1.684702	7.60	1.513467	5.63	0.2890993	1.33	1.227033	6.32	1.303762	1.58	26.44622	3.97
K_t	0.0127076	1.23	0.0191339	1.78	-0.3845542	-5.23	-0.4745512	-10.87	-0.0499819	-8.94	-0.2757755	-4.60
TFP_t	0.0076775	3.58	0.0064628	2.63	-0.0275415	-2.83	-0.0039578	-0.57	0.0078605	2.30	0.0101888	3.67
ECI_t	-0.0694986	-0.88	-0.0590708	-0.76	-0.2196358	-1.08	-0.048137	-0.37	0.0988695	0.80	0.1300834	1.31
I_t/Y_t	0.0044833	1.10	0.0073481	1.48	0.0097937	0.69	-0.0364415	-3.39	0.0226643	3.73	0.0091389	1.45
G_t/Y_t	0.0286006	3.27	0.0211242	2.07	-0.0478708	-1.77	-0.0140106	-0.83	-0.0036278	-0.21	-0.002365	-0.19
Open_t	0.002237	1.62	0.0012093	0.83	-0.0184586	-5.38	0.0026627	0.72	-0.0049659	-5.74	-0.0018241	-1.76
D_t/Y_t	0.0054715	3.39	0.004976	3.10	-0.0012228	-0.33	0.0007755	0.35	–	–	–	–
ln RER_t	0.1990504	1.81	0.2596922	2.08	0.1933294	0.69	-0.5847398	-2.91	-0.1072113	-0.43	-0.0011887	-0.01
Top $1\%_t$	0.0035167	0.41	0.0037134	0.44	0.0586964	1.98	0.0663621	3.57	0.0119925	1.33	0.0075136	1.07
Const.	-3.610551	-5.57	-3.603963	-5.63	-1.5159	-0.93	-6.187469	-5.29	-0.3636259	-0.32	-17.62636	-3.83
k_1	1		1		1		1		1		1	
k_2	12		13		12		13		11		12	
q	1.0000		1.0000		1.0000		1.0000		1.0000		1.0000	
c	0.6931		0.6931		0.6931		0.6931		0.6931		0.6931	
kappa	41.0		52.7		47.8		46.2		41.1		441.7	

among other things, guarantees an all-encompassing public system of child-care facilities (e.g. Lechevalier, 2019). Our findings somehow suggest the possibility of relevant non-linearities or thresholds in the OADR-growth relationship. A deeper assessment of the differences between alternative regimes goes beyond the scope of the paper, but it is essential to acknowledge their existence. On the other hand, in Portugal, Germany, and France, our results indicate that for a 0.5% annual rate of population decline, output growth will slow down between 0.3 and 2.25%. This calculation follows that the estimated coefficient of *Pop* lies in the range of 0.67 in Germany to 4.5 in France.

Tables 3 and 4 bring our robustness checks using the BMA approach. In this case, the computational burden required to obtain the appropriate estimate is proportional to the dimension of the model space. Some coefficients lose significance. For example, OADR is no longer significant for Germany. Such a change also happens in Austria in the last set of regressions. Still, overall our main results are the same. An increase of 10-units in the OADR is related to reducing up to 2% in ρ for Italy and Spain. There is an increase in non-price competitiveness in Portugal and France up to 2%. On the other hand, population decline is likely to be a problem in these two countries. We understand these differences might be explained by the different moments each country finds itself in demographic transition and characteristics of the respective productive structures.

The relationship between demographic transition and the productive structure, as captured by ρ, might be mediated by labour productivity. This observation could explain why we obtain coefficients with opposite signs in different countries. At least two main mechanisms could be involved and a third is worth mentioning. First, in the long-run, a reduction in the size of the population is associated with shrinking markets. A weaker investment follows the prospect of declining demand, increasing the average plant age, reducing its competitiveness and the ability to explore dynamic economies of scale (a line of reasoning similar to the Kaldor-Verdoorn law, see Kaldor, 1966; 1967). Overlapping generations models predict that a decline in fertility rates and the size of the working-age population are associated with a lower rate of return to physical capital and may lead to a reduction in investment (e.g. Ludwig et al., 2012; Devriendt and Heylen, 2020). The expected final result is a reduction in labour productivity that might affect the non-price competitiveness of the country.

On the other hand, as there is a reduction in the workforce size, labour shortages might increase the bargaining power of workers and their ability to obtain real wage increases above productivity gains. Firms respond by increasing their search for labour-saving production techniques, thus increasing labour productivity. This argument has many similarities with the induced technical change hypothesis and goes back to classical authors such as K. Marx and more modern references such as J. Hicks in his *The Theory of Wages* (for a formalisation applied to the ageing problem, see Manfredi and Fanti, 2006; Rada, 2012). The third and final element in this puzzle corresponds to age-specific productivity profiles. An older workforce may be less open to innovation and the adoption of new technologies. Evidence on this last claim is controversial as some studies indicate that more experienced workforces can be more productive (as in Malmberg et al., 2008). Further research on disaggregating between each effect is to be encouraged.

So far, our discussion has not separated between the natural rate of growth of the population and the effect coming from net migration. Differentiating between these two elements brings significant heterogeneity into the picture. For instance, in Spain, *Pop* and *Mig* have a negative sign. On the other hand, reducing population growth without migration

Table 3: BMA estimates of the determinants of non-price competitiveness in Southern Europe

	Dependent variable: ln ρ_{t+1}																	
	Italy						Spain						Portugal					
Explanatory	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip
OADR_t	-0.2131691	-1.48	0.77	-0.2152581	-1.95	0.89	-0.0630536	-1.61	0.81	-0.214398	-5.90	1.00	0.1019155	6.42	1.00	0.0099257	0.36	0.75
Pop_t	-0.2180814	-0.47	0.34	–	–	–	-0.2752271	-0.61	0.49	–	–	–	0.8153868	7.31	1.00	–	–	–
Nat_t	–	–	–	7.435716	4.25	1.00	–	–	–	-2.580826	-5.40	1.00	–	–	–	0.9122014	6.82	1.00
Mig_t	–	–	–	-5.157901	-6.42	1.00	–	–	–	-0.9244487	-3.93	1.00	–	–	–	-0.2254762	-0.66	0.57
HC_t	-9.440539	-1.57	0.80	-7.091474	-1.54	0.80	-3.798806	-3.91	1.00	-8.03414	-8.54	1.00	1.129706	15.52	1.00	0.5178463	2.62	0.91
K_t	-0.0074935	-0.18	0.13	-0.7176401	-6.15	1.00	0.0235494	0.27	0.23	-0.0462118	-0.81	0.47	0.125426	5.64	0.99	-0.015533	-0.37	0.54
TFP_t	-0.0158143	-0.60	0.34	0.0271152	1.36	0.74	-0.002002	-0.43	0.28	0.0003284	0.13	0.10	0.0001003	0.11	0.09	0.0001772	0.16	0.11
ECI_t	-0.8938852	-0.85	0.50	0.0296711	0.14	0.09	0.9039822	4.06	1.00	0.2761489	0.97	0.57	0.0068563	0.16	0.09	0.0077188	0.16	0.13
I_t/Y_t	0.005063	0.26	0.17	-0.0069939	-0.35	0.20	0.0277334	2.07	0.87	-0.0003064	-0.06	0.12	0.0006034	0.35	0.18	0.0028169	0.83	0.49
G_t/Y_t	-0.0047847	-0.16	0.13	-0.0507043	-0.77	0.48	-0.0130569	-0.40	0.25	-0.0087345	-0.58	0.34	-0.0002624	-0.13	0.09	-0.0025544	-0.42	0.24
Open_t	-0.0492266	-2.78	0.99	-0.0102631	-0.67	0.40	-0.0208897	-4.05	0.99	-0.0203746	-4.75	1.00	-0.0000409	-0.09	0.08	0.0000188	0.04	0.09
D_t/Y_t	-0.0136701	-0.94	0.64	0.0125839	0.90	0.55	0.0113347	2.26	0.89	-0.001096	-0.37	0.22	-0.0000417	-0.12	0.09	-0.0001616	-0.24	0.16
In RER_t	-0.3075675	-0.40	0.22	-0.0832672	-0.25	0.14	1.196737	2.36	0.91	0.9005545	2.46	0.92	0.004322	0.09	0.08	0.047824	0.39	0.19
Top $1\%_t$	-0.3425113	-1.79	0.83	-0.223757	-1.70	0.83	-0.0024053	-0.10	0.10	-0.0050771	-0.23	0.11	-0.003451	-0.28	0.14	-0.0032814	-0.31	0.16
Const.	23.1521	2.26	1.00	14.36371	1.83	1.00	-2.145597	-0.73	1.00	8.808334	3.04	1.00	-4.846588	-6.81	1.00	-1.345627	-1.16	1.00
k_1	1			1			1			1			1			1		
k_2	12			13			12			13			12			13		
Model space	4096			8192			4096			8192			4096			8192		

Table 4: BMA estimates of the determinants of non-price competitiveness in Western Europe

	Dependent variable: ln ρ_{t+1}																	
	Germany						France						Austria					
Explanatory	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip
OADR_t	0.0075556	0.67	0.39	0.0028675	0.47	0.27	0.123842	2.15	0.92	0.2088946	6.65	1.00	-0.0462225	-2.00	0.89	-0.0023514	-0.28	0.15
Pop_t	0.7961317	11.07	1.00	–	–	–	5.312225	1.82	0.87	–	–	–	0.067567	0.23	0.25	–	–	–
Nat_t	–	–	–	-0.0293109	-0.14	0.13	–	–	–	15.06028	9.66	1.00	–	–	–	-23.88571	-4.62	0.99
Mig_t	–	–	–	0.798474	11.16	1.00	–	–	–	-1.52305	-0.85	0.52	–	–	–	18.26771	4.85	0.99
HC_t	2.160956	7.92	1.00	1.972123	8.35	1.00	0.0781693	0.38	0.20	1.094857	6.46	1.00	1.181541	0.98	0.70	38.18578	5.25	1.00
K_t	0.0021453	0.29	0.16	0.0023223	0.34	0.18	-0.4093869	-3.23	1.00	-0.5015563	-10.25	1.00	-0.0524519	-4.60	1.00	-0.3809158	-5.97	1.00
TFP_t	0.0091707	2.71	0.95	0.0065472	1.90	0.88	-0.0284867	-1.85	0.85	-0.0069538	-0.84	0.8	0.0082402	1.07	0.64	0.0068736	1.23	0.69
ECI_t	-0.0379453	-0.41	0.21	-0.0330149	-0.43	0.22	-0.2574199	-0.84	0.50	-0.0271415	-0.29	0.14	0.0227141	0.23	0.14	0.0074317	0.15	0.10
I_t/Y_t	2.57e-06	0.00	0.09	0.0002669	0.15	0.09	0.0194514	0.89	0.5	-0.0287673	-1.88	0.91	0.0250079	2.17	0.89	0.0008869	0.21	0.12
G_t/Y_t	0.0117514	1.01	0.59	0.0010545	0.23	0.14	-0.044424	-0.99	0.56	-0.0021598	-0.19	0.12	-0.0049005	-0.31	0.17	-0.0013665	-0.18	0.10
Open_t	0.0020076	1.08	0.61	0.0010522	0.75	0.43	-0.021971	-5.36	1.00	0.0001172	0.06	0.11	-0.0053073	-4.22	1.00	-0.0000625	-0.09	0.09
D_t/Y_t	0.0083604	3.76	1.00	0.0076144	4.49	1.00	-0.0000901	-0.03	0.17	0.0011351	0.40	0.20	–	–	–	–	–	–
In RER_t	0.0265074	0.32	0.17	0.0524007	0.48	0.25	0.0519638	0.27	0.13	-0.2101536	-0.69	0.40	0.0220845	0.17	0.10	0.0249098	0.22	0.11
$\text{Top 1\%}_t$	0.0006844	0.16	0.10	0.0009718	0.22	0.11	0.0309085	0.61	0.36	0.0491119	1.35	0.73	0.0029329	0.36	0.18	0.0014292	0.26	0.13
Const.	-3.380066	-4.22	1.00	-2.934565	-3.96	1.00	-1.129871	-0.55	1.00	-8.28695	-5.96	1.00	-0.6192759	-0.65	1.00	-25.15719	-4.86	1.00
k_1	1			1			1			1			1			1		
k_2	12			13			12			13			11			13		
Model space	4096			8192			4096			8192			2048			8192		

positively correlates with long-run economic performance. More importantly, immigrants also seem to be related to reducing non-price competitiveness. A possible explanation for these findings is that, in this country, high qualified labour is emigrating while those arriving might not be occupying "good jobs", which could explain why native high-skilled labour left the country in the first place. Notice that a consistent population decline is technically impossible in conventional (semi)endogenous growth models because it implies that no long-run balanced growth path exists in the first place (see, for example, Prettner, 2013).[5]

We also documented a negative correlation between rho and Mig for Italy, Portugal, and France. However, the coefficient of Nat is positive and significant. From Tables 1 and 2, we estimate that, without migration, a 0.5% population decline in those countries correlates with 3.5% lower long-run growth in Italy, 0.5% in Portugal, and 7.25% smaller y_{BP} in France. Natural population decline and net immigration seem to be related to lower growth in these nations. There is an evident contrast of such a profile with the case of Austria. It appears at the other extreme because, for a 0.5% annual rate of population decline, output growth will speed up 8% through ρ. Moreover, an increase of 1 percentage point in the net migration rate is related to 0.7% higher growth in Germany and 12.7% in Austria. We interpret these coefficients as reflecting a specific productive structure in which "good jobs" have been created in a proportion that has allowed immigrants to be absorbed in sectors related to higher long-run growth.

While we have argued that, in the long-run, growth is balance-of-payments constrained, the reader may question whether similar results could be obtained in terms of simple growth trends, y^T. Appendix A.4 reports alternative WALS models for this case. Our evaluation is that, in general, this last set of regressions confirms the main results presented in the paper. We want to highlight two in particular. First, the contrast between an "Italian model" in which ageing is strongly related to lower growth while population decline is associated with improved economic performance; and the "French case", where we have opposite signs in motion. Second, a contrast between countries in Southern Europe, in which Mig does not seem to be correlated with better economic performance, and the Germany & Austria club, where migration and growth seem to be moving hand-in-hand. Still, the main advantage of our approach comes precisely from exploring a novel channel through which demographic transition might affect long-run growth: the trade-multiplier.

5 Final considerations

Europe is experiencing a dramatic shift in its demographic structure that ends three centuries of unprecedented population growth. Whether population ageing and eventually its decline should be regarded as a problem is a controversial matter. There are few empirical estimates of the realised effect of such a process on economic growth. The present article attempts to fill this gap in the literature by assessing the impact of the demographic transition on the long-run economic performance of six European countries between 1971 and 2019.

[5] We would like to emphasise that the determinants of immigration as well as emigration are very specific and would require an investigation in its own right. Such an assessment might involve additional elements, including gender, education, age, among others. A comprehensive assessment of those issues goes beyond the scope of this paper. However, research exploring them, especially in an open-economy framework, is to be encouraged.

Most studies have relied on production functions in which factors are paid accordingly with marginal productivities in a closed economy set-up. Instead, we adopted an open economy framework under the premise that the income elasticity of exports over imports reflects the fundamentals of the productive structure. In this way, we explored a novel link between demographic transition, long-run economic performance, and the dynamic trade-multiplier. Applying time-varying-parameter estimation techniques, we showed that the growth rate compatible with equilibrium in the balance-of-payments is a good predictor of long-run growth. Furthermore, under the premise that the ratio between the income elasticity of exports over imports reflects the fundamentals of the productive structure, these estimates were employed to investigate the importance of age structure dynamics as one of its determinants. In Italy, for instance, a 10-points increase in the old-age dependency ratio is associated with a 3% lower y_{BP}, while in France, we have a slightly smaller opposite effect. We showed that the consequences of population decline are conditional to controlling for migration, with Germany and Austria differentiating themselves from their Southern Europe counterparts.

The relationship between demographic transition and the productive structure, captured by non-price competitiveness as in the trade-multiplier, might be mediated by labour productivity. We argued that at least two main mechanisms could be involved and a third is worth mentioning. First, a reduction in the size of the population signals the prospect of declining aggregate demand. Under shrinking markets, firms would respond by reducing investment plans, thus increasing the average plant age and reducing its correspondent competitiveness. Furthermore, one should expect a lower ability to explore dynamic economies of scale, adversely affecting overall productivity. Second, a reduction in the size of the labour force might increase *ceteris paribus* the bargaining power of workers, reducing investment profitability. To save profit margins, however, firms respond by increasing their search for labour-saving production techniques, increasing productivity and non-price competitiveness. Finally, an age-specific productivity profile might play an important role, as an older workforce is prone to be less open to adopting new technologies. The interaction between such contrasting forces explains why the net final effects of the demographic transition on long-run growth seem moderate, and there is significant heterogeneity between countries.

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A Appendices

A.1 The trade-multiplier as a centre of gravity

Theory indicates that, in the long-run, the actual rate of growth does not deviate from the rate compatible with equilibrium in the balance-of payments, i.e. $y = y_{BP}$. Thirlwall (1979) used Spearman's rank correlation coefficient to test the degree of association between actual and predicted growth rates. A more rigorous test was proposed by McGregor and Swales (1985) and consisted in regressing y on y_{BP}. Alternatively, the so-called McCombie test defines the hypothetical income elasticity of demand that exactly equates the actual and the balance-of-payments growth rates as $\pi' = x/y$. Then, if π' and the estimated π are not statistically significantly different, the hypothesis that a country is balance-of-payments constrained cannot be refuted (see McCombie and Thirlwall, 1994). Given that we obtained time-varying estimates of the income elasticities, in the present paper, we follow Felipe and Lanzafame (2020). Define $\Upsilon = y - y_{BP}$. Their procedure is consistent with the following testable hypothesis:

- Υ is a zero-mean reverting process.

To assess this condition, we proceed in two steps. First, we show that Υ is stationary. As reported in Tables A1 and A2, both the traditional Augmented Dickey-Fuller (ADF) and the non-parametric Phillips-Perron (PP) tests strongly reject the null of a unit root, suggesting that series are integrated of order zero, I(0). Thirlwall's law, y_{BP} was obtained using $\rho - CF$ estimates. It is possible to conclude that the difference between actual and predicted growth rates reverts to the mean.

We continue by estimating the following Autoregressive process:

$$\Upsilon_t = \alpha_0 + \sum_{i=1}^{l} \alpha_i \Upsilon_{t-i} + \varepsilon_{\Upsilon,i}$$

with $l = 1, 2, 3, 4$. As long as

$$H_0: \ \alpha_0 = 0$$

deviations from y_{BP} have zero-mean.

Tables A1 and A2 indicate that we cannot reject the null that α_0 is equal to zero. Altogether, these results support the idea that we are dealing with a zero-mean stationary process. In Fig. 5 and 7, we already showed that the long-run trend of the rate of growth in our sample of 6-EU countries is well-approximated by y_{BP}. Our last set of regressions suggests that short-term divergences between actual and estimated rates do not last nor are very persistent. Similar outcomes are obtained if we instead rely on $\rho - HP$ estimates. They are available to the reader under request.

Table A.1: y_{BP} as a centre of gravity in Southern Europe

	Mean reverting process: Unit root test Υ											
	Italy				Spain				Portugal			
	ADF		PP		ADF		PP		ADF		PP	
	t	Prob.	Adj. t	Prob.	t	Prob.	Adj. t	Prob.	t	Prob.	Adj. t	Prob.
	-6.224120	0.0000	-6.206480	0.0000	-3.324050	0.0193	-2.806135	0.0649	-2.676113	0.0875	-4.146205	0.0020

	Zero mean process: Dependent variable Υ_t											
	Italy				Spain				Portugal			
Explanatory	AR(1)	AR(2)	AR(3)	AR(4)	AR(1)	AR(2)	AR(3)	AR(4)	AR(1)	AR(2)	AR(3)	AR(4)
Υ_{t-1}	0.099749	0.101889	0.131548	0.134425	0.711633***	0.820117***	0.797043***	0.789867***	0.494917***	0.543017***	0.494808***	0.695892***
Υ_{t-2}	–	-0.12055	-0.120315	-0.122682	–	-0.177916	-0.116773	-0.116086	–	-0.180433	-0.321080**	-0.435730***
Υ_{t-3}	–	–	0.177461	0.180662	–	–	-0.066725	0.041630	–	–	0.158813	0.470043***
Υ_{t-4}	–	–	–	-0.019175	–	–	–	-0.141642	–	–	–	-0.384704***
α_0	-0.400701	-0.443131	-0.372847	-0.382868	-0.104547	-0.194619	-0.215094	-0.210936	-0.140312	-0.236420	-0.398469	-0.222001

*, **, ***, stand for10%, 5%, and 1% of significance, respectively

Table A.2: y_{BP} as a centre of gravity in Western Europe

	Mean reverting process: Unit root test Υ											
	Germany				France				Austria			
	ADF		PP		ADF		PP		ADF		PP	
	t	Prob.	Adj. t	Prob.	t	Prob.	Adj. t	Prob.	t	Prob.	Adj. t	Prob.
	-6.054544	0.0000	-6.507068	0.0000	-5.474242	0.0000	-5.382005	0.0000	-5.670317	0.0000	-5.932124	0.0000

	Zero mean process: Dependent variable Υ_t											
	Germany				France				Austria			
Explanatory	AR(1)	AR(2)	AR(3)	AR(4)	AR(1)	AR(2)	AR(3)	AR(4)	AR(1)	AR(2)	AR(3)	AR(4)
Υ_{t-1}	0.153787	0.183303	0.130797	0.142580	0.0239740*	0.250864*	0.215650	0.178748	0.156312	0.108915	0.061731	0.045945
Υ_{t-2}	–	-0.296953**	-0.300586**	-0.314346**	–	-0.125424	-0.177791	-0.203983	–	-0.149373	-0.212477	-0.294966*
Υ_{t-3}	–	–	-0.065011	-0.040772	–	–	-0.055654	-0.022039	–	–	0.107678	0.098074
Υ_{t-4}	–	–	–	-0.077664	–	–	–	-0.20494	–	–	–	-0.188983
α_0	-0.057297	-0.111567	-0.177578	-0.162454	0.034131	0.026882	-0.030045	-0.034843	-0.130298	-0.226962	-0.282093	-0.382238

*, **, ***, stand for10%, 5%, and 1% of significance, respectively

A.2 Comparison between y_{BP} and z^T

In Section 3, we estimated the time-varying income elasticities of exports and imports. The ratio between them gives us a measure of non-price competitiveness (ρ). A given country will grow faster or slower than the rest of the world (z) conditional to this variable being $\gtrless 1$:

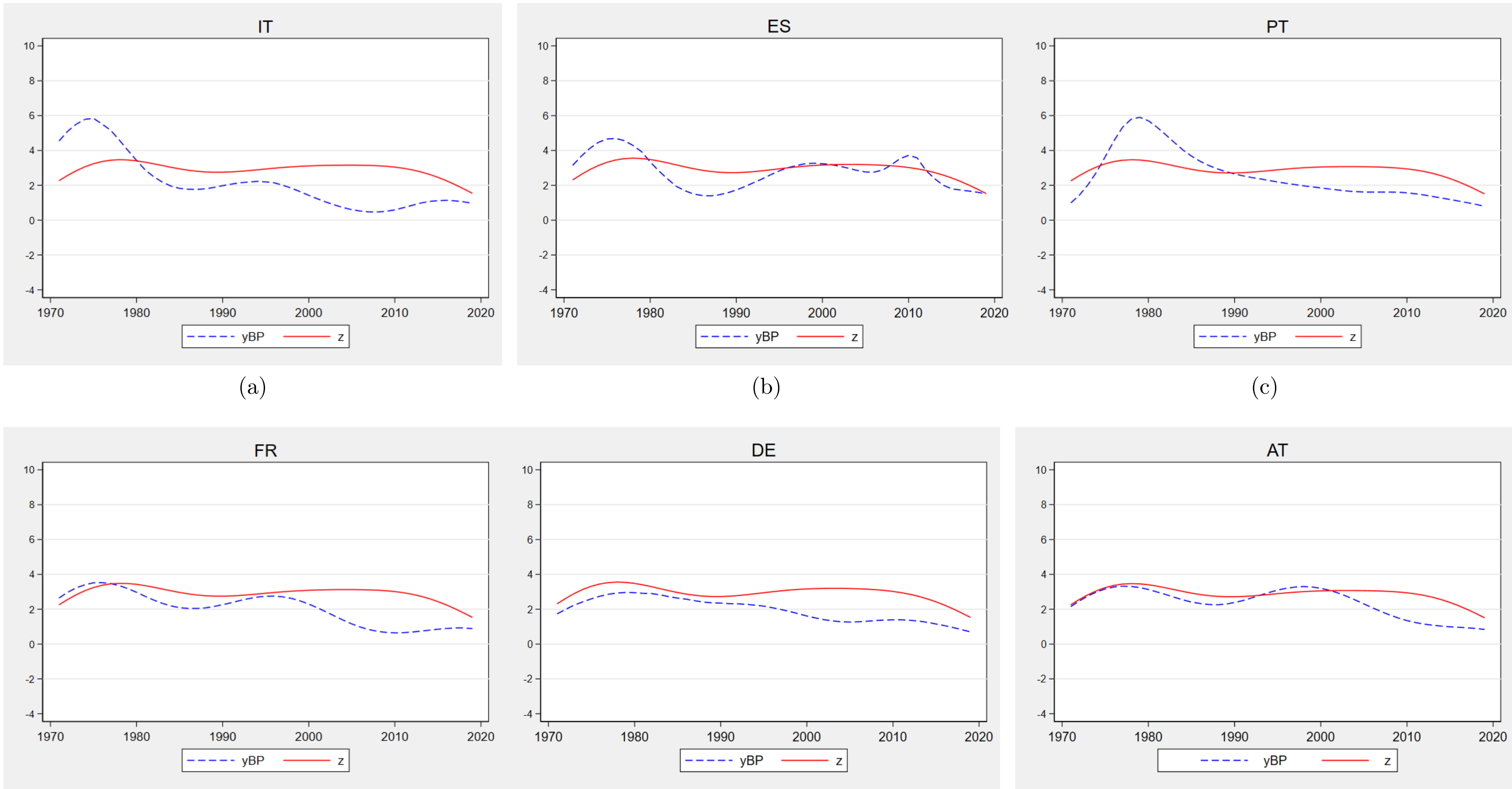
$$y_{BP,t} = \rho_t z_t^T$$

As showed in Fig. 6, until the 1990s, Southern Europe was growing more or less at the same pace as the rest of the world, i.e. $\rho \approx 1$. Nonetheless, such a trajectory has changed in the last 30 years of our sample for Italy and Portugal. They have been growing consistently less than the global economy, $\rho < 1$. Regarding Western Europe, similar trajectories emerge. Before the 1990s, Germany, France, and Austria grew more or less at the same pace as the rest of the world. After that, all three countries have been growing proportionally less. Fig. A1 provides an additional visualisation of such trajectories. The blue dotted line indicates the balance-of-payments constrained growth rate (y_{BP}). In red, we have z as obtained with CF filter.

A.3 Robustness checks using the HP filter

As indicated in the main text, we employed two different filters to separate trend and cycle components before estimating the respective trade equations, namely CF and HP. The use of alternative methods allowed us to obtain two different indicators of ρ. Section 4 presented our estimates of the effect of the demographic transition on growth using $\rho - CF$. In this Appendix, our purpose is to show that those findings are robust to using $\rho - HP$. Tables A3 and A4 report the WALS estimates for both samples of countries. There are somehow important differences in terms of the magnitudes of the obtained coefficients. For instance, in the case of Italy, we obtained an increase of 1 point in OADRs is related to 0.8-0.15% reductions in ρ, almost half of what was reported in Table 1. Still, the signs are the same, bringing some robustness to our analysis. The importance of differentiating between population growth with and without migration is highlighted. We obtained a negative and significant effect of Mig in Italy, Spain, Portugal, and France, while a positive sign for Germany and Austria.

We proceed by performing a series of similar tests with the BMA estimator, as in Tables A5 and A6. OADR coefficients lose significance for Italy, Portugal, Germany, and Austria. Only in Spain and France we can reject the null hypothesis that they are different from zero. Nonetheless, Nat and Mig are significant, with the obtained signs similar to those reported in Tables 1-4. Given the small time-dimension of our sample, and that BMA uses a less transparent concept of ignorance about the role of the auxiliary regressors (see De Luca and Magnus, 2011), it is not completely surprising that variances are higher in BMA than in WALS. We conclude that the obtained effects are moderate, and there is significant heterogeneity between countries. In any case, we believe empirical evidence gives some support to the hypothesis that demographic transition is likely to affect long-run growth through non-price competitiveness, as in Thirlwall's law.



(a) (b) (c)

(d) (e) (f)

Figure A.1: A comparison between y_{BP} and z^T, 1971-2019. The rate of growth compatible with equilibrium in the balance-of-payments was obtained using $\rho - CF$ estimates. Growth trends were also obtained using the CF filter.

Table A.3: WALS estimates of the determinants of non-price competitiveness in Southern Europe

	Dependent variable: ln ρ_{t+1}											
	Italy				Spain				Portugal			
Explanatory	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
OADR$_t$	-0.1569018	-1.63	-0.0837966	-0.95	-0.1044779	-3.00	-0.2160816	-4.48	0.0152468	1.32	-0.0058625	-0.55
Pop$_t$	-0.2694958	-0.64	–	–	0.0149404	0.04	–	–	0.0096259	0.09	–	–
Nat$_t$	–	–	1.961696	1.76	–	–	-2.85624	-2.72	–	–	0.5946747	4.25
Mig$_t$	–	–	-1.372372	-2.09	–	–	-1.018241	-1.98	–	–	-0.70526	-3.93
HC$_t$	-5.168715	-1.31	-3.201182	-0.93	-4.220871	-3.94	-8.291712	-4.89	1.082831	26.78	0.6662324	6.72
K$_t$	0.0232484	0.40	-0.0194523	-0.37	-0.105526	-1.90	-0.0796707	-1.64	-0.0766106	-5.75	-0.0919232	-8.06
TFP$_t$	-0.0203092	-1.83	-0.0111627	-0.97	-0.0135297	-1.68	-0.012086	-1.85	0.0083565	4.88	0.0039096	2.30
ECI$_t$	-0.5064401	-0.98	-0.0722058	-0.14	1.050297	4.06	0.5971045	2.28	-0.0478253	-0.74	-0.0675138	-1.32
I$_t$/Y$_t$	0.0109206	0.41	0.0014534	0.06	0.0332412	2.22	-0.0057382	-0.30	-0.0060081	-2.60	-0.0013937	-0.65
G$_t$/Y$_t$	-0.0682291	-1.29	-0.125545	-2.19	0.0356004	1.48	-0.0143349	-0.54	0.0171009	3.01	-0.0065571	-1.03
Open$_t$	-0.0379891	-4.87	-0.0386006	-5.26	-0.0256349	-3.79	-0.025663	-4.53	0.0023092	2.86	0.0002001	0.25
D$_t$/Y$_t$	-0.0163024	-1.48	-0.0080334	-0.77	0.0112969	3.52	-0.0038611	-0.65	0.0001664	0.25	-0.0005188	-1.02
In RER$_t$	-0.3580496	-0.55	-0.3143799	-0.52	1.911248	3.99	1.618523	3.88	-0.2567277	-2.01	0.0083743	0.06
Top 1%$_t$	-0.1592378	-2.29	-0.1098425	-1.54	-0.1029401	-1.37	-0.1053472	-1.67	-0.0076684	-0.71	0.009588	1.02
Const.	17.11914	1.98	7.730649	1.58	-2.292845	-0.90	8.668729	2.02	-1.184298	-1.86	-0.6681814	-1.27
k_1	1		1		1		1		1		1	
k_2	12		13		12		13		12		13	
q	1.0000		1.0000		1.0000		1.0000		1.0000		1.0000	
c	0.6931		0.6931		0.6931		0.6931		0.6931		0.6931	
kappa	105.9		115.5		48.1		93.6		57.1		97.6	

Table A.4: WALS estimates of the determinants of non-price competitiveness in Western Europe

	Dependent variable: ln ρ_{t+1}											
	Germany				France				Austria			
Explanatory	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
OADR$_t$	-0.0085373	-0.95	-0.0308288	-2.98	0.0590954	1.71	0.1678493	5.63	-0.0252668	-2.05	-0.005814	-0.55
Pop$_t$	0.4056811	5.08	–	–	0.1932654	0.22	–	–	0.3071395	1.06	–	–
Nat$_t$	–	–	-1.9331	-2.11	–	–	9.440837	5.53	–	–	-2.716356	-3.26
Mig$_t$	–	–	0.3235554	4.20	–	–	-5.305258	-4.57	–	–	1.39975	4.22
HC$_t$	1.303351	5.04	0.8992342	3.37	-0.2213311	-0.93	-0.0194168	-0.11	1.837584	1.95	4.458835	4.84
K$_t$	0.0663779	6.49	0.066817	7.20	-0.091066	-2.96	-0.1348192	-5.94	-0.0475811	-5.17	-0.0882664	-7.30
TFP$_t$	0.0067379	3.17	0.002957	1.24	-0.0157302	-1.98	-0.0137075	-2.44	0.0078768	2.27	0.0021764	0.71
ECI$_t$	-0.0750163	-1.1	0.0074441	0.10	0.0206981	0.11	0.1262954	0.94	0.0708465	0.58	0.0968193	1.03
I$_t$/Y$_t$	0.0117378	3.22	0.0165795	4.60	-0.0100392	-0.92	-0.0246818	-3.38	0.0238716	4.01	0.0191603	3.80
G$_t$/Y$_t$	0.0144745	1.78	0.0059684	0.71	-0.0996163	-5.00	-0.060681	-4.03	0.0083519	0.56	-0.0151447	-1.13
Open$_t$	-0.0014137	-1.19	-0.0024007	-2.07	-0.0192292	-5.08	-0.0074674	-2.11	-0.004173	-5.05	-0.0038032	-5.69
D$_t$/Y$_t$	0.0066799	3.85	0.0052375	3.33	-0.0077033	-1.88	-0.0111079	-3.84	–	–	–	–
In RER$_t$	0.0133936	0.13	0.108211	1.12	0.8457296	2.87	-0.0383765	-0.15	-0.1757272	-0.69	-0.0287324	-0.15
Top 1%$_t$	-0.0052877	-0.66	0.0028097	0.37	0.0515036	1.76	0.0487238	2.40	0.0149316	1.67	0.0129202	1.95
Const.	-2.26851	-3.34	-2.069548	-3.31	-1.071984	-0.59	-3.471223	-2.70	-1.096112	-0.96	-2.81829	-3.14
k_1	1		1		1		1		1		1	
k_2	12		13		12		13		11		12	
q	1.0000		1.0000		1.0000		1.0000		1.0000		1.0000	
c	0.6931		0.6931		0.6931		0.6931		0.6931		0.6931	
kappa	47.3		65.1		40.0		44.4		41.2		52.8	

Table A.5: BMA estimates of the determinants of non-price competitiveness in Southern Europe

	Dependent variable: ln ρ_{t+1}																	
	Italy						Spain						Portugal					
Explanatory	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip
OADR_t	-0.0129241	-0.30	0.20	0.0012658	0.07	0.15	-0.1592567	-4.90	0.99	-0.2573229	-7.22	1.00	0.019977	0.70	0.51	0.0010612	0.14	0.10
Pop_t	0.0512576	0.30	0.23	–	–	–	-0.8100578	-2.82	0.94	–	–	–	0.0670262	0.36	0.31	–	–	–
Nat_t	–	–	–	3.264317	3.04	0.96	–	–	–	-3.064578	-6.07	1.00	–	–	–	0.5594984	3.62	0.98
Mig_t	–	–	–	-1.923064	-2.39	0.92	–	–	–	-1.366608	-4.50	0.99	–	–	–	-0.4373836	-3.25	0.97
HC_t	-0.0833501	-0.06	0.15	-0.259668	-0.35	0.25	-6.829618	-7.43	1.00	-9.527961	-10.33	1.00	1.095104	14.74	1.00	0.7779034	10.09	1.00
K_t	-0.0004994	-0.03	0.09	-0.0065207	-0.30	0.15	-0.0065622	-0.25	00.13	-0.0299707	-0.68	0.40	-0.0759354	-2.16	0.87	-0.092206	-8.36	1.00
TFP_t	-0.0342987	-3.57	0.98	-0.0059718	-0.61	0.40	-0.0014138	-0.25	0.15	-0.0016486	-0.32	0.16	0.0056778	1.37	0.76	0.0009896	0.43	0.23
ECI_t	-0.0487312	-0.16	0.13	-0.0318278	-0.20	0.12	1.399813	5.55	1.00	0.7173427	2.07	0.89	-0.0021932	-0.04	0.11	-0.0084335	-0.20	0.10
I_t/Y_t	0.0043829	0.33	0.17	-0.0026432	-0.23	0.14	0.0036906	0.45	0.25	-0.00063	-0.15	0.11	-0.0023643	-0.57	0.33	-0.0001155	-0.08	0.10
G_t/Y_t	-0.026445	-0.69	0.41	-0.1490141	-2.37	0.93	-0.0005575	-0.06	0.12	-0.0015069	-0.22	0.12	0.0198173	1.82	0.84	-0.0007376	-0.14	0.14
Open_t	-0.0509148	-6.02	1.00	-0.0482128	-7.87	1.00	-0.0163905	-2.86	0.97	-0.0249457	-4.50	1.00	0.0005256	0.40	0.21	0.0000258	0.006	0.08
D_t/Y_t	-0.0111777	-1.87	0.85	-0.0000614	-0.02	0.19	0.010047	3.55	0.99	0.0001074	0.07	0.11	0.0003184	0.40	0.24	-0.0000446	-0.13	0.09
In RER_t	-0.0239725	-0.13	0.10	-0.1948206	-0.47	0.25	1.658128	4.35	1.00	1.347151	2.96	0.99	-0.1724909	-0.48	0.27	-0.0165012	-0.18	0.10
Top $1\%_t$	-0.0771201	-0.85	0.50	-0.0187374	-0.38	0.20	-0.0049073	-0.17	0.11	-0.0829308	-1.12	0.64	-0.002817	-0.23	0.14	0.0012877	0.18	0.10
Const.	7.275062	2.84	1.00	6.001112	2.46	1.00	0.5289658	0.82	1.00	9.773213	3.54	1.00	-1.627506	-1.25	1.00	-0.7452885	-1.75	1.00
k_1	1			1			1			1			1			1		
k_2	12			13			12			13			12			13		
Model space	4096			8192			4096			8192			4096			8192		

Table A.6: BMA estimates of the determinants of non-price competitiveness in Western Europe

	Dependent variable: ln ρ_{t+1}																	
	Germany						France						Austria					
Explanatory	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip	Coef.	t	pip
OADR_t	0.0002285	0.07	0.11	-0.0016363	-0.22	0.14	0.0018544	0.17	0.15	0.1982563	3.74	0.99	-0.0167291	-0.71	0.42	-0.000044	-0.01	0.10
Pop_t	0.5664483	7.46	1.00	–	–	–	-0.2952011	-0.47	0.30	–	–	–	0.2981145	0.76	0.50	–	–	–
Nat_t	–	–	–	-0.0823213	-0.15	0.11	–	–	–	12.74281	4.54	0.99	–	–	–	-2.804044	-2.35	0.93
Mig_t	–	–	–	0.5986975	5.91	1.00	–	–	–	-6.398482	-5.08	1.00	–	–	–	1.779419	3.94	0.99
HC_t	1.892974	9.72	1.00	1.924223	6.12	0.99	-0.040655	-0.29	0.15	-0.0401088	-0.29	0.18	2.07039	1.43	0.78	5.802388	5.49	1.00
K_t	0.0535335	5.26	1.00	0.0520498	4.45	1.00	-0.1222791	-3.07	0.94	-0.1857637	-3.93	0.99	-0.0542301	-3.05	1.00	-0.1054668	-6.86	1.00
TFP_t	0.008124	3.32	0.98	0.0091945	3.47	0.97	-0.000584	-0.23	0.13	-0.0097873	-0.98	0.58	0.0056872	0.76	0.46	0.0005768	0.28	0.15
ECI_t	-0.0205648	-0.36	0.18	-0.0031215	-0.11	0.08	-0.0014647	-0.02	0.09	0.0179796	0.25	0.12	0.0075091	0.12	0.12	0.0112116	0.20	0.11
$\mathrm{I}_t/\mathrm{Y}_t$	0.00189	0.47	0.25	0.0046781	0.81	0.49	-0.0024101	-0.28	0.16	-0.0173856	-1.23	0.69	0.0198107	1.76	0.87	0.020944	3.51	0.98
$\mathrm{G}_t/\mathrm{Y}_t$	0.0016053	0.34	0.8	0.0001953	0.07	0.09	-0.0872063	-3.27	1.00	-0.030309	-0.95	0.57	-0.0001432	-0.02	0.12	-0.0031726	-0.29	0.16
Open_t	-0.0001014	-0.16	0.10	-0.0003577	-0.34	0.17	-0.0220383	-6.77	1.00	-0.0047128	-0.86	0.52	-0.0046707	-3.92	1.00	-0.0030534	-3.69	1.00
$\mathrm{D}_t/\mathrm{Y}_t$	0.0091812	5.28	1.00	0.0094004	4.55	0.99	-0.0000921	-0.07	0.11	-0.011174	-2.25	0.98	–	–	–	–	–	–
In RER_t	0.0039902	0.11	0.08	0.0051157	0.14	0.08	1.027308	2.08	0.89	-0.0202743	-0.15	0.10	0.0172154	0.15	0.10	0.014	0.15	0.09
Top $1\%_t$	-0.000415	-0.13	0.09	-0.0004927	-0.16	0.09	0.0846955	2.93	0.96	0.0451442	1.27	0.71	0.0048576	0.48	0.26	0.0041055	0.51	0.27
Const.	-2.767827	-5.68	1.00	-3.01672	-5.05	1.00	-2.602684	-0.87	1.00	-6.236666	-2.67	1.00	-1.55328	-1.81	1.00	-3.809611	-4.51	1.00
k_1	1			1			1			1			1			1		
k_2	12			13			12			13			11			13		
Model space	4096			8192			4096			8192			2048			8192		

A.4 Robustness checks using growth trends

Throughout this paper, we argued that, in the long-run, growth is balance-of-payments constrained as in the dynamic trade-multiplier. We showed that our estimates of y_{BP} work as a centre-of-gravity of the economy, to the extent that the difference with the actual rate of growth is a mean-reverting process. The income elasticity of exports over imports captures the non-price competitiveness of the country and is determined by the fundamentals of the productive structure. Empirical evidence seems to give some support that ρ changes hand-in-hand with the demographic transition, though the estimated effects are moderate and there is significant heterogeneity between countries.

Still, the reader might wonder whether analogous correlations can be found in terms of output growth trends, y^T. Indeed, in Figs. 4 and 5, we could see that y_{BP} and the filtered rate of growth are very similar. This Appendix reports WALS estimates of Eq. (10) using y^T as a dependent variable. The latter was obtained using the CF filter. For consistency, control variables in growth rates were also detrended using the same method. Table A.7 presents results for Southern Europe, while in Table A.8, we have the case of Western Europe. Our evaluation is that, in general, this last set of WALS regressions confirms the main results reported in the paper. BMA estimations do not provide additional qualitative insights and are available under request. For instance, in Italy, population ageing is negatively correlated with long-run growth. Population decline, on the other hand, is associated with higher growth. The Italian model can be contrasted with the French one, given that in the latter, an increase in OADR is related to higher growth while the coefficient of *Pop* is positive.

Ageing is also negatively correlated with growth in Spain. However, some differences appear in the cases of Portugal, Germany, and Austria. Our previous estimates were inconclusive for Portugal, while now we have a clear negative and significant coefficient for OADR, ranging between -0.25 and -0.42. In Germany, something similar happens. The reported coefficients in Tables 2, 4, and A.8 were either very small or non-significant. Austria perhaps appears as the main surprise, given that the modest but negative coefficient is now positive and quite significant, ranging between 0.1 and 0.14.

Migration continues to harm growth in Italy and Portugal, becoming non-significant in Spain and France. Once more, we obtain a strongly significant effect in Germany and Austria. We explained these differences as reflecting a specific productive structure in which jobs have been created in magnitudes that have allowed immigrants to be absorbed in sectors related to higher long-run growth. Moreover, it is well known that these two countries compete in the international arena in terms of the quality and differentiation of the goods or services they produce rather than price.

Table A.7: WALS estimates of the determinants of y^T in Southern Europe

	Dependent variable: y^T_{t+1}											
	Italy				Spain				Portugal			
Explanatory	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
OADR_t	-0.2132285	-2.62	-0.1253319	-2.32	0.0072676	0.07	-0.3147582	-2.28	-0.4266949	-5.94	-0.2542133	-2.15
Pop_t	-0.5569018	-1.33	–	–	2.487826	1.80	–	–	-2.496926	-4.97	–	–
Nat_t	–	–	5.632905	4.84	–	–	-2.814076	-1.43	–	–	-2.822067	-4.97
Mig_t	–	–	-3.659033	-5.53	–	–	1.023507	0.88	–	–	-0.1197902	-0.09
HC_t	-6.230053	-1.79	-1.671028	-0.79	5.414503	1.56	-3.668908	-0.93	1.742976	6.86	3.008562	3.93
K_t	-0.2161479	-2.68	-0.6642229	-6.68	-0.3752642	-1.43	-0.5101373	-2.10	-0.6495579	-6.25	-0.3563266	-1.94
TFP_t	-0.0101233	-0.74	0.0226524	1.87	-0.0096902	-0.42	-0.0075104	-0.44	0.0009056	0.10	-0.0001189	-0.01
ECI_t	-0.5594725	-0.93	0.0780686	0.16	2.549506	4.27	1.396655	2.24	-0.0834147	-0.30	-0.1216335	-0.40
I_t/Y_t	-0.0034261	-0.10	-0.0159009	-0.60	0.0582934	1.35	-0.0142707	-0.34	0.0131642	1.31	0.017014	1.61
G_t/Y_t	-0.1160152	-1.67	-0.1474971	-2.73	-0.2821081	-3.09	-0.2745477	-3.41	-0.1022093	-4.43	-0.0891509	-3.48
Open_t	-0.0410607	-3.71	-0.0236286	-2.48	-0.0354373	-2.03	-0.0334024	-2.38	-0.0060444	-1.55	-0.0052493	-1.38
D_t/Y_t	-0.0280586	-2.24	0.0036925	0.35	0.0482906	4.58	0.0181082	1.36	0.0023398	0.92	0.0058033	1.81
ln RER_t	-1.129782	-1.37	-0.4321532	-0.75	3.49887	3.05	2.912502	2.93	1.445426	2.86	1.068341	1.97
Top $1\%_t$	-0.2901688	-3.29	-0.1921535	-2.86	-0.3608187	-1.84	-0.4053163	-2.46	0.0707406	1.40	0.0434939	0.81
Const.	28.58847	3.40	13.81192	2.42	-13.60204	-1.99	10.68951	1.12	8.509701	2.60	2.685203	0.58
k_1	1		1		1		1		1		1	
k_2	12		13		12		13		12		13	
q	1.0000		1.0000		1.0000		1.0000		1.0000		1.0000	
c	0.6931		0.6931		0.6931		0.6931		0.6931		0.6931	
kappa	74.0		86.6		68.5		106.6		77.9		194.3	

Table A.8: WALS estimates of the determinants of y^T in Western Europe

	Dependent variable: y^T_{t+1}											
	Germany				France				Austria			
Explanatory	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
OADR_t	0.024683	1.10	0.0020873	0.10	0.0925742	1.13	0.1678037	1.95	0.1096574	7.12	0.1438156	13.34
Pop_t	1.641936	12.40	–	–	6.315984	1.79	–	–	2.62341	5.93	–	–
Nat_t	–	–	-0.9652392	-0.61	–	–	15.14115	2.63	–	–	-27.33738	-5.33
Mig_t	–	–	1.589143	12.60	–	–	0.4583183	0.11	–	–	24.31587	6.56
HC_t	4.049481	7.96	3.383906	5.72	1.00188	1.92	1.806273	2.82	12.34836	9.44	55.41043	7.51
K_t	0.0760477	3.15	0.0900593	3.70	-0.4630047	-2.82	-0.5438915	-3.41	-0.1389653	-16.45	-0.5284515	-7.95
TFP_t	0.0239993	4.88	0.0186739	3.46	-0.005871	-0.27	0.0138733	0.62	-0.0190584	-3.56	-0.0158068	-4.56
ECI_t	-0.3377462	-1.87	-0.3027112	-1.74	-0.7393677	-1.56	-0.6254039	-1.39	0.60617	3.53	0.6775091	5.92
I_t/Y_t	-0.0128639	-1.38	-0.0021312	-0.19	-0.0315011	-0.97	-0.0697871	-1.99	0.0088863	0.99	-0.0164035	-2.31
G_t/Y_t	0.0155062	0.77	-0.0040485	-0.17	-0.0311236	-0.52	-0.0002184	0.00	-0.0013997	-0.05	-0.0150926	-0.88
Open_t	0.0031186	0.99	0.0008283	0.24	-0.0050038	-0.59	0.0138487	1.09	-0.0041173	-3.17	0.0006108	0.50
D_t/Y_t	0.0114851	3.11	0.0090874	2.55	-0.0060137	-0.72	-0.0045396	-0.59	–	–	–	–
ln RER_t	0.2869565	1.14	0.5608251	2.04	2.047529	2.94	1.365784	1.79	-0.489009	-1.51	-0.2391441	-1.12
Top $1\%_t$	-0.0312627	-1.59	-0.0284456	-1.52	0.011263	0.17	0.012775	0.20	-0.0107594	-0.88	-0.0176411	-2.28
Const.	-4.178	-2.83	-4.29027	-3.05	-8.523139	-2.21	-12.59175	-2.94	-4.207897	-2.70	-33.82178	-6.64
k_1	1		1		1		1		1		1	
k_2	12		13		12		13		11		12	
q	1.0000		1.0000		1.0000		1.0000		1.0000		1.0000	
c	0.6931		0.6931		0.6931		0.6931		0.6931		0.6931	
kappa	41.0		52.7		47.8		46.2		41.1		441.7	