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Demographics, pension systems, and the current account: an empirical assessment using the IMF current account model[*]

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Abstract

This paper empirically assesses the link between demographics, pension systems, and current account (CA) balances using the IMF External Balance Assessment (EBA) model. We propose two refinements to the EBA model. We first refine the existing demographic variables to better account for the entire population age structure of countries. Compared to the EBA specification, we find a more robust, smoother, and economically intuitive effect of demographics on CA balances across countries. We then introduce new indicators to account for pension systems. We find a positive and statistically significant relationship between the generosity and coverage of fully funded pension systems and CA balances. Our refinements broadly improve the EBA model fit, especially for advanced economies with a fully funded pension system.

JEL classification: F32, F41, H55, J11.
Keywords: current account, demographics, pension systems, EBA model.

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1 Introduction

Since the global financial crisis, global current account (CA) surpluses and deficits have remained broadly stable, at approximately 3% of world GDP (IMF, 2019). Nonetheless, they remain a significant source of concern for economists (Obstfeld, 2018). The main question regarding global CA balances is whether rebalancing is warranted. Answering this question, however, is not straightforward. On the one hand, CA surpluses or deficits may be warranted by macroeconomic fundamentals and policies, reflecting countries' intertemporal optimal resource allocation. On the other hand, they may reflect an accumulation of risks, driven by macroeconomic distortions. When determining whether adjustment is warranted, the difficulty is thus to distinguish 'healthy' from 'excessive' CA balances (Lane & Milesi-Ferretti, 2011).

The International Monetary Fund (IMF) developed the External Balance Assessment (EBA) methodology to support this policy objective. The methodology centres on a CA model, which empirically examines CA determinants through the lens of the absorption approach and estimates the 'optimal' level of CA balances across countries that is warranted by macroeconomic fundamentals. Using this EBA model, the IMF estimates that 35 to 45% of overall CA balances were 'excessive' in 2018 and recommends policy adjustments to reduce them (IMF, 2019). However, a significant share of these 'excessive' CA balances cannot be traced back to identified distortions but reflects the model residuals, which are treated as distortions. Articulating policy recommendations on the basis of model residuals may be difficult, especially if those residuals could be explained by fundamentals outside the EBA empirical framework.

Understanding the determinants of CA balances is thus essential to provide sound policy advice. The IMF's EBA model builds on the empirical literature that examines CA determinants using large cross-country panel data sets (Chinn & Prasad, 2003; Gruber & Kamin, 2007, 2009; Chinn & Ito, 2008; Ca'Zorzi et al., 2012; Chinn et al., 2014). Our paper contributes to this literature by introducing new drivers of the CA balance to the EBA model. We show that within the EBA framework, accounting for countries' entire population age structure and specific aspects of pension systems – funding, generosity, and coverage – matters for CA balances across countries. Taken together, our refinements broadly reduce the EBA model's residuals, especially for small advanced economies with a fully funded pension system.

Our first refinement introduces an alternative demographic measure to the EBA model following Fair & Dominguez (1991), which accounts for a country's entire population age structure. To do so, their approach restricts age-group coefficients to lie on a polynomial, thereby minimizing the number of estimated coefficients, while still identifying the full demographic effect. Within the EBA framework, this new modelling approach generates statistically and economically significant demographic effects, consistent with the 'hump'-shaped saving pattern of the life-cycle hypothesis (Ando & Modigliani, 1963).

Modelling demographics following Fair & Dominguez (1991) attenuates limitations of the EBA model's current demographic variables (the population growth, the prime savers share, and the old-age dependency ratio). First, we reduce the dependence on the researcher's modelling choice, as we do not restrict demographics to certain age groups and instead account for the entire population age structure. Second, our refinement generates smoother predictions of the contribution of countries' population age structure to the CA balance over time, consistent with slow-moving demographics. It finally yields economically intuitive predictions of the contribution of countries' population age structure to CA balances. For instance, demographics are associated with a lower CA balance in countries with a young population, and with a higher CA balance in countries with a large working age population. Moreover, countries with a similar population age structure have a similar demographic contribution to their CA balance.

Our second refinement introduces indicators for pension systems to the EBA model. A large literature argues that the design of pension systems may influence the level of aggregate saving, and thus the CA (Samuelson, 1958; Auerbach & Kotlikoff, 1987; Feldstein, 1996; Poterba et al., 1996; Loayza et al., 2000; Samwick, 2000; Orszag & Stiglitz, 2001; Börsch-Supan et al., 2005; Engelhardt & Kumar, 2007; Gelber, 2011; Eugeni, 2015; Keuschnigg et al., 2015; Davoine, 2019). Finding adequate indicators to assess this relationship, however, is not straightforward given the complexity of pension systems across the world and the high data requirements in the EBA framework. In this paper, we focus on three aspects of pension systems: funding, generosity, and coverage. We follow Bloom et al. (2007), who construct replacement rates for pay-as-you-go (PAYG) and fully funded pension systems and an indicator for de jure universal coverage.[1] Following their methodology, we extend their data to match the EBA coverage over time and across countries. We complement their de jure coverage measure with two de facto coverage measures from the World Bank (WB) and the International Labour Organization (ILO), which better account for the cross-sectional variation in coverage.

In a first empirical test, we find a positive and statistically significant relationship between the replacement rate of fully funded systems and the CA balance. In contrast, we find no such relationship for PAYG systems.

[1] The replacement rate is the ratio of the annual pension to the annual salary of a representative worker. Under a PAYG system, the government taxes the current working population to pay the pensions of current retirees. Under a fully funded system, each individual has a personal retirement account into which funds are deposited during working years that will finance the worker's retirement. PAYG systems thus generally rely on intergenerational transfers, while fully funded systems do not.

We then allow for interactions between funding-specific replacement rates and coverage. Across our three coverage measures, we find a positive and statistically significant relationship between the interaction of coverage with the fully funded replacement rate and the CA balance. We thus find that the CA balance increase with the replacement rate and coverage of fully funded pension systems, but find no such effect for PAYG systems. These empirical findings are in line with Davoine (2019) and suggest that a fully funded pension system forces agents to save and increases aggregate savings, while a PAYG system does not affect total savings. Both results contradict the rational agent view (Auerbach & Kotlikoff, 1987) and are consistent with the presence of some frictions, such as myopic agents or borrowing constraints (Feldstein, 1974; Samwick, 2000).

Introducing both refinements into the EBA model broadly improves the model fit. In particular, our refinements reduce residuals for most countries with a fully funded pension system but perform best for small advanced economies, such as Denmark, the Netherlands, Switzerland, and Sweden. Accounting for these countries' fully funded pension systems, which are characterized by high replacement rates and broad coverage, significantly reduces the model residuals.

The remainder of this paper is structured as follows. Section 2 provides a brief review of the EBA model. Section 3 introduces the new demographic measure and quantifies its impact on countries' CA balances. Section 4 introduces the new pension indicators and examines their impact on countries' CA balances. In Section 5, we include both refinements in the EBA model and examine how they perform in terms of model fit. Section 6 concludes.

2 The EBA model

This paper focuses on the IMF's External Balance Assessment current account (CA) model (Phillips et al., 2013), which we denote as the EBA model for the rest of this paper. Because of its surveillance mandate, the IMF has a long tradition of analysing the determinants of CA balances. Since the mid-1990s, the IMF has proposed several generations of models providing theory-based assessments of CA drivers. These models build on the absorption approach, namely on the identity between the CA balance and the gap between saving and investment. The EBA model, introduced in 2012, is the newest generation of these models.

The EBA model builds not only on the IMF's expertise but also on a wide literature examining the determinants of CA balances (Chinn & Prasad, 2003; Gruber & Kamin, 2007, 2009; Chinn & Ito, 2008; Ca'Zorzi et al., 2012; Chinn et al., 2014; Moral-Benito & Roehn, 2016). Since its introduction, the IMF has refined the EBA model specification twice, in 2015 and in 2018, to reflect the latest advances in the analysis of CA drivers.

As a state-of-the-art model for the assessment of CA balances, the EBA model is used for the external sector assessment of IMF membership countries as part of their Article IV consultations, and in the annual IMF External Sector Report (ESR), which assesses the external sector positions of the world's largest economies. Beyond the IMF, the EBA model is widely used by policymakers and academics for various research topics. For example, Brumm et al. (2019) study the impact of global value chains on CA balances. Joy et al. (2018) analyze how countries' specialization in goods or services trade shapes global CA balances.

The EBA model serves a policy agenda: it aims to identify 'excessive' CA balances, requiring external adjustment, and their associated risks. To do so, the EBA model has three distinct steps. The first step is the estimation of the relationship between the CA balance and its drivers using a regression analysis. Based on this estimated relationship, the second step constructs the 'optimal' CA balance, namely the CA balance that a country should run based on its current fundamentals. The third step compares the 'optimal' CA balance to the observed CA balance and detects 'excessive' CA balances. In this paper, we focus on the EBA model's first step, namely the regression analysis.

The EBA model estimates a reduced-form equation between the CA balance and a set of determinants:

$$y_{it} = \delta \mathbf{D}_{it} + \beta \mathbf{X}_{it} + u_{it}, \tag{1}$$

where i indexes the country and t the year, y_{it} is the CA balance as a ratio to GDP, $\mathbf{D}$ is a vector of static demographic variables, which we single out from the vector of other fundamental drivers $\mathbf{X}$ given the focus of this paper. Static demographic variables $\mathbf{D}$ are population growth, the old-age dependency ratio, and the share of prime savers, which we examine in greater detail in the next section. Fundamentals include CA drivers such as the fiscal balance, output per worker, public health spending, and institutional quality.[2] The EBA model also includes two dynamic demographic variables: the life expectancy of a current prime-aged saver and the interaction between life expectancy and the future old-age dependency ratio. In this paper, we focus exclusively on refining the static demographic variables and therefore allocate the dynamic demographic variables to the main vector of fundamental drivers $\mathbf{X}$. Table A1 in the Appendix lists the static demographic variables and the fundamentals, and their definitions. While we refer to Phillips et al. (2013) and Cubeddu et al. (2019) for a detailed analysis, we

[2]The IMF further distinguishes policy variables (e.g., the fiscal balance) from fundamentals (e.g., output per worker). This distinction serves the policy agenda by allowing the identification of policy distortions, which may underlie 'excessive' CA balances. For the purpose of this paper, this distinction is unnecessary. We therefore treat policy variables as fundamentals and include them in the vector $\mathbf{X}$.

now highlight three important features of the EBA model.

The EBA sample provides a broad coverage both in terms of countries and time. It covers 49 countries, which include most advanced economies and the largest emerging market economies, and accounts for more than 90% of world GDP. The sample spans the period 1986-2016. Table A1 in the Appendix lists the sample.

The EBA model assesses countries' external positions in a multilaterally consistent framework, meaning that it estimates the impact of a country's fundamentals on its own CA balance, while also taking into account how fundamentals of other countries affect that country's CA balance. Formally, the explanatory variables are defined as deviations from the yearly GDP-weighted world average. Constructing the variables in this way captures two theoretical features. First, a change in any fundamental, say the fiscal balance, may only affect the CA balance to the extent that the fiscal balance in other countries does not change by the same amount. Intuitively, if all countries run the same fiscal balance, then fiscal balances around the world cannot have a net impact on CA balances across countries. Second, defining variables as deviations from the world average captures a country's size relative to the rest of the world. Intuitively, the fundamentals of a small, open economy may have a large impact on its own CA balance but a relatively small impact on other countries' CA balances. Conversely, fundamentals of a large economy may significantly drive both its own CA balance, and other countries' CA balances.

The objective of the EBA model is to determine the CA balance that is consistent with fundamentals and to detect 'excessive' CA balances. The nature of this exercise precludes using country and time fixed effects since they could rationalize long-run CA distortions and would be counterproductive to the IMF's policy objective. Therefore, the EBA model is estimated using pooled GLS with a panel-wide AR(1) correction. Table A2 in the Appendix reports the EBA baseline estimation.

This paper makes two refinements to the EBA model. It first proposes a new specification for the static demographic variables. It then proposes to include pension indicators in the EBA model. The following sections examine each refinement in turn.

3 Demographics

Since people at different ages save at different rates (Ando & Modigliani, 1963), demographics affect aggregate saving behaviour. Accordingly, if countries differ in their population age structure, they should also differ in their saving behaviour. Countries with a youthful population will tend to save less than countries with a large working age population. The variation in population age structures across countries thus matters for global CA balances.

This section presents the first refinement to the EBA specification, which focuses on demographics. It first examines the limitations of the EBA demographic variables, then introduces our approach to measuring demographics, and finally examines how our refinement performs in the EBA framework.

3.1 The EBA demographic variables

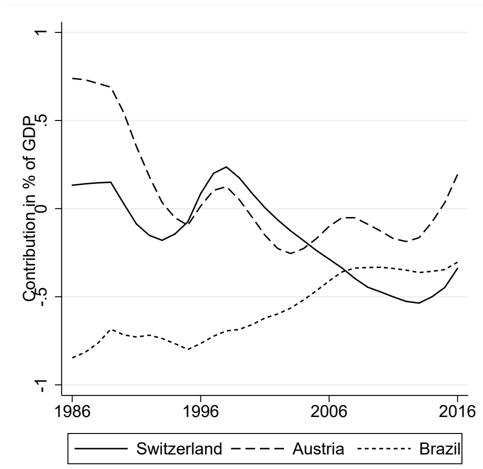
The EBA model's demographic variables—population growth, the old-age dependency ratio, and the share of prime savers—aim to capture the effect of the population age structure on the CA balance. Population growth is the annual growth rate of the total population. The old-age dependency ratio is defined as the ratio of the population over 65 years of age to the population between 20 and 64 years of age. These two variables account for the fact that countries with a growing population, i.e., larger young cohorts, or with larger old cohorts tend to dissave. An increase in population growth or in the old-age dependency ratio is associated with a lower CA balance. The share of prime savers is defined as the share of the population between 45 and 64 years of age in the total working age population (ages 30-64). It accounts for the fact that countries with a larger share of prime savers tend to save more. An increase in the prime savers share is associated with a higher CA balance. Overall, each static demographic variable accounts for a specific group of a country's population and their age-specific saving behaviour.[3]

While accounting for demographics is necessary, finding a suitable measure is not straightforward. This difficulty stems from the strong non-linear effects of demographics as people of different ages save at different rates (Deaton & Paxson, 1997; Attanasio et al., 2016). The modelling of demographics within the EBA model has also encountered some difficulties. Unlike other aspects of the EBA model, the specification of demographics was changed after each revision (Phillips et al., 2013; IMF, 2015; Cubeddu et al., 2019). These revisions were motivated by limitations in the modelling approach or the difficulty in interpreting the results. Although each revision has attenuated some concerns regarding the specification of demographics, some shortcomings remain. In this paper, using country cases, we examine three of them: the large volatility of country-level predictions over time, the contradicting predictions for countries with similar population age structures, and the dependence on the researcher's modelling choice.

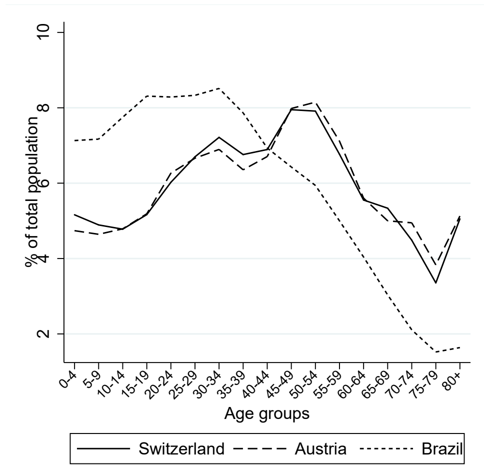
[3]One can easily show that population growth is positively correlated with the share of young cohorts in the total population and negatively correlated with the share of old cohorts. In a model that accounts for the prime savers and the old-age dependency ratio, population growth thus informs on the share of young cohorts. Conversely, if one includes a measure of young cohorts in the EBA model, such as the young-age dependency ratio, the coefficient on population growth is no longer significant while the young-age dependency ratio is statistically significant and negative.

At the country level, the contribution of the EBA demographic variables to the CA balance can be quite volatile over time. Such volatility is at odds with the presumed slow-moving demographic evolution. To illustrate this pattern, Figure 1a plots the contribution of the EBA demographic variables to the CA balance of selected countries over the sample period. Considering the Swiss case, Figure 1a shows that the contribution of demographics has been quite volatile, alternating between negative and positive contributions within short periods of time. For example, the contribution went from −0.2% of GDP in 1993 to +0.2% of GDP in 1997, then back to −0.2% of GDP in 2004. This large volatility is not unique to Switzerland. Figure 1a also reports the Austrian case, which shows large fluctuations of the contribution over time. These predictions suggest rapid shifts in Swiss and Austrian demographics or population shocks, which are difficult to rationalize based on the data.

Figure 1: Contribution of the EBA demographic variables to the CA balance and population age structure of selected countries



(a) EBA demographic contribution



(b) 2016 population age structure

Notes: Figure (a) reports the contribution of the EBA demographic variables (population growth, old-age dependency ratio, and the share of prime savers) to the CA balance of selected countries. Estimates refer to the EBA baseline regression, as in equation (1). Figure (b) reports the 2016 population age structure of selected countries.
Sources: IMF, UN, own calculations.

The predictions of the EBA demographic variables can further be quite different for countries with similar population age structures. To illustrate this pattern, Figure 1b reports the 2016 population age structures of Switzerland, Austria, and Brazil. In 2016, Switzerland and Austria had strikingly similar population age structures, with relatively few young cohorts and a large late working age population. In contrast, Brazil had a much different population age structure, with many young cohorts and a relatively small late working age population. Based on the population age structure of these three countries, one would expect the EBA demographic variables to contribute positively and in similar amounts to the 2016 Swiss and Austrian CA balances, while predicting a lower contribution to the 2016 Brazilian CA balance. Figure 1a shows that this is not the case. In 2016, the EBA demographic variables contributed −0.3% of GDP to the Swiss CA balance but +0.2% of GDP to the Austrian CA balance. The 0.5 percentage points of GDP discrepancy in the contribution is thus difficult to reconcile with the data because the population age structures of these two countries are very similar. Furthermore, the EBA demographic variables contributed to −0.3% of GDP to the Brazilian CA balance, almost exactly the same amount as for Switzerland. Based on their population age structures, however, one would expect Brazilian demographics to contribute more negatively to the CA balance than Swiss demographics. The EBA demographic variables thus generate some puzzling results across countries.

These first two limitations can broadly be traced back to the third limitation: the dependence on the researcher's modelling choice, which shapes the EBA demographic variables and their predictions. In particular, certain age groups (prime savers, or cohorts above 64) are singled out, while others (the younger cohorts) are not explicitly taken into account. This choice may not give a complete picture of a country's population age structure, while proxying for younger cohorts with population growth may induce counterintuitive volatility in the estimates. Furthermore, the sharp age cut-offs, which underly the old-age dependency ratio and the prime savers share, may induce some bias in the estimated coefficients given the large country sample. IMF staff notes this difficulty and has considered shifting the definition of working age population and prime-age savers by five years to account for country-specific characteristics (IMF, 2018). Because of these aspects, the EBA demographic variables may produce puzzling estimates of their impact on CA balances, especially when one more closely examines country-level predictions. Given these shortcomings, we see continued scope for improvement in modelling demographics within the EBA model.

3.2 An alternative approach to modelling demographics

Following Fair & Dominguez (1991), we propose using a polynomial combination of the population age distribution. A number of different studies model demographics following their approach. For example, similar to our paper, Higgins (1998) and Gerigk et al. (2018) use a polynomial to investigate the relationship between population age distributions, national saving, and the CA balance. The polynomial approach is also used to study the impact of demographics on capital flows (Higgins & Williamson, 1997; Lane & Milesi-Ferretti, 2001), financial markets (Arnott & Chaves, 2012), and inflation and monetary policy (Juselius & Takàts, 2015).

Fair & Dominguez (1991) argue that a demographic measure should account for all population age groups. Doing so allows the researcher to remain agnostic in terms of defining the age ranges of old-age or prime-age individuals. A naive approach would be to split the population of country i at time t into G age groups, construct the share of each age group in the total population, $n_{git} = \frac{N_{git}}{N_{it}}$, and estimate a coefficient for each age group. Within the EBA framework, one would thus estimate:

$$y_{it} = \sum_{g=1}^{G} \alpha_g n_{git} + \beta \mathbf{X}_{it} + u_{it}, \tag{2}$$

where, consistent with the EBA framework, age-group shares n_{git} are defined as deviations from the GDP-weighted world average, and α_g is the age-group coefficient to be estimated.

However, this naive approach raises two main issues. First, it would yield imprecise estimates because of the substantial multicollinearity of the many demographic variables. The finer the division of the total population is, the larger the correlation between consecutive age groups. Second, the unconstrained coefficients may jump back and forth between close age groups in an economically puzzling fashion.

To address these issues, Fair & Dominguez (1991) introduce a polynomial combination of individual age groups that fully accounts for a country's population. Their idea is to limit the differences between the estimated effects of consecutive age groups by restricting the age-group coefficients to lie on a polynomial. This approach minimizes the number of estimated parameters while still allowing the identification of the full demographic effect. Following Fair & Dominguez (1991), we impose two restrictions.

We first restrict the age-group coefficients α_g in equation (2) to follow a polynomial combination. Formally, we define α_g as:

$$\alpha_g = \sum_{p=0}^{P} \gamma_p g^p, \tag{3}$$

for $g = 1, \ldots, G$ and where P is the degree of the polynomial.

We further require a zero constraint on the age-group coefficients. Formally, we impose:

$$\sum_{g=1}^{G} \alpha_g = 0. \tag{4}$$

Intuitively, this zero-sum constraint implies that demographics do not enter our estimation equation if there is (i) no effect of demographics on the CA or

(ii) the population of a country is uniformly distributed across age groups.[4]

Instead of estimating G age-group coefficients α_g, these two restrictions allow us to estimate P polynomial-specific coefficients γ_p. We assume that $P = 3$. This is consistent with age-group coefficients following a 'hump'-shaped pattern as predicted by the life-cycle hypothesis (Ando & Modigliani, 1963).

Using equations (3) and (4), we can rearrange the expression $\sum_{g=1}^{G} \alpha_g n_{git}$ to isolate the polynomial-specific coefficient to be estimated. We construct a new demographic polynomial variable,

$$Z_{pit} = \sum_{g=1}^{G} \Big(n_{git} g^p - \frac{1}{G} g^p \Big), \tag{5}$$

such that the refined EBA estimation equation boils down to:

$$y_{it} = \sum_{p=1}^{P} \gamma_p Z_{pit} + \beta \mathbf{X}_{it} + u_{it}. \tag{6}$$

Based on equation (6), one can estimate the polynomial-specific coefficient γ_p. Note that we only estimate γ_p for $p = 1, \ldots, 3$, while γ_0 is identified from the zero constraint of equation (4).

From the estimated γ_p coefficients, we simply recover the age-group coefficients α_g using equations (3) and (4). Because the relationship in equation (3) is linear, it is straightforward to recover the standard errors for the age-group estimates from the covariance matrix associated of the γ_p estimates.

3.3 Testing the demographic polynomial in the EBA model

We now take the demographic polynomial to the data. We construct the polynomial terms using UN population data for the 49 EBA countries between 1986 and 2016. These data provide yearly observations for $G = 17$ five-year age groups n_{git}, spanning from ages 0-4 to 80+. Following the EBA methodology, we construct age groups as deviations from the GDP-weighted yearly average shares in the sample.

We estimate equation 6. Namely, we replicate the EBA model and replace the static demographic variables, i.e., the old-age dependency ratio, population growth, and the share of prime savers, with the demographic polynomial, i.e., the three Zs of equation (5).

[4] For a detailed explanation of this restriction, see Almon (1965) and Smith & Giles (1976).

3.3.1 Regression results

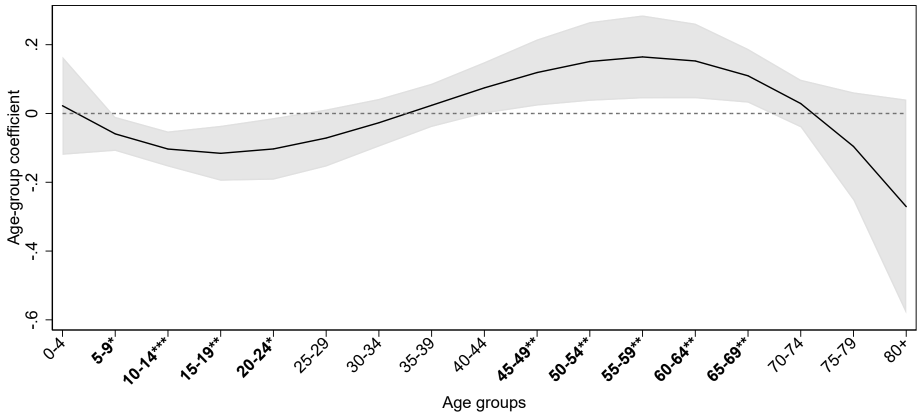
Given the construction of the demographic polynomial, we cannot directly interpret the size, sign or significance of the Z coefficients as they appear in the regression results. Rather, we have to solve for the implied age-group coefficients α_g. Figure 2 shows these age-group coefficients with their 90% confidence intervals, which reflect the marginal effect of the relative size of an age group on the CA balance. We report the detailed regression results in Tables A2 and A3 in the Appendix.

The estimates point to statistically significant and economically powerful demographic effects, describing the 'hump'-shaped pattern predicted by the life-cycle hypothesis.[5] The age-group coefficients are negative for the young and become positive at approximately 35 years of age. They reach a peak in the mid-50s, decline sharply after retirement, and become negative shortly thereafter. The coefficients are statistically significant for the cohorts aged between 5 and 24, and those aged between 45 and 69.

Our results thus suggest that an increase in the relative size of cohorts aged between 45 and 64 has a positive and economically significant effect on the CA balance. This result is consistent with the positive and significant coefficient of the prime savers share in the baseline EBA model. Among these age groups, the 55-59 cohort contributes the most to an increase in the CA balance: all else equal, a 1% increase in a country's share of the 55-59 cohort (relative to the world average) is associated with an increase in the CA balance by 0.16% of GDP. Conversely, cohorts aged between 5 and 24 have a significantly negative impact on the CA balance, consistent with the life-cycle hypothesis. While the impact of this cohort is not directly accounted for by the EBA demographic variables, our refinement finds that having a relatively large share of young cohorts in the population is associated with a lower CA balance. Among these age groups, the 15-19 cohort contributes the most to a decrease in the CA balance: all else equal, a 1% increase in a country's share of the 15-19 cohort (relative to the world average) is associated with a decrease in the CA balance by 0.12% of GDP.

[5] The 'hump'-shaped pattern is also due to the assumption of a third-degree polynomial structure. Had we chosen a second-degree configuration as Fair & Dominguez (1991), we would have obtained a parabolic shape. Please view Smith & Giles (1976) for the different polynomial structures and the resulting shape of the coefficient diagram. We thus base the choice of the degree of the polynomial on economic theory, which is prioritized by Smith & Giles (1976) and is at the core of the EBA model. In an unpublished robustness check, we reject that a second-degree polynomial performs better than a third-degree polynomial, but cannot reject that a third-degree polynomial performs better than a fourth-degree polynomial. However, even if we use a fourth-degree polynomial, the main conclusions of our paper are unchanged.

Figure 2: Regression results – demographics



Notes: This figure reports the estimated age-group coefficients α_g, consistent with equation (6). Full regression results are reported in Tables A2 and A3. The 90% confidence interval is depicted in grey. *** p<0.01, ** p<0.05, * p<0.1

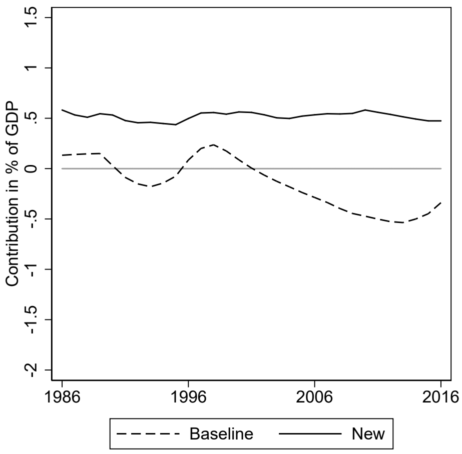
3.3.2 Country cases

The advantage of including the polynomial becomes more visible once one considers single countries. Again, we take the cases of Switzerland, Austria, and Brazil to compare our results with those of the EBA baseline specification. We also take the example of Japan, which offers the insightful case of a country in a very late stage of its demographic transition.

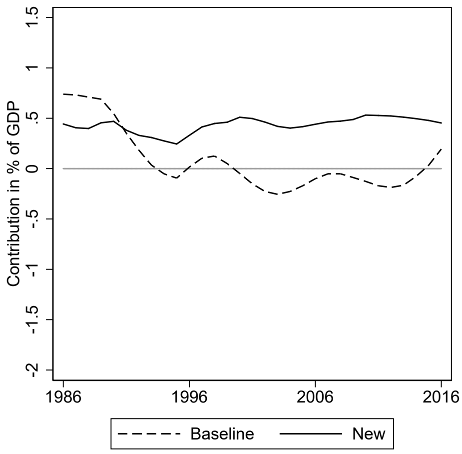
The contribution of our refined demographic specification to the Swiss CA balance is more stable and economically intuitive than the EBA baseline. Figure 3a plots the contribution of the static demographic variables in the EBA baseline vs our refined specification for Switzerland. As examined in the previous section, the baseline contribution is quite volatile, alternating between negative and positive contributions in short periods of time. In the refined specification, the variation is much smaller: the contribution remains almost constant over time, at approximately +0.5% of GDP. Furthermore, it is in line with economic intuition: Switzerland, having a large late working age population, should save more relative to the rest of the world.

Similar to Switzerland, the contribution of our refined demographic specification to the Austrian CA balance is more in line with economic intuition. As shown in Figure 3b, the volatility of the demographic contribution is lower based on our refined specification. Over the sample period, it hovers around +0.5% of GDP. This contribution is thus very close to the predictions for Switzerland, as one would expect based on the data. Taking the example of 2016, the contribution of the demographic polynomial is +0.45% of GDP for Austria and +0.47% of GDP for Switzerland. Our refined demographic measure thus produces similar predictions of the demographic contribution to the CA balance for countries with similar population age structures.

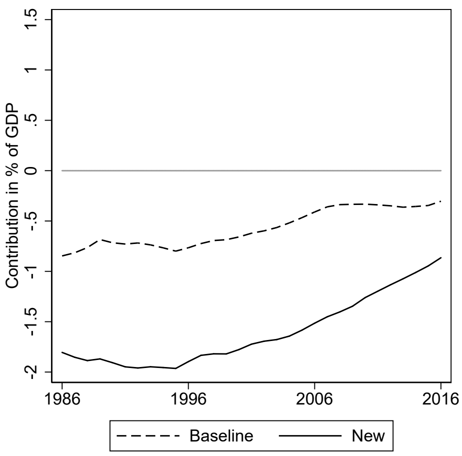
Figure 3: Contribution of demographics to the CA balances of selected countries



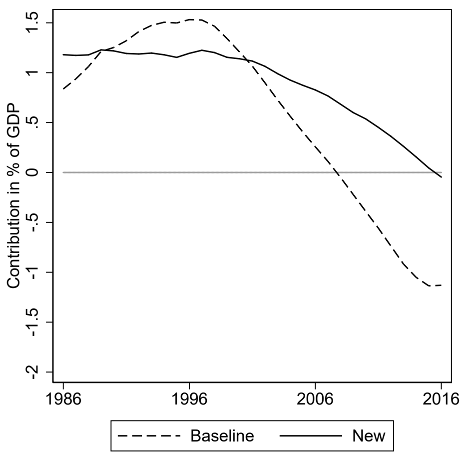
(a) Switzerland



(b) Austria



(c) Brazil



(d) Japan

Notes: This figure reports the contribution of demographic variables under the baseline EBA regression – consistent with equation (1)– and of our refined specification using a demographic polynomial – consistent with equation (6)– to the CA balances of selected countries over the sample period.

Brazil offers the interesting case of a relatively young country in an early stage of its demographic transition. Figure 3c plots the demographic contribution for Brazil. Consistent with Brazil's low median age, the static contribution of demographics to the CA balance has been negative since the start of the observation period. However, Brazil is aging. Accordingly, the negative contribution has halved, from −1.8% of GDP in 1986 to approximately −0.9% of GDP in 2016. Compared to the EBA demographics, our measure predicts a more negative contribution to the Brazilian CA balance, suggesting that the EBA specification could underestimate the youthfulness of the Brazilian population compared to the rest of the world. Our measure further shows a larger shift in the demographic contribution to the CA balance, suggesting that the EBA demographic specification could underestimate how shifts in a country's population structure over time may matter for total savings. Nevertheless, the trend of the contribution is consistent across both measures, capturing the fact that Brazil is aging.

Finally, Japan is another valuable case that shows the demographic contribution to the CA balance of a country in a late stage of its demographic transition. Figure 3d shows that Japan already reached the peak of its demographic contribution approximately 20 years ago. The demographic contribution has been slowly but steadily declining since, becoming slightly negative in 2016. This pattern is consistent with the shrinking workforce in Japan. Compared to the EBA demographics, our measure suggests a slower shift in the contribution to the Japanese CA balance, becoming negative only in 2016. As for the Brazilian case, the trend of the demographic contribution to the Japanese CA balance is nevertheless broadly consistent across both measures.

These country cases nicely illustrate several distinguishing patterns of the demographic contribution to the CA balance under our refined specification compared to the baseline. First, the volatility is reduced. This is particularly visible for advanced economies. Table 1 shows that the standard deviation of the demographic contribution across advanced economies declines in the refined specification compared to the baseline, from 0.59 to 0.54. Across emerging markets, the standard deviation increases in the refined specification to the baseline. This does not mean that the demographic contribution is more volatile from year to year, but reflects that the refined specification better captures the change in those countries' population age structures and how it affects total savings. The case of Brazil illustrates this pattern.

Second, demographic contributions to the CA balance are more heterogeneous in the refined than in the baseline specification. Demographic contributions are higher in advanced, relatively older countries. The average contribution is 0.18% of GDP in the refined specification, compared −0.05% of GDP in the baseline. Conversely, emerging market economies, which are relatively younger, exhibit lower demographic contributions to their CA balance in the refined specification than in the EBA baseline. The average contribution is −1.41% of GDP in the refined specification, compared to −0.49% of GDP in the baseline.

Overall, these results suggest that our refined specification is able to

Table 1: Summary statistics: demographic contribution

All countries	Min	Max	Mean	St. Dev.
Baseline	-2.53	1.53	-0.29	0.72
Refined	-3.62	1.33	-0.66	1.18
Advanced Economies	Min	Max	Mean	St. Dev.
Baseline	-2.53	1.53	-0.05	0.59
Refined	-1.53	1.33	0.18	0.54
Emerging market economies	Min	Max	Mean	St. Dev.
Baseline	-2.22	1.46	-0.49	0.77
Refined	-3.62	1.01	-1.41	1.09

Notes: This table reports the summary statistics of the demographic contribution to the CA balance (as a percentage of GDP) in the baseline EBA model and in the refined specification for the full sample, for advanced economies, and for emerging market economies.

mitigate the identified limitations of the EBA demographic specification. Namely, our refinement produces smoother, economically intuitive predictions of the demographic impact on CA balances in a multilaterally consistent manner, while reducing the impact of the researcher's modelling choice.

4 Pension systems

In the atomistic life-cycle model, individuals save during their working lives and dissave during retirement (Ando & Modigliani, 1963). This behaviour can be institutionalized through pension systems that reduce income during working years and provide retirement benefits.

The potential impact of pension systems on aggregate saving has been widely discussed in the literature, starting with Samuelson (1958) and largely relying on Auerbach & Kotlikoff (1987). Differences in the design of pension systems may lead individuals to differently adjust their economic behaviour, therefore affecting saving and the CA balance differently. An extensive literature has shown how pension system policies affect aggregate saving and the CA (Feldstein, 1996; Poterba et al., 1996; Loayza et al., 2000; Samwick, 2000; Orszag & Stiglitz, 2001; Börsch-Supan et al., 2005; Engelhardt & Kumar, 2007; Gelber, 2011). Eugeni (2015) builds an OLG model allowing for PAYG systems and finds cross-sectional evidence that the CA balance decreases with the coverage of a PAYG system. Davoine (2019) builds on the theoretical framework of Keuschnigg et al. (2015), which allows for PAYG and fully funded pension systems in an OLG model, and finds cross-sectional evidence that a fully funded system is associated with a higher CA balance, while he finds no relationship between PAYG pension systems and the CA balance.

This section presents the second refinement to the EBA specification, which focuses on pension systems. It first introduces our approach to measuring pension systems across countries, then examines how these pension indicators perform in the EBA framework.

4.1 Measuring pensions

Accounting for pension systems in an empirical framework is not straightforward. A first difficulty stems from the complexity of pension systems across countries. A second one stems from data requirements. To match the EBA framework, we require data for 49 countries between 1986 and 2016. Keeping these difficulties in mind, we propose to include indicators for three aspects of pension systems: funding, generosity, and coverage. This section examines how these indicators are constructed, then illustrates their main features.

4.1.1 Data

Our main data source is Bloom et al. (2007), who construct funding-specific replacement rates and coverage indicators to study how increased longevity influences saving rates across countries depending on the characteristics of their pension systems. Bloom et al. (2007) account for the funding, generosity, and coverage of pension systems. To construct these three indicators, they use reports from the US Social Security Administration (SSA), which rely on information from the Social Security Programs Throughout the World surveys and on statements from countries' social security officers, and data from the OECD, the World Bank, and the IMF.

Regarding funding, Bloom et al. (2007) differentiate between two setups: pay-as-you-go (PAYG) and fully funded pension systems. Generally, under a PAYG system, the government taxes the current working population to pay for the pensions of current retirees. In the context of their paper, Bloom et al. (2007) define PAYG systems as those where the pension fund is limited to hold only government debt. In contrast, under a fully funded system, each individual has a personal retirement account into which funds are deposited during working years. Upon retirement, the pension fund will be holding the individual's contributions and the interest and dividends earned on them. This accumulated wealth then finances the individual's consumption in retirement. Bloom et al. (2007) define fully funded systems as those where pension assets are held either by independent provident funds or by freely investing private firms.[6]

Regarding generosity, Bloom et al. (2007) use the replacement rate, namely the ratio of the annual pension to the annual salary of a representative worker. They construct two replacement rates, one for PAYG systems and one for fully funded systems.

Regarding coverage, Bloom et al. (2007) construct a dummy variable indicating universal coverage. This dummy is a de jure measure, reflecting a country's existing legal framework. A system is considered to be universal if all workers are covered by law. A system would be classified as non-universal if some groups of workers are excluded from it. Commonly excluded groups are workers in small businesses, the self-employed, and agricultural workers.

Their dataset covers 61 countries for the years 1960 to 2002. To match the EBA coverage over time, we expand their indicators following the same definitions and underlying data sources, namely SSA reports for the years 2002 to 2016. Only 40 EBA countries are present in the original Bloom et al. (2007) dataset. To match the EBA coverage across countries, we further construct the pension indicators for nine missing countries (China, Costa Rica, the Czech Republic, Guatemala, Hungary, Pakistan, Poland, Russia, and Thailand). For these countries, we typically have data from 2002 onwards only and impute data for early years from 2002 values.[7]

We make two departures from the approach of Bloom et al. (2007). First, Bloom et al. (2007) focus on mandatory pension systems as the SSA only covers mandatory schemes. However, they make an exception for the Danish quasi-mandatory fully funded pension system, which they include in their indicators, although it is not, per se, mandatory. In our dataset, we further account for the quasi-mandatory fully funded pension systems of the Netherlands and Sweden. These systems are compulsory for those working in specific activities and have wide coverage. For example, there is no statutory obligation in the Netherlands for employers to offer a pension scheme to their employees, but industrial-relations agreements mean that over 90% of employees are covered. To construct the relevant replacement rates for these systems, we use OECD reports and governmental sources. Note that fully funded but voluntary schemes in countries such as Germany and the United States remain excluded from the analysis.

Second, while the coverage dummy of Bloom et al. (2007) varies over time and thus captures changes in the institutional setup of pension systems, it lacks, by construction, variation across countries in the extent of de facto

[6] We do not rely on the defined contribution or defined benefit aspect of pension systems. There can be an accumulation of assets, consistent with fully funded schemes, in both defined contribution and defined benefit schemes.

[7] Aside from these nine countries, there are generally only a few missing values in the data, which we impute based on the closest available year. In a robustness check not reported in the paper, we run regressions on the reduced sample only, without imputing earlier years. Results are largely unaffected.

coverage. To attenuate this issue, we propose two alternative measures of coverage, which account for the cross-country variation.

The first cross-country coverage measure is proxied by the percentage of total contributors to pensions in the total working age population based on World Bank data.[8] This measure is available for all EBA countries except for New Zealand, but for a single year per country only, ranging from 2005 to 2012. As a means of comparison, we construct a similar coverage measure based on data from the International Labour Organization (ILO), which publishes the percentage of active contributors to an old age contributory scheme to the working age population. Data are available for all EBA countries, except for New Zealand, and for a single year per country only, from 2005 to 2013.[9]

The main advantage of the World Bank and ILO coverage measures is that they capture variation in de facto coverage across countries. However, because they are available only on a cross-sectional basis, we have to make the strong assumption that coverage shares remain constant over time. In the empirical analysis, we therefore rely on the coverage measures from Bloom et al. (2007), the World Bank, and the ILO to account for variation in coverage over time and across countries.

4.1.2 Descriptive statistics

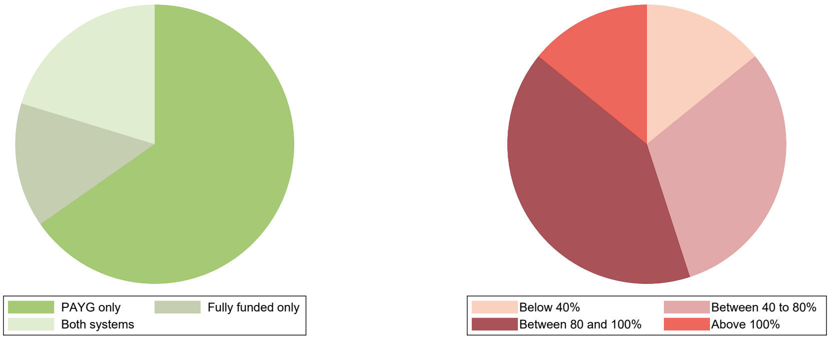
The funding and generosity of pension systems differs significantly across EBA countries. Figure 4 provides a snapshot, for 2016, of the data on funding and generosity across EBA countries. As shown in Figure 4a, almost two-thirds of countries operate exclusively a PAYG system in 2016. This is the case for many of the world's largest economies, e.g., Germany, Japan, and the United States. In contrast, 14% of countries operated only a fully funded system. These countries are mainly emerging market economies (including India, Indonesia, and Mexico). Finally, 20% of countries operate both systems. These include many small advanced economies, such as Denmark, the Netherlands, Switzerland, and Sweden.

Replacement rates, irrespective of funding, also show substantial variation across EBA countries in 2016. As shown in Figure 4b, 14% of countries guarantee a replacement rate below 40% of a representative worker's wage. This is the case for countries with a PAYG system, such as Canada or Ireland, and for those with a fully funded system, such as Indonesia or Mexico. In contrast, 31% of countries guarantee a replacement between 40%

[8] The dataset draws on administrative data provided by country authorities and is supplemented with information from household surveys.

[9] As New Zealand's mandatory pension system is exclusively financed by tax revenues, we consider every worker in New Zealand as a contributor to the pension scheme and impute the coverage share by using the number of individuals in the labour force as a share of the 2015 working age population, published by Statistics New Zealand.

Figure 4: Funding and generosity of pension systems in EBA countries



(a) Funding

(b) Generosity

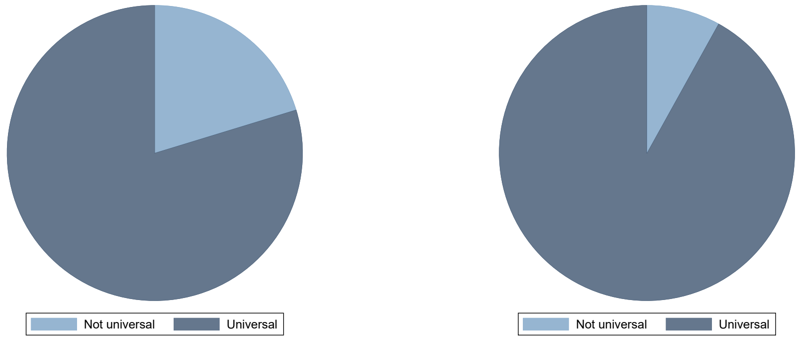
Notes: This figure provides a snapshot, for 2016, of the funding and generosity of pension systems across EBA countries. Figure (a) shows the proportion of EBA countries that exclusively operate a PAYG pension system, exclusively operate a fully funded pension system, or operate both systems. Figure (b) reports the distribution of replacement rates, i.e., the ratio of the annual pension to the annual salary of a representative worker, here reported as a percentage across EBA countries.
Sources: Bloom et al. (2007), SSA, OECD, national authorities, own calculations.

and 80% of a representative worker's wage. Japan and the United States belong to this group. In 41% of countries, replacement rates are between 80% and 100% of a representative worker's wage. Denmark, Germany, the Netherlands, and Switzerland belong to this group. Finally, among the most generous, 14% of countries promise a replacement rate above 100% of a representative worker's wage. Greece's PAYG system guarantees the highest replacement rate, at 125% of a representative worker's wage.

Based on the de jure measure, most EBA countries have a pension system with universal coverage. As shown in Figure 5a, 80% of countries have a pension system with universal coverage at the beginning of the sample period. This share increases over time. Figure 5b shows that 92% of countries have a pension system with universal coverage at the end of the sample period.

The two cross-sectional measures show that de facto coverage differs substantially across EBA countries. Figure 6a first shows the World Bank coverage measure. In one-fourth of countries, coverage is below 25% of all workers. This is the case for India, Indonesia, and Sri Lanka. Coverage varies between 25% and 50% of workers in a fifth of countries, including Brazil, China, and Spain. The pension systems of 41% of countries have coverage between 25% and 50% of workers. This is the case for many European countries, such as France, Germany, and the Netherlands, but also other major economies such as the United States. Finally, only 12% of countries have a pension system with coverage above 75% of workers. This is for

Figure 5: De jure coverage of pension systems in EBA countries



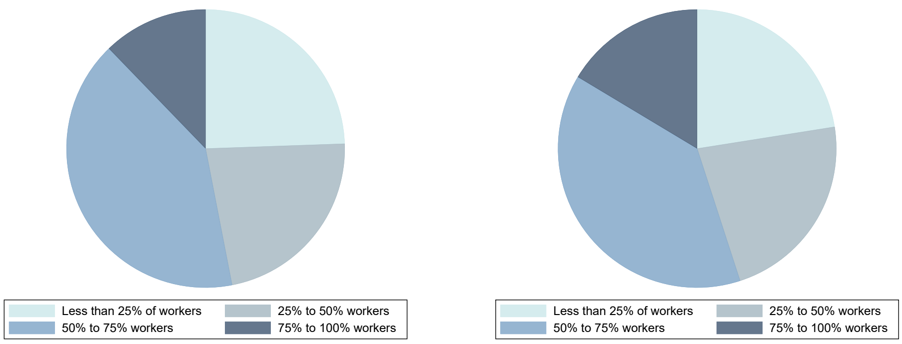
(a) Start of the sample period

(b) End of the sample period

Notes: This figure reports the proportion of countries with and without a pension system with de jure universal coverage based on Bloom et al. (2007) data at the beginning of the sample period (1986, or earliest available year) and at the end of the sample period (2016).
Sources: Bloom et al. (2007), SSA, own calculations.

example the case in Denmark, Japan, and Switzerland. Overall, coverage thus tends to be lowest in emerging market economies and the highest in advanced economies.

Figure 6: De facto coverage of pension systems in EBA countries



(a) World Bank

(b) ILO

Notes: Figures (a) and (b) show the distribution of de facto coverage rates in EBA countries based on the World Bank and the ILO data, respectively.
Sources: World Bank, ILO.

The ILO coverage is very close to the World Bank coverage, with a correlation of 0.93. As shown in Figure 6b, coverage is below 25% of all workers in 22% of countries, between 25% and 50% of workers in 22% of countries, between 50% and 75% of workers in 39% of countries, and above

75% of countries in 16% of countries. Again, coverage tends to be lowest in emerging market economies and highest in advanced economies.

4.2 Augmenting the EBA model with pension indicators

We now take our pension indicators to the EBA model. We first present the regression results, then examine country cases, which illustrate how the pension indicators matter for the CA balance of selected countries.

4.2.1 Estimation equation

We augment the EBA model with our pension indicators. Formally, we evaluate the following relationship

$$y_{it} = \delta \mathbf{D}_{it} + \beta \mathbf{X}_{it} + \zeta \mathbf{P}_{it} + u_{it}, \tag{7}$$

where $\mathbf{P}$ is a vector of the pension indicators, $\mathbf{D}$ are the EBA static demographic variables and $\mathbf{X}$ are the EBA fundamental drivers. Consistent with the EBA framework, the pension indicators are constructed as deviations from the GDP-weighted world average.

4.2.2 Regression results

Table 2 presents the regression results. Table A2 in the Appendix reports the detailed results for all EBA variables.

We find a positive and statistically significant relationship between the replacement rate of fully funded pension systems and the CA balance. As shown in Columns (1) through (3), the magnitude and statistical significance of the estimated coefficient on the fully funded replacement rate are robust across the different data sources we use. All else equal, a 1% increase in the replacement rate under a fully funded system, relative to the world average, is associated with an increase in the CA balance by 0.029 to 0.031% of GDP. In contrast, we find no relationship between the replacement rate of PAYG systems and the CA balance.

We further find suggestive evidence of a positive and statistically significant relationship between coverage and the CA balance. As shown in Columns (2) and (3), the World Bank and ILO coverage measures suggest that a 1% increase in coverage of the pension system is associated with an increase in the CA balance by 0.041 to 0.056% of GDP. Nevertheless, as shown in Column (1), we find no economically or statistically significant relationship between coverage from Bloom et al. (2007) and the CA balance. We therefore remain cautious regarding the robustness of the empirical link between coverage and the CA balance, although the lack of statistical significance for the de jure coverage could be explained by its limited variation.

As a next step, we consider the interaction between replacement rates per funding type and coverage. Columns (4) to (6) of Table 2 show the results. We find a statistically significant and positive relationship between the interaction of the fully funded replacement rate with coverage and the CA balance. This holds across all data sources for coverage. Intuitively, this suggests that CA balances increase with the generosity and coverage of fully funded pension systems. For example, a generous fully funded system would have a limited impact on the CA balance if it is restricted to a small share of the population. Similarly, an ungenerous fully funded system, requiring only little asset accumulation, would have a limited impact on total saving and the CA balance, even with high coverage. Thus, the impact on the CA balance is highest when both coverage and generosity are high. In contrast to fully funded pension systems, we find no relationship between generosity, coverage, and the CA balance under PAYG systems.

Our results suggest that the presence of a fully funded pension system forces the population to save, increasing aggregate saving, and thus the CA. Our results are thus in line with the findings of Davoine (2019). They are also in line with studies finding that introducing a fully funded system increases total household saving (Feldstein, 1974; Poterba et al., 1996; Madrian & Shea, 2001; Benartzi & Thaler, 2013; Chetty et al., 2014). One explanation for this finding could be that agents are myopic (Feldstein, 1974; Samwick, 2000).

Conversely, our results contradict the view that in the presence of a fully funded pension system total saving will remain unaffected as there will be perfect substitution between mandatory and voluntary saving (Auerbach & Kotlikoff, 1987; Kotlikoff, 1996; Mitchell & Zeldes, 1996). Our results thus contrast with the assumption of perfectly rational agents, who fully offset the tax burden with a reduction in savings. A number of studies have found such evidence of imperfect substitution (Feldstein, 1974, 1996; Bernheim, 2002; Feldstein & Liebman, 2002; Holzmann & Hinz, 2005).

Further, our results do not support the conclusions of Eugeni (2015), who shows cross-sectional evidence that countries with high coverage under a PAYG system exhibit a lower CA balance. Davoine (2019) also fails to support those conclusions.

4.2.3 Country cases

Another useful way to illustrate our results is to consider country cases. Based on our estimates, we show how the pension indicators contribute to the CA balances of four countries: Switzerland, the Netherlands, Chile, and the United States. These countries have different institutional setups for their pension systems and thus provide contrasting predictions of our pensions indicators. For each country, we report the minimum and maximum contributions of the pension indicators across the specifications of Table 2.

Table 2: Regression results – pensions

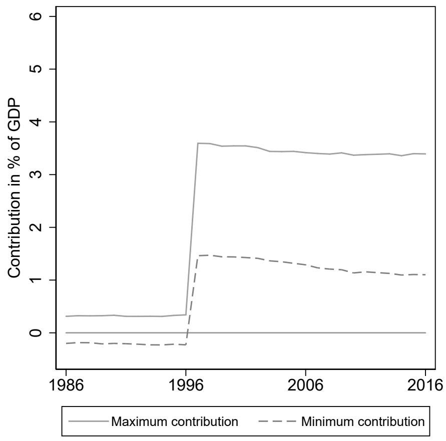
	Bloom	WB	ILO	Bloom	WB	ILO
	(1)	(2)	(3)	(4)	(5)	(6)
Replacement rate PAYG #	0.005	0.006	0.007	-0.006	-0.003	0.004
	(0.006)	(0.006)	(0.006)	(0.017)	(0.013)	(0.013)
Replacement rate FF #	0.029***	0.029***	0.031***	0.002	0.000	0.012
	(0.008)	(0.008)	(0.008)	(0.016)	(0.014)	(0.014)
Coverage #	-0.003	0.041**	0.056***	-0.015	0.024	0.046**
	(0.005)	(0.016)	(0.016)	(0.014)	(0.020)	(0.020)
Replacement rate PAYG * coverage #				0.012	0.010	0.001
				(0.018)	(0.023)	(0.020)
Replacement rate FF * coverage #				0.034*	0.069***	0.047**
				(0.019)	(0.023)	(0.021)
EBA fundamentals	Yes	Yes	Yes	Yes	Yes	Yes
EBA static demographics	Yes	Yes	Yes	Yes	Yes	Yes
Observations(Countries)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)
R-squared	0.583	0.584	0.597	0.589	0.589	0.600

Notes: The dependent variable is the CA balance as a ratio to GDP. Replacement rates for PAYG and fully funded (FF) systems come from Bloom et al. (2007). Coverage comes from Bloom et al. (2007) (Bloom, columns 1/4), the World Bank (WB, columns 2/5), and ILO (columns 3/6). Table A2 in the Appendix reports the detailed regression results for all EBA variables. # indicates demeaning relative to the GDP-weighted world average. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

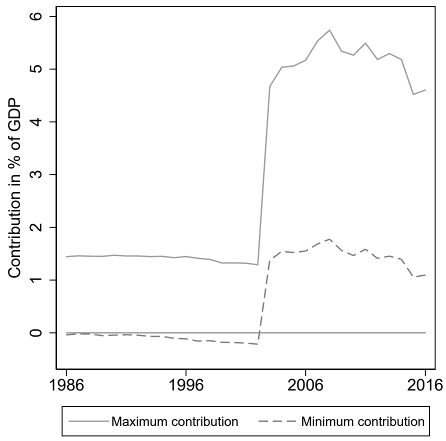
Switzerland is one of 14 EBA countries that operate a mixed pension system, with both a mandatory PAYG and a mandatory fully funded pension pillar in place. Based on the Bloom et al. (2007) data, the Swiss fully funded replacement rate becomes positive in 1996. Prior to 1996, Figure 7a shows that the total contribution of the pension indicators to the Swiss CA balance is relatively small, between −0.2 and +0.5% of GDP. After 1996, the total contribution of the pension indicators to the Swiss CA balance increases sharply and remains relatively constant over time. We estimate that in 2016, the Swiss pension system contributed between 1.1 and 3.4% of GDP to the Swiss CA balance.

The Netherlands is another valuable case to discuss. In addition to having a mandatory PAYG system, the Netherlands operate a large quasi-mandatory fully funded system. Bloom et al. (2007) classify the Dutch pension system as having a mandatory PAYG pillar only. Therefore, Figure 7b shows a limited pension contribution to the Dutch CA balance up until 2002, which is relatively stable, with our estimates ranging between 0 and 1.8% of GDP. Note that even if the quasi-mandatory fully funded pension system is not accounted for prior to 2002, the upper bound of our estimates is relatively high because of the high coverage in the Netherlands. From 2002 onwards, we account for the Dutch quasi-mandatory fully funded pension system. The contribution of the pension indicators increases significantly. We estimate that in 2016, the Dutch pension system contributed between 1.1 and 4.6% of GDP to the Dutch CA balance. The high fully funded replacement rate and the high coverage both add to this large contribution to the CA balance.

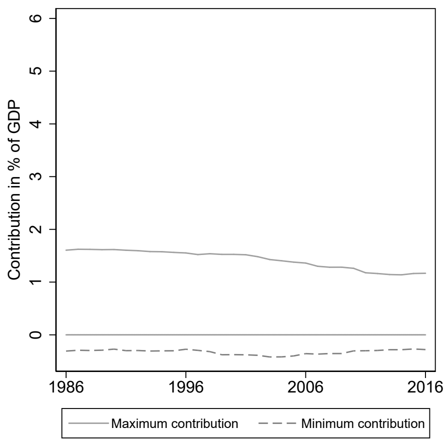
Figure 7: Contribution of the pension indicators to the CA balance of selected countries



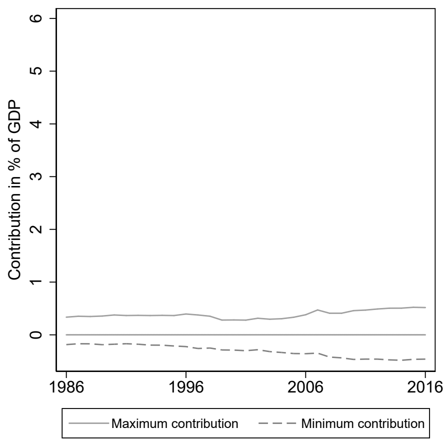
(a) Switzerland



(b) The Netherlands



(c) Chile



(d) United States

Notes: This figure reports the contribution of the pension indicators to the CA balance of selected countries over the sample period. It reports the minimum and maximum contributions across all specifications of our pension indicators, consistent with the results of Table 2.

Not all countries with a fully funded pension system show such significant positive contributions of the pension indicators to their CA balances. Consider the example of Chile, which exclusively operates a fully funded system pension. As shown in Figure 7c, we estimate that in 2016, the pension indicators contributed between −0.3 and +1.2% of GDP to the Chilean CA balance. Unlike Switzerland or the Netherlands, coverage in Chile is relatively low, at approximately 40%, while the replacement rate is relatively high (57% in 2016). Thus, the lower contribution of our pension indicators to the Chilean CA balance can be traced back to the relatively low coverage.

Finally, compared to countries with a fully funded system, Figure 7d shows that the US paints a different picture. Over the sample period, the total contribution of the pension indicators to the US CA balance remains relatively small. In 2016, we estimate that the pension indicators contribute between -0.5 and $+0.5$% of GDP to the US CA balance. It is important to underline two mechanisms that explain these estimates. First, the US exclusively operates a mandatory PAYG pension system. Since we find a statistically insignificant, and economically small relationship between PAYG systems and the CA balance, the contribution of the pension indicators has a limited impact on the CA balance of countries with PAYG systems only. However, the US has relatively high coverage, which may explain some positive contribution of the pension indicators. Second, consistent with the EBA framework, the pension indicators are defined as deviations from the world average. A positive contribution of pension indicators in countries with a fully funded pension system must be compensated by a negative contribution in other countries. This is the case for the US and other countries without fully funded pension systems.

These cases illustrate the significant heterogeneity across countries. To offer a more comprehensive view, Table 3 shows summary statistics of the pension contributions to the CA balance across the model specifications of Table 2. Based on the coverage measure of Bloom et al. (2007), pension contributions to the CA balance range from -0.7 to 4% of GDP, with an average contribution of 0.2% of GDP. The average pension contribution is thus close to zero, but overall pension contributions are skewed towards positive contributions. The specification thus captures the positive impact of fully funded systems.

Allowing for an interaction yields similar results. Accounting for de facto coverage significantly increases the heterogeneity of the results. Based on World Bank data, pension contributions to the CA balance range from -2.8 to 2.6% of GDP, with an average contribution of -0.3% of GDP. Based on ILO data, pension contributions to the CA balance range from -4.1 to 3.9% of GDP, with an average contribution of -0.7% of GDP. Allowing for interactions reflects the multiplicative effect of countries with high coverage and generous fully funded pension systems. Maximum contributions to the CA balance are the highest, 4.5 and 5.7% of GDP under the World Bank and ILO measures, respectively. Minimum contributions also increase, -2.1 and -3.4% of GDP under the World Bank and ILO measures, respectively.

Table 3: Summary statistics: pension contribution

Model		Min	Max	Mean	St.Dev
	(1) Bloom et al. (2007)	-0.69	4.01	0.21	0.76
Without interactions	(2) World Bank	-2.81	2.62	-0.31	1.10
	(3) ILO	-4.10	3.91	-0.65	1.51
	(4) Bloom et al. (2007)	-0.79	4.06	0.30	0.81
With interactions	(5) World Bank	-2.09	4.47	-0.17	1.15
	(6) ILO	-3.44	5.74	-0.52	1.48

Notes: This table reports summary statistics of the estimated pension contribution to the CA balance (as a percentage of GDP). The model specifications correspond to the regression results of Table 2. Models (1) to (3) include the replacement rate for PAYG and fully funded pension systems and the coverage variable—without interactions—to the baseline EBA model. Models (4) to (6) additionally include interaction terms between funding-specific replacement rates and the coverage variable. Models (1)/(4) use coverage following Bloom et al. (2007), models (2)/(5) use World Bank coverage, and models (3)/(6) use ILO coverage.

5 Introducing both refinements to the EBA model

In the final step of this paper, we simultaneously introduce both refinements to the EBA model and examine the robustness of the results and the model fit.

5.1 Estimation equation

We introduce both refinements to the EBA framework. Formally, we evaluate:

$$y_{it} = \sum_{p=1}^{P} \gamma_p Z_{pit} + \beta \mathbf{X}_{it} + \zeta \mathbf{P}_{it} + u_{it}, \tag{8}$$

where Z_{pit} is the demographic polynomial, as introduced in Section 3, $\mathbf{P}$ are the pension indicators, as described in Section 4, and $\mathbf{X}$ are the EBA fundamentals.

5.2 Regression results

Introducing both refinements to the EBA model does not alter our main findings. Table 4 shows the relevant regression results, while Table A3 in the Appendix reports the corresponding age-group coefficients and Table A2 gives the detailed results.

On the one hand, including the pension indicators does not change our findings regarding the demographic polynomial. The magnitude of each polynomial coefficient remains broadly robust across all specifications of the pension indicators. When backing out the corresponding age-group coefficients, we still find a significant and positive effect for cohorts between 45 and 69 of age, and a negative and significant effect for those between 5 and 19 of age.

On the other hand, including the demographic polynomial does not change our findings regarding the pension indicators. As shown in Table 4, the magnitude and significance of the coefficients of the pension indicators are broadly in line with the results of Table 2. We find a positive and significant effect of the generosity of fully funded pension systems across all data sources and a positive and significant coefficient for the World Bank and ILO coverage measures. Finally, we find a statistically significant and positive coefficient on the interaction between the fully funded replacement rate and the three coverage measures. We find no statistically significant relationship for PAYG pension systems.

Table 4: Regression results – demographics and pensions

	Bloom (1)	WB (2)	ILO (3)	Bloom (4)	WB (5)	ILO (6)
Demographics 1 #	-0.110	-0.101	-0.104	-0.118	-0.099	-0.093
	(0.101)	(0.101)	(0.101)	(0.099)	(0.099)	(0.100)
Demographics 2 #	0.019	0.018	0.018	0.021	0.018	0.017
	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)
Demographics 3 #	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Replacement rate PAYG #	0.006	0.006	0.007	-0.001	-0.000	0.008
	(0.006)	(0.006)	(0.006)	(0.017)	(0.013)	(0.013)
Replacement rate FF #	0.029***	0.029***	0.030***	0.001	0.000	0.013
	(0.008)	(0.008)	(0.008)	(0.016)	(0.014)	(0.014)
Coverage #	-0.004	0.028*	0.048***	-0.015	0.014	0.040**
	(0.005)	(0.016)	(0.016)	(0.014)	(0.020)	(0.020)
Replacement rate PAYG * coverage #				0.008	0.004	-0.007
				(0.018)	(0.023)	(0.021)
Replacement rate FF * coverage #				0.036*	0.070***	0.048**
				(0.018)	(0.023)	(0.021)
EBA static demographics	No	No	No	No	No	No
EBA fundamentals	Yes	Yes	Yes	Yes	Yes	Yes
Observations(Countries)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)
R-squared	0.583	0.583	0.593	0.590	0.589	0.597

Notes: The dependent variable is the CA balance as a ratio to GDP. Demographics 1/2/3 refer to the demographic polynomial Z_p defined in equation (5). Replacement rates for PAYG and fully funded (FF) systems come from Bloom et al. (2007). Coverage comes from Bloom et al. (2007) (Bloom, columns 1/4), the World Bank (WB, columns 2/5), and ILO (columns 3/6). Full results for the EBA specification are reported in Table A2. Corresponding estimates of age-group coefficients are reported in Table A3. # indicates demeaning relative to the GDP-weighted world average. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Furthermore, the core EBA results are largely unchanged by the introduction of our refinements. Namely, the magnitude and statistical significance of EBA fundamentals are broadly unaffected. This suggests that our refinements, in particular the pension indicators, capture additional drivers of CA balances rather than singling out an effect that is indirectly already accounted for in the EBA model.

5.3 Model fit

Our refinements improve the EBA model fit. As shown in Table A2, the R^2 is 0.55 under the baseline specification. Our refinements increase the R^2 by up to 10.9%, from 0.55 to 0.60.

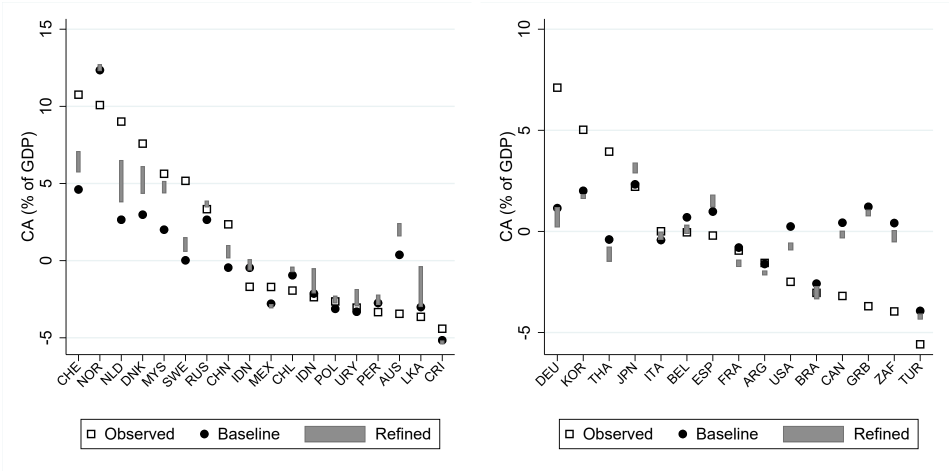
Given the policy agenda underlying the EBA model, another useful way of evaluating model fit is to examine country-specific residuals. Figure 8 plots the observed and fitted CA balances in the baseline EBA model and across the specifications of Table 4 for countries with a fully funded pension system and ESR countries with a PAYG system only. We further focus on the end of the sample period and take averages of the observed and fitted CA balances between 2010 and 2016. Doing so smoothes out undue volatility in CA balances and reduces potential data issues. As in the previous section, we report a band representing the minimum and maximum fitted CA balances across all our specifications of Table 4.

Our refinements reduce residuals for most countries with a fully funded pension system, but perform best for small advanced economies, such as Denmark, the Netherlands, Sweden, and Switzerland. Figure 8a reports the model fit for these countries. For example, the 'optimal' Swiss CA balance ranges from 5.7% to 7.1% of GDP based on our refinements, while the EBA baseline suggests a 4.6% of GDP 'optimal' CA balance. Our refinements bring the fitted Swiss CA balance closer to the observed 10.8% of GDP Swiss CA balance. Similarly, the 'optimal' Dutch CA balance ranges from 3.8% to 6.5% of GDP based on our refinements, while the EBA baseline suggests a 2.7% of GDP 'optimal' CA balance. As in the Swiss case, our refinements bring the fitted Dutch CA balance closer to the observed 9% of GDP Dutch CA balance.

Our refinements tend to perform worse for emerging market economies with a fully funded pension system. They predict 'optimal' CA balances for countries, such as Indonesia and Sri Lanka, that fit the observed CA balances less well than the EBA baseline. For instance, the 'optimal' Sri Lankan CA balance ranges from −3.1% to −0.4% of GDP based on our refinements, while the EBA baseline suggests a −3% of GDP 'optimal' CA balance, broadly in line with the observed −3.6% of GDP CA balance.

These patterns suggest that some of our specifications overestimate the CA balance for emerging market economies with a fully funded pension system. However, this overestimation largely disappears if we consider only the specifications with an interaction between the replacement rate and the cross-sectional coverage measures (either from the World Bank or ILO). For example, consider Sri Lanka, where coverage is among the lowest in our sample (15% and 7% of workers based on the World Bank and ILO data, respectively), but the fully funded replacement rate among the highest (115% of a representative worker's wage). Without an interaction, the fully funded replacement drives a significant increase in the Sri Lankan 'optimal' CA

Figure 8: Model fit



(a) Fully funded countries

(b) PAYG only countries

Notes: This figure reports observed and fitted CA balances, averaged for the period between 2010 and 2016. Fitted CA balances include the IMF EBA baseline, and those predicted by our refinements, which are reported as a band representing the minimum and maximum fitted CA balances for each country across all model specifications of Table 4. Figure (a) reports values for countries with a fully funded pension system. Figure (b) reports values for ESR countries with a PAYG system only.

balance. Interacting the replacement rates with the cross-sectional coverage attenuates this effect. Considering the specification with interactions, we find that our refinements more closely fit the observed CA balances of emerging market economies, while they still generate a better fit for advanced economies. This gives some support that specifications with an interaction between replacement rates and coverage measures, which account for cross-sectional variation, should be our preferred estimates.[10]

Countries without a fully funded pension system experience smaller, but sometimes non-negligible adjustments to their 'optimal' CA balance. Figure 8b reports the model fit for ESR countries exclusively operating a PAYG pension system. Our refinements reduce residuals for some of these countries, such as Canada, South Africa, and the United States. For instance, the 'optimal' US CA balance ranges from -0.5% to -0.9% of GDP based on our refinements, while the IMF baseline suggests a 0.2% of GDP 'optimal' CA balance. Our refinements thus bring the fitted US CA balance closer to the observed -2.5% of GDP US CA balance. This better fit for countries without a fully funded pension system is partly driven by the mul-

[10]Interacting replacement rates and the de jure coverage measure from Bloom et al. (2007) does not improve the fit because most countries are classified as having universal coverage.

tilaterally consistent framework underlying the EBA model. Larger fitted CA surpluses in some countries must be compensated by lower CA balances in other countries.

6 Conclusion

This paper proposes two refinements to the empirical specification of the EBA model by including new demographic variables and pension indicators. First, to account for the fact that individuals at different ages save at different rates, we replace the demographic variables of the EBA model with a polynomial combination of a country's entire population age structure following Fair & Dominguez (1991). Within the EBA model, we find robust evidence that the demographic polynomial is able to reduce the counterintuitive volatility of the current static demographic variables while generating robust and economically intuitive predictions of the demographic contribution to the CA balance.

We then propose introducing pension indicators into the EBA model. We find a positive relationship between the generosity and coverage of fully funded pension systems and the CA balance, while we find no such relationship for PAYG systems. These results imply significantly different predictions of the contribution of our pension indicators at the country level.

Introducing both refinements to the EBA model broadly improves the model fit. In particular, our refinements reduce residuals for most countries with a fully funded pension system, but perform best for small advanced economies, such as Denmark, the Netherlands, Sweden, and Switzerland. These countries' fully funded pension systems, which are characterized by high replacement rates and broad coverage, contribute to their CA balance and significantly reduce the unexplained model residual.

The EBA methodology, in particular the EBA model, is an integral part of the IMF's toolkit for the assessment of countries' external sector positions. This paper suggests two new avenues that could support more consistent policy advice across countries and over time. Nevertheless, evaluating the impact of demographics and of pension systems on CA balances across countries is a complex endeavour, to which this paper makes only a tentative contribution. Further work might need to improve on the data underlying the pension indicators, consider other aspects of pension systems, such as their sustainability, and evaluate the interaction of demographics with the pension indicators.

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Appendix

Table A1: Description of the EBA sample and variables

Country sample	
Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Costa Rica, the Czech Republic, Denmark, Egypt, Finland, France, Germany, Greece, Guatemala, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, New Zealand, Norway, Pakistan, Peru, the Philippines, Poland, Russia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Tunisia, Turkey, the United Kingdom, the United States, and Uruguay.	
Static demographic variables	
Prime savers share #	Share of prime-aged savers (ages 45-64) as a proportion of the total working age population (ages 30-64)
Population growth #	Annual growth rate of the total population, taken from the UN World Population Prospects
Old-age dependency ratio #	Ratio of population over 65 to the population between 20 and 64 years of age
Fundamentals	
Prime age life expectancy	Life expectancy of a current prime-aged saver
Prime age life expectancy # * future OADR	Life expectancy of a current prime-aged saver interacted with future (20 years ahead) old-age dependency ratio
L. NFA/GDP	Lagged net foreign asset as a ratio to GDP
L.NFA/GDP*(dummy if NFA/GDP$< -60\%$)	Lagged NFA/GDP interacted with a dummy for countries with a NFA position below -60% of GDP
L.Relative output per worker	Ratio of PPP GDP to working age population relative to average of Germany, Japan, and U.S., lagged
L.Relative output per worker*K openness	Lagged relative output per worker interacted with the Quinn index of capital openness
Oil/gas balance*resource temporariness #	Oil and natural gas trade balance (as a % of GDP) interacted with the degree of temporariness (ratio of current extraction to proven reserves). Enters only if the oil and natural trade balance is positive.
Expected GDP growth #	5-year forecast of real GDP growth from the WEO
Own currency's share in world reserves	Share of the country's own currency in total stock of world reserves proxies for the "exorbitant privilege"
L.VOX(#)*K-openness	Lagged VOX Index (deviations from historical average) interacted with Quinn index of capital account openness
L.VOX(#)*K-openness *world reserves share	Lagged VOX index interacted with capital account openness and share of a country's currency in world reserves
Output Gap #	Estimates of the output gap
Commodity ToT gap*trade openness	Ratio of a geometric weighted-average price of commodity export categories to the correspond import price, each relative to manufactured goods prices in advanced economies, weighted by share in the countries trade. HP filtered to produce cyclical component.
Detrended private credit/GDP #	Total credit (bank and nonbank) provided to the non-financial private sector, excluding non-bank cross-border flows from the BIS. HP-filtered.
Cyclically adjusted fiscal balance, inst. #	General government fiscal balance, cyclically adjusted following staff estimates, instrumented with lagged global and country-specific factors variables
(Δ reserves)/GDP*K controls, inst. #	Change in central bank foreign exchange reserves including off-balance sheet foreign exchange intervention during the year, scaled by nominal GDP. Instrumented and interacted with capital controls index.
Institutional quality (ICGR-12) #	12 sub-indicators from the International Country Risk Guide (government stability; internal conflict; external conflict; military in politics; law; ethnic tensions; bureaucracy quality; socioeconomic conditions; investment; corruption; religious tensions; and democratic accountability)
L.Public health spending/GDP #	Lagged level of public health spending relative to GDP

This table gives the country sample covered by the EBA model and a brief description of the EBA model's baseline variables. # indicates that the variables is defined as the deviation from the GDP-weighted world average. Cubeddu et al. (2019) gives detailed information on the construction of the variables and the data source.

Table A2: Regression results: demographics and pensions

	Baseline	Demographics	Pensions						Demographics & pensions					
			Bloom	WB	ILO	Bloom	WB	ILO	Bloom	WB	ILO	Bloom	WB	ILO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Demographics 1 #		-0.150							-0.110	-0.101	-0.104	-0.118	-0.099	-0.093
		(0.101)							(0.101)	(0.101)	(0.101)	(0.099)	(0.099)	(0.100)
Demographics 2 #		0.025*							0.019	0.018	0.018	0.021	0.018	0.017
		(0.015)							(0.015)	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)
Demographics 3 #		-0.001*							-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
		(0.001)							(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Replacement rate PAYG #			0.005	0.006	0.007	-0.006	-0.003	0.004	0.006	0.006	0.007	-0.001	-0.000	0.008
			(0.006)	(0.006)	(0.006)	(0.017)	(0.013)	(0.013)	(0.006)	(0.006)	(0.006)	(0.017)	(0.013)	(0.013)
Replacement rate FF #			0.029***	0.029***	0.031***	0.002	0.000	0.012	0.029***	0.029***	0.030***	0.001	0.000	0.013
			(0.008)	(0.008)	(0.008)	(0.016)	(0.014)	(0.014)	(0.008)	(0.008)	(0.008)	(0.016)	(0.014)	(0.014)
Coverage #			-0.003	0.041**	0.056***	-0.015	0.024	0.046**	-0.004	0.028*	0.048***	-0.015	0.014	0.040**
			(0.005)	(0.016)	(0.016)	(0.014)	(0.020)	(0.020)	(0.005)	(0.016)	(0.016)	(0.014)	(0.020)	(0.020)
Replacement rate PAYG * coverage #						0.012	0.010	0.001				0.008	0.004	-0.007
						(0.018)	(0.023)	(0.020)				(0.018)	(0.023)	(0.021)
Replacement rate FF * coverage #						0.034*	0.069***	0.047**				0.036*	0.070***	0.048**
						(0.019)	(0.023)	(0.021)				(0.018)	(0.023)	(0.021)
Prime savers share #	0.138**		0.116**	0.086	0.081	0.119**	0.092	0.084						
	(0.056)		(0.056)	(0.057)	(0.056)	(0.055)	(0.056)	(0.055)						
Population growth #	-0.692*		-0.784**	-0.877**	-0.758**	-0.812**	-0.900**	-0.780**						
	(0.369)		(0.363)	(0.360)	(0.356)	(0.359)	(0.359)	(0.357)						
Old-age dependency ratio #	-0.069		-0.059	-0.086**	-0.095**	-0.060	-0.080*	-0.090**						
	(0.043)		(0.043)	(0.043)	(0.042)	(0.042)	(0.042)	(0.042)						
Prime age life expectancy #	-0.005***	-0.006***	-0.005***	-0.007***	-0.007***	-0.006***	-0.006***	-0.007***	-0.006***	-0.007***	-0.008***	-0.007***	-0.007***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Prime age life expectancy # *future OADR	0.013***	0.014***	0.013***	0.017***	0.018***	0.015***	0.016***	0.017***	0.014***	0.016***	0.017***	0.016***	0.016***	0.018***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
L. NFA/GDP	0.023***	0.024***	0.022***	0.022***	0.024***	0.023***	0.022***	0.024***	0.023***	0.023***	0.024***	0.024***	0.023***	0.023***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
L.NFA/GDP*(dummy if NFA/GDP < -60%)	-0.006	-0.007	-0.006	-0.005	-0.005	-0.009	-0.007	-0.007	-0.007	-0.006	-0.005	-0.009	-0.008	-0.007
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
L.Relative output per worker	0.023	0.017	0.032	0.016	0.014	0.028	0.014	0.016	0.027	0.014	0.010	0.023	0.012	0.013
	(0.020)	(0.020)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
L.Relative output per worker*K openness	0.041*	0.035*	0.032	0.038*	0.037*	0.036*	0.039*	0.035*	0.025	0.033	0.034	0.030	0.032	0.030
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Oil/gas balance * resource temporariness #	0.310***	0.336***	0.303***	0.316***	0.326***	0.292***	0.327***	0.335***	0.326***	0.335***	0.347***	0.319***	0.349***	0.360***
	(0.089)	(0.089)	(0.088)	(0.087)	(0.086)	(0.086)	(0.085)	(0.085)	(0.088)	(0.087)	(0.087)	(0.086)	(0.085)	(0.086)
Expected GDP growth #	-0.302***	-0.272***	-0.343***	-0.345***	-0.370***	-0.337***	-0.320***	-0.353***	-0.318***	-0.320***	-0.341***	-0.308***	-0.293***	-0.323***
	(0.104)	(0.104)	(0.104)	(0.103)	(0.103)	(0.104)	(0.104)	(0.103)	(0.104)	(0.104)	(0.104)	(0.105)	(0.104)	(0.104)
L.VIX(#)*K openness	0.020	0.022	0.019	0.020	0.022	0.019	0.022	0.023	0.021	0.021	0.022	0.021	0.023	0.024
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
L.VIX(#)*K openness*world reserves share	0.002	-0.002	0.004	-0.000	-0.003	-0.001	-0.009	-0.010	0.000	0.000	-0.003	-0.008	-0.010	-0.011
	(0.067)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)
Own currency's share in world reserves	-0.030***	-0.031***	-0.027**	-0.024**	-0.028**	-0.027**	-0.019	-0.024**	-0.028**	-0.025**	-0.027**	-0.027**	-0.020*	-0.023**
	(0.012)	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Output gap #	-0.356***	-0.358***	-0.360***	-0.355***	-0.352***	-0.359***	-0.354***	-0.351***	-0.362***	-0.360***	-0.357***	-0.361***	-0.358***	-0.355***
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Commodity ToT gap*trade openness	0.161***	0.160***	0.161***	0.165***	0.165***	0.165***	0.171***	0.170***	0.160***	0.161***	0.162***	0.165***	0.168***	0.167***
	(0.036)	(0.036)	(0.036)	(0.035)	(0.035)	(0.036)	(0.035)	(0.035)	(0.036)	(0.036)	(0.035)	(0.036)	(0.036)	(0.035)
Detrended private credit/GDP #	-0.104***	-0.106***	-0.104***	-0.101***	-0.102***	-0.103***	-0.100***	-0.101***	-0.107***	-0.105***	-0.105***	-0.105***	-0.105***	-0.105***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Cycl. adjusted fiscal balance, inst. #	0.329***	0.327***	0.330***	0.316***	0.311***	0.302***	0.267***	0.272***	0.331***	0.333***	0.325***	0.295***	0.279***	0.284***
	(0.087)	(0.086)	(0.087)	(0.087)	(0.086)	(0.088)	(0.088)	(0.087)	(0.086)	(0.085)	(0.086)	(0.088)	(0.086)	(0.087)
(Δ reserves)/GDP* K controls, inst. #	0.754***	0.712***	0.650***	0.680***	0.665***	0.633***	0.687***	0.672***	0.609***	0.643***	0.632***	0.584**	0.645***	0.633***
	(0.236)	(0.234)	(0.232)	(0.232)	(0.231)	(0.231)	(0.231)	(0.231)	(0.230)	(0.231)	(0.230)	(0.228)	(0.229)	(0.229)
Institutional quality (ICGR-12) #	-0.047**	-0.050**	-0.050**	-0.058***	-0.064***	-0.046**	-0.054***	-0.059***	-0.053***	-0.059***	-0.065***	-0.049**	-0.055***	-0.060***
	(0.019)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.020)	(0.020)	(0.020)	(0.020)	(0.019)	(0.020)
L.Public health spending/GDP #	-0.399***	-0.436***	-0.343***	-0.372***	-0.417***	-0.332**	-0.419***	-0.456***	-0.375***	-0.403***	-0.449***	-0.363***	-0.449***	-0.487***
	(0.134)	(0.134)	(0.132)	(0.132)	(0.130)	(0.131)	(0.131)	(0.130)	(0.131)	(0.131)	(0.131)	(0.130)	(0.130)	(0.130)
Constant	-0.009***	-0.007**	-0.011***	-0.010***	-0.008**	-0.011***	-0.011***	-0.009***	-0.008***	-0.008**	-0.006*	-0.009***	-0.009***	-0.007**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Observations(Countries)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)	1367(49)
R-squared	0.550	0.552	0.583	0.584	0.597	0.589	0.589	0.600	0.583	0.583	0.593	0.590	0.589	0.597

Notes: Demographics 1/2/3 refer to the demographic polynomial Z_p defined in equation (5). Replacement rates for PAYG and fully funded (FF) systems come from Bloom et al. (2007). Coverage comes from three data sources: Bloom et al. (2007), the World Bank (WB), and ILO. Corresponding estimates of age-group coefficients are reported in Table A3. Column (1) is the EBA baseline. Column (2) is consistent with the results of Figure 2, which correspond to our first refinement to the EBA static demographic variables only. Columns (3) through (8) correspond to Table 4 across specifications with the pension indicators only. Columns (9) through (14) correspond to Table 4 across specifications with the demographic polynomial and the pension indicators. Standard errors reported in parentheses. # indicates demeaning relative to the GDP-weighted world average. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A3: Regression results: age-group coefficients

	No pensions	Without interactions			With interactions		
		Bloom	WB	ILO	Bloom	WB	ILO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
0-4	0.022	-0.010	-0.003	0.012	-0.013	-0.015	-0.009
	(0.083)	(0.082)	(0.082)	(0.082)	(0.082)	(0.081)	(0.083)
5-9	-0.059*	-0.068**	-0.055*	-0.042	-0.074**	-0.065**	-0.056*
	(0.029)	(0.029)	(0.029)	(0.030)	(0.029)	(0.029)	(0.031)
10-14	-0.103***	-0.096***	-0.081**	-0.070**	-0.104***	-0.089***	-0.078**
	(0.030)	(0.030)	(0.031)	(0.031)	(0.030)	(0.031)	(0.031)
15-19	-0.116**	-0.101**	-0.085*	-0.075	-0.108**	-0.091*	-0.079
	(0.046)	(0.046)	(0.047)	(0.047)	(0.046)	(0.047)	(0.047)
20-24	-0.103*	-0.086	-0.071	-0.062	-0.091*	-0.076	-0.063
	(0.052)	(0.052)	(0.053)	(0.053)	(0.051)	(0.052)	(0.052)
25-29	-0.071	-0.057	-0.044	-0.037	-0.059	-0.048	-0.036
	(0.048)	(0.048)	(0.049)	(0.048)	(0.047)	(0.048)	(0.048)
30-34	-0.027	-0.019	-0.010	-0.003	-0.017	-0.011	-0.001
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
35-39	0.024	0.023	0.029	0.034	0.029	0.029	0.036
	(0.037)	(0.037)	(0.037)	(0.036)	(0.037)	(0.036)	(0.036)
40-44	0.074	0.065	0.067	0.070	0.075*	0.068	0.072
	(0.043)	(0.044)	(0.044)	(0.043)	(0.044)	(0.043)	(0.043)
45-49	0.119**	0.102*	0.099*	0.101*	0.114*	0.101*	0.102*
	(0.056)	(0.057)	(0.056)	(0.056)	(0.056)	(0.055)	(0.055)
50-54	0.151**	0.128*	0.121*	0.120*	0.142**	0.124*	0.122*
	(0.067)	(0.067)	(0.067)	(0.067)	(0.066)	(0.066)	(0.066)
55-59	0.164**	0.139*	0.128*	0.125*	0.152**	0.132*	0.126*
	(0.070)	(0.070)	(0.071)	(0.071)	(0.069)	(0.069)	(0.070)
60-64	0.153**	0.130*	0.116*	0.109*	0.141**	0.121*	0.111*
	(0.063)	(0.063)	(0.064)	(0.064)	(0.062)	(0.063)	(0.063)
65-69	0.110**	0.095**	0.079	0.069	0.102**	0.086*	0.073
	(0.045)	(0.045)	(0.046)	(0.046)	(0.045)	(0.046)	(0.046)
70-74	0.029	0.031	0.014	-0.000	0.029	0.022	0.005
	(0.040)	(0.040)	(0.041)	(0.041)	(0.040)	(0.040)	(0.040)
75-79	-0.096	-0.068	-0.084	-0.104	-0.081	-0.076	-0.095
	(0.091)	(0.092)	(0.091)	(0.091)	(0.091)	(0.090)	(0.090)
80+	-0.271	-0.208	-0.219	-0.247	-0.235	-0.211	-0.232
	(0.181)	(0.182)	(0.181)	(0.180)	(0.179)	(0.177)	(0.178)

Notes: This table reports the estimated age-group coefficients α_g, backed out from the estimated polynomial-specific coefficient γ_p. Column (1) is consistent with the results of Figure 2, which correspond to our first refinement to the EBA static demographic variables only. Columns (2) through (7) correspond to Table 4 across specifications with the pension indicators. Standard errors reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

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