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Long-run fiscal consequences of refugee migration – The case of Austria

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Abstract

We use a rich numerical OLG model of Auerbach-Kotlikoff type to simulate the long-run effects of refugee migration starting 2015 for a country with an aging society and a generous welfare system, namely Austria. The respective refugee cohorts are on average younger, less educated and less productive than both natives and the average migrant. The net fiscal contribution results from two opposing effects: a positive demographic effect which is counteracted by worse labor market outcomes. We robustly find that public debt is higher throughout the simulation horizon 2015–2060 compared to the baseline. We further analyze the group-specific welfare consequences resulting from differentiated wage effects.

Keywords: refugee migration, fiscal effects, overlapping generations model, general equilibrium

JEL Classification: F22, H68, J11, J15, J61

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1 Introduction and motivation

Within the EU 2.8 million (net) asylum applications[1] were registered in the years 2015 to 2017. Hence, humanitarian migration has been the dominant migration type during that period contributing significantly to the total net migration flow to the EU of 4.4 million persons. The observed refugee flows to Europe have been geographically concentrated on countries of origin and destination: 58% of applications were filed by citizens of only six countries of origin, while 80% of applications were filed in only six EU member states.[2] Austria, which has a long tradition of humanitarian migration, ranks third in per capita terms w.r.t. received applications (behind Sweden and Hungary) as well as positive asylum decisions (behind Sweden and Germany) and will be at the focus of the present paper. The unprecedented dimension of refugee flows to Europe since World War II led to a polarized public debate which also picked up the discussion about the economic consequences of refugee migration for the host countries. A cross-country data analysis for 20 European countries by Dustmann and Preston (2006) identifies the fiscal consequences of migration as the single most important issue in the public debate. Our work tries to objectify and contribute to this discussion by evaluating the long-run economic impact of the recent refugee migration surge for a small open economy with a generous welfare system and an aging society, namely Austria.

When analyzing the fiscal impact of migration it is essential to distinguish humanitarian or refugee migration (residence permits subject to asylum, subsidiary or humanitarian protection) from regular migration (residence permits for work or study[3]). Labor market integration of refugees is typically slower as access to the labor market is limited during clarification of legal status (see Konle-Seidl and Bolits, 2016 for a comprehensive survey[4]). Often refugees cannot provide proper documentation of education or skill, which hampers skill recognition and job placement. Further, refugee migration in general implies short-run 'arrival' costs related to registration, processing of asylum applications, provision of basic care and shelter, integration measures, etc. Moreover, socioeconomic characteristics typically differ. In the past, refugees were, on average, younger and less educated than

[1]We compute net asylum applications as 3.3 million filed minus 0.5 million withdrawn applications.

[2]Using only positively decided instead of all filed asylum applications reveals an even higher concentration: 81% of all positively decided asylum applications stem from citizens of only six source counties while 88% of all positively decided applications affect only six host countries. This is even more the case for Austria: citizens from only six source countries are responsible for 76% of all filed applications and 89% of positively decided.

[3]In Austria, third country nationals, i.e. not EEA or Swiss citizens, have to apply for different immigration programs for students, highly qualified or other key workers, etc.

[4]Further evidence, specifically on labor market outcomes and effects of refugees, is provided by Colic-Peisker and Tilbury (2007) (Australia), Lundborg (2013), Aldén and Hammarstedt (2014) and OECD, 2016 (Sweden) and Bevelander and Pendakur (2014) (Canada and Sweden). Borjas and Monras (2017) discusses various historical refugee supply shocks.

regular migrants. While historical refugee waves to Austria predominately stemmed from neighboring countries within Europe, they have originated mainly from the Middle East and sub-Saharan Africa in recent years (figure 2). This implies that the current flow of newly arriving refugees considerably differs from the existing stock, leading to more pronounced differences in sociodemographic characteristics. Currently arriving refugees are even younger and less educated compared to historical refugee waves. Extrapolating insights about the economic impact from historical refugee waves should therefore only be done with great care; even more so as the large size of the current refugee influx (figure 1) implies potential additional integration obstacles.

Figure 1: Migration and asylum applications in Austria

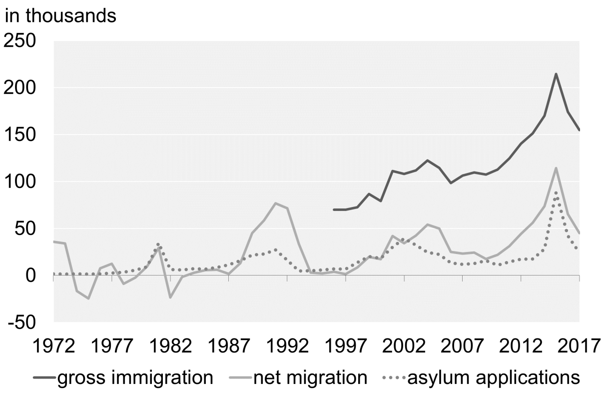
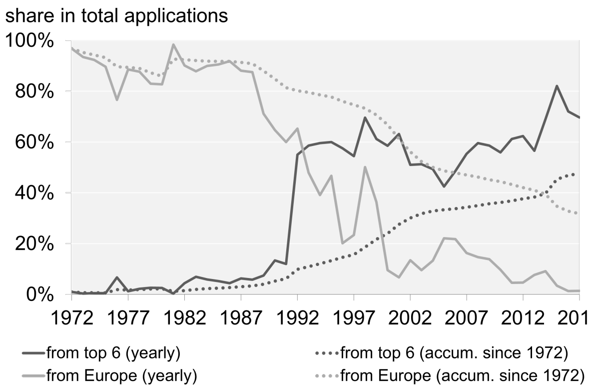


Figure 2: Asylum applications in Austria by origin



Source: Statistics Austria, Eurostat and the Austrian Federal Ministry for the Interior. Note: Gross immigration available only after 1996. Net migration includes statistical adjustment. The current 'top 6' refers to Afghanistan, Iran, Iraq, Russia (including former republics of the Soviet Union), Somalia and Syria. 'Europe' excludes Turkey, Russia and all former republics of the Soviet Union.

The socioeconomic characteristics of refugees crucially determine the long-term economic impact. With respect to the recent refugee wave two opposing effects can be identified. First, the compared to the Austrian population young refugee cohort implies a demographic potential to ease the burden of increasing dependency ratios and decreasing labor supply, which pose substantial future stress for the Austrian economy and the welfare state (pension- and health care system). Second, low education levels and slow labor market integration imply lower tax revenues and more transfers which can in turn increases stress for the welfare system.

We build on a large body of theoretical and empirical literature on the economic effects of migration, which predominantly focuses on labor markets. At the heart of this literature are wage and employment effects of immigration, which critically depend on the degree of substitutability of native and foreign workers, a question that is still debated (e.g. see the discussion Borjas, 2003 and Borjas et al., 2008 vs. Ottaviano and Peri, 2012 or more recently Borjas, 2014 vs. Card and Peri, 2016). We use a flexible specification that can replicate different degrees of substitutability. The total effect on public finances goes beyond the labor market induced changes in labor tax revenue and non-employment benefits. In addition, changes in other tax revenue (consumption, profits, etc.), further cash transfers (pensions, family, etc.) and in-kind benefits (education, health, etc.) have to be taken into account. Estimates of the fiscal impact are provided by a series of studies and vary widely depending on the applied method, labor market conditions, country-specific design of social security systems of host countries and socioeconomic characteristics of the migrants at hand (see OECD, 2013 or Preston, 2014 for an extensive overview). Methods applied range from static cash-flow calculations, which contrast revenue and expenditure of a current stock of migrants within a year (e.g. Borjas, 1994 for the United States, Dustmann and Frattini, 2014 and Dustmann et al., 2010 for the United Kingdom or Ruist, 2014 for Sweden), to generational accounting exercises that take life-cycle revenue/cost profiles into account (e.g. Auerbach and Oreopoulos, 1999 for the United States, Bonin et al., 2000 and Manthei and Raffelhüschen (2018) for Germany, Storesletten, 2003 for Sweden and Mayr, 2005 for Austria) to general equilibrium OLG models (e.g. Storesletten, 2000 for the United States, Chojnicki and Ragot, 2016 for France and Berger et al., 2016 and papers cited therein for various other European countries) that in addition include behavioral responses and price effects. By applying a full-scale Auerbach-Kotlikoff model our paper falls into this last mentioned group.

So far, the evidence on the fiscal impact of refugee immigration is limited. Static cash flow approaches which specifically differentiate between different immigration groups (see Cully et al., 2011 for Australia and Aldén and Hammarstedt, 2016 for Sweden) derive clear negative fiscal effects of refugee migration with yearly net fiscal costs however decreasing rapidly in the duration of stay. In a similar framework Ruist (2015) computes a negative net fiscal impact of the stock of refugees living in Sweden in 2007. The recent refugee surge to Europe led to a number of applied policy studies[5] that were mainly short- and medium-run oriented. To our knowledge this paper is the first to analyze the fiscal consequences of refugee migration with a long-run focus using a comprehensive full-scale OLG model. The model is applied to Austria that is one of the main destination countries and for which labor market outcomes of recent refugee cohorts are well documented based on register data (Huber and Böhs, 2017). Although our estimations are Austria-specific the results should in principle be generalizable for countries with similar tax-transfer-systems and migrant cohorts of similar characteristics. Our contribution to the literature is threefold: First, we identify the key characteristics of refugee migration that determine their long-

[5] See for example European Commission (2016), Aiyar et al. (2016) or Sinn et al. (2016) for a summary of the discussion in Germany.

run net fiscal impact. Second, we estimate the long-run net fiscal impact of refugees migrating to Austria from 2015 to 2020 and decompose the effect along various dimensions. Third, our general equilibrium approach allows us to analyze the group-specific welfare consequences based on the differentiated wage effects. The paper is structured as follows. Section 2 presents the main blocks of the OLG model applied. Section 3 thoroughly explains used data and assumptions. Section 4 presents the simulation results and contrast them with sensitivity scenarios and robustness checks in the consecutive section. Section 6 concludes.

2 Model description

The paper uses an overlapping generations model developed for Austria in the tradition of Auerbach and Kotlikoff (1987), i.e. based on single-year age groups. Austria is modeled as a small open economy. The behavior of households and firms, who interact in different markets (labor, capital, assets), is explicitly modeled and forward-looking. The government influences their behavior by collecting taxes and paying transfers and through its role as a consumer of final goods. The model is characterized by a neoclassical core with exogenous growth in labor-augmenting productivity. The sections below provide an overview of the main blocks of the model. Interested readers are referred to the technical model documentation (Schuster, 2018) for details.

2.1 Household sector

Households[6] differ along four dimensions: age, skill, subpopulation and savings type described by the vector (a, s, n, x).[7] In the implementation we use 97 age groups, 5 skill groups, 2 subpopulations and 2 savings types of households. We denote the subpopulations as 'Austrian subpopulation' and 'refugee subpopulation'. Household savings types are 'Ricardian' or unconstrained and 'rule-of-thumb' or constrained.

[6]Households are interpreted in an individualistic way, i.e. we do not model actual household structures. Hence, the terms 'household' and 'individual' are used interchangeably.

[7]In fact the demographic module of the model further distinguishes households by gender in order to compute newborns based on age-specific fertility rates and the number of females between 15 and 50 and average mortality rates.

Demography

Let $N_t^{a,s,n,x}$ be the mass of a representative household of characteristic (a, s, n, x) at time t. The demographic laws are

$$N_{t+1}^{0,s,n,x} = NB_{t+1}^{s,n,x} + Mig_{t+1}^{0,s,n,x} \tag{1}$$

$$N_{t+1}^{a+1,s,n,x} = \gamma_{t+1}^{a,s} N_t^{a,s,n,x} + Mig_{t+1}^{a+1,s,n,x}, \quad \gamma_{t+1}^{\overline{a}} = 0 \ \forall t. \tag{2}$$

where NB, Mig and γ denote newborns, net migration and the survival rate. Note that this specification does not allow switching of skill group, subpopulation and savings type during life-time. Households are allocated to skill groups based on highest attained education over life-time. We assume that the share of unconstrained households π^s is independent of age, subpopulation and time but varies based on the skill level. Households make active decisions between age $\underline{a} = 15$ and $\overline{a} = 96$. Persons aged below $\underline{a}$ are inactive but are tracked in the model, e.g. to compute aggregate education costs. Their consumption is implicitly included in their parents' consumption. We now describe the decision problems of households of age $\underline{a} \leq a \leq \overline{a}$ for the two savings types. To save notation we omit the superscripts for skill and subpopulation in the following presentation.

Ricardian households

Ricardian or unconstrained households can save and borrow and therefore face a dynamic optimization problem of choosing consumption every period subject to the following intertemporal budget constraint.

$$GA_{t+1}^{a+1} = \bar{R}_{t+1}^W \left[A_t^a + y_t^a + \tilde{y}_t^{U,a} - p_t^C C_t^{U,a} \right]. \tag{3}$$

$G = 1 + g$ is the exogenous growth factor[8], A denotes asset holdings and $\bar{R}^W = 1 + r^W(1 - \tau^R)$ is the after-tax portfolio interest factor for households. Assets can be held in firm shares, government bonds and foreign assets, which are assumed to be imperfect substitutes such that financial arbitrage is limited and rates of return of different asset types are not equalized.[9] Per period saving without interest is per period income $y_t^a + \tilde{y}_t^{U,a}$ minus spendings on consumption $p^C C^{U,a}$, where p^C is the after-tax price of consumption. Income stream $\tilde{y}_t^{U,a}$ collects net asset transfers received, e.g. from inter-vivo transfers and

[8]The model is de-trended by the exogenous growth of labor-augmenting productivity.

[9]This assumption allows us to set the return rate of domestic government bonds freely.

accidental bequests.[10] Income related to the labor market status y_t^a is given by

$$y_t^a = \delta_t^a(1-\tau_t^{W,a})w_t\ell_t^a\theta_t^a + (1-\delta_t^a)\hat{b}_t^a - \tau_t^{l,a}, \quad \text{where} \tag{4}$$
$$\hat{b}_t^a = \phi_t^a b_t^a + (1-\phi_t^a)(1-\tau_t^{P,a})y_{pens,t}^a, \quad y_{pens,t}^a = \left[\varsigma_t^a P_t^a + P_t^{0,a}\right]. \tag{5}$$

After-tax income from work is received with probability (or share[11]) of participation $\delta^a \in [0,1]$ and consists of wage rate w times hours ℓ^a times productivity θ^a subject to average tax rate $\tau^{W,a}$. The representative households within a specific skill group are equipped with two types of labor: native and foreign (superscripted with H and F), which are imperfect substitutes in production. Domestic labor share per efficiency unit (μ) is given exogenously such that the average wage rate by skill and subpopulation is $w^{s,n} = \mu^{s,n}w^{H,n} + (1-\mu^{s,n})w^{F,n}$. In our application the share of domestic labor in the refugee subpopulation is set to zero, i.e. $\mu^{s,n=2} = 0$ while for the Austrian subpopulation $\mu^{s,n=1}$ is set to match the share of labor supplied by Austrian natives living in Austria in total labor supply in Austria. In case of non-participation households receive non-employment benefits b^a or after-tax pension benefits depending on the pension eligibility parameter $\phi^a \in [0,1]$. Gross pension y_{pens}^a depends on the current stock of accumulated pension points in the household's pension account P^a and a flat earnings history independent part $P^{0,a}$. Accumulation of pension points follows the following law

$$GP_{t+1}^{a+1} = G_t^{P,a}\left[P_t^a + m_t^a\delta_t^a w_t\ell_t^a\theta_t^a\right], \tag{6}$$

where m^a is the accumulation rate and $G^{P,a}$ governs indexation of pension claims, i.e. wage indexation ($G^P = G$) during the active phase and inflation indexation ($G^P = 1$) after retirement. The problem of a Ricardian household is to maximize life-time utility w.r.t. consumption, hours and participation subject to the intertemporal budget constraint and the pension account accumulation law.

$$V(A_t^a, P_t^a) = \max_{C_t^{U,a},\ell_t^a,\delta_t^a} \left[{}^1\!/\!_\rho\left(\tilde{C}_t^{U,a} - \Psi_t^a\right)^\rho + \beta\gamma_{t+1}^a G^\rho V_{t+1}^{a+1}\right], \quad \text{s.t. (3), (6) and} \tag{7}$$
$$\tilde{C}_t^{U,a} = C_t^{U,a} - \kappa C_{t-1}^{U,a-1} \quad \text{and} \quad \Psi_t^a = \delta_t^a\varphi^{\ell,a}(\ell_t^a) + \varphi^{\delta,a}(\delta_t^a). \tag{8}$$

Ψ_t^a represents total disutility of work and is convexly increasing in hours and participation. $\sigma = 1/(1-\rho)$ is the intertemporal elasticity of substitution. Parameter κ governs the extend of habit persistence in consumption.

[10] In our simulation we abstract from inter-vivo transfers within the refugee subpopulation as well as remittance payments.

[11] We use an income pooling assumption following Andolfatto (1996) which implies that actual and expected per-period income are equal.

Rule-of-thumb households

Rule-of-thumb (or constrained) households do not save or borrow and therefore spend all of their disposable income in the same period. This can be motivated by liquidity constraints or by assuming cognitive restrictions which prevent these households from performing a full intertemporal optimization and consumption smoothing (see e.g. Campbell and Mankiw, 1989 and Mankiw, 2000). In the absence of income effects (due to the specification of linear separability) optimally chosen hours and participation are independent of the current consumption level and therefore do not differ between the savings types, and neither does the respective income y^a. Consumption of a constrained household is given by the simple relation

$$C_t^{C,a} = \left[y_t^a + \tilde{y}_t^{C,a}\right] / p_t^C. \tag{9}$$

2.2 Firm sector

The firm sector is standard (e.g. Keuschnigg and Kohler, 2002) and consists of two types of firms, a representative capital goods firm building up the economy-wide capital stock and a mass n^h of domestic final goods producers selling differentiated varieties subject to monopolistic competition. The representative capital goods firm's investment behavior is based on expected future profits from renting capital to the final goods producers and subject to capital adjustment costs, profit taxes and subsidies. A final goods firm indexed with i produces its variety using a constant returns to scale production function which takes three[12] composites of effective labor and capital

$$Y_i = f\left(L_i^1, L_i^2, L_i^3, K_i\right). \tag{10}$$

The three labor composites are imperfect substitutes characterized by increasing complementarity to capital the higher the skill level. Further, each of these three labor composites consists of native and foreign labor which are also imperfect substitutes.[13] Conditional on skill and type (native vs. foreign) a firm does not distinguish between age or savings type. A variety producer chooses optimal demand for labor efficiency units L_i^s and capital

[12]To ease computations and calibration the five skill groups are aggregated to three: 'low', 'medium' and 'high' with 'medium' corresponding to labor from skill groups 2, 3 and 4. That means that skill groups 2, 3 and 4 can still have different age-profiles for productivity, employment rates, taxes, transfers, public consumption, etc. but wage effects are the same.

[13]The employed production function is a two-level CES function where the upper is of nested-CES form in the spirit of Krusell et al. (2000), i.e. $Y_i = A^0 \cdot f^1\left(L_i^1, f^2\left(L_i^2, f^3\left(L_i^3, K_i\right)\right)\right)$ with Allen-Uzawa elasticities of substitution that fulfill $\sigma^{L^1,K} > \sigma^{L^2,K} > \sigma^{L^3,K}$. At the second level every labor composite is split into native and foreign labor, i.e. $L_i^j = g^j(L_i^{H,j}, L_i^{F,j})$ for $j \in \{1,2,3\}$ with elasticity of substitution σ^{L^H,L^F} that by assumption is the same for all skills.

K_i and charges a price p_i^h with a constant mark-up over marginal costs, which includes taxes on factor usage (e.g. payroll taxes). We assume free entry such that in equilibrium profits of the final goods producers are driven down to zero, which pins down the mass of firms n^h.

2.3 Government sector

The government collects revenue Rev from taxes on labor and pensions (wage and assessed income tax, social contributions, payroll taxes, etc.), consumption (value-added tax, excise taxes, etc.) and profits and capital gains (corporate income tax, interest tax, dividend tax, etc.). Government expenditure Exp (excluding interest payments) consists of pension payments, non-employment transfers, family transfers, subsidies and government consumption. The latter is split by functions: health care, long-term care, education and public goods provision. For each function except that last one, expenditure is computed based on skill and age dependent average cost profiles and the corresponding mass of households. The government can issue debt (D^G), which evolves according to the of primary balance flows (PB)

$$GD_{t+1}^G = R_{t+1}^G \left(D_t^G - PB_t \right), \quad PB_t = Rev_t - Exp_t, \tag{11}$$

where $R^G = 1 + r^G$ is the interest factor of domestic government bonds. The government has to be equipped with a budget rule that guarantees that debt (in detrended terms) is stabilized (at least in the long-run[14]) by adjusting one of the mentioned budget instruments.

2.4 Final demands

Demand for final goods stems from difference sources: private consumption, government consumption, investment and from abroad. Consumption is a 2-level CES aggregate. At the upper level composite consumption is split between domestically produced (C^h) and imported bundles (C^m). At the bottom level both are composed of measures n^h (and n^m respectively) of varieties C_i^h (and C_i^m respectively). We use similar assumptions for government consumption and investment where we allow for different import shares. For export demand, a reduced-form downward sloping demand curve characterized by a constant price elasticity of $\lambda^E < 0$ replaces the upper level. At the bottom level the bundle E^h is composed of varieties E_i^h analogously to other final demands. The domestic final goods prices p_i^h emerge from market clearance for all domestic varieties and coincide

[14] One can allow the government to disregard the budget rule for a limited amount of time and let debt float freely.

by symmetry, i.e. $p^h = p_i^h, \ \forall i$.

2.5 Equilibrium

We define equilibrium if for all t the following conditions are met: (1) all optimality conditions defining household and firm behavior hold, (2) $2 \cdot s$ labor markets ($w^{H,s}$,$w^{F,s}$), the capital good market (p^K) and n_t^h domestic final goods markets (p_i^h) clear and (3) PB_t fulfills the chosen government budget rule. Note that by symmetry the n_t^h domestic final goods markets can be treated as one. The model is numerically solved using a Generalized Fair-Taylor algorithm (Wilcoxen, 1989), i.e. by iterating over paths of temporary equilibria until households' and firms' expectations are aligned with the respective realizations.

2.6 Calibration

The model is calibrated at a yearly frequency. Demographic parameters (age-specific mortality and fertility rates and net migration flows) are based on Eurostat's long-run projection (EUROPOP2013). The model is fit to national accounts data according to the European System of Accounts (ESA2010) with 2014 as base year. Calibration of the household sector is based on various micro data sources. We distinguish five separate skill groups of highest educational attainment:[15] $s = 1$: compulsory schools, $s = 2$: apprenticeships, $s = 3$: intermediate technical and vocational schools, $s = 4$: academic secondary schools and higher technical and vocational schools and $s = 5$: tertiary education. The important difference between $s = 3$ and $s = 4$ is that $s = 4$ is completed with an high-school exit exam ('Matura'). Skill and age-specific profiles of employment rates were taken from the 'register based labor market statistics' (RBLMS)[16]. Labor income and transfer profiles were retrieved from the EU statistics on income and living conditions (EU-SILC), as was the share of native in total labor supply for the Austrian subpopulation ($\mu^{n=1} = 0.867$). Average labor tax and contribution rates were computed using the tax liability simulator (TaLiS) as provided by Reiss and Schuster (2018). Further life-cycle information on age and skill specific expenditure for health care, long-term care and education was taken from the national transfer accounts (NTA) as computed by Hammer (2015) for Austria. A summary of the calibration outcomes for the most important monetary flows per person is provided in table 8. A detailed description of the calibration and justification for parameter choice can be found in the technical model description (see Schuster, 2018). We therefore just list the key parameter choices here.

[15]The corresponding Austrian terms are: $s = 1$: 'Pflichtschule', $s = 2$: 'Lehre', $s = 3$: 'berufsbildende mittlere Schule (BMS)', $s = 4$: 'allgemeinbildende/berufsbildende höhere Schule (AHS/BHS)' and $s = 5$: 'Universität und Fachhochschule'.

[16]'Abgestimmte Erwerbsstatistik' as provided by Statistics Austria.

The share of unconstrained households per skill group is $\pi^{s=1,\dots,5} = \{0.5, 0.6, 0.7, 0.8, 0.9\}$. The intertemporal elasticity of substitution was set to $\sigma = 0.25$. The parameter for habit persistence in consumption is $\kappa = 0.3$. The labor supply elasticities for participation and hours are $\varepsilon_\delta = 0.26$ and $\varepsilon_\ell = 0.3$. The export demand elasticity was set to $\lambda^E = -2.5$. The Allen-Uzawa elasticities of substitution of factor inputs are $\sigma^{L^1,K} = 1.4$, $\sigma^{L^2,K} = 0.8$ and $\sigma^{L^3,K} = 0.5$. In the default calibration the elasticity of substitution between native and foreign labor is chosen to be $\sigma^{L^H,L^F} = 10$ following Felbermayr et al. (2010). As in the Ageing Report 2015 (European Commission, 2015) the rate of exogenous technological progress is set to $g = 0.014$. In order to facilitate the interpretation of the long-run results we set the long-run real interest rate of domestic government bonds to $r^G = g$ such that the interest-rate-growth differential is zero and accumulated debt in detrended terms is equal to the sum of primary balances.[17] Return rates of other assets are set higher such that the interest rate of the portfolio for the households (r^W) is close to 3%. Sensitivity of our results to changes in these parameters is thoroughly discussed later.

3 Method, data and assumptions

In order to identify the economic impact of the extraordinary refugee inflow we contrast two scenarios: a baseline with historically observed levels of refugee immigration and a refugee scenario with the actual development 2015 to 2017 succeeded by a period of normalization 2018 to 2020. To capture long-run developments we set the simulation horizon to 2015 to 2060.

3.1 Baseline

The *baseline* is based on assumptions and outcomes of the long-run projection from the Ageing Report 2015 (European Commission, 2015) for Austria, which at that time did not anticipate the large inflow of refugees starting 2015. Besides demographic projections (EUROPOP2013) we replicate the number of employees and retirees by adjusting participation and retirement rates accordingly. We further used the report's assumptions for long-run productivity growth.[18] Long-run costs for education, health care and long-term care were computed based on current age and skill-specific average cost profiles, which were indexed with trend inflation and productivity growth.[19] The same indexation rule was used for transfers which would otherwise vanish in the long run. In addition,

[17] The choice is also supported empirically. Excluding the crisis year 2009 the (government debt) interest-rate-growth differential averaged to 0.07 percentage points during the period 2005 to 2015 in Austria.

[18] We neglect the implications of structural skill shift by assuming that shifts in supply and technology cancel.

[19] The resulting estimates are broadly in line with those of the Ageing Report.

we implement a budget rule by assuming that debt per capita in de-trended terms (i.e. after de-trending by trend inflation and productivity growth) stays constant over time. Changes in public goods provision serve as budget closing instrument.

3.2 Refugee scenario

The *refugee scenario* builds upon the baseline and adds the extraordinary refugee inflow starting 2015. We label asylum applications as 'extraordinary' if the number exceeds the yearly average of the period 2008 to 2014 of 16.5 thousand. This implies that a certain number of incoming refugees, as experienced in the past, is part of the baseline and not captured in the measured effect. We further assume that regular migration is an exogenous event and is unaltered compared to the baseline. We apply a 'no-policy-change' assumption. This means we do not assume endogenous policy reactions to a change in the budget balance, e.g. a variation in the generosity of non-employment benefits[20], etc. In the refugee scenario we hold all budget instruments in comparison to the baseline constant and let debt float freely.[21] The change in debt is then interpreted as the cumulated fiscal effect of the extraordinary refugee inflow. An important determinant for the overall assessment is how government expenditure that cannot be directly linked to a person reacts to the population increase. These 'indirect' costs can broadly be split into demography-related costs (i.e. health care, long-term care and education) and expenditure for the provision of public goods. We assume that demography-related costs increase one to one for every additional person based on age- and skill-specific average cost per person. For the remaining expenditure (e.g. public administration, defense and investment in networking infrastructure) we assume public good characteristics and set the marginal cost per refugee to zero.[22] In addition to the endogenously determined expenditure we take exogenous costs directly related to the arrival (i.e. transportation, border management, immediate basic welfare support) and integration of refugees into account.

The legal status of persons migrating to Austria determines their right to participate in the labor market and to receive government transfers. In general the Austrian asylum procedure only grants minor rights to participate in the labor market during the application process. While applicants do not receive regular government transfers from the social

[20]In Austria minimum income is means-tested not only against income but also against assets. During the first years, eligibility for non-working accepted refugees, who in general arrive with negligible assets, is virtually 100% and is therefore considerably higher than for an average non-working resident. We let eligibility and pick-up rates linearly converge to the Austrian average over 20 years (table 8).

[21]For technical reasons a budget rule has to be put in place in the very long run in order to stabilize debt and guarantee the existence of a final steady state. The budget rule is activated 145 years in the future and hence considerably later than the end of our simulation period 2015 to 2060.

[22]This assumption is not innocuous and addressed in the sensitivity analysis.

system they receive basic care (i.e. food, shelter, health care and pocket money) from the Austrian authorities. Applicants that are allowed to stay in Austria (subject to asylum, subsidiary and humanitarian protection) hold rights to enter the labor market and receive social benefits broadly equivalent to the rights of the native Austrian population.[23] The simulation of the refugee scenario requires a variety of detailed information about refugees who have migrated or are expected to migrate to Austria within our considered shock period of 2015 to 2020. We use existing information of refugee cohorts 2015 to 2017 while for the cohorts 2018 to 2020 we assume the same composition and sociodemographic characteristics. In addition we use data of previous refugee cohorts (2005 to 2014) to fill in gaps, e.g. the developments of employment and productivity after arrival over the medium run, which are not yet observable for the current cohorts. As we have to operate with a number of different data sources and assumptions we critically examine and discuss them in detail in the remainder of this section.

Number of applications, accepted refugees and demographic aspects

Starting from the last available data point in 2017 we linearly fade out the number of 'extraordinary' applications by 2021 (table 1) which reflects the self-commitment of the Austrian government in 2015 to reduce the number of applications again in the medium run.

Table 1: Assumptions concerning application numbers

Asylum applications (in thousands)	2015	2016	2017	2018	2019	2020	2021	Sum
total	88.2	42.3	24.3	22.3	20.4	18.4	16.5	232.4
above past average ('extraordinary')	71.7	25.8	7.8	5.9	3.9	2.0	0.0	117.0
of which: positive decision	38.4	13.8	4.2	3.1	2.1	1.0	0.0	62.6
of which: 'new arrivals'	35.5	4.3	3.0	2.3	1.5	0.7	0.0	47.3
of which: family reunification	2.9	9.5	1.2	0.8	0.6	0.4	0.0	15.4

Source: Eurostat, Austrian Federal Ministry of the Interior, own calculations and assumptions.

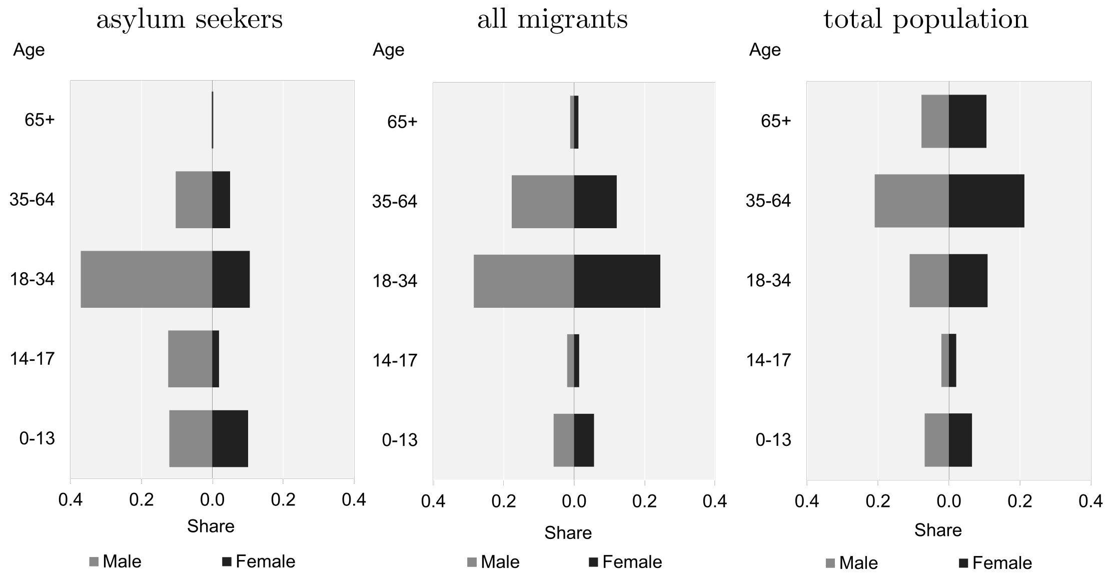
We use Eurostat data on asylum applications and decisions for the period 2015Q1 to 2017Q4 to compute acceptance rates, gender and age structures of asylum seekers.[24] In combination with information provided by the Austrian Federal Ministry of the Interior we calculate the effective acceptance rate with respect to filed applications to be 54% and a family reunification of 0.3 persons (lagged by one period) per accepted person. The application decision takes one year, such that accepted asylum seekers can potentially enter the labor force one year after their arrival. People who are rejected are not allowed

[23]For a detailed description of the Austrian asylum procedure and relevant legal documents, see Knapp (2015) or www.unhcr.at/english/austrian-asylum-legislation.html.

[24]Note that data on applications and decisions is not linked and can correspond to different cohorts. As applications and decisions therefore do not match, we compute average acceptance rates and multiply them with filed applications rather than taking absolute positive decisions as reported by Eurostat.

to participate in the labor market and are not counted in the model (Mig). The recorded asylum seeker cohort was predominantly male and in working age. 40% of the asylum seekers were minors (aged under 18). Figure 3 illustrates the demographic potential. While migrants are younger on average than the Austrian population, this is even more the case for asylum seekers.[25] However, the characteristics of refugees vary substantially by country of origin, as demonstrated in table 2 that shows selected statistics for the six countries whose citizens filed the most positively decided applications in Austria during 2015 to 2017 in terms of relative weight, acceptance rates, skill, age and gender distribution as well as total fertility rates.

Figure 3: Differences in age structures in Austria



Source: Eurostat for asylum seekers 2015 to 2017, Statistics Austria for total population 2014 and population 2014 conditional on having moved to Austria within the last year (all migrants).

There is evidence that return migration plays a sizable role in migration dynamics. For example Dustmann and Weiss (2007) find that 20% of non-white immigrants to the UK have left the country again after 10 years, which averages to an annual emigration rate of about 2.45%. As we lack detailed information on return migration of refugees for Austria we decided to simulate our baseline without return migration but run simulations with return migration in the sensitivity section.

Our assumptions result in about 63 thousand additional residents above the baseline that arrive in the years 2015 to 2020. This number does not include the offspring (newborns) of the 'extraordinary' migration. In order to compute the demographic development of the

[25] If one conditions on acceptance the respective population is even younger and more female.

refugee subpopulation we have to make assumptions concerning fertility and mortality. Fertility data for refugees living in Austria do not exist, we therefore approximate the data by using a weighted average of the fertility rate of the six most important source countries amounting to 3.2 (captured in NB).[26] Further, we use information on the average age when first giving birth from Turkish-born women living in Austria (as the best available proxy) to shift the age-dependent distribution of fertility rates such that average birth is given 3 years younger compared to native women. Both, earlier birth and higher fertility are assumed to linearly converge to the Austrian values within 60 years. We use the same age- and education-specific mortality rates $(1 - \gamma_t^{a,s})$ as for the native population, which increase with age and decrease with education. Because of the relatively high share of low-educated males in the refugee subpopulation average life-expectancy is lower because of two reasons: first, males have lower life-expectancy and second, the education-specific difference is considerably more pronounced for males.[27]

Educational attainment and skill transmission

The skill composition of arriving refugees is of tremendous importance for the estimation of the fiscal impact of extraordinary refugee migration. The first systematic recording of educational attainment happens when persons register with the Austrian public employment agency (Public Employment Service Austria, AMS) which only occurs after receiving access to the Austrian labor market following a positive asylum decision. Data on educational attainment for the years 2015 to 2017 is available via the 'Bali' database of the Austrian Ministry of Social Affairs for the stock of unemployed and the outflow out of unemployment by nationality, gender and age. Unfortunately the data set does not differentiate between types of migration and the duration of stay in Austria. We therefore use the skill distributions of the registered unemployed[29] from the top six asylum application source countries and weight them with the corresponding number of applications

[26]Data is from 2015 from the World Bank, weighted by the relative share of positive decisions, see table 2. The total fertility rate (TFR) in Turkey is 2.1 while it 2.2 for Turkish-born women in Austria, suggesting that there is no immediate significant change in fertility behavior after immigration. The consequence of this assumption is checked in the sensitivity analysis where we assumed a TFR of 2.2 instead of 3.2.

[27]Klotz and Asamer (2014) published the latest available education-specific life tables for Austria from 2010/2011. The difference in life-expectancy at age 35 between $s = 5$ and $s = 1$ is 7 years for males and close to 3 years for females. We adjusted the forecasted mortality rates from EUROPOP to kept the education-specific differences constant over time.

[28]In the last two decades the majority of Russian asylum seekers has come from the Chechen Republic. According to the 2017 Demographic Yearbook of Russia the total fertility rate (TFR) in this constituent entity was 2.8 in 2015 and therefore considerably higher the Russian average. Because of the low relative weight our average TFR of 3.2 would change only at a later decimal place, if we used the Chechen instead of the overall Russian fertility rate.

[29]We compared educational attainment of the outflow out of unemployment (as proxy for employment) and the stock of unemployed and found no substantial deviations.

Table 2: Selected statistics for top six asylum origin countries, 2015 - 2017

	Afghanistan	Iran	Iraq	Russia	Somalia	Syria	data source
asylum applications							
- absolute (in thousands)	40.8	6.9	17.8	4.7	4.3	41.1	Eurostat
- share in total applications	26%	4%	11%	3%	3%	27%	Eurostat
- share of females	27%	29%	30%	50%	36%	43%	Eurostat
- share of 17 years or younger	53%	17%	33%	59%	45%	48%	Eurostat
- share of 35 years or older	9%	22%	18%	19%	6%	17%	Eurostat
application decisions							
- absolute (in thousands)	27.5	3.3	10.0	5.2	4.5	40.9	Eurostat
- share in total decisions	23%	3%	8%	4%	4%	34%	Eurostat
positive decisions (first instance)							
- absolute (in thousands)	12.8	2.3	6.0	2.2	3.3	40.6	Eurostat
- share in total positive decisions	17%	3%	8%	3%	4%	54%	Eurostat
registered unemployed							
- share of low skilled ($s = 1$)	89%	54%	72%	78%	92%	66%	Bali
- share of high skilled ($s = 5$)	2%	19%	12%	7%	1%	11%	Bali
total fertility rate (2015)	4.8	1.7	4.4	1.8[28]	6.4	3.0	World Bank

Note: All numbers represent aggregates over the period 2015 to 2017 unless stated otherwise. Total fertility rates are measured in the countries of origin. 'Bali' refers to the online labor market database of the Austrian Federal Ministry of Labour, Social Affairs and Consumer Protection (`http://www.dnet.at/bali/`).

and acceptance rates.

The resulting skill distribution for 15–64 year old persons gives us a share of low-skilled ($s = 1$)[31] of 68% and 11% high-skilled ($s = 5$). This is considerably worse than the distribution found in the Labour Force Survey (LFS) ad-hoc module 2014 summarized in Dumont et al. (2016), with 35% low-skilled and 20% high-skilled refugees. The deviation is explained by two factors. First, the LFS was looking at the stock of refugees in 2014 which as argued before has a quite different composition of nationalities and sociodemographic characteristics than the 2015 to 2017 wave. Second, LFS data is self-reported, while Bali records educational attainment based on recognized proof of education.[32]

[30] As a principle remark note that the categorization into skill groups used throughout the paper differs from the RBLMS as we sort persons into skill groups according to the highest education a person will attain in his or her lifetime in contrast to the moment of measurement.

[31] Persons with no formal education are mapped into the lowest available Austrian skill level of 'compulsory education only' ($s = 1$). This leads to an overestimation of the actual skill levels.

[32] The LFS itself provides evidence for the significance of this disparity as it reports that self-reported over-qualification is particularly high for refugees compared to native-borns and regular migrants.

Table 3: Skill structure of recognized refugees (aged 15-64)

	Skill groups				
	$s = 1$	$s = 2$	$s = 3$	$s = 4$	$s = 5$
2016	68.0%	3.8%	1.3%	16.1%	10.8%
2020	62.2%	5.8%	3.8%	17.0%	11.2%
2030	49.9%	10.2%	9.0%	19.1%	11.8%
2040	43.2%	12.5%	11.6%	20.4%	12.3%
2050	36.3%	14.3%	13.7%	22.4%	13.3%
2060	28.2%	16.2%	16.0%	24.9%	14.8%
Memo: AUT 2014	18.2%	33.7%	14.4%	13.9%	19.7%
Memo: MIG 2014	41.2%	21.0%	7.9%	10.7%	19.1%

Source: Own calculations and Statistics Austria. Note: 'AUT' refers to the Austrian population, 'MIG' to the stock of foreign citizens in Austria. Figures are corrected for persons in education.[30]

So far, we discussed the skill distribution of arriving refugees. In a long-run analysis we have to define how the skill distribution of the refugee subpopulation will evolve over time. We do this by using estimated skill transition matrices for Austria. Schneebaum et al. (2013, 2016) report estimates for non-EU migrants in Austria, which we use as a closest possible proxy (see table 9 in the appendix). The matrix is applied to all newborns within the refugee subpopulation during the simulation period 2015 to 2060 based on the current skill level of their mothers. To take into account that minor refugees will receive schooling in Austria we also apply the transition matrix to all arriving children aged 15 or below. Table 3 shows the resulting change in the skill structure of the refugee subpopulation over time, reported for persons in working age. At arrival, recognized refugees exhibit lower average skills compared to the total population as well as the stock of foreign citizens in Austria. Although the improvement over time is considerable, at the end of our observation horizon in 2060 the skill distribution of the refugee subpopulation is still worse than the skill distribution of the Austrian population as of 2014.

Labor market integration and productivity

Next to educational attainment, labor market integration is the crucial driver in the determination of net fiscal effects over the life-cycle as it governs whether the benefits of education can be transformed into actual tax payments. With respect to labor market integration we rely on the experiences for refugee cohorts 2005 to 2014 taken from individual social security register data (AMDB) as presented in Huber and Böhs (2017).[33]

[33] The 'Austrian Labor Market Database' (AMDB) provides access to the individual social security status and employment history of every insured person in Austria. Once an application for asylum is filed refugees are health insured which is specifically coded in the database. If the person is granted access to the labor market – in case of approval of the asylum application – the health insurance marker

Table 4: Employment rates and productivity profiles of refugee subpopulation

calendar year	2016	2017	2018	2019	2020	2021	2026	2036	2046	2056
year after arrival for first cohort	1	2	3	4	5	6	11	21	31	41
year after labor market entry for first cohort	0	1	2	3	4	5	10	20	30	40
					absolute					
employment rates										
– first cohort	0%	11%	34%	41%	45%	48%	49%	49%	49%	49%
– total subpopulation	0%	11%	28%	37%	41%	44%	52%	61%	64%	67%
					relative to native subpopulation					
employment rates										
– total subpopulation	-	0.15	0.40	0.52	0.58	0.63	0.72	0.82	0.87	0.92
productivity (cond. on skill)										
– first cohort	-	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
– total subpopulation	-	0.83	0.83	0.83	0.84	0.84	0.85	0.88	0.91	0.96
productivity (average)										
– total subpopulation	-	0.68	0.68	0.69	0.68	0.69	0.71	0.77	0.85	0.91

Source: Employment and productivity time profiles for first cohort based on individual social security register data (Huber and Böhs, 2017), averaged over cohorts 2006 to 2015. Profiles for total subpopulation based on mechanical composition effects given the assumptions presented in section 3. Note: Employment rates are reported without behavioral effects.

They compute average employment rates[34] for refugees conditional on the year of entering the Austrian labor market. We averaged their results over cohorts which is reported in table 4. The key empirical finding is that the average employment rate increases quite rapidly to about 0.45 five years after entering the labor market but labor market integration comes to a halt after around 10 years at an employment rate of close to 0.5. We make three assumptions to embed this empirical findings in our long-run analysis. First, we assume that employment rates of the current cohorts (first generation) evolve equivalently to the cohorts 2005 to 2014. Second, we extrapolate the employment rate of close to 0.5 after 10 years of arrival to stay constant thereafter as hinted by the data. Third, refugees who either arrive at age 15 or below or are born in Austria (second generation) receive schooling in Austria and are assumed to have to same employment rates as their native Austrian counterparts (conditional on skill) – an assumption that is checked in the sensitivity analysis. The resulting average employment rate of the refugee subpopulation over time is reported in table 4. During the first couple of years the average employment

is switched. Refugees with access to the labor market can therefore be identified in the data and tracked over time.

[34]The employment rate of a single person is measured as the share of employed days in total working days within a quarter which are then combined to yearly employment rates. For computing average employment rates only persons aged 15 to 64 are taken into account.

rate of the subpopulation is lower compared to the first cohort as the second, third, etc. cohorts lower the average. However, over time the average employment rate steadily increases as the share of persons who received schooling in Austria continues to rise such that after 40 years the average employment rate of the refugee subpopulation is about 90% of the native Austrian subpopulation.

The AMDB also records information on the social security tax base, i.e. monthly labor income. Huber and Böhs (2017) compute the development of the tax base conditional on employment for individual refugee cohorts from 2005 to 2014 and find that they are on average around 30% lower than for natives with no evidence of convergence over time. Considering the different educational compositions we compute an average 17% labor income 'penalty' for refugee workers conditional on skill which we capture in our model by adjusting the productivity profile parameter ($\theta_t^{a,s,n=2}$).[35] We further assume that the penalty does not converge to the Austrian average for the first generation, while persons from the refugee subpopulation who receive schooling in Austria are equipped with the same productivity profiles as their native Austrian counterparts, conditional on skill. Because of the increasing share of persons schooled in Austria as well as the improvement of the skill composition over time the average gap in productivity decreases from around 30% in 2017 to around 10% after 40 years.

Exogenous costs

All refugee-related public expenditures which are not endogenously covered by the economic model are summarized as exogenous costs. These costs (table 5) can broadly be split into three expenditure categories: welfare support (basic care during the application process and care for unaccompanied minors), the handling and management of the refugee influx (administration of applications, transport, border management and security) and the integration of refugees into the Austrian society and labor market (e.g. language courses). Exogenous costs consist of parts that are directly linked to actual developments (e.g. the number of applicants determines expenditure for basic care) while others are accumulating over certain periods (e.g. unaccompanied minor refugees are assumed to stay in care until they reach adulthood), have fixed cost characteristics, disappear at the end of the refugee shock (e.g. border patrol) or fade out inversely with labor market integration (e.g. integration costs).

[35] Note that from the data we cannot distinguish if lower monthly income results from lower hourly wages or fewer hours worked. In our analysis this however does not matter as these two factors are not interpreted individually.

Table 5: Exogenous costs, 2015 - 2060

in % of GDP of 2014	2015	2016	2017	2018	2019	2020	2040	2060
Welfare support	0.09	0.29	0.21	0.09	0.05	0.05	0.00	0.00
Handling and management	0.05	0.08	0.08	0.04	0.04	0.03	0.00	0.00
of which: Security and border patrol	0.01	0.02	0.02	0.01	0.01	0.01	0.00	0.00
of which: Administration	0.02	0.02	0.03	0.03	0.03	0.02	0.00	0.00
of which: Transportation	0.03	0.04	0.02	0.01	0.00	0.00	0.00	0.00
Integration	0.04	0.06	0.08	0.08	0.08	0.05	0.02	0.00
Sum	0.18	0.44	0.37	0.21	0.16	0.13	0.02	0.00

Source: Austrian Federal Ministry of the the Interior, Austrian Federal Ministry of Finances, Eurostat, own calculations and assumptions.

4 Results

4.1 Refugee scenario

This section presents the main simulation results concerning demography, macroeconomic and fiscal effects for the refugee scenario presented in section 3.2. Detailed results are collected in table 10 in the appendix. The sensitivity of our results with respect to the assumptions taken is analyzed in the subsequent section.

Table 6: Change in Austrian population size

population in thousand persons, baseline and deviation from baseline

	2020		2030		2040		2050		2060	
	Base	Dev.	Base	Dev.	Base	Dev.	Base	Dev.	Base	Dev.
0-14	1,272	+28.6	1,352	+27.9	1,343	+33.1	1,355	+36.0	1,362	+33.7
15-24	933	+13.2	945	+19.9	1,012	+18.1	985	+20.9	969	+24.4
25-54	3,643	+20.9	3,540	+31.2	3,568	+44.6	3,483	+50.7	3,408	+58.1
55-64	1,244	+3.0	1,278	+2.9	1,147	+5.8	1,256	+11.2	1,166	+12.6
65+	1,701	+1.2	2,154	+3.6	2,531	+5.3	2,662	+8.7	2,782	+16.4
Total	8,793	+66.9	9,270	+85.4	9,602	+106.9	9,741	+127.4	9,687	+145.3

population in thousand persons, deviation from baseline split in males and females

	2020		2030		2040		2050		2060	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
0-14	+14.4	+14.2	+13.9	+13.9	+16.6	+16.6	+18.0	+18.0	+16.9	+16.9
15-24	+7.2	+6.0	+10.0	+9.8	+9.1	+9.0	+10.4	+10.4	+12.2	+12.2
25-54	+11.2	+9.7	+17.0	+14.2	+23.6	+21.0	+26.0	+24.6	+29.2	+28.9
55-64	+1.5	+1.5	+1.4	+1.5	+3.1	+2.7	+6.1	+5.1	+6.8	+5.8
65+	+0.6	+0.6	+1.7	+1.9	+2.6	+2.8	+4.4	+4.3	+8.8	+7.6
Total	+34.9	+32.0	+44.1	+41.3	+54.8	+52.1	+65.0	+62.4	+73.9	+71.4

Source: 'Baseline' based on Eurostat (EUROPOP2013), own calculations.

Demography

The size and demographic composition of refugee migration determines its impact on the overall economy and the social welfare system, where the demographic potential can nicely be summarized as the ratio of additional persons in non-working to persons in working age (i.e. age from 15 to 64). The first generation refugee cohorts of 63 thousand persons imply a population increase of 67 thousand persons or 0.8% of the Austrian subpopulation by 2020. This figure increases to 145 thousand persons or 1.5% of the Austrian population by 2060 (table 6). The gap in the relative share of male versus female refugees is slightly decreasing over time but still present in 2060. The age difference of the refugee subpopulation to the Austrian population is considerable but decreasing over time (21 years younger in 2020 and 13 years younger in 2060). In total, the extraordinary refugee immigration only slightly reduces the expected increase in average age of the overall population (41.7 years in 2015, 47.1 years in 2060) by 8 weeks in 2015 and 10 weeks in 2060.

Figure 4: Age structure of the refugee subpopulation

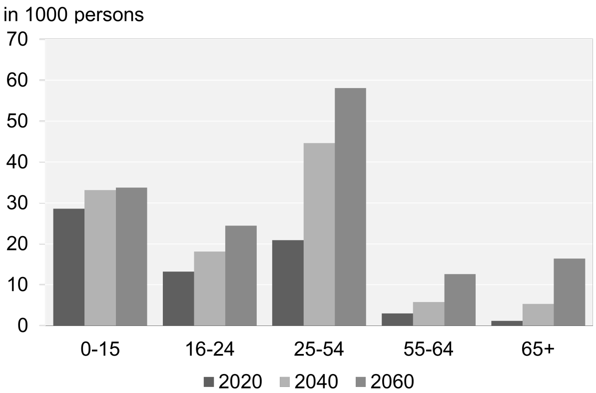
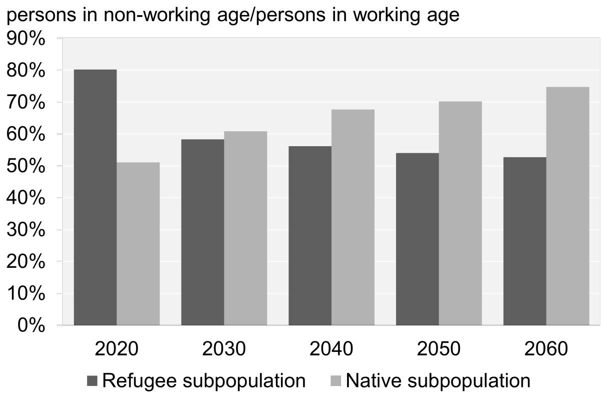


Figure 5: Ratio of persons in non-working and working age



Source: Own calculations.

The change in the age structure of the refugee subpopulation (figure 4) can be attributed to three elements. First, arriving refugees are particularly young and are in this respect not representative of their source country populations.[36] Similar to the 'baby-boomer'-effect, the current high concentration of persons at the left-hand side of the age distribution slowly moves to the right implying a steady increase in average age. Second, the low share of female refugees lowers the number of newborns in comparison to the case where the gender split would be 50:50. Third, fertility gradually adjusts over time to the values of the Austrian subpopulation. In total, the mean age of the refugee subpopulation increases from 21.4 years in 2016 to 34.0 years in 2060. From the age structure one can derive the demographic potential measured as the ratio of persons in non-working to persons in working age captured by figure 5. Within the refugee subpopulation this ratio is strongly improving during the first years of stay, as many children (arriving at age below 15) grow into working age and stays constant at around 50% from 2030 onwards, while the ratio

[36] Only 15% of all applications in 2015 to 2017 were filed by persons older than 35, while the share of people over 35 in the total population is 28% in Syria (2011) and 24% in Afghanistan (2016) according to the United Nations Demographic Yearbook 2016.

continues to deteriorate for the native subpopulation.

Macroeconomic effects

The macroeconomic consequences are driven by supply as well as demand effects. Note that in the explanation and quantitative presentation of these effects we always argue in comparison to the baseline. In the model total labor supply in efficiency units per skill group is $L_t^s = \sum_a \delta_t^{a,s} \ell_t^{a,s} \theta^{a,s} N^{a,s}$, i.e. the sum of all persons (N) who participate in the labor market (δ) times the average number of hours (ℓ) times productivity (θ). Given the perpetual increase in persons and employability over time total, labor supply is constantly expanding. The capital labor ratio deteriorates and firms invest into physical capital to increase marginal productivity per labor efficiency unit. Aggregate demand expands due to the increase in private and public consumption including exogenous costs, where part of the additional demand is met by higher imports. Higher domestic demand pushes up the prices of domestic final goods leading firms to hire more workers and to increase investment and output. Note that the presented macroeconomic effects strongly depend on our baseline assumption that additional net expenditure is debt-financed. Later in this section we present results for an alternative budget rule of instantaneous fiscal consolidation, which alters the macroeconomic effects.

Figure 6: Evolution of GDP and private consumption

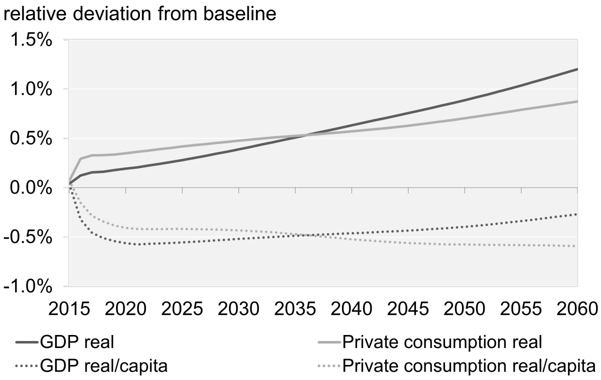
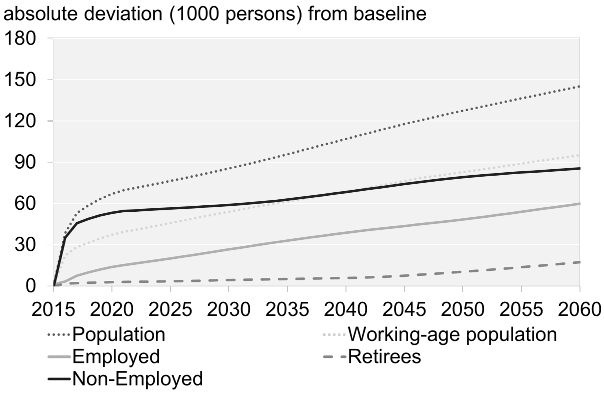


Figure 7: Evolution of population and employment



Source: Own calculations.

Additional labor supply and higher consumption lead to steadily increasing GDP. The extraordinary refugee inflow is estimated to increase GDP by about 1.2% in 2060. Private consumption is a strong driver of GDP in the short run[37], while its effect is somewhat

[37]Recall that the model is not designed as a business cycle model and even though short-run GDP effects (between 0.1 and 0.2% in 2016) are in line with what was predicted in economic short-run forecasts, short-term results should be interpreted with caution.

Figure 8: Changes in employment

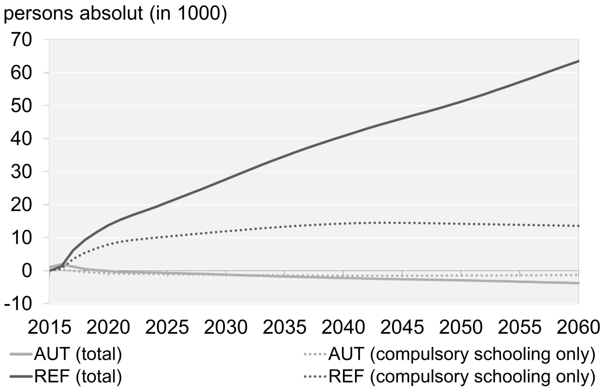
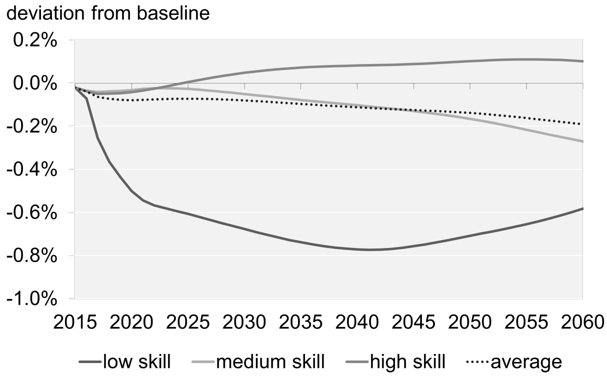


Figure 9: Change in real hourly wages



Source: Own calculations. Notes: Wages are measured as rates per efficiency unit. 'AUT'... domestic subpopulation, 'REF'... refugee subpopulation, 'low skill'... skill group 1, 'medium skill'... skill groups 2, 3 and 4, 'high skill'... skill group 5.

lower (+0.9%) in the long-run (figure 6). Because refugees exhibit lower than average productivity, which is also the case in the long run, the model predicts a drop in GDP and private consumption per capita throughout the whole simulation horizon. Looking at the evolution of population and employment (figure 7) reveals the increasing share of refugees in working-age being employed over time. Nevertheless, throughout the simulation horizon the number of employed falls short of the number of non-employed in the refugee subpopulation, which negatively influences the effects on public finances. Changes in employment of both subpopulation are illustrated in figure 8. Overall the model predicts that the labor supply shock induced pressure on wages leads to a reduction of employment in the Austrian subpopulation of around 4 thousand persons at the peak. This reaction is due to the fact that in contrast to domestic demand, export demand is not scaled by domestic population size and labor supply shocks concentrated on the domestic economy are not fully absorbed in the model.[38] Hence, the average wage rate is bound to decline vs. the baseline though it does so to a modest extent (less than -0.2% in 2060). The development of the real wage rates by skill[39] (figure 9) reflects relative additional supply along a weakly decreasing path for the average wage rate. Wage effects are most pronounced for low skill ($s = 1$) workers and show a U-shaped evolution. Because of increasing labor supply highly concentrated in the low skill sector we predict the low-skill wage rate to decline by up to 0.8% in the mid 2030s and to partly recover when the relative share of low-skilled persons in the labor force is declining due to skill improvement. We further

[38]This mechanism is discussed in more detail in section 5.2.

[39]The real wage rate per skill group is the wage per efficiency unit in terms of the price of the final output goods, i.e. w^s/p^h, where w^s is the wage index consisting of the fundamental wage rates for domestic ($w^{H,s}$) and foreign labor ($w^{F,s}$), i.e. the unit expenditure function in the cost minimization problem of the firms.

find that wage effects of medium and high skilled workers are close to zero. Figure 9 summarizes the effects on real wage rates conditional on the skill and averaged over the subpopulations, which diverge because of imperfect substitutability between skill classes. Within a certain skill class wage effects further differ depending on the degree of imperfect substitutability of domestic and foreign labor. For our default choice of substitutability ($\sigma^{L^H,L^F} = 10$) the overall drop in the real wage rate of low skilled labor by 0.6% in 2060 can be decomposed in a drop by 2% for foreign labor and by 0.3% for domestic labor. The effect of alternative choices of the degree of substitutability will be discussed more thoroughly in the robustness section.

Fiscal effects

Our model provides an intuitive way to analyze the fiscal effect of the simulated refugee shock by disaggregating individual net fiscal contributions by age and skill. We define the net fiscal contribution of a person as all taxes paid minus all public transfers received by the person including public consumption (health care, long-term care and education). Over a life-time one can distinguish three phases: education, working age and retirement. During phase one, *education*, the net fiscal contribution is clearly negative, while during phase two, *working age*, the net fiscal contribution is usually positive. Nevertheless, for our refugee subpopulation we observe that persons with low education on average achieve a negative net fiscal contribution also during the working age phase in the first years after arrival. A result that is due to the difficulties of refugees to enter the labor market captured by low employment rates. As employment rates continuously rise over time, refugees of all skill groups on average become net contributors during working age. In addition to increasing employment rates, net fiscal contributions during working age profit from the continuous improvement in the skill distribution of the refugee subpopulation. Phase three, *retirement*, is characterized by negative net fiscal contributions due to received pension payments and increased health care costs. The top panels of figures 10 and 11 illustrate the calculated evolution of the net fiscal contributions of the refugee subpopulation conditional on skill and age until 2060. In essence, the aggregate yearly fiscal effect of the refugee subpopulation is given by weighting the net fiscal contribution profiles with the age and skill structure of the refugee subpopulation (bottom four panels of figures 10 and 11).[40]

[40] In our illustrations of the net fiscal contribution profiles in figures 10 and 11 we excluded taxes and subsidies for firms which cannot be allocated to individual persons as well as the arrival related short-run costs. Nevertheless, the changes in these budget items are taken into account in our aggregate results. Other government consumption with pure public good characteristics has marginal costs of zero by assumption and is therefore neither included in the net fiscal contribution profile figures nor in the aggregate results.

Figure 10: Decomposition of net fiscal contribution in 2020

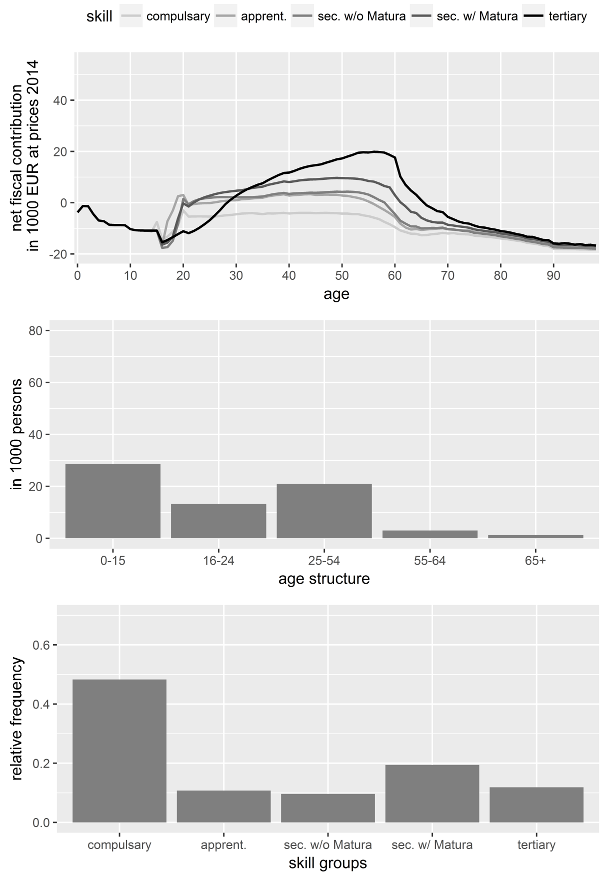
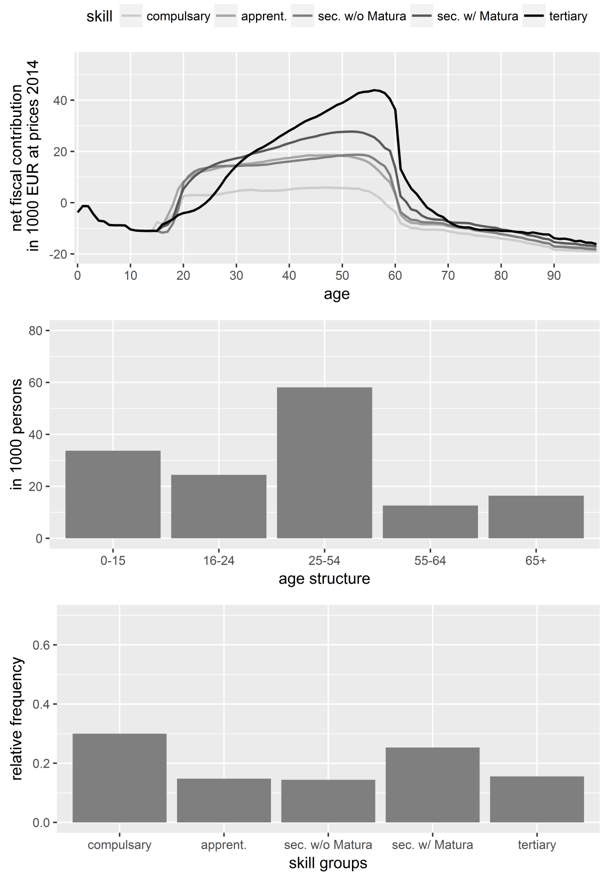


Figure 11: Decomposition of net fiscal contribution in 2060



Source: Own calculations. Note: See remarks in footnote 40.

We find that on aggregate over the next decades the positive net fiscal contributions during working age cannot offset the net fiscal costs encountered during education and retirement. This is true despite the at a first glance high demographic potential implied by the large share of refugees in working age. On a yearly basis, the aggregate net fiscal effect is equivalent to the deviation of the primary balance, i.e. additional government revenue minus additional expenditure excluding interest payments, from the baseline. In the first years after arrival a pronounced negative effect can be observed (figure 12) that is mainly driven by exogenous costs for handling and managing the influx of refugees and their basic welfare support. As exogenous costs fade out over time and employment rates rise, the negative primary balance effect continuously declines and eventually turns positive in the mid 2050s. Translating the yearly primary balance deviation into euro at prices 2014 per accepted refugee results in net costs of 10 thousand euro in 2020 and 2 thousand euro in 2040 and a net benefit of around 3 thousand euro in 2060.[41]

[41] The short-run profile is comparable to the results from Aldén and Hammarstedt (2016) who use ex-post data for Sweden to compute the net fiscal contribution of refugees for the first seven years.

Figure 12: Change in primary balance (vs. baseline)

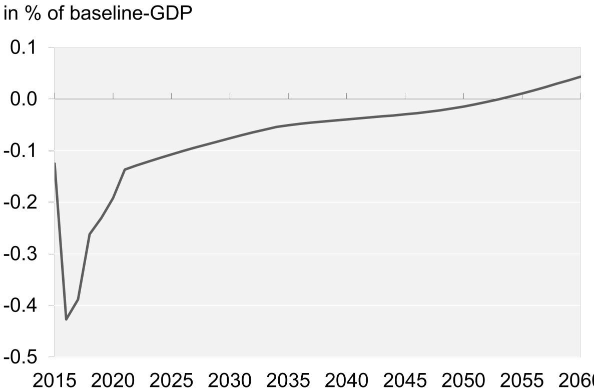
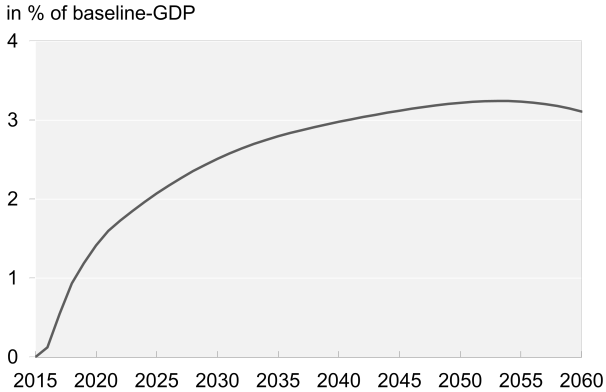


Figure 13: Change in debt level (vs. baseline)



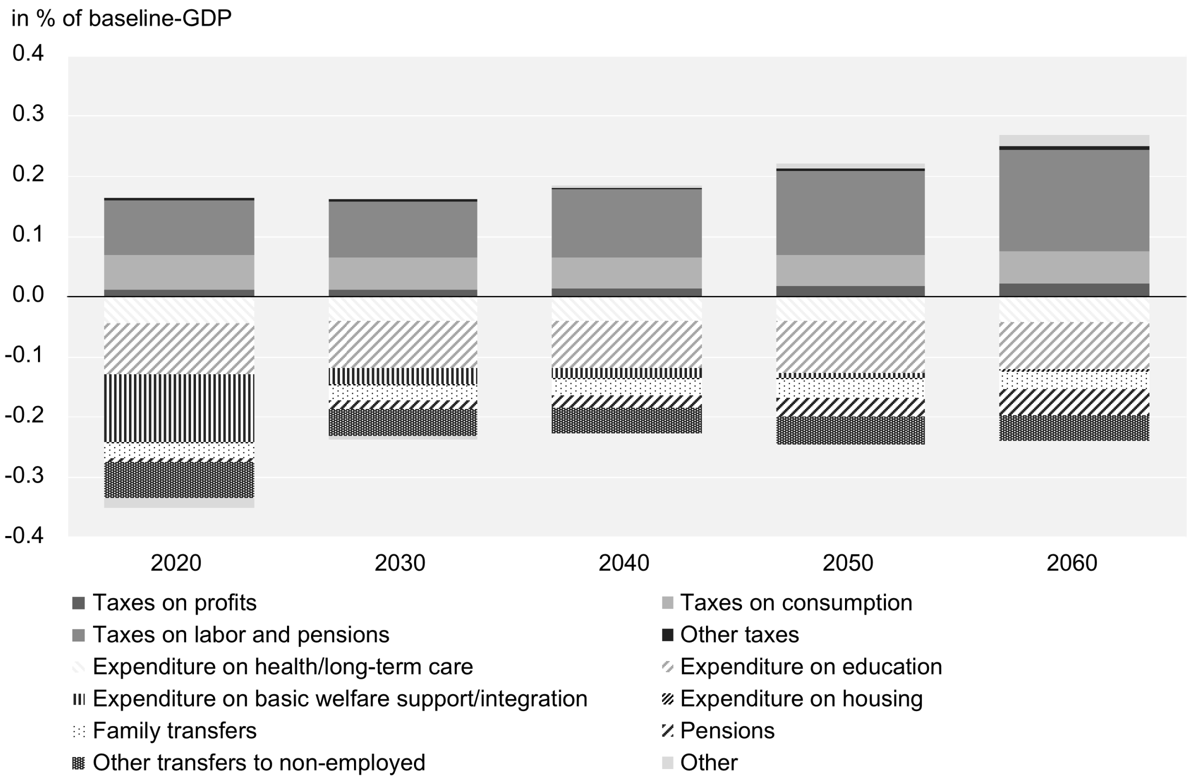
Source: Own calculations.

In order to determine the underlying dynamics, figure 14 and table 10 provide a decomposition of the primary balance deviations by expenditure and revenue categories. In the short run expenditures for basic welfare support, integration, etc. as well as expenditures for social transfers (in particular in the form of means-tested minimum income) and education dominate. The first two mentioned short-run costs that are specifically relevant for refugee migration decrease over time because of increased labor market participation and the vanishing relevance of arrival-specific costs. As the refugee subpopulation ages, expenditures for health care, long-term care and pensions gain in importance. Extra revenue is dominated by taxes on labor and consumption and slightly U-shaped over time. After the first years government revenue slightly decreases as the expansionary effect of arrival related costs (higher public consumption) fades out, before revenue picks up in the mid 2020s because of rising employment rates.

The accumulated budgetary effect including interest payments corresponds to the change in the debt level compared to the baseline. In 2060 debt increases by 3.1% of GDP[42] or 11.5 billion euro evaluated at prices 2014 (figure 13). To ease the comparison with other studies we normalize for the shock size and compute accumulated average net fiscal costs per accepted refugee of around 183 thousand euro by 2060. A result that has to be interpreted with great care for the following reasons. First, following a large part of the generational accounting literature (see e.g. Storesletten, 2003) we divide by the number of accepted refugees, which means that we implicitly include gains and costs of

[42]We measure all deviations in terms of baseline-GDP of the corresponding year to facilitate comparisons of different scenarios. Note that this is not equivalent to a change in the debt-to-GDP ratio which includes a denominator effect. In terms of debt-to-GDP ratio we compute an increase of 2.5 percentage points by 2060. All fiscal results are reported in terms of GDP of the baseline as well as in euro at prices 2014 per accepted refugee (table 11).

Figure 14: Effect on government revenue and expenditure (vs. baseline)



Source: Own calculations.

refugee offspring in the net contribution of the first generation refugees. Second, the aggregate number also includes short-run costs for additional border management, basic care after arrival (including persons who are eventually rejected), etc. which implies that one should not interpret this number as the marginal costs of an additionally accepted refugee.[43] Third, the presented number strongly depends on the choice of the long-run interest rate. Assuming a real interest rate of $r^G = 3\%$ instead of 1.4%, which is used in our benchmark szenario, results in accumulated net costs per accepted refugee of 300 thousand euro by 2060 (see section 5 for more details and sensitivity analyses).

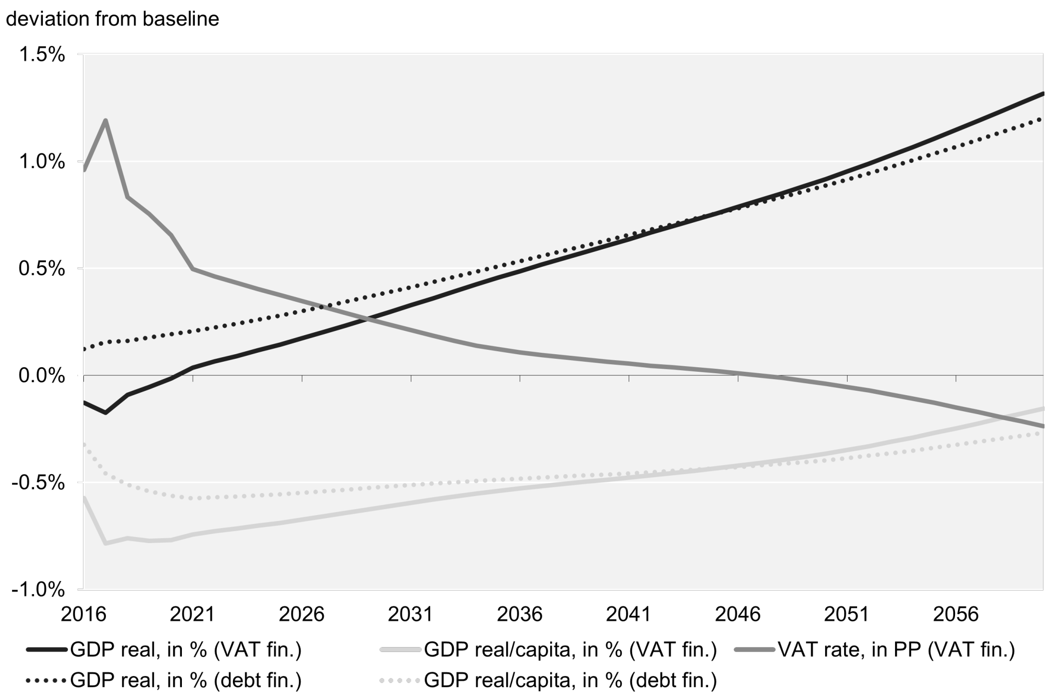
4.2 Fiscal burden

So far, we set the budget rule such that the government leaves the tax and transfer system untouched. Deviations in the primary balance from the baseline directly translate to changes in the debt level. Hence, we implicitly assumed that the fiscal burden is borne by future generations outside our simulation horizon (*intergenerational burden sharing*). Alternatively, this section analysis the case where per-capita debt is held constant (in de-trended terms) by a government that continuously adjusts the value-added tax (VAT)

[43] Out of the 183 thousand euro per accepted refugee about 14 thousand are explained by costs for border management, security and transportation.

rate accordingly. In this case of instantaneous consolidation the fiscal burden is borne by the current population and consequently mainly by the domestic subpopulation (*intra-generational burden sharing*). A corresponding policy translates in our framework to an increase of the VAT rate by up to 1.2 percentage points in the first years (figure 15). In the short run the dampening impact on economic activity slightly overcompensates the demand-induced stimulation, discussed in the debt-financed scenario. As the effect on the yearly primary balance in the debt-financed scenario becomes slightly positive in the long run, it follows that the VAT rate can be set to a somewhat lower rate compared to the baseline at the end of our simulation horizon. These insights underline that the budget rule that determines fiscal burden sharing is crucial for the welfare implications of the refugee influx.

Figure 15: Instantaneous consolidation vs. debt-financing



Source: Own calculations.

In order to address welfare consequences it is important to isolate the effects on the domestic subpopulation (i.e. total population including regular migrants without refugees and their offspring). According to our simulations, GDP and consumption per capita are lower throughout the whole simulation horizon. One might however question whether this effect is just driven by a change in the composition of the population, leaving actually no representative domestic household considerably worse off. To address this question table 7 shows the changes in individual consumption for the domestic subpopulation alone. First, we focus on the left columns from the debt-financed scenario. In line with the wage and employment effects, persons[44] that are of similar characteristics as the refugee subpopulation suffer, i.e. low-skilled and medium-skilled (at the end of the simulation horizon), while high-skilled experience small gains in consumption. The average effect on individual consumption of domestic persons are negligibly small in the debt-financed case. A fact that changes when looking at the case of immediate VAT-financed consolidation, which seems to be a more appropriate perspective when discussing the consequences for the domestic population than the case where fiscal costs are shifted to future generations. On aggregate, immediate consolidation implies that domestic households suffer a loss in individual consumption by around 0.5% in 2020. The loss is decreasing over time and turns to a gain at the end of the simulation horizon. Translated into euro (prices 2014) immediate consolidation implies an additional average VAT payment of around 200 euro per capita (age 15+) at the peak during 2017, with additional payments vanishing over time and turning even negative at the end of the simulation horizon (2060: -60 euro).

Table 7: Change in individual consumption of the domestic subpopulation

deviation from baseline in %

	debt-financed					VAT-financed				
skill group	2020	2030	2040	2050	2060	2020	2030	2040	2050	2060
$s = 1$	-0.31	-0.38	-0.40	-0.35	-0.28	-0.82	-0.59	-0.46	-0.32	-0.09
$s = 2$	0.05	0.05	0.03	0.00	-0.06	-0.47	-0.17	-0.03	0.03	0.14
$s = 3$	0.07	0.05	0.01	-0.04	-0.11	-0.47	-0.17	-0.05	0.00	0.09
$s = 4$	0.15	0.11	0.05	-0.01	-0.10	-0.41	-0.13	-0.02	0.02	0.10
$s = 5$	0.23	0.26	0.25	0.24	0.22	-0.31	0.03	0.18	0.27	0.40
age	2020	2030	2040	2050	2060	2020	2030	2040	2050	2060
15–24	-0.07	-0.11	-0.14	-0.16	-0.17	-0.41	-0.17	-0.07	0.00	0.13
25–34	-0.03	-0.10	-0.16	-0.20	-0.25	-0.53	-0.28	-0.15	-0.07	0.06
35–44	0.03	-0.06	-0.13	-0.18	-0.25	-0.56	-0.28	-0.18	-0.09	0.05
45–54	0.09	-0.01	-0.10	-0.15	-0.22	-0.55	-0.26	-0.16	-0.11	0.05
55–64	0.12	0.10	0.03	-0.02	-0.07	-0.49	-0.15	-0.05	0.00	0.11
65–74	0.08	0.17	0.18	0.14	0.11	-0.40	-0.08	0.07	0.12	0.19
75+	0.03	0.14	0.23	0.27	0.27	-0.46	-0.17	0.04	0.18	0.29
	2020	2030	2040	2050	2060	2020	2030	2040	2050	2060
total	0.04	0.02	-0.01	-0.02	-0.06	-0.50	-0.20	-0.07	0.01	0.14

Source: own calculations.

5 Sensitivity analyses

In order to check the robustness of our results and to enhance the understanding of the key mechanisms driving the outcomes we perform a series of sensitivity analyses. As

[44] Recall that the domestic subpopulation also includes already present foreign workers in Austria, who in case of imperfect substitutability face higher reactions in their wage rates than the native workers. While table 7 averages out these differences, table 14 addresses the differential wage effects explicitly.

some of the key assumptions, e.g. the speed of labor market integration, can potentially be influenced by economic policy, they can deliver valuable insights for policy design. However, we do not consider the cost side of these policy measures, which is ultimately needed to do a proper cost benefit analysis and rank individual policies. Therefore the different shocks cannot be meaningfully normalized, which rules out quantitative comparisons of the sensitivity results. The considered scenarios presented in the next subsections capture different data- but also model-specific assumptions and are contrasted with the results from the debt-financed refugee scenario as described in section 3.2 in the following referred to as *main refugee scenario*.

5.1 Data-related sensitivity analyses

This subsection presents ten different scenarios that deviate for crucial data assumptions characterizing the size, socioeconomic characteristics and labor market potential of the refugee cohorts as well as related cost assumptions. A summary of the resulting deviations from the baseline can be found in table 11. **Scenario 1** checks the consequences of a slower than expected return to the baseline number of applications. We increase the application number by around 30 thousand such that positive decisions rise by 16 thousand in total (table 12). Including offspring this increases the size of the refugee subpopulation in 2060 by 35 thousand persons in comparison to the main refugee scenario. Debt increases by an additional 0.5% of baseline GDP while debt per accepted refugee slightly falls mainly due to the non-proportional increase in arrival-related short-run costs. **Scenario 2** assumes lower fertility rates. Total fertility rate of refugees at arrival is reduced by one child to 2.2 which also corresponds to the total fertility rate of Turkish-born women living in Austria.[45] This implies that the mean age of the refugee subpopulation increases to 38.1 in 2060 instead of 34.0. The effect on primary balance and debt are less negative than in the main refugee scenario. This can be explained by the fact that a majority of the additional persons resulting from higher fertility have not reached the life span 40–60 in 2060, which generates the highest fiscal contribution. Simulations beyond the simulation horizon suggest that starting in the 2080s this scenario generates worse primary balance effects than the main refugee scenario. **Scenario 3** halves the family reunification rate of 0.3. This translates to a lower share of females and 5 thousand fewer persons in 2060 compared to the main refugee scenario. Because of the same mechanism as described in the changed fertility scenario we simulate a lower increase in public debt (-0.1% of baseline GDP). **Scenario 4** returns to the question of return migration and set yearly return migration to 2.45% of the yearly size of the refugee subpopulation. In lack of more detailed information the return migration rate is set uniformly for all skill and

[45] We abstracted from changes in employment rates due to additional time for child caring.

age groups. This has a substantial effect on the size of the subpopulation in the long run. In 2060 we only compute 54 thousand additional residents in comparison to 145 thousand in the main refugee scenario. However, the reduction in the debt increase by 0.5% of GDP is comparably small because net costs per refugee are particularly high in the first years, while the difference in the size of the subpopulation between scenario 4 and the main refugee scenario steadily increases over time.

Scenario 5 addresses the importance of the initial skill structure of arriving refugees. Instead of the educational attainment derived from register data we now use the more favorable results of the LFS ad-hoc module from 2014 for Austria with $s = 1$: 35%, $s = 2, 3, 4$: 45% and $s = 5$: 20%. The increase in debt by 2060 is lower by 0.4% of GDP. If the difference in skill structures between the LFS and the register data was only due to the question of self-reported vs. officially recognized educational attainment, this simulation could be interpreted as an estimate of the fiscal effect of eliminating the problem of over-qualification. In order to check the influence of skill transmission to the next generation we simulate **scenario 6**, where we assume that transmission is sped up by skipping one generation. This means we assume that skill transmission matrix T, as described in table 9 is applied twice, i.e. $T \times T$. This reduces the debt increase in 2060 by 0.2% of GDP, mainly reflecting improvements in the primary balance at the end of the simulation horizon.

In **scenario 7** we drop the 17% productivity penalty assumption for the first generation and equip accepted refugees with the same productivity profiles as their native counterparts conditional on skill and age. The reduction of the debt increase by 0.1% of GDP is relatively small. This is explained by the high concentration of low educated persons in the first generation who face low average tax rates if employed. In **scenario 8** we relax the assumption that labor market integration of the first generation comes to a halt after 10 years at an average employment rate of around 0.5. Instead we let employment rates linearly approach the Austrian value of around 0.7 after 30 years. This reduces the debt increase by 0.4% of GDP. In **scenario 9** we introduce a 10% productivity and employment rate penalty for the second generation, who in the main refugee scenario are assumed to correspond to the Austrian natives conditional on skill and age. This results in an additional increase of 1.0% of baseline GDP, which in comparison to scenarios 7 and 8 highlights the relative importance of persons that currently have not reached working age (second generation) for the long-run effect on government debt.

In the main refugee scenario we assumed that residual public consumption excluding demography-related costs for health care, long-term care and education and arrival related costs as summarized in table 5 does not increase with the number of refugees. For some functions of government, such as public defense, this is a plausible assumption. For others such as public infrastructure it might not be the case. To contrast this assumption we simulate **scenario 10** where residual public consumption increases with population size at full average costs. This has rather strong implications and raises debt by an additional 2.0% of GDP in 2060.

5.2 Model-related sensitivity analyses

Next to the sensitivity simulations related to the assumptions characterizing the refugee shock we also perform model-specific sensitivity analyses of the important deep parameters to check the robustness of our results. Table 13 in the appendix summarizes the corresponding results. Overall, no alarming deviations from the results of our base specification are found. This section focuses on the discussion of the most interesting aspects.

The choice of the **export demand elasticity** is of important quantitative consequence as it has different effects in the short versus the long run. A less elastic export demand enforces the positive demand-side effect by pushing up domestic prices, wages and employment. In contrast in the long run increased (labor) supply is confronted with increased domestic demand and export demand, which did not increase proportionally to population. The steeper the export demand curve the more dampening for domestic prices, etc. This shows that a model with a small open economy assumption with infinitely elastic export demand (as often used) would underestimate the resulting GDP consequences in the short run and overestimate them in the long run.

The labor market consequences and the role of substitutability are at the core of many migration-related studies. In our main refugee scenario we chose domestic and foreign labor to be fairly substitutable (in efficiency units and conditional on skill), i.e. $\sigma^{L^H,L^F} = 10$. Table 14 compares the wage effects for different choices: $\sigma^{L^H,L^F} \in \{0.7, 1.2, 3, 10, \infty\}$. The less substitutable the better for domestic labor and the worse for foreign labor (including already present foreign workers). For perfect substitutability the real wage rate of low skilled workers declines by 0.59% in 2060 versus the baseline, while it increases for high skilled workers by 0.11%. In case of $\sigma^{L^H,L^F} = 1.2$ the winner-loser pattern is shifted from low vs. high skill to domestic vs. foreign labor. The former experience real wage rate increases for all skill levels (low: +2.3%, medium: +1.7%, high: +2.7%), while the labor supply shock has dramatic consequences for foreign labor (low: -11.2%, medium: -7.6%, high: -10.1%). Hence, while the choice of **substitutability** has serious consequences for the winner-loser pattern, the aggregate effect on public finances is rather modest: debt increases by 3.4% of GDP (P7: $\sigma^{L^H,L^F} = 1.2$) instead of 3.1% (main refugee scenario: $\sigma^{L^H,L^F} = 10$).

In addition we simulated a hypothetical scenario where we replaced the characteristics (fertility, mortality, participation, educational attainment) of the refugee cohorts with those of the cross section of the domestic population. We kept the age structure and dropped the exogenous costs for basic care, integration, etc. This exercise was done to verify that the model is not potentially misspecified in a way that it punishes all forms of immigration. We find that in this case debt would decrease by 2.5% of baseline GDP in 2060. Hence, the unfavorable socioeconomic characteristics and the arrival related short-run costs are the key factors of the calculated debt increase for the refugee scenario.

6 Conclusions

Our work highlights that the estimation of the impact of migration on public finances is driven by a variety of key factors that can be broadly split into three categories: modeling-specific, cohort-specific and policy-specific factors. Besides the crucial choice of the static or dynamic structure of the modeling framework, which is mainly driven by the question at hand, the first type of key factors also includes the modeling choice concerning the attribution of indirect costs (i.e. public administration, infrastructure investments and demography-related expenditures) to the immigrants either at average or marginal cost. The second group of key factors captures the demographic and socioeconomic characteristics of the migrant cohort. For the analyzed refugee cohorts these two components point in opposite directions. While, the average remaining time in working-age is high and favorable, educational attainment, productivity and employment rates are low and effects public finances unfavorably. The third category, policy-specific factors, includes the structure of the economy and the welfare state as well as existing regulations that determine the potential of migrants to integrate into the labor market or to receive public transfers.

In general, the fiscal impact of refugee migration is driven by the same economic mechanisms as regular migration. Nevertheless, refugee migration shows certain peculiarities that substantially influence its impact on public finances. First, in contrast to regular migration, initial basic welfare support, handling and management and integration of refugees that apply for asylum cause substantial short-run costs that play an important role in the overall determination of net fiscal impacts. Second, the productivity and skill levels of refugees are in general considerably lower than those of regular migrants. Third, even if one corrects for skill differences, the labor market integration of refugees follows a slower pattern compared to regular migration. Forth, in general legal rules do not allow to select persons with special characteristics from refugee cohorts while this is typically possible in the case of regular migration.

Using a rich OLG model, we analyze the long-run impact of the refugee cohorts migrating to Austria from 2015 to 2020. We find that high short-run arrival-related expenditures, low average educational attainment and only slowly increasing employment rates overcompensate the demographic potential of the mainly working age refugee cohort. The government's primary balance is strongly negatively affected in the short run. As short-run costs fade out and skill composition and labor market integration improve over time the negative impact on the primary balance is reduced and (in our main refugee scenario) turns positive at the end of the simulation horizon. The public debt level is substantially and robustly higher during the simulation horizon 2015 to 2060 compared to the baseline. Due to the skill composition of the refugee cohort, wages and consequently individual consumption of low-skilled domestic workers is negatively affected while the aggregate effect on the domestic population is negligibly small. If the corresponding fiscal burden is not transferred to future generations by debt financing but borne by current generations, e.g. via higher VAT rates, the aggregate impact on all domestic individuals' consumption becomes negative, in particular in the short and medium run. Using different degrees of substitutability between domestic and foreign labor has pronounced distributional effects concerning wages and welfare between the domestic and the refugee subpopulations but only modest influence on the aggregate fiscal effect.

Throughout the simulation exercise we employed a no-policy-change assumption. Nevertheless, our sensitivity analysis hints at the effects of potential policy options. While some key factors (e.g. the initial skill distribution of refugees at arrival) can not be influenced, others are sensitive to public policy. Factors such as the arrival-related short-run costs for border management and control might strongly depend on the form of refugee immigration (e.g. unorganized surge vs. managed resettlement) and the degree of international coordination. Other factors are in more direct control of the domestic government. A shorter duration of the asylum procedure or the opening up of the labor market during the application process reduces the time of inactivity after arrival and decreases short-run costs. Next to the arrival-related costs, labor market integration is the key driving factor for the short-run fiscal impact. In contrast, improvements in intergenerational educational mobility become effective with a substantial time lag and imply considerable positive effects on long-run primary balances but have only a small dampening impact on the short- and medium-run debt increase. The impact of changes in fertility depends on the interaction with educational mobility, i.e. higher fertility has a negative fiscal effect in the short and long run but a positive effect in the very long run (after 2060).

There are various related aspects that we could not cover in our analyses and which are left for future research. One potentially interesting additional aspect is the existing evidence that the current position in the economic cycle at the time of immigration can have long lasting effects on labor market outcomes of migrants (see e.g. Blom, 2004, Åslund and Rooth, 2007, or Orrenius and Zavodny, 2009). A further potential extension could focus on the sensitivity of regular migration to the domestic labor market conditions, which are influenced by a large refugee influx. Another possible direction for future research could be to model an explicit link of (costly) integration measures and integration outcomes to analyze optimal policy design.

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Appendix

Table 8: Summary of calibration outcomes for important monetary flows per person

	age 15+	age 15+ by skill		
in thousand EUR at prices 2014		low	med.	high
average income	27.54	15.70	26.82	41.39
average income (cond. on working)	37.54	25.39	34.80	55.88
average income (cond. on not working)	15.19	8.58	15.39	23.00
average income (cond. on being retired)	21.68	12.54	20.17	38.32
average income (cond. on not working and not being retired)	4.12	4.18	4.39	3.49
MTMI per single grown-up (cond. on eligibility and take up)	8.68	8.68	8.68	8.68
MTMI per child (cond. on eligibility and take up)	2.55	2.55	2.55	2.55
minimum pension (cond. on eligibility)	10.13	10.13	10.13	10.13
family transfers per child	2.29	2.29	2.29	2.29
average labor taxes (cond. on working)	20.62	12.16	18.78	33.16
average pension taxes (cond. on being retired)	4.65	1.10	4.00	11.34
average consumption taxes	9.08	7.00	8.87	11.79
	All	by age		
in thousand EUR at prices 2014		0–29	30–64	65+
average public expenditure for education	1.67	4.72	0.20	0.09
average public expenditure for health and long-term care	2.77	1.28	2.34	6.63

Source: based on used data sources as described in Schuster (2018). Note: 'MTMI' refers to means-tested minimum income.

Table 9: Intergenerational skill transition matrices

	from mother to son					from mother to daughter				
from\to	$s=1$	$s=2$	$s=3$	$s=4$	$s=5$	$s=1$	$s=2$	$s=3$	$s=4$	$s=5$
$s=1$	0.29	0.28	0.28	0.12	0.03	0.54	0.14	0.14	0.15	0.03
$s=2$	0.11	0.30	0.30	0.27	0.02	0.08	0.23	0.23	0.31	0.16
$s=3$	0.11	0.30	0.30	0.27	0.02	0.08	0.23	0.23	0.31	0.16
$s=4$	0.05	0.10	0.10	0.43	0.33	0.07	0.03	0.03	0.59	0.29
$s=5$	0.02	0.19	0.19	0.38	0.23	0.00	0.02	0.02	0.29	0.68

Source: Schneebaum et al. (2013). Note: Information for $s=3$ approximated by $s=2$.

Table 10: Effects of refugee scenario

deviation from baseline	2020	2030	2040	2050	2060
in persons					
total	66,871	85,438	106,938	127,441	145,258
in working age	37,106	53,971	68,484	82,727	95,128
in employment	13,719	26,528	38,623	48,337	59,765
in retirement	2,689	4,204	5,810	10,279	17,193
in %					
GDP real	0.193	0.389	0.631	0.886	1.201
GDP real/capita	-0.562	-0.519	-0.463	-0.396	-0.269
private consumption real	0.348	0.476	0.571	0.704	0.873
private consumption real/capita	-0.408	-0.433	-0.523	-0.577	-0.592
public consumption real	1.116	0.748	0.806	0.911	0.957
investment real	0.322	0.581	0.848	1.108	1.476
wage rate real	-0.080	-0.081	-0.112	-0.138	-0.191
low skilled	-0.501	-0.677	-0.772	-0.708	-0.583
medium skilled	-0.032	-0.051	-0.103	-0.166	-0.270
high skilled	-0.042	0.048	0.082	0.102	0.101
in % of baseline-GDP					
revenue	0.165	0.162	0.181	0.213	0.251
taxation of profits	0.012	0.012	0.014	0.017	0.021
taxation of consumption	0.058	0.053	0.050	0.052	0.054
taxation of labor and pensions	0.090	0.093	0.114	0.139	0.170
other taxes	0.004	0.004	0.004	0.004	0.006
expenditure (w/o interest)	0.352	0.238	0.225	0.236	0.221
health and long-term care	0.043	0.041	0.041	0.041	0.042
education	0.085	0.079	0.077	0.086	0.079
basic welfare/integration	0.113	0.025	0.016	0.008	0.000
housing	0.002	0.002	0.002	0.002	0.003
family transfers	0.025	0.025	0.027	0.030	0.029
pensions	0.008	0.015	0.022	0.032	0.043
transfers to non-employed	0.059	0.046	0.043	0.046	0.044
other expenditure	0.018	0.006	-0.003	-0.009	-0.019
primary balance	-0.192	-0.076	-0.039	-0.015	0.043
debt	1.414	2.511	2.980	3.220	3.109

Source: Own calculations.

Table 11: Assumption-related sensitivity scenarios

deviation from baseline in % of baseline-GDP	2020	2030	2040	2050	2060
primary balance					
refugee scenario	-0.19	-0.08	-0.04	-0.01	0.04
S1: more applications	-0.32	-0.09	-0.05	-0.02	0.05
S2: lower family reunification	-0.19	-0.07	-0.04	-0.01	0.04
S3: lower fertility	-0.19	-0.06	-0.02	0.00	0.05
S4: return migration	-0.19	-0.06	-0.02	0.00	0.04
S5: better initial skills	-0.19	-0.07	-0.03	0.00	0.06
S6: fast skill transmission	-0.19	-0.07	-0.03	-0.01	0.06
S7: no productivity penalty for 1st gen.	-0.18	-0.07	-0.03	-0.02	0.03
S8: higher long-run empl. rates of 1st gen.	-0.19	-0.07	-0.03	0.00	0.05
S9: prod. and empl. penality for 2nd gen.	-0.20	-0.09	-0.06	-0.05	-0.02
S10: full average costs	-0.23	-0.12	-0.08	-0.07	-0.02
debt level					
refugee scenario	1.41	2.51	2.98	3.22	3.11
S1: more applications	1.47	2.90	3.47	3.77	3.66
S2: lower family reunification	1.41	2.48	2.93	3.15	3.05
S3: lower fertility	1.40	2.46	2.76	2.81	2.54
S4: return migration	1.41	2.40	2.73	2.80	2.61
S5: better initial skills	1.41	2.47	2.87	2.99	2.69
S6: fast skill transmission	1.41	2.49	2.93	3.10	2.87
S7: no productivity penalty for 1st gen.	1.39	2.41	2.82	3.04	2.98
S8: higher long-run empl. rates of 1st gen.	1.40	2.46	2.85	2.94	2.71
S9: prod. and empl. penality for 2nd gen.	1.43	2.59	3.21	3.72	4.07
S10: full average costs	1.54	3.05	3.92	4.63	5.07
deviation from baseline per accepted refugee in thousand EUR at prices 2014	2020	2030	2040	2050	2060
primary balance					
refugee scenario	-10.31	-4.22	-2.25	-0.85	2.55
S1: more applications	-13.81	-4.08	-2.15	-0.87	2.29
S2: lower family reunification	-10.19	-4.07	-2.16	-0.80	2.33
S3: higher fertility	-10.39	-3.55	-1.09	0.21	3.20
S4: return migration	-9.98	-3.40	-1.31	0.10	2.17
S5: better initial skills	-10.19	-3.92	-1.68	0.06	3.81
S6: fast skill transmission	-10.26	-4.09	-1.97	-0.32	3.47
S7: no productivity penalty for 1st gen.	-9.90	-3.81	-1.98	-0.90	1.91
S8: higher long-run empl. rates of 1st gen.	-10.14	-3.90	-1.51	0.00	3.04
S9: prod. and empl. penality for 2nd gen.	-10.50	-4.83	-3.48	-3.00	-0.96
S10: full average costs	-12.55	-6.52	-4.86	-3.93	-1.23
debt level					
refugee scenario	75.97	139.44	170.60	188.06	182.90
S1: more applications	62.82	127.53	157.57	174.37	170.55
S2: lower family reunification	75.92	137.64	167.70	184.25	179.63
S3: higher fertility	75.30	136.56	157.76	163.83	149.48
S4: return migration	75.97	133.42	156.24	163.56	153.81
S5: better initial skills	75.53	137.09	164.15	174.39	158.53
S6: fast skill transmission	75.72	138.37	167.66	181.26	169.15
S7: no productivity penalty for 1st gen.	74.79	133.95	161.63	177.50	175.36
S8: higher long-run empl. rates of 1st gen.	75.31	136.87	163.10	171.90	159.65
S9: prod. and empl. penality for 2nd gen.	76.57	143.72	183.57	217.19	239.36
S10: full average costs	82.85	169.52	224.45	270.31	298.53

Source: Own calculations.

Table 12: Number of applications and composition - assumption comparison

Refugee scenario

Asylum applications (in thousands)	2015	2016	2017	2018	2019	2020	2021	Sum
total	88.2	42.3	24.3	22.3	20.4	18.4	16.5	232.4
above past average ('extraordinary')	71.7	25.8	7.8	5.9	3.9	2.0	0.0	117.0
of which: positive decision	38.4	13.8	4.2	3.1	2.1	1.0	0.0	62.6
of which: 'new arrivals'	35.5	4.3	3.0	2.3	1.5	0.7	0.0	47.3
of which: family reunification	2.9	9.5	1.2	0.8	0.6	0.4	0.0	15.4
return migration of positively decided	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exogenous add. costs in % of GDP 2014	0.18	0.44	0.37	0.21	0.16	0.12	0.05	1.52

Sensitivity scenario S1: more applications

Asylum applications (in thousands)	2015	2016	2017	2018	2019	2020	2021	Sum
total	88.2	42.3	24.3	33.5	30.6	27.6	16.5	263.0
above past average ('extraordinary')	71.7	25.8	7.8	17.0	14.1	11.2	0.0	147.6
of which: positive decision	38.4	13.8	4.2	9.1	7.5	6.0	0.0	79.0
of which: 'new arrivals'	35.5	4.3	3.0	8.3	5.3	4.6	0.0	61.0
of which: family reunification	2.9	9.5	1.2	0.8	2.2	1.4	0.0	18.0
return migration of positively decided	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exogenous add. costs in % of GDP 2014	0.18	0.44	0.37	0.23	0.24	0.26	0.05	1.76

Sensitivity scenario S2: lower family reunification cases

Asylum applications (in thousands)	2015	2016	2017	2018	2019	2020	2021	Sum
total	88.2	42.3	24.3	22.3	20.4	18.4	16.5	232.4
above past average ('extraordinary')	71.7	25.8	7.8	5.9	3.9	2.0	0.0	117.0
of which: positive decision	38.4	13.8	4.2	3.1	2.1	1.0	0.0	62.6
of which: 'new arrivals'	35.5	9.1	3.0	2.7	1.7	0.8	0.0	52.8
of which: family reunification	2.9	4.7	1.2	0.4	0.4	0.2	0.0	9.9
return migration of positively decided	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exogenous add. costs in % of GDP 2014	0.18	0.44	0.37	0.21	0.16	0.12	0.05	1.52

Sensitivity scenario S4: return migration

Asylum applications (in thousands)	2015	2016	2017	2018	2019	2020	2021	Sum
total	88.2	42.3	24.3	22.3	20.4	18.4	16.5	232.4
above past average ('extraordinary')	71.7	25.8	7.8	5.9	3.9	2.0	0.0	117.0
of which: positive decision	38.4	13.8	4.2	3.1	2.1	1.0	0.0	62.6
of which: 'new arrivals'	35.5	4.3	3.0	2.3	1.5	0.7	0.0	47.3
of which: family reunification	2.9	9.5	1.2	0.8	0.6	0.4	0.0	15.4
return migration of positively decided	0.0	-0.9	-1.3	-1.4	-1.5	-1.6	-1.7	-8.5
Exogenous add. costs in % of GDP 2014	0.18	0.43	0.36	0.20	0.15	0.11	0.04	1.47

Source: Austrian Federal Ministry of the the Interior, Austrian Federal Ministry of Finances, Eurostat, own calculations and assumptions.

Table 13: Model-related sensitivity analyses

deviation from baseline in % of baseline-GDP	2020	2030	2040	2050	2060
primary balance					
refugee scenario	-0.19	-0.08	-0.04	-0.01	0.04
P1: share of unconstrained ($\pi^s/2$)	-0.19	-0.08	-0.04	-0.01	0.05
P2: intertemp. sub. elast. ($\sigma \cdot 2$)	-0.21	-0.09	-0.05	-0.02	0.05
P3: exogenous labor supply ($\varepsilon_\ell = \varepsilon_\delta = 0$)	-0.18	-0.06	-0.02	0.01	0.07
P4: export demand elast. ($\lambda^E/2$)	-0.18	-0.09	-0.07	-0.07	-0.04
P5: no habit formation ($\kappa = 0$)	-0.19	-0.07	-0.04	-0.01	0.05
P6: low capital-skill complementarity [1)]	-0.19	-0.08	-0.04	-0.01	0.05
P7: sub. of dom. vs. for. labor ($\sigma^{L^H,L^F} = 1.2$)	-0.19	-0.08	-0.05	-0.02	0.03
P8: higher real interest rate ($r^G = 0.03$)	-0.19	-0.07	-0.04	-0.01	0.05
P9: 'domestic' migration	-0.04	0.03	0.08	0.09	0.10
debt level					
refugee scenario	1.41	2.51	2.98	3.22	3.11
P1: share of unconstrained ($\pi^s/2$)	1.41	2.50	2.99	3.23	3.13
P2: intertemp. sub. elast. ($\sigma \cdot 2$)	1.50	2.76	3.36	3.66	3.54
P3: exogenous labor supply ($\varepsilon_\ell = \varepsilon_\delta = 0$)	1.43	2.42	2.74	2.78	2.44
P4: export demand elast. ($\lambda^E/2$)	1.27	2.35	3.01	3.67	4.17
P5: no habit formation ($\kappa = 0$)	1.42	2.49	2.94	3.15	3.01
P6: low capital-skill complementarity [1)]	1.40	2.49	2.96	3.19	3.07
P7: sub. of dom. vs. for. labor ($\sigma^{L^H,L^F} = 1.2$)	1.42	2.54	3.05	3.37	3.38
P8: higher real interest rate ($r^G = 0.03$)	1.47	2.88	3.82	4.66	5.26
P9: 'domestic' migration	0.14	0.30	-0.27	-1.09	-2.00

Source: Own calculations. Notes: 1) $\sigma^{L_1,K} = 1.1, \sigma^{L_2,K} = 1.0, \sigma^{L_3,K} = 0.9$.

Table 14: Effects of different elasticities of substitution between native and foreign labor assumptions on real wage rates

deviation from baseline in %	year	domestic labor low	domestic labor medium	domestic labor high	foreign labor low	foreign labor medium	foreign labor high
$\sigma^{L^H,L^F} = 0.7$	2020	0.96	0.14	0.40	-9.36	-1.13	-2.90
	2040	1.93	0.84	1.38	-16.38	-6.09	-8.29
	2060	2.33	1.70	2.73	-17.41	-12.22	-16.29
$\sigma^{L^H,L^F} = 1.2$ (sensitivity P7)	2020	0.39	0.07	0.22	-5.90	-0.68	-1.73
	2040	0.91	0.46	0.87	-10.51	-3.68	-4.97
	2060	1.25	0.93	1.74	-11.15	-7.57	-10.09
$\sigma^{L^H,L^F} = 3$	2020	-0.13	0.01	0.06	-2.75	-0.29	-0.72
	2040	-0.06	0.13	0.41	-4.92	-1.56	-1.99
	2060	0.20	0.23	0.80	-5.11	-3.31	-4.21
$\sigma^{L^H,L^F} = 10$ (main ref. scenario)	2020	-0.39	-0.02	-0.01	-1.19	-0.11	-0.25
	2040	-0.56	-0.03	0.18	-2.06	-0.54	-0.55
	2060	-0.35	-0.12	0.32	-1.99	-1.20	-1.23
$\sigma^{L^H,L^F} = \infty$	2020	-0.50	-0.03	-0.04	-0.50	-0.03	-0.04
	2040	-0.78	-0.10	0.09	-0.78	-0.10	0.09
	2060	-0.59	-0.27	0.11	-0.59	-0.27	0.11

Source: Own calculations.