A Parsimonious Model of AHV Expenditures

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Abstract

We develop a simple model of AHV expenditures based on publicly-available and easily-accessible Swiss data. We then use the model to forecast expenditures through 2040 under different population and macroeconomic scenarios. Under our baseline scenario, annual expenditures grow by around 80% to just over 90 billion CHF by 2040. We give particular attention to pensions paid abroad and the evolution of the Swiss age distribution.

1 Introduction

The old-age and survivors' insurance (AHV) is the compulsory pension insurance system in Switzerland. It forms the state pillar of the Swiss three-pillar system for securing basic needs.[1] The AHV is financed on a pay-as-you-go basis (73%), complemented by contributions by the federal government (20%) and VAT and other taxes (7%).[2]

We develop a simple model of the expenditure side of AHV based on publicly-available and easily-accessible Swiss data. We then use the model to forecast

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[1] Supplementary benefits (Ergänzungsleistungen EL) can be paid out as need-tested benefits. The latter, however, are financed through public funds (federal government, cantons, municipalities) and are therefore not part of this analysis.

[2] See https://www.bsv.admin.ch/bsv/de/home/sozialversicherungen/ahv/grundlagen-gesetze/leistungen-finanzierung.html.

expenditures through 2040 under different population and macroeconomic scenarios, giving particular attention to pensions paid abroad and the evolution of the Swiss age distribution.[3]

Our model divides AHV expenditure into four groups in order to separate the more straightforward components from the more elusive ones: (1) old-age pension payments to men in Switzerland, (2) old-age pension payments to women in Switzerland, (3) old-age pension payments to people abroad, and (4) non-old-age pension benefits, which is by far the smallest component. We separately model the number of pensions and average payments, as they are driven by distinct forces. We model payments to people in Switzerland as functions of the age distribution and price and wage indexes. Pensions abroad are more complicated, but we suggest a framework based on long-lagged variables pertaining to foreign workers in Switzerland and net emigration. Our model very closely matches the components of AHV expenditure in-sample, but our framework for pensions abroad comes with many caveats due to the short span of publicly-available data.

Forecasting with our model only requires assumptions about the future evolution of the Swiss age distribution and wage/price inflation (and the accounting for recent policy changes like the 13th payment). Under baseline BSV/BFS assumptions, our model forecasts a roughly 80% increase in total yearly AHV expenditures to just over 90 billion CHF by 2040. Over this period, expenditures on men in Switzerland rise by 97% to around 35 billion CHF. Payments to women in Switzerland increase by about 78% to roughly 40 billion CHF, and payments abroad rise by 70% to roughly 11 billion CHF.

We perform two sets of robustness checks. First, in our "scenario" analysis we alter our assumptions about the future regarding demographics, inflation, and policy changes. For example, BFS "high" and "low" population growth scenarios create a band of $+2.5/-2.5$ billion CHF around the baseline by 2040. Relative to the baseline, the 13th payment costs almost 7 billion CHF in 2040, while our results suggest that the tapering of the retirement of the baby boom provides substantial cost saving by 2040. And expenditure appears quite sensitive to assumptions regarding inflation and wages.

Second, we explore "model uncertainty" by seeing how the forecast changes when altering the model itself, with a focus on the most elusive aspects of our in-sample analysis. For the perturbations we consider, model uncertainty gener-

[3]In performing these exercises, we had the goal of creating a completely new and independent forecast. During our analysis, we neither researched the existing approaches within the Swiss government nor checked recent forecasts.

ates less uncertainty about expenditure in 2040 than does the scenario analysis. However, while the effect of changing the model of average payments is relatively muted (though not trivial in absolute amounts), altering the pensions abroad model in some ways can generate swings of around 1 or 2 billion CHF by 2040. Overall, two modeling conclusions we draw from our analysis are (1) for producing credible AHV forecasts, understanding the number of pensions is somewhat more important than understanding average payments, and (2) pensions abroad should continue to be a central area of focus in future modeling attempts.

The remainder of the introduction briefly explains the design of the pension system and the main parameters that are relevant for the calculation of pensions. Section 2 describes the data we employ for building the model and forming assumptions about future demographics and inflation. Section 3 explains the model and presents the baseline forecast and in-sample fit. Section 4 shows how the forecast changes under different scenarios and modeling assumptions, and Section 5 provides our self assessment, recommendations for future research, and general thoughts on forecasting AHV expenditures. Appendix A further delves into details and changes regarding Swiss migration policies and the legal framework for international pension payments.

1.1 Origin and Major Reforms

The AHV has its roots in the salary and earnings compensation fund for military personnel, which was redesigned during the active service periods of the Second World War. On July 6, 1947, the AHV was approved in a referendum based on a similar concept, with 80% of votes in favor. It was introduced on January 1, 1948. In order to adapt the AHV to the needs of changing demographics, it has regularly been revised. The 10th AHV revision (approved in 1995 by 60.7% of voters) is regarded as a milestone in the system change towards a more gender-neutral pension system. With the 10th AHV revision, all women received an independent pension entitlement and splitting was introduced. All income earned by married couples during the years of marriage is split and credited in equal parts to both spouses. Family duties are taken into account on a gender-neutral basis with child-raising and care credits. In return, the retirement age for women was raised in two stages (in 2001 and 2005) from 62 to 64. Furthermore, widowers also became entitled to a survivors' pension, which before had only been available to widows (Degen, 2007).

In 2019, voters approved the STAF proposal (66.4% in favor), which combined

a reduction in corporate taxes with an annually recurring contribution of CHF 2 billion to the AHV. This was financed through a 0.3% increase of payroll contributions (the first contribution increase in decades), and another additional CHF 800 million paid annually by the Federal Government.

On September 25, 2022, the electorate approved the reform "AHV 21", with a marginal share of 50.5% in favor. The reform, which came into force on January 1, 2024, provides for a standardization of the reference age for women and men to 65. Special transitional provisions apply for women born between 1961 and 1969 (EDI and BSV, 2023).

The "Initiative for a 13th OASI pension payment" was approved on March 3, 2024, adding a 13th pension payment each year on top of the normal 12 payments (beginning in 2026)(Geschichte der Sozialen Sicherheit, 2024).

1.2 Entitlement

Men receive old-age pensions from the age of 65. For women, the reference age was increased from 62 to 64 by 2005. As of January 1, 2024, the reference age for women was increased to 65. However, transitional provisions apply, such that effectively, the female retirement age will be 65 by January 1, 2028. Since 1997, it is possible to draw an AHV pension up to two years before reaching the legal retirement age. Drawing an AHV pension can also be postponed for up to five years, after which a supplement to the pension is granted.

Survivors' pensions are paid to widows and widowers with underage children or children in education living in the same household, yet widowers have only been entitled to a widower pension since 1997. Until now, women have always received a pension after the death of their husband, provided they have reached the age of 45.[4] In the case of a registered partnership, the surviving partner also receives a pension. This currently corresponds to the widower's pension.

[4] A ruling by the European Court of Human Rights (ECtHR) on October 11, 2022 found that widowers and widows are not treated equally (ECtHR complaint no. 78630/12). Until a fair solution is found, a lifelong pension also applies temporarily to widowers. According to current reform plans, widows will no longer receive a lifelong pension in the future. Without children, widows or widowers will only receive a widow's or widower's pension for 2 years, with children only until the youngest child reaches the age of 25. If the child being cared for is disabled, the widow's pension can be paid for longer. Widowed persons aged 58 and over who are at risk of poverty after the death of their spouse are entitled to supplementary benefits. For childless widows or widowers who reached the age of 55 when the law was amended, the widow's or widower's pension will continue to be paid as before. For details on the suggested reform, see https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-99297.html.

1.3 Pension Calculation

The individual pension currently ranges between CHF 1,225 and CHF 2,450 per month, depending on the level of contributions. The pension for married couples is capped at 150% of the maximum pension, i.e., CHF 3,675. These minimum and maximum pensions are calculated based on average earnings over the contribution years plus child-raising credits for each year a person had children under the age of 16. The amount of this child-raising credit corresponds to three times the minimum annual pension (split among spouses) Finally, the average income is then adjusted for inflation.[5]

However, missing contribution years lead to a reduction in the pension (i.e., the effective pension can fall below the minimum pension). The regular contribution duration required to reach the maximum benefit is 44 years ("Pension Scale 44"; 43 years for women, given their earlier legal retirement age). Missing contribution years lead to so-called contribution gaps. In such a case, the AHV can only pay a partial pension, applying pension scales 1 to 43. Each missing contribution year generally leads to a pension reduction of at least 2.3% (or 1/44).

Before reaching retirement, the survivors' pension amounts to 80% of the deceased's pension, or of what the deceased spouse would have received as an old-age pension, respectively.[6] Upon reaching the reference age for retirement, either the deceased's own pension plus a widow's supplement of 20%, or the widow's pension will continue to be paid. The higher of the two amounts is paid out. The cap of the maximum pension still applies. Without missing years, the survivor's pension is therefore between CHF 980 and CHF 1,960 per month, depending on the average income earned (as of 2024). For each missing year, the pension is reduced accordingly. The entitlement expires when the surviving spouse remarries.

When an existing pensioner's spouse dies, a supplement of 20% is added (up the maximum).

1.4 Contributions

Since the AHV is a general and compulsory national insurance scheme that covers everyone who works or lives in Switzerland, persons not active in the labor market

[5]For details on the adjustment, see https://www.ahv-iv.ch/de/Formulare/Diverse-Listen/Aufwertungsfaktoren.

[6]The maximum pension is achieved when the deceased has no contribution gaps from age 20 until the date of death (taking into account contribution years before age 20 to fill possible gaps). If the deceased had not yet reached the age of 45 at the time of death, the average earned income is inflated by an age-dependent "career supplement". Child-raising credits are also included in the calculation of the relevant average income, if applicable.

also need to make contributions to avoid missing contribution years. The obligation to contribute begins at the age of 17 for those in employment, and at the age of 20 for those not in employment. The following cases can be distinguished:

- **Married individuals without income:** These individuals are also liable to contribute but can be covered through their spouse's contributions, provided the spouse pays at least double the minimum AHV contribution on their income. The same applies to insured persons who work in their spouse's business without receiving a cash salary.

- **Students:** Students aged 20 and older who do not work or do not reach the annual minimum contribution through gainful employment must make contributions directly to the compensation office to avoid missing years. In 2023, the minimum contribution was CHF 514 (reached with an annual gross salary of CHF 4,851). Students aged 25 and older, who are not gainfully employed, must contribute according to their financial situation (see next bullet for details) (EDI, 2024).

- **Non-employed persons:** Contributions are calculated on the basis of replacement income and assets. The maximum contribution was CHF 21,100 in 2023.

- **Workers abroad:** Swiss, EU or EFTA nationals who live abroad *outside the EU or EFTA* can also take out voluntary AHV insurance under certain conditions in order to prevent a later pension reduction due to gaps in contributions. Similarly, students who give up their place of residence in Switzerland to pursue an education abroad can continue their insurance under certain conditions.
  For nationals of the EU or EFTA and other countries with which Switzerland has concluded a social security agreement, special provisions apply (see Appendix Section A.2 for detials).

- **Children:** Although covered by AHV and entitled to children's and orphans' pensions, children are not required to contribute.

Young adults who are already gainfully employed start making contributions towards the AHV from January 1 after their 17th birthday. These so-called youth years can be used to make up for missing contribution years. Cross-border commuters working in Switzerland and living abroad, or guest workers, contribute

to the AHV like any other person active in the Swiss labor force. Special provisions apply to employees who live abroad, work there for an employer domiciled in Switzerland and are remunerated by that employer, as well as their non-working spouses who accompany them abroad.

The obligation to pay contributions also applies to working pensioners. Anyone who has already reached the reference age but is still gainfully employed must continue to pay contributions. However, there is an allowance for working pensioners of currently CHF 16,800, on which no contributions are payable.

While employee contributions are deducted by the employer and transferred to the compensation fund together with the employer's contribution, self-employed persons are responsible to settle directly with the compensation office. The contributions are based on the income according to the assessment for direct federal tax. The compensation office decides whether someone is self-employed within the meaning of the AHV.

1.5 AHV Expenditures in 2023

By the end of 2023, approximately 2.546 million people were receiving old-age pensions under the Swiss AHV system. Additionally, 218,000 individuals were receiving survivors' pensions. Around 350,000 people relied on supplementary benefits to meet their living needs, especially if their pensions were insufficient (12.2% of AHV pensioners and 50.1% of disability benefit recipients). The total expenditure for the AHV reached approximately CHF 50 billion in 2023. The purchasing power of pensions in 2023 had risen to about four times that of 1948, reflecting an increase in real terms and purchasing power since the system's inception.[7]

2 Data

Before explaining the model and providing forecasts under different scenarios, we first list the data we use, both with regard to creating the model in-sample as well as forming assumptions about future inflation, wage growth, and the evolution of the Swiss age distribution.

[7]The annual maximum pension in 1948 was 1500 CHF, corresponding to 7,257 real CHF of 2023 (based on CPI inflation). In contrast, the annual maximum pension for a non-married person in 2023 was 29,400 CHF.

2.1 Expenditure Data and Population Scenarios

Annual AHV expenditure data, broken down by number of payments and average monthly payments, are available from 2001 to the present from BSV (Bundesamt für Sozialversicherungen), with detail on nationality, place of residence, sex, and type of AHV benefit.[8] These are the series we are attempting to match in-sample and forecast. For our model of the number of pensions abroad, we gather data from BFS (Bundesamt für Statistik) regarding the number of foreign workers in Switzerland[9] and net migration.[10] For average pension amounts paid abroad, we employ the age distribution of foreign workers in Switzerland from BFS,[11] as well as publicly-available KOF data on cross-border commuters contained in our replication files.[12] Central to our analysis is the age distribution within Switzerland. Historical data on the Swiss population by sex are available from BFS.[13]

Our forecasts depend on future Swiss population scenarios provided by BFS that attempt to predict the age distribution in Switzerland over the coming decades.[14] In our baseline forecast we use the "reference scenario" (Referenzszenario A-00-2020), but we also consider the "high scenario" (hohes Szenario B-00-2020) and the "low scenario" (tiefes Szenario C-00-2020). The BFS writes:

> "The Federal Statistical Office has been commissioned by the Federal Council since 1984 to produce - together with other Federal Offices - population scenarios for Switzerland. Forecasts of demographic growth focus on hypotheses about population growth in Switzerland, about employment and the level of education. The 2020-2050 scenarios were published in May 2020 ...
>
> Three new basic scenarios were calculated. The reference scenario (A-00-2020) describes the growth that seems most plausible in the coming decade. The 'high' scenario (B-00-2020) is based on a combination of

[8] https://www.pxweb.bfs.admin.ch/pxweb/de/px-x-1305000000_101/-/px-x-1305000000_101.px/

[9] https://www.bfs.admin.ch/asset/de/je-d-03.02.01.02

[10] "Wanderungssaldo inkl. Änderung des Bevölkerungstyps" from https://www.pxweb.bfs.admin.ch/pxweb/de/px-x-0102020000_103/px-x-0102020000_103/px-x-0102020000_103.px.

[11] https://www.bfs.admin.ch/asset/de/32170467

[12] The share of foreign workers in Switzerland that are cross-border commuter is in column E of the sheet "migration_workers_hist" in the excel file AHV_data_11_09_2024.xlsx. This series, from the KOF archives, was originally obtained from BFS.

[13] "Bestand am 31. Dezember" from https://www.pxweb.bfs.admin.ch/pxweb/de/px-x-0102020000_103/px-x-0102020000_103/px-x-0102020000_103.px

[14] https://www.pxweb.bfs.admin.ch/pxweb/de/px-x-0104000000_102/px-x-0104000000_102/px-x-0104000000_102.px

> hypotheses that promotes future population growth, whereas the 'low' scenario (C-00-2020) combines hypotheses, favoring a slower population growth ...
>
> Known as the component method (population projection), this technique is used to calculate population scenarios based on the selection of certain hypotheses on future demographic change with regard to fertility, mortality, immigration and emigration as well as naturalisations ...
>
> The reference scenario is calculated using the reference assumptions for both fertility and mortality or migration. The high scenario is a combination of high assumptions for all three components of population change and the low scenario is a combination of low assumptions. These three scenarios are the baseline scenarios for this series of projections. They define an area that currently appears to be the most plausible for the development of Switzerland's permanent resident population over the next few decades."[15]

Importantly, as we will see, we also need forecasts and historical data for CPI and wage growth.

2.2 The Mixed Index: CPI and Wage Inflation

Data on the development of consumer prices and wages were taken from BFS.[16] The baseline scenario for the future trajectory of prices and wages was provided by BSV, based on forecasts from the State Secretariat for Economic Affairs (SECO). In addition, we propose two alternative scenarios for the future evolution of these variables. The construction of the inflation and wage scenarios can be outlined in two stages: in the short term, we utilize official inflation forecasts from SECO. Following this, we model inflation using a stable autoregressive process of order 1 (AR(1)), which rapidly converges to the long-term inflation rate.[17] In one of the scenarios, this long-term rate is set at 1%, which represents the midpoint of the

[15] https://www.bfs.admin.ch/bfs/en/home/statistics/population/population-projections/national-projections.html.

[16] https://www.bfs.admin.ch/bfs/de/home/statistiken/preise/landesindex-konsumentenpreise.html and https://www.bfs.admin.ch/bfs/de/home/statistiken/arbeit-erwerb/loehne-erwerbseinkommen-arbeitskosten/lohnindex.html

[17] We calibrate the AR process for inflation π as $\pi_t = (1-\rho)\bar{\mu} + \rho\pi_{t-1} + \varepsilon_t$ where $\bar{\mu}$ is the unconditional (long run) mean and the persistence is determined by ρ, which we set to 0.9. For inflation forecasting and AR models see Stock and Watson (1999).

Figure 1: Wage and Inflation Scenarios

range deemed consistent with price stability by the Swiss National Bank (SNB).[18]

Wage inflation is estimated in the short term using an ARX(1) model, which incorporates lagged inflation, reflecting the backward-looking nature of the wage-setting process in Switzerland.[19] In the long term, wage growth is expected to reflect both inflation compensation and productivity gains, which correspond to real wage growth. In our first scenario ("Alt. CPI/Wage"), the inflation trajectory is nearly identical to that provided by BSV. However, the projected path of wage inflation diverges, as the implied real wage growth in the official scenario rises after 2028, whereas it remains at the historical average of 0.5% in our scenario.

In the second scenario ("Low CPI/Wage"), we set the long-term inflation rate to the historical average since 1999,[20] which is below 1%. This lower inflation trajectory leads, in the second stage, to a correspondingly lower expected wage growth, assuming the same real wage growth as in the other alternative scenario. The assumptions are depicted in Figure 1.

3 Model

To facilitate the modeling of total AHV expenditure, we divide it into four groups: old-age pensions for men living in Switzerland ("CH Men"), old-age pensions for women living in Switzerland ("CH Women"), old-age pensions for people abroad ("Abroad"), and the other non-old-age pension components of AHV such as orphan and widow benefits ("Other"). Payments to Swiss men and Swiss women follow clear patterns in our sample, and the Other payments are a relatively small component of AHV (around 5% in 2023). Given recent publicly-available data,

[18] According to the SNB's monetary strategy: "The SNB equates price stability with a rise in the Swiss consumer price index (CPI) of less than 2% per annum. Deflation, i.e. a sustained decrease in the price level, also breaches the objective of price stability."

[19] The model is based on the idea of staggered price and wage setting, for an overview of the literature see Taylor (1999).

[20] This marks the year when the SNB adopted its current monetary policy strategy.

the more elusive component of AHV is the payment abroad. Our level of granularity thus separates the relatively straightforward components from the more challenging payments abroad and relatively small Other payments. At the same time, the model remains easy-to-understand because there are only four groups. Note that we do not subdivide by nationality. "CH" refers to people living in Switzerland, while "Abroad" includes Swiss nationals living abroad.

We now introduce our mathematical notation.[21] Let PO_t^i denote the average monthly pension paid in year t to group $i \in \{M, F, A\}$, where the groups are Swiss men (M), Swiss women (F), and pensions abroad (A). For example, $PO_{2023}^F = 1928$, a little over 1900 Swiss francs per month in 2023 for a female pensioner in Switzerland, according to recent data.[22]

Let N_t^i be the number of pensions in year t paid to group $i \in \{M, F, A\}$. For example, $N_{2023}^A = 796{,}427$, that is, 796,427 old-age pensions were paid by Switzerland to recipients abroad in 2023.[23] This includes both foreign nationals who had previously worked in Switzerland as well as Swiss nationals who retired abroad.

The total annual expenditures are then given by:

$$
\begin{aligned}
Total_t^M &= PO_t^M \times N_t^M \times 12 \\
Total_t^F &= PO_t^F \times N_t^F \times 12 \\
Total_t^A &= PO_t^A \times N_t^A \times 12 \\
Total_t &= \left(Total_t^M + Total_t^F + Total_t^A + Other_t\right) \times (1 + adj),
\end{aligned}
$$

where $Total_t$ is the total annual AHV expenditure target of our model, and $Other_t$ is the (relatively small) non-old-age pension components of AHV. The parameter adj is a small scale-up factor included to match the official accounting measure of AHV expenditure, which includes costs aside from social benefits.

We separately model the average payments PO_t^i and number of pensions N_t^i. Intuitively, this is because they are driven by separate forces. The number of pensions is driven by the ageing of the population, while the average pension value for a group is driven by the economic/demographic composition within age cohorts.

Another key variable in our model is the cost-of-living correction to average

[21] Replication materials in R are described in Appendix B.

[22] $PO_{2023}^F = 1928$ is the December 2023 value from the BSV website, so it will differ slightly from the actual average over all of 2023.

[23] To be precise, this is the December 2023 number from the BSV website.

payments, which we call Π_t. According to Swiss policy, the monthly pension scale is adjusted upwards in odd years according to the so-called "mixed index" of consumer price index (CPI) inflation and nominal wage growth over the previous two years. For payments in an even year, 2022 for example, the pension scale remains unchanged, so $\Pi_{2022} = 1$. In an odd year, 2021 for example, the adjustment factor is

$$\Pi_{2021} = 1 + \frac{1}{2}\left(\frac{CPI_{2020} - CPI_{2019}}{CPI_{2019}} + \frac{CPI_{2019} - CPI_{2018}}{CPI_{2018}}\right) + \frac{1}{2}\left(\frac{wages_{2020} - wages_{2019}}{wages_{2019}} + \frac{wages_{2019} - wages_{2018}}{wages_{2018}}\right),$$

where $wages_t$ is the nominal wage index for Switzerland.[24]

While average monthly payments can change in even years due to the economic and demographic composition of pensioners, such factors are slow-moving, and average payments roughly follow Π_t's step function in recent times. Given initial average payments in 2007,[25] PO^i_{2007}, suppose that for all groups

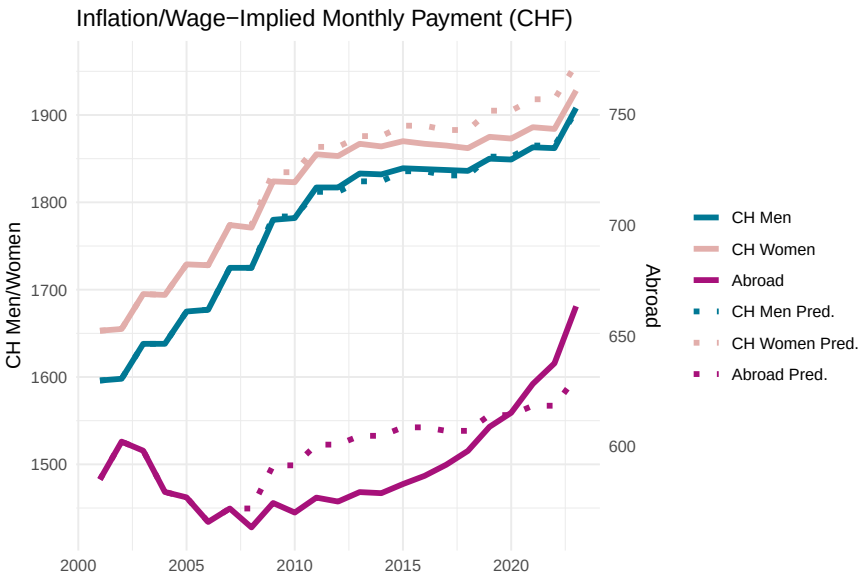
$$PO^i_t = \Pi_t \times PO^i_{t-1}. \tag{3.1}$$

Figure 2 projects average payments for Swiss Men/Women and Abroad over 2007-2023 using the rule in Equation 3.1. The in-sample fit for Swiss Men is excellent, so this will be our model for average male pension payments in Switzerland (Section 3.1). The actual average payment for Swiss women has not fully aligned with the mixed index trend. However, the step pattern is observable, and the deviation from the index, while present, remains within an acceptable range. In Section 3.2 we offer a simple model, based on widow supplements, that potentially explains the lagging growth. Average payments abroad were clearly not primarily driven by the mixed index over the last decades. They were also substantially lower than payments made in Switzerland, due to pensioners abroad missing many contribution years. In Section 3.3, we propose that the composition of pensioners abroad has changed over the last 20 years, specifically with regard to the retirement of cross-border commuters and the lagged age distribution of foreign workers in Switzerland.[26]

[24] Our arithmetic average of growth in wages and CPI does not exactly correspond to growth in the mixed index itself (the rate dictated by Swiss law), but the difference is very small.

[25] Throughout our report, we begin our in-sample exercises in 2007, which makes sense because the earlier publicly available data for 2001-2006 were heavily influenced by policy changes unique to that period.

[26] Due to the limited span of publicly-available data, it is challenging to rule out explanations



Note: Solid lines are data. Dotted lines are projections from 2007 using Equation 3.1. CH values on left axis, abroad values on right.

Figure 2: Predicting Average Payments In-Sample with Mixed Index

3.1 Men in Switzerland

As we have already described, our baseline model of average payments to Swiss Men is $PO_t^M = \Pi_t \times PO_{t-1}^M$, which assumes the average payments evolve only according to the mixed index cost-of-living correction. The in-sample fit from 2007 is good (Figure 2) but not perfect. Nevertheless, this specification has the advantage that it relies on no estimated coefficients, and forecasting it only requires assumptions about the future paths of CPI and wages.

To model the number of Swiss male pensions N_t^M, we simply assume they are a fixed fraction of the number of 65+ men residing in Switzerland:

$$N_t^M = \tau^M \times (CH\ Men\ 65+)_t\,, \tag{3.2}$$

where the parameter τ^M is what we call the "take-up rate." In recent years, the number of Swiss male pensions has been quite steady at around 99% of the 65+ male population, so we set $\tau^M = 0.99$. Figure 8 shows that the in-sample fit is

for average Swiss Women and Abroad payments other than our proposals in Sections 3.2 and 3.3, and other explanations would yield different forecasts. However, we will illustrate below that average payments are less-quantitatively important than the evolution of the number of pensions, and in Section 4 we explore the implications of many scenarios and alternate modeling assumptions. For example, using the "CPI/Wage Only" model of Equation 3.1 increases total AHV expenditure by less than 1 billion CHF in 2040 (relative to our baseline forecast).

very close since 2007.

The Swiss Men model, which fits very well in-sample despite the simplicity, provides straightforward forecasts under government assumptions. BSV assumptions for CPI and wage growth imply growth in the mixed index of 25.84% over 2023-2040, and the BFS reference scenario for the Swiss population implies growth of 44.24% in the 65+ male population over 2023-2040. Finally, the 13th payment (see Section 3.5) increases the 2040 average payment by an additional 8.33% (on top of the cost-of-living adjustment). Therefore, we forecast 2023-2040 Swiss Men total expenditure growth to be $(1 + 0.4424)(1 + 0.2584)(1 + 0.0833) - 1$, or approximately 97% (see Figure 10).

3.2 Women in Switzerland

As we saw in Figure 2, the average Swiss female pension lagged the mixed index over the period 2007-2023. Simultaneously, there was a narrowing in the difference between the average age of retirement-age women (64+) and retirement age-men (65+) in Switzerland. We call this average age difference variable $AgeGap_t$: the average age of women 64+ minus the average age of men 65+. As Figure 3 shows, the Age Gap was steady prior to 2010 at just under 1.2, meaning retirement-age women were on average 1.2 years older than retirement-age men. But $AgeGap_t$ has been trending downwards since 2010, coincident with average Swiss female pensions lagging behind the mixed index, and the BFS reference population scenario forecasts a continued decline through 2040 (although not to zero). As the gap narrows, fewer retired women are eligible for the 20% widow top-up, so one would expect this trend to dampen growth in average payments to women.

Table 1 column (2) regresses average Swiss female pensions on the inflation/wage-implied payment, the age gap, and a constant over 2008-2022.[27] This regression in column (2) gives us our baseline model of the average payment to Swiss women:

$$PO_t^F = 2.366 + 0.964 \times \Pi_t^{F07} + 49.248 \times AgeGap_t, \tag{3.3}$$

where we use Π_t^{F07} to denote the mixed index-implied average payment according to Equation 3.1, beginning with 2007 as the initial condition. Figure 4 shows the in-sample fitted values, along with the actual payments, revealing an excellent fit.

[27] When running the model, the 2023 population distribution had not yet been released, so the age gap variable was not available for 2023. The fitted residuals appear stationary, indicating a cointegrating relationship, but it is difficult to reject strongly a unit root with so few data points.

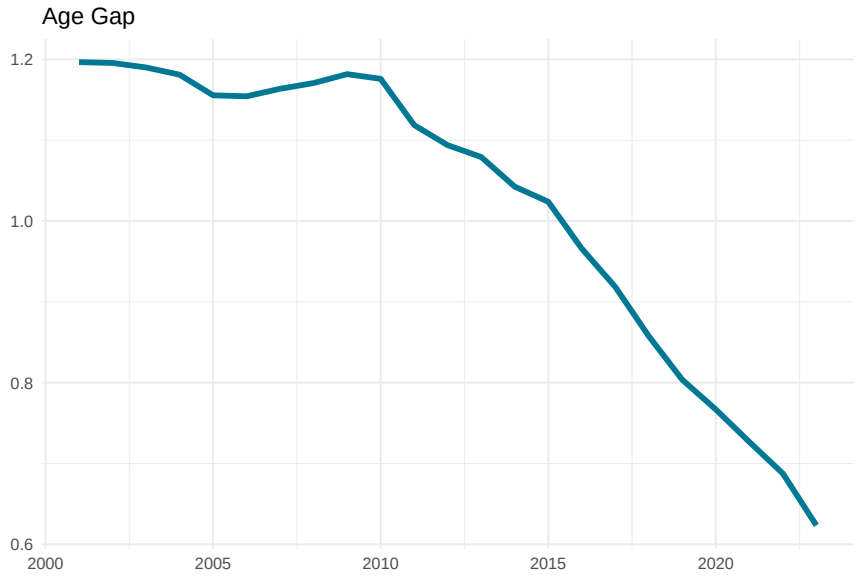


Figure 3: Average Age of 64+ CH Women Minus Average Age of 65+ CH Men

The figure also shows the fitted values from column (1) of Table 1, which performs the regression without the age gap variable. The fit is a bit worse in this case, but the model is simpler, and we consider it also in Section 4 when discussing forecast sensitivity.

Turning to the number of Swiss women's pensions, as with Swiss men, a fixed take-up rate fits closely after 2011, except in the case of women we need $\tau^F = 0.98$ (vs. 99% for men) and the relevant population is women 64+ (vs. 65+ for men). A 98% take-up rate performs worse over 2008-2011 because that period had a lower penalty for early retirement (at the end of the phase-in of the increased retirement age for women). According to a BSV report, around 14*pp* extra women aged 62−63 were retiring early then (relative to the apparent steady-state of around 11%).[28] Taking this into consideration, our model is

$$2008-2011: N_t^F = \tau^F \times (CH\ Women\ 64+)_t + 0.14 \times (CH\ Women\ 62-63)_t$$
$$2012-2040: N_t^F = \tau^F \times (CH\ Women\ 64+)_t,$$

which is a close fit in-sample, as we can see in Figure 8.

[28] See "Vorbezug der Altersrente in der Altersversicherung" (March 2014) by Jacques Méry.

	Dependent variable:	
	Average CH Women Payment	
	No Age Gap	Baseline
	(1)	(2)
Inflation/Wage-Implied Payment from 2007	0.797***	0.964***
	(0.035)	(0.039)
Age Gap		49.248***
		(8.646)
Constant	363.140***	2.366
	(65.650)	(80.934)
Observations	16	15
R^2	0.974	0.991
Note:	*p<0.1; **p<0.05; ***p<0.01	
	(1): 2008-2023	
	(2): 2008-2022	

Table 1: Average CH Women Payments Regressions

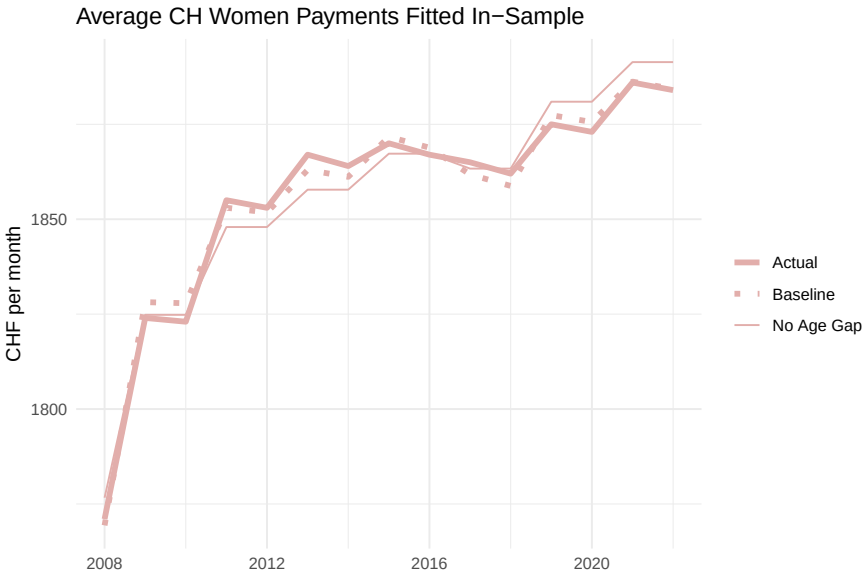


Figure 4: Fitted Values for Regressions in Table 1

3.3 Pensions Abroad

The number of pensions paid abroad is the cumulation of people who worked in Switzerland at some point in the past and later claimed a Swiss pension while living outside of Switzerland after retirement age. A fully accurate prediction of the number of pensions abroad would thus require a long record of emigrants from Switzerland by age, combined with a record of return migration to Switzerland, mortality abroad, and numbers on the rate of applying for a pension abroad given eligibility. Furthermore, understanding the average payments abroad requires information about the cross-sectional distribution of this population over time. Overall, such public data are somewhat limited, but we propose here a potentially promising approach to addressing these issues. See Appendix A.2 for an extensive discussion of the rules surrounding claiming Swiss pensions abroad.

Figure 5 shows net emigration (emigration from Switzerland minus immigration to Switzerland) for different age groups over 1971 to the present.[29] The series are plotted as a fraction of the total Swiss population. In most years there is positive net immigration into Switzerland, but there were two periods of positive net emigration: the mid 1970s and late 1990s. Moreover, volatility in net emigration is driven primarily by people under 50 years old, and the net emigration of people over 50 is relatively steady over time and close to zero.

As pensions abroad are claimed from the *stock* of emigrants who do not ultimately return to Switzerland, rates of lagged net migration should be related to the growth of pensions abroad. But what is the appropriate lag to consider? Given that net migration appears to be driven by people under 50 and given that emigrants from Switzerland under 20 will generally be ineligible for a Swiss old-age pension, emigration patterns relevant for future pensions abroad should be roughly centered around age 35 ($= (50 + 20)/2$). Since people aged around 35 retire roughly 30 years later, our hypothesis is that around a 30 year lag in migration is the relevant variable for current changes in Swiss pensions being claimed abroad. Under this hypothesis, the relatively high net emigration of the 1970s should correspond to faster growth in pensions abroad in the 2000s. Likewise, the lower net emigration of the 1980s should translate into slower Abroad pension growth in the 2010s. And indeed, the observed high and then lower growth of Abroad pensions over 2001-2023 is the most striking feature of that series (see Figure 8). Interestingly, since net emigration dramatically spiked again in the 1990s, one might expect a temporary return to faster Abroad pension growth in

[29] Figure 24 in Appendix Section A.4 further decomposes migration flows by country and age groups. Unfortunately, this more detailed information is only available starting in 1991.

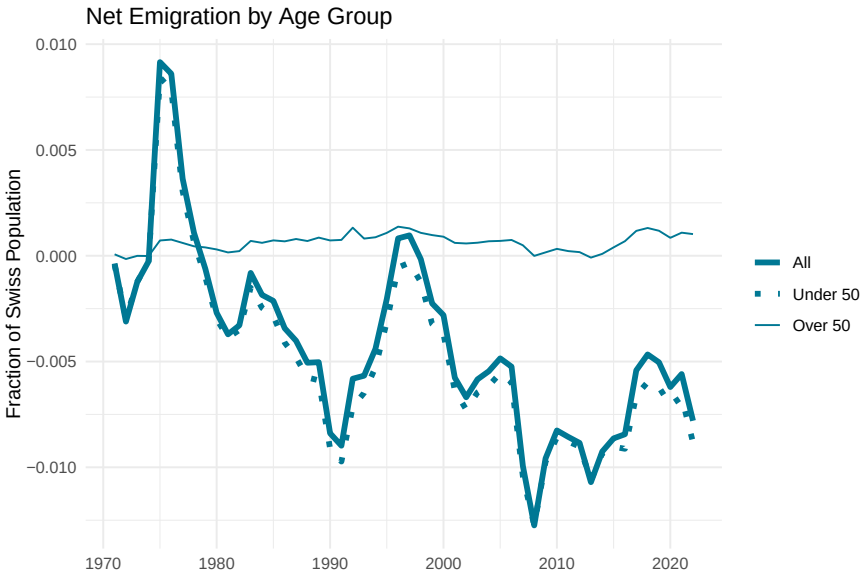


Figure 5: Net Emigration / Swiss Population by Age (All, Under 50, and Over 50)

the 2020s. This will be a feature of our baseline forecast below. In Appendix A.1 we delve into the historical and legal context behind Figure 5.

With this discussion in mind, we construct two variables plotted in Figure 6. The first, which we call the "net emigration rate" (E_t), is a 5 year (centered) moving average of net emigration divided by the stock of foreign workers in Switzerland. This variable is a measure of the rate at which foreign workers in Switzerland are moving abroad. The second (W_t) is the growth rate of a 5 year moving average of the number of foreign workers in Switzerland.

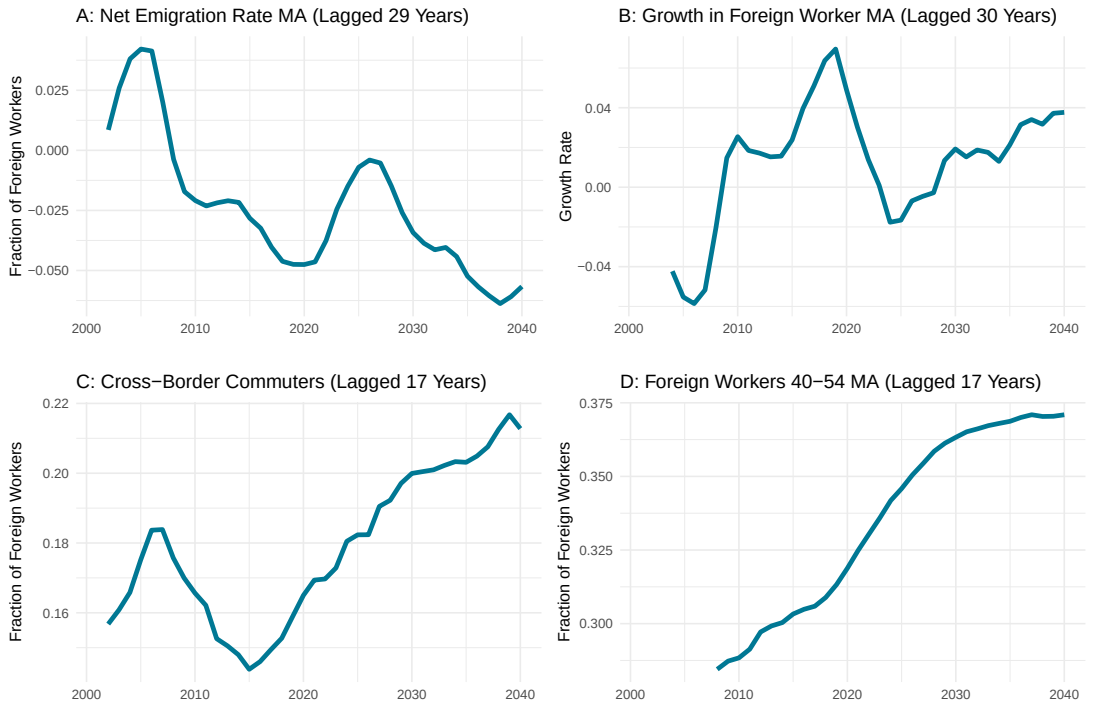
Over the period 2008-2022, we regress Abroad pension growth on a constant, growth in $(CH\ Men\ 65+)_t$, the lagged net emigration rate E_{t-29}, and the further lagged growth in foreign workers (W_{t-30}). The results are in column (2) of Table 2 and are the basis of our baseline model of the number of Abroad pensions:

$$g_t^A = 0.053 + 0.382 \times (Growth\ CH\ Men\ 65+)_t + 1.495 \times E_{t-29} + 0.346 \times W_{t-30} \tag{3.4}$$

$$N_t^A = N_{t-1}^A \times (1 + g_t^A),$$

where g_t^A denotes the growth rate of N_t^A.[30] The motivation for (3.4) is that the number of pensions abroad can grow for three reasons. First, when a high fraction

[30]Note that the extrapolation of the level of N_t^A depends on the particular exercise. In-sample, we begin with the observed value of N_{2007}^A, whereas for the forecast we initialize at N_{2023}^A.



Note: Each line is the corresponding lagged value relative to the year on the axis. For example, in Panel B, the observation for 2030 refers to foreign worker growth in 2000.

Figure 6: Emigration and Foreign Workers

of the lagged foreign labor force emigrates, there is an increase in the stock of former Swiss workers of retirement-age living abroad. Second, for a given rate of emigration, the number of Abroad pensions can increase when the foreign labor force had previously increased. Third, Abroad pensions could increase purely due to general ageing in Switzerland (although $(Growth\ CH\ Men\ 65+)_t$ is not significant in our baseline specification).[31] The R^2 for the growth regression is 0.947, and the baseline model closely matches the level of Abroad pensions in-sample (see Figure 8).[32] While there is a general story behind this baseline specification, the choice of $t-29$ and $t-30$ is motivated by the quality of the in-sample fit (vs. a precise theory). The small sample size limits a full econometric investigation, but columns (1) and (3)–(6) of Table 2 present alternative specifications for Abroad pension growth. Shifting the lags provides a worse fit, while excluding emigration and worker variables altogether greatly worsens the fit. While our simple

[31] We use men 65+ as our proxy for Swiss demographics because of its tight link with the number of CH pensions in-sample.

[32] Even though we suspect that emigrants around age 35 are the most important driver of future pensions abroad, ideally one would include many different lags regarding emigration and foreign workers. We decided, instead, to employ moving averages to capture other lags because of the very small sample size and potential for overfitting.

model strikes us as reasonable and the in-sample fit is excellent, one should remain somewhat skeptical about the extent to which we can understand the evolution of pensions abroad with so little data: we only observe the number of pensions over 2001-2023, and we were unable to find time series on "return immigration" (emigrants going back and forth).[33] Nor is there, to our knowledge, a public record of the stock of former Swiss workers living abroad, by age.[34] In Section 4, we investigate how the different models in Table 2 affect our forecasts through 2040.

But despite these model uncertainties, our approach has a major advantage over other possible strategies: the long lags are still in-sample, even by 2050, so this approach to forecasting the number of Abroad pensions does not require forecasts of the explanatory variables themselves (other than the population scenarios already created by BFS).

Next, we turn to average payments made abroad. As we showed above, the mixed index is not the key driver in-sample. Instead, it is evident that there have been non-trivial changes in the composition of foreign workers in Switzerland, both with regard to their incomes and contribution years.[35] The main challenge is the lack of readily-available public data regarding the work and income histories of emigrants from Switzerland. Here, we offer a tentative explanation for the recent rise in average payments abroad (see Figure 2), but the in-sample fit is less-convincing than the other components of our model, so our model uncertainty analysis in Section 4 is especially relevant with regard to this point.

Examining public data with a sufficient time span for our analysis, two aspects of the composition of foreign workers in Switzerland stand out (Figure 6 Panels C and D). The first is the increase in the share of foreign workers in Switzerland that are cross-border commuters over the late 1990s to the present (the figure illustrates the increase over 2015-2040, since the series is lagged 17 years). The increase was over 6*pp*, from under 15% to over 21%. We call this variable com_t. Appendix A.2.3 provides additional detail on cross-border commuters. The second is the ageing of foreign workers in Switzerland over a similar period, with the 5 year (centered) moving average[36] share of foreign workers aged 40-54 increasing

[33] This is one reason we look at net emigration vs. gross emigration. Netting out immigration to some degree controls for return immigration. Another reason is that the gross flows are only available since the 1980s.

[34] One could attempt to construct such data using emigration flows by age, but the problem is challenging due to return immigration and the unknown initial distribution.

[35] The composition and number of Swiss nationals retiring abroad has also clearly been changing. But this group comprises only around 5% of the number of pensions in 2023 (and 4% of old-age pension expenditure), so it was not a focus of our analysis.

[36] We do not take a moving average of com_t because it already appears quite smooth.

	Dependent variable:					
	Growth in Number of Pensions Abroad					
	(1)	(2)	(3)	(4)	(5)	(6)
Growth in 65+ CH Men	2.780***	0.382	1.498***	1.403*	1.594***	2.706***
	(0.426)	(0.482)	(0.439)	(0.709)	(0.425)	(0.567)
E lagged 29 years		1.495***				
		(0.248)				
W lagged 30 years		0.346***				
		(0.097)				
E lagged 30 years			1.034***			
			(0.222)			
W lagged 31 years			0.360**			
			(0.136)			
E lagged 28 years				1.192**		
				(0.451)		
W lagged 29 years				0.444**		
				(0.166)		
E lagged 33 years					−0.044	
					(0.214)	
W lagged 34 years					−0.249	
					(0.148)	
E lagged 24 years						−0.212
						(0.320)
W lagged 25 years						−0.051
						(0.201)
Constant	−0.043***	0.053**	0.008	0.016	−0.013	−0.046**
	(0.011)	(0.018)	(0.013)	(0.028)	(0.012)	(0.016)
Observations	15	15	15	15	15	15
R^2	0.767	0.947	0.935	0.864	0.918	0.785
Note:	*p<0.1; **p<0.05; ***p<0.01 Sample: 2008-2022 E: Moving Average of Net Emigration Rate W: Growth in Moving Average of Foreign Worker Growth					

Table 2: Growth in Abroad Pensions Regressions

substantially. We call this variable wma_t. Our hypothesis is that these trends, lagged 17 years, reflect a current shift in pensions claimed abroad towards richer and more permanent foreign employees in Switzerland. That is, we suspect that prior to the last decade, pensions abroad were being claimed disproportionately by people who worked fewer years in Switzerland while young. While in recent years, we conjecture that a greater share of pensions abroad are claimed by richer, more-established former foreign workers who often had the ability to cross-border commute following free-movement reforms described in Appendix A.1.[37]

Motivated by Figure 6, we regress the average payment abroad on a constant, com_{t-17}, wma_{t-17}, and the inflation/wage-implied payment from 2007 (Π_t^{A07}). The choice of a 17 year lag is motivated by the eventual retirement of a worker aged 40-54 and the start-date of wma_t in 1991. The results are in column (2) of Table 3, along with the specification with only a constant and Π_t^{A07} (column (1)).[38] Column (2) yields our baseline model of average payments abroad:

$$PO_t^A = -271.175 + 0.657 \times \Pi_t^{A07} + 1134.069 \times wma_{t-17} + 763.020 \times com_{t-17}, \quad (3.5)$$

which appears to be a reasonable fit in-sample according to Figure 9. However, the fit is worse (by R^2) relative to PO_t^M and PO_t^F, and we thus reiterate that it is important to consider the "CPI/Wage Only" scenario in Section 4 that extrapolates average payments based on the mixed index alone.[39]

3.4 Non-Old-Age Pension Expenditures

We have given less attention to the non-old-age pension AHV expenditures, which include various survivor benefits and child supplements, as they currently comprise less than 5% of total AHV expenditure. The most salient feature of this part of AHV is that it has been declining as a fraction of old-age pension expenditures, while perhaps seeming to level-off at around 5%. In our baseline, we regress (over 2008-2023) these "other" expenditures on total old-age pension spending (in billions of CHF), but we also consider in Section 4 the "Other Fraction" scenario,

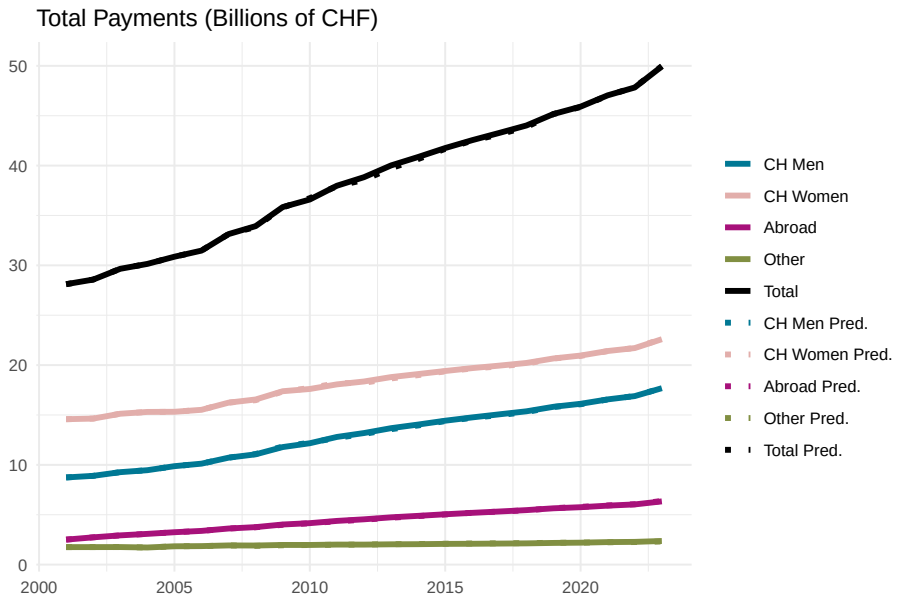
[37] As we discuss in Appendix A.2.2, Switzerland has also experienced substantial changes in the number and composition of seasonal workers. The effect on pension payments abroad is a potentially fruitful area for future research.

[38] Unlike with the number of pensions abroad, here we are limited in our ability to do lag sensitivity analysis: the series on foreign workers by age starts in 1991, and lesser lags would not allow forecasting to 2040 and beyond.

[39] Also, the cointegrating relationship is less clear than with the PO_t^F regression.

	Dependent variable:	
	Average Abroad Payment	
	(1)	(2)
Inflation/Wage-Implied Payment from 2007	1.778***	0.657***
	(0.280)	(0.197)
Age 40-54 foreign worker share MA (lagged 17 years)		1,134.069***
		(174.525)
Cross-border commuter share (lagged 17 years)		763.020***
		(106.391)
Constant	−481.772**	−271.175***
	(169.993)	(82.231)
Observations	16	16
R^2	0.742	0.989
Note:	*p<0.1; **p<0.05; ***p<0.01	
	Sample: 2008-2023	

Table 3: Average Abroad Payments Regressions



Note: Solid lines are data, and dotted lines are in-sample projections. For both data and predictions, "Total" refers to social benefit spending times the accounting adjustment factor.

Figure 7: Predicting AHV Expenditures In-Sample from 2007

which assumes this category has leveled-off as of 2023:

$$\text{"Baseline:"}\ Other_t = 1.007 + 0.028 \times \left(Total_t^M + Total_t^F + Total_t^A\right) \tag{3.6}$$

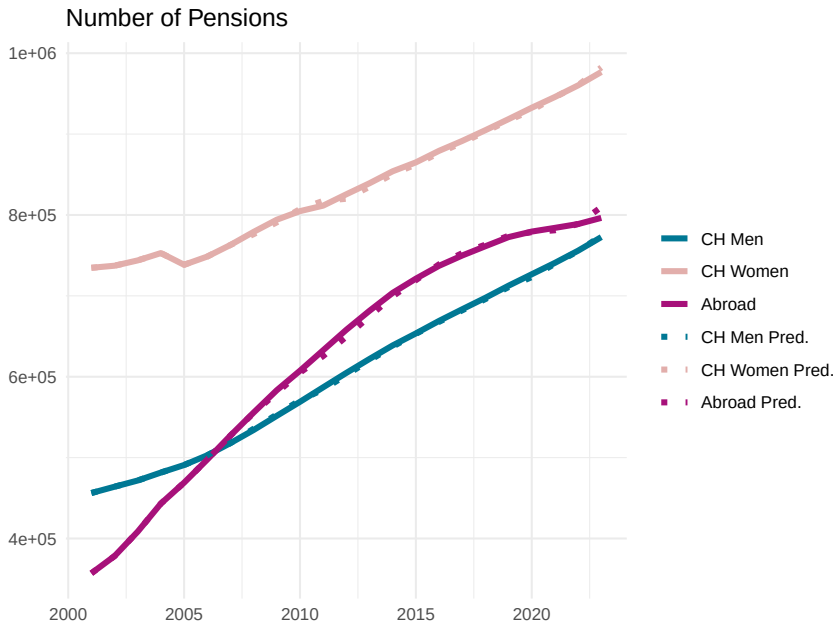
"Other Fraction (2023-):" $Other_t = 0.051 \times \left(Total_t^M + Total_t^F + Total_t^A\right)$.

Finally, we scale-up our measure of total expenditures by approximately 2% ($adj \approx 0.02$) to match the official accounting measure of AHV expenditure, which includes costs aside from social benefits. The percent difference between official total AHV expenditure and the benefits we model appears to be stable in recent years, at around 2%.

3.5 Baseline In-Sample Fit and Forecast

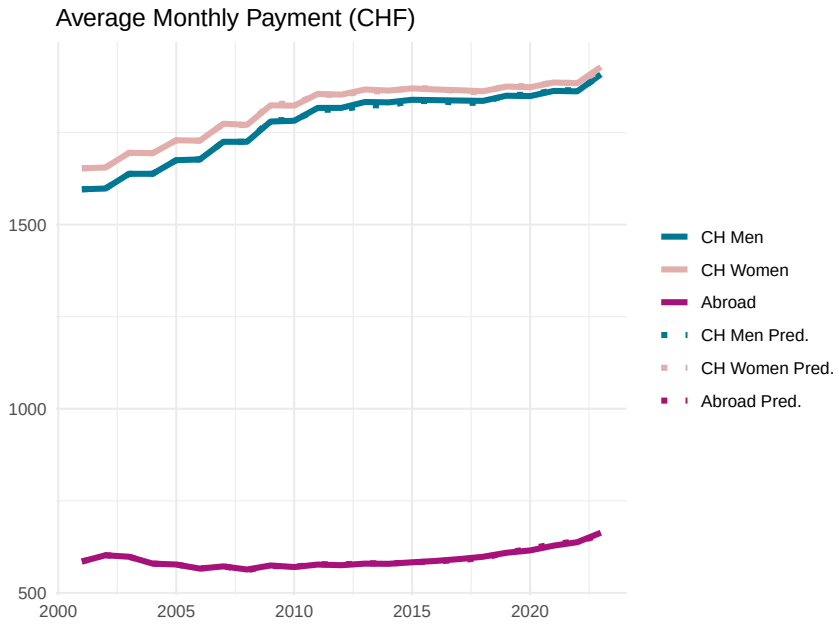
Figure 7 shows that, in-sample from 2007, our baseline model fits total expenditures by category very closely. Observing only the age distribution, the mixed index, and lags of emigration and foreign worker variables, one can match expenditures in-sample. Figures 8 and 9 show the in-sample fits for the number of pensions and average payments, respectively.

Given BFS assumptions about the future Swiss population and BSV assump-



Note: Solid lines are data, and dotted lines are in-sample projections based on current and lagged demographic variables. See the main text for details.

Figure 8: Predicting Number of Pensions In-Sample from 2007



Note: Solid lines are data, and dotted lines are in-sample projections. See the main text for details.

Figure 9: Predicting Average Payments In-Sample from 2007

tions about the future mixed index, we can forecast expenditures through 2040 because the emigration/foreign worker lags are still in-sample by then. These assumptions were described in Section 2.[40]

We also include in our forecast the recently-passed 13th payment, which begins in 2026. To account for this, we first compute the baseline forecast of the average monthly payment for each group PO_t^i, ignoring the 13th payment. Then, from 2026 onwards, we replace the average payment forecast with

$$\widetilde{PO}_t^i = \frac{13}{12} PO_t^i,$$

increasing the average monthly payment by around 8% and implying an average annual payment of $13 \times PO_t^i$ (vs. $12 \times PO_t^i$ before 2026).[41]

Ideally, one would also account for the AHV 21 legal changes[42] that will, along with many other reforms, increase the female retirement age from 64 to 65 over 2025-2028. A comprehensive analysis of AHV 21 is beyond the scope of our parsimonious model, and we ignore it in our baseline projections.[43]

Figure 10 compares, by group, 2023 expenditures and 2040 forecasts. Total expenditure grows by over 80% to around 91 billion CHF, with CH Men experiencing the most growth of over 97% to around 35 billion CHF by 2040. Expenditure on CH Women grows by around 78% to 40 billion CHF, and expenditure abroad grows by around 70% to 11 billion CHF. The paths of expenditure by group are shown in Figure 13.

Figure 11 displays the forecasts for the number of pensions. For CH Men and Women, one can observe a decrease in the rate of growth at the end of the forecast period, due to the end of the baby boom retirement period. Quite striking is the

[40] The BFS population scenarios were formed in 2020. Therefore, the population levels from the scenarios do not match the observed data in recent years, perhaps in part due to COVID. To more smoothly splice together the observed population distribution with the scenarios, we forecast the population distribution using growth rates from the BFS scenarios, with the latest observed data (2023) as the initial condition. In particular, from the scenarios we construct growth rates for men 65+, women 64+, and the age gap, and project forward from 2023 using the growth rates.

[41] This simple formulation of the 13th payment potentially overstates the expenditure impact somewhat due to mortality throughout the year. We have not performed an in-depth analysis on this point, but we conjecture the effect is small.

[42] https://www.bsv.admin.ch/bsv/de/home/sozialversicherungen/ahv/reformen-revisionen/ahv-21.html.

[43] To adjust our forecast to include AHV 21, one could add to our numbers the projections from the BSV analysis: https://www.bsv.admin.ch/dam/bsv/de/dokumente/ahv/finanzperspektiven/finanzperspektiven-ahv-bis-2031.pdf.download.pdf/FinanzperspektivenderAHVbis2033.pdf. See, for example, "Grafikblatt: Projektionen der AHV-Ausgaben und der Umlageergebnisse" (https://www.newsd.admin.ch/newsd/message/attachments/89633.pdf), which amends the BSV AHV 21 numbers to our baseline.

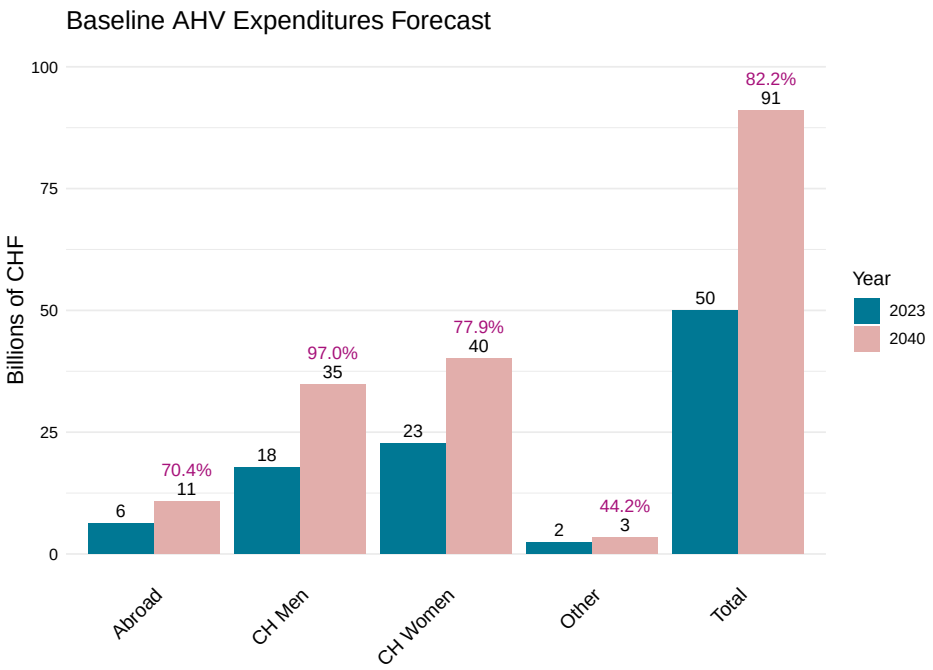


Figure 10: Baseline Forecast

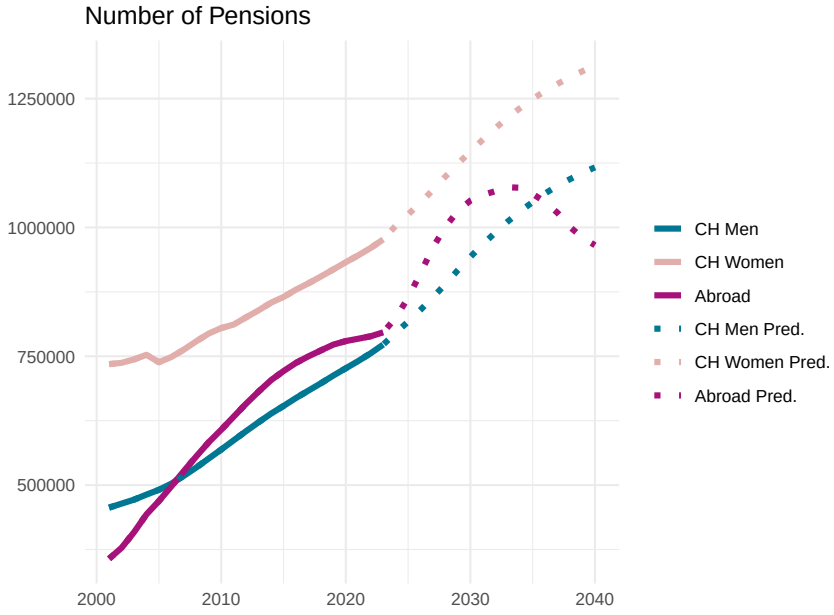


Figure 11: Baseline Forecast of Number of Pensions 2023-2040

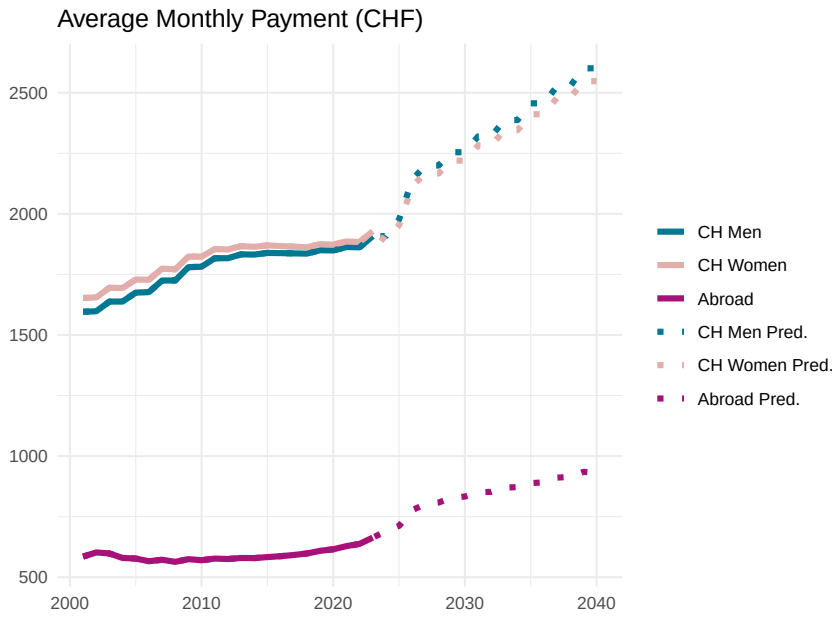


Figure 12: Baseline Forecast of Average Payments 2023-2040

spike in pensions abroad through the early 2030s, due to the emigration of foreign workers in the 1990s.

Figure 12 shows average payment forecasts. Payments clearly jump due to the 13th payment. CH Men and CH Women follow the mixed index, with CH Women falling slightly behind due to the age gap effect. Abroad payments do not continue their recent accelerated growth because of the recent leveling-off of rates of cross-border commuters and the share of older foreign workers.

Figure 14 shows cumulative in-sample growth of old-age pension payments, decomposing the cumulated growth into contributions from the number of pensions and the average payments. Figure 15 performs the same exercise for our forecast, but with the 13th payment separated from the average payment component. In-sample, we see that the most growth in expenditure, by far, stemmed from the number of pensions. In our forecast, the average payment is relatively more important, but much of its increased attribution is due to the 13th payment. While average payments are expected to contribute more to growth going forward (due to higher inflation relative to the in-sample period), the number of pensions remains the single most important factor.

For reference, Figures 16 and 17 decompose total cumulated AHV expenditure growth into the components CH Men, CH Women, Abroad, and Other, both in-sample and in the baseline forecast. They show that the domestically paid old age pensions dominated the evolution of the expenditure in sample but also equally

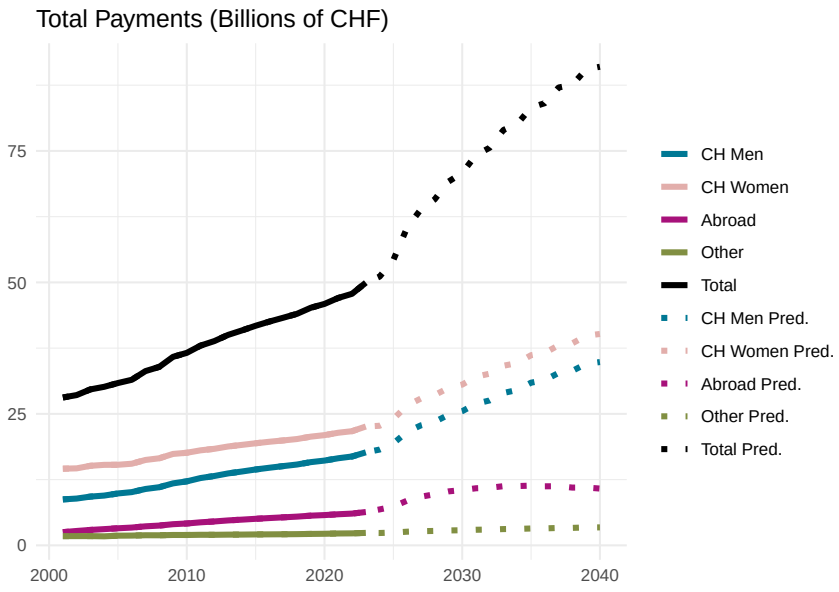
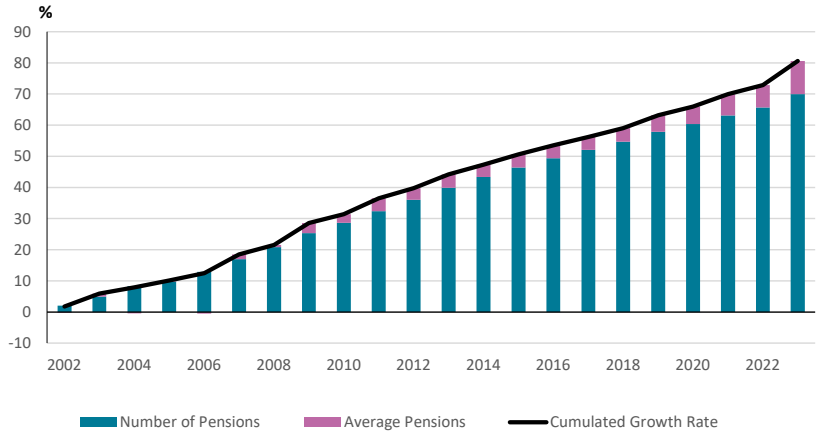
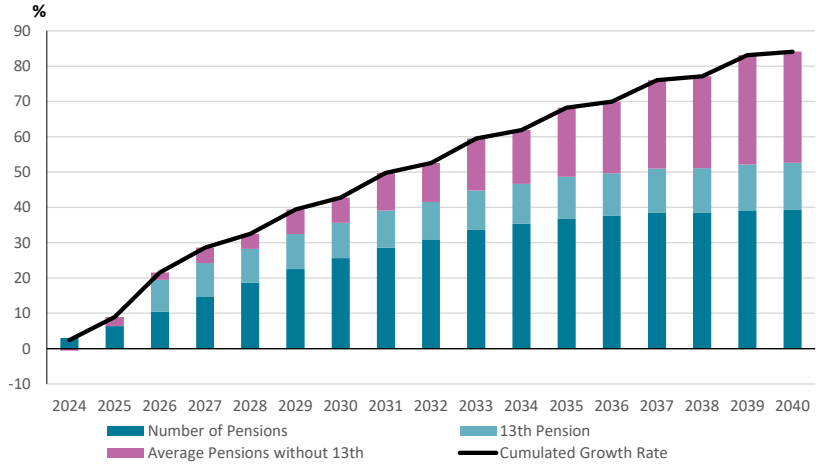


Figure 13: Baseline Forecast of AHV Expenditures 2023-2040



Notes: growth contributions are rescaled to account for cross-product approximation errors while preserving the relative size of the contributions.

Figure 14: Cumulated Growth Contributions to Old-Age Pensions: Number vs. Average Payment, 2001–2023 (in-sample)



Notes: growth contributions are rescaled to account for cross-product approximation errors while preserving the relative size of the contributions. 13th pension effect calculated as difference between model with and without the introduction of the 13th payment.

Figure 15: Cumulated Growth Contributions to Old-Age Pensions: Number vs. Average Payment, 2024-2040 (forecast)

in the forecast.

4 Scenarios and Model Uncertainty

To investigate the robustness of our baseline forecast, we perform two sets of sensitivity analyses. First, we maintain our baseline in-sample model but vary assumptions about the future of the evolution of the Swiss population, the legal code, and the mixed index. We refer to these exercises as "Scenarios." Second, we vary the specification of the in-sample model to show how the forecast changes with the exclusion of explanatory variables, different lags, and so on. We refer to these exercises as "Model Uncertainty."[44]

Scenarios:

(i) **Alt. Mixed Index:** We use our own mixed index forecast, described in Section 2, instead of the baseline BSV assumption. The main difference is we do not include the jump in nominal wage growth after 2028.

[44]For "Model Uncertainty," we focus on perturbing the model of the number of pensions abroad, as the number of pensions is the biggest driver of expenditure and pensions abroad are the most uncertain aspect of that component (given our data). We show results for five alternate specifications on this point, but formal model selection/averaging exercises would be a fruitful area for further research, especially with respect to moving average windows. We explored robustness to a lesser extent with respect to average pension payments because they appear less pivotal in understanding total expenditure, once accounting for the mixed index.

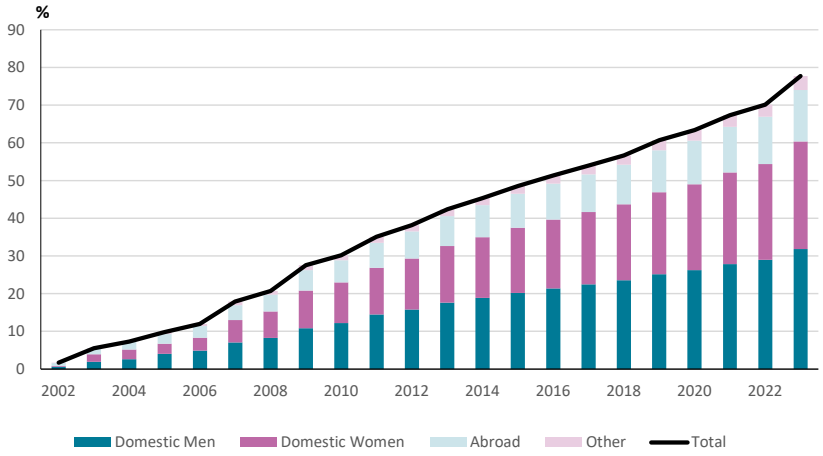


Figure 16: Total AHV Cumulated Growth Contributions by Category, 2001-2023 (in-sample)

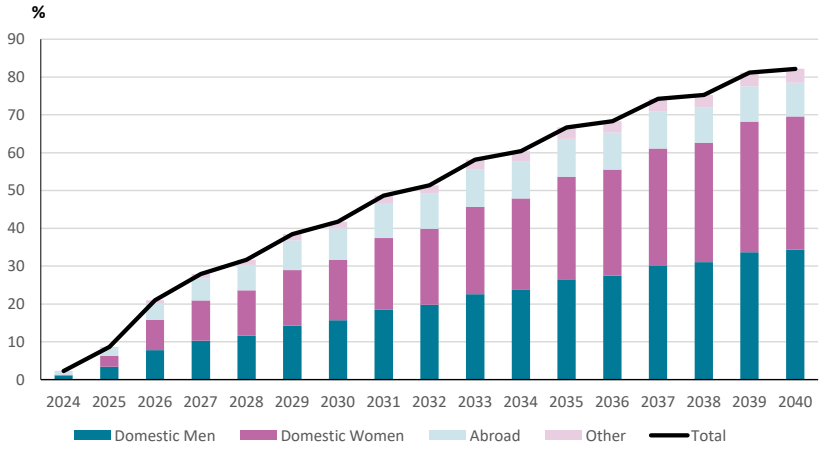


Figure 17: Total AHV Cumulated Growth Contributions by Category, 2024-2040 (forecast)

(ii) **Low Mixed Index:** We use a low inflation forecast, described in Section 2, instead of the baseline BSV assumption. The main difference is lower future CPI inflation, which also pushes down nominal wage growth.

(iii) **No 13th:** We remove the 13th AHV payment after 2025.

(iv) **High BFS Scenario:** We use the "high" population scenario described in Section 2, instead of the reference scenario.

(v) **Low BFS Scenario:** We use the "low" population scenario described in Section 2, instead of the reference scenario.

(vi) **No Baby Bust:** We remove the effect of the end of the retirement of the baby boom. In particular, after 2033 we set the growth of CH Men 65+ to 2.5% and the growth of CH Women 64+ to 1.7%, which are roughly the observed average growth rates over 2008-2022. In contrast, under the reference scenario, these growth rates fall to under 1% by 2040.

Model Uncertainty:

(i) **CPI/Wage Only:** We replace our baseline models of average payments with forecasts based only on the mixed index from 2023 (Equation 3.1).

(ii) **Fixed Abroad:** The number of pensions abroad remains fixed at its 2023 value. This scenario is motivated by the recent flattening of pensions abroad (see Figure 8).

(iii) **Abroad Lags -1:** We shift the lags back one in our baseline model of the number of pensions abroad (column (3) of Table 2).

(iv) **Abroad Lags +1:** We shift the lags forward one in our baseline model of the number of pensions abroad (column (4) of Table 2).

(v) **Abroad Lags -4:** We shift the lags back four in our baseline model of the number of pensions abroad (column (5) of Table 2).

(vi) **Abroad Lags +5:** We shift the lags forward five in our baseline model of the number of pensions abroad (column (6) of Table 2).

(vii) **Other Fraction:** We assume Other payments remain at 5.1% of old-age pension expenditures (the 2023 fraction).

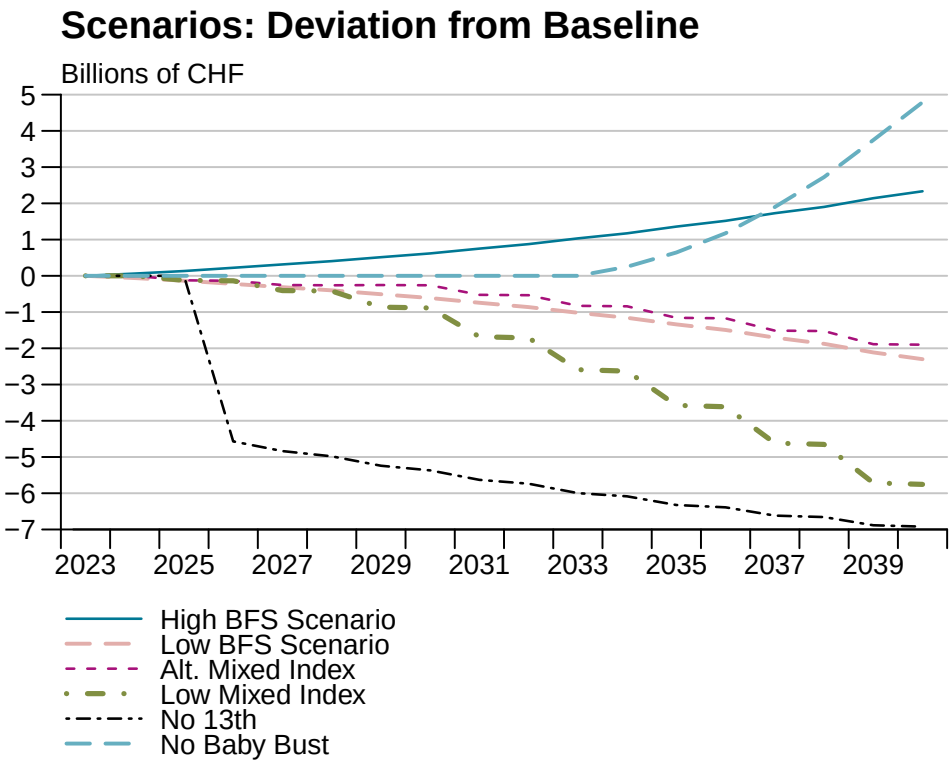


Figure 18: Forecast Scenarios: Population, Legal Changes, and Mixed Index

Figure 18 shows, for the scenarios, the deviation from the baseline (in billions of CHF) over 2023-2040, and Figure 19 shows the final values at 2040. Two alternate assumptions clearly stand out as having the biggest effect on expenditures: removing the tapering of the baby boom retirement after 2033 ("No Baby Bust") and removing the 13th payment ("No 13th"). Without the 13th, expenditure would be almost 7 billion CHF lower by 2040. In contrast, the model suggests that removing the tapering of the baby boom would increase 2040 expenditure by over 4 billion CHF relative to the baseline. One could argue that the tapering of the baby boom is offsetting a substantial fraction of the 13th payment.

The "Alt. Mixed Index" and "Low Mixed Index" scenarios, which assume lower inflation or nominal wage growth than in the baseline, illustrate that AHV expenditure is quite sensitive to assumptions about the mixed index. Our own mixed index forecast cuts almost 2 billion CHF from 2040 expenditure, and the low scenario decreases expenditure by over 5.5 billion CHF in 2040. The reason is that the cost-of-living adjustments compound over time.

Finally, the alternate population scenarios "High" and "Low" yield a symmetric band of roughly $+2.5/-2.5$ billion CHF by 2040, around the baseline.

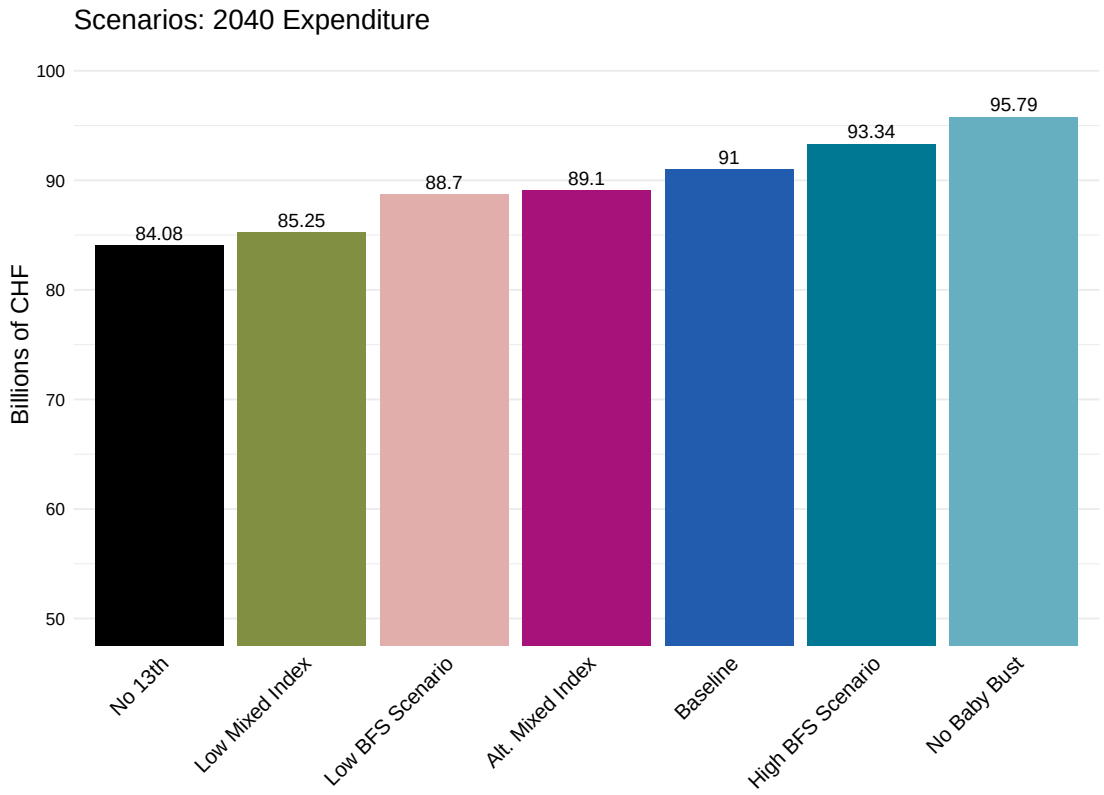


Figure 19: Forecast Scenarios: Population, Legal Changes, and Mixed Index

Turning to model uncertainty (Figures 20 and 21), we see there is less variation by 2040 than with our scenario analysis. In 2040, the band around the baseline ranges from roughly -2 billion CHF to +2 billion CHF. However, the +2 billion estimates come from specifications with relatively worse in-sample fit, so +1 is a more reasonable upper bound for the perturbations we consider. While these numbers are clearly not small in an absolute sense, one could argue that our forecasts are more sensitive to assumptions about the mixed index and the evolution of the Swiss age distribution than to model uncertainty.

Another implication of the model uncertainty analysis is that our forecast appears more sensitive to assumptions about the number of pensions vs. average payments. Ignoring our Swiss Women and Abroad payments models and instead assuming average payments simply follow the mixed index ("CPI/Wage Only"), the effect on expenditure is relatively small by 2030 and less than 1 billion CHF higher in 2040. This is comforting in the sense that, in our opinion, our average payments Abroad model is the least-convincing aspect of our framework.

Perhaps the most interesting aspect of Figure 20 is the variation caused by changing the model of the number of pensions abroad. Our forecast is relatively

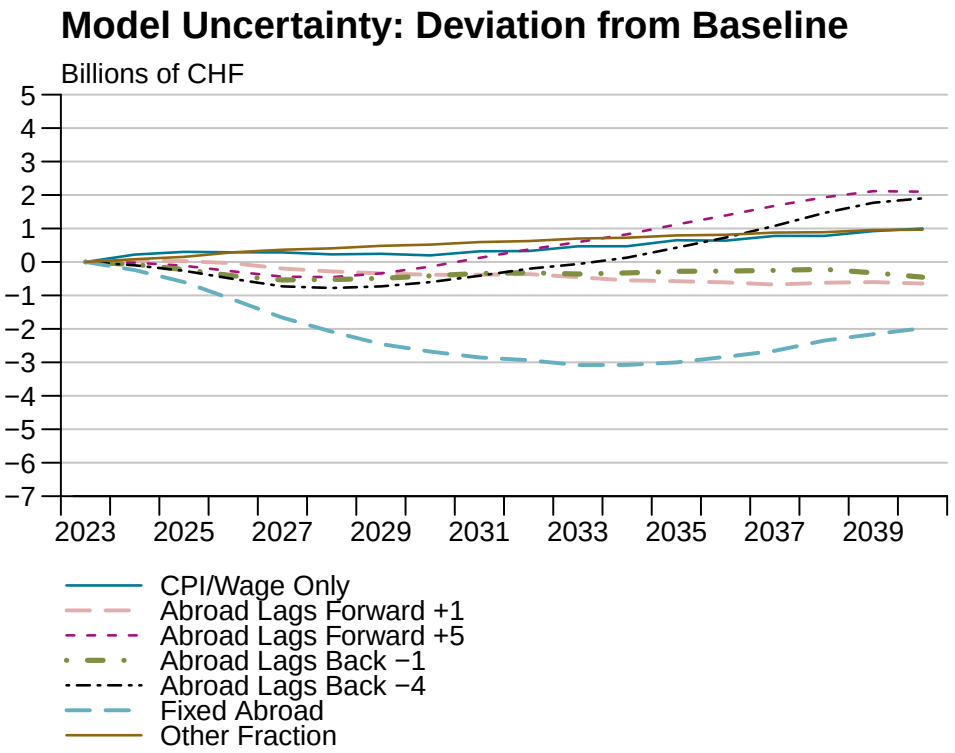


Figure 20: Model Uncertainty

robust to shifting the lags in this part of the model ("Abroad Lags Back -1" and "Abroad Lags Forward +1"). But capping the number of pensions abroad at the 2023 level ("Fixed Abroad"), motivated by the recent flattening in Figure 8, decreases total expenditures by 3 billion CHF in 2033 and 2 billion CHF in 2040.[45] In our model, pensions abroad are driven by lagged emigration and foreign workers, and the recent flattening is a consequence of lower emigration of foreign workers in the 1980s. Ignoring this feature of the model, and assuming the slowing of growth in Abroad pensions is permanent, one misses the effect of emigrations in the 1990s, which we argue have yet to be fully realized in pension data. The takeaway is that, in terms of total expenditure, the model is most sensitive to assumptions about the number of pensions abroad, so this aspect of AHV should be one of the focuses of future research and analysis. That said, we emphasize that the biggest swings in expenditure forecasts come from assumptions about the mixed index and the evolution of the age distribution in Switzerland.

[45] One might argue this is a lower bound, because recent Abroad pension growth has not slowed to actual zero.

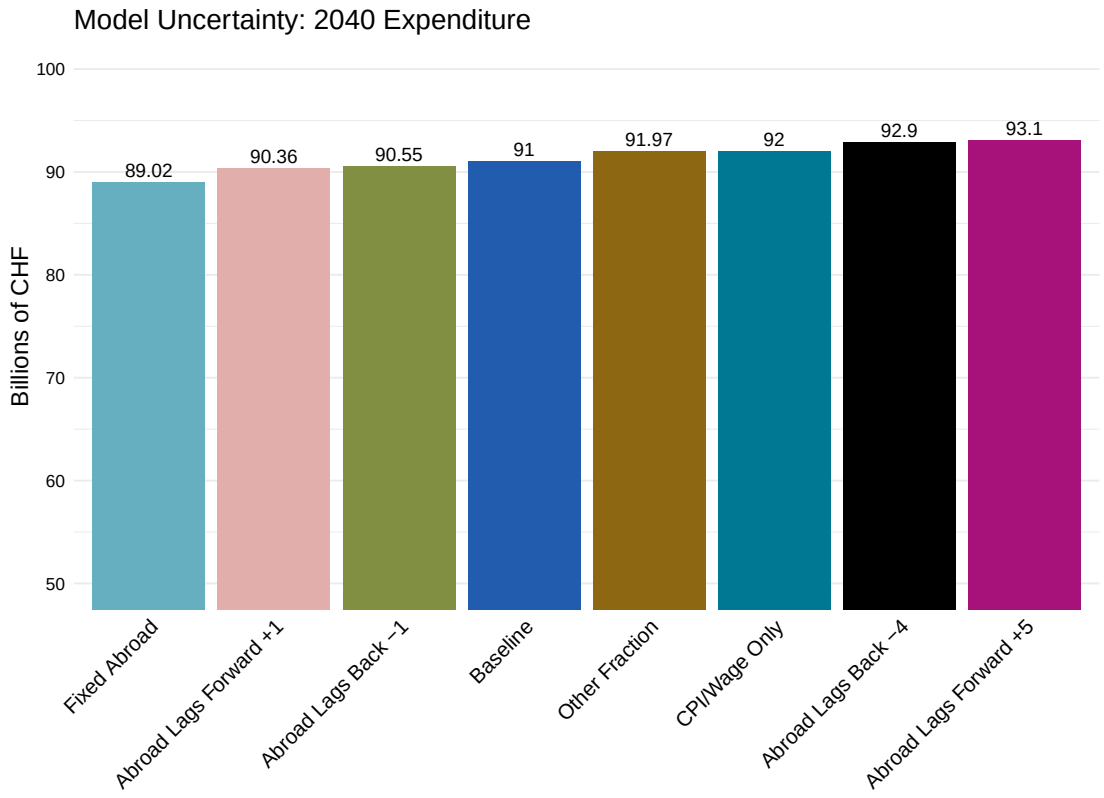


Figure 21: Model Uncertainty

5 Discussion, Recommendations, and Self Assessment

The provision of social security is one of the most important functions of government, both in Switzerland and around the world. The structure and financing of social security affect almost every family, especially those with the greatest needs, so economic research in this area is particularly high stakes. Thus, while the task of attempting to forecast AHV expenditure is a fulfilling challenge, the required precision renders it difficult. We hope that our estimates prove useful in understanding the past and future of AHV expenditures, but we would like to offer here some caveats for interpreting our findings.

The time frame for this project, from initial background research to final report, was just over two months, but many of the weeks contained preexisting (and often overlapping) other commitments for different members of our small team. In short, time was quite tight. Our model and forecasts go beyond a rough back-of-the-envelope, but many more months would have been required to develop and test a fully-convincing framework, both by our own standards and the standards

demanded by the importance of the topic. For example, in the ideal world, we would have spent many more weeks searching for and analyzing historical time series in an exploratory fashion before even attempting to write a model. Indeed, there are probably useful data we missed due to time constraints. And there are features of AHV, the rules surrounding married couples for example, that we simply did not have time to incorporate in the model, despite our initial plans. Another example is related to theory. With limited data, the problem of modeling AHV really demands a more structural model that can accommodate endogenous decisions with respect to early/late retirement, migration, and so on. Such a model would remove some of the burden of the data, help prevent overfitting, and guide interpretation of parameters, but there was not time for us to develop such a model. Quantitative structural models with optimizing agents can take years to implement.

Having to rely on a more empirical, reduced-form modeling approach, the amount of data became the biggest constraint. Annual pension data from 2001-2023 greatly restricts the number of possible explanatory variables and limits the ability to explore the effect of the business cycle, which is likely important for pensions abroad especially. Compounding this problem is the appearance of many trending variables, which present econometric problems even in much larger samples. Our biggest issue was dealing with the lack of data on the stock of former Swiss workers living abroad by age. We attempted to address this problem with lags of migration and foreign worker series, but many variables we considered did not go back far enough.

We conclude with sets of data that would have improved our model and forecast (with the caveat that some of these data may be available and we simply did not find them):

(i) A longer history of aggregated AHV data (average payments and number of pension by sex, residence, and nationality) going back to, say, 1980 would enable regressions with many more explanatory variables and lags and an analysis of the role of business cycles.

(ii) A record of the stock of previous AHV contributors/Swiss workers living abroad (by age) would greatly simplify the task of predicting the number of pensions abroad. Even a handful of years going back a few decades could be sufficient because the full distribution could potentially be reasonably inferred from emigration flows and some other assumptions.

(iii) Longer time series on the economic and demographic characteristics of for-

eign workers and emigrants would be extremely useful for building a better model of average payments paid abroad. Something like, "emigration by age and years spent in Switzerland" going back through the 1970s would have helped us greatly.

(iv) In the aggregate, more detailed data on the average number of contribution years for the sub-categories might have proved to be helpful.

(v) While clearly beyond the scope of our project, in an ideal environment one would start not from heavily aggregated but rather individual data using the full history of contributions for all individuals.

Once again, we hope that our analysis is useful in improving models and forecasts of social security systems.

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A Legal Context: Migration and Pensions Payable Abroad

To better understand how migration affects pension payouts, we document the institutional setting and changes therein over the past decades. This description can be divided into two sections. First, migration policy determines who was able to come to work in Switzerland and hence contribute to the AHV. Second, we document how social security agreements between Switzerland and other countries as well as the European Union (EU) as a whole determine the eligibility and calculation for pension claims.

A.1 Immigration Policy

Swiss immigration law underwent substantial changes over the past fifty years. These changes have affected the degree as well as the composition or type of labor migration into the country, with implications on the pension payments received by immigrants. In the following section, we outline the main features of the legislation in force at different times.

Post-War Period

Due to labor shortages and a booming economy, Swiss migration policy in the post-war period aimed to recruit foreign workers while at the same time avoiding their permanent settlement in Switzerland. However, the so-called rotation model

was abandoned in the 1960s, and migration policy began to pursue an approach that became more open to the integration and assimilation of migrants. As a result, more and more immigrants received a permanent settlement permit and welfare state benefits.

Against this backdrop, a series of initiatives between 1965 and 1988 called for a limit to the number of foreign residents in the country – including the referendum "Schwarzenbach Initiative" in 1970 and the initiative "against foreign infiltration and overpopulation in Switzerland" in 1974. In connection with the political upheavals triggered by the "Schwarzenbach Initiative", the Swiss government decided on a so-called stabilization policy with a global ceiling ("Globalplafond"): immigration was to be slowed down by introducing annual immigration quotas and restricting the rights of immigrants, e.g. when changing jobs and place of residence. In 1974/75, the recession led to a decline in labor migration. By the early 1980s, the absolute number of foreign nationals in Switzerland had fallen significantly (Riaño and Wastl-Walter, 2005; Vuilleumier, 2015; Huter, 2021).

1980s: Global Ceiling Rule

Under the global ceiling rule, foreigners wishing to take up employment in Switzerland needed a residence permit, which in turn required having a job lined up before entering the country (hence, in practice, there was no real distinction between residence and work permits). The quota system gave preference to domestic workers (Swiss nationals and persons with permanent residence, i.e., a C permit). Permits for first-time employment, job changes, and extensions could only be issued if no domestic workers could be found for the job (Sheldon, 2007, p.13; Can et al., 2013, p. 9).

The quotas were set annually by the Federal Council and consisted of a maximum of new residence permits for the whole of Switzerland. They were calculated on the basis of expected departures and set in such a way that the proportion of foreigners would remain constant (Sheldon, 2007, p. 11). There were separate quotas for seasonal, short-term, and annual residents. However, the quotas did not include seasonal workers who made use of the right to convert to an annual residence permit nor people who entered the country as part of family reunification and then applied for a work permit (Sheldon, 2007, p. 12). Renewals of annual residence permits were also not subject to the maximum numbers. According to Sheldon, 2007, in the 1980s and 1990s, only one-fifth of newly arriving foreigners were therefore subject to quotas.

Every 12 months, the Federal Council decided on an annual quota for the admission of new workers. This was based on the Ordinance on the Limitation of the Number of Foreign Nationals (Verordnung über die Begrenzung der Zahl von Ausländern, BVO). The quota was the result of an extensive annual consultation process between the federal government, cantons, employers' organizations, and trade. The final decision was made by the Federal Council or the Federal Administration. The ordinance was presented in October and came into force on November 1. The ministry of economics (formerly named Bundesamt für Industrie, Gewerbe und Arbeit, BIGA) first allocated some of the quotas directly to the cantons and companies that had a shortage of workers and had submitted an application. A second quota was then allocated to the cantons, who would allocate it to the companies in the canton on their own authority (Mahnig and Piguet, 2003, p.80 ff.).

1991: Introduction of the Three-Circles-Model

In the 1990s, Switzerland sought closer ties with the EU and took measures to facilitate immigration from EU member states. Immigration from other countries was severely restricted in order to offset concerns about "foreign infiltration." In 1991, the so-called three-circle model was introduced. It regulated the admission of labor migrants on the basis of their country of origin and their alleged "cultural proximity". "Culturally close" foreign nationals were described as more likely to adapt to Swiss culture than "culturally distant" foreign nationals, who were considered less likely to assimilate. Foreigners were divided into three different groups on this basis: while labor migrants from EU and EFTA states ("first circle") were given preference, the number of labor migrants from countries in the "second circle" (e.g. USA, Canada, Central and Eastern European states) was limited. Immigration from all other countries ("third circle") was restricted to highly qualified workers.

In 1998, the three-circle model was abandoned and replaced by a dual admission system. It continued to privilege immigration from EU and EFTA states and limited immigration from third countries. The Federal Act on Foreign Nationals (Bundesgesetz über die Ausländerinnen und Ausländer, AuG), which came into force in 2008, maintained this dual admission model. To this day, labor migration from third countries is limited to highly qualified workers.

2002: Agreement on the Free Movement of Persons from EU/EFTA Countries

The Agreement on the Free Movement of Persons (Personenfreizügigkeitsabkommen FZA) was signed between the European Union (EU) and Switzerland on June 21, 1999. In 2000, the "Bilaterals I" treaty package that contained the FAZ was approved by the Swiss electorate. As a result, the Agreement on the Free Movement of Persons from the EU-15 states[46] came into force in 2002.

In the following years, the right to free movement was extended to the newly acceded EU states with additional protocols. In 2006, it was granted to citizens of the states that had joined the EU in 2004.[47] In 2009, the protocol was extended to Bulgaria and Romania (Protocol II), who joined the EU in 2007, with a transition period until 2019 during which immigration from these countries was controlled through annual quotas (Bundesrat, 2019). The extension of the FZA to Croatia, who joined the EU in 2013, was negotiated in a new Protocol III. While the FZA has also been applicable to Croatia since 2017, the Federal Council reintroduced quotas for Croatian immigrants who wished to take up gainful employment in Switzerland. These were lifted in 2022 but reintroduced in 2023 due to the strong increase of immigration from Croatia in 2022. Since January 1, 2023, both the short-term residence permit L and the residence permit B have therefore been subject to quotas for Croatian workers (SEM, 2021).

Under the FZA, immigrants from EU/EFTA countries must find a job or have sufficient financial resources as a non-employed person in order to stay in Switzerland.

A.2 International Pension Payments

Foreigners residing in Switzerland can claim their pension in Switzerland just like Swiss citizens. The AHV pension can also be paid abroad, but exactly what rules apply depends on nationality (not the country of residence). For a pension to be payable abroad, an agreement with the native country is required. Accordingly, two groups of citizenship can be distinguished, those from a country with an agreement in vigor (Group A) and those from a country without such an agreement (Group B). Within Group A, citizens of EU/EFTA countries hold a special place, as they fall under a multilateral agreement.

[46] Belgium Denmark, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Spain, the United Kingdom, and Sweden.

[47] Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, Slovakia, and the Czech Republic.

Whether the pension can be exported does depend on whether an agreement with the native country is in place, but not where the person lives at the time of retirement: they can retire in Switzerland and only then move abroad and have their pension exported, or they can move abroad before reaching retirement and start claiming the Swiss AHV pension abroad once they reach the legal Swiss pension age (or two years earlier at most).

Importantly, in all cases only the Swiss contribution years will be taken into account when calculating the pension. Even under the existence of a social security agreement, contribution years from another country cannot be credited towards the Swiss AHV pension.[48] Furthermore, AHV supplementary benefits or personal independence payments (Ergänzungsleistungen or Hilflosenentschädigung) are paid out only to individuals residing in Switzerland.

Group A: Swiss or EU/EFTA Citizenship and Citizenship of Countries with Bilateral Agreements

The right to freedom of movement under the PFZA is supplemented by the mutual recognition of professional qualifications and the coordination of social security systems. The same regulations apply to nationals of EFTA countries. Hence, Swiss as well as EU/EFTA nationals have the right to draw their Swiss AHV pension abroad. For foreign citizens that fall under the PFZA or another bilateral agreement, including the country-by-country agreements in place with European countries before the introduction of the PFZA, pensions can be exported from the date on which the respective agreement came into force.

Table 4 shows all the social security agreements Switzerland holds with other countries. Panel A) lists the agreements with EU/EFTA countries before the PFZA came into force, or before they joined the EU, respectively.[49]

An agreement on social insurance had also been in place with the former Federal People's Republic of Yugoslavia since the early 1960s (agreement of June 8, 1962), which also provided for the export of pensions. The social security agreement with former Yugoslavia from 1962 was no longer applied in relation to Kosovo as of April 1, 2010. Until the new Swiss agreement with Kosovo came into force in 2019, Kosovo was subsequently a non-contracting state and Kosovar nationals could only request the reimbursement of contributions when leaving Switzerland

[48] Under the agreement with Turkey, it is possible to export the Swiss contributions into the Turkish pension system. Prior to the introduction of the PFZA, this was also the case for Italy and Greece.

[49] Appendix Table 6 lists all EU countries and the date when they joined.

(see details on Group B below).

Agreements with non-EU/EFTA countries are listed in Panel B) of Table 4. Furthermore, a few countries are currently under negotiation for an agreement (Panel C) of Table 4).

Group B: Citizenship of Countries without Bilateral Agreements

If Switzerland does not have a social security agreement with the native country, the entitlement to the Swiss AHV pension is lost once a person without Swiss citizenship settles abroad permanently. However, these persons are entitled to receive an interest-free refund of their contribution payments, including contributions made by the employer. If pension payments have already been received in Switzerland, these will be deducted from the refund.[50]

Table 4: Social Security Agreements

Country	Initial Date	Supplements/Updates
Panel A) EU/EFTA Countries		
Italy	Sep 1964	Jul 1973, Feb 1974, Feb 1982
Germany	May 1966	Nov 1976, Apr 1990
Austria	Jan 1969	Jul 1974, Dec 1979, Jan 1990, July 1998
Spain	Sep 1970	Nov 1983, Aug 1990
Netherlands	Jul 1971	Apr 1987
Greece	Dec 1974	
France	Nov 1976	
Portugal	Mar 1977	Nov 1995
Belgium	May 1977	
Sweden	Mar 1980	1986
Norway	Nov 1980	Aug 1985
Denmark	Dec 1983	Oct 1986, Dec 1997
Finland	Oct 1986	
Liechtenstein	May 1990	Nov 1996, Aug 2002
UK	Apr 1996	Nov 2021
Cyprus	Jan 1997	EU-member: 2004

[50] See: https://www.ch.ch/en/retirement/oasi-pension-abroad#further-information.

Country	Initial Date	Supplements/Updates
Czech Republic	Jan 1997	EU-member: 2004
Slovenia	Aug 1997	EU-member: 2004
Slovakia	Dec 1997	EU-member: 2004
Croatia	Jan 1998	EU-member: 2013
Hungary	Jan 1998	EU-member: 2004
Ireland	Jul 1999	
EU/EFTA	**June 2002**	**May 2004, an 2007, Jul 2013**
Bulgaria	Dec 2007	EU-member: 2007
Panel B) Non EU/EFTA Countries		
Turkey	Jan 1972	June 1981
San Marino	1983	
Israel	Oct 1985	
Canada & Quebec	Oct 1995	
Chile	Mar 1998	
North Macedonia	Jan 2002	
Philippines	Mar 2004	
Australia	Jan 2008	
Japan	Mar 2012	
USA	Aug 2014	
Uruguay	Apr 2015	
Serbia	Jan 2019	
Montenegro	Jan 2019	
Kosovo	Sep 2019	
Brazil	Oct 2019	
Bosnia and Herzeg.	Sep 2021	
Panel C) Countries Currently Under Negotiation		
Argentina		
Ecuador		
Peru		
Moldova		

A.2.1 Special Case I: Asylum Seekers, Temporarily Admitted Persons, and Refugees

Asylum seekers, temporarily admitted persons, persons with protection status S, and recognized refugees are entitled to a pension if they have paid contributions (i.e., at least the minimum contribution) for at least one full year, or if they can be credited with child-raising or care credits for at least one full year. Once they take up gainful employment, they start paying regular contributions.

Although the obligation to pay contributions for asylum seekers and persons with protection status S, respectively, who are not gainfully employed in principle applies from the time they take up residence in Switzerland, the contributions are suspended while they are not gainfully employed. The contributions are only determined and levied once they:

- are recognized as refugees,
- receive a residence permit,
- are entitled to AHV or IV benefits.[51]

In the latter cases, contributions are levied retroactively from the date of taking up residence, subject to the 5-year limitation period (Art. 16 para. 1 AHVG). The corresponding contributions and contribution periods then form the basis for calculating the corresponding pension benefit.

Refugees and Stateless Persons may have their AHV pension paid abroad if they leave Switzerland. For refugees, whether they can have the pension paid abroad does not depend on their citizenship, but on the country in which they take up residence. Hence, to receive the payments abroad, they must take up residence in a contracting state (see Table 4). If they reside in a non-contracting state, they can only apply for reimbursement of their AHV contributions (see Appendix 1 of the directives on the reimbursement of contributions paid to the AHV in accordance with Art. 18 para. 3 AHVG and the RV-AHV).

Currently, around 2.4 million foreign nationals live in Switzerland. According to the State Secretariat for Migration (SEM), around 220,000 of these were in the asylum system at the end of 2023. Of these, 81,000 are recognized refugees and 45,000 are temporarily admitted.[52] There were also 19,000 asylum seekers whose asylum procedure was still pending. Finally, 66,000 people with protection status S from Ukraine are also included in these numbers.

[51] Art. 14 para. 2bis AHVG. Also see https://sozialesicherheit.ch/de/asylbereich-wer-hat-anspruch-auf-leistungen-der-ersten-saeule/ for more detials.

[52] For example, people who cannot return to their country due to civil war but are not recognized refugees within the meaning of the Asylum Act.

Country	N	% of all foreigners
Eritrea	30,403	1.3%
Syria	13,882	0.6%
Turkey	10,045	0.4%
Afghanistan	5,610	0.2%
Sri Lanka	4,769	0.2%
Iraq	2,096	0.1%
Somalia	1,798	0.1%
Iran	1,584	0.1%
Bosnia and Herzegovina	1,071	0.0%
Stateless	1,085	0.0%
Other	8,636	0.4%
Total	80,979	3.4%

Table 5: Recognized Refugees, 2023

A.2.2 Special Case II: Seasonal Workers

Seasonal workers were allowed to stay in Switzerland only up to 9 months within a calendar year. The months during which seasonal workers were gainfully employed in Switzerland and paid contributions are counted as contribution periods. Therefore, if a seasonal worker left Switzerland again after their seasonal residence permit expired (9 months), the 9 months are taken into account, even if the amount of OASI contributions paid would be high enough to cover the entire year. From 1964, the seasonal permit was transformed into an annual permit for Italians after five *consecutive* seasons. This innovation was extended to nationals of other countries in 1976. The possibility to obtain a full-year permit after 5 consecutive seasons was therefore an important improvement regarding the AHV coverage of seasonal workers (although it is not clear how many seasonal workers benefited from this in practice, as they still depended on getting a job for the year).

If a seasonal worker did not leave Switzerland after their residence permit expired and stayed illegally in the country, but continued to work in Switzerland and paid AHV contributions, the corresponding additional months are also taken into account. Contributions from "illegal employment" are therefore also taken into account as long as the corresponding contributions were paid.[53]

The calculation of the pension benefits follows the standard procedure described above, i.e., benefits depend on the average reference income (adjusted for inflation) and the number of contribution years. Payments abroad are possible if a social security agreement is in place.

[53] See, e.g., judgment of the Federal Supreme Court I 628/04 20.12.2005, E 3.4.

The proportion of seasonal workers in the working foreign population tended to decrease: in 1957 it was 26.5%, in 1967 19.7%, in 1977 10.3% and in 1987 13.9%. In 1967 there were 153,510 seasonal workers (83.3% of whom were Italian), in 1977 only 67,280 (37% Italian, 26.8% Yugoslavian, 23.3% Spanish), in 1987 again 114,640 (30.3% Yugoslavian, 28.1% Portuguese). In 1997, their number was only 28,000 (Arlettaz, 2012).

A.2.3 Special Case III: Cross-Border Commuters

People who are gainfully employed in Switzerland are generally subject to the Swiss social security system, even if they live abroad. Hence, cross-border commuters (who typically exit the country every night to return home), are subject to the same conditions as any worker living in Switzerland.

The number of cross-border commuters is subject to business cycle fluctuations, but has been steadily increasing over time, as can be seen from Figure 22. Figure 23 further shows the composition of cross-border commuters. While the share of Germans has been relatively stable over time, the share of cross-border commuters from France has been increasing at the expense of cross-border commuters from Italy (Source: Kreis, 2007). Note that in the Lac Léman region many cross-border commuters are of nationalities other than French (including Swiss).

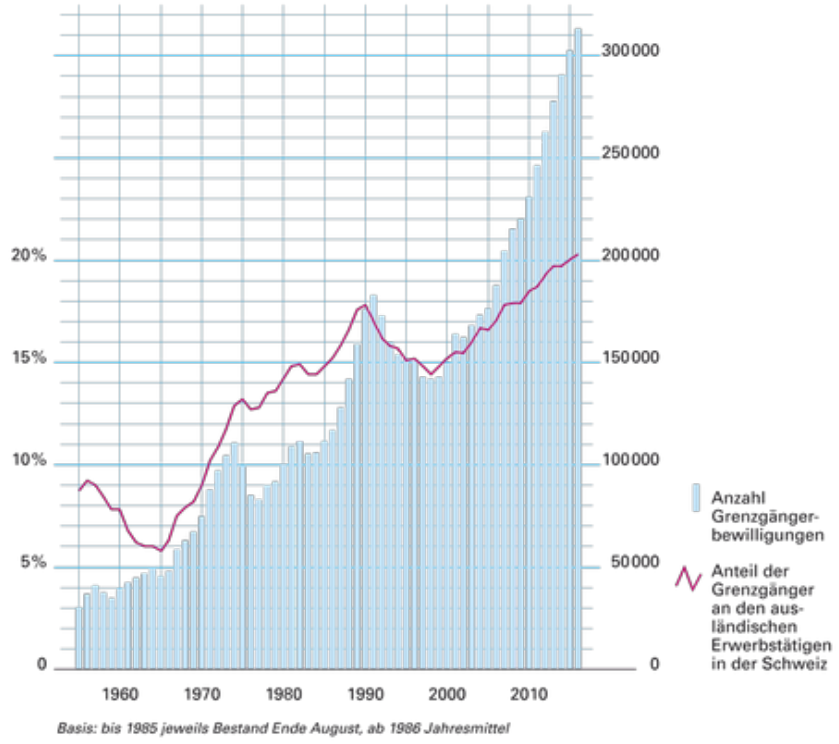


Figure 22: Cross-Border Commuters in the Swiss Labor Force

Source: Kreis, 2007.

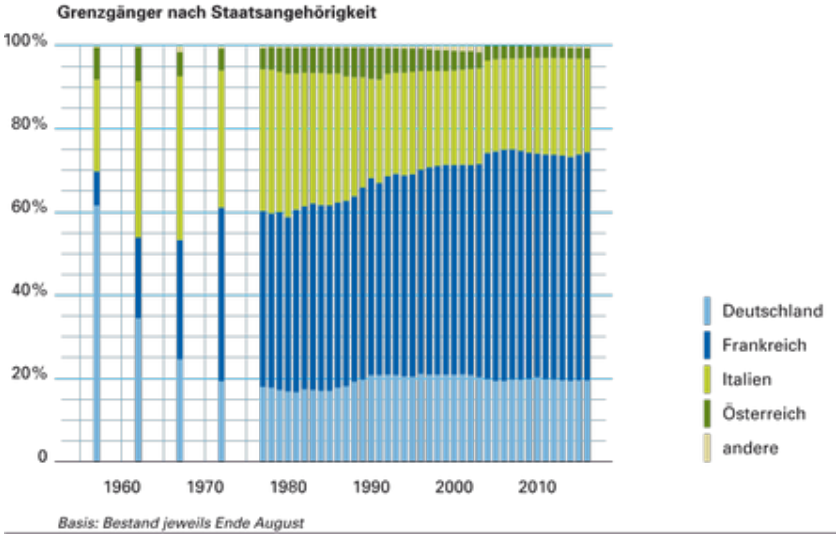


Figure 23: Composition of Cross-Border Commuters in the Swiss Labor Force

Source: Kreis, 2007.

A.3 Additional Historical and Legal Details

Table 6: EU Member Countries by Date of Joining

Country	Date of Joining
Founding Members (1958)	
Belgium	January 1, 1958
France	January 1, 1958
Germany (as West Germany)	January 1, 1958
Italy	January 1, 1958
Luxembourg	January 1, 1958
Netherlands	January 1, 1958
First Enlargement (1973)	
Denmark	January 1, 1973
Ireland	January 1, 1973
UK[54]	January 1, 1973
Southern Enlargement (1981 and 1986)	
Greece	January 1, 1981
Portugal	January 1, 1986
Spain	January 1, 1986
Northern Enlargement (1995)	
Austria	January 1, 1995
Finland	January 1, 1995
Sweden	January 1, 1995
Eastern Enlargement (2004)	
Cyprus	May 1, 2004
Czech Republic	May 1, 2004
Estonia	May 1, 2004
Hungary	May 1, 2004
Latvia	May 1, 2004
Lithuania	May 1, 2004
Malta	May 1, 2004
Poland	May 1, 2004
Slovakia	May 1, 2004
Slovenia	May 1, 2004
Further Enlargement (2007)	

[54]Left the EU on January 31, 2020

Country	Date of Joining
Bulgaria	January 1, 2007
Romania	January 1, 2007
Latest Enlargement (2013)	
Croatia	July 1, 2013

EU/EFTA Coordination of Social Security Schemes

Agreement between the Swiss Confederation and the European Community and its Member States on the free movement of persons.

Art. 8 Coordination of social security schemes

The Contracting Parties shall regulate the coordination of social security schemes in accordance with Annex II, in particular to ensure the following:

a) equal treatment;

b)determination of the applicable legislation;

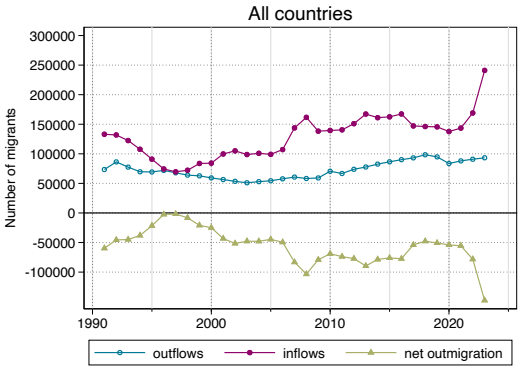
c) aggregation of all periods of insurance taken into account under the various national legislations for the acquisition and retention of the right to benefits and for the calculation of benefits;

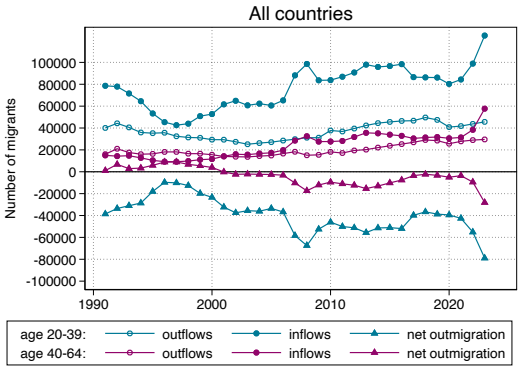
d) payment of benefits to persons resident in the territory of the Contracting Parties;

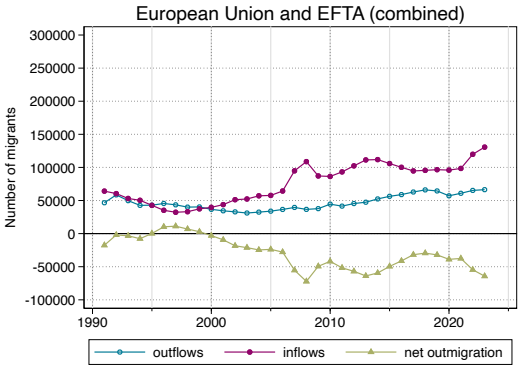
e) administrative assistance and cooperation between the authorities and institutions.

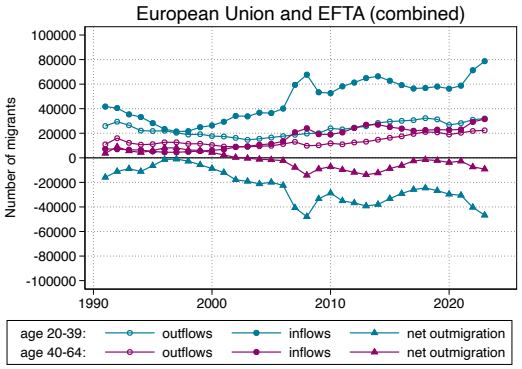
A.4 Immigration and Emigration by Country / Region

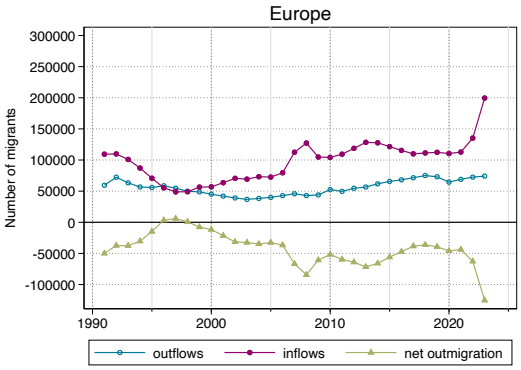
Figure 24 below shows the migration patterns for regions of the world and the most important origin countries of Swiss immigration. Beyond age 64, migration flows are typically very, very small. Migration flows are largest for the age groups 20-39 and 40-64, respectively. The flows of minors typically track the flows of the age group 20-39. Regions from which migration flows are driven by wars and conflict (see Former Yugoslavia, Ukraine, and to some degree also Turkey in recent years) typically include more minors.

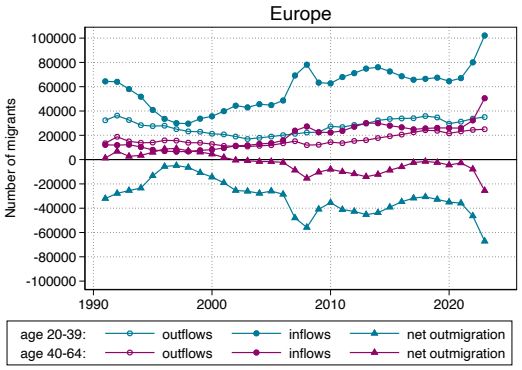

All countries
Number of migrants
300000
250000
200000
150000
100000
50000
0
-50000
-100000
1990
2000
2010
2020
outflows
inflows
net outmigration

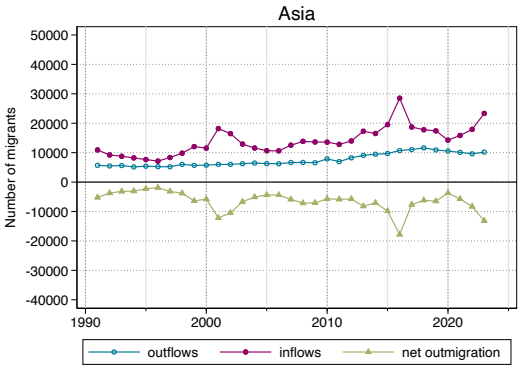

All countries
Number of migrants
100000
80000
60000
40000
20000
0
-20000
-40000
-60000
-80000
-100000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

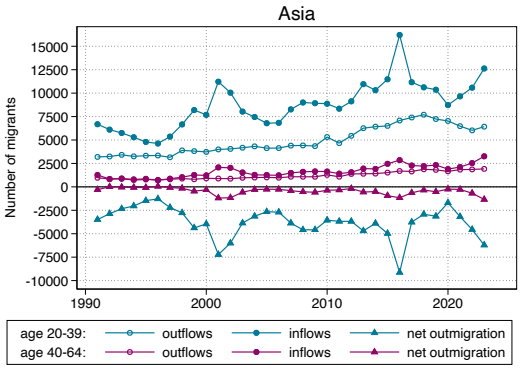

European Union and EFTA (combined)
Number of migrants
300000
250000
200000
150000
100000
50000
0
-50000
-100000
1990
2000
2010
2020
outflows
inflows
net outmigration

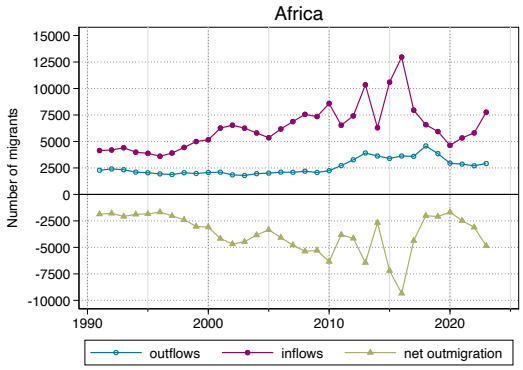

European Union and EFTA (combined)
Number of migrants
100000
80000
60000
40000
20000
0
-20000
-40000
-60000
-80000
-100000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

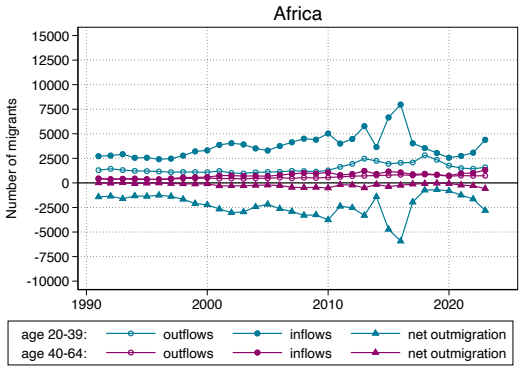

Europe
Number of migrants
300000
250000
200000
150000
100000
50000
0
-50000
-100000
1990
2000
2010
2020
outflows
inflows
net outmigration

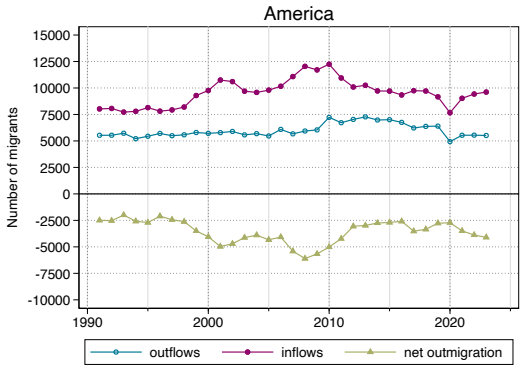

Europe
Number of migrants
100000
80000
60000
40000
20000
0
-20000
-40000
-60000
-80000
-100000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

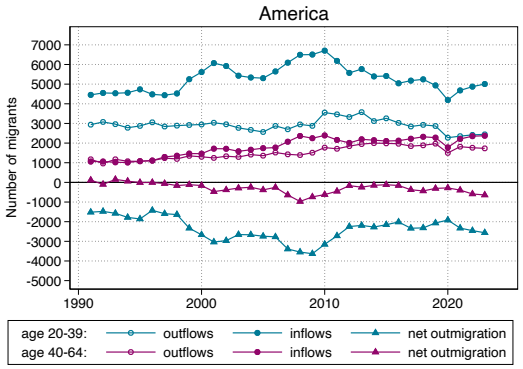

Asia
Number of migrants
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1990
2000
2010
2020
outflows
inflows
net outmigration

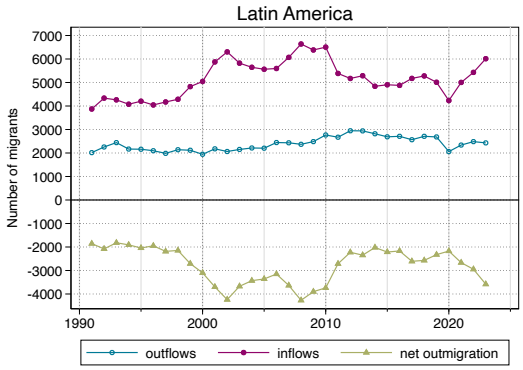

Asia
Number of migrants
15000
12500
10000
7500
5000
2500
0
-2500
-5000
-7500
-10000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

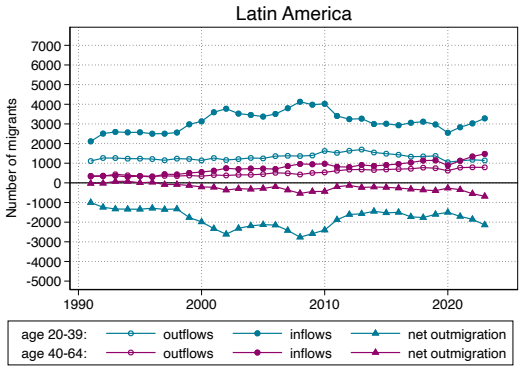

Africa
Number of migrants
outflows
inflows
net outmigration

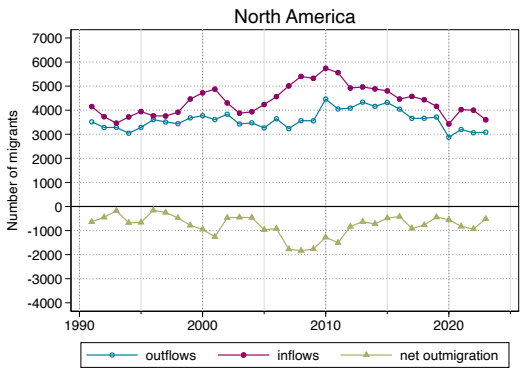

Africa
Number of migrants
age 20-39:
age 40-64:
outflows
inflows
net outmigration

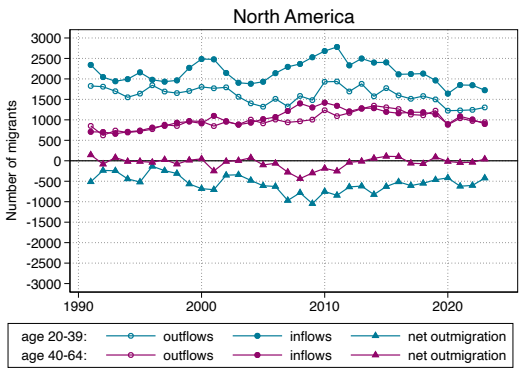

America
Number of migrants
outflows
inflows
net outmigration

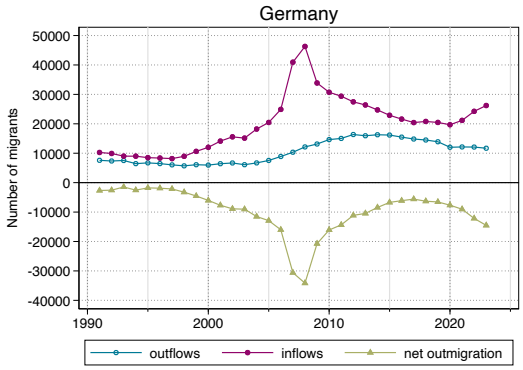

America
Number of migrants
age 20-39:
age 40-64:
outflows
inflows
net outmigration

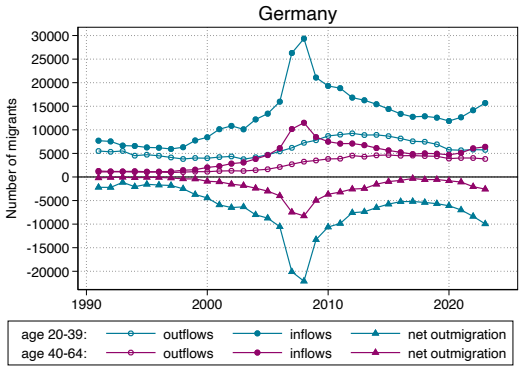

Latin America
Number of migrants
outflows
inflows
net outmigration

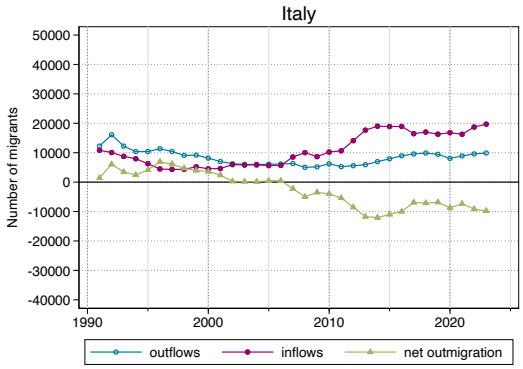

Latin America
Number of migrants
age 20-39:
age 40-64:
outflows
inflows
net outmigration

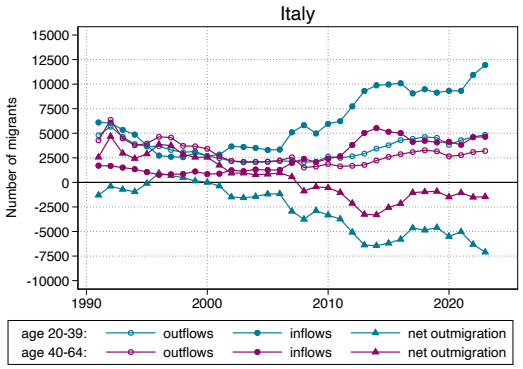

North America
Number of migrants
outflows
inflows
net outmigration

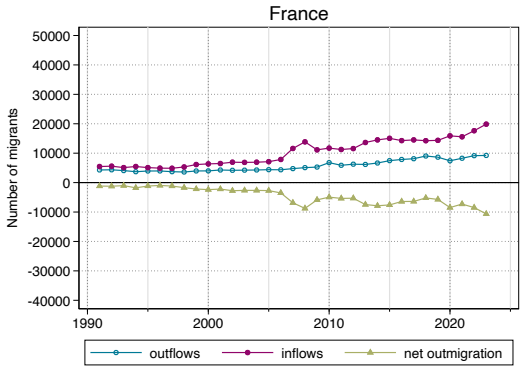

North America
Number of migrants
age 20-39:
age 40-64:
outflows
inflows
net outmigration

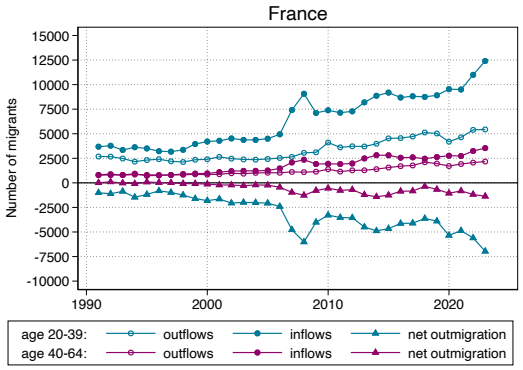

Germany
Number of migrants
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1990
2000
2010
2020
outflows
inflows
net outmigration

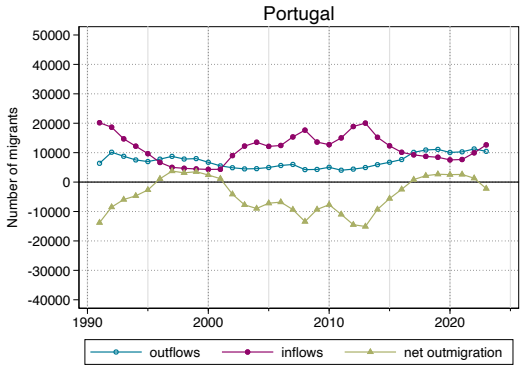

Germany
Number of migrants
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

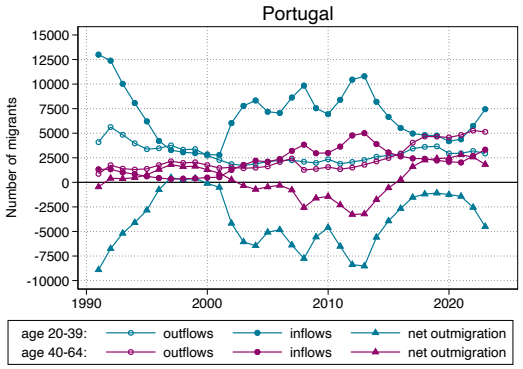

Italy
Number of migrants
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1990
2000
2010
2020
outflows
inflows
net outmigration

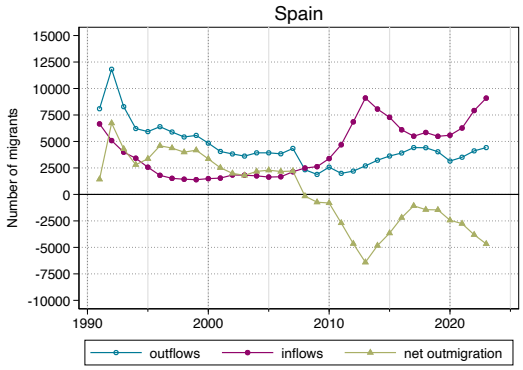

Italy
Number of migrants
15000
12500
10000
7500
5000
2500
0
-2500
-5000
-7500
-10000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

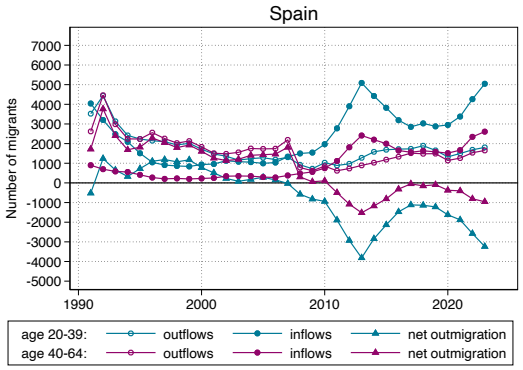

France
Number of migrants
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1990
2000
2010
2020
outflows
inflows
net outmigration

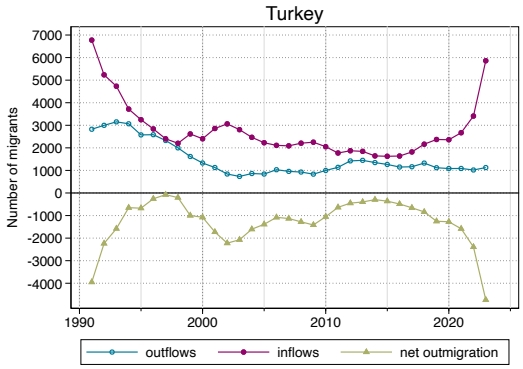

France
Number of migrants
15000
12500
10000
7500
5000
2500
0
-2500
-5000
-7500
-10000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

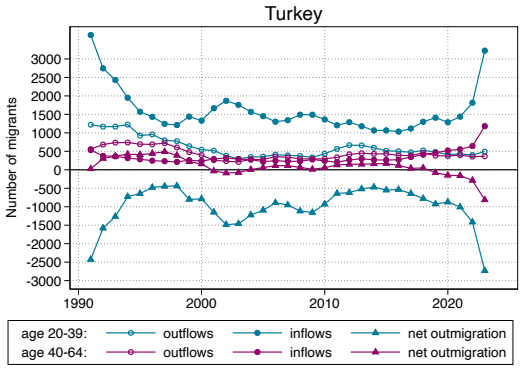

Portugal
Number of migrants
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1990
2000
2010
2020
outflows
inflows
net outmigration

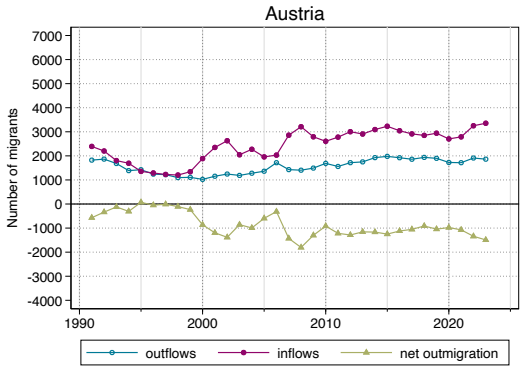

Portugal
Number of migrants
15000
12500
10000
7500
5000
2500
0
-2500
-5000
-7500
-10000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

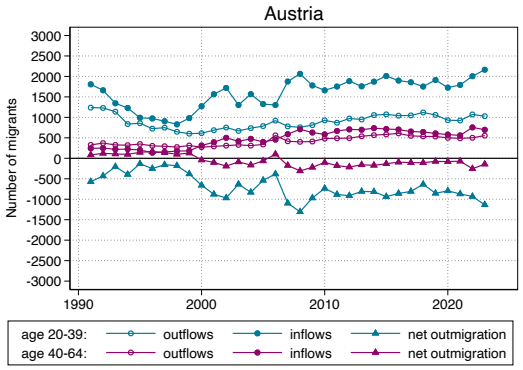

Spain
Number of migrants
15000
12500
10000
7500
5000
2500
0
-2500
-5000
-7500
-10000
1990
2000
2010
2020
outflows
inflows
net outmigration

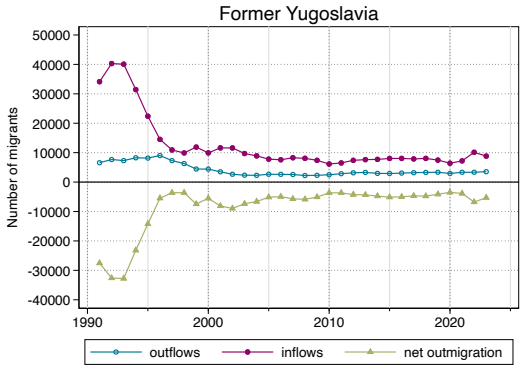

Spain
Number of migrants
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

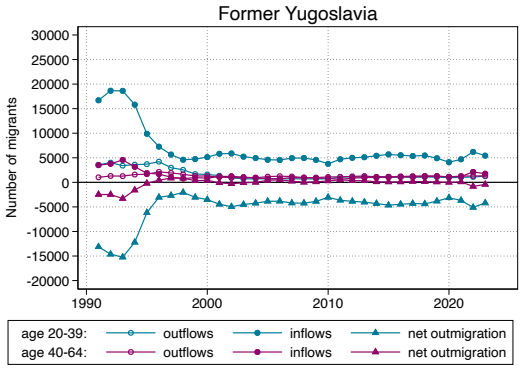

Turkey
Number of migrants
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
1990
2000
2010
2020
outflows
inflows
net outmigration


Turkey
Number of migrants
3000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-3000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration


Austria
Number of migrants
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
1990
2000
2010
2020
outflows
inflows
net outmigration


Austria
Number of migrants
3000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-3000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration


Former Yugoslavia
Number of migrants
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
1990
2000
2010
2020
outflows
inflows
net outmigration


Former Yugoslavia
Number of migrants
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
1990
2000
2010
2020
age 20-39:
age 40-64:
outflows
inflows
net outmigration

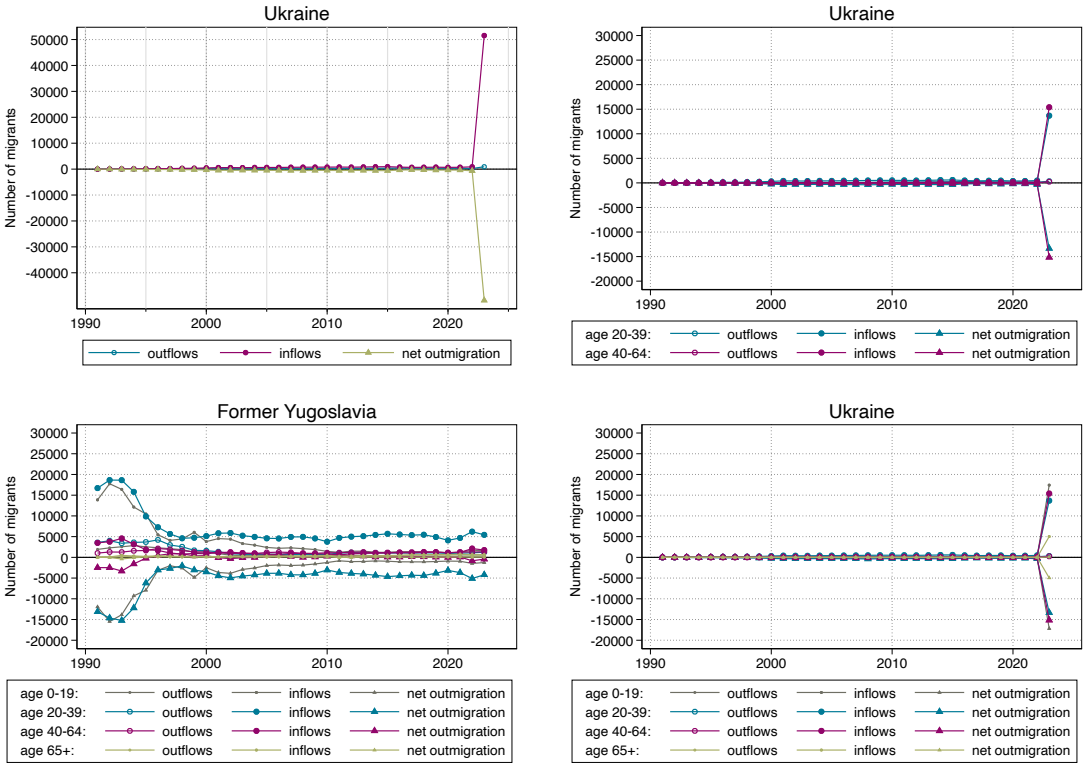


Figure 24: Migration Flows by Country/Region and Age

Source: BFS. Einwanderung/Auswanderung der ständigen ausländischen Wohnbevölkerung nach detaillierter Staatsangehörigkeit, Geschlecht und Alter.

B Replication Materials

Model calculations were performed in R version 4.4.1 (2024-06-14 ucrt), Rstudio 2024.04.2 Build 764. Replication files are contained in KOF_AHV_final_28_10_2024.zip.

The program consists of three .R files and one EXCEL file:

(i) AHV_model1.R: a flexible script that calibrates the model based on empirical estimates and produces the model results under various assumptions

(ii) Scenarios.R: an outer program that runs the model many times under different assumptions to compare graphically

(iii) Func_AHV.R: a function version of AHV_model1.R called by Scenarios.R, for comparing across runs graphically

(iv) AHV_data_11_09_2024.xlsx: the underlying data

Our code uses the following R libraries:

(i) ggplot2: 3.5.1

(ii) tidyr: 1.3.1

(iii) patchwork: 1.2.0

(iv) writexl: 1.5.0

(v) readxl: 1.4.3

(vi) reshape2: 1.4.4

(vii) scales: 1.3.0

(viii) stargazer: 5.2.3

(ix) dplyr: 1.1.4

(x) tstools: 0.4.3

(xi) kofvja: 1.2.4

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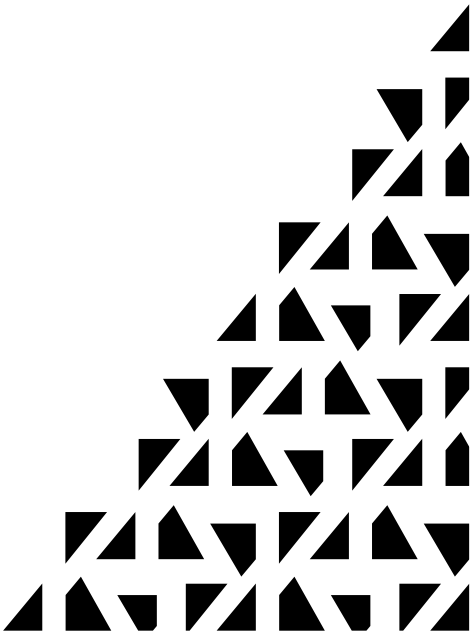

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