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The Asymmetric Unemployment Response of Natives and Foreigners to Migration Shocks*

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Abstract: *This paper provides new evidence on the macroeconomic effects of net migration shocks in Germany using monthly data from 2006 to 2019 and a variety of identification strategies in a structural vector autoregression. Migration shocks are expansionary, increasing persistently industrial production, per capita net exports and tax revenue. In the labor market, they boost persistently job openings and, after a year and a half, hourly wages in manufacturing. Unemployment falls persistently for natives, driving a decline in total unemployment, while it rises for foreigners. Our analysis disentangles the effects of job-related migration from OECD countries and migration (including refugees) from less developed economies. Using also quarterly data in a mixed-frequency SVAR, we shed light on the employment and participation responses for natives and foreigners. Taken together, our results highlight a job-creation effect for natives and a job-competition effect for foreigners. The mixed-frequency SVAR also shows that migration shocks increase per capita GDP, investment and hourly wages of the aggregate economy.*

JEL classification codes: *C11, C32, E32, F22, F41.*
Keywords: *Migration, unemployment, job creation, job competition, mixed-frequency SVAR.*

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1 Introduction

What is the macroeconomic impact of migration in the second-largest destination for migrants after the United States? In 2018, approximately 20.8 million people, or equivalently one in four, in Germany had a migrant background according to the microcensus results of the Federal Statistical Office (Destatis).[1] Immigration is a key determinant of changes in labor supply and, currently, the only source of population growth in the German economy, where unemployment has remained remarkably low in recent years.[2] This paper provides new macroeconometric evidence on the expansionary effects of net migration shocks in Germany and the asymmetric unemployment response between natives and foreigners to these shocks.

Understanding better the migration effects in the labor market and the macroeconomy is crucial for migration policy design and can also help to curb the rise in xenophobic movements. While a large literature has analyzed the impact of immigration on employment and wages using disaggregate data, the migration literature in the context of macroeconometric models is still limited due to a lack of data at high frequency over sufficiently long time. Interestingly, such data is available for Germany. Destatis has been collecting monthly data on the arrivals of foreigners (i.e., non-Germans) by country of origin on the basis of population registers at the municipal level since 2006. Registration is obligatory by the registration law of March 2002 ("Melderechtsrahmengesetz") and is necessary to obtain the income tax card required to sign any employment contract or to issue an invoice as self-employed, and also to rent an apartment.

Using monthly data on net migration flows for the period 2006:1-2019:10, we identify net migration shocks in a structural vector autoregression (SVAR) model using the Cholesky decomposition, traditional sign restrictions and mixed (sign and narrative) restrictions. Our analysis places special focus on the response of unemployment, which theoretically is ambiguous, depending on various channels, for instance how fast migrants enter the labor market and whether they do so as employed or as job seekers. In addition, if natives and immigrants are imperfect substitutes in production, increasing inflows exert stronger labor market competition on earlier immigrants than on natives.[3] Furthermore, there is potentially a job-creation effect stemming from the increase in both demand and labor supply, which can reduce unemployment.

We find that net migration shocks have expansionary effects in Germany, increasing industrial production, per capita net exports and tax revenue. The response of inflation appears statistically non-significant, but a subsample analysis reveals that this result comes from a combination of a positive response to job-related migration shocks from OECD countries and a negative response to migration shocks from less developed areas of the world, such as Africa.

[1] A migrant background refers to having at least one parent who did not acquire German citizenship by birth. Naturalization rates have been low so that immigrants' offsprings often do not have the German citizenship.

[2] The strong decline in German unemployment from 2005 onwards and the exceptionally small increase during the Great Recession have been associated with the earlier labor market ("Hartz") reforms.

[3] Natives and immigrants are typically employed in different occupations, which makes them imperfect substitutes in production (Ottaviano and Peri (2012), Manacorda, Manning, and Wadsworth (2012), Llull (2018)). Usually, immigrants (natives) have a comparative advantage in manual-intensive (language-intensive) tasks.

In the former case, a demand effect seems prevalent while in the latter case, where migration is predominantly low-skilled and often political in nature (including refugees), a supply effect prevails. Furthermore, once we include Syrian flows in our baseline net migration variable, we find that migration shocks are disinflationary, thus behaving like typical supply shocks.[4]

In the labor market, migration shocks boost job openings persistently and, after a year and a half, hourly wages in the manufacturing sector, while they reduce unemployment. The increase in vacancies highlights a job-creation effect and is in line with the inverse relation between vacancies and unemployment typically depicted by the Beveridge curve.[5] Interestingly, we uncover asymmetric unemployment responses between natives and foreigners: unemployment falls persistently for natives, driving the response of total unemployment, while it increases significantly after a year for foreigners. This asymmetrical response remains robust when we use for net migration subsamples for OECD and non-OECD countries and also when we examine data on the refugee wave from Syria, originally not included in our migration variable. Moreover, we find that the rise in foreigners' unemployment is reinforced in the case of predominantly low-skilled migration flows from less developed areas of the world, such as Syria or Africa. In the latter case, this increase becomes statistically significant immediately after the impact period. Importantly, the output and unemployment effects of migration shocks continue to hold if we combine our baseline sample with data on net flows from Syria.

The next step is to investigate more in depth the labor market impact of net migration shocks. Sign restrictions schemes in the literature typically restrict job-related immigration shocks to have on impact a positive effect on labor force participation and a negative effect on real hourly wages (see, e.g., Furlanetto and Robstad (2019)). Focusing on a wider notion of migration (including also non-OECD countries of origin), we find that net migration shocks decrease persistently the participation rate, while they increase hourly wages in manufacturing a year and a half after the shock. Immigration can boost productivity and wages over time when firms respond by expanding, investing, adjusting product specialization, adopting efficient technologies, and creating new businesses (Peri (2014)). While the positive response of wages is mainly driven by OECD migration shocks, the negative participation response is driven by flows from non-OECD countries. Generally, immigrants from Africa, Asia and South America, including asylum seekers, do not enter rapidly into the labor force (Furlanetto and Robstad (2019)).

To gain deeper insights, we investigate also quarterly data on participation and employment of natives and foreigners using a mixed-frequency SVAR model. The participation rate of natives increases significantly after approximately two years, while that of foreigners decreases roughly until then, driving the decrease in aggregate participation. Our results also show that the employment rate of natives (foreigners) increases significantly for approximately two years (one year). The positive responses of participation and employment rates for natives imply that

[4]For a theoretical analysis on the inflation response to immigration shocks, see, e.g., García and Guerra-Salas (2020).

[5]For the Beveridge curve in Germany, see, e.g., Figure 2 in Iftikhar and Zaharieva (2019).

the unemployment decrease for this group comes from the boost in employment and not because natives drop out of the labor market. Furthermore, the mixed-frequency SVAR exercise provides evidence that net migration shocks also increase real hourly wages of the aggregate economy as well as per capita GDP and investment, thus confirming the expansionary effects.

Taken together, our results highlight a job-creation effect of migration for natives and a job-competition effect on foreigners. On the one hand, jobs can be created directly by self-employed immigrants or entrepreneurs and indirectly by immigrant innovators (Constant (2014)). Migrants often complement and rarely substitute for natives, choosing locations where they fill shortages by accepting jobs that natives will not do. High-skilled immigrants boost technological adaptation and low-skilled immigrants foster occupational mobility, specialization, and human capital creation. In addition, immigrants raise demand, which increases job openings. On the other hand, the competition effect underscores the need for policymakers to address, through redistribution, challenges faced by foreigners while ensuring that the economy benefits from the expansionary effects of migration.

Related Literature. Our paper contributes to the literature on the macroeconomic effects of migration.[6] A strand of this literature has performed steady-state analysis with search models, focusing on the U.S. economy. When natives and illegal immigrants serve as imperfect substitutes in production and compete for jobs in the same market, Liu (2010) shows that immigration increases the unemployment rate due to displacement (job competition) effects on natives (immigrants). If there are two labor markets, skilled natives are insulated from competition and can benefit from the rise in their marginal product of labor, which decreases their unemployment. In Chassamboulli and Palivos (2014), the job-creating response of firms leads to positive employment effects on natives. Under imperfect substitutability between skilled and unskilled inputs, different search cost between natives and immigrants, cross-skill matching, and imperfect transferability of foreign human capital, Liu, Palivos, and Zhang (2017) find that the immigration influx of 2000-2009 reduced the unemployment rate for all workers. Under non-random hiring, Albert (2020) finds that the job-creation effect due to lower wages dominates the competition effect from undocumented immigration, decreasing the unemployment rate and raising wages for natives. Battisti et al. (2018) show that immigration has increased native welfare of both low and high-skilled workers in 20 OECD countries. For Germany, Iftikhar and Zaharieva (2019) find that the 25% immigration increase of 2012–2016 has a negative effect on the welfare of low skill workers in manufacturing whose unemployment rises due to competition, while all other workers gain. Our paper empirically validates in German data the job-competition effect for foreigners and the employment gains for natives.

Another body of literature has used SVAR models for empirical analysis (see, e.g., Furlanetto and Robstad (2019), Smith and Thoenissen (2019), Kiguchi and Mountford (2019)), d'Albis,

[6] See Vella, Caballé, and Llull (2020) for a recent edited collection.

Boubtane, and Coulibaly (2016), d'Albis, Boubtane, and Coulibaly (2019), and Schiman (2018)).[7] These studies typically highlight the expansionary effects of migration for the receiving economy, except for Smith and Thoenissen (2019) who find no statistically significant effect on per capita GDP and Kiguchi and Mountford (2019) who show a temporary reduction. Regarding the response of unemployment, Furlanetto and Robstad (2019) find it to be negative both for natives and foreigners in Norway, d'Albis, Boubtane, and Coulibaly (2016) show that family immigration reduces France's unemployment rate, and d'Albis, Boubtane, and Coulibaly (2019) find that the unemployment rate falls by 0.1 percentage points the year of the migration shock and for two years after the shock. On the other hand, Kiguchi and Mountford (2019) and Schiman (2018) show that unemployment increases after an immigration shock in the United States and Austria, respectively.[8] To the best of our knowledge, the only previous macroeconometric study examining the unemployment responses of natives and foreigners is Furlanetto and Robstad (2019) without finding job-competition effects. Providing evidence on the participation responses of natives and foreigners is another novel aspect of our paper.

Our aggregate time-series approach is also complementary to the large immigration literature with a microeconometric focus on the basis of disaggregate data, pioneered by the seminal work of George Borjas (see, e.g., Borjas (2014)). Different approaches typically yield different results, but there is some consensus that some groups of native workers benefit through their relative complementarity with immigrants. Ottaviano and Peri (2012) and Manacorda, Manning, and Wadsworth (2012) provide evidence of the role of imperfect elasticity of substitution between natives and immigrants in the size of wage effects. Our paper is also related to studies exploring the differential impact of immigration on natives and foreigners specifically in Germany. Using administrative data and a labor-market equilibrium model, D'Amuri, Ottaviano, and Peri (2010) show that the immigration of the 1990s had little adverse effects on native wages and employment. Instead, it had adverse employment and wage effects on previous immigrants, driven by a higher degree of substitution between old and new immigrants and by wage rigidities. Felbermayr, Geis, and Kohler (2010) estimate a structural model of labor demand with annual survey data from the German Socio-Economic Panel. In a counterfactual exercise without restrictions for migration from new EU members before 2011, they find adverse wage and unemployment effects for incumbent foreigners, but positive effects for natives. Finally, using a difference-in-difference approach to assess the effect of a policy-induced migrant labor supply shock in 2016, Scharfbillig and Weißler (2019) find a negative employment effect only for other foreign residents. In a comprehensive framework allowing also to assess the expansionary effects of migration shocks, our paper provides new empirical evidence on the participation and

[7] Business cycle analysis in migration models without labor frictions can be found in Mandelman and Zlate (2012), Smith and Thoenissen (2019), and Burriel, Fernández-Villaverde, and Rubio-Ramırez (2010). In the context of dynamic stochastic general equilibrium models with labor frictions, Lozej (2019) finds that immigration raises unemployment temporarily, but the effect may subsequently switch sign if wages fall sufficiently so that firms post vacancies. Kiguchi and Mountford (2019) stress that a temporary rise in unemployment may occur if immigration causes non-participants to enter the pool of job seekers.

[8] Smith and Thoenissen (2019) do not consider unemployment in their analysis.

(un)employment responses of natives and foreigners, while abstracting from wage effects for each group separately because of data limitations at high frequency.

Structure. The rest of the paper is organized as follows. Section 2 lays out the data and econometric model, and Section 3 discusses our baseline empirical findings. Section 4 performs a subsample analysis for various geographical origins of migrants and also examines the impact of the recent refugee wave from Syria. Section 5 discusses the methodology and the results of a mixed-frequency SVAR. Finally, Section 6 concludes.

2 Empirical Methodology

In this section, we first describe the monthly data on net migration flows in Germany. Then, we present the details of the econometric model and the identification strategy.

2.1 Monthly Data on Net Migration Flows

Since January 2006, Destatis has been collecting monthly data on the arrivals of foreigners by country of origin, defined as the country of last residence, on the basis of population registers at the municipal level. All geographical continents are covered (Europe, Asia, Australia and Oceania, America, and Africa). The exact list of countries is presented in the Appendix. The municipalities have a strong incentive to record new residents since their fiscal revenue depends on the number of registered, while they impose penalties on non-compliants with the mandatory registration. The difference between the numbers of arrivals and departures (de-registrations) produces the net migration figures, also available from Destatis.

Figure 1 shows the evolution of the net migration rate in Germany by various geographical origins over our sample period 2006:1-2019:10. The net migration rate is computed as the ratio of inflows minus outflows of non-Germans to the working-age population, multiplied by a thousand.[9] We observe a large increase during the period under study. Specifically, the total net migration rate (cyan line) rises from close to 0% in 2009 to 0.4% in 2014 and peaks at more than 1.8% with the refugee crisis in 2016. Notably, this significant increase is observed even if we exclude Syrian flows, which explain the bulk of the 2015-2016 spike (green line). We refer to this measure that is net of the Syrian flows as the baseline migration rate (blue line). Moreover, EU migration (orange line) is a key contributor to the rise in the net migration rate during the European sovereign debt crisis of 2009-2014. The surge is also certainly related to the Eastern enlargement of the EU.[10] Net migration flows from OECD countries are of smaller magnitude than those from the EU member states due to negative values mainly for Canada, the

[9]The data is seasonally adjusted with JDemetra+ X13, consistently with Destatis.

[10]In 2011 free mobility started for the EU8 countries (Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia and Slovakia), which joined the EU in 2004, and in 2014 for Romania and Bulgaria, which joined in 2007.

U.S., Australia, and Japan in various years. The net migration rate from Africa peaks in 2016 at around 0.1%. Finally, between 2016 and 2018 the total net migration rate fluctuates between 0.4% and 0.6% and after 2018 it tends to get stabilized close to 0.4%, which is higher than the level at the start of our sample.

We conduct below an in-depth empirical analysis to study the effects of the sizeable increase in net migration on the labor market and the macroeconomy in Germany. For the main analysis, we use the baseline migration rate (blue line), thus leaving Syrian flows out of our sample. We examine the effects of those flows in Section 4.

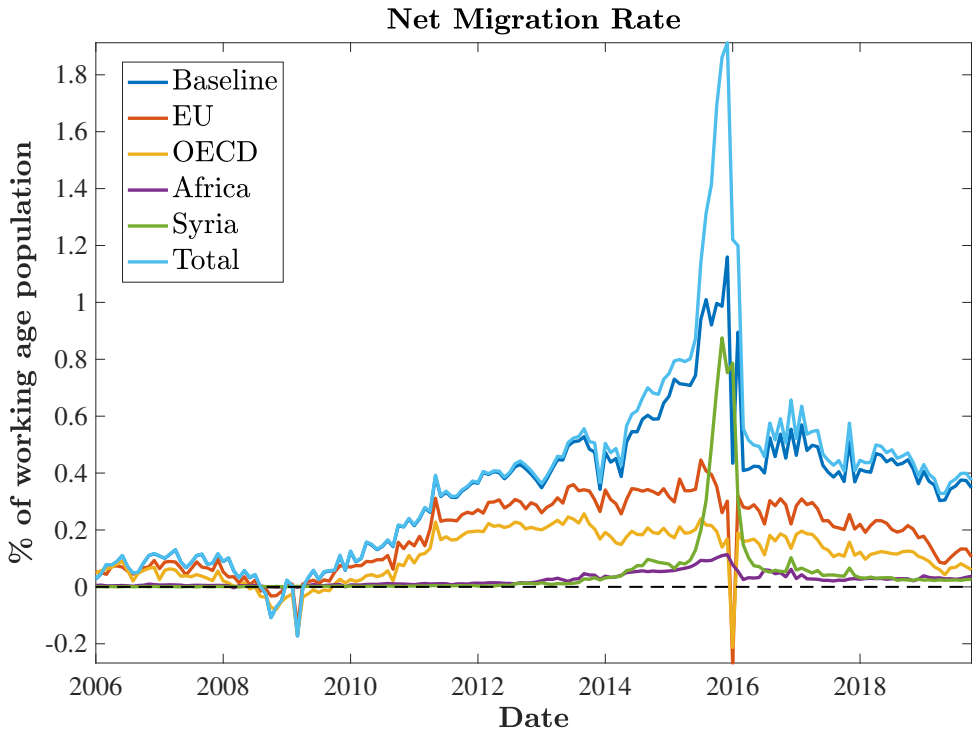


Figure 1: Net Migration Rate in Germany by Geographical Origin, 2006-2019

Note: The baseline migration rate excludes Syrian flows total net flows. EU migration refers to the EU-28 excluding Germany, thus covering 27 countries. From the group of OECD countries we exclude Chile, Colombia, and Mexico. Data comes from the Federal Statistical Office (Destatis).

2.2 Econometric Model and Identification

We consider the following reduced-form VAR(p) model:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + u_t \tag{1}$$

where Y_t is a n x 1 vector containing n endogenous variables, C is a n x 1 vector of constants, $A_1, ..., A_p$ are n x n matrices of coefficients associated with the p lags of the dependent variable and $u_t \sim N(0_n, \Omega)$ is the reduced-form residual. In the baseline model, Y_t contains three variables in the following order: the net migration rate, the logarithm of the industrial production

index, and the registered unemployment rate.[11] [12] To disentangle the unemployment responses of natives and foreigners, we also run the SVAR specification by replacing the registered unemployment rate with the unemployment of natives and foreigners. For these two variables, we take the ratios of the number of native and of foreigners who are registered unemployed to the economically active population (participants).

In further exercises, we add, one at a time, and order last in the system the following 8 variables using data from Destatis: population[13], number of labor market participants, labor force participation rate, number of registered vacancies, real hourly wages in the manufacturing sector, real labor income tax revenue per capita, real tax revenues of the Federation per capita, real net exports per capita and the CPI index. We also perform an exercise in which we substitute the unemployment rate with the employment rate. All these variables enter in a logarithmic form except for the participation and employment rates.

The model is estimated using Bayesian methods with a flat prior such that the information in the likelihood is dominant. We use 3 lags of the dependent variable, which is the average of the AIC, BIC and HQC criteria. We also use alternative lags specifications as a robustness check in the Appendix (see Figure A.1). Let the mapping between reduced-form and structural disturbances be $u_t = S\epsilon_t$, where $\epsilon_t \sim N(0_n, I_n)$ is the n x 1 vector of unit variance structural disturbances. The model is structural in that the errors ϵ_t are mutually uncorrelated and have an economic interpretation. In the baseline specification, we define S as the Cholesky decomposition of Ω, thus as the unique lower triangular matrix such that $SS' = \Omega$, and give an economic interpretation to the first shock only (see, e.g., d'Albis, Boubtane, and Coulibaly (2016)).

We interpret the migration shock as the only one that has a contemporaneous effect on the net migration rate. Other shocks in the receiving country, which we we call "residual shocks" without giving a formal interpretation, such as business cycle or domestic labor supply shocks, affect net migration with a lag. While this assumption could be easily contested if we worked with annual or quarterly data, this is not the case with monthly data. The reason is simple: migration decisions motivated by positive conditions in the receiving country take some time to materialize in the statistics and, arguably, one month may be thought of as a lower-bound estimate of the period required. Let us provide an intuitive example. Suppose that someone decides to move to Germany because of current favorable economic developments there. It would certainly take some time before first acknowledging these developments, then taking the decision to move, start looking for a job and temporary accommodation, and finally registering with the authorities to be able to sign the employment contract and move to more permanent accommodation. It is difficult to argue that this process would take less than a month and will

[11] This is defined as the share of registered unemployed in the economically active population. The latter is computed as the sum of the number of residents in Germany who are in employment (from Destatis) and the number of registered unemployed (from the Federal Employment Agency - "Bundesagentur für Arbeit"). The industrial production index refers to the following sectors: mining and quarrying, manufacturing, energy and construction. Series in logs are multiplied by 100.

[12] We also consider quarterly data on per capita GDP in Section 3.5 where we use a mixed-frequency VAR model.

[13] This variable is interpolated from quarterly data.

be even longer for those in need of a VISA. The reverse of this example can be applied to those leaving Germany.

As alternative identification strategy, we consider both traditional sign restrictions and more recently proposed mixed (sign and narrative) restrictions. A SVAR approach based on sign restrictions allows to disentangle the exogenous and the endogenous component of immigration in a system that fully takes into account feedback effects between different variables. Therefore, it addresses potential concerns about the response of immigration to the host country's economic conditions. Recently, Antolín-Díaz and Rubio-Ramírez (2018) developed a methodology which allows to impose that around selected historical events structural shocks and/or historical decompositions agree with some narrative information. For example, it is possible to impose that around a quarter (or several quarters) one specific shock has to be positive (or negative) or that this shock has to be the main (or the least important) driver of a variable or more (less) important than all the other shocks combined for a specific variable. The first is a restriction on the sign of the structural shocks. The second and the third are restrictions on the historical decompositions. Antolín-Díaz and Rubio-Ramírez (2018) focus on oil and monetary shocks and show that imposing only a few narrative sign restrictions may sharpen and even change the inference of a SVAR originally identified via traditional sign restrictions. Our model with net migration shocks constitutes an appropriate setup to incorporate narrative sign restrictions, previously employed in the study of immigration shocks by Furlanetto and Robstad (2019).

Table 1 reports our signs restrictions. We restrict the migration shock to have the highest positive impact response on net migration and a positive effect on industrial production. Alternatively, we make a joint use of the sign restriction that there is a positive effect on both industrial production and the net migration rate and of the narrative restriction that over the period 2014-2016 immigration is the biggest contributor to the net migration rate (see Figure 1). Notably, the response of unemployment after migration shocks, which is ambiguous as explained in the Introduction, is left unrestricted. The restrictions are imposed only on impact following Canova and Paustian (2011) and are implemented using the algorithm of Rubio-Ramírez, Waggoner, and Zha (2010).[14]

Table 1: Alternative identification strategy

Sign Restrictions			
	Immigration Shock	Residual Shock 1	Residual Shock 2
Net migration rate	+	$\lvert b_{21}\rvert < b_{11}$	$\lvert b_{31}\rvert < b_{11}$
Industrial production	+	+	+
Unemployment rate	/	-	+

Note: b_{i1} denotes the impact response of variable i to a net migration shock.

[14]Results (available upon request) are very similar to the ones obtained with Cholesky if we impose instead that the migration shock explains the bulk of the variance decomposition of net migration in the first three months.

3 Results

In this section, we present impulse response functions to one-standard-deviation net migration shocks. The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months.

3.1 The Expansionary Effects of Net Migration Shocks

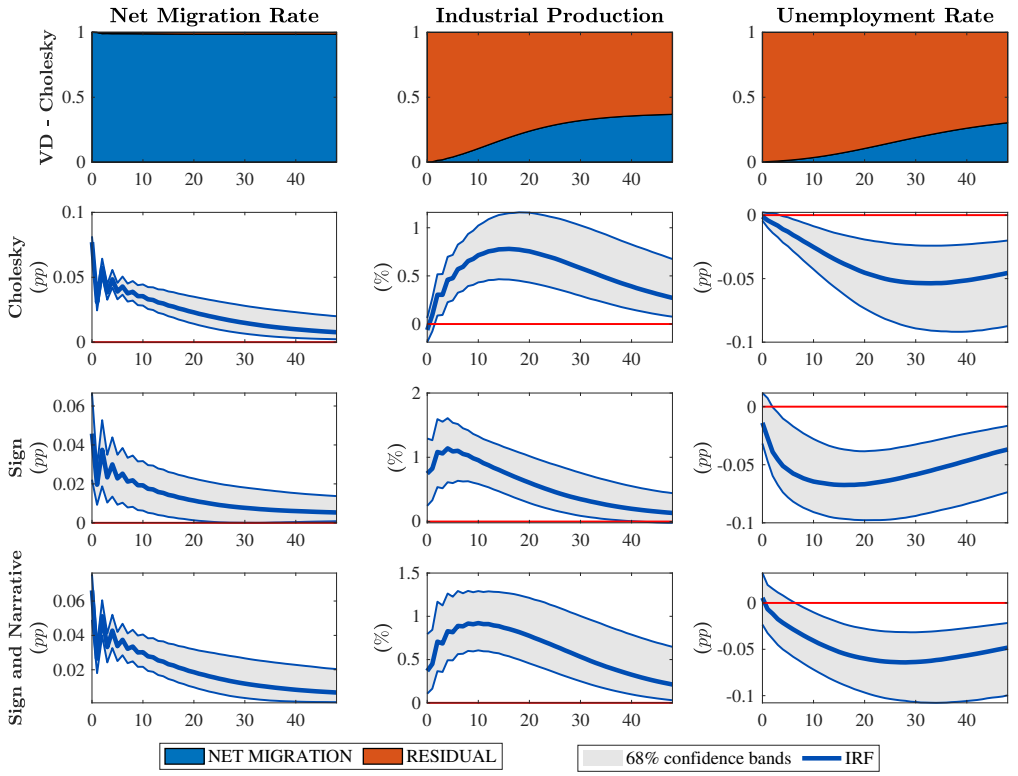
The second row of Figure 2a shows that a positive net migration shock increases persistently the net migration rate. The effects on the German economy are clearly expansionary as industrial production increases significantly after the first bimester and the total unemployment rate decreases significantly after the first quadrimester. These effects appear quantitatively important. The first row of Figure 2a shows that the migration shock explains entirely monthly fluctuations of the net migration rate. Regarding industrial production and unemployment, the migration shock explains around 40% and 25% respectively. Unsurprisingly, the other shocks in the system account for the bulk of fluctuations in industrial production and unemployment. These results are robust to different lag specifications, harmonized - instead of registered - unemployment, and different ordering of the net migration variable (see Figure A.1 in the Appendix).

In the third and fourth rows of Figure 2a we present impulse responses when the shocks are identified using sign restrictions. Specifically, the third row reports responses when we restrict the migration shock to be the one with the highest positive impact response of net migration and a positive effect on output. Recall that we leave the response of the unemployment rate to net migration shocks unrestricted. The fourth row reports responses when we make a joint use of the sign restriction of Table 1 and the narrative restriction that over the period 2014-2016 immigration is the biggest contributor to the net migration rate, as shown in Figure 1. In both cases, the persistent and expansionary effects of the net migration shock, namely the rise in industrial production and the fall in the unemployment rate, are confirmed. The responses exhibit very similar dynamics to the ones of the baseline framework, despite the use of a minimal amount of sign restrictions. We thus feel confident to use our baseline Cholesky approach to assess next the effects of net migration shocks on a variety of macroeconomic and labor market variables.

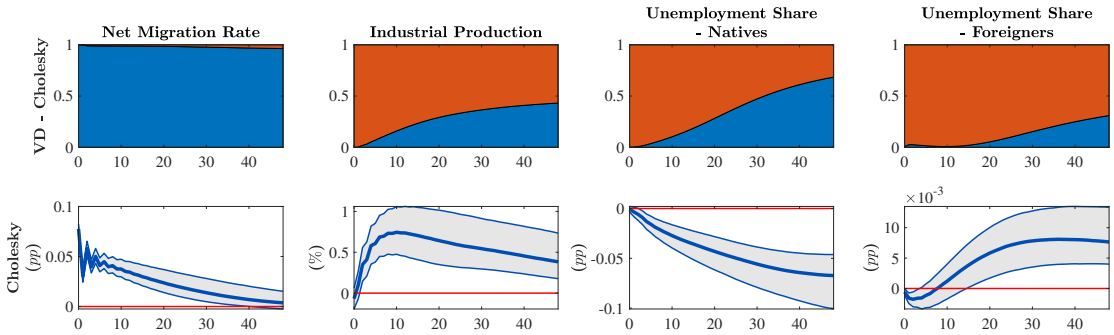
3.2 Asymmetric Unemployment Responses of Natives and Foreigners

Figure 2b shows the results when we augment our Cholesky SVAR with the unemployment shares of natives and foreigners in the labor force, which replace total unemployment in the baseline specification. The responses we obtain are asymmetric: the unemployment share of natives decreases significantly and persistently after the first two months, while the unemployment share of foreigners increases after slightly more than a year. In terms of magnitude, unemployment responds more strongly in the case of natives than of foreigners.

Figure 2: Impulse response functions to an one-standard-deviation net migration shock



(a) Different identification strategies in the SVAR with total unemployment



(b) Cholesky SVAR with unemployment of natives and foreigners

Note: The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months. VD denotes variance decomposition.

On the one hand, these results highlight competition effects from newly settled migrants on earlier migrants. This dynamic competition channel has been little analyzed until now as the literature has largely focused on the effects of immigration on natives. On the other hand, net migration shocks have largely beneficial effects in terms of unemployment for native workers, thus not confirming possible displacement effects.[15] As emphasized in the Introduction,

[15]Figure A.2a in the Appendix shows results when we break down the pool of unemployed into natives and foreigners. We observe a decline for natives and an increase for foreigners in line with Figure 2b. The total pool of

migrants often complement and rarely substitute for native workers.

We check if these findings remain robust when we use subsamples on migration flows from OECD and nob-OECD countries and on the refugee wave from Syria in Section 4. We also investigate further the labor market responses of natives and foreigners in Section 5.

3.3 Other Key Macroeconomic and Labor Market Variables

Immigrant workers are over-represented in manufacturing and construction jobs in Germany (Iftikhar and Zaharieva (2019)), which is the largest manufacturing economy in Europe and one of the world's major manufacturing powerhouses.[16] In this section, we augment our baseline SVAR with real hourly wages in the manufacturing sector, for which monthly data is available, and also with other key variables listed in Section 2.2 (one at a time). The goal is to investigate the impact of net migration on labor supply, labor demand, hourly wages and inflation.

Figure 3a presents the impulse response functions, while variance decompositions are included in Figure 3b. The net migration shock increases persistently labor demand (vacancies), the employment rate, and also real hourly wages after around 18 months. The positive response of vacancies highlights a job-creation effect of migration and is in line with the inverse relation between vacancies and unemployment depicted by the Beveridge curve (see, e.g., Figure 2 in Iftikhar and Zaharieva (2019)). For inflation we do not find a statistically significant effect. Subsample analysis presented in the next section sheds light on this result.

Turning to labor supply effects, the shock leads to a protracted increase in the pool of labor force participants 5 months after the shock, which is outweighed though by a higher rise in population, resulting in a short-run decrease in the participation rate. This result is in contrast to the typical association of job-related migration shocks with an increase in participation (see, e.g., Furlanetto and Robstad (2019)). To understand better this result, we will conduct a subsample analysis in Section 4 and we will also investigate, through a mixed-frequency SVAR approach, quarterly data on participation of natives and foreigners in Section 5.

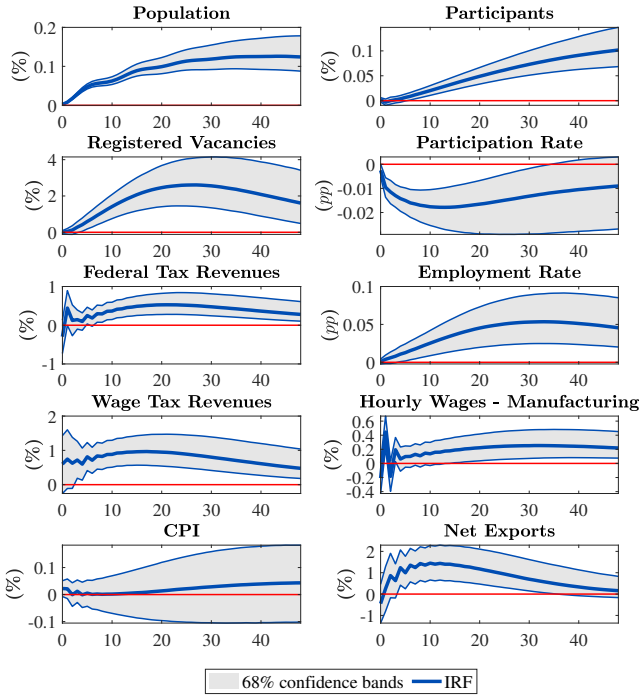
Given the positive impact on employment and wages, labor income tax revenue rises significantly a couple of months after the shock. The response of federal total tax revenue also appears positive 8 months after the shock. Regarding the impact on international trade, the net migration shock raises significantly net exports for more than 2 years (see Figure 3a). These findings further corroborate the expansionary macroeconomic effects of net migration in Germany.

Finally, the variance decomposition in Figure 3b reveals that the net migration shock is the major driver of fluctuations in population over the entire horizon considered. This finding confirms that immigration is the main source of population growth in our sample. The effects are non-negligible for other variables, too. Net migration explains a large share of the variance of participants and vacancies, approximately 63% and 40% respectively, and a non-negligible

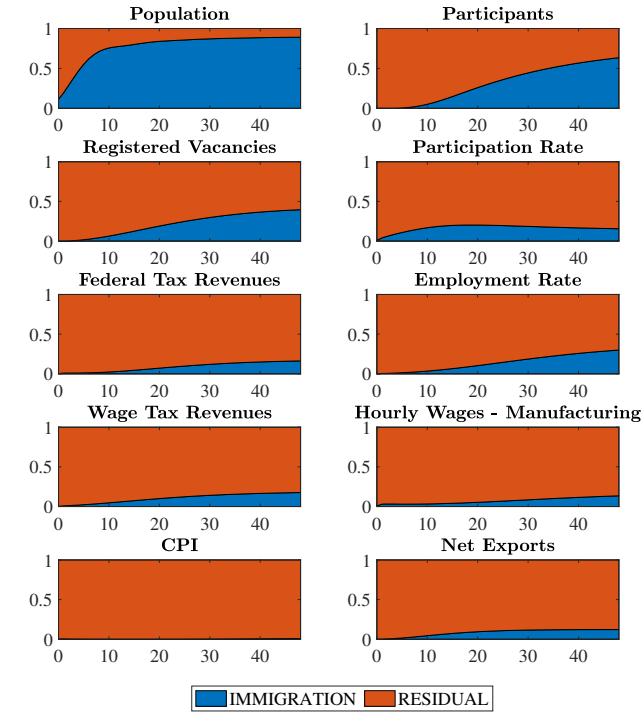
unemployed decreases in line with Figure 2a.

[16] Germany has an exceptionally large employment share in manufacturing (around 25% in 2014).

Figure 3: Monthly baseline SVAR with additional variables



(a) Impulse response functions



(b) Variance decomposition

Note: The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months.

share for the other variables, with the exception of the CPI index. Altogether, these findings stress the role of net migration in macroeconomic and labor market volatility.

4 Geographical Origins of Migrants and the Refugee Wave

Empirical evidence suggests that the average education level of immigrants from developed and developing countries differs. In addition, so far we have not used data on the wave of predominantly low-skilled refugees from Syria, which increased immigration flows in Germany to about one million people in 2015 - 2016 (see also Figure 1). In this section, we study the effects of net migration shocks accounting for the geographical origin and the impact of refugee migration. To this end, we estimate the SVARs of Figure 2a (second row), Figure 2b and Figure 3 by changing the first variable to the net migration rate originating from the region of interest, namely EU countries, OECD countries, Africa, and Syria.[17] We also show findings when we add Syrian flows to the baseline migration variable used until now.

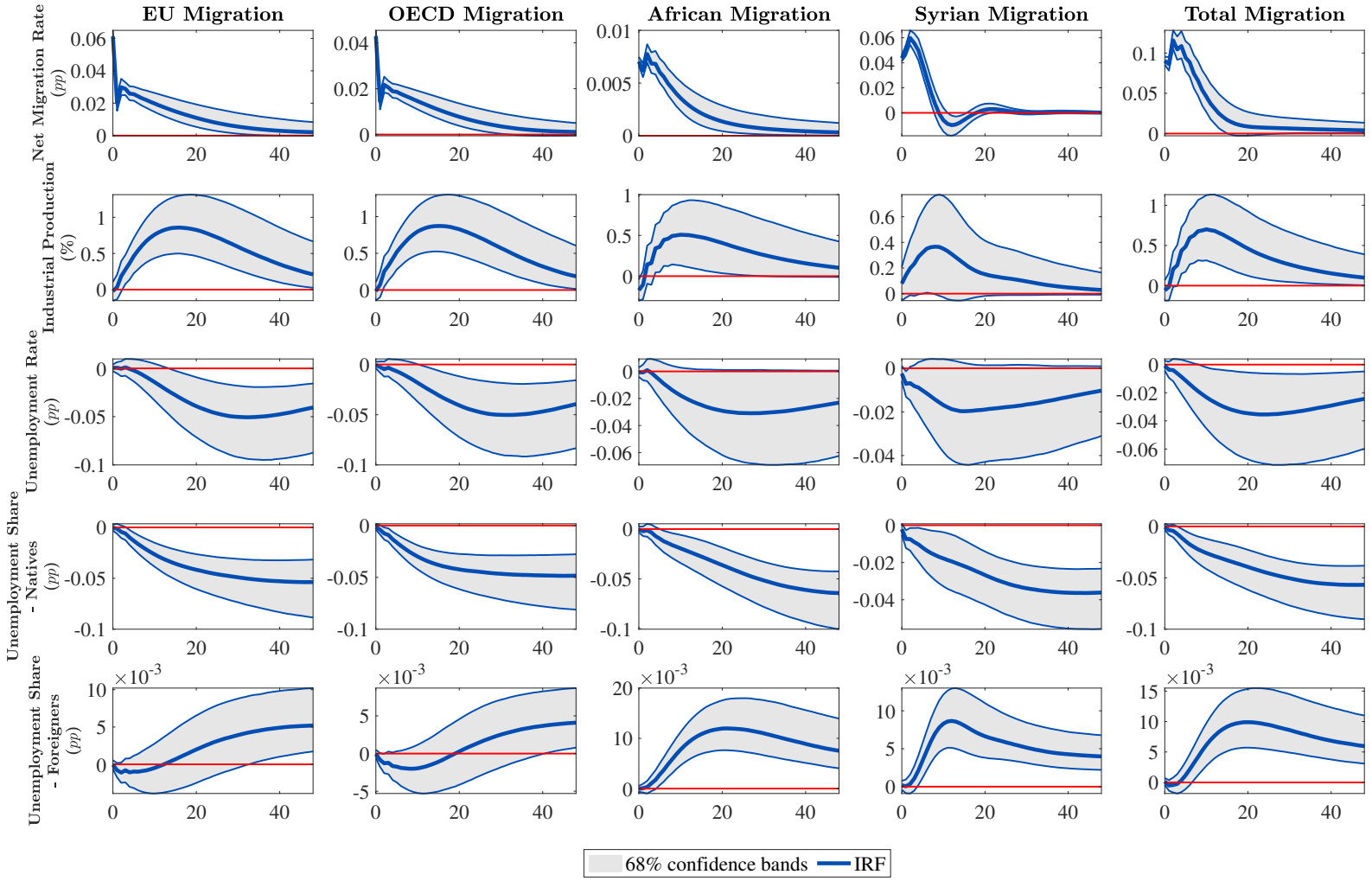
Figure 4 shows responses for the net migration rate, industrial production, total unemployment rate, and the unemployment shares of natives and foreigners. Results remain qualitatively unchanged in all cases. Net migration shocks from EU and OECD countries have very similar effects (columns 1 and 2). In the case of net migration from Africa (column 3), the negative response of total unemployment is no longer statistically significant, while the increase of foreigners' unemployment becomes statistically significant shortly after the impact period and stronger in magnitude compared to both columns 1 and 2 and to Figure 2b. When our net migration variable includes only Syrian flows (column 4), the effects remain qualitatively the same, but loose statistical significance for industrial production and total unemployment, while they do maintain it for natives' and foreigners' unemployment. Importantly, all our results continue to hold and are statistically significant when we combine data on Syrian flows with our baseline data sample for net migration (column 5).

Figure 5 presents responses for the participation rate, vacancies, hourly wages in manufacturing, inflation, and net exports.[18] The negative response of the participation rate in Figure 3a is mainly driven by non-OECD economies (Africa or Syria), whereas the response is not statistically significant for net migration from OECD countries and is negative and significant only for nearly the first half of the time horizon for net migration from EU countries. As mentioned in Furlanetto and Robstad (2019), immigrants from Africa, Asia and South America are mostly those who do not enter rapidly into the labor force (as is the case for asylum seekers, for example). The positive response of vacancies is very robust in all cases shown in Figure 5. The positive response of hourly wages in the second half of the time horizon in Figure 3a is confirmed here for net migration from OECD (and EU) countries. The response of the CPI index

[17] Results for net migration flows from Asia are mainly driven by Syria and therefore look very similar. Net flows from South America were found to be little relevant for our analysis. Both sets of results are available upon request.

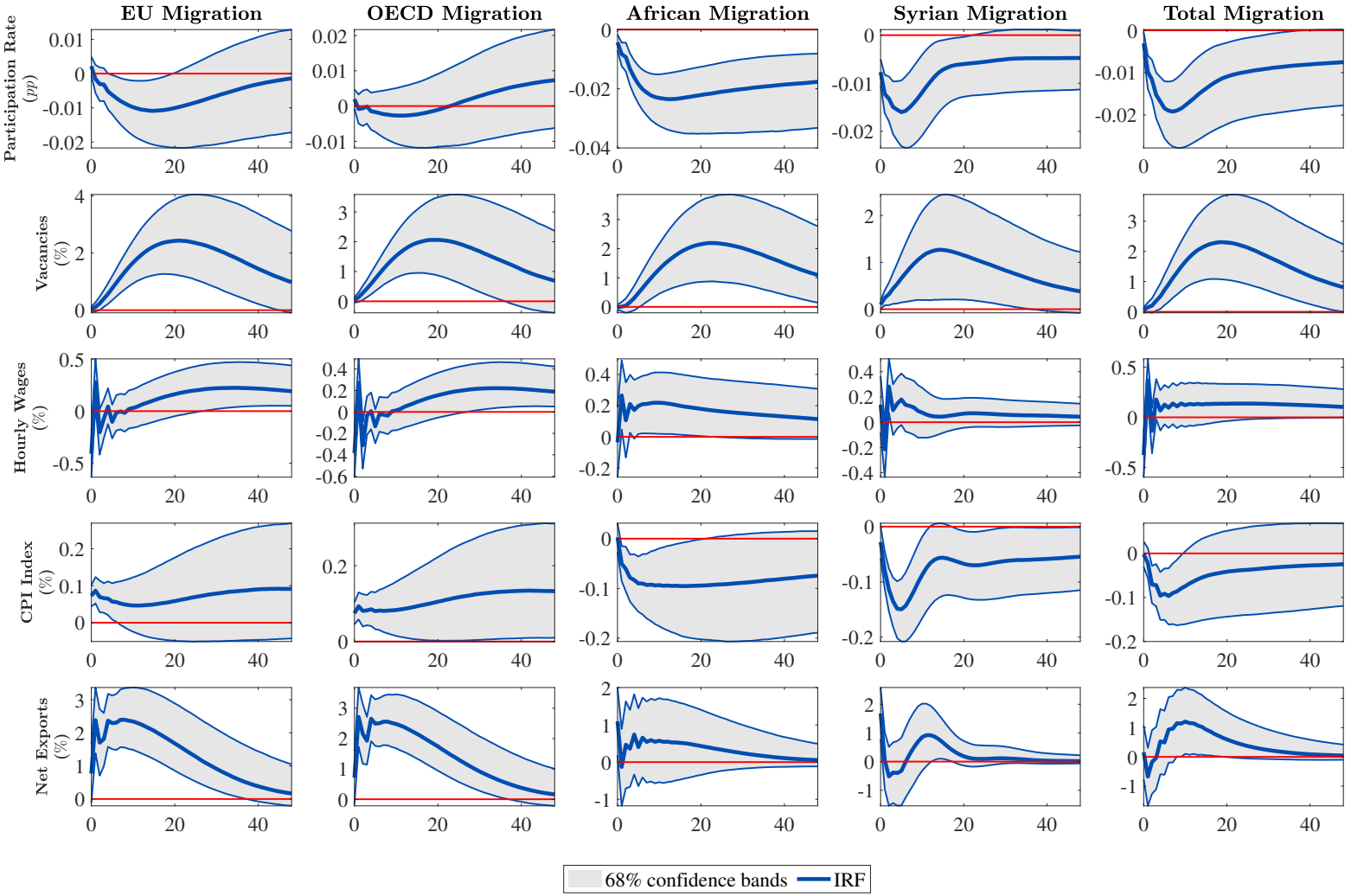
[18] Responses for population, participants, federal and wage tax revenues are included in Figure A.3 of the Appendix.

Figure 4: Subsample analysis and the refugee wave: Output and unemployment variables



Note: Total migration results from augmenting the net migration variable used in the baseline SVAR with net flows from Syria. The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months.

Figure 5: Subsample analysis and the refugee wave: Selected macroeconomic and labor market variables



Note: Total migration results from augmenting the net migration variable used in the baseline SVAR with net flows from Syria. The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months.

is also insightful. Recall that the inflation response in Figure 3a was not statistically significant. The subsample analysis shows that this is explained by a positive response to OECD (and EU) migration shocks and a negative response to African and Syrian migration shocks. This finding suggests that for the former a demand effect is prevalent, while for the latter a supply effect. Once we include Syrian flows in our baseline net migration variable (column 5), we observe that migration shocks appear to decrease the CPI index, thus behaving like typical supply shocks. The response of net exports is also interesting. While net exports increase on impact and for a couple of months in the case of OECD (and EU) migration shocks, the response is substantially more muted if we examine African or Syrian migration.

Overall, the analysis in this section disentangles the effects of job-related migration from OECD countries and predominantly low-skilled migration (including refugees) from less developed economies. This distinction matters qualitatively for the effects on inflation and quantitatively for participation, hourly wages, foreigners' unemployment and net exports.

5 Deeper Insights from a Mixed-Frequency SVAR

So far, we have shown that the participation rate falls after net migration shocks, but we have not examined the responses of natives and foreigners separately. Since data on participation (and employment) by nationality is available quarterly, in this section we proceed with a mixed-frequency SVAR. This approach allows us further to explore quarterly data on per capita consumption, investment, GDP, and real hourly wages for the aggregate economy.

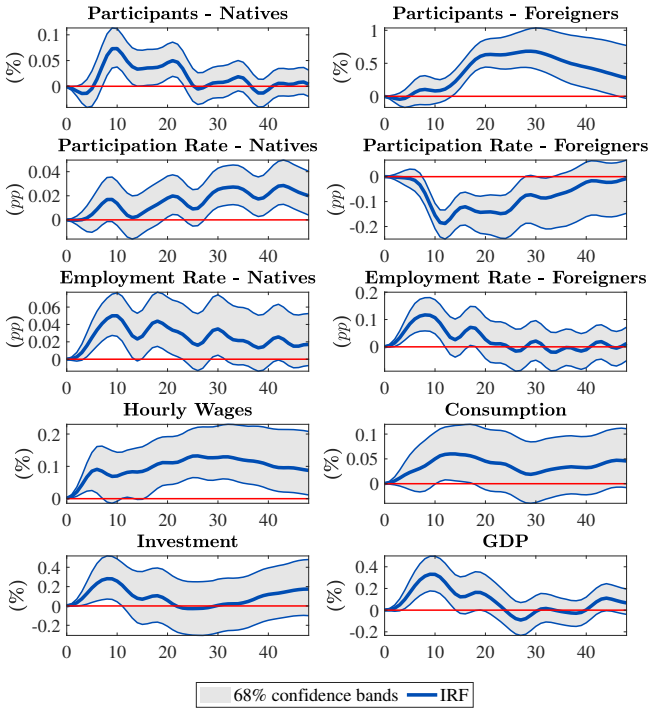
5.1 The Model and Data

The main advantage of the mixed-frequency SVAR model is that we can assess the effects of net migration shocks on variables for which data is available at quarterly but not monthly frequency, while keeping our identifying restrictions unchanged. Estimation is carried along the lines of Schorfheide and Song (2015).

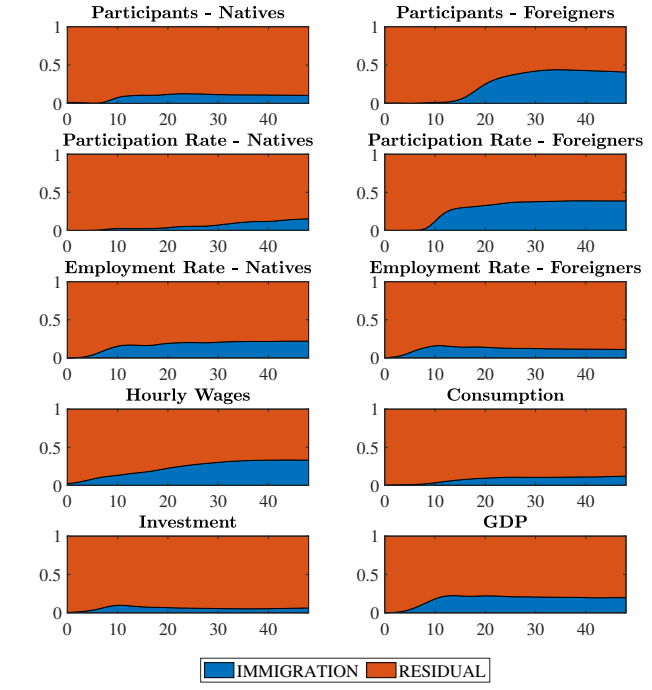
We complement the three variables of our baseline Cholesky SVAR (net migration rate, industrial production, unemployment rate) with (a) the participation rate and the logarithm of employed workers, as they convey relevant information to properly estimate the model, and (b) the following quarterly variables of interest (one at a time): participation rate of natives, participation rate of foreigners, the number of participants natives (in logs), the number of participants foreigners (in logs), the employment rate of natives, the employment rate of foreigners, real hourly wages for the total economy, per capita real consumption, per capita real investment, and per capita real GDP. We specify a flat rather than Minnesota prior in line with our monthly SVAR model and we include 6 lags of the dependent variable to ensure enough feedback.[19]

[19]This might cause some impulse responses in 6a to gyrate. With a smaller number of lags, impulse responses are less robust especially if we exclude variables from the system. Results with 6 lags, instead, are robust even

Figure 6: Mixed-Frequency SVAR



(a) Impulse response functions



(b) Variance decomposition

Note: The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months.

Data by nationality on the number of employed is available from the Eurostat's Labor Force Survey (LFS). By taking the sum of the numbers of employed and registered unemployed for natives and foreigners, we obtain a measure of native and non-native participants, respectively. We construct the employment rate by nationality by taking the corresponding ratio of the number of employed to the number of participants. Since population data distinguishing Germans and non-Germans is not available quarterly to compute participation rates by nationality, we rely again on the LFS data. Real hourly wages are defined as hourly gross wages and salaries from Destatis, deflated by the CPI index. The remaining macroeconomic variables (consumption, investment and GDP) are taken from the Destatis and FRED databases.

5.2 Participation and Employment Responses of Natives and Foreigners

Figure 6a shows impulse responses for the quarterly variables to a net migration shock. The participation rate of natives increases significantly after approximately two years, while that of foreigners decreases roughly until then, driving the decrease in the aggregate participation rate over the same period in Figure 3a. This result suggests that newly settled migrants enter the labor market only gradually, which can explain why it takes time for foreigners' unemployment to increase significantly in Figure 2b. As a result, the immediate rise in population outweighs the rise in total participants (Figure 3a).

Figure 6a also shows that the employment rate of natives (foreigners) increases significantly for approximately two years (one year). For natives, this increase coincides with an increase in participants. The participation and employment responses imply that the unemployment decrease for natives in Figure 2b is due to a boost in their employment following the net migration shock and not because natives respond by dropping out of the labor market. Possible displacement effects of net migration on natives are not found here.

For foreigners, the magnitude of the increase in the employment rate is roughly double compared to natives.[20] Over the same period, the number of foreigners' participants does not move, which matches well the initially insignificant response of foreigners' unemployment share in Figure 2b. The increase in the pool of foreigners participants a year after the shock is roughly ten times higher compared to natives, marking the gradual integration of newly settled immigrants in the labor market. As a result, foreigners' participation rate returns now to its pre-shock level after declining during the first year after the shock. This leads to stronger competition for jobs and higher unemployment among foreigners (see Figure 2b).

In terms of variance decomposition, Figure 6b shows that net migration is an important driver of fluctuations in participation for foreigners, but less relevant for natives. The aggregate importance of net migration for participation is thus almost entirely driven by foreigners.

without participation and employed workers in the specification.

[20] Figure A.2a in the Appendix shows that the response of employed natives appears smaller in magnitude than that of foreigners, while Figure A.2b shows that the responses of participants and employment rate for foreigners and natives do not change if we use unemployment data from the LFS instead of the Federal Employment Agency.

5.3 Responses for Aggregate Wages, Consumption, Investment and GDP

Figure 6a shows a significant and protracted increase in real hourly wages of the aggregate economy. Together with the positive response of hourly wages in the manufacturing sector in Figure 3a, our results indicate that, on average, net migration does not depress but, instead, boosts wages in Germany. The response of per capita investment is also statistically significant and positive for almost a year after the shock. A similar result, with higher statistical significance, is obtained for per capita GDP.[21] The response of per capita consumption is also positive but slightly significant (i.e., from month 10 to 17-18). The results from the variance decomposition in Figure 6b show that net migration shocks contribute to variability in hourly wages and per capita GDP, while they explain a small share of fluctuations in per capita consumption and investment. Overall, these results add to the positive responses of industrial production and per capita net exports and tax revenue from the monthly SVAR model, further confirming the expansionary effects of migration shocks in Germany.

6 Conclusion

The recession induced by the COVID-19 pandemic is expected to have long, deep, and pervasive consequences. Considering also that migrants have been among the most vulnerable groups to infection, the sanitary and economic crisis could exacerbate xenophobic sentiments around the world. This paper contributes to a better understanding of the migration effects in the labor market and the macroeconomy, which is crucial for migration policy design and for the effort required to curb the rise in xenophobic movements.

Using monthly and mixed-frequency SVAR models applied to data for Germany, we show that net migration shocks are expansionary, increasing persistently per capita output, investment, net exports and tax revenue. Shocks to net migration from OECD countries appear to be inflationary, reflecting demand forces, while the opposite is true for non-OECD migration shocks, for which supply-side effects are mostly prevalent.

In the labor market, migration shocks increase (over time) real hourly wages. The participation rate of foreigners decreases, driving a decrease in the aggregate participation rate, while that of natives increases. Migration shocks also boost new hirings and decrease the unemployment rate, in line with the inverse relation depicted by the Beveridge curve. Interestingly, we uncover asymmetric responses for the unemployment of natives and foreigners. Natives' unemployment decreases persistently, driving the response of total unemployment, while foreigners' unemployment increases. Newly settled migrants mainly from non-OECD countries enter the labor market at relatively slow pace. Our results highlight a job-creation effect of migration for natives and a job-competition effect for foreigners, which can be rationalized by imperfect substitutability of the two labor inputs in production. Job competition effects for foreigners are

[21] Figure A.4 in the Appendix plots the estimates of monthly GDP from the mixed-frequency SVAR.

stronger in the case of predominantly low-skilled migration from non-OECD countries. With respect to wage effects for natives and foreigners, our study is unfortunately limited by the lack of data at high frequency. We leave theoretical investigations as a topic for future research.

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APPENDIX

A List of countries in the migration flows dataset of Destatis

OECD countries. Destatis provides data for European OECD countries as a whole. We also consider Australia, Canada, Israel, Japan, Korea Republic, New Zealand, and the United States. We thus do not include Chile, Colombia, Mexico.

EU countries (as of July 2013). Austria, Belgium, Bulgaria, Czech Republic, Croatia, Cyprus, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

Other European countries. Albania, Andorra, Belarus, Bosnia and Herzegovina, Iceland, Kosovo, Macedonia, Montenegro, Norway, Russian Federation, Serbia, Switzerland, Turkey, Ukraine, Rest of Europe.

Africa. Algeria, Angola, Cameroon, Cote d'lvoire, Egypt, Ethiopia, Ghana, Kenya, Central African Republic, Republic of Congo, Dem. Republic of Congo, Libya, Morocco, Namibia, Niger, Nigeria, Rwanda, Senegal, Somalia, South Africa, Tanzania, Tunisia, Uganda, Rest of Africa.

America. Argentina, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Honduras, Mexico, Nicaragua, Paraguay, Peru, United States, Uruguay, Venezuela, Rest of America.

Asia. Afghanistan, Arab Republic, Armenia, Azerbaijan, China, Georgia, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, the People's Republic of Korea, Democratic Republic of Korea, Lebanon, Pakistan, Philippines, Saudi Arabia, Singapore, Syria, Tajikistan, Thailand, United Arab Emirates, Uzbekistan, Vietnam, Yemen, Rest of Asia.

Australia and Oceania. Australia, New Zealand, Rest of Oceania.

B Bayesian estimation of the VAR model

Consider the reduced form VAR model presented in Section 2.2:

$$Y_t = C + \sum_{j=1}^{p} A_j Y_{t-j} + u_t$$

The process above can be stacked in a more compact form as follows:

$$\mathbf{Y} = \mathbf{X}B + \mathbf{U}$$

where:
1) $\mathbf{Y} = (Y_{p+1}, ..., Y_T)'$ is a $(T-p)$ x n matrix, with $Y_t = (Y_{1,t}, ..., Y_{n,t})'$.
2) $\mathbf{X} = (\mathbf{1}, \mathbf{Y}_{-1}, ..., \mathbf{Y}_{-p})$ is a $(T-p)$ x $(np+1)$ matrix, where $\mathbf{1}$ is a $(T-p)$ x 1 matrix of ones and $\mathbf{Y}_{-k} = (Y_{p+1-k}, ..., Y_{T-k})'$ is a $(T-p)$ x n matrix.
3) $\mathbf{U} = (u_{p+1}, ..., u_T)'$ is a $(T-p)$ x n matrix.
4) $B = (C, A_1, ..., A_p)'$ is a $(np+1)$ x n matrix of coefficients.
Vectorizing the equation above, we obtain:

$$\mathbf{y} = (I_n \otimes \mathbf{X})\beta + \mathbf{u}$$

where $\mathbf{y} = vec(\mathbf{Y})$, $\beta = vec(B)$, $\mathbf{u} = vec(\mathbf{U})$ and $\mathbf{u} \sim N(0, \Sigma \otimes I_{T-p})$.
Given the assumption of normality of the reduced-form errors, $u_t \sim N(0, \Sigma)$, we can express the likelihood of the sample, conditional on the parameters of the model and the set of regressors $\mathbf{X}$, as follows:

$$L(\mathbf{y}|\mathbf{X}, \beta, \Sigma) \propto |\Sigma \otimes I_{T-p}|^{-\frac{T-p}{2}} exp\left\{ \frac{1}{2}(\mathbf{y} - I_n \otimes \mathbf{X}\beta)'(\Sigma \otimes I_{T-p})^{-1}(\mathbf{y} - I_n \otimes \mathbf{X}\beta) \right\}$$

Denote $\hat{\beta} = vec(\hat{B})$, where $\hat{B} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{Y}$ is the OLS estimate, and let $S = (\mathbf{Y} - \mathbf{X}\hat{B})'(\mathbf{Y} - \mathbf{X}\hat{B})$ be the sum of squared errors. Then we can rewrite the likelihood as follows:

$$L(\mathbf{y}|\mathbf{X}, \beta, \Sigma) \propto |\Sigma \otimes I_{T-p}|^{-\frac{T-p}{2}} exp\left\{ \frac{1}{2}(\beta - \hat{\beta})'(\Sigma^{-1} \otimes \mathbf{X}'\mathbf{X})(\beta - \hat{\beta}) \right\}$$
$$exp\left\{ -\frac{1}{2} tr(\Sigma^{-1} S) \right\}$$

By choosing a non-informative (flat) prior for B and Σ that is proportional to $|\Sigma|^{-\frac{n+1}{2}}$, namely:

$$p(B|\Sigma) \propto 1$$
$$p(\Sigma) \propto |\Sigma|^{-\frac{n+1}{2}}$$

We can compute the posterior of the parameters given the data at hand using Bayes rule, as follows:

$$P(B, \Sigma|\mathbf{y}, \mathbf{X}) \propto L(\mathbf{y}|\mathbf{X}, \beta, \Sigma)p(B|\Sigma)p(\Sigma)$$
$$= |\Sigma|^{-\frac{T-p+n+1}{2}} exp\left\{\frac{1}{2}(\beta - \hat{\beta})'(\Sigma^{-1} \otimes \mathbf{X}'\mathbf{X})(\beta - \hat{\beta})\right\} exp\left\{-\frac{1}{2}tr(\Sigma^{-1}S)\right\}$$

This posterior distribution is the product of a normal distribution for β conditional on Σ and an inverted Wishart distribution for Σ. Thus, we draw β conditional on Σ from:

$$\beta|\Sigma, \mathbf{y}, \mathbf{X} \sim N(\hat{\beta}, \Sigma \otimes (\mathbf{X}'\mathbf{X})^{-1})$$

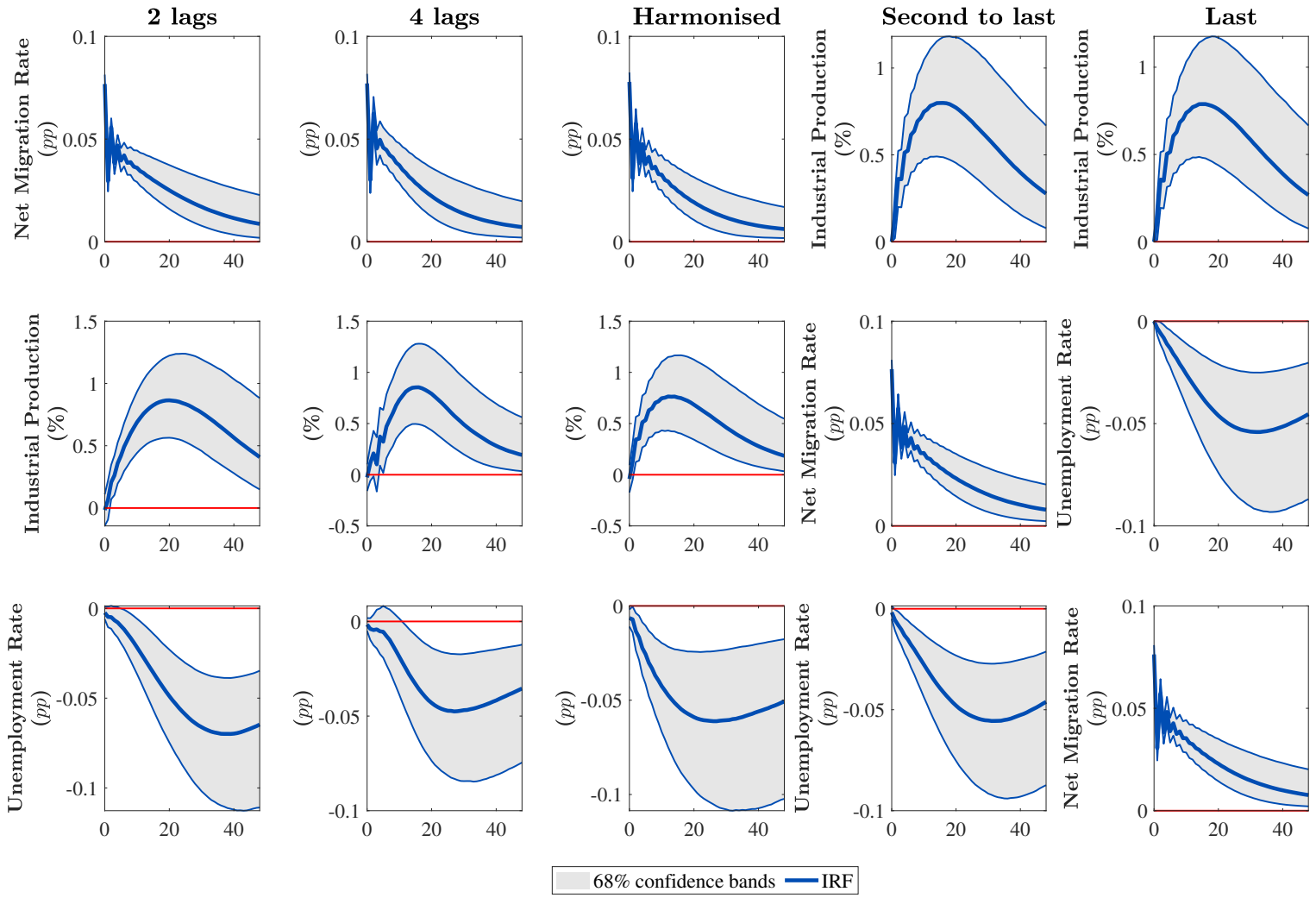
and Σ from:

$$\Sigma|\mathbf{y}, \mathbf{X} \sim IW(S, v)$$

through Gibbs sampling, where $v = T - p - np - 1$.

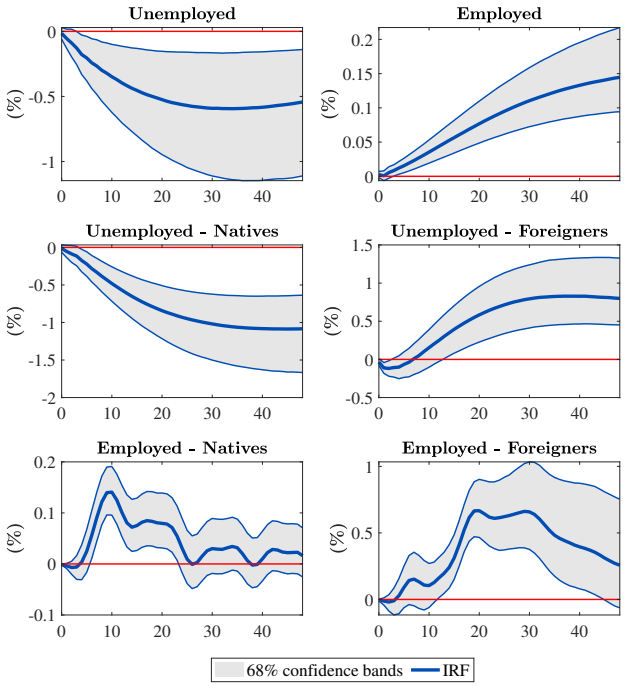
C Robustness checks and additional results

Figure A.1: Impulse response functions to an one-standard-deviation net migration shock: Robustness

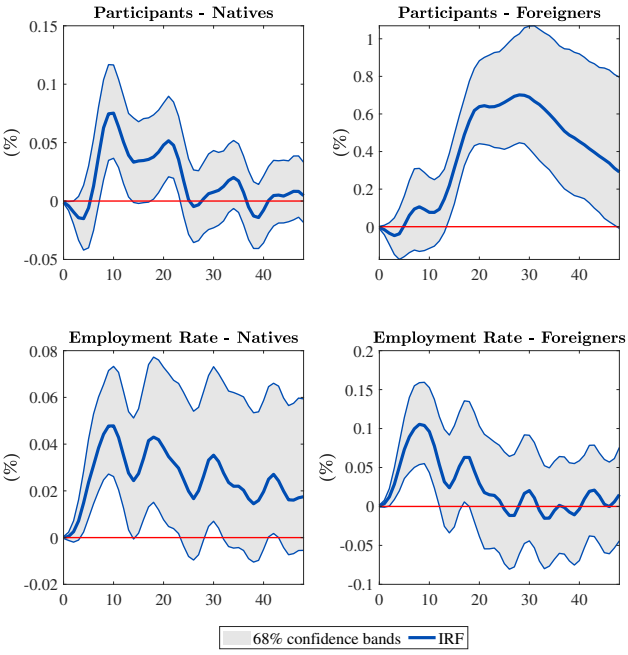


Note: In column 3, we replace the registered unemployment rate with harmonized unemployment. In columns 4 and 5, the net migration rate is ordered in the SVAR second to last and last, respectively. The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months.

Figure A.2: More impulse response functions to an one-standard-deviation net migration shock



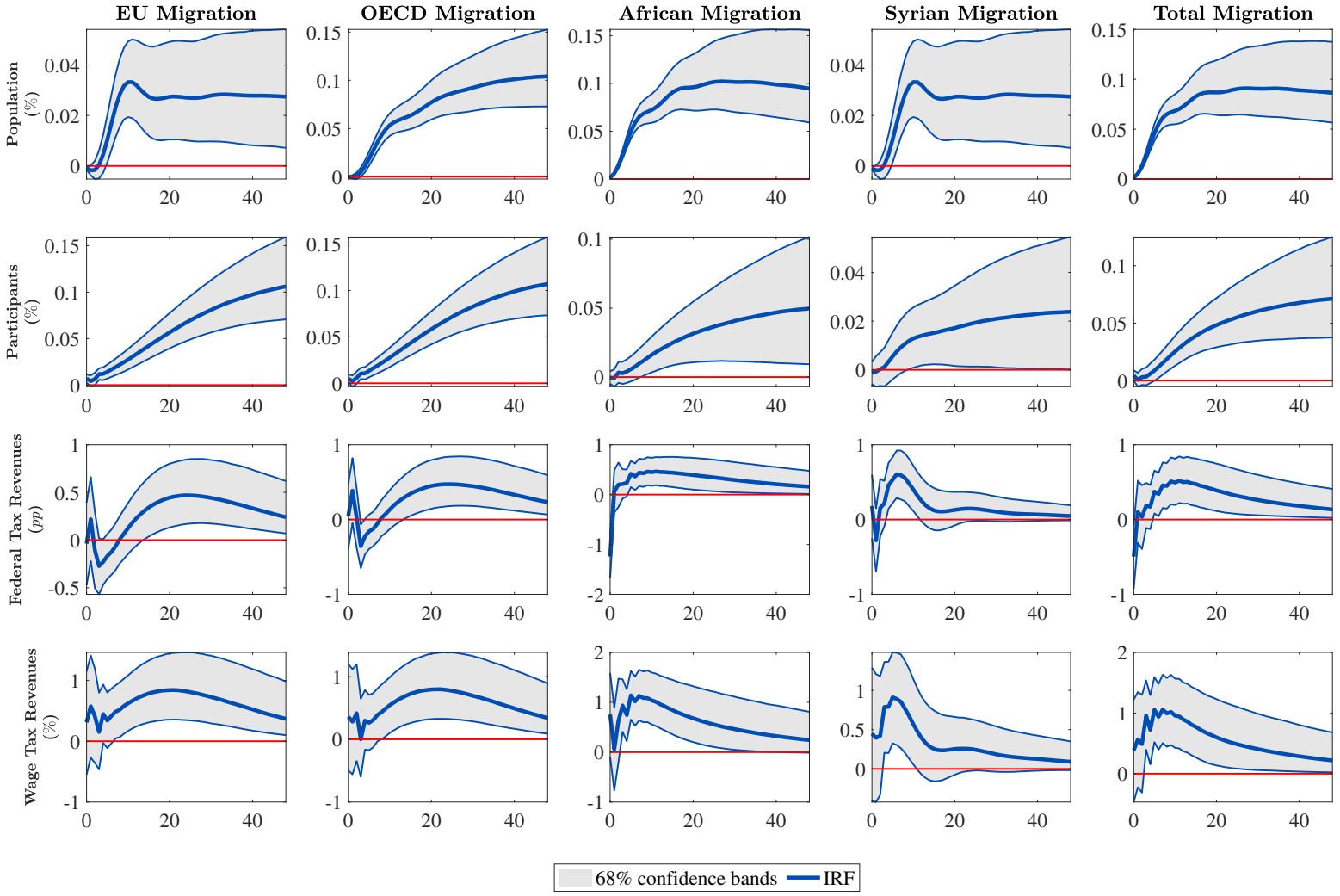
(a) Additional variables in the monthly SVAR



(b) LFS data in the Mixed-Frequency SVAR

Note: The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months. In the bottom panel, variables are constructed as explained in Section 4.1, using both employment and unemployment data from the Eurostat Labor Force Survey.

Figure A.3: Subsample analysis and the refugees wave: Additional variables



Note: Total migration results from augmenting the net migration variable used in the baseline SVAR with net flows from Syria. The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to time periods, measured by months.

Figure A.4: Estimated monthly GDP (in logs)