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Does Immigration Grow the Pie? Asymmetric Evidence from Germany

Nicolò Maffei-Faccioli

Eugenia Vella

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Does Immigration Grow the Pie? Asymmetric Evidence from Germany*

Nicolò Maffei-Faccioli[†1] and Eugenia Vella[‡2]

[1]IGIER, Bocconi University
[2]Athens University of Economics and Business and MOVE

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Abstract

We provide empirical evidence suggesting that net migration shocks can have substantial demand effects, potentially acting like positive Keynesian supply shocks. Using monthly administrative data (2006-2019) for Germany in a structural VAR, we show that the shocks stimulate vacancies, wages, house prices, consumption, investment, net exports, and output. Unemployment falls for natives (dominant job-creation effect), driving a decline in total unemployment, while rising for foreigners (dominant job-competition effect). The geographic origin of migrants and the education level of residents matter crucially for the transmission. Overall, the evidence implies that the policy debate should focus on redistributive strategies between natives and foreigners.

Keywords: Migration, job creation, job competition, Keynesian supply shocks.

JEL classification codes: C11, C32, E32, F22, F41.

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[†]nicolo.maffei@barcelonagse.eu

[‡]evella@aueb.gr, evgenia.vella@movebarcelona.eu

1 Introduction

The Alternative für Deutschland party in Germany, the UK Independence Party, and the Front National party in France, all gained prominence with anti-immigration platforms. Similar positions have underpinned the Brexit vote and policies of the Trump administration. The perception that newcomers adversely impact natives in the labor market is one of the most common arguments in favor of immigration restrictions. Understanding the aggregate and distributional effects of migration is fundamental to curb the rise in xenophobic movements and to design effective policies.

While a large literature has analyzed the impact of immigration with disaggregated data (see, e.g., Borjas (2014)), macroeconometric research is more limited partly due to a lack of high-frequency data. Based on municipal registers, monthly data on the arrivals of foreigners by country of origin is available since 2006 for Germany, the second-largest destination after the United States.[1] Immigration is a key determinant of changes in labor supply and, currently, the only source of population growth in the country. The German economy forms an ideal laboratory to investigate the effects of *mixed migration flows*, defined as "complex migratory population movements including refugees, asylum-seekers, economic migrants and other types of migrants" (Richard and Redpath-Cross (2011)). The German data enables us to study the potentially heterogeneous impact of migration from OECD and non-OECD countries, and the potentially asymmetric effects on natives' and foreigners' unemployment by education levels. This is the first paper that jointly explores these channels.

We identify net migration shocks in a structural vector autoregression (SVAR) model using a recursive scheme. Our analysis places a special focus on the response of unemployment. Contrary to the traditional view that migration causes slack in the receiving labor market by increasing labor supply, this response is in fact theoretically ambiguous. It depends, for instance, on how fast migrants enter the labor market and whether they do so as employed or job seekers. In addition, if domestic and immigrant workers are imperfect substitutes in production, increased inflows exert stronger competition on previous immigrants than on natives. Moreover, the job-creating response of firms may lower unemployment.[2]

The first contribution of the paper is to provide new evidence on the potentially dominant demand effects of net migration shocks, which remain largely unexplored so far. Typically, sign restrictions schemes impose that job-related immigration shocks on im-

[1] Registration is obligatory by law ("Melderechtsrahmengesetz", 2002) and is necessary to obtain the income tax card required for renting an apartment, signing a work contract, or issuing invoices as self-employed.

[2] Jobs can be created directly by self-employed immigrants or entrepreneurs and indirectly by immigrant innovators. Also, immigrants may boost technological adaptation, foster occupational mobility, and raise consumer demand (Constant (2014)).

pact increase participation and decrease wages (see, e.g., Furlanetto and Robstad (2019)). Focusing instead on the wider notion of *mixed migration* and leaving the two variables unrestricted, we obtain the opposite outcome. Immigration can stimulate productivity and wages when firms respond by expanding, investing, adjusting product specialization, adopting efficient technologies, and creating new businesses (Peri (2014)). The negative participation response is driven by non-OECD migration, suggesting a generally slow entry into the labor force, as we show below.[3] Migration shocks boost job openings and reduce unemployment, in line with the inverse relation of the Beveridge curve.[4] The fact that participation does not increase even for OECD migration (the response is non-significant), along with the rise in wages and vacancies, seem to imply that the transmission of migration shocks occurs predominantly through the demand side of the economy.

Consistently, we find that net migration shocks are expansionary, increasing industrial production, per capita net exports, and tax revenue. A mixed-frequency SVAR exercise further documents increases in per capita GDP, per capita investment, per capita consumption and house prices. The short-run decrease of CPI inflation that we uncover for total migration masks an inflationary demand-type effect of OECD migration shocks and a disinflationary supply-type effect of shocks from less developed areas of the world, such as Africa and Syria.[5] In the latter case, migration is predominantly low-skilled and often political in nature (including refugees). Based on the notion that demand is endogenous and affected by the supply shock, Guerrieri et al. (2020) define Keynesian supply shocks as supply shocks that trigger changes in aggregate demand larger than the shocks themselves. We argue that the inflationary effect of OECD migration shocks may represent a feature of positive Keynesian supply shocks, which offers a novel perspective in the immigration literature.

The second contribution is to shed light on the asymmetric labor market responses between natives and foreigners. Unemployment falls persistently for natives (dominant job-creation effect), driving the decline of aggregate unemployment, while it increases for foreigners (dominant job-competition effect). This finding goes against the common perception that newcomers adversely impact natives in the labor market. It also goes one step further by showing that the adverse impact falls upon the previous cohorts of immigrants. In addition, we demonstrate that the rise in foreigners' unemployment is stronger in the case of migration from Syria or Africa. To the best of our knowledge,

[3]Participation rates of asylum seekers are initially low and increase slowly over time (Brell, Dustmann, and Preston (2020)). For instance, the majority of refugees who arrived in 2015-16 started to enter the labor market in 2017. Lengthy asylum procedures impede investments in acquisition of the host country's language and delay labor market entry.

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

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

this paper is the first to bring this evidence in the literature. Intuitively, if domestic and immigrant workers are imperfect substitutes in production, increased migration inflows exert stronger competition on previous immigrants than on natives.[6] Results from the mixed-frequency SVAR confirm that a decrease in foreigners' participation drives the decline of aggregate participation, while for natives the response is positive. Concerning employment, we obtain symmetric (positive) responses between natives and foreigners.

The third contribution is to investigate potential sources of heterogeneity in the previous effects. Even if the unemployment response is, on average, negative for natives, it is still possible that some sub-groups are impacted by a dominant job-competition effect. To investigate the distributional impact, we consider unemployment rates by education levels. We find that the asymmetric response of unemployment between natives and foreigners is confirmed for medium-skilled workers – the largest subgroup for natives and the second-largest for foreigners.[7] Yet, we also find that OECD migration shocks increase unemployment rates of high-skilled natives, while decreasing those of low-skilled foreigners. Migration from Africa or Syria, on the other hand, entails an almost nil effect on high-skilled natives and a dominant job-creation effect for low- or medium-skilled natives. We thus conclude that only the high-skilled among the natives may be susceptible to migration. This happens in the case of flows from developed economies, which normally include more high-skilled migrants, and hence stronger job competition, relative to flows from non-OECD countries.

In a nutshell, a clear insight that emerges from the paper is that immigration, like trade, enlarges the aggregate economic pie. The rise in wages, vacancy postings, house prices, investment, output – and inflation and net exports for OECD migration shocks – along with the reduction of unemployment, point to substantial positive demand effects. Importantly, the distribution of the economic benefits warrants attention from policymakers since immigration entails, on average, a dominant job-creation effect for natives but a dominant job-competition effect for foreigners. Moreover, the geographic origin of migrants and the education level of locals introduce some heterogeneity in these effects. Policy debates should thus shift focus from immigration restrictions to the design of redistributive strategies.

Related Literature. The paper contributes to the growing literature on the macroeconomics of migration.[8] The most relevant strand for our work has used SVAR mod-

[6] As the migration literature has emphasized, natives and immigrants are typically employed in different occupations, which makes them imperfect substitutes in production (see, among others, D'Amuri, Ottaviano, and Peri (2010), Ottaviano and Peri (2012), and Manacorda, Manning, and Wadsworth (2012)). Immigrants (natives) often have a comparative advantage in manual-intensive (language-intensive) tasks.

[7] Throughout the paper, we use interchangeably the terms skilled and educated.

[8] See Vella, Caballé, and Llull (2020) for a recent edited collection on the macroeconomics of migration.

els (see Schiman (2021) for Austria, Furlanetto and Robstad (2019) for Norway, Smith and Thoenissen (2019) for New Zealand, d'Albis, Boubtane, and Coulibaly (2016) and d'Albis, Boubtane, and Coulibaly (2019) for France and for a panel of 19 OECD countries respectively, and Kiguchi and Mountford (2019) for the United States). Below, we discuss the first two studies, which are more closely related to ours.

Regarding the labor market responses of natives and foreigners, Furlanetto and Robstad (2019) find a symmetric (negative) response of unemployment to job-related migration shocks from developed economies. Instead, we demonstrate for OECD migration shocks that the aggregate unemployment response is positive for foreigners and also masks heterogeneous impacts by education. Similarly, we show that the negative response of natives masks a positive response of the high-skilled. We emphasize that the unemployment effects of OECD migration shocks are substantially different from the effects of shocks from less developed areas, such as Africa or Syria.

Abstracting from potential asymmetric effects on unemployment or participation, and educational or geographic sources of heterogeneity, Schiman (2021) finds an asymmetric response of employment between foreigners and natives. For foreign employment, the response is restricted to be positive, while for native employment is left unrestricted. Positive sign restrictions are also imposed on the foreign to domestic employment ratio and the unemployment rate. Leaving (un)employment variables unrestricted, our results indicate a stronger positive response of employment for foreigners than natives and a decrease in total unemployment.

With respect to demand effects, Furlanetto and Robstad (2019) and Schiman (2021) show that immigration shocks and labor supply shocks, respectively, might have *medium-run* inflationary effects. In Schiman (2021), the response of vacancies to foreign labor supply shocks is not significant, while it is not examined in Furlanetto and Robstad (2019). Overall, we provide robust evidence for a substantial demand impact of migration shocks on a variety of variables, as mentioned above.

Differences in the notion of migration and in the macroeconomic data play an important role in the differences in findings with those two papers. First, we use a wider notion of migration flows, namely "mixed" flows, capturing various types of migrants, instead of just job-related migration. Relative to Norway and Austria, migrants in Germany come from a wider set of countries and migration flows are more heterogeneous. Second, there are different features of the macroeconomic data, namely Germany is different from Norway and Austria. For example, unemployment in Norway moves little, in Austria it increases, while Germany exhibits a large decrease over the sample considered (see Figure A.1 in the Appendix).[9]

[9]We discuss differences in the identification strategy in detail in Section 2.3. We argue that the identifica-

Another strand of the macro-labor literature has performed steady-state analysis with search models for the U.S. immigration. If there are two markets, skilled natives are insulated from competition by unskilled immigrants and can experience a fall in unemployment through a rise in their marginal product of labor (Liu (2010)). In Chassamboulli and Palivos (2014), the firms' job-creating response increases natives' employment. Under non-random hiring, Albert (2021) finds that the job-creation effect of undocumented immigration decreases unemployment and raises wages for natives. For Germany, Iftikhar and Zaharieva (2019) find that the 25% immigration increase of 2012–2016 had a (moderate) negative effect on the welfare only of low-skilled workers in manufacturing. While abstracting from separate wage effects due to data limitations at high frequency, our paper analyzes empirically the dynamic job-creation and job-competition channels for natives and foreigners, respectively.

Finally, our results for the German economy are consistent with recent studies on the economic benefits of (historical) immigration in the United States. Tabellini (2020) shows that European immigration to U.S. cities between 1910 and 1930 increased natives' employment, spurred industrial production, and did not generate losses even among natives working in highly exposed sectors. Similarly, Sequeira, Nunn, and Qian (2020) find that U.S. counties with more historical immigration have higher income and less unemployment, while Azoulay et al. (2020) argue that immigrants act as net job creators.

Structure. Section 2 lays out the data and econometric model. Section 3 discusses the baseline findings. Section 4 performs a subsample analysis for migration flows by geographic origin and examines the impact of the refugee wave. Section 5 studies the response of unemployment by education level. Section 6 reports the results of a mixed-frequency SVAR. Finally, Section 7 concludes.

2 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.

tion strategy does not drive the difference in findings. For example, when we examine migration flows from OECD countries in Section 4, which are very similar to the countries considered in Furlanetto and Robstad (2019) for job-related migration, we can confirm many of the results for the variables that are common in the two papers.

2.1 Monthly Data on Net Migration Flows

Since January 2006, the Federal Statistical Office of Germany (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 continents are covered (Europe, Asia, Australia and Oceania, America, and Africa). The exact list of countries is presented in the Appendix.[10] 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 of Destatis.[11]

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 population.[12] We observe a large increase during the period under study. Specifically, the total net migration rate (blue 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 2015. Notably, this significant increase is observed even if we exclude (cyan line) Syrian flows (green line), which explain the bulk of the 2015-2016 spike during the Europe's migrant crisis. 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.[13] 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 U.S., Australia, and Japan in various years. The net migration rate from Syria peaks in November 2015 at around 0.9%. 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 total net migration rate (blue line), corresponding to the notion of mixed migration flows. In Section 4, we check the robustness of our results to (a)

[10] The data set does not contain information on education levels. Such information is available for migrants' stocks at annual or quarterly frequency from survey data (see Figure A.2 of the Appendix and Section 5).

[11] Data starting from 2008 is available online through the Genesis database of Destatis. We obtained a longer data set starting from 2006 and including information on the countries of origin through a special request.

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

[13] 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. From 2015 to 2016, net migration to Germany fell by more than half, partly due to the closing of the Balkan route to extra EU migrants (March 2016). Net migration was negative from almost all Balkan states and also decreased considerably from Poland and Romania.

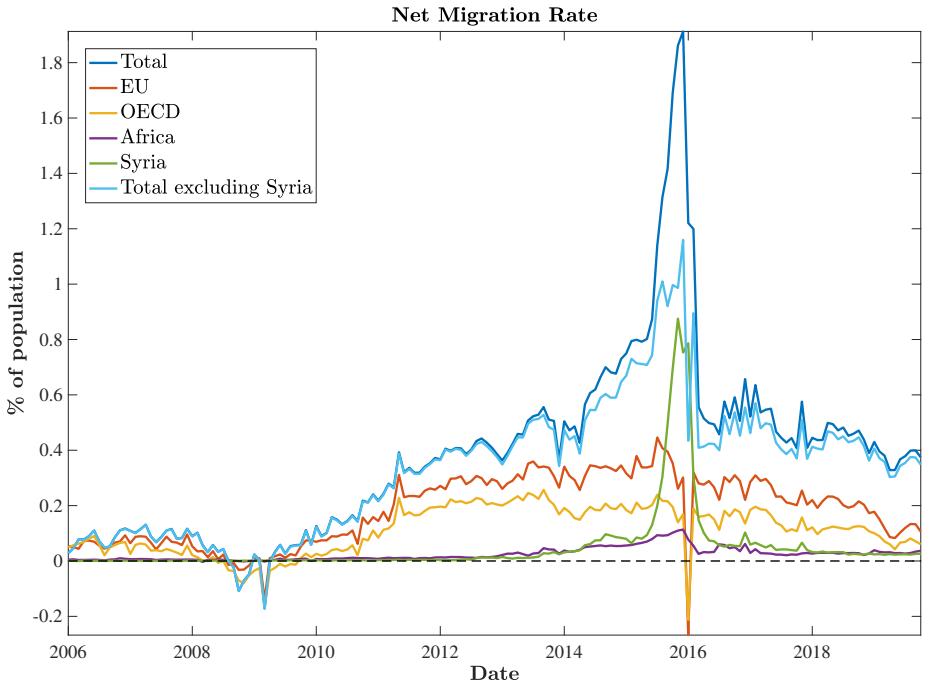


Figure 1: Net Migration Rate in Germany by Geographic Origin, 2006-2019

Note: EU refers to the EU-28 excluding Germany, thus covering 27 countries. From the group of OECD countries we exclude Chile, Colombia and Mexico. Source: Federal Statistical Office (Destatis).

excluding Syrian flows from the sample and (b) focusing on different geographic origins of migration.

2.2 Econometric Model

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 $n \times 1$ vector containing n endogenous variables, C is a $n \times 1$ vector of constants, $A_1, ..., A_p$ are $n \times n$ 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 five variables in the following order: net migration rate, business expectations index (logarithm), consumer confidence index (logarithm), industrial production index (logarithm), and registered unemployment rate.[14]

[14]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, manufac-

We include variables in levels in the VAR model, as our interest is in explaining short- to medium-run fluctuations, rather than long-run patterns. The time series included are, with the exception of the unemployment rate, non-stationary in level and cointegrated (see Table 1 and Table 2 in the Appendix). Estimation of the model in levels is thus appropriate, as it results in no mis-specification and is consistent. When there is cointegration between the variables in the system, taking their first difference would result in a loss of information contained in the data (see Sims, Stock, and Watson (1990)).

We include consumer confidence and business expectations to address potential concerns that migration flows may be driven by expectations about future economic developments in Germany, and thus to avoid potential non-fundamentalness issues (see Forni and Gambetti (2014)). The Consumer Confidence Index, available from the OECD, provides an indication of future developments of households' consumption and savings, based upon answers regarding their expected financial situation, their sentiment about the general economic situation, unemployment and capability of savings. The second variable is the expectations component of the Ifo Business Climate Index, which is the most important early indicator of economic developments in Germany. It is published on a monthly basis and is based on approximately 9,000 monthly survey responses of firms in manufacturing, services, construction, wholesaling and retailing. The firms are asked to give their assessments of the current business situation and their expectations for the next six months. The two measures are highly informative of both consumer and firm expectations about current and future developments in the economy. By including both of them in the system, we can be confident that we are using a wide set of expectations and information about the economy.

To disentangle the unemployment responses of natives and foreigners, we also run the VAR 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 natives and of foreigners who are registered unemployed to the economically active population (participants). We decompose further the effects on natives and foreigners unemployment by education level using data available from 2009:01, which we obtained from the Federal Employment Agency by submitting online a request form.

In further exercises using data from Destatis, we add to the baseline model one at a time, and order last in the system, the following ten variables: population (interpolated from quarterly data), number of labor market participants, labor force participation rate, number of employed workers, number of registered vacancies, real hourly wages in the manufacturing and mining sector, real labor income tax revenue per capita, real tax revenues of the Federation per capita, real net exports per capita and the CPI. These variables

turing, energy and construction. Series in logs are multiplied by 100.

enter in logarithmic form except for the participation rate.

2.3 Estimation and Identification

The model is estimated using Bayesian methods with a flat prior such that the information in the likelihood is dominant (see the Appendix for details). We use three 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 (see Section 3.3). 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. 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. Examples of such shocks are given by the EU enlargement process to Eastern European countries or by shocks in immigrants' countries of origin, which are unrelated to developments in the German economy. Other shocks in Germany, which 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 current or expected 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. Let us provide an intuitive example. Suppose that someone decides to move to Germany because of current or expected favorable economic developments in the country. 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 a more permanent accommodation. It is difficult to argue that this process would take less than a month, and will be even longer for those in need of a VISA, who represent a non-negligible share of our series of mixed migration flows. The reverse of this example can be applied to those leaving Germany.

Finally, let us briefly explain why we have not opted for the sign restrictions schemes used in recent literature. Such schemes typically rely on the assumption that immigrants enter the labor force rapidly, restricting the impact response of variables such as output, wages, participation and employment to migration shocks. While these assumptions are sensible in the case of job-related migration, they are likely violated when immigrants access the destination country via family reunification or as asylum seekers (see Furlanetto

and Robstad (2019)). These types of migrants represent a relevant share in our net migration series, making such restrictions unappealing in our context. Instead, the recursive identification scheme can be applied in our case since we focus on mixed migration flows with administrative data available at monthly frequency.

3 Main Results

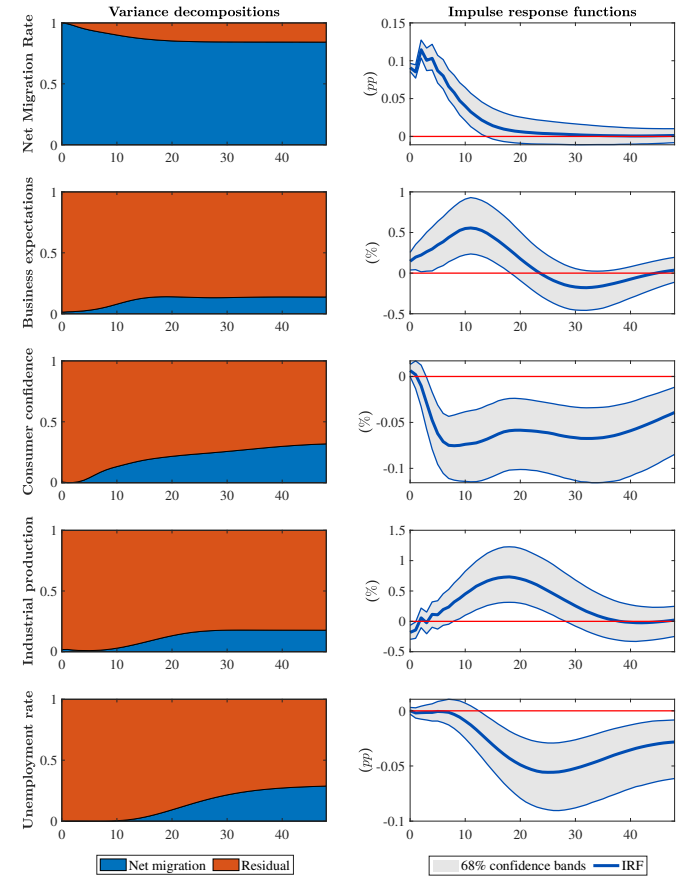
In this section, we present impulse response functions to one-standard-deviation net migration shocks. The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers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

3.1 The Expansionary Effects of Net Migration Shocks

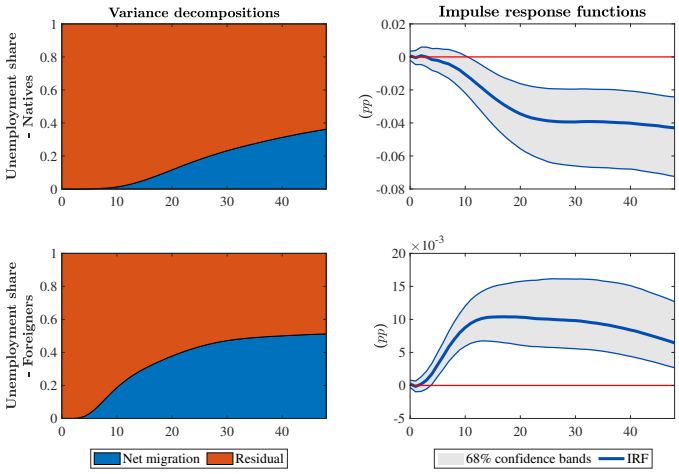
The second column of Figure 2a shows that a positive net migration shock increases persistently the net migration rate. The effects on the German economy are clearly expansionary as industrial production increases and the unemployment rate decreases significantly over the horizon considered. Industrial production exhibits an inverted U-shaped pattern in response to the shock, with negligible effect on impact and maximal effect after a year and a half following the shock. The unemployment rate starts decreasing significantly after one year, reflecting a sluggish response of the macroeconomy to the migration shock. Interestingly, this shock induces a negative response of consumer confidence. This result pairs well with the narrative that migration waves are often perceived as a labor market threat by the natives, thus decreasing their confidence about the state of the economy. In this respect, it would be hard to argue that the migration shock we identify reflects standard demand shocks. On the other hand, business expectations rise significantly, potentially reflecting expected positive externalities for the firms from the increase in labor supply.

The effects appear quantitatively important. The first column of Figure 2a shows that the migration shock explains the bulk of monthly fluctuations of the net migration rate. Regarding industrial production and unemployment, the migration shock explains around 20% and 30% respectively after approximately four years. The shock also explains a non-negligible share of the variance of business expectations and consumer confidence – about 14% and 32% respectively after four years. Unsurprisingly, the other shocks in the system account for the bulk of fluctuations in these variables.

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



(a) SVAR with total unemployment



(b) 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 months.

3.2 Unemployment Responses of Natives and Foreigners

Figure 2b shows the results when we augment our SVAR model with the unemployment shares of natives and foreigners in the labor force, which replace total unemployment. Interestingly, the responses we obtain are asymmetric: the unemployment share of natives decreases significantly and persistently after a year, while the unemployment share of foreigners increases after a semester.[15] Migration shocks appear particularly relevant for foreigners' unemployment, explaining around 50% of its variance at a horizon of four years.

On the one hand, these results highlight dominant and important 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 at the aggregate level. As emphasized in the Introduction, migrants often complement and rarely substitute for native workers.

In the next subsection, we assess the robustness of these findings to different specifications of the econometric model and alternative identification strategies. Moreover, we check if our results remain robust when we perform a subsample analysis for migration flows by geographic origin in Section 4. We consider unemployment of natives and foreigners by education levels in Section 5. Finally, we investigate further the labor market responses of natives and foreigners by looking at participation rates and employment in Section 6.

3.3 Robustness: Identification and Model Specification

Our results are robust to a variety of sensitivity checks with respect to both the identification strategy and the model specification.

Recursive identification. To further assess the effects of net migration after controlling for the potential impact of expectations, we order the net migration rate after business expectations and consumer confidence and identify the migration shock with the assumption that it has no impact effect on these two variables. This robustness check ensures that our main results are not due to expectation-driven shocks. Additionally, we order the net migration rate last in the system of variables, allowing all the shocks to contem-

[15] The impulse responses for the remaining variables in the system are presented in the Online Appendix. We also include in the Online Appendix the 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, while the total pool of unemployed decreases in line with Figure 2a.

poraneously affect this variable and assuming that a migration shock affects expectations and the macroeconomy with a lag. The first two columns in Figure A.3 of the Appendix report the results, which remain essentially unaffected. Note that, while both approaches are useful to assess the robustness of our findings, imposing that migration shocks have no contemporaneous effects on the other variables in the system, especially expectations or confidence, might be a contestable assumption.

Sectors. Data from the Microcensus of the Federal Statistical Office (Destatis), with representative annual statistics of the population and the labour market, shows that the highest concentration of foreign workers in 2019 is observed in manufacturing (22.52%), trade, maintenance and repair of motor vehicles (13.29%), hospitality (10.76%), health and social services (10.37%), and construction (9.33%).

If immigrants are concentrated in sectors that lead the business cycle, as construction or manufacturing, they will enter the German labor force before or at the same time as industrial production increases. While current and expected developments in these sectors are reflected in the measure of business expectations, we nevertheless perform two additional exercises to ensure that our identified migration shocks are not plagued by such issues. Data on wages and employment for the manufacturing and mining sector are readily available from Destatis for our baseline sample, and for the construction sector starting from 2009:1. First, we include wages for the manufacturing and mining sector and order them first in the system of variables of our recursive SVAR. We identify the migration shock with the restriction of no impact effect on wages in the manufacturing sector. Second, we repeat this exercise with wages for the construction sector. Columns four and five in Figure A.3 of the Appendix report the results, which are extremely similar to the baseline specification. In the Online Appendix, we show that our results are also robust when we include, before the migration variable, hours worked of employees for these sectors, which are typically important leading indicators of the business cycle.

Narrative sign restrictions. Recently, Antolín-Díaz and Rubio-Ramírez (2018) and Ben Zeev (2018) developed a methodology which allows to impose that around selected historical events structural shocks and/or historical decompositions agree with some narrative information. Our model with net migration shocks constitutes an appropriate setup to incorporate such restrictions. We restrict the migration shock to have a positive impact effect on the net migration rate and to be its major driver between 2014:04 - 2016:01 (Europe's migrant crisis). Considering the nature of the large inflows of migrants (largely, asylum seekers), it is reasonable to assume that migration, during that period, was mainly due to events happening outside of Germany, and thus not because of its domestic eco-

nomic developments. To further sharpen the identification of the migration shock, there are a number of key events in the sample period 2006:01-2019:10 which can be employed as narrative information. We consider three events in May 2011, January 2016 and March 2016. The first refers to the labor market liberalization (free mobility) in Germany for the EU8 countries, which joined the EU in 2004. We restrict the migration shock to be positive for this month. January 2016 corresponds to the implementation of Turkey's commitments under the EU-Turkey Joint Action Plan, which aimed to reduce transit migration directed towards the EU. March 2016 refers to the closure of the Balkan route (see footnote 13). We restrict the net migration shock to be negative on both dates. The responses of unemployment, industrial production, consumer confidence and business expectations are left unrestricted, and we do not impose any additional restriction regarding the remaining shocks in the system. The restrictions are implemented using the algorithm of Antolín-Díaz and Rubio-Ramírez (2018). The results, presented in the third column of Figure A.3 (additional results are included in the Online Appendix), are robust to this alternative identification strategy.

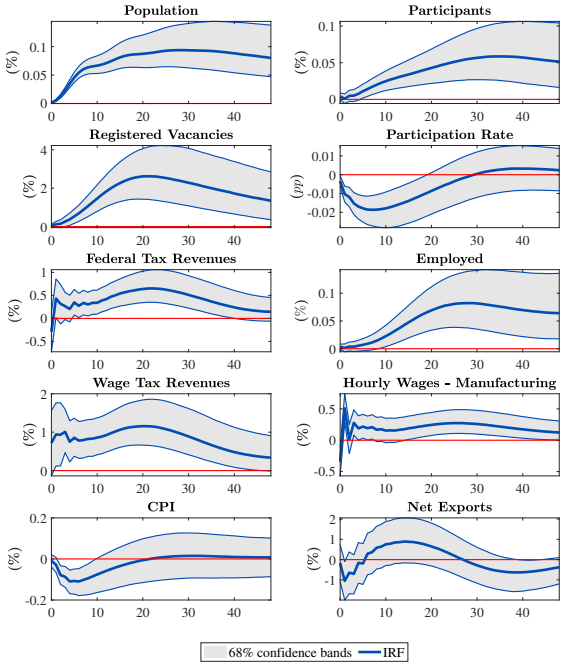
Model specification. Figure A.4 in the Appendix reports the results of our recursive SVAR when (i) we use a larger number of lags in the VAR, (ii) we include a linear or quadratic trend, (iii) we specify a shorter sample up to 2014:12, to address the potential concern that our results may be driven by the migration crisis of 2015. Including four or five lags (see columns one and two), hardly affects the impulse responses. Including trends (see columns three and four) does not change qualitatively the responses, but decreases significance (see the discussion about the inappropriateness of using trends in Bayesian VARs in Uhlig (1994)). Finally, the key findings of the paper remain essentially unchanged when we end our sample at 2014:12 (see column five). The only difference that we obtain is in the response of consumer confidence, which now becomes positive. However, this finding is actually not surprising. As we will see in Section 4, the decline in confidence in our baseline specification may be driven by migration flows from African countries and Syria (which are predominant between 2015-2016, but relatively small before).

Following the battery of sensitivity checks reported above, we feel confident to use our baseline recursive approach to assess below the effects of net migration shocks on a variety of macroeconomic and labor market variables.

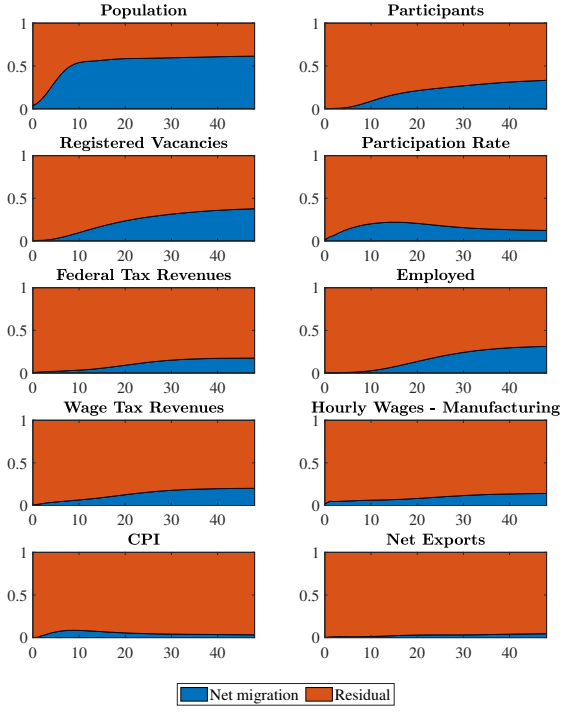
3.4 Other Key Variables and Local Projections

Given that Germany has an exceptionally large employment share in manufacturing (around 25% in 2014) and immigrant workers have a strong presence in this sector, in this section,

Figure 3: 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 months.

we augment our baseline (recursive) SVAR with real hourly wages in the manufacturing and mining 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.

Figures 3a and 3b present the impulse response functions and the variance decompositions, respectively. The net migration shock increases persistently labor demand (vacancies), the pool of employed workers, and also real hourly wages gradually. The positive response of vacancies highlights a job-creation effect 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)). While Schiman (2021) consistently finds a positive response of wages and vacancies to labor supply shocks in the medium run, pointing to substantial labor demand effects, the vacancies' response to foreign labor supply shocks is not statistically significant in the paper and is not examined in Furlanetto and Robstad (2019) either. Regarding inflation, we find a short-lived negative effect, which turns non-significant once we exclude migration flows from Syria (see Figure 5 below). Subsample analysis in the next section reveals that the response of inflation depends on the geographical origin of migrants, providing evidence of both inflationary and disinflationary effects.

Turning to labor supply effects, the shock leads to a protracted increase in the pool of labor force participants five months after the shock, which is outweighed though by a higher rise in population, resulting in a decrease in the participation rate. Focusing on the wider notion of mixed migration flows, this result deviates from the typical association of labor migration shocks with an increase in participation (see, e.g., Furlanetto and Robstad (2019)). The fact that aggregate participation does not increase, along with the rise in wages and vacancies, seem to imply that the transmission of the migration shock occurs predominantly through the demand side of the economy. Sections 4 and 5 shed more light on the participation response through a subsample analysis and a mixed-frequency SVAR exercise with quarterly data on natives and foreigners, respectively.

Given the positive impact on employment and wages, labor income tax revenue rises significantly and persistently. The response of federal total tax revenue also appears positive five months after the shock. The impact on international trade (net exports) appears to be non-significant.

The variance decomposition in Figure 3b reveals that the net migration shock is a major driver of fluctuations in population over the horizon considered. This finding confirms that the immigration shock we identify is the main source of population growth in our sample. The effects are relevant for other variables, too. Net migration explains a large share of the variance of participants and vacancies, approximately 30% and 40% respec-

tively, and a non-negligible share for the other variables, with the exception of the CPI and net exports. Altogether, these findings stress the role of net migration as driver of macroeconomic and labor market fluctuations in Germany.

As an alternative to the estimation of a different recursive SVAR for each additional variable, we also estimate a simple local projection and assess the robustness of our findings. This approach ensures that we use the same identified shock for each variable, thus not altering the model each time. We regress each variable on a constant, its lag and the median shock obtained from the Cholesky SVAR corresponding to Figure 2a. Figure A.5 in the Appendix reports the results, which continue to hold qualitatively.

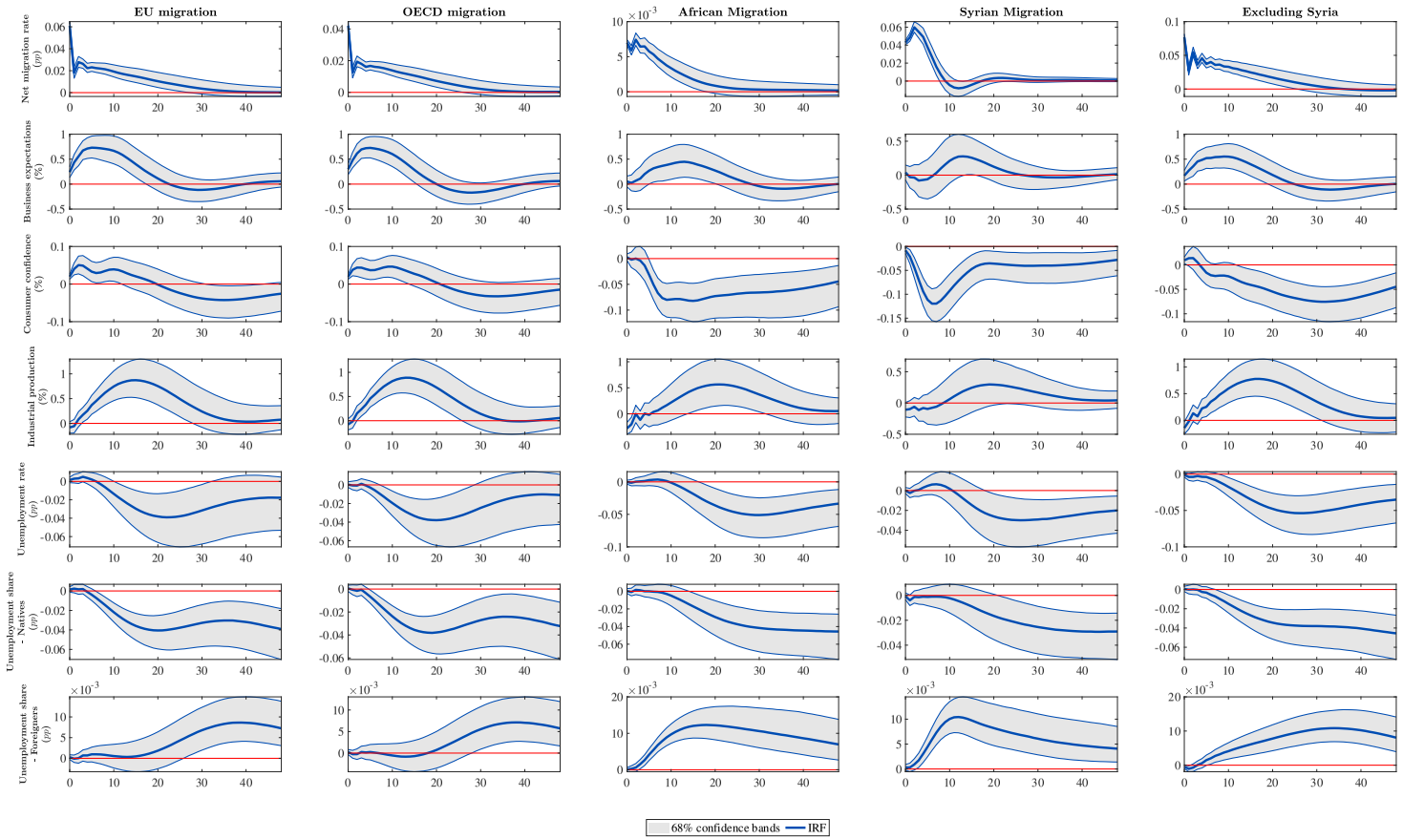
4 Geographic Origins and the Refugee Wave

Empirical evidence suggests that the average education level of immigrants is higher from developed than developing countries. In addition, so far, we have not investigated separately 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 recursive SVARs of Figure 2a, 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.[16] We also show findings when we exclude Syrian flows from the total migration variable used until now.

Figure 4 shows responses for the net migration rate, business expectations, consumer confidence, industrial production, total unemployment rate, and the unemployment shares of natives and foreigners. Results remain qualitatively unchanged in all cases with the exception of consumer confidence, which is positive for OECD and EU migration, while being negative for African and Syrian migration. This could suggest that the population negatively views predominantly low-skilled and often political immigration from non-developed countries. Net migration shocks from EU and OECD countries have very similar effects (columns 1 and 2). Interestingly, the increase in foreigners' unemployment share is more muted and becomes significant only after more than two years after the shock. In the case of net migration from Africa (column 3) and Syria (column 4), the positive response of industrial production is reduced and becomes insignificant, respectively. The unemployment rate of natives declines more sluggishly, while the increase in foreigners' unemployment is quicker and stronger in magnitude compared to the baseline

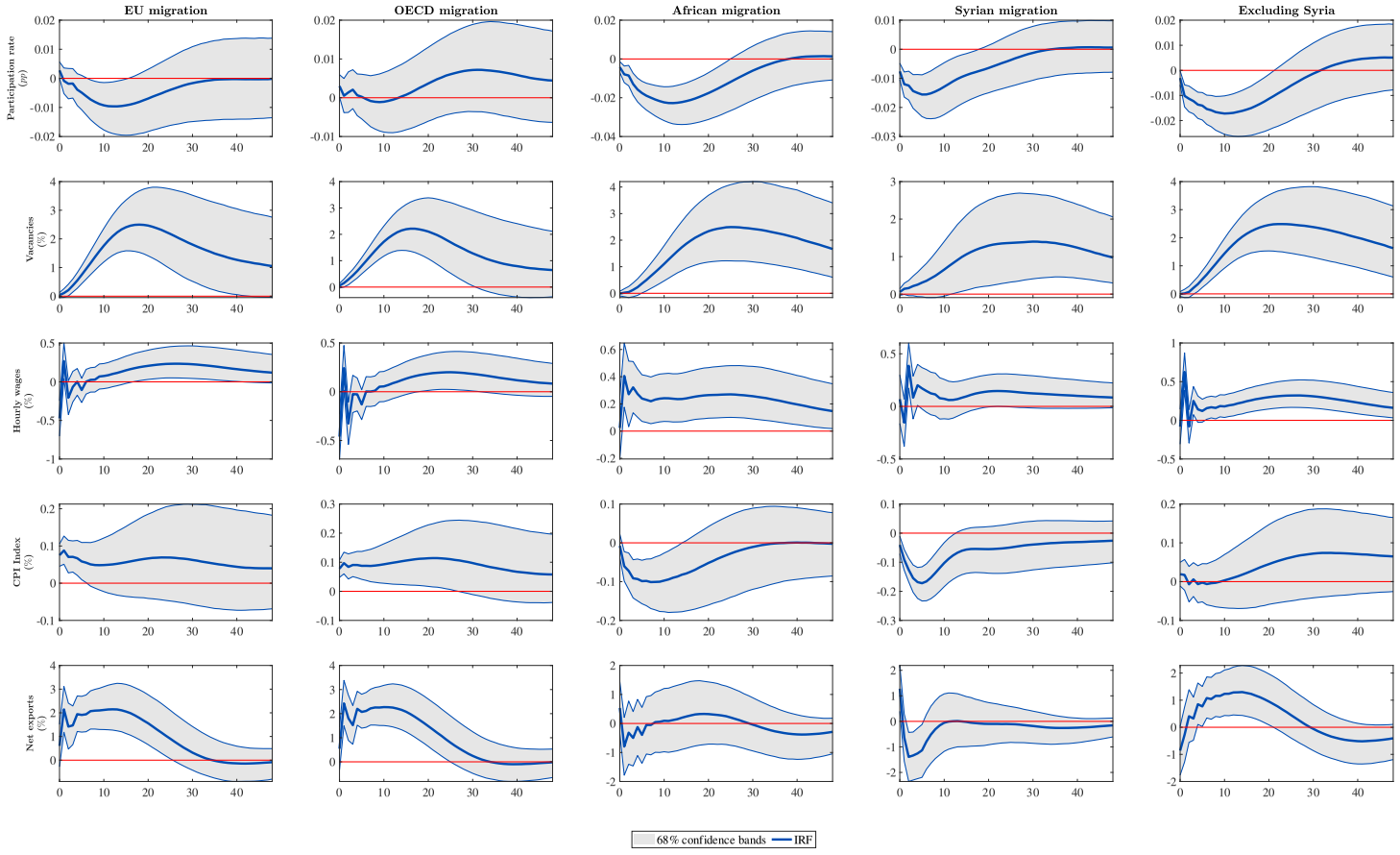
[16] Results for net migration flows from Asia are mainly driven by Syria and therefore look very similar. Net flows from South America were found to be little relevant for our analysis. Both sets of results are available upon request.

Figure 4: Geographic origins and the refugee wave (subsample analysis Part A)



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 months.

Figure 5: Geographic origins and the refugee wave (subsample analysis Part B)



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 months.

of Figure 2b. Importantly, all our results continue to hold and are statistically significant when we exclude Syrian flows from the total net migration rate (column 5).

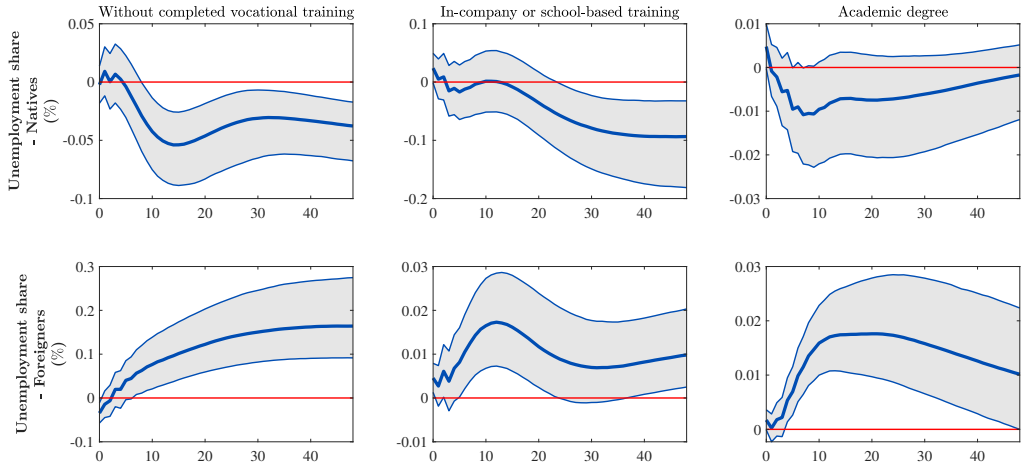
Figure 5 presents responses for the participation rate, vacancies, hourly wages in manufacturing and mining, inflation, and net exports.[17] The negative response of the participation rate in Figure 3a is mainly driven by non-OECD economies (Africa or Syria), whereas the response is not statistically significant for net migration from OECD countries and is negative and slightly significant only during the first year following the shock for EU migration. 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). Indeed, while the response of participants is positive and significant on impact for EU and OECD (job-related) migration, it is insignificant for African and Syrian migration (see the Online Appendix).

The positive responses of vacancies and hourly wages is confirmed in all cases shown in Figure 5. Notably, wages appear to decrease on impact for job-related migration (EU and OECD countries), in line with the restrictions of Furlanetto and Robstad (2019). The response of the CPI is also interesting. Recall that the response in Figure 3a was negative and significant in the short-run. When we exclude Syrian flows from the net migration rate variable, the CPI response becomes insignificant. The subsample analysis shows that this masks a positive response to OECD and EU migration shocks (prevalent demand effect) and a negative response to African and Syrian migration shocks (prevalent supply effect). We argue that the inflationary demand-type effect of OECD migration shocks may represent a feature of positive Keynesian supply shocks, defined as supply shocks that trigger changes in aggregate demand larger than the shocks themselves (Guerrieri et al. (2020)). The response of net exports is also insightful. When we exclude Syrian flows from the net migration rate, the net export response becomes positive and significant (it was not significant in Figure 3a). Net exports increase persistently in the case of OECD and EU migration shocks, while the response is not significant if we examine African or Syrian migration.

The analysis in this section has disentangled the effects of migration from EU and OECD countries and predominantly low-skilled migration (including refugees) from less developed economies, such as African countries and Syria. This distinction matters for a number of variables: consumer confidence, unemployment of foreigners, participation rate, the CPI, net exports and wages.

[17] Responses for population, participants, federal and wage tax revenues are included in the Online Appendix.

Figure 6: SVAR with unemployment by education levels



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 months.

5 Unemployment Responses by Education Levels

In Section 3.2, we uncovered asymmetric unemployment responses to migration shocks – positive for foreigners and negative for natives. Even if the response is, on average, negative for natives, it is still possible that some sub-groups are impacted by a dominant job-competition effect. To investigate the distributional impact, in this section we examine the responses of unemployment by education level. The Federal Employment Agency provides monthly data on the number of foreign and native unemployed workers from 2009:01 for three education groups: (a) without completed vocational training, (b) with in-company or school-based training, and (c) with an academic degree. We consider these groups as a proxy for low, medium and high-skilled workers, respectively.

Figure 6 shows the results of the baseline recursive SVAR where the total unemployment rate is replaced with the unemployment shares by the education/skill level of natives and foreigners. Unemployment declines significantly for the low-skilled natives less than a year after the migration shock and for the medium-skilled natives two years after the shock, while the response is not statistically significant for the high-skilled. For foreigners, unemployment rises after the first three to five months in all cases.

Next, we repeat the subsample analysis for different geographic origins of migrants. Starting with natives in Figure 7a, there are two findings that stand out. First, the non-significant response for the high-skilled natives in Figure 6 is confirmed for migration from Africa (third row) and when we exclude flows from Syria (fifth row). Second, for OEDC or EU migration shocks (first two rows), this response becomes statistically sig-

nificant and positive. For the low-skilled natives, the unemployment decline in Figure 6 becomes non-significant for EU and OECD migration.

Continuing with foreigners in Figure 7b, the unemployment responses of Figure 6 are confirmed if we examine migration shocks from Africa (third row) and Syria (fourth row). In the case of OEDC or EU migration (first two rows), the unemployment increase for the high-skilled foreigners becomes non-significant, while for the low-skilled foreigners the unemployment response changes sign, turning negative in the short-run. Finally, the findings of Figure 6 both for natives and foreigners remain unaltered if we exclude Syrian flows from our total net migration variable (last row in Figures 7a and 7b).

Overall, the results suggest that mixed migration shocks increase unemployment for foreigners of all education levels, while they decrease it for the low- and medium-skilled natives. The subsample analysis reveals for OECD (or EU) migration shocks that, while the previous asymmetric impact is preserved for medium-skilled workers – the largest sub-group for natives and the second-largest for foreigners, these shocks are also distinct in that they increase unemployment rates of high-skilled natives, but they decrease those of low-skilled foreigners.[18]

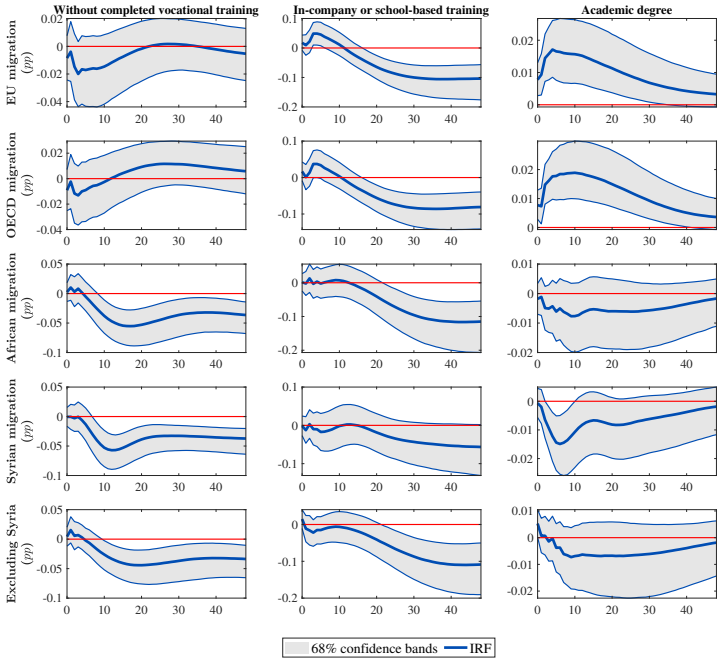
Migration flows from developed countries do involve a higher proportion – relative to developing countries – of high-skilled labor immigrants, who directly compete with high-skilled natives, for instance in occupations with language-intensive tasks. At the same time, high-skilled immigrants create jobs, including for previous cohorts of low-skilled immigrants, by enhancing productivity through technological progress and spillovers, increasing consumer demand, and helping companies expand when filling critical roles.

6 Deeper Insights from a Mixed-Frequency SVAR

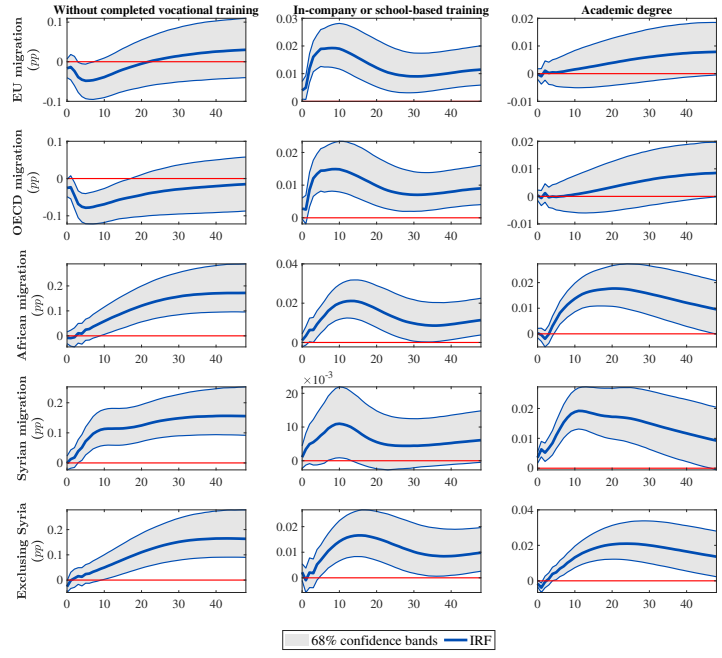
So far, we have shown that the participation rate falls after net migration shocks, but we have not examined the responses of natives and foreigners separately. Since data on participation (and employment) by nationality is available quarterly, in this section we proceed with a mixed-frequency SVAR. This approach allows us further to explore quarterly data on consumption, investment, GDP, house prices, and real hourly wages for the aggregate economy. In the Online Appendix, we provide similar results obtained through local projections, as discussed in Section 3.4.

[18] According to Figure A.2 in the Appendix, the largest fraction of natives are medium-educated (57%), while of foreigners are low-educated (50% in 2006 and 40% in 2019). The fraction of highly educated tends to converge over the last fifteen years.

Figure 7: SVAR with unemployment by education levels and migrants' origin



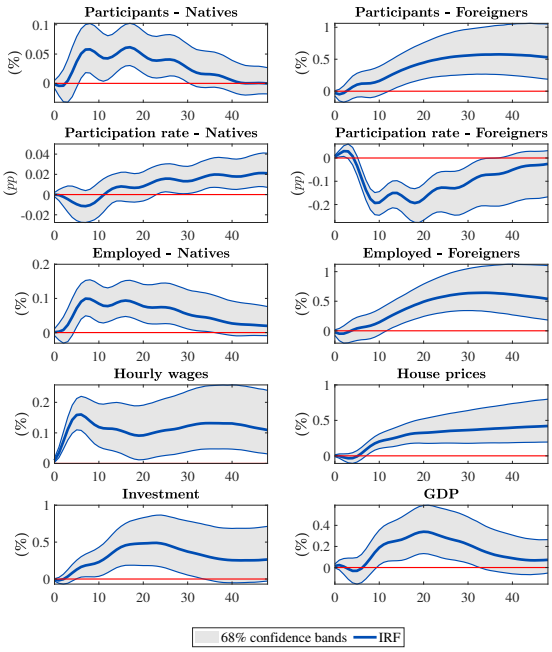
(a) Natives



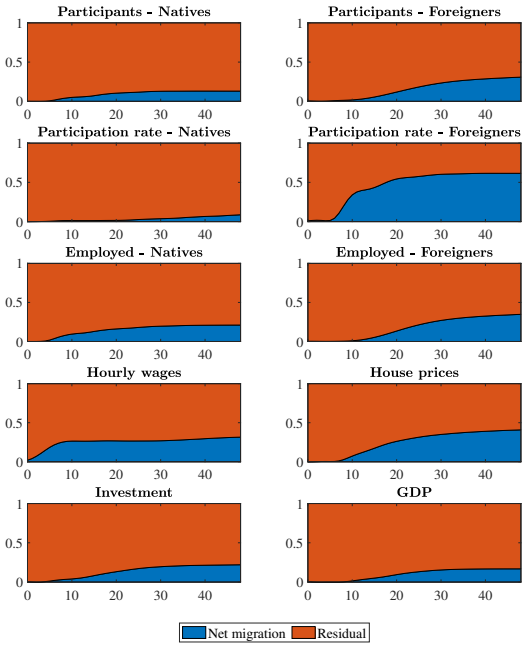
(b) Foreigners

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 months.

Figure 8: 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 months.

6.1 The Model and Quarterly 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) using the toolbox of Ferroni and Canova (2020).

We consider two different models: one for the labor market variables and one for the aggregate macroeconomic variables. In the first model, we complement the five variables of our baseline recursive SVAR (net migration rate, business expectations, consumer confidence, industrial production, unemployment rate) with (a) the number of employed workers (in logs), as it conveys relevant information to properly estimate the model, and (b) the following quarterly variables (one at a time): participation rate of natives, participation rate of foreigners, the number of participants natives (logarithm), the number of participants foreigners (logarithm), the number of employed natives (logarithm), and the number of employed foreigners (logarithm). The unemployment rate considered in this specification is the one of foreigners (natives) when the augmented variable in (b) refers to foreigners (natives). The second model complements the five baseline variables with the following quarterly variables (one at a time): real hourly wages for the total economy, house price index, per capita real consumption, per capita real investment, and per capita real GDP. In both models, we specify flat priors in line with our monthly SVAR model and we include three lags of the dependent variable.

Data by nationality on the number of employed, the number of participants and the participation rate is available from the Eurostat's Labor Force Survey (LFS). Real hourly wages are defined as hourly compensation of employees from Destatis, deflated by the CPI. The remaining macroeconomic variables (house price index, consumption, investment, and GDP) are taken from the Destatis and FRED databases.

6.2 Participation and Employment of Natives and Foreigners

Figure 8a shows impulse responses for the quarterly variables to a net migration shock. The participation rate of natives increases significantly in the second half of the time horizon, while that of foreigners decreases persistently driving the decrease in the aggregate participation rate 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. The immediate rise in population outweighs the rise in total participants (Figure 3a).

Figure 8a also shows that the number of employed natives and employed foreign-

ers both increase significantly and persistently. Notice that our results differ from Schiman (2021), who documents a decrease in domestic employment and an increase in foreign employment following a foreign labor supply shock in Austria. Nevertheless, our findings are still in line with Schiman (2021)'s sign restriction on the ratio between domestic and foreign employment (after the impact period), as the magnitude of the increase in the number of employed foreigners is bigger than employed natives. 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 shock and not because natives respond by dropping out of the labor market.

Over the same period, the number of foreigners' participants increases, which matches well the rise in the foreigners' unemployment share in Figure 2b. This leads to stronger competition for jobs and higher unemployment among foreigners (see Figure 2b). The pool of natives participants also increases significantly after a semester.

In terms of variance decomposition, net migration is an important driver of fluctuations in participation and employment for foreigners, but less relevant for natives (Figure 8b). The importance of net migration for aggregate participation is largely driven by foreigners.

6.3 Aggregate Wages, House Prices, Investment and GDP

Figure 8a 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 and mining sector in Figure 3a, our results indicate that, on average, net migration does not depress but, instead, fosters wages in Germany. The response of per capita investment is also statistically significant and positive a semester after the shock. For example, skilled immigrants may contribute to a boost in investment via the capital-skill complementarity channel. A similar result is obtained for per capita GDP and, with higher persistence, for house prices. The response of per capita consumption is mildly positive (see the Online Appendix). The results from the variance decomposition in Figure 8b show that net migration shocks contribute to fluctuations in hourly wages, investment, GDP and house prices. Overall, the evidence confirms the expansionary effects of migration shocks.

7 Concluding Remarks

Germany is an ideal country case to study the macroeconomic and labor market effects of mixed migration flows, including economic migrants, refugees, asylum-seekers, and other types of migrants. In a SVAR setup, we show that migration shocks can have substantial

demand effects, potentially acting like positive Keynesian supply shocks. Immigration expands the overall pie in the economy, entailing, on average, a dominant job-creation effect for natives but a dominant job-competition effect for foreigners. Intuitively, if native and immigrant workers are imperfect substitutes in production, newly arrived migrants compete more strongly with existing immigrants than natives. Our study encompasses the analysis of two dimensions of heterogeneity which matter for the transmission, namely the geographic origin of migrants and the education level of residents.

The Covid-19 recession is currently reviving the migration debate. This paper contributes to a better understanding of the aggregate and distributional effects of migration, which is crucial for the design and implementation of effective policy. Overall, the evidence suggests a need to shift the debate focus from immigration restrictions to redistributive policies between natives and foreigners. We leave theoretical investigations as a topic for future research.

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APPENDIX

A List of countries in the migration flows dataset

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 Supplementary Tables and Figures

Table 1: Augmented Dickey-Fuller test

	Level		First difference	
Variable	t-stat	p-value	t-stat	p-value
Net migration rate	-3.4066	0.0542	-25.0131	0.0000
Firms expectations index	-1.5863	0.7929	-9.4408	0.0000
Consumer confidence index	-1.6243	0.7743	-5.0596	0.0000
Industrial production index	-1.8168	0.6801	-13.3600	0.0000
Unemployment rate	-6.1727	0.0000	-6.0581	0.0000

Note: A constant and a linear time trend is included for variables in levels. For variables in first differences, only the constant is included.

Table 2: Johansen cointegration (trace) test

No. of cointegrating relations r	test statistic	p-value	eigenvalue
$r = 0$	122.4728	0.0010	0.2789
$r = 1$	69.5055	0.0010	0.1831
$r = 2$	36.7491	0.0071	0.1184
$r = 3$	16.3255	0.0375	0.0744
$r = 4$	3.7967	0.0514	0.0232

Note: The test assesses the null of at most r cointegrating relations for the baseline set of variables, namely the net migration rate, business expectations, consumer confidence, industrial production and the unemployment rate.

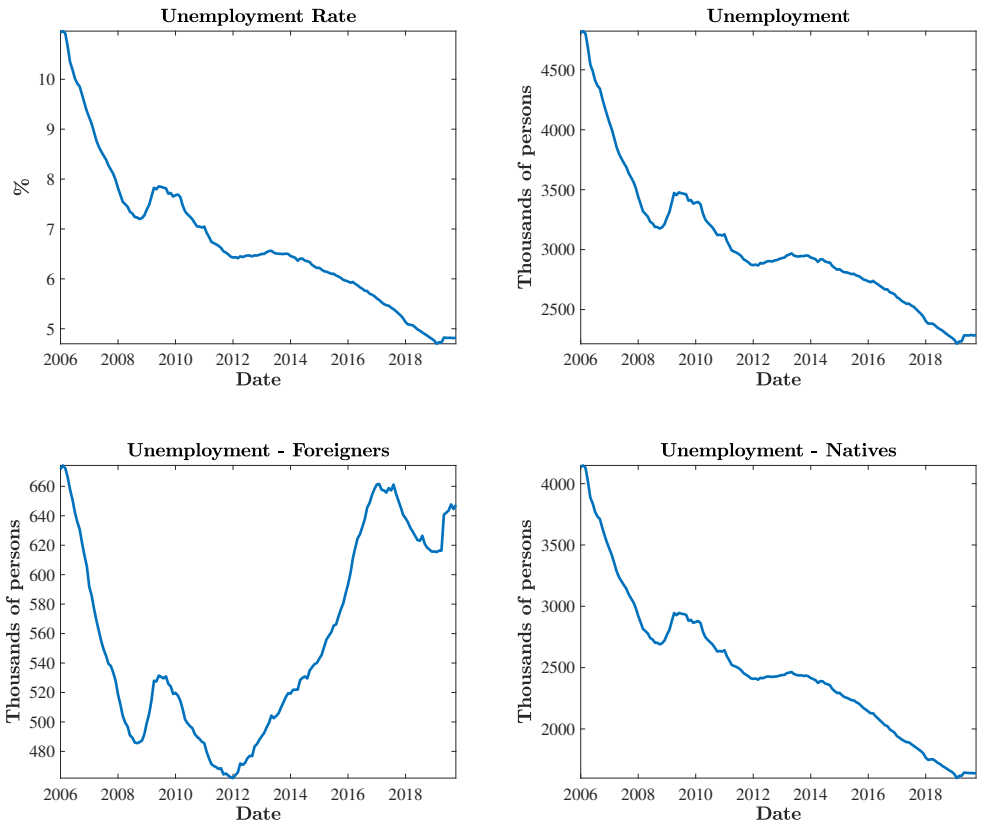


Figure A.1: Unemployment data for Germany (Source: Destatis)

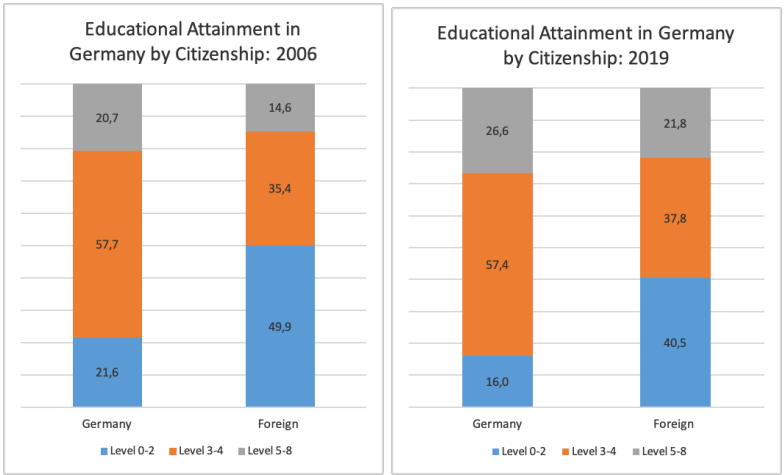
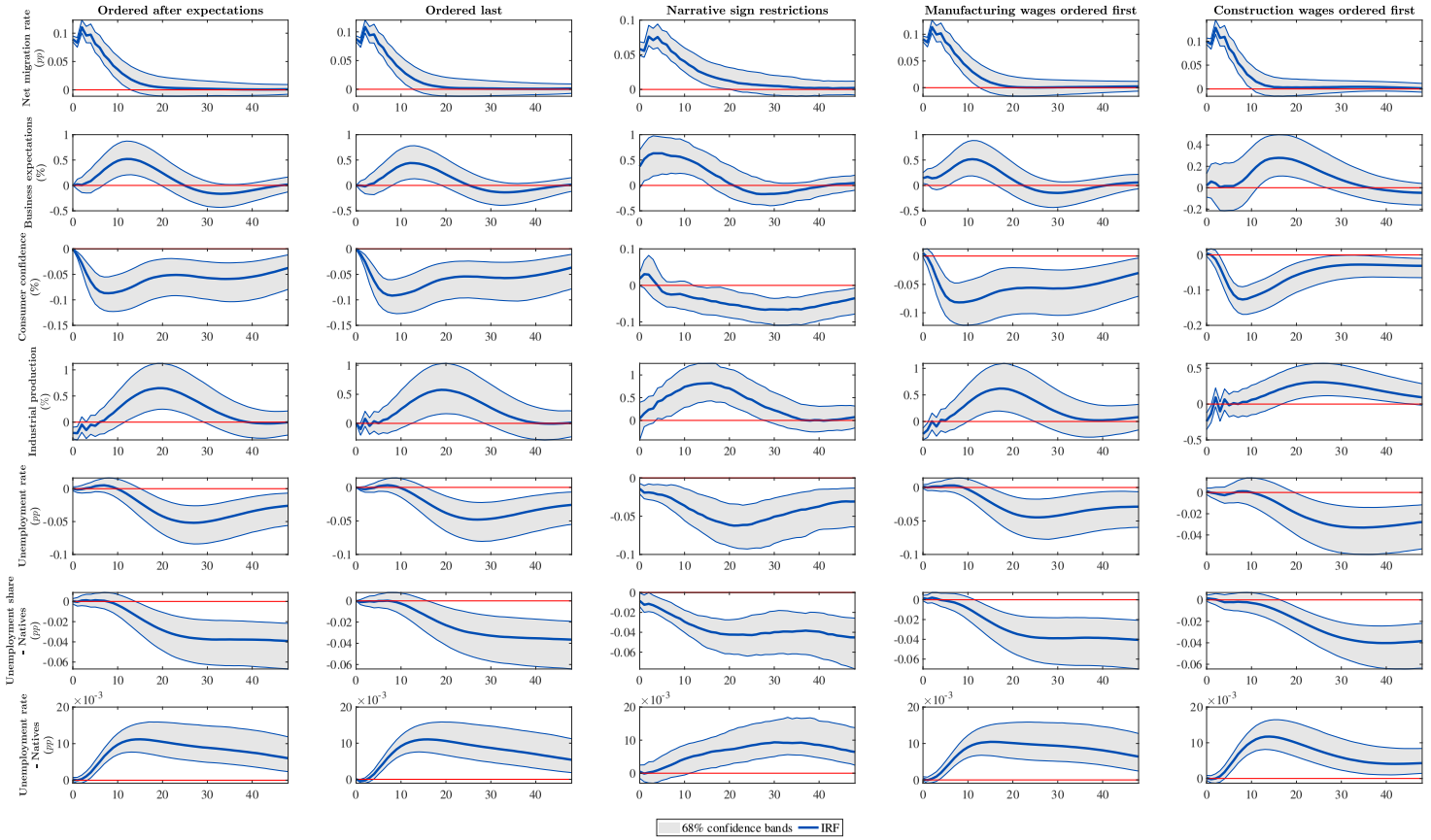


Figure A.2: Educational attainment in Germany by country of citizenship (% population)

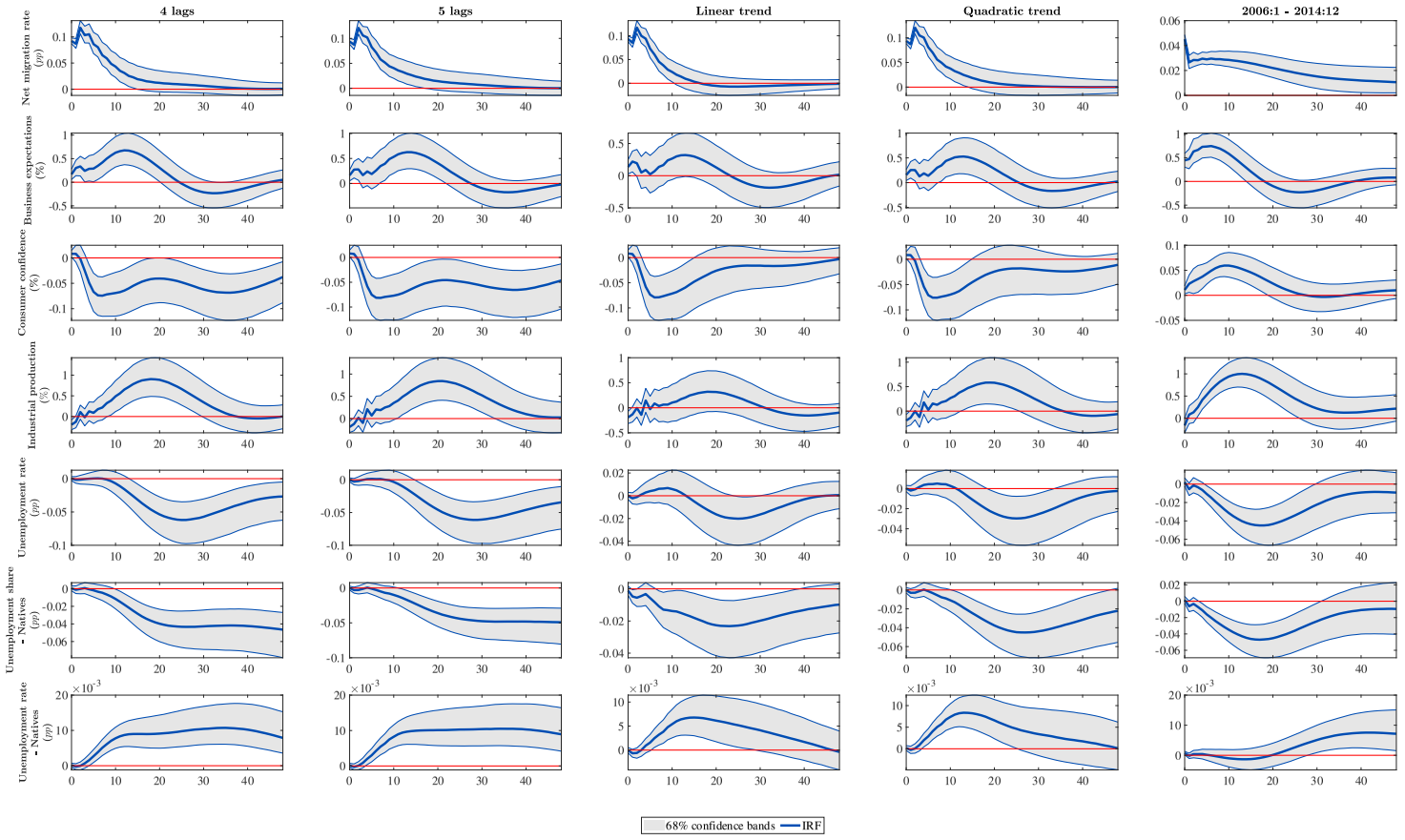
Note: Educational attainment follows the division of ISCED (2011): less than primary, primary and lower secondary education (levels 0-2); upper secondary and post-secondary non-tertiary education (levels 3 and 4); and tertiary education (levels 5-8). Source: Eurostat.

Figure A.3: Impulse responses to a one-standard-deviation net migration shock: Alternative identifications



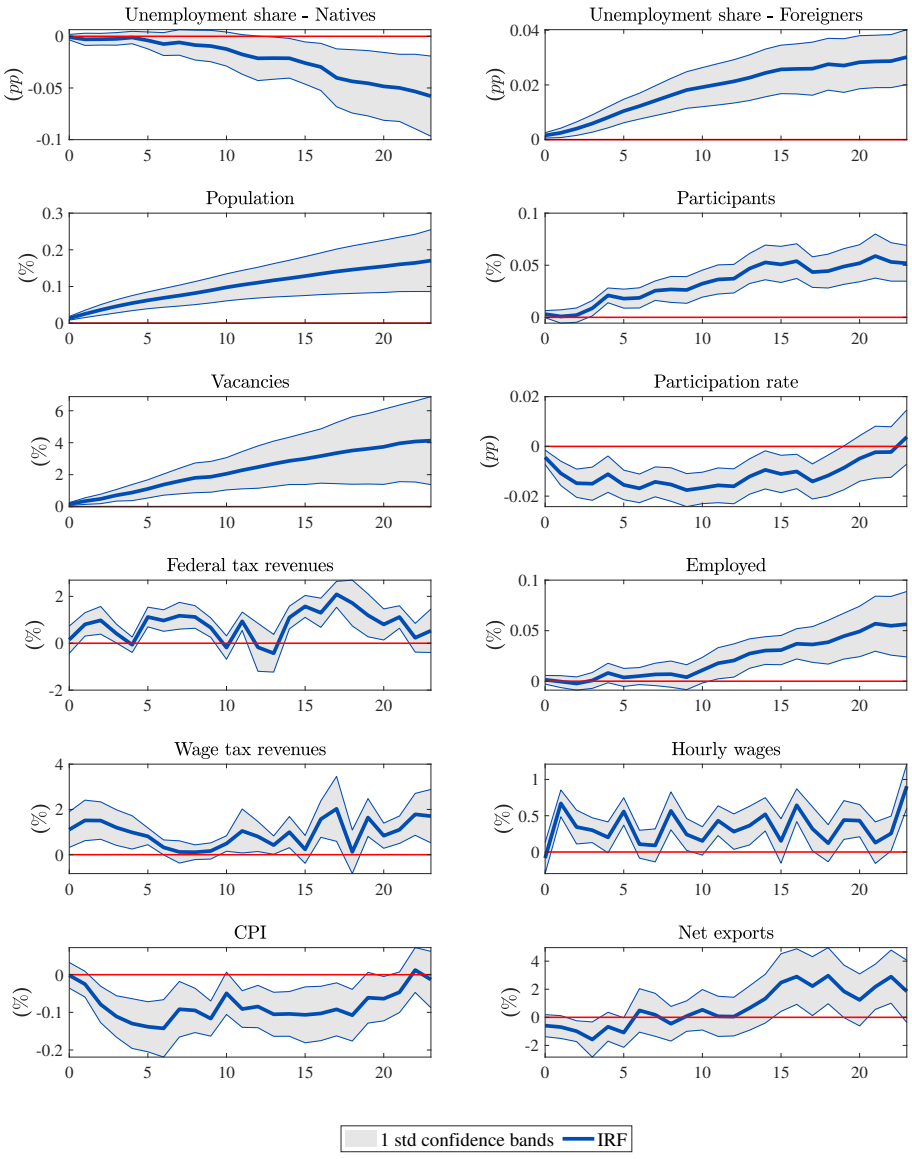
Note: In columns 1 and 2, the net migration rate is ordered in the SVAR after consumer confidence and business expectations and last, respectively. The continuous lines represent the posterior median at each horizon and the shaded areas indicate the 68th posterior probability region of the estimated impulse responses. The horizontal axis refers to months.

Figure A.4: Impulse responses to a one-standard-deviation net migration shock: Changes in model specification



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 months.

Figure A.5: Local projections with the shock identified from the baseline SVAR



Note: The continuous lines represent the point estimate and the shaded areas indicate one-standard-deviation confidence bands of the estimated impulse responses. The horizontal axis refers to months.