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NBP Working Paper No. 373

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Narodowy Bank Polski
Warsaw 2025

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The authors would like to thank Paweł Kopiec, Jacek Kotłowski, Błażej Kowalski, Wojciech Łątkowski, Serhiy Stepanchuk, Karol Szafranek, Robert Wyszyński and the participants to the 8th Joint NBU-NBP 2024 Annual Research Conference and internal seminar at NBP for useful suggestions and comments. The authors are also grateful to an anonymous referee for the valuable comments and suggestions. The views in this paper are those of the authors and do not necessarily reflect the views of Narodowy Bank Polski.

Published by:
Narodowy Bank Polski
Education & Publishing Department
ul. Świętokrzyska 11/21
00-919 Warszawa, Poland
nbp.pl

ISSN 2084-624X

Contents

Abstract

This paper investigates the role of immigration shocks in shaping unemployment and wage dynamics in Poland – a country that experienced a significant influx of immigrants following Russia's invasions of Ukraine in 2014 and 2022. To achieve this, we construct novel proxies for the size of immigration to Poland and use them to estimate structural BVAR models. Our results suggest that the impact of the 2022 refugee wave on the Polish economy differs from previous immigration inflows, primarily influencing aggregate demand and, to a lesser extent, boosting labour supply. More specifically, in recent years, immigration shocks have slightly reduced the unemployment rate and, to a greater extent, lowered the annual growth rate of real wages. At the same time, they contributed to higher growth in nominal wages, particularly after 2022, when the influx of non-working immigrants, which created significant consumption demand, was at its highest.

Keywords: immigration, Bayesian VAR, labour market
JEL Classifications: C11, C32, E32, J61

1 Introduction

For a very long time, the Polish population emigrated willingly and frequently. This was particularly evident after accession to the European Union (EU) in 2004, when thousands of Poles decided to leave their home country and look for work in wealthier old EU member states. As reported by Strzelecki et al. (2022), between 2002 and 2013 approximately 1.2 million Polish citizens (about 3% of the population) emigrated, and the most substantial and rapid wave occurred between 2004 and 2008, with around 0.7 million emigrants heading to the UK and Ireland.

The situation completely changed in 2014, when the outbreak of the armed conflict in Eastern Ukraine and the subsequent economic crisis in the country triggered a large and rapid surge in the number of Ukrainians migrating to the EU, and Poland in particular. In the years 2014-2018, Poland admitted probably between one and two million immigrants from Ukraine (Strzelecki et al., 2022). The scale of this inflow was unprecedented in Poland's history and raised many questions, especially in the context of labour market outcomes, as well as long-term growth prospects. According to the estimates by Statistics Poland (GUS, 2020) based on administrative registers and information provided by the Border Guard, at the end of 2019, Ukrainians were by far the most numerous group of foreigners in Poland, with their number exceeding 1.35 million.

A full-scale Russian aggression against Ukraine in 2022 entailed another spike in the number of Ukrainians leaving the country. The resulting refugee crisis, estimated by UNHCR (2022) at 6.3 million persons, was the largest displacement in Europe since World War II. According to the Polish Border Guard data, the number of crossings of the Ukrainian-Polish border by foreign citizens in the first two months of the conflict amounted to almost 3.5 million. Although many refugees stayed in Poland only temporarily and later moved to other European countries, Poland still shelters a relatively large number of Ukrainians fleeing the war. As of June 2023, it was the second (after Germany) largest host country for refugees from Ukraine, sheltering almost 1 million Ukrainian escapees (OECD, 2023).

The Russian invasion changed not only the size but also the structure of immigration from Ukraine. The group of previous immigrants was dominated by men and economically active persons (Kaczmarczyk, 2022), which, given the relatively strong demand for workers in Poland at that time, provided great support to the Polish labour market, alleviating labour shortages and mitigating wage pressures. On the other hand, Ukrainian refugees are mainly women, children and elderly persons, characterised by, on average, lower activity rates. Consequently, the impact of the latest refugee wave on the Polish economy may be different from previous immigrant inflows, affecting the aggregate demand and, to a lesser extent, boosting the labour supply. Our goal in this paper is to shed more light on both these channels and add to the debate on the macroeconomic impacts of immigration shocks and, in particular, to quantify their importance in shaping unemployment and wage fluctuations.

To this end we estimate several Bayesian Vector Autoregressive (BVAR) models using quarterly data from Poland from 2004q1-2023q3 and identify the structural shocks through the sign restrictions on the variables' impact responses. Our starting point is the specification proposed by Foroni et al. (2018) that includes four endogenous variables (i.e. output, prices, real wages and unemployment rate), which we next extend with newly constructed immigration proxies based on Border Guard data. We find that the immigration shocks do matter for the dynamics of the labour market variables in Poland. In recent years they have been moderately lowering the unemployment rate and, to a greater extent, the growth of real wages. On the other hand, the identified immigration shocks significantly contributed to higher growth of nominal wages due to the positive impact of immigration on aggregate demand in the short term.

The existing papers on immigration from Ukraine, probably due to the lack of reliable data measuring its size, are primarily descriptive. They discuss immigrants' characteristics and challenges faced by host countries (e.g., Górny et al., 2019; Duszczyk and Kaczmarczyk, 2022; Kaczmarczyk, 2022; Chmielewska-Kalińska et al., 2023), while more quantitative analysis focusing on its macroeconomic consequences is very scant. An important exception here is the paper by Strzelecki et al. (2022), which extends a growth accounting exercise by Gradzewicz et al. (2018)

with immigration data to find that the Ukrainian workers increased the effective labour supply and GDP growth in Poland in 2013–2018 by 0.8% and 0.5 pp. per annum, respectively. Due to the adopted method and annual data utilised, the research by Strzelecki et al. (2022) is focused on supply-side tendencies and abstracts from explicit modelling of the reaction of unemployment and wages to immigration. Moreover, it is based on data prior the 2022 Russian invasion of Ukraine. To our knowledge, we are the first to (i) consider Ukrainian immigration in structural VAR models and analyse its impact on the Polish labour market variables and (ii) analyse the effects of immigration from Ukraine on Poland's economy including data after February 2022.

More generally, our paper is related to the large body of studies on immigration.[1] Most of the work in this part of the literature is based on the disaggregate data and analyses, i.a., the economic performance of immigrant workers compared to the native population (e.g., Büchel and Frick, 2005; Clark and Drinkwater, 2008), the impact of immigration on native workers' wages (e.g., Ottaviano and Peri, 2012) and employment rates (e.g., Moreno-Galbis and Tritah, 2016), the attitudes of natives towards immigrants (e.g., Mayda, 2006; Dustmann and Preston, 2007), or the impact of immigration on house prices (e.g., Saiz and Wachter, 2011; Sá, 2014).

Less numerous works based on the aggregate immigration data include both studies using DSGE frameworks[2] and SVAR models. In the latter group, Kiguchi and Mountford (2019) estimate the VAR model on the annual postwar US data and use the penalty function approach to show that unemployment temporarily rises and real wages decline in response to an immigration shock. Furlanetto and Robstad (2019) provide an analysis on Norwegian data using the sign-restricted BVAR model in which the exogenous immigration shock lowers unemployment, and has a small positive effect on prices and public finances. Maffei-Faccioli and Vella (2021) use monthly data for Germany over the sample period 2006-2019 in a SVAR identified with a recursive scheme to find that net migration shocks stimulate vacancies, wages,

[1] For extensive immigration literature surveys see, e.g., Dustmann et al. (2016), Kerr and Kerr (2011) or Okkerse (2008)

[2] E.g., Mandelman and Zlate (2012); Aubry et al. (2016); Braun and Weber (2021); Caliendo et al. (2021); Kiiashko and Kopiec (2022).

house prices, consumption, investment, net exports, and output, and drive unemployment down. The other important contributions include d'Albis et al. (2019) on France, Smith and Thoenissen (2019) on New Zealand and Schiman (2021) on Austria.

Our paper relates also to the empirical studies aimed at disentangling technology and demand shocks from labour market disturbances. For example, Foroni et al. (2018) and Consolo et al. (2023) focus on labour supply, wage bargaining and matching efficiency shocks, Hairault and Zhutova (2018) and Consolo and Petroulakis (2022) account for reallocation and matching efficiency shocks, while Bergholt et al. (2022) identify automation shocks. Differently from these studies, we also identify immigration shocks. Importantly, since the most rapid influx of immigrants coincided with the massive rise in energy prices and supply chain disruptions, in the robustness analysis we include the Producer Price Index for energy (PPI-energy) and Supplier's Delivery Times Index (SDTi) in the set of endogenous variables to better disentangle immigration shocks from other disturbances.

The remainder of the paper is structured as follows. Section 2 describes the model by Foroni et al. (2018) estimated on Polish data—we refer to this model as our baseline model without immigration. Section 3 extends this model with variables measuring immigration size. Section 4 presents additional results and robustness checks, while Section 5 concludes.

2 Baseline model without immigration

2.1 Data and model

We start from the standard reduced-form VAR representation:

$$y_t = B_0 + \sum_{i=1}^{p} B_i y_{t-i} + \varepsilon_t, \quad t = 1, 2, ..., T \tag{1}$$

where y_t is an $N \times 1$ vector of N endogenous variables, B_0 is an $N \times 1$ vector of constants, B_i for $i = 1, 2, ..., p$ are $N \times N$ parameter matrices, with p denoting the number of lags, T is the size of the sample used for the regression, and ε_t is an $N \times 1$ vector of residuals following a multivariate normal distribution $\varepsilon_t \sim \mathcal{N}(0, \Sigma)$, with Σ being a $N \times N$ symmetric positive definite variance-covariance matrix.

Since the data sample is relatively short and the number of parameters is large, we estimate the model using Bayesian methods. We apply normal diffuse priors to make the impact of data on posterior estimates dominant. Similarly as in many other applications of Bayesian VAR models based on quarterly data (e.g., Foroni et al., 2018), we set the number of lags to five.

Our baseline model is inspired by Foroni et al. (2018) and uses four endogenous variables: output measured by real gross domestic product (GDP), Consumer Price Index (CPI) as a measure of prices, real wages measured by the wages in the national economy deflated by the CPI and unemployment rate by Labour Force Survey (LFS). Notably, the coverage of immigrants in Polish LFS has been deficient until recently. As a result, we can think of the LFS unemployment rate as a measure of unemployment of natives rather than total unemployment. Because migration is a very difficult phenomenon to measure with quarterly frequency, we do not explicitly include it in the baseline model. However, when interpreting shocks, we may think of migration as one of their sources.

As Bayesian methods can be applied even when data has unit roots (Sims et al., 1990), the model is estimated with variables in log-levels. All data series are seasonally adjusted and enter the VAR model in logs except for the unemployment rate, which is expressed in percent of the workforce. The data is at a quarterly frequency, and the sample spans the period of 2004q1-2023q3. Although all series are available before 2004, we focus on a period corresponding with the monetary policy regime in Poland aimed at stabilizing inflation around the inflation target rather than dragging inflation down to the target at the potential cost of high unemployment (monetary policy regime in Poland before 2004).

The residuals ε_t from the reduced-form estimation can be expressed as a linear combination of structural shocks η_t, i.e. $\varepsilon_t = A\eta_t$, with A being a nonsingular parameter matrix and $\eta_t \sim \mathcal{N}(0, I_N)$, where I_N is an $N \times N$ identity matrix. The variance-covariance matrix can be thus expressed as $\Sigma = AA'$. To identify A from the posterior distribution of Σ, we use the set of sign restrictions imposed on the variables' impact response to shocks utilising the framework of Arias et al. (2018).

Our identification restrictions presented in Table 1 follow the scheme proposed by Foroni et al. (2018) and identify one demand shock and three supply disturbances: a technology shock, a labour supply shock and a wage bargaining shock. According to our restrictions, a positive demand shock raises output and prices and lowers the unemployment rate. In contrast to the demand shock, the supply shocks generate an inverse co-movement between output and prices. Thus, the expansionary technology shock increases output and real wages and decreases prices. Following Foroni et al. (2018), we separate the technology shock from two labour market shocks using the data on real wages and assume that the labour supply and wage bargaining shocks move output and real wages in opposite directions. A positive labour supply shock increases the number of economically active people – both employed and unemployed – and thus leads to an (at least temporary) increase in the unemployment rate. A higher number of job seekers lowers firms' hiring costs, which translates into lower wages and prices and higher output. Wage bargaining shock, known from the search and matching literature (e.g., Pissarides, 2017), results in a reduction in workers' bargaining power in wage negotiations and firms benefiting from a larger share of the bargaining surplus, which directly translates into lower wages and thus also lower

marginal costs and prices. Wage cuts encourage employers to post more vacancies and increase hiring, ultimately decreasing the unemployment rate. It should be noted that the wage bargaining shock identified with this set of restrictions may also capture other disturbances originating in the labour market. A similar response of variables is observed after, e.g., an exogenous reduction in the unemployment benefits or an improvement in matching efficiency. In new Keynesian models these types of shocks are typically called wage markup shocks.

Table 1: Identification scheme via sign restrictions

	Shocks			
	demand	technology	labour supply	wage bargaining
output	+	+	+	+
prices	+	-	-	-
real wages		+	-	-
unemployment	-		+	-

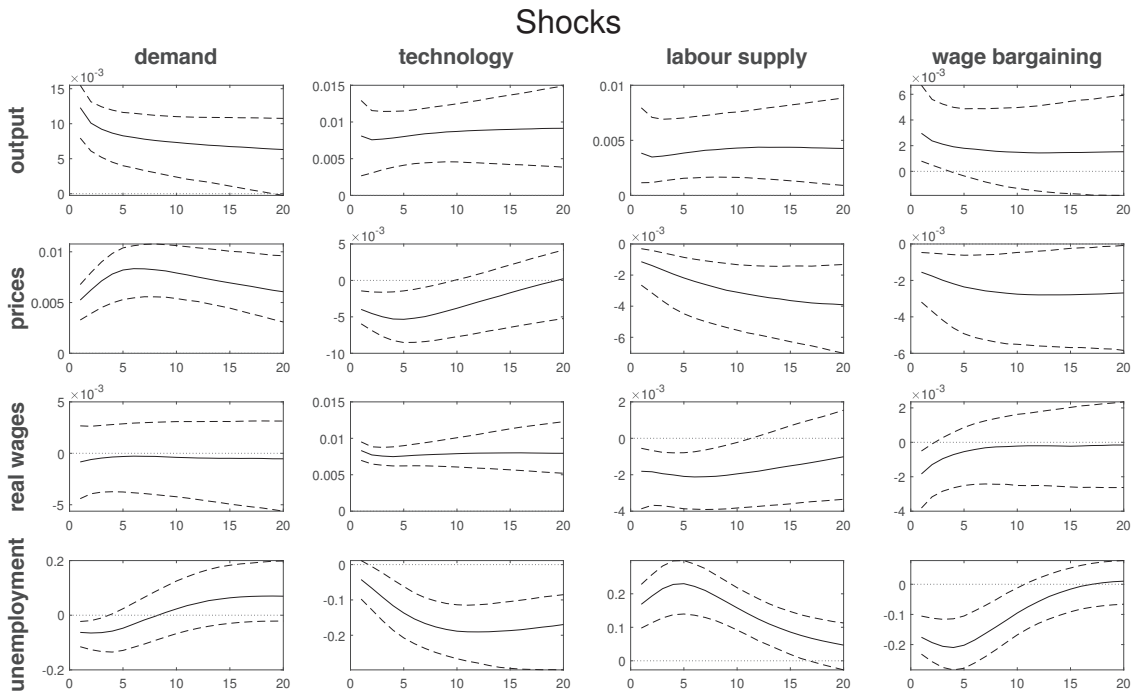
All estimations are conducted using BEAR 5.0 routines presented in Dieppe et al. (2016) and Dieppe and van Roye (2018).

2.2 Results

Figure 1 presents the median of the posterior distributions of impulse responses to one standard deviation structural shocks, along with the 68% credibility bands. Although the restrictions imposed in the identification scheme apply only to an impact reaction, the responses of most variables are relatively long-lasting, and their overall direction is consistent with the sign of the immediate response. The high persistence of the IRFs results from the model being estimated with mostly log-level variables that contain unit roots. Yet, the estimated BVAR model is stable, i.e. all roots of the characteristic polynomial lie inside the unit circle.

In the identification scheme, we do not impose restrictions on the response of wages to a demand shock and the response of the unemployment rate to a technology shock. According to our estimates, the real wages hardly change after the demand shock, which implies that the magnitude of the nominal wages increase is very similar to the one of the prices. The technology shock leads to a pronounced decline in the unemployment rate, which is consistent with findings from previous empirical work (see, e.g., Mumtaz and Zanetti, 2015; Consolo et al., 2023). Higher productivity encourages more hiring, leading to an increase in the job-finding rate, and discourages layoffs, resulting in a lower job separation rate.

Figure 1: Posterior impulse responses



Notes: The solid lines represent the posterior median at each horizon, whereas the dashed lines indicate the 16th and 84th percentiles of the impulses responses.

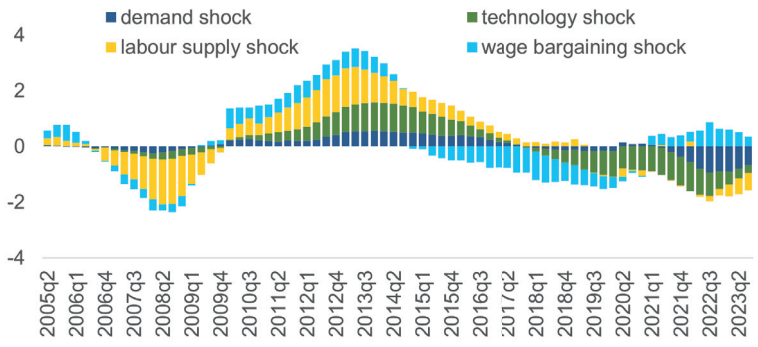
The forecast error variance decompositions (Figure 2) and historical decompositions (Figures 3 - 5) reveal that the variance of real wages in Poland is predominantly, and to a greater extent than in the U.S. (Foroni et al., 2018), driven by technology

shocks at all horizons considered. Labour market shocks are prime movers of the unemployment rate fluctuations in the short run, but at longer horizons, they are (taken together) roughly as important as technology shocks, which affect unemployment only with some lag. Surprisingly, in contrast to (Foroni et al., 2018), the FEVD suggests little role for demand shocks in driving either real wages or unemployment rate, even in the very short run. Demand shocks, being crucial drivers for price dynamics, are, however, key drivers of fluctuations in nominal wages (since 2014 in particular).

As mentioned, the presented baseline model does not explicitly include migration shocks. However, they are, to some extent, "disguised" as the model structural shocks. For example, working migration shocks may be treated as a combination of labour market and technology shocks (due to migrants' different labour productivity). In contrast, non-working migration shocks may be perceived as mainly demand shocks, at least in the short run. Therefore, the effects of the 2004-2008 wave of emigration from Poland to the UK and Ireland and a few waves of immigration from Ukraine to Poland may be inferred narratively, with a certain degree of caution, from the historical decompositions of the model variables. For instance, the outflow of relatively low-skilled and underemployed Poland's workforce in 2004-2008 is likely manifested as adverse labour supply shocks and positive technology shocks, which lowered unemployment and raised real wages, while the 2022 inflow of refugees is a strong demand shock, which reduced unemployment at the cost of higher prices and nominal wages.

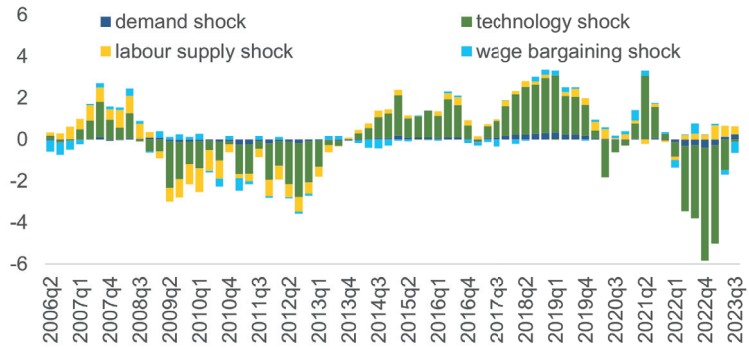
Figure 2: FEVD for the endogenous variables

Figure 3: Historical decomposition of unemployment rate (in pp.)



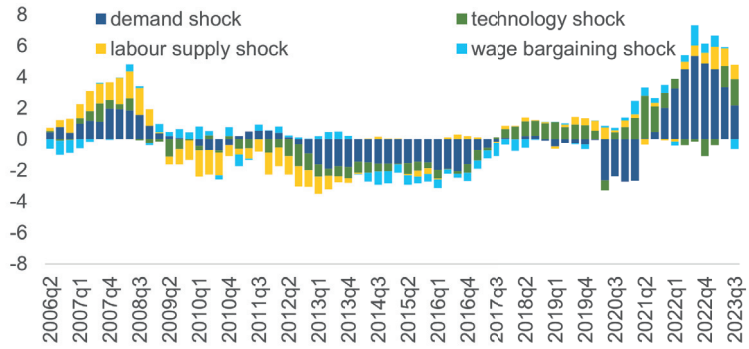
Notes: The graph presents the median of the posterior distribution of the historical contribution of the structural shocks for the variable in deviation from its posterior median (see Dieppe and van Roye, 2018).

Figure 4: Historical decomposition of real wage growth (annual % change)



Notes: See notes of Figure 3.

Figure 5: Historical decomposition of nominal wage growth (annual % change)



Notes: See notes of Figure 3.

2.3 Robustness checks

Before we add an immigration proxy to the baseline model, we perform several exercises to assess the reliability of the main findings from the baseline model without immigration. In particular, we check the robustness of our results by i) estimating the model with four instead of five lags, ii) estimating the model with Minnesota prior instead of normal diffuse prior, iii) adding production capacity to the set of endogenous variables and identifying capacity utilization shock, and finally iv) adding number of workers to the set of endogenous variables and identifying labour

hoarding shock. For all robustness checks, the sample period remains the same, and in exercises i) and ii), we use the same sign restrictions as in the baseline model.

Side-by-side comparisons of impulse response functions, forecast error decompositions and historical decompositions reveal that all results are virtually the same for both i) the alternative lag length and ii) the different type of prior. We also find that the baseline model without immigration aptly captures the main drivers of the labour market variables: adding additional variables and shocks leads to a minuscule role of the additional shocks in iii) and iv). Bearing this in mind, we rather stick to the model proposed by Foroni et al. (2018) as our baseline model without immigration. The detailed results of the performed sensitivity analysis are available upon request.

3 Adding immigration proxies

Since the main focus of our paper is on the role of immigration, we now extend the model from the previous section with a variable approximating its volume. We should emphasize that we are not focused on estimating the exact number of immigrants but on capturing its variance over time. Recall that the exact levels are not important from the perspective of VAR modelling and the standard shock identification procedures, but the applied proxy should satisfy: $true \approx a + b \cdot proxy$. Later, we discuss caveats related to this condition in greater detail.

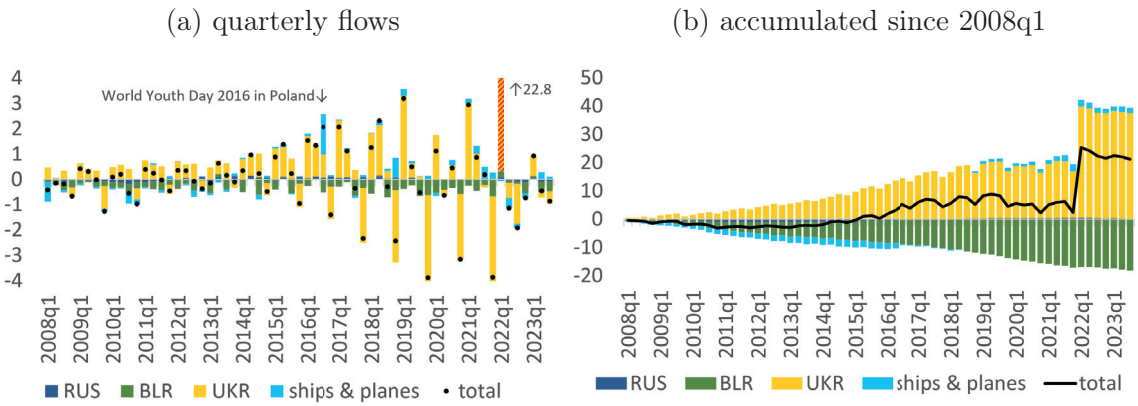
Our preferable proxy is based on the quarterly Polish Border Guard data on the net number of Schengen Area border crossings (inflow minus outflow) by foreigners for 2007q1-2023q4. We accumulate the net number of crossings quarterly, assuming that in 2007q1, the variable equals 1 million. This starting value overestimates the actual volume of immigration in Poland (see, e.g., Szałtys, 2018), but this is a technical assumption to guarantee that the proxy variable is greater than zero, and we can take the logarithm of its value for the purpose of BVAR modelling. We have verified that this assumption has no meaningful impact on the results as long as the applied starting value is reasonable.[3] For 2007q1-2021q4, the series is seasonally adjusted, while for 2022q1-2023q3, we stick to raw data since we are not able to estimate seasonal factors reliably after the 2022 Russian invasion of Ukraine and, presumably, the immigration flows were then primarily driven by war-related rather than seasonal factors. The series for the period 2004q1-2006q4 is backcasted with the use of exponential smoothing, and it is roughly constant at a value very close to 1 million. The immigration proxy enters the BVAR model in its log-level form.

Figure 6 depicts the net number of Schengen Area border crossings by foreigners in a breakdown by border country. Before the 2013-2014 Euromaidan protests in Ukraine and the 2014 Annexation of Crimea by the Russian Federation, the dynamics of the net number of border crossings were mainly driven by relatively stable (excluding seasonal fluctuations): the net outflow of migrants at the Poland-Belarus border and

[3] $Corr(x_t, a + x_t) = 1$ holds for $a \in R$, while $Corr(\ln(x_t), \ln(a + x_t)) \approx 1$ is useful if a/x_t is relatively small.

the net inflow of migrants at the Poland-Ukraine border, with the average balance being slightly negative. In 2014, the net inflow of migrants at the Poland-Ukraine border intensified and reached its before-pandemic peak in 2019. During that time, the net outflow of migrants at the Poland-Belarus border remained similar to before 2014, and the migration balance turned strongly positive. The outbreak of the COVID-19 pandemic in 2020 tampered with migration flows. Initially, the inflows were hit more severely than outflows, and the balance of migration became negative, but soon, the situation reversed, and the balance turned positive again. A full-scale Russian aggression against Ukraine resulted in an unprecedented inflow of refugees to Poland in 2022q1. Interestingly, positive balances of flows were also observed at the borders between Poland and Belarus and between Poland and Russia. In subsequent quarters (apart from 2023q1), however, the outflows were more intense than inflows in the case of all Schengen Area borders of Poland.

Figure 6: Net number of Poland's border crossings by foreigners (in hundreds thousand)



Notes: net number of crossings := inflow - outflow

We fully acknowledge the fact that not every foreigner who crosses the border and enters Poland should be treated literally as an immigrant. Typically, an immigrant status refers to permanent residency, while a non-immigrant status is held by persons who visit a country on a temporary basis, but temporary immigration is also a recognized and named phenomenon. In practice, however, the distinction between immigration and migration is even more difficult because the actual status of a

migrant may change over time, and it is not necessarily reflected in their official status. Although we consistently stick to the term "immigration" throughout the paper, this caveat should be considered.

We also should clarify that we cannot control for Poland being only a transition country for foreigners migrating or travelling from Eastern Europe to other Schengen Area countries (Germany in particular) and vice versa. Our proxy appropriately captures the variance of immigration over time only if the share of foreigners treating Poland as a transition country is relatively constant, which is a very questionable assumption.

Considering the reservations mentioned above, we also estimate the model in which we replace our preferable proxy with the one based on the Eurostat annual[4] data on population, residence permits and temporary protection. Since Eurostat statistics count only immigrants whose status is formally confirmed with appropriate documentation, the two proxies are conceptually different and measure different phenomena. Alternatively, we may consider the proxy based on the Eurostat data as the lower limit or a conservative estimate of the number of immigrants. Both measures of immigration differ in levels, see Figure 7, but they co-move closely, with the correlation coefficient of 0.95 for the full sample and 0.76 for the 2004q1-2021q4 sample, i.e. excluding the surge in the number of immigrants after the full-scale Russian invasion. This co-movement translates into the corresponding correlations between the identified (median) immigration shocks reaching 0.93 and 0.87, respectively. Therefore, the results from models with both immigration proxies are barely the same despite conceptual differences. For that reason, in what follows, we present only findings from the model, including a measure of immigration based on Border Guard statistics.

[4]This annual data is interpolated into quarterly frequency using our preferable proxy.

Figure 7: Immigration proxies (in millions)

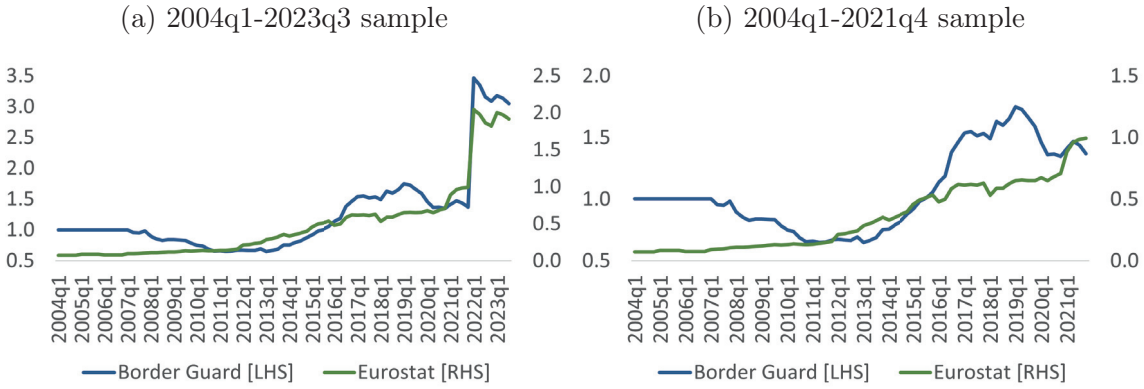


Table 2 shows the identification scheme in the extended model. Based on the previous work (see, e.g., Ottaviano and Peri, 2008; Furlanetto and Robstad, 2019), we assume that an increased influx of immigrants leads to an immediate increase in output and prices[5] and a decline in real wages. We also assume that immigration rises in response to a positive demand shock and a negative labour supply shock, which should increase the demand for foreign labour force. Our identification scheme generally follows the recommendation by Canova and Paustian (2011) to have at least one opposite sign restriction on impact response for every pair of shocks. The only exception in this respect is the pair of a demand shock and an immigration shock, in the case of which differences in sign restrictions are less clear-cut. We assume that an immigration shock has a negative impact on real wages, while we leave the response of real wages to a demand shock unrestricted. The opposite holds for the response of unemployment to both shocks. However, the median correlation between demand and immigration shocks (Table 3) is acceptably low.

[5]As argued by Furlanetto and Robstad (2019), the effect of an immigration shock on prices is not obvious, and the empirical evidence is somewhat mixed (see, e.g., Lach, 2007; Cortes, 2008; Furlanetto and Robstad, 2019). On the one hand, the wage mitigating effect of higher labour supply may exert downward pressure on prices. On the other hand, a larger population boosts demand, which may lead to an increase in prices if the supply does not adjust immediately. To better disentangle the shocks, especially immigration and technology ones, we decided to impose a positive price response to the immigration shock. However, leaving this response unrestricted does not significantly affect the estimation results.

Table 2: Identification scheme via sign restrictions

	Shocks				
	demand	technology	labour supply	wage bargaining	immigration
output	+	+	+	+	+
prices	+	-	-	-	+
real wages		+	-	-	-
unemployment	-		+	-	
immigrants	+		-		+

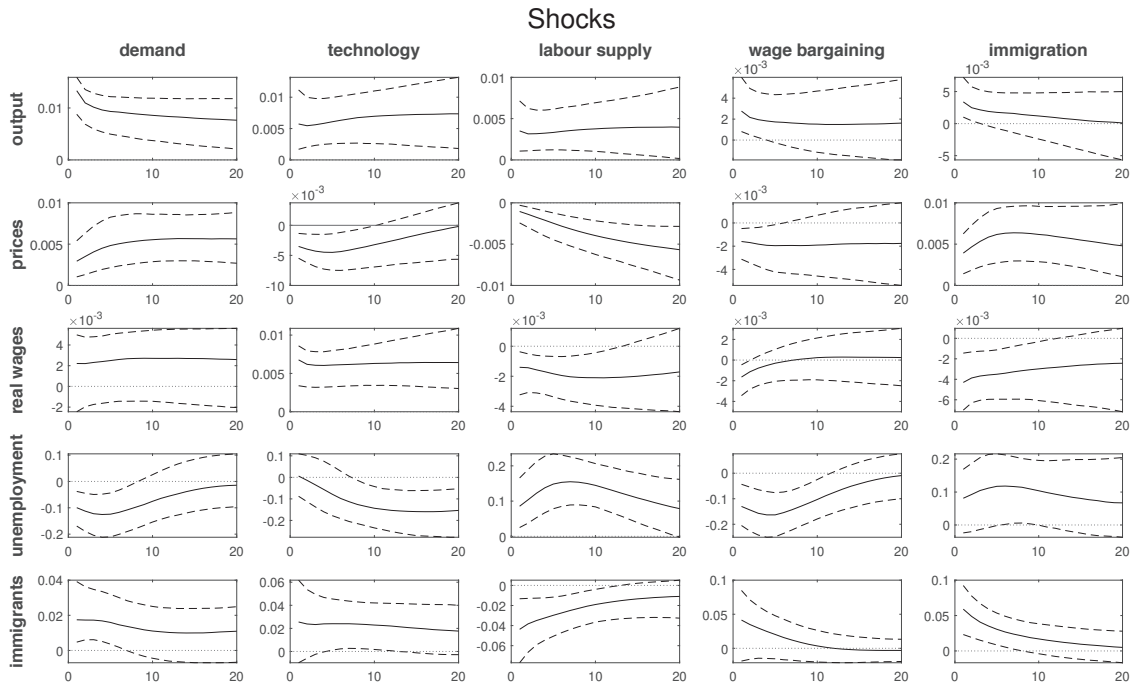
Table 3: Median correlation coefficients between structural shocks

	demand	technology	labour supply	wage bargaining	immigration
demand	1				
technology	-0.01	1			
labour supply	0.03	-0.01	1		
wage bargaining	-0.02	-0.01	-0.02	1	
immigration	-0.04	0.01	-0.01	-0.02	1

Notes: The pairwise correlation coefficients take on values within the range of -0.49 to 0.49.

Figure 8 depicts the posterior impulse responses from the model with immigration. A positive immigration shock leads to a decline in real wages, and a long-lasting rise in output, prices and the unemployment rate. As argued by Maffei-Faccioli and Vella (2021), the response of unemployment to immigration shocks is theoretically ambiguous. On the one hand, migration may intensify job competition among the unemployed due to increased labour supply (job-competition effect), exerting upward pressure on unemployment. On the other hand, immigrants expand consumer demand for goods and services and hence may enhance the creation of additional jobs (job-creation effect), pushing unemployment down. Our results suggest that, on average in our sample, the job-competition effect dominates. The responses of endogenous variables to other shocks are very similar to the responses obtained in the baseline model.

Figure 8: Posterior impulse responses



Notes: See notes to Figure 1.

Accounting for immigration reduces the role of supply shocks (technology and both labour market shocks) and increases, especially in the short-term, the role of demand shocks in driving unemployment rate fluctuations (see Figures 10 and 9). Now, the contribution pattern of demand shocks in the FEVD of unemployment rate resembles the one from Foroni et al. (2018). When integrated over the forecast horizon, immigration shocks are roughly as important in driving unemployment rate fluctuations as technology shocks. The immigration shocks contributed to a higher unemployment rate in 2010-2015 and a lower unemployment rate between 2016 and 2021. From 2022 onward, i.e. in the period of the highest inflow of immigrants, their impact on unemployment appears to be slightly positive (recall that, according to the IRF, unemployment increases following the positive immigration shock). As discussed in the Introduction, however, the impact of the recent refugee wave on the Polish economy may differ significantly from previous immigration inflows, with a

stronger effect on aggregate demand (and thus a stronger job-creation effect) and a relatively smaller effect on labour supply (and therefore a weaker job-competition effect). Since our measure of immigration combines all types of immigrants, it does not allow us to capture changes in the relative strength of the job-creation and job-competition effects over time. To address this limitation, in Section 4.1, we separate immigrants into working (primarily affecting labour supply) and non-working (primarily affecting aggregate demand) groups and find that the net effect of both types of immigration shocks on unemployment, in the period following the full-scale Russian invasion in 2022, is negative.

Immigration shocks significantly reduce the role of technology shocks in shaping the real wages dynamics (see Figures 9 and 11), especially in 2022 and the first half of 2023, when the largest drops in real wages were observed. The baseline model without immigration interprets this recent decline in annual real wage dynamics as driven almost entirely by technology shocks. In the extended model, the technology and immigration shocks each account for roughly half of the decline in recent periods. According to the FEVD, immigration shocks are the second most important driver of real wage fluctuations.

Due to the inflationary nature of immigration shocks[6], their contributions to nominal wage dynamics tend to be opposite to those of real wages (see Figures 11 and 12). In particular, despite the strongly negative impact of the immigration shocks on real wage growth in 2022, their contribution to nominal wage dynamics was positive throughout the period (and in 2023).

[6]The FEVD (see Figure 9) even suggests that immigration shocks are prime movers of inflation fluctuations. This result should be, however, treated exceptionally cautiously because immigration shocks may be strongly correlated with external inflationary shocks such as energy and fuel price shocks or soft commodities price shocks. In Section 4.3, we estimate a model extended with energy prices and supply chain disruptions to address this issue. Including these variables limits the role of immigration shocks in shaping inflation, but they remain one of the key drivers of the elevated inflation in 2022-2023.

Figure 9: FEVD for selected endogenous variables

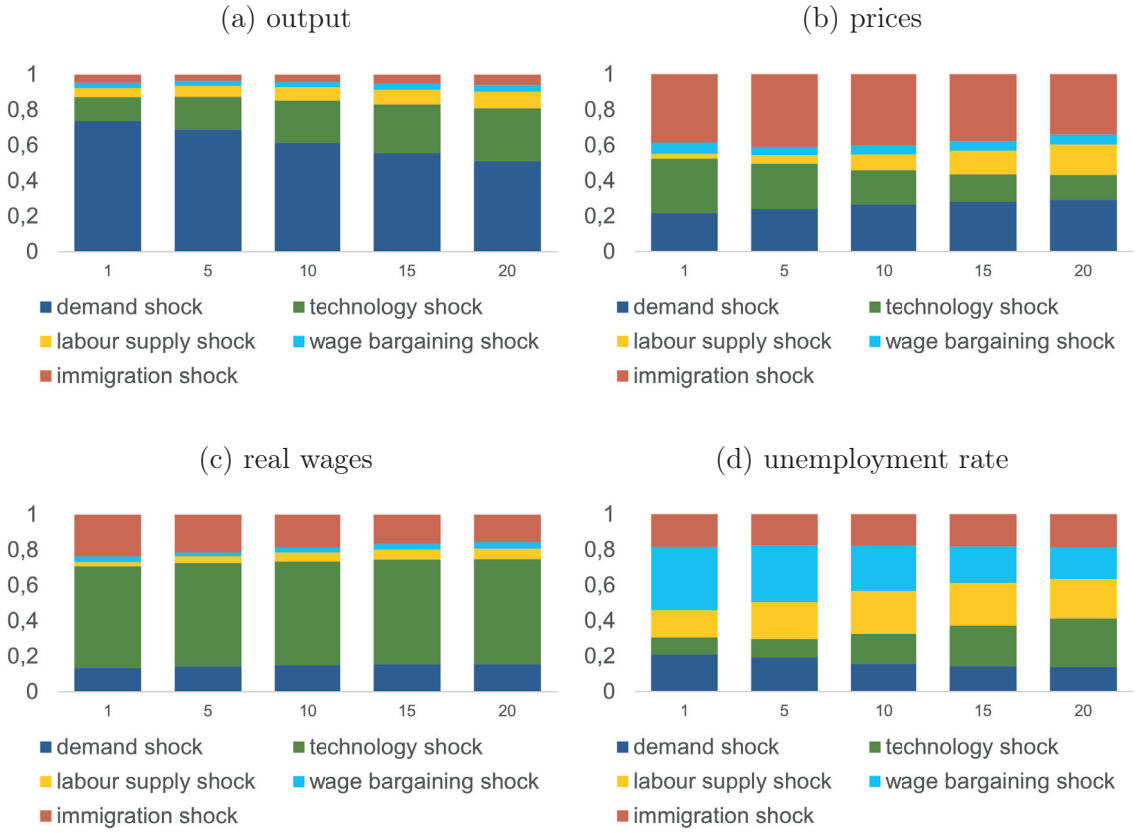
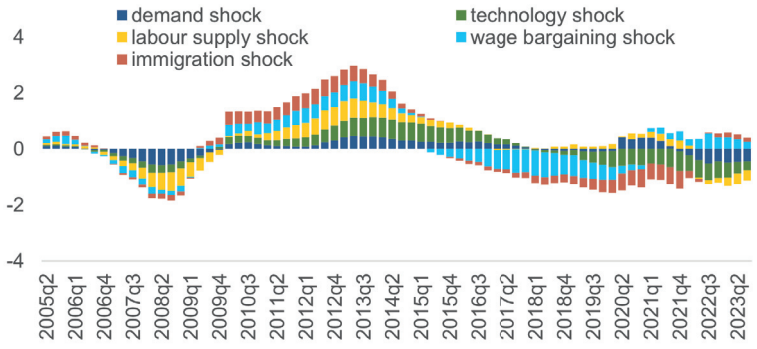
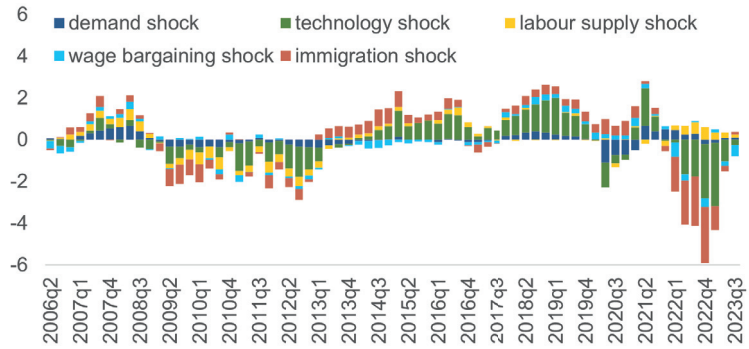


Figure 10: Historical decomposition of unemployment rate (in pp.)



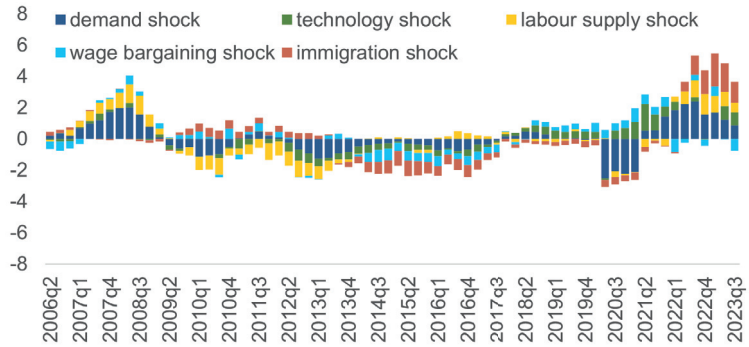
Notes: See notes of Figure 3.

Figure 11: Historical decomposition of real wage growth (annual % change)



Notes: See notes of Figure 3.

Figure 12: Historical decomposition of nominal wage growth (annual % change)



Notes: See notes of Figure 3.

4 Additional results and robustness checks

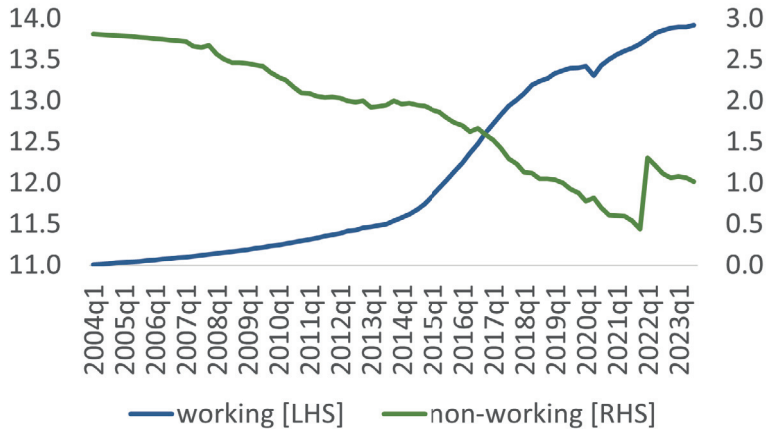
4.1 Distinction between working and non-working immigrants

Immigration is a heterogeneous phenomenon with respect to many dimensions. A crucial aspect in terms of analyzing the impact of immigration on the labour market from the macroeconomic perspective refers to whether immigrants participate in the domestic labour market or stay outside it. As emphasized by Strzelecki et al. (2022), prior to the 2014 Russian invasion of Ukraine, Poland experienced an inflow of less than 0.2 million primarily temporal agricultural workers. Soon after, however, Poland became a destination country for a new, long-lasting wave of economic immigrants who mostly succeeded in finding employment and settlement here. At the same time, border traffic developed even more rapidly. These processes were interfered with in 2020 when the COVID-19 pandemic burst out; the flow of immigrants slowed down, while the number of border crossings substantially dropped. But this is the 2022 Russian invasion of Ukraine being the most critical structural break in immigration to Poland, not only in terms of the number of immigrants but, above all, in terms of the non-economic type of immigration. As mentioned in the introduction, in the first two months after the invasion, Poland allowed in almost 3.5 million refugees, while the number of refugees as of June 2023 was estimated at almost 1 million (OECD, 2023).

Considering this huge structural break, we split our immigration proxy into (1) a proxy for working immigration and (2) the remainder part being, implicitly, our proxy for non-working immigration. We proxy working immigration with the data from the Polish Social Insurance Institution (Zakład Ubezpieczeń Społecznych, ZUS) on the number of foreign citizens registered for pension and disability insurance (i.e. paying their social contributions). This data is available for 2012q1-2023q4; therefore, similarly, as in the case of our proxy for total immigration, we backcast historical data (for 2004q1-2011q4) using exponential smoothing. Our proxy for working immigration enters the model in its log-levels, while the remainder of immigration is

expressed as a log-difference between our proxy for total immigration and the proxy for working immigration.[7] The proxies thus calculated are presented in Figure 13.

Figure 13: Proxies of working immigration (log-level) and non-working immigration (log-difference between total immigration and working immigration)



It should be emphasized that our proxy for working immigration systematically underestimates the actual number of working immigrants because the data on social contributions does not cover persons working on the basis of some types of civil law contracts or working in a shadow economy. However, similarly as in the case of our immigration proxy, we are interested in capturing the variance of working immigration over time rather than its exact levels.

Due to a lack of relevant data, we cannot differentiate between unemployed and economically inactive immigrants among non-working immigrants. This distinction is probably of less importance for the period before the 2022 Russian invasion of Ukraine, when unemployment among immigrants was, to some extent, regulated by an option of coming back to a country of origin. Although it may matter a bit more for the recent refugee crisis, since many immigrants could stay involuntarily unemployed for a more extended period with no outside option and a significant share of refugees are non-active in the labour market (older people and children in

[7] The results are qualitatively the same if the non-working immigration series is defined as $\log(\textit{total immigration} - \textit{working immigration})$.

particular), the unemployment rate for 2022q1-2023q4 was at its historical minimum of around 2.7-2.9% suggesting a very absorptive labour market in Poland at that time. Yet, the lack of clear distinction between unemployed and economically inactive immigrants in our data is important in terms of interpreting the model results. Any shifts in this respect should materialize in our model as a labour supply shock and possibly a wage bargaining shock rather than an immigration shock.

As a robustness check, we also estimate the model in which we replace the proxy mentioned above for working immigration with the one supplied by experts of Narodowy Bank Polski for inflation and GDP projections based on the NECMOD model. Since the series is annual, we interpolate it into quarterly data using our baseline proxy for working immigration. The results from both models are very similar. Therefore, we present only findings from the model that includes a measure of working immigration based on the Polish Social Insurance Institution data.

Table 4 presents the identification scheme for the model that includes two immigration variables (working immigrants and other immigrants) and two corresponding immigration shocks. We assume that both immigration shocks have a positive impact on output, but only a non-working immigration shock (2) has a negative effect on unemployment (via the demand channel). We leave the impact of a working immigration shock (1) on unemployment unrestricted because it is not ex-ante clear to what extent economically active immigrants compete with natives on the labour market (recall that the analysed unemployment rate should be treated as the unemployment rate among natives because it does not cover immigrants adequately). We also expect that a working immigration shock lowers real wages because, in this respect, it should work similarly as a combination of labour supply and wage bargaining shocks. Yet its impact on prices is ambiguous due to its dual demand and supply nature. We restrict the impact of non-working immigration shock on prices to be positive due to the demand nature of this shock. We are agnostic on the effects of a non-working immigration shock on the number of working immigrants, but we assume that a working immigration shock increases non-working immigration (e.g. because a whole family may immigrate following a working head of the family). We do not restrict the response of non-working immigration to any shock from the baseline model (without immigration). However, we expect demand and labour supply shocks to attract more working immigrants.

Table 4: Identification scheme via sign restrictions

	Shocks					
	demand	technology	labour supply	wage bargaining	immigration (1)	immigration (2)
output	+	+	+	+	+	+
prices	+	-	-	-		+
real wages		+	-	-	-	
unemployment	-		+	-		-
working immigrants	+		-		+	
other immigrants					+	+

Accounting for two types of immigration may pose some challenges concerning the empirical identification of a demand shock due to similar sign restrictions patterns. We show, however, that the median correlation between the identified shocks is very low (see Table A.1).

The figures and tables with results from the model with working and non-working immigrants are presented in Appendix A. Including two types of immigration in the model slightly increases the aggregate role of immigration shocks in driving labour market variables (particularly for years 2007-2009 and 2015-2018 when the contribution of non-working immigration shocks interferes with the contribution of labour supply shocks) but the results are in the same ballpark. More importantly, however, the model with two immigration shocks interprets the 2022 inflow of refugees as a non-working immigration shock (driving unemployment down), and therefore, the net contribution of both immigration shocks to the unemployment rate at that time is negative, not positive as in the model with total immigration.

Therefore, the main advantage of accounting for the heterogeneity of immigration is that it provides a better insight into the composition of the contribution of immigration shocks in driving the market labour variables. Although, in principle, both models with immigration tell a similar economic story, disentangling working from non-working immigration helps to quantify the effects of the recent refugee crisis in particular.

4.2 Shorter samples

4.2.1 Excluding the period of massive emigration

In 2004, Poland joined the European Union (EU), making it easier for its citizens to travel and work in Western European countries. As a result, many Poles decided to move abroad, and the number of emigrants from Poland more than doubled in the first three years after EU-accession[8]. Such a scale of outflow had never been observed before in Poland's post-war history and affected the country in many ways, including the labour market (see, e.g., Walerych, 2024). Although we believe that impacts of emigration are captured in our model by a combination of the identified shocks, we verify the robustness of our findings by estimating the model on the sample excluding the periods of peak population outflows, i.e. starting in 2008.[9] For identification, we use the same set of sign restrictions as in the baseline model with immigration.

The figures and tables with results from the model estimated on the sample 2008q1-2023q3 are presented in Appendix B. The shortening of the sample does not significantly alter the impulse response functions and the FEVD graphs. The only difference compared to the baseline model with immigration is a slightly higher role of immigration shocks in shaping the unemployment rate dynamics, while the role of labour market shocks for this variable is reduced. In the historical decompositions, the direction of the shocks' impact on individual variables has also remained essentially unchanged. However, the magnitude of the shocks in the model using the shortened sample is significantly smaller than in the baseline model.

Additionally, we estimated our model on a sample excluding the period before the Russian annexation of Crimea (2014q1-2023q3). Since such a shortening of the sample does not significantly impact the findings, we do not report the detailed results from this estimation, and the results are available upon request.

[8] According to Statistics Poland data, at the end of 2004, the number of Poles living abroad for more than two months amounted to 1 million, while at the end of 2007, the number of Poles residing abroad for more than three months was 2.27 million. Since then, the changes in the emigrant stock have been much less dramatic.

[9] Including emigration in the set of variables used in estimation is not possible due to the absence of reliable quarterly series for this variable.

4.2.2 Excluding the period of COVID-19 pandemic and the full-scale Russian aggression

As discussed in Section 3, the outbreak of the COVID-19 pandemic in 2020 and, even more so, the armed conflict between Russia and Ukraine that began in 2022 had a significant impact on migration inflows to Poland. To ensure that the findings from the baseline model are not solely driven by this specific period, we estimate the model using a sample that ends in 2019q4 and present the most important results from such model in Appendix C.

Although the impulse responses are similar for most variables, several differences stand out. First, the median reaction of prices to the labour supply shock is negative for only three quarters before turning positive. The shape of this response now aligns with the estimates by Foroni et al. (2018) for the U.S. Second, the median response of output to an immigration shock is now more prolonged, while the reaction of prices is weaker on impact and more short-lived. These differences are also reflected in the FEVD: the importance of immigration shocks, especially over longer horizons, is greater for output and significantly smaller for prices. Importantly, contrary to the baseline model, immigration shocks are not currently the main driver of price fluctuations. Technology shocks dominate in shorter horizons, while demand shocks take precedence in longer horizons. The smaller role of immigration shocks for the dynamics of prices, as obtained from the estimation on the sample excluding the period of the COVID-19 pandemic and full-scale Russian aggression, confirms our assumptions that the inflationary impact of these disturbances was particularly evident in the most recent period, when the inflow of non-working immigrants, which created significant consumption demand, was at its highest.

In the baseline model, technology shocks were the primary driver of real wage fluctuations, accounting for almost 60% of the FEVD across all horizons. In the model estimated on the shorter sample, the role of productivity shocks is significantly reduced (to around 30%), in the short horizons in favor of immigration shocks, and in the long horizons in favor of labour supply shocks. The greater explanatory power of labour supply shocks in the long run is also manifested in the FEVD for the unemployment rate.

Altogether, the estimation on the shorter sample confirms that immigration shocks do matter for labour market fluctuations in Poland. The role of these shocks in shaping real wages is even greater than in the model estimated on the full sample, while their impact on the unemployment rate and nominal wages appears to be comparable to that in the baseline model. It should be noted, however, that the impact on the dynamics of nominal wages this time results from the significant role of immigration shocks in the dynamics of real wages, rather than, as in the case of the baseline model, from their inflationary nature. As a result, the contribution of these shocks in the historical decomposition of nominal wage dynamics tends to be in the same direction as that of real wages.

4.3 Adding energy prices and supply chain disruptions

The large and rapid inflow of immigrants in 2022 coincided with high increases in energy prices and supply chain disruptions. All these three developments are generally inflationary, so one might be concerned that the identified strong impact of immigration shocks on prices, and thus also on nominal wages in recent periods, is not due to immigration *per se*, but rather due to two other factors that have been highly correlated with immigration at that time. To address this problem, we extend the set of endogenous variables with the Producer Price Index for energy according to main industrial groupings (MIG) by Eurostat (PPI-energy) and inverted Supplier's Delivery Times Index (SDTi), i.e. 100-SDTi[10].

The identification scheme for such an extended model is presented in Table 5. We assume that an energy shock has a negative impact on output and a positive effect on prices, while energy prices are positively affected by a demand shock and both labour market shocks (due to their positive impact on economic activity). We leave the response of energy prices to an immigration shock unrestricted (instead of assuming a positive sign) to avoid a situation where the hikes in energy prices in 2022 are

[10]SDTi captures the extent of supply chain delays in an economy. It can take values between 0 and 100: readings of 50 indicate no change in delivery times compared to the previous period, readings above 50 indicate that delivery times have improved, and readings below 50 indicate that delivery times have deteriorated.

(somewhat a priori) attributed to increases in immigration flows. Alternatively, we could pick an exogenous measure of energy prices (with respect to Poland's economy) and treat it as an exogenous variable in the BVAR; however, historical decompositions from such a model would not be directly comparable to the ones from previous models due to a different definition of steady-state. We also assume that supply chain disruptions positively affect prices, but the effects on output are unrestricted (recall that Poland's exports rely heavily on intermediate goods, (see, e.g., Hagemejer and Mućk, 2019)). In line with the formula for PMI, we suppose a positive response of inverted SDTi to a demand shock.

The restrictions in the applied identification scheme are not clear-cut because we treat the energy prices and the supply chain disruptions as only control variables, and we are not interested in the precise identification of the additional two shocks. Nevertheless, the median correlation between all pairs of shocks is still very low (Table D.1).

The figures and tables with results from the extended model are presented in Appendix D. Although accounting for energy prices and supply chain disruptions reduces the role of immigration shocks for all three considered labour market variables, and nominal wages in particular, these shocks remain the important driver of labour market fluctuations in Poland. In recent years, the immigration shocks have been mildly lowering the unemployment rate and, to a greater extent, the annual growth rate of real wages. On the other hand, they also significantly contributed to higher growth of nominal wages due to the positive impact of immigration on aggregate demand and their estimated inflationary nature in the short run.

As an additional robustness check regarding the inflationary effects of immigration shocks, we also estimated a model with energy prices, supply chain disruptions, and wheat prices. Since the outcome was merely the same as in the model without wheat prices, we do not present the results here; they are available upon request.

Table 5: Identification scheme via sign restrictions

	Shocks						
	demand	technology	labour supply	wage bargaining	immigration	energy	supply chain
output	+	+	+	+	+	-	
prices	+	-	-	-	+	+	+
real wages		+	-	-	-		
unemployment	-		+	-			
immigrants	+		-		+		
energy prices	+		+	+		+	
100 - SDTi	+						+

5 Conclusions

In this paper, we add to the debate on the macroeconomic impacts of immigration and quantify its importance in shaping unemployment and wage fluctuations in Poland, which experienced an intense inflow of immigrants following Russia's invasions of Ukraine in 2014 and 2022. To this point, we estimate several BVAR models using quarterly data from Poland from 2004q1 to 2023q3 and identify the structural shocks through the sign restrictions on the variables' impact responses.

Our starting point is the specification proposed by Foroni et al. (2018) that includes four endogenous variables (i.e. output, prices, real wages and unemployment rate), which we next extend with newly constructed immigration proxies (based on Boarder Guard data). To our knowledge, we are the first to (i) consider Ukrainian immigration in structural VAR models and analyse its impact on the Polish labour market variables and (ii) analyse the effects of immigration from Ukraine on Poland's economy using data after February 2022, i.e. after the start of the full-scale Russian invasion which triggered large and very rapid migratory movements.

We find that immigration does matter for the dynamics of the labour market variables in Poland. In recent years, it has been mildly lowering the unemployment rate and, to a greater extent, the annual growth rate of real wages. On the other hand, the identified immigration shocks significantly contributed to higher nominal wage growth, particularly after 2022, due to the positive impact of immigration on aggregate demand and their estimated inflationary nature in the short run. Considering the elevated inflation after the full-scale Russian invasion of Ukraine, the inflationary effects of immigration shocks seem to be an interesting area for future research, particularly from the monetary policy perspective.

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Appendix

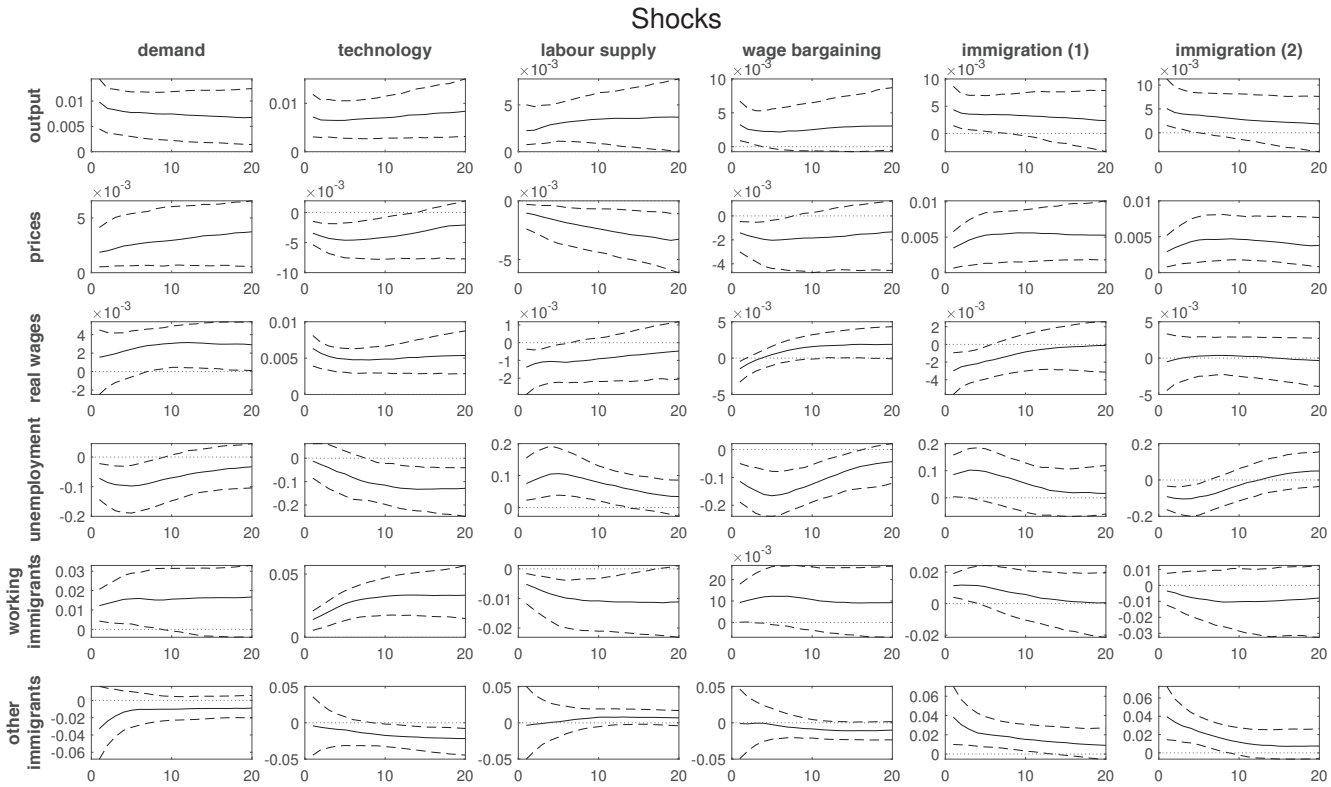
A Model with working and non-working immigrants

Table A.1: Median correlation coefficients between structural shocks

	demand	technology	labour supply	wage bargaining	immigration (1)	immigration (2)
demand	1					
technology	0.00	1				
labour supply	0.01	0.00	1			
wage bargaining	-0.02	0.00	-0.02	1		
immigration (1)	-0.03	0.01	0.00	0.00	1	
immigration (2)	-0.01	0.00	-0.01	-0.01	-0.03	1

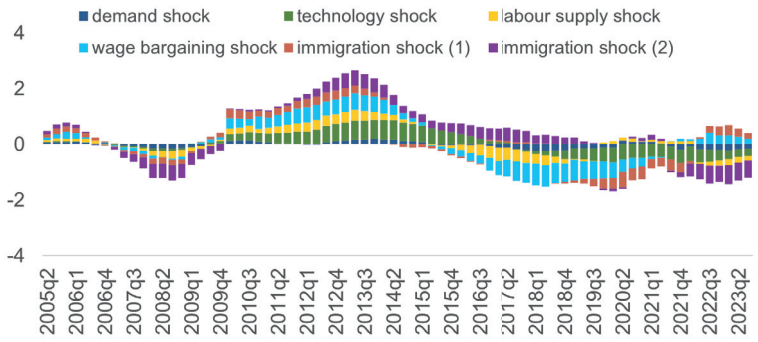
Notes: The pairwise correlation coefficients take on values within the range of -0.39 to 0.40.

Figure A.1: Posterior impulse responses



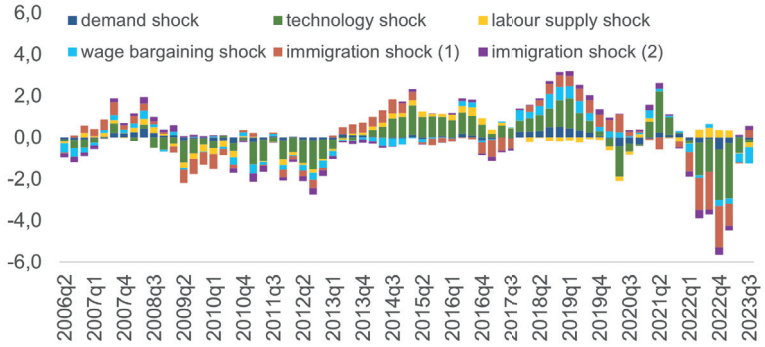
Notes: See notes to Figure 1.

Figure A.2: Historical decomposition of unemployment rate (in pp.)



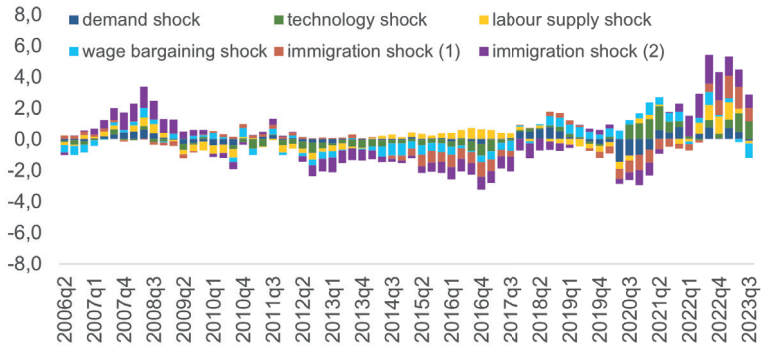
Notes: See notes of Figure 3.

Figure A.3: Historical decomposition of real wage growth (annual % change)



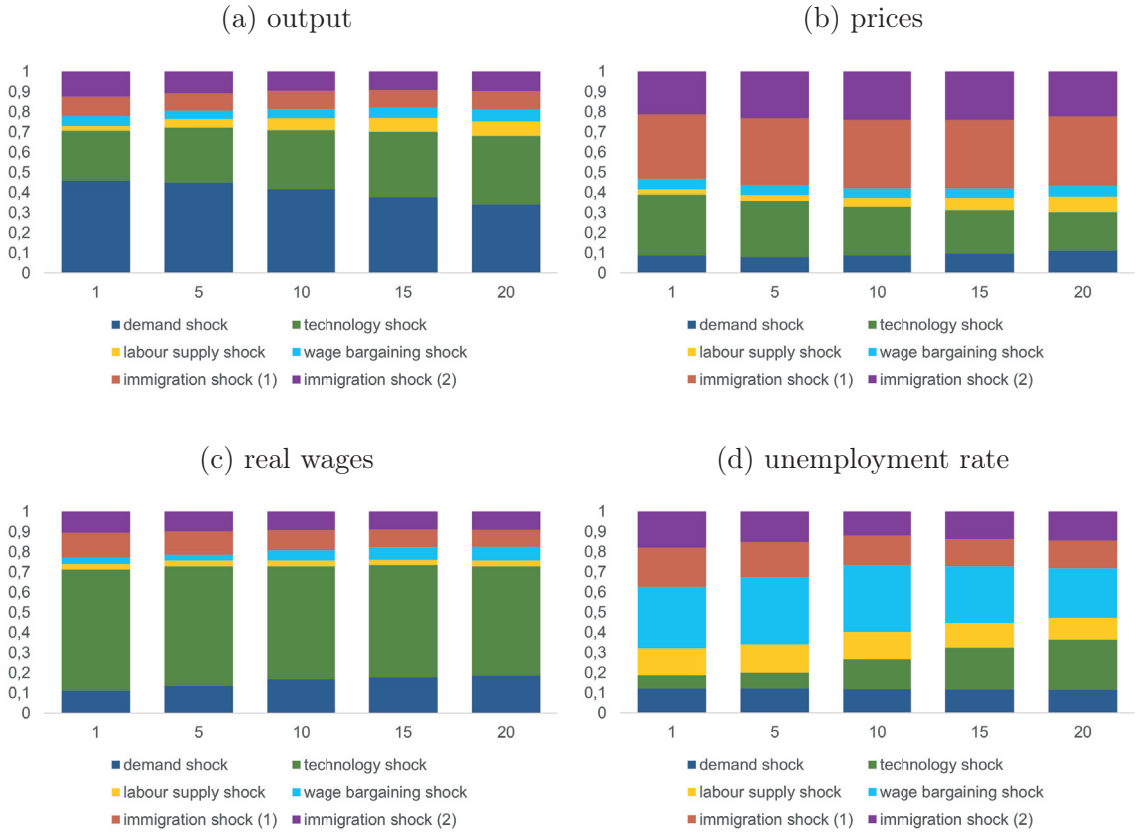
Notes: See notes of Figure 3.

Figure A.4: Historical decomposition of nominal wage growth (annual % change)



Notes: See notes of Figure 3.

Figure A.5: FEVD for selected endogenous variables



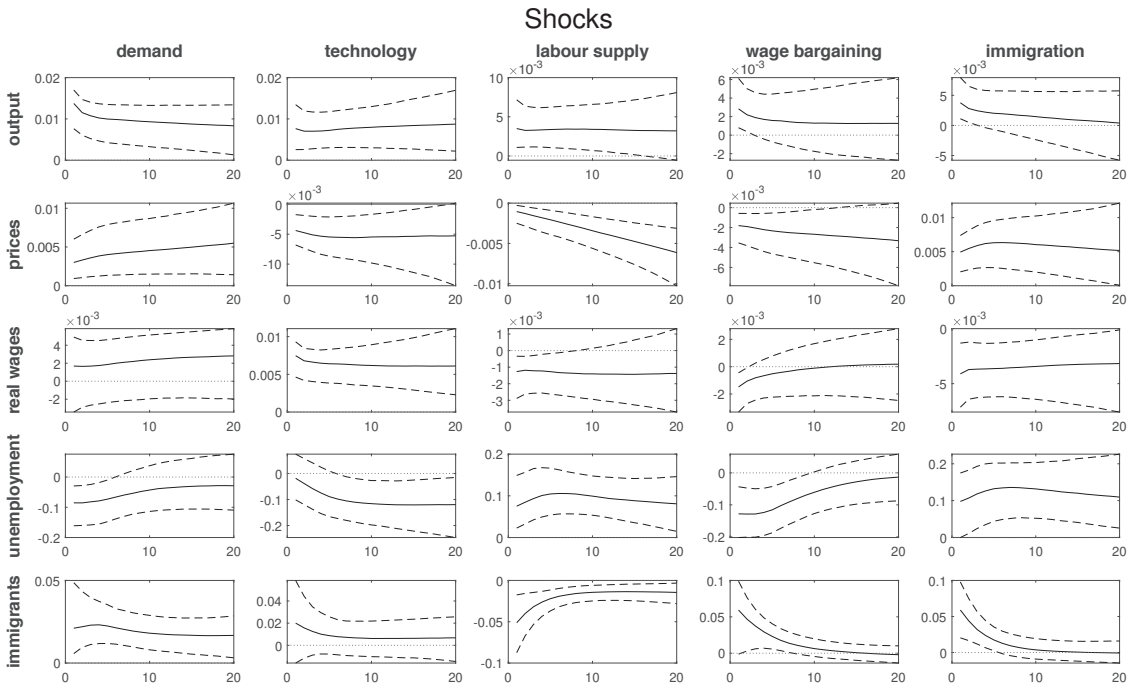
B Model estimated on the sample 2008q1-2023q3

Table B.1: Median correlation coefficients between structural shocks

	demand	technology	labour supply	wage bargaining	immigration
demand	1				
technology	-0.02	1			
labour supply	0.04	-0.01	1		
wage bargaining	-0.04	-0.01	-0.03	1	
immigration	-0.06	0.01	-0.01	-0.02	1

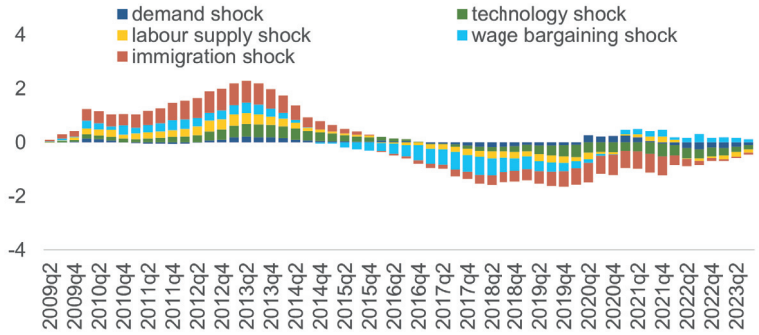
Notes: The pairwise correlation coefficients take on values within the range of -0.51 to 0.51.

Figure B.1: Posterior impulse responses



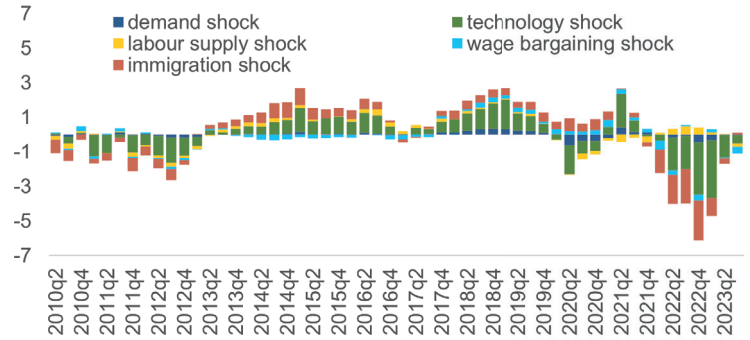
Notes: See notes to Figure 1.

Figure B.2: Historical decomposition of unemployment rate (in pp.)



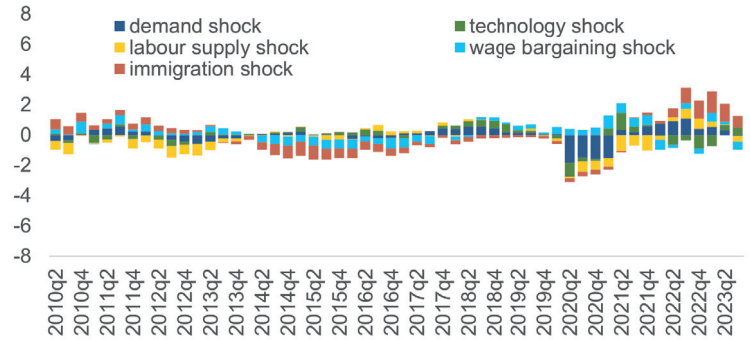
Notes: See notes of Figure 3.

Figure B.3: Historical decomposition of real wage growth (annual % change)



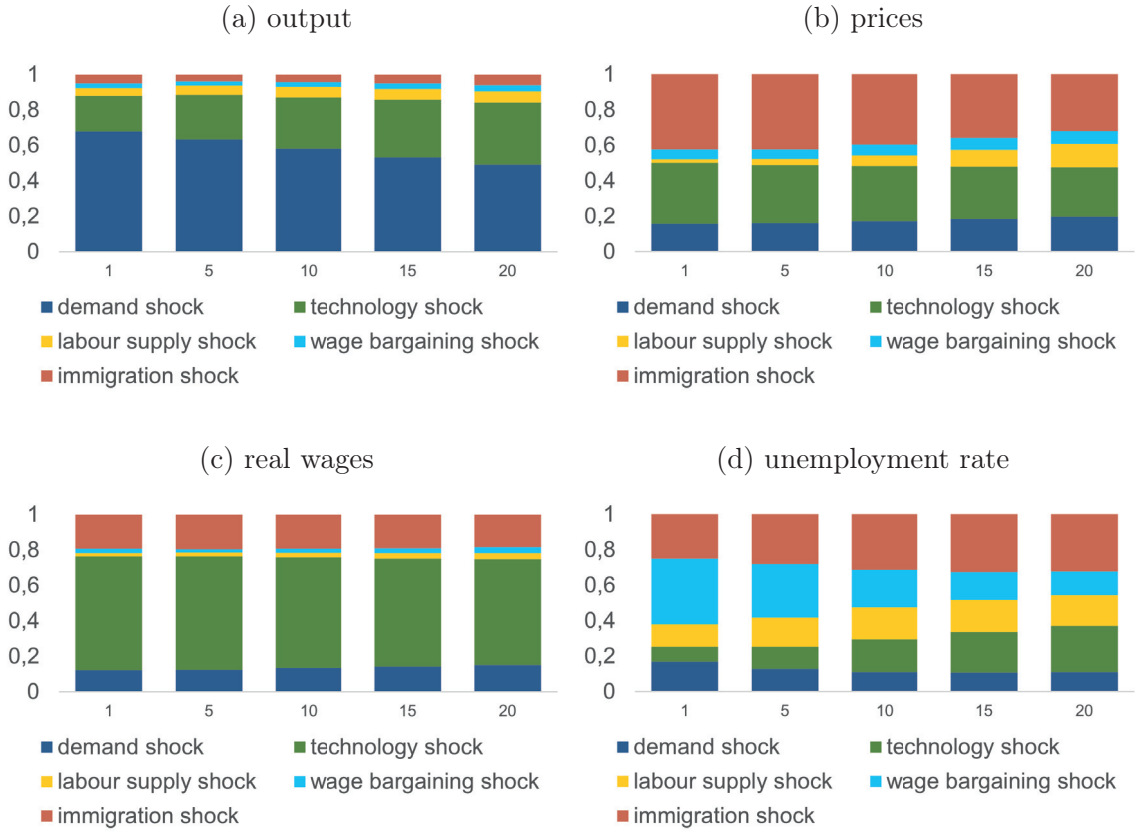
Notes: See notes of Figure 3.

Figure B.4: Historical decomposition of nominal wage growth (annual % change)



Notes: See notes of Figure 3.

Figure B.5: FEVD for selected endogenous variables



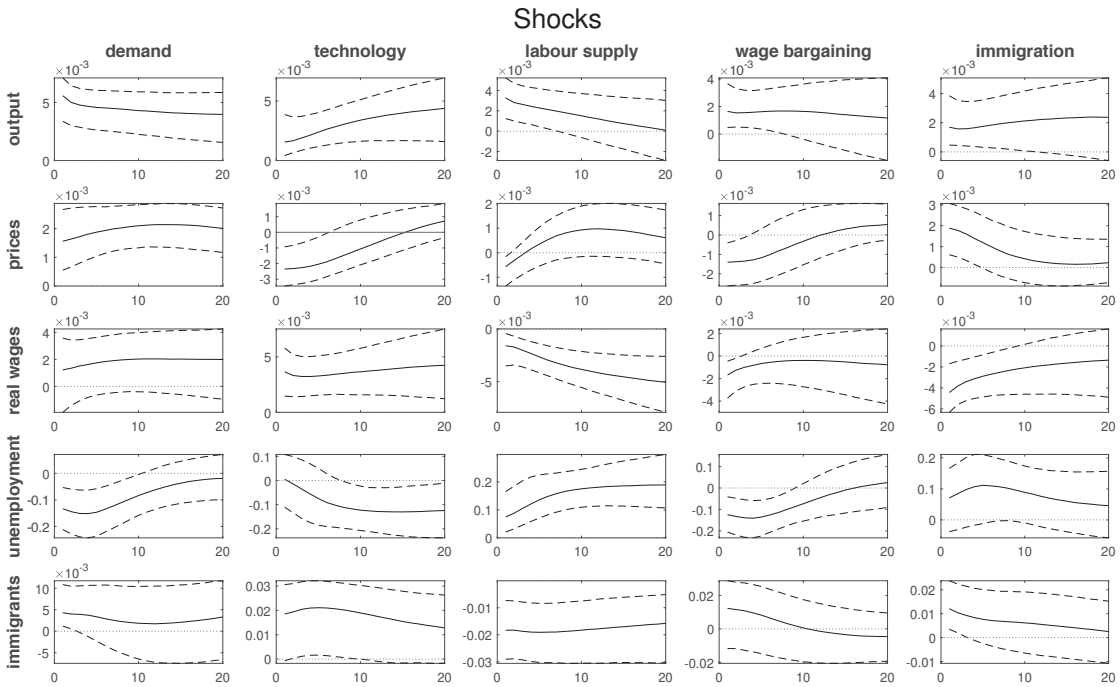
C Model estimated on the sample 2004q1-2019q4

Table C.1: Median correlation coefficients between structural shocks

	demand	technology	labour supply	wage bargaining	immigration
demand	1				
technology	-0.04	1			
labour supply	0.06	-0.03	1		
wage bargaining	-0.04	-0.02	-0.04	1	
immigration	-0.06	0.00	0.00	-0.02	1

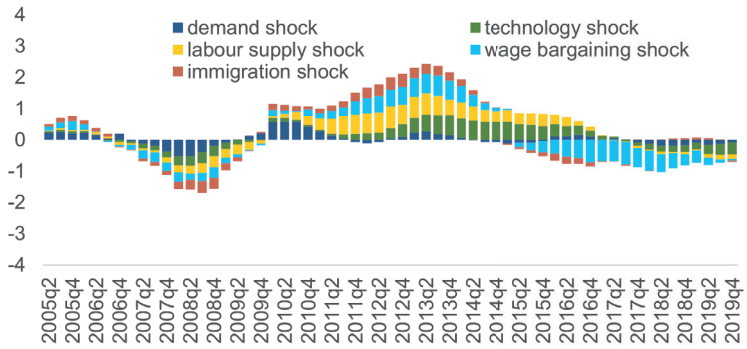
Notes: The pairwise correlation coefficients take on values within the range of -0.50 to 0.48.

Figure C.1: Posterior impulse responses



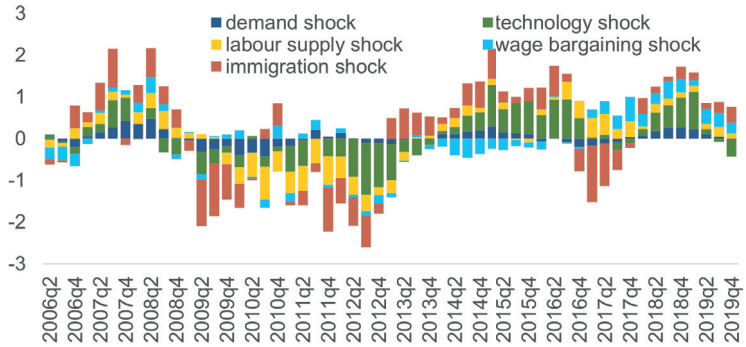
Notes: See notes to Figure 1.

Figure C.2: Historical decomposition of unemployment rate (in pp.)



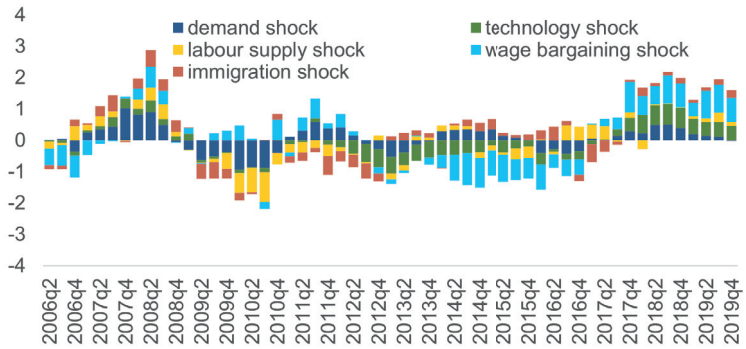
Notes: See notes of Figure 3.

Figure C.3: Historical decomposition of real wage growth (annual % change)



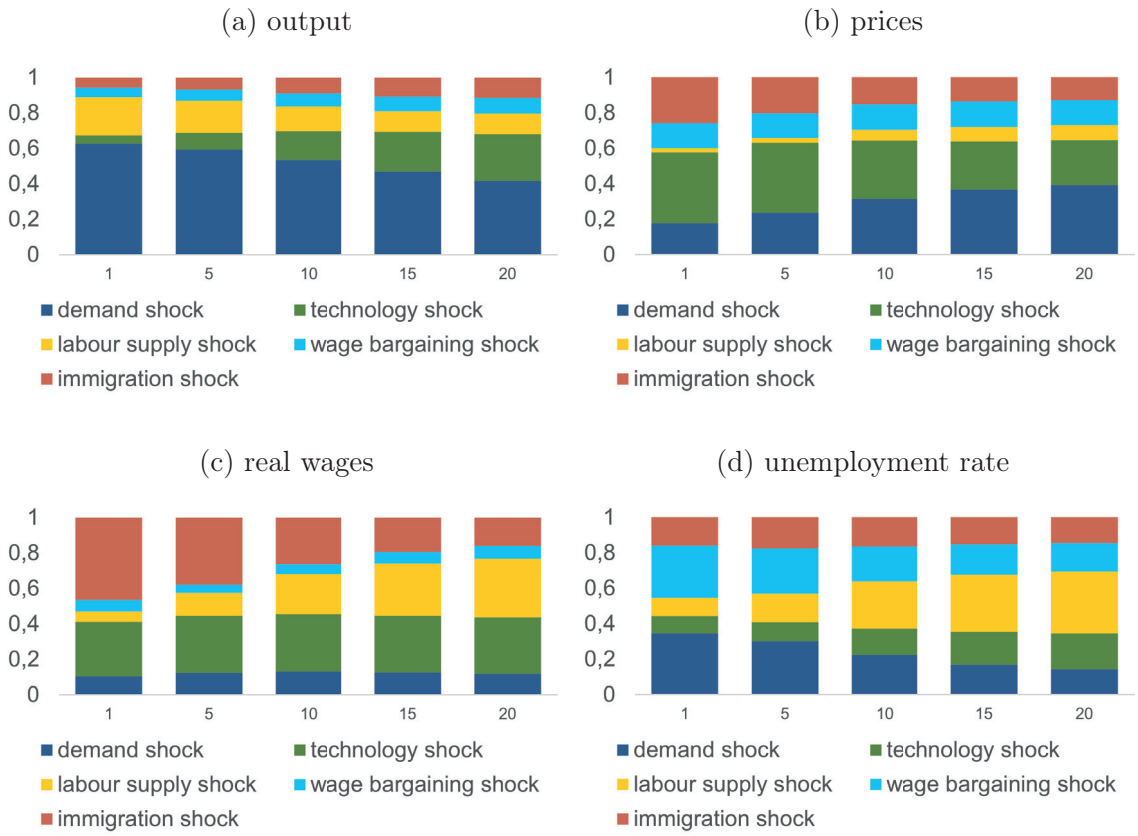
Notes: See notes of Figure 3.

Figure C.4: Historical decomposition of nominal wage growth (annual % change)



Notes: See notes of Figure 3.

Figure C.5: FEVD for selected endogenous variables



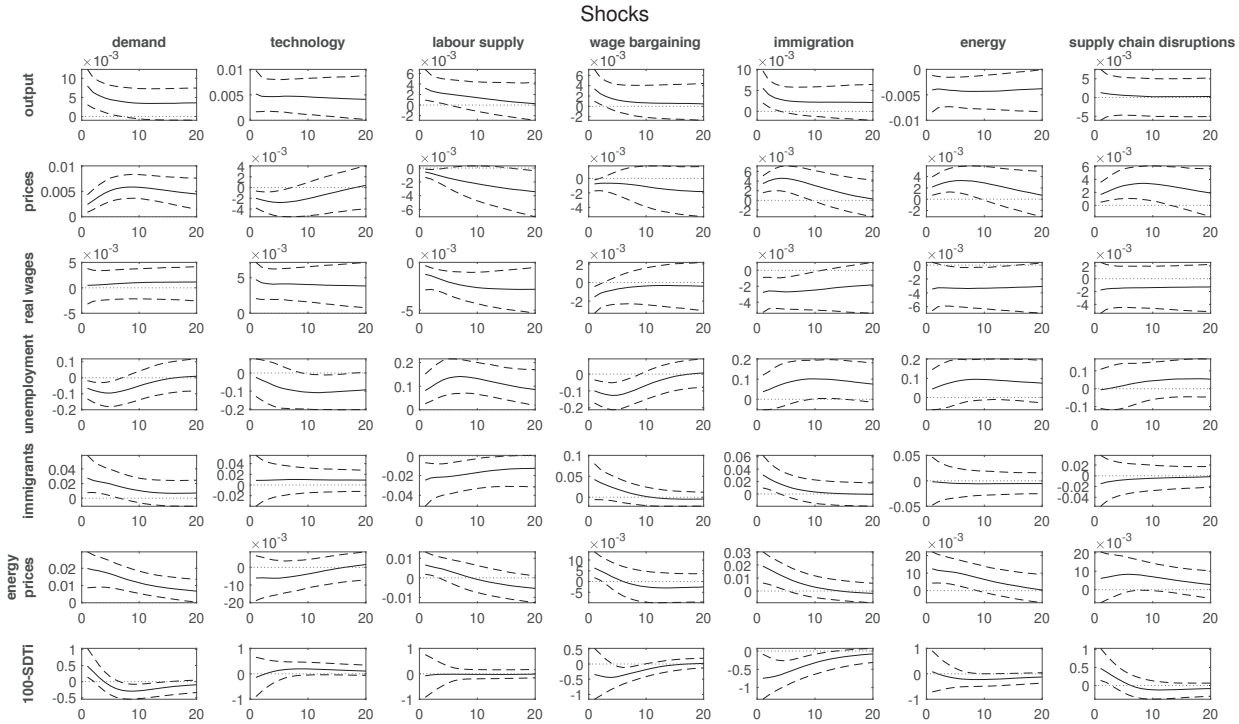
D Model with energy prices and supply chain disruptions

Table D.1: Median correlation coefficients between structural shocks

	demand	technology	labour supply	wage bargaining	immigration	energy	supply chain disruptions
demand	1						
technology	0.00	1					
labour supply	0.02	-0.01	1				
wage bargaining	-0.03	-0.01	-0.03	1			
immigration	-0.03	0.01	0.00	-0.02	1		
energy	0.00	0.03	0.01	0.00	-0.01	1	
supply chain disruptions	-0.02	0.01	0.01	0.02	0.00	-0.01	1

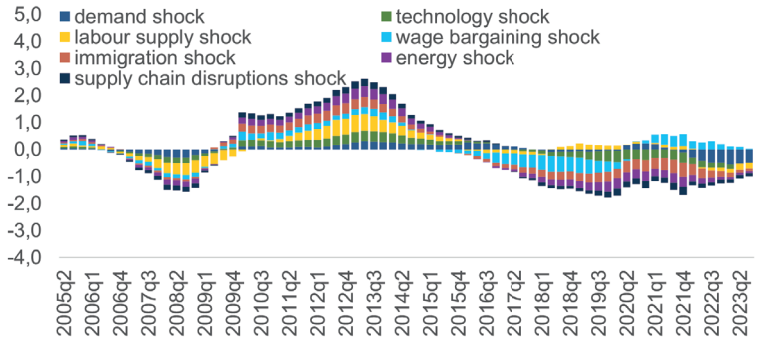
Notes: The pairwise correlation coefficients take on values within the range of -0.51 to 0.46.

Figure D.1: Posterior impulse responses



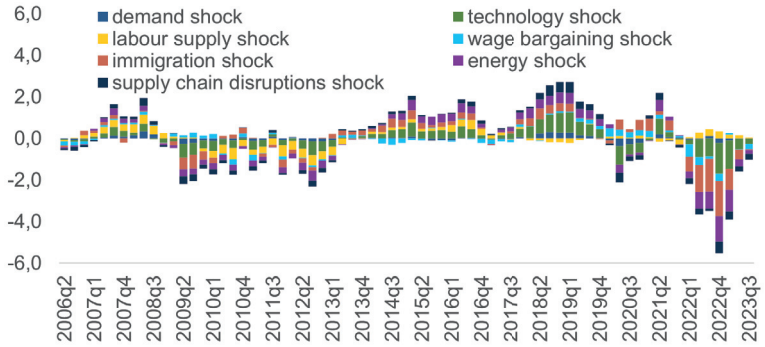
Notes: See notes to Figure 1.

Figure D.2: Historical decomposition of unemployment rate (in pp.)



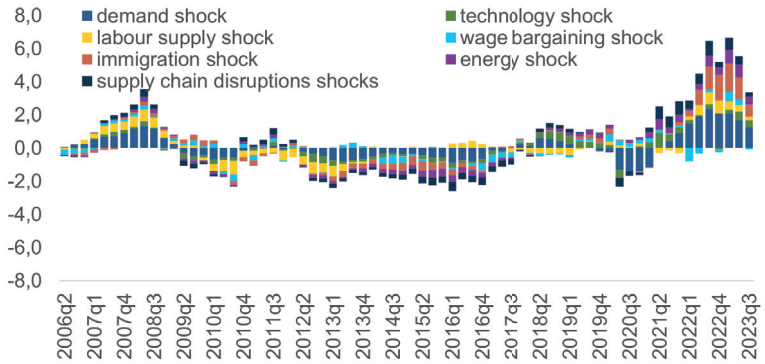
Notes: See notes of Figure 3.

Figure D.3: Historical decomposition of real wage growth (annual % change)



Notes: See notes of Figure 3.

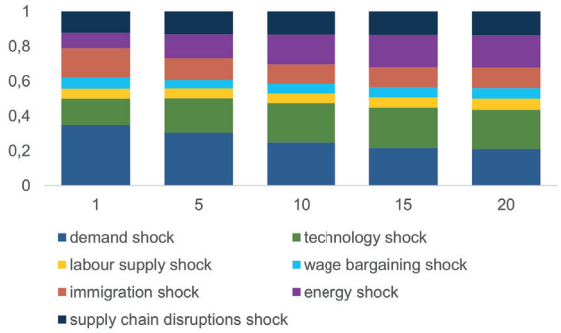
Figure D.4: Historical decomposition of nominal wage growth (annual % change)



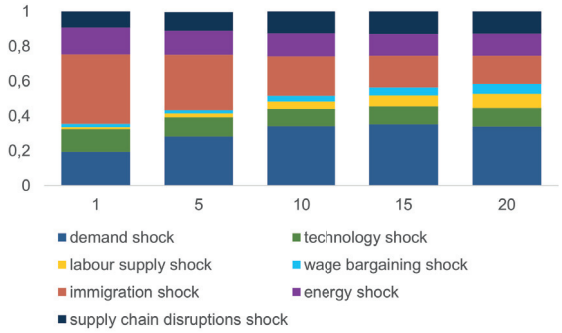
Notes: See notes of Figure 3.

Figure D.5: FEVD for selected endogenous variables

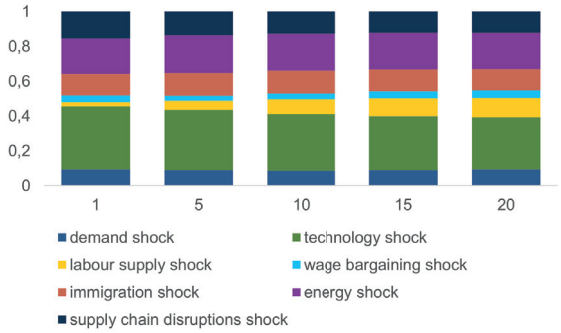
(a) output



(b) prices



(c) real wages



(d) unemployment rate