How do regional labor markets adjust to immigration? A dynamic analysis for post-war Germany *

Sebastian Till Braun† Henning Weber‡

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Abstract

This paper provides a comprehensive analysis of the dynamic labor market effects of one of the largest forced population movements in history, the mass inflow of eight million German expellees into West Germany after World War II. The expellee inflow was distributed very asymmetrically across two West German regions. We develop a dynamic equilibrium model that closely fits two decades of historical data on the regional unemployment differential and the regional migration rate. Both variables increase dramatically after the expellee inflow and decline only gradually over the next decade. These adjustments imply losses in the lifetime labor income of native workers of more than one percent and represent economic costs not covered by conventional steady state analyses. Regional migration serves as an important adjustment margin for native workers to ensure against further income losses. In counterfactual analyses, we show that a more gradual inflow of expellees would have significantly reduced native income losses and dampened adjustment dynamics in regional labor markets.

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†University of Bayreuth, Kiel Institute for the World Economy and RWI Research Network. University of Bayreuth, Faculty of Law, Business and Economics, Chair VWL 7–Quantitative Economic History, 95440 Bayreuth, Germany, Tel: +49 921 55-6256, sebastian.braun@uni-bayreuth.de.

‡Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main, Germany, Tel: +49 69 9566-2217, henning.weber@bundesbank.de.

1 Introduction

This paper studies how regional labor markets in West Germany adjusted to one of the largest forced population movements in history, the mass inflow of German expellees after World War II. The eight million expellees who had arrived in West Germany by the end of 1949–most of whom from the territories that Germany relinquished after the war–were distributed very unevenly across the country. The share of expellees in the population ranged from 3.1% in the federal state of Rhineland-Palatinate to 33.3% in Schleswig-Holstein. We exploit this large, unexpected, and highly uneven inflow of expellees to take up two key research questions. First, how quickly and by what margins did regional labor markets adjust to the expellee inflow? Second, how did the inflow affect the native population's labor income along the adjustment path?

Our paper contributes to an extensive literature in labor economics that analyzes labor market adjustments to immigration.[1] Over the past two decades, interest in the issue has been fueled by sharply rising numbers of international migrants and public concern about the consequences of immigration. The recent surge in forced migration and the growing inflow of refugees into Europe have only added to these concerns. Despite strong public interest, the burgeoning literature on immigration has hardly addressed two major aspects of the adjustment process (Borjas 2014): the length of the adjustment process and the relative importance of different adjustment margins along the adjustment process.[2] Our paper addresses these two aspects.

We start our analysis by presenting novel empirical facts on how regional labor markets in West Germany adjusted to the inflow of expellees, drawing on administrative data from 1939-70. We derive these facts by contrasting the economic development of two stylized regions: a high-inflow region H that consists of what were known as the "refugee states" of Bavaria, Lower Saxony, and Schleswig-Holstein, and a low-inflow region L that consists of the remaining West German states. The two regions had similar unemployment and population growth rates before World War II. However, during and after World War II, much more expellees fled or were transferred to region H than to region L, largely because region H is located much closer to the

[1] Okkerse (2008), Longhi, Nijkamp, and Poot (2010), Kerr and Kerr (2011), Dustmann, Schönberg, and Stuhler (2016), and Peri (2016) provide comprehensive reviews, meta-analyses, and critiques of the existing literature.

[2] In fact, the existing literature focuses mainly on changes in wages as the key margin through which labor markets adjust to immigration (see, e.g., Aydemir and Borjas (2011), Manacorda, Manning, and Wadsworth (2012) or Dustmann, Frattini, and Preston (2013)). Moreover, the literature typically analyzes the labor market effects of immigration in a static framework (see, e.g., Card (2001), Boustan, Fishback, and Kantor (2010) or Braun and Mahmoud (2014)). In contrast, remarkably little is known about the labor market effects of immigration along the adjustment path and about the time that it takes the labor market to digest an immigration-induced labor supply shock (Jaeger, Ruist, and Stuhler 2018). We discuss related work on the dynamic labor market effects of immigration below.

homelands of expellees than region L. We compare economic developments in the two regions before the inflow and document their subsequent relative development until 1970, two decades after the expellee inflow was complete. We argue that this comparison is informative about the adjustment path because regional differences in initial inflow rates were large and exogenous to local labor market conditions.

Our empirical facts reveal that by 1950, the unemployment rate in region H was as high as 16.7% and exceeded the unemployment rate in region L by a factor of two and a half. Regional unemployment rates then gradually converged during the 1950s and eventually fell to around 1% by the early 1960s. The decrease and convergence in regional unemployment was accompanied by large regional migration flows. In 1950 alone, net migration from region H to L amounted to 1.9% of the population in region H.

These large migration flows diffused the labor market effect of the expellee inflow from region H to region L and re-equilibrated local regional labor markets. Consequently, a direct comparison of labor market outcomes between the two regions will underestimate, except on impact, the true causal effect of receiving high rather than low expellee inflows even if the initial distribution of expellees was exogenous to local labor market conditions. After all, such comparison would show little or no differences because, over time, the high inflow of expellees into region H affected not only region H itself but also region L.

To isolate the causal effect of the expellee inflow along the entire adjustment path, we develop a dynamic equilibrium model that accounts for regional migration and its effect on regional labor markets. The backbone of this model is a dynamic two-region search and matching model of unemployment where workers take recurrent and forward-looking migration decision between the two regional labor markets. Migration is subject to costs, except for the initial expellee inflow which we model as an exogenous increase in the number of non-employed workers. In each region, a representative firm employs many workers and accumulates capital to produce output. The firm faces costs when it adjusts its workforce or capital stock.

To calibrate the model to historical data, we exploit both the cross-section and time dimension of the data. We show that the calibrated model's adjustment dynamics after the asymmetric historical expellee inflow closely fit our empirical facts, including those that we did not target in the calibration. Using the calibrated model, we find that regional labor markets approached the new steady state about a decade after the expellee inflow. Regional migration played a crucial role in the adjustment process. About one-third of the initial increase in region H's population was eventually absorbed through migration to the low-inflow region L.

The adjustment process of the native population differs strongly from the process of the population as a whole. The employment probability of native workers decreases in the first few quarters of the adjustment process, whereas the employment probability of the average worker increases monotonically throughout. The negative effect of the expellee inflow on native employment is largest about nine quarters after the arrival of the expellees. When measured at that time, native employment decreases by 4.65 workers for every ten expellees who arrive in region H. Of those 4.65 native workers, 1.59 leave the labor force, 2.23 enter the unemployment pool, and 0.83 leave region H for region L.

The large and long-lasting adjustment dynamics in regional labor markets, reflecting the expellee inflow, decreased the expected discounted lifetime labor income of the average native worker in West Germany by 1.38%. The short-term decline, measured by per-period labor income, is much larger and reaches 5.34% nine quarters after the shock. Regional migration is a quantitatively important adjustment margin for native workers to ensure against income losses arising from the asymmetric expellee inflow. In fact, migration reduces the asymmetry in regional income losses of natives, as measured by the Gini coefficient, by 50%. We also find that it takes more than a decade for 90% of the loss in lifetime labor income of the average native worker to be realized, and that the magnitude of the loss depends on a worker's location and labor market status at the time of the inflow. The short-run wage elasticities, which in our calibrated model are between -0.12 and -0.16, are in line with empirical estimates that we produce based on a large scale survey of employees' earnings in trade and industry. All these results survive a battery of robustness checks, in which we account for the–potentially confounding–influence of pre-existing differences between regional labor markets.

Counterfactual analyses show that changes in the timing and regional distribution of the expellee inflow can significantly reduce native income losses and dampen adjustment dynamics. In particular, the adverse effects of expellees on native income are much less pronounced if the inflow is spread out over time. Distributing expellees more equally across regions than was the case historically accelerates expellees' integration into the labor market and increases their income. Surprisingly, however, a more equal distribution also increases the income loss of the average native worker.

Related literature. Our finding of prolonged adjustment processes after the expellee inflow complements a nascent literature that studies the dynamic wage effects of immigration. Cohen-Goldner and Paserman (2011) analyze the impact of the inflow of more than one million Soviet Jews into Israel after the collapse of the Soviet Union. The authors show that the initially negative wage effect of the inflow dies out after five to seven years. Edo (2017) studies the dynamic wage effect of the sudden inflow of repatriates from Algeria to France in 1962. He finds that wages fell between 1962 and 1968 and then returned to their pre-shock level in 1976. Cohen-Goldner and Paserman (2011) and Edo (2017) exploit variation in the migrant share across labor market segments, assuming that these labor market segments are isolated from each other. In contrast, our structural approach directly accounts for movements between regional labor market segments and therefore allows us to quantify the role of regional migration as an adjustment margin.

In recent work, Colas (2018) considers a dynamic equilibrium model of local US labor markets to study dynamic wage and income effects of immigration. Colas (2018) finds that the wage effect of immigration is cut in half ten years after the shock, as natives move away from high inflow locations. Employed workers experience a larger decline in life-time income than unemployed workers. Our paper also documents pronounced differences in life-time income depending on workers' labor market status at the time of the shock. However, we show that employed native workers suffer less than non-employed natives, as the former are initially shielded from the decrease in job-finding rates caused by the inflow of initially non-employed expellees.

In a related setting, Monras (2018) studies local labor market adjustments in the US, including internal migration and its effect on life-time income, induced by the Great Recession.[3] When treating this event as a permanent change in local productivity, he finds that adjustments in most locations are completed within a decade . An important difference between our paper and both Colas (2018) and Monras (2018) is the calibration strategy. While Colas (2018) and Monras (2018) calibrate their models to moments of the distribution of workers obtained from cross-sectional or panel data, we calibrate the model directly to the adjustment dynamics observed for different groups of workers following the expellee inflow. We also consider a natural experiment involving a one-time inflow of exceptional size, whereas Colas (2018) considers

[3] Monras (2015) analyzes the short- and long-term effects of Mexican immigration into the US on the wages of low-skilled natives. He finds that Mexican-US immigration has large negative wage effects in the short run, and that regional migration quickly dissipates local labor supply shocks. Monras (2015) uses a dynamic structural model to obtain the evolution of wages in a counterfactual no-migration scenario. In contrast to our paper, however, he focuses on wage effects only – and hence abstracts from the unemployment and labor force participation margins.

ongoing immigration inflows of normal size.

Grossmann, Schäfer, Steger, and Fuchs (2017) consider the dynamic effects of labor market integration on migration flows, capital formation, and house prices following German reunification. While the authors emphasize the role of the initial regional capital stock for the adjustment dynamics in their setting, our results do not depend on varying the initial regional capital stock.

Another related literature, which, however, abstracts from adjustment dynamics, studies the link between immigration and subsequent internal migration of native workers. Some studies find that native workers indeed respond to immigration by moving out to other areas (see, for example, Filer (1992), Borjas (2006) or Boustan, Fishback, and Kantor (2010)), while other studies find no such effect (see, for example, Card and DiNardo (2000), Card (2001) or Kritz and Gurak (2001)). Our paper demonstrates that the effect of immigration on native out-migration depends crucially on the regional asymmetry of the immigrant inflow, and on the time elapsed since the inflow.

The economic literature has paid scarce attention to the labor market effects of forced rather than voluntary migration (see Ruiz and Vargas-Silva (2013) for a review), despite the tens of millions of persons who are forcefully displaced worldwide (UNHCR 2015). Braun and Mahmoud (2014) is, to the best of our knowledge, the only other study that analyzes the labor market effects of our specific episode of forced migration.[4] The authors demonstrate that expellees had a substantially negative effect on native employment in 1950. In contrast to our paper, Braun and Mahmoud (2014) focus on the short-term effect of the expellee inflow and do not quantify the relative importance of different margins through which the West German economy adjusted over time to the expellee inflow.

Our paper is also related to an emerging theoretical literature that studies the effect of immigration within search and matching models. Ortega (2000) studies a two-country model, in which unemployed workers decide where to search for a job. Chassamboulli and Palivos (2014) analyze the effects of immigration into the US, while Liu (2010) and Chassamboulli and Peri (2015) analyze the effect of *illegal* immigration into the US. Battisti, Felbermayr, Peri, and Poutvaara (2018) analyze the welfare effects of immigration on low-skilled and high-skilled

[4] Additional work has studied the economic integration of expellees in post-war West Germany (Bauer, Braun, and Kvasnicka 2013, Braun and Dwenger 2018, Falck, Heblich, and Link 2012), and the effect of the expellee inflow on sectoral change and output growth in 1939-50 (Braun and Kvasnicka 2014), on productivity and regional economic development (Peters 2017), and the spatial equilibrium of population (Braun, Kramer, and Kvasnicka 2017, Schumann 2014). Burda (2006) analyzes the reallocation of production factors after German reunification in 1990, and shows that the integration process involves significant migration from East to West Germany.

natives in 20 countries. Our work differs from these papers in three main respects. First, we focus on the adjustment dynamics triggered by immigration rather than on the steady-state effects of immigration. Second, we study the role of regional migration within a country as an adjustment margin to immigration. Third, we calibrate key model parameters using data from a natural experiment.

This paper proceeds as follows. Section 2 provides background on our historical setting, and Section 3 derives empirical facts on how regional labor markets in West Germany adjusted to the expellee inflow. Section 4 develops the equilibrium model that we use to analyze the historical data. Section 5 explains the calibration of model parameters and assesses the model fit. Section 6 contains our main results on the channels through which regional labor markets adjusted to the expellee inflow and the associated income effects for native workers. Section 7 reports the results from our counterfactual exercises. Finally, Section 8 concludes.

2 Historical background and nature of the expellee inflow

Below, we shall refer to those territories east of the present-day eastern border of Germany that were part of the German Reich before World War I as eastern territories (see Figure 1 for an overview of Germany's territorial losses between 1919 and 1945). We shall refer to the Federal Republic of Germany as West Germany and to the German Democratic Republic as East Germany (again, see Figure 1). Together, West and East Germany represent the territory of present-day Germany, to which we refer as post-war Germany.

Three phases of displacement. The displacement of Germans from central and eastern Europe took place between 1944 and 1950, and occurred in three different phases. The first phase took place during the final stages of the war, the second phase occurred between the end of the war in May 1945 and the Potsdam Agreement in August 1945, and the third phase after the conclusion of the Potsdam Agreement.

The first phase of the displacement took place as the Red Army advanced westwards in the final stages of World War II. As a result, hundreds of thousands of Germans from the eastern territories of the German Reich fled further inland. Most of these refugees planned to return home after the end of the war, and therefore fled to regions close to their former homelands. After Nazi Germany's unconditional surrender in May 1945, some refugees did indeed manage to return home.

Figure 1: German territorial losses in World War I and II

Base maps: MPIDR and CGG (2011).

The second phase of the displacement took place in the months immediately following the end of the war. Polish authorities first prevented refugees from returning to their former homelands and then started to expel the remaining German population. These "wild" expulsions had not yet been sanctioned by an international treaty. The Czechoslovakian authorities soon followed the Polish example and also began to drive the German population out of the country.

The third phase of the displacement began after the Soviet Union, the United Kingdom, and the United States concluded the Potsdam Agreement of August 1945. The Agreement authorized the expulsion of Germans from central and eastern Europe and shifted the German-Polish border westwards to the Oder-Neisse line. The eastern territories that Germany lost after World War II were placed under Polish or Russian control (see Figure 1). Germans remaining east of the new border were brought to post-war Germany in compulsory and organized transfers.

The Potsdam Agreement also divided post-war Germany into British, French, American, and Soviet zones of occupation. The three western zones were merged into West Germany in 1949. The Soviet zone became East Germany in 1950. Below, we characterize the expellee inflow to West Germany, which is the focus of our analysis.

Regional distribution of expellees. The expellee inflow prompted a dramatic increase in the population of West Germany. Despite heavy war losses, the West German population grew from 39 million in 1939 to 48 million in 1949. By the end of 1949, 7.7 million expellees had arrived in West Germany, accounting for 16.3% of the West German population.

More than half of the expellees came from the eastern territories that Germany had ceded after World War II, such as East Prussia and Silesia. Another quarter had lived in Czechoslovakia before the war, most of them in the mainly German-speaking Sudentenland, which Nazi Germany annexed in 1938. The remaining expellees came mostly from the eastern territories that Germany had already ceded after its defeat in World War I, such as Posen and West Prussia.

The share of expellees in the population differed greatly across West German states, and ranged at the end of 1949 from 3.1% in the state of Rhineland-Palatinate to 33.3% in Schleswig-Holstein. There are three main reasons for the very uneven regional distribution of expellees in West Germany. First, German refugees who fled the approaching Red Army during the final stages of the war (first phase of displacement) mainly sought shelter in regions close to their former homelands. The "wild" expulsions (second phase of displacement) only added to the uneven regional distribution, as Polish and Czechoslovakian authorities often just drove Germans across the border into post-war Germany.

Second, the French refusal to admit any of the organized expellee transfers (third phase of displacement) to their zone of occupation led to a very uneven distribution of expellees between West German occupation zones. As they had not been invited to the Potsdam Conference, the French did not feel bound by the Potsdam Agreement. Therefore, expellees to West Germany were initially transferred only to the American and British zones of occupation.

Third, expellees were more likely to be placed in areas where housing was available. Since the Allied bombing campaigns had destroyed much of the housing stock in major West German cities, the expellees often had to be transferred to more rural regions that had been less devastated by the war (Connor 2007, Burchardi and Hassan 2013).

Unlike in most other immigration episodes, the initial regional distribution of expellees in West Germany was not driven by local labor market conditions (Braun and Kvasnicka 2014, Braun and Mahmoud 2014). This was because in all three phases of the displacement, expellees were generally unable to choose their initial destination in West Germany based on local economic conditions. As mentioned before, expellees fled to the most accessible regions west of the front line in the first phase of the displacement, and were brought to West Germany in compulsory expellee transfers in the second and third phase. Local authorities then distributed expellees based on the availability of housing, not jobs (Nellner 1959). Regions that received many expellees thus differed little in their pre-inflow economic conditions from regions that received only few expellees. We will back up this point in Section 3.

The regional distribution of expellees remained largely unchanged until the end of 1949 because the occupying powers banned relocations in the immediate post-war period.[5] The occupying powers wanted all German residents, irrespective of whether they were expellees or not, to remain wherever they had arrived in Germany or had been located on the day of armistice. After the total ban was abolished in 1947, moving required permission from the military administration (permission was granted mostly for family reunification). The restrictions on regional mobility were lifted only as late as May 1949 (Müller and Simon 1959, Ziemer 1973).

Socio-demographic characteristics of expellees. Expellees were relatively close substitutes to native West Germans on the German labor market. They were all German native speakers and had been educated in German schools. In addition, expellees and native inhabitants had, in most cases, been living in the same country for decades (the eastern territories, home to most expellees, had been part of the German Reich since it was founded in 1871). Moreover, expellees were not a selected sub-group of their home regions, as virtually all Germans living east of the new German-Polish border were forced to migrate. This contrasts with most other migration episodes, in which immigrants are a selected group of the population from the countries of orgin (Borjas 1987, Chiquiar and Hanson 2005).

Table A1 in Appendix A.1 shows that expellees and native West Germans were indeed very similar in their socio-demographic characteristics. There were more women than men among both expellees and non-expellees, a legacy of the two world wars. Expellees were slightly younger than native inhabitants and, therefore, also less likely to be married. Moreover, expellees had almost identical years of schooling to natives, a similar probability of having completed vocational training, and a slightly higher probability of having graduated from university. Overall, therefore, differences between natives and expellees were small – especially when compared with other migration episodes.

[5] The state-level expellee shares in 1946 and 1949 are highly correlated, with a correlation coefficient of 0.996.

3 Empirical facts on regional development

We now present novel empirical facts on how regional labor markets in West Germany adjusted to the large and asymmetric inflow of expellees. We derive these facts by comparing the demographic and economic developments of two stylized regions, a high-inflow region H and a low-inflow region L, between 1939 and 1970. Our key labor market variables are regional unemployment rates and the West German labor force participation rate. We further describe the evolution of regional population and the underlying migration flows between the two regions. Finally, we use regional GDP per capita as a measure of regional income differences.[6]

3.1 Regional classification and pre-war differences

Table 1 shows how we classified the West German federal states (*Bundesländer*) into a high- and a low-inflow region. It also provides an overview of expellee inflows into these regions, of economic characteristics before the war and of the regional degree of war damage.

The high-inflow region H consists of Bavaria, Lower Saxony, and Schleswig-Holstein. These three states were called "refugee states" (*Flüchtlingsländer*) in contemporary publications. Although the refugee states accounted for only a third of West Germany's pre-war population, they hosted more than 60% of all expellees by the end of 1949. The population share of expellees in region H was 25.1% (see column (3) of Table 1). The low-inflow region L consists of the remaining West German states, namely Baden-Württemberg, Hesse, Rhineland-Palatinate, North Rhine-Westphalia, and the city states of Bremen and Hamburg.[7] The population share of expellees in region L was 10.5% at the end of 1949, and thus less than half of the population share in region H.

The states in region H hosted considerably more expellees than those in region L for all three reasons discussed in Section 2. First, all three states in region H were relatively easily accessible for refugees who were fleeing the approaching Red Army during the final stages of the war. Bavaria was the prime destination for refugees from neighboring Sudetenland, and Schleswig-Holstein was the prime destination for refugees from East-Prussia arriving via the

[6]Since our theoretical analysis focuses on labor income of workers, we would have preferred to use wages. Unfortunately, data on total wage income in the two regions is, to the best of our knowledge, not available for the period of our analysis, so that we cannot present empirical facts on the evolution of regional wages. However, we provide descriptive evidence on the short-run effects of the expellee inflow on wage earnings in Appendix B.

[7]Saarland was not yet part of West Germany in 1949. West Berlin was, in legal terms, occupied territory and *defacto* a West German enclave until reunification in 1990. Baden-Württemberg was formed in 1952 from the territories of the formerly independent states of Baden, Württemberg-Baden, and Württemberg-Hohenzollern.

Baltic Sea. Lower Saxony received an over-proportional number of refugees because of its general proximity to the eastern territories. Second, all three states were not located in the French zone of occupation that was initially sealed for expellees. Third, all three states retained a relatively intact housing stock during the war.

Before we compare the economic developments in the regions after the expellee inflow, we briefly study whether the regions already differed before the inflow. Pre-existing differences might provide an alternative explanation, other than the asymmetric expellee inflow, for observed differences in regional economic development after the inflow.

Columns (4) to (7) of Table 1 report pre-war data on regional population growth, unemployment, agricultural employment, and national income per capita, and column (8) shows the percentage of housing destroyed in the war. Before the war, population growth rates were very similar in the two regions. The population in region H grew by 10.7% between 1925 and 1939, only 0.7 percentage points more than the population in region L. Likewise, unemployment rates were very similar before the war, reaching 1.6% in region H and 2.0% in region L in 1938 (see column (4)).[8]

However, Table 1 also shows that region H was less industrialized and more rural in nature than region L. As discussed in Section 2, expellees were more likely to be transferred to rural areas than to urban areas. The table illustrates that in 1939, 36.5% of the labor force in region H, but just 21.8% in region L, worked in the agricultural sector (see column (6)). Since the agricultural sector was less productive than the non-agricultural sector (Eichengreen and Ritschl 2009), region H was also somewhat poorer than region L (see column (7)). In fact, national income per capita was around 8% lower in H than in L in 1936.[9] Moreover, the more rural region H also suffered less from war damage than region L, since the Allied bombing campaign primarily targeted German cities. Around 12% of all dwellings in region H were destroyed during the war, considerably less than the West German average of 20.3% (see column (8)).

[8]In the wake of the massive rearmament policy undertaken by Nazi Germany, full employment existed in 1938. Unemployment figures for 1938 might, therefore, be uninformative about structural differences in unemployment rates between the two regions. Prior to 1938, unemployment tended to be somewhat lower in region H than in region L. In fact, the unemployment rate in 1936 was 6.3% in region H and 9.2% in region L. Importantly, there is no evidence that unemployment was higher in region H before the war, as we observe it for the post-war period.

[9]Since pre-war data on income are not available for the West German states in their post-war borders, we had to approximate their values for regions H and L. See Appendix A.2 for the details.

Table 1: Expellee inflows, pre-war differences and war damage in West German states

	Expellee[1] inflows			Pre-war differences				War damage
	1949 population (in 1,000s)	1949 expellee population (in 1,000s)	% expellees in 1949 population	Population change, 1925-39 (%)	1938 unemployment rate (%)[2]	Share of 1939 labor force in agriculture (%)	1936 national income per capita (RM)[3]	Share of destroyed dwellings (%)[4]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bavaria	9,158	1,938	21.1	9.9		38.0		12.5
+ Lower Saxony	6,790	1,851	27.3	13.1		36.6		12.0
+ Schleswig-Holstein	2,649	882	33.3	8.1		28.9		10.5
Region H	18,597	4,671	25.1	10.7	1.6	36.5	898	12.1
Baden-Wüerttemberg	6,318	792	12.5	10.3		31.5		10.4
+ Hesse	4,280	703	16.4	9.3		27.8		13.7
+ Rhineland-Palatinate	2,908	91	3.1	8.1		38.1		16.3
Region L'	13,506	1,586	11.7	9.4	1.6	32.1		12.8
+ North Rhine-Westphalia	12,988	1,267	9.8	8.8		14.1		30.0
+ Bremen	544	44	8.1	37.0		3.9		41.0
+ Hamburg	1,558	103	6.6	15.4		2.1		49.1
Region L	28,596	3,000	10.5	10.0	2.0	21.8	974	24.2
Federal Republic	47,194	7,671	16.3	10.3	1.9	27.0	955	20.3

Data sources: Data on expellees in 1949 come from Statistisches Bundesamt (1955c). Data on the population and the agricultural employment share in 1939 are from Statistisches Bundesamt (1954a). Data on the expellee share in 1946 come from Statistisches Bundesamt (1952b), and data on the population in 1925 from Hohls and Kaelble (1989). Data on national income and on 1938 unemployment rates come from Länderrat des Amerikanischen Besatzungsgebiets (1949), and data on the share of destroyed dwellings in 1946 from Deutscher Städtetag (1949).
Notes: [1] Expellees are defined as German nationals or ethnic Germans who on 1 September 1939 lived (i) in the former German territories east of the Oder-Neisse line, (ii) in Saarland or (iii) abroad. [2] The unemployment rate is expressed as a percentage of the dependent labor force. Pre-war unemployment data is not available for the West German states in their post-war borders. The unemployment rate of region H is approximated by the labor-force-weighted average of the unemployment rates in the employment agency districts of Bavaria, Lower Saxony, Nordmark. The unemployment rate of region L is approximated by the average of the unemployment rates in Hesse, Southwest Germany, Rhineland and Westphalia. [3] Pre-war national income data are not available for the West German states in their post-war borders. National income of region H is approximated as the population-weighted average of national income in Bavaria, Hannover, and Schleswig-Holstein. National income of region L is approximated as the average income of Baden, Württemberg, Hesse, and Hesse-Nassau, the Rhine Province and Westphalia. [4] The share of destroyed dwellings is calculated as the share of dwellings that were completely destroyed as a percentage of the housing stock in mid-1943.

Our benchmark model ignores pre-existing differences between the two regions. In additional robustness checks, however, we incorporate these differences into our analysis in two ways (see Appendix A.4 and D). First, we account for them directly in our model. In particular, we allow for regional differences in the degree of war damage. Second, we use an alternative classification of federal states that levels out pre-existing differences in the degree of industrialization and war damage. We then show that both the empirical facts and our quantitative results in the structural model are robust to the use of this alternative classification.

3.2 Empirical facts

We compare the demographic and economic developments of regions H and L in 1939, i.e., before the flight and expulsion, and between 1950 and 1970, i.e., in the first two decades after the expellee inflow was complete.

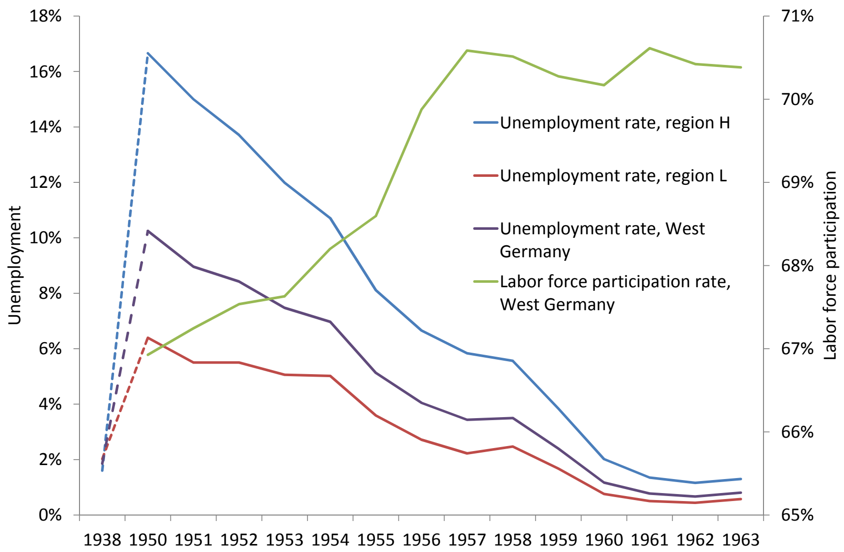
Unemployment and labor force participation. Figure 2 shows the unemployment rates in regions H and L before the war in 1938, and between 1950 and 1963 (our data series ends in 1963, as time-consistent regional employment data is not available after then). Before the war, both regions had almost full employment. Unemployment then increased dramatically in both regions in the immediate post-war period. However, the situation was much more severe in the high-inflow region H, where the unemployment rate was 16.7% in 1950, than in the low-inflow region L, where it was 6.4%. The 1950 unemployment rate in region H thus exceeded the unemployment rate in region L by a factor of two and a half. Expellees were much more likely to be unemployed than native workers at that time: every third unemployed person in West Germany was an expellee in 1950 (compared with a share of expellees in the population of 16.5%).[10]

Regional unemployment rates in both regions then gradually decreased in the 1950s. By the early 1960s, both regions were back at what was basically full employment. Nevertheless, unemployment remained slightly higher in region H than in region L until 1963.

We augment the unemployment data with data on labor force participation because the unemployment data only cover persons who were officially registered as unemployed. In contrast, persons who would generally like to work but have nevertheless withdrawn from the labor market,

[10] Expellees then benefited dis-proportionally from the fall in unemployment in the 1950s. By 1958, their share among the unemployed had fallen to 22.0%. Unfortunately, we cannot calculate separate unemployment rates for expellees and non-expellees, as our data on employment does not distinguish between the two groups.

Figure 2: Unemployment and labor force participation rates, 1938-63



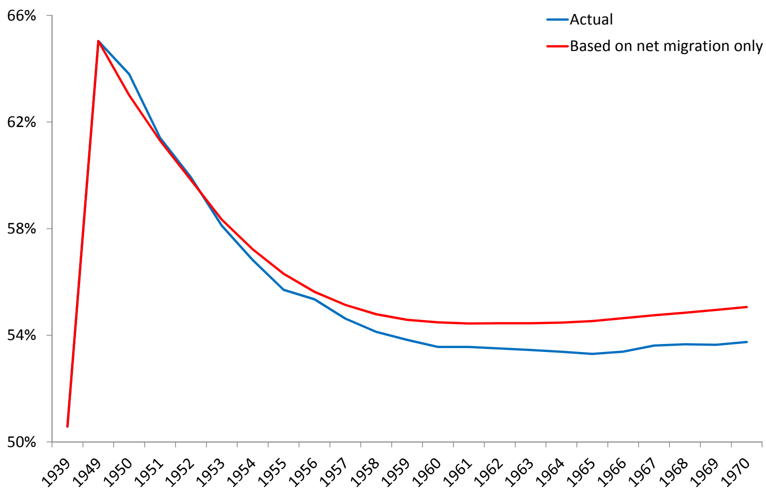
Data sources: The unemployment data come from Länderrat des Amerikanischen Besatzungsgebiets (1949) (for 1938) and from various issues of the *Amtliche Nachrichten* of the Bundesanstalt für Arbeitsvermittlung und Arbeitslosenversicherung (for 1950-63). Data on economically active persons, used to calculate the labor force participation rate, are taken from Sensch (2004), Table B3.1. Data on the total population aged 16-65 come from the Statistisches Bundesamt.
Notes: The unemployment rate is expressed as a percentage of the dependent labor force. The unemployment rate of region H in 1938 is approximated by the (labor force-weighted) average of the 1938 unemployment rates of Bavaria, Lower Saxony, Nordmark, the unemployment rate of region L by the average of the unemployment rates of Hesse, Southwest Germany, Rhineland and Westphalia. The labor force participation rate is the ratio of all economically active persons to the population aged 15-65.

say because they consider their chances of finding a job to be small, are not officially registered as unemployed. An increase in the number of discouraged workers does not, therefore, show up as an increase in unemployment, but rather as a fall in labor force participation.

Figure 2 shows that the decline in regional unemployment in the 1950s coincided with an increase in the West German labor force participation rate from 66.9% in 1950 to 70.6% in 1957 (unfortunately, participation rates are not available at a regional level for 1950-63).[11] Labor force participation was, therefore, low in 1950, most likely because labor market prospects were dire. This suggests that hidden unemployment was high at that time. As the labor market recovered, and the probability of finding a job grew, formerly discouraged workers might have increasingly chosen to re-join the labor force.

[11] We report the labor force participation rate for the same period, for which unemployment data are available. The labor force participation rate is the ratio of all economically active persons to the population aged 15-65. We do not compare the post-war labor force participation rate to its pre-war level because the war dramatically changed the demographic composition of the West German population. For instance, men in their twenties were more likely to die in the war than women or older men. Since labor force participation rates vary strongly by age and gender, the war is likely to have had a major effect on labor force participation.

Figure 3: Population in region H over population in region L, 1939-70



Data source: Statistisches Bundesamt, Institut für Raumforschung.
Note: Population is measured at the end of each year. The population series that is based on migration only is calculated by adding to the actual population figure of the H and L region on 31 December 1949 (cumulated) net migration between the two regions.

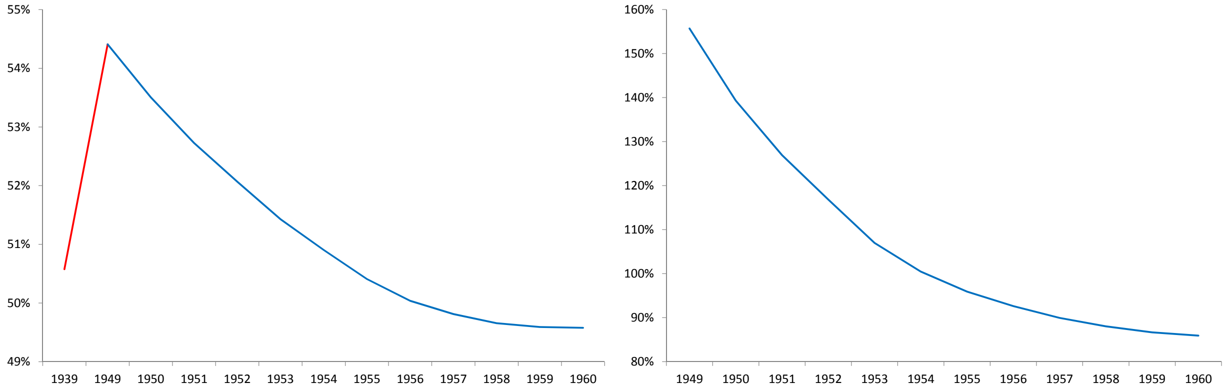
Population and internal migration. The red line in Figure 3 shows that the population size of region H relative to region L soared from 50.6% in 1939 to 65.0% at the end of 1949. The expellee inflow, therefore, changed the relative size of the two regions dramatically.[12] Relative population then gradually came down again and reached 53.7% in 1970.

The blue line in Figure 3 shows that regional migration from H to L was by far the most important factor in moving the relative population size of the two regions back towards its pre-war level. The line shows how the relative population size of the two regions would have evolved if the only reason for changes in the relative population size had been migration between region H and region L. The migration-based population series thus abstracts from other potential influences, such as differences in fertility rates or migration from abroad, on the relative population size of the two regions. It declines from 65.0% in 1949 to 54.5% in 1960.

Figure 4 plots the migration-based population series separately for native inhabitants and expellees, and shows that regional migration markedly reduced the relative population of both groups in the 1950s. Through migration alone, the relative native population fell from 54.4% in 1949 to 49.6% in 1960 and that of expellees fell from 155.7% to 85.9%. The strong decline in the relative expellee population also suggests that expellees were more likely to leave region H for region L than natives. In fact, the migration rate of expellees stood at a stunning 4.4% in 1950 – and was thus four times higher than the migration rate of natives (1.1%). It fell in tandem

[12] Appendix A.3 shows that factors other than the expellee inflow were only of minor importance for the increase in relative population.

Figure 4: Population in region H over population in region L for either natives or expellees, based on net migration, 1939-70



(a) Natives (b) Expellees

Data sources: Statistisches Bundesamt, Institut für Raumforschung.
Notes: Population is measured at the end of each year. The population series is calculated by adding to the actual native (expellee) population figure of the H and L region on 31 December 1949 (cumulated) net migration of native workers (expellees) between the two regions.

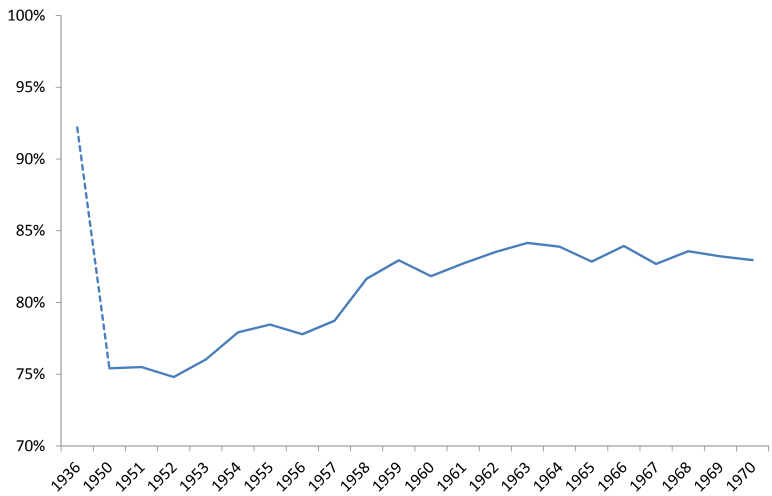
with the overall regional migration rate but still exceeded it in 1958.

GDP per capita. Figure 5 shows GDP per capita of region H relative to region L between 1950 and 1970. The data shows that in 1950, GDP per capita of region H reached just 75.4% of region L's level. The regional gap then narrowed considerably during the 1950s and early 1960s, and relative GDP per capita stood at 84.2% in 1963. The mid- and late-1960s saw no further improvement in region H's relative GDP per capita. If anything, the gap in comparison with region L widened again.

How did relative GDP per capita change between 1939 and 1950? Unfortunately, there are no pre-war GDP data for West German regions that are comparable to the post-war data. Instead, we use two proxies for regional differences in GDP per capita before the war (Appendix A.2 discusses these proxies in detail). The first proxy uses national income data from 1936, as also reported in Table 1. National income per capita of region H reached 92% of region L's value in 1936. Judged by this measure, region H suffered a significant fall in relative GDP per capita following the expellee inflow (Figure 5 shows the 1936 value of relative national income along with data for relative GDP per capita for 1950-70). The second proxy for regional differences in GDP per capita uses firm sales as a proxy for production, as suggested by Vonyó (2012). Relative sales per capita in region H fell from 69.5% of region L's value in 1935 to 59.1% in 1950, and then increased to 63.6% in 1955.[13]

[13] As evident, the relative level of sales per capita is lower than the relative level of GDP per capita. This is

Figure 5: GDP per capita in region H relative to region L, 1950-70



Data sources: Data for 1936 are from Länderrat des Amerikanischen Besatzungsgebiets (1949), data for 1950-70 are from the Statistisches Bundesamt.
Notes: The data point for 1936 is the (approximated) national income of region H relative to region L. We calculate the 1936 national income in region H as the population-weighted average of income in Bavaria, Hanover, and Schleswig-Holstein. We then use the average national income in the rest of West Germany (excluding Hamburg and Bremen, Oldenburg, Braunschweig, Lippe, Schaumburg-Lippe) as a proxy for national income in region L. See the text for further explanation. All other data points give GDP per capita of region H relative to region L.

Overall, therefore, both proxies suggest that relative GDP per capita decreased significantly in region H between 1939 and 1950. Relative GDP per capita then bounced back in the 1950s (and early 1960s). Since we do not have comparable data on GDP per capita from before the war, we cannot be certain whether relative GDP per capita returned to its pre-inflow level.

Summary of empirical facts. To sum up, we have established five empirical facts.

1. Unemployment rates increased dramatically between 1938 and 1950 in both regions. The 1950 unemployment rate was two and half times larger in region H than in region L. Unemployment then gradually declined during the 1950s, and both regions recorded full employment in the early 1960s. Expellees were much more likely to be unemployed than natives.

2. The labor force participation rate in West Germany increased strongly between 1950 and 1957, and remained constant thereafter.

3. The relative population size of region H went up from 50.6% in 1939 to 65.0% at the end of 1949, and then gradually decreased in the 1950s.

mainly due to the fact that the share in sales per capita of the two city states, which are both part of region L, is much larger than their share in GDP per capita. Comparable data is no longer available after 1955.

4. Migration from region H to L was the decisive factor in moving relative population back towards its pre-war level in the 1950s. Expellees were much more likely to leave region H for region L than native inhabitants.

5. Relative GDP per capita of region H declined between 1939 and 1950. After 1950, region H experienced considerably faster economic growth than region L until the early 1960s.

To quantify to what extent these empirical facts can indeed be understood as a consequence of the expellee inflow, we now derive a dynamic two-region search and matching model of unemployment. The benchmark model acts upon the assumptions that the two regions were identical before the inflow, and that no asymmetric shock other than the expellee inflow hit the two regions over the time period considered. We relax both assumptions in our robustness checks in Appendix D.

The dynamic search and matching model allows us to quantify and interpret the regional adjustment processes after the inflow shock also over the medium and long run, because it offers three important advantages over a reduced-form regression model. First, the search and matching model accounts for the effect of regional migration on local labor markets. Since, over time, regional migration flows will diffuse the labor market effect of the expellee inflow from region H to region L, a simple comparison of labor market outcomes between the two regions will underestimate the causal effect of receiving high rather than low expellee inflows on native labor market outcomes (Borjas and Monras 2017). After all, such comparison would show little or no differences, simply because the high inflow of expellees into region H will–through migration–also affect region L over time.

Second, the dynamic search and matching model allows us to assess the effect of the expellee inflow on variables that we do not directly observe in the data, such as regional wages, regional employment of native workers and expellees, regional labor force participation of native workers and expellees, or the cost of regional migration. This allows us to decompose the expellee inflow into a comprehensive set of adjustment margins, and to quantify the effects of immigration on natives using comprehensive income measures. Finally, the dynamic search and matching model allows us to run counterfactual exercises, in which we can disentangle the importance of different variables, such as the regional distribution of the expellee inflow or the magnitude of migration costs, in shaping adjustment dynamics and the effect on native income.

4 A dynamic model of regional labor markets

The backbone of our model is the textbook Diamond-Mortensen-Pissarides search and matching model of unemployment. We depart from a version of this model with endogenous labor force participation and extend it in two directions that are motivated by the particular historical episode that we study.[14]

Our first extension is regional migration. We consider two regional labor markets–one in region H and another in region L–that interact via migration. Workers who search for a job choose whether to search in region H or L.[15] Migration decisions are forward looking and subject to migration costs. Our second extension incorporates regional expellee inflows into the model. We model them as an exogenous increase in the number of non-employed workers, i.e., as a labor supply shock, and calibrate the regional distribution of this shock from the historical data.

In each region, a representative firm employs many workers and accumulates capital to produce output. Output is homogenous across regions and serves as numeraire. Adjusting employment or the capital stock is subject to adjustment costs. Furthermore, we consider a competitive equilibrium, in which firms and workers bargain over the wage. Our description of the model focuses on region H with the understanding that region L is formulated symmetrically to region H. Variables that pertain to region L are superscripted by a star and/or subscripted by L.

4.1 Labor market stocks and flows

The working-age population P_t in region H at time t comprises employed workers N_t, unemployed workers U_t, and non-participating workers R_t, and hence $P_t = N_t + U_t + R_t$. Regional population evolves over time, because X_t expellees enter the labor market in region H exogenously and non-employed workers move endogenously between regions. This yields

$$P_t = P_{t-1} + X_t + G_t^\star - G_t \ , \tag{1}$$

[14]A salient feature of the historical episode that we do not explicitly consider is the growth spurt of the West German economy in the 1950s. Economist have advanced three explanations for this growth spurt (see Eichengreen and Ritschl (2009) for a review): neoclassical convergence, structural change, and a shock to total factor productivity (TFP) with subsequent recovery. Our model only accounts for the first of the three explanation (as we allow for capital deepening during the adjustment process). While Eichengreen and Ritschl (2009) largely dismiss the structural change explanation, they provide strong evidence for the TFP explanation. However, Eichengreen and Ritschl (2009) are interested in the aggregate growth performance of the West German economy. In contrast, we focus on regional differences in economic performance–and are thus most concerned with regional differences in productivity growth. Appendix D shows that all our main results remain robust if we account for potential regional differences in productivity growth.

[15]Ortega (2000) and Chassamboulli and Peri (2015) also assume that only workers who search for a job, but not workers who are employed, decide whether to migrate.

where $G_t^\star - G_t$ denotes net migration to region H.

We assume that all expellees are non-employed upon arrival, because they were forced to emigrate to a new environment and, hence, gave up previous employment. Despite initial non-employment, however, some expellees in the model are employed by the end of the first period, because a worker can pass through several labor market states within a period.

We also assume that expellees are homogenous to native workers in our model. The homogeneity assumption reflects the fact that expellees and natives were close substitutes on the West German labor market (see Section 2). Burda (2006) and Grossmann, Schäfer, Steger, and Fuchs (2017) adopt a similar homogeneity assumption in their analyses of regional economic integration between East and West Germany after German reunification.

Non-employed workers, both expellees and natives, decide at the beginning of period t whether or not to participate in the labor market. The workers' participation probability, denoted by π_t, then determines the size of the reserve pool R_t of workers who are out of the labor force:

$$R_t = (1 - \pi_t)[P_{t-1} + X_t - (1 - \lambda)N_{t-1}] \; . \tag{2}$$

Square brackets in this equation contain the number of non-employed workers at time t, and $0 < \lambda < 1$ denotes the exogenous separation rate.

Participating workers who are non-employed decide whether they migrate to region L's labor market. The participation decision predates the migration decision, because we treat migration as being motivated by labor market prospects. The workers' migration probability, denoted by γ_t, then determines H to L migration:

$$G_t = \gamma_t[P_{t-1} + X_t - (1 - \lambda)N_{t-1} - R_t] \; . \tag{3}$$

Production in region H takes place once the participating workers who stay in region H have moved into either unemployment or employment. Employment, which evolves according to

$$N_t = (1 - \lambda)N_{t-1} + M_t, \tag{4}$$

corresponds to new jobs, denoted by M_t, plus workers with ongoing jobs. The sum of employed and unemployed workers equals the labor force, i.e., $L_t = N_t + U_t$. In Appendix C.1, we show that equations (1) to (4) determine population, employment, H to L migration, and the labor force in region H given initial conditions P_{-1} and N_{-1}, L to H migration $G_t^\star$, expellee inflow X_t, and transition probabilities π_t and γ_t.

4.2 Labor market states and their values

In each period, a worker occupies one out of six labor market states. These states are employment, unemployment, and non-participation in either region H or L. Each state is accompanied by a value function that determines a worker's value of being in this state. The value of an employed worker in region H at date t is denoted by W_t and recursively computed as

$$\begin{aligned} W_t \quad &= \quad w_t + (1-\lambda)\beta W_{t+1} + \lambda\beta E_h\big[\max(H_{t+1}(h), \\ &\qquad E_\mu\big[\max(\phi_{t+1}W_{t+1} + (1-\phi_{t+1})Q_{t+1},\ \phi^\star_{t+1}W^\star_{t+1} + (1-\phi^\star_{t+1})Q^\star_{t+1} - \mu)\big]\big)\big]\ . \end{aligned} \tag{5}$$

The employed worker receives wage w_t (in units of the numeraire) at date t and the expected continuation value, discounted at $0 < \beta < 1$, at date $t+1$. This value has two parts. The first part occurs with likelihood $1-\lambda$ and is the value W_{t+1} of a worker who remains employed in the next period. The second part occurs with likelihood λ and is the value of a worker who loses his job at the end of period t. This second part depends on the two sequential decisions, each indicated by a max operator, that the worker takes at the beginning of period $t+1$.

The worker decides to participate in the labor market if the value of non-participation, denoted by $H_{t+1}(h)$, is smaller than the value of participation (captured by $E_\mu[\dots]$ in equation (5)). The value of non-participation depends on the idiosyncratic home benefit parameter $h \geq 0$ that each non-employed worker draws at the beginning of a period from a distribution with cdf Ξ, and E_h denotes the worker's date t expectation about this source of date $t+1$ uncertainty.

Furthermore, the worker decides to migrate to region L if the value of searching for a job in region H is smaller than the value of searching for a job in region L net of migration costs. The value of searching for a job in region H, $\phi_{t+1}W_{t+1} + (1-\phi_{t+1})Q_{t+1}$, depends on the job-finding rate ϕ_{t+1}, the value of an employed worker W_{t+1}, and the value of an unemployed worker Q_{t+1}. Migration costs are denoted by $\mu \geq 0$ and are idiosyncratic. At the beginning of a period, each non-employed worker draws μ from a distribution with cdf Γ. Draws μ and h are independent of each other.

The value of an unemployed worker in region H is recursively computed according to

$$
\begin{aligned}
Q_t &= z + \beta E_h\big[\max(H_{t+1}(h), \\
&\quad E_\mu\big[\max(\phi_{t+1}W_{t+1} + (1-\phi_{t+1})Q_{t+1},\ \phi^\star_{t+1}W^\star_{t+1} + (1-\phi^\star_{t+1})Q^\star_{t+1} - \mu)\big])\big] \ .
\end{aligned} \tag{6}
$$

The unemployed worker receives unemployment benefits $z > 0$ and the expected discounted continuation value. Finally, the value of a worker who does not participate in the labor market and has home benefit parameter h corresponds to

$$
H_t(h) = h - z + Q_t \ . \tag{7}
$$

This parsimonious formulation of $H_t(h)$ emerges, because we model participation as a decision about the current period only. Thus, the continuation values of the unemployed worker and the the non-participating worker coincide.

4.3 Migration and participation probabilities

The worker with idiosyncratic migration costs μ^c_t is indifferent between regions, with

$$
\mu^c_t = [\phi^\star_t W^\star_t + (1-\phi^\star_t)Q^\star_t] - \{\phi_t W_t + (1-\phi_t)Q_t\} \ . \tag{8}
$$

Idiosyncratic migration costs μ below μ^c_t induce the worker to migrate, whereas idiosyncratic costs above μ^c_t prevent migration. Accordingly, μ^c_t determines the probability of a worker migrating from region H to L in period t, conditional on this worker being non-employed at the beginning of this period, $\gamma_t = \Gamma(\mu^c_t)$. We assume that Γ is uniform over $[0, a]$ with parameter $a > 0$. We interpret $1/a$, which determines the sensitivity of γ_t with respect to μ^c_t, as workers' propensity to migrate. A small propensity to migrate coincides with large (unconditional) expected migration costs, which are equal to $a/2$.

The worker with idiosyncratic home benefits h^c_t is indifferent between participation and non-participation provided that

$$
H(h^c_t) = E_\mu\big[\max(\phi_t W_t + (1-\phi_t)Q_t,\ \phi^\star_t W^\star_t + (1-\phi^\star_t)Q^\star_t - \mu)\big] \ .
$$

Rearranging this equation using the probability of migrating, γ_t, and expected idiosyncratic migration costs conditional on migration, $\bar{\mu}_t = E_\mu[\mu|\mu < \mu_t^c]$, yields

$$H(h_t^c) \quad = \quad (1-\gamma_t)\big[\phi_t W_t + (1-\phi_t)Q_t\big] + \gamma_t\big[\phi_t^\star W_t^\star + (1-\phi_t^\star)Q_t^\star - \bar{\mu}_t\big] \ .$$

Replacing $H(h_t^c)$ by $h_t^c - z + Q_t$ (see equation (7)) and further rearranging yields

$$h_t^c \quad = \quad z + \phi_t(W_t - Q_t) + \gamma_t(\mu_t^c - \bar{\mu}_t) \ . \tag{9}$$

Thus, h_t^c is bounded from below by the level of unemployment benefit z and increases when labor market prospects improve. Improved prospects in region H increase the expected net value of work $\phi_t(W_t - Q_t)$. Furthermore, improved prospects in region L make migration from region H to L more attractive and, hence, increase the expected net value of migration $\gamma_t(\mu_t^c - \bar{\mu}_t)$. The critical level of home benefits determines the probability of participating, $\pi_t = \Xi(h_t^c)$. We assume that Ξ is uniform over $[e_0, e_1]$ with $e_0 < e_1$. We interpret e_0, which determines the sensitivity of the participation probability with respect to h_t^c, as workers' propensity to participate in the labor market.

In Appendix C.2, we express value functions (5) and (6) in terms of $\gamma_t(\mu_t^c - \bar{\mu}_t)$, $(1-\pi_t)(\bar{h}_t - h_t^c)$ and transition probabilities which are endogenously determined in equilibrium. In Appendix C.3, we derive solutions for probabilities γ_t and π_t and conditional expectations $\bar{\mu}_t$ and $\bar{h}_t$.

4.4 Firm behavior, wage bargaining, and labor market matching

Firms in region H use their workforce and capital stock to produce output, which is homogenous across regions and serves as numeraire. Firms are indexed by $j \in [0,1]$, and the representative firm j maximizes the discounted sum of period profits, which correspond to

$$F(K_{jt-1}, N_{jt}) - w_t N_{jt} - I_{jt} - C(V_{jt}, N_{jt}, q_t).$$

The firm produces output with technology $F(N_t, K_{t-1}) = A N_t^\chi K_{t-1}^{1-\chi}$, with $A > 0$ and $\chi \in (0,1)$, and deducts from its sales the wage bill $w_t N_{jt}$, investment I_{jt}, and employment adjustment costs $C(\cdot)$. The firm's workforce evolves according to $N_{jt} = (1-\lambda)N_{jt-1} + q_t V_{jt}$, where q_t denotes the job-filling rate (defined below). Its capital stock evolves according to $K_{jt} = (1-\delta)K_{jt-1} + (1 - B(I_{jt}/I_{jt-1}))I_{jt}$, where δ denotes the depreciation rate δ and $B(I_t/I_{t-1}) = b(I_t/I_{t-1} - 1)^2/2$ denotes investment adjustment costs, with $b \geq 0$. Solving the firm problem yields standard optimality conditions (see Appendix C.4).

Employment adjustment costs (EACs) correspond to (omitting the j subscript)

$$C(V_t, N_t, q_t) \quad = \quad \kappa_0 N_t + \frac{\kappa_1}{\kappa_2}(\exp[\kappa_2(q_t \nu_t - \lambda)/\lambda] - 1)N_t \ , \tag{10}$$

with ν_t denoting the vacancy rate V_t/N_t, $q_t\nu_t$ denoting the hiring rate, and non-negative parameters κ_0, κ_1, and κ_2.[16] Adjustment costs are proportional to employment and incorporate fixed costs per worker to capture recruiting and on-the-job training of new workers but also incumbent workers' fringe benefits, such as sick leave, health insurance and pensions. Also, adjustment costs are convex in the hiring rate to capture costs for training and integrating new workers into the workforce.[17] We interpret parameter κ_2, which governs costs convexity, as firms' propensity to not adjust employment. A convenient property of equation (10) is that it decouples the model's steady state (depending on κ_0 and κ_1) from the model's dynamics (also depending on κ_2).

The wage rate is determined by Nash bargaining and thus maximizes the weighted product $(W_t - Q_t)^\alpha J_{jt}^{1-\alpha}$, which comprises a worker's net surplus from work $W_t - Q_t$ and the firm's net surplus from one extra worker J_{jt}. The bargaining process yields the surplus sharing rule $W_t - Q_t = \frac{\alpha}{1-\alpha} J_{jt}$, where $0 < \alpha < 1$ denotes a worker's share of the total surplus from the job.

Non-employed workers who participate in the labor market in region H are matched to firms in this region through the regional matching function $M(S_t, V_t) = \Omega S_t^\xi V_t^{1-\xi}$, with $\Omega > 0$ and $\xi \in (0, 1)$, denoting by $S_t = U_t + M_t$ the number of job searchers and by V_t the number of vacancies. We postulate two regional matching functions instead of one aggregate matching function, as we have assumed that regional labor markets are segregated.[18] For later use, we define labor market

[16]We also considered a more general specification of EACs that allows for vacancy posting costs. However, in no case did we find that vacancy posting costs improved the fit of our model to the historical data. This is consistent with Yashiv (2000) who also finds a predominant role of post-match EACs using data on the Israeli labor market. Similarily, Silva and Toledo (2009) estimate that post-match EACs account for about 92% of both post-match and pre-match EACs in US data.

[17] EACs tend to be convex in the literature that uses aggregate data, but they tend to be linear and contain a fixed costs component in the literature that uses disaggregated (firm-level) data. Our historical data refer to regional labor markets and are, hence, accompanied by an intermediate degree of aggregation. For aggregate data, Yashiv (2000) and Yashiv (2006) use adjustment costs that are convex (cubic) in vacancies and new workers; Merz and Yashiv (2007) use a generalized convex cost function that increases in the hiring rate; and Gertler, Sala, and Trigari (2008) and Christiano, Eichenbaum, and Trabandt (2016) apply quadratic adjustment costs to hiring new workers. For firm-level data, Yaman (2011) estimates linear EACs; Bloom (2009) and Cooper, Haltiwanger, and Willis (2007) estimate linear EACs with a strong fixed cost component; and Dolfin (2006) demonstrates the relevance of fixed costs per worker.

[18]The assumption of segmented labor markets is common in the literature (see, for example, Epifani and Gancia (2005) and Lkhagvasuren (2012)), and also describes the German labor market in the 1950s well. Communication was still costly at that time, and the average household did not own a car or a telephone. Furthermore, we consider two large regional labor markets, so that the average distance between two arbitrary locations within these labor markets is large as well. Therefore, workers would have had to travel relatively great distances to reach the other labor market for, for instance, a job interview.

tightness as the ratio of aggregate vacancies over workers searching for jobs, $\theta_t = V_t/S_t$, and the job-filling rate as matched workers over aggregate vacancies, $q(\theta_t) = M(S_t, V_t)/V_t$. Appendix C.5 describes the model solution and summarizes the model equations after imposing firm symmetry.

5 Model calibration and fit

We choose the parameters of the model in three steps. In the parametrization step, we set initial conditions and expellee inflow rates to historical values and a first set of parameters to values conventional in the literature. In the second step, we calibrate a second set of parameters by targeting steady-state values of endogenous variables. In the third step, we calibrate the remaining three parameters by minimizing the distance between the model's adjustment dynamics after the expellee inflow and a subset of the historical time series described in Section 3. We use the other historical time series as non-targeted moments to evaluate the model fit, and discuss in Appendix D the model fit for plausible alternative parameter calibrations.

5.1 Parametrization

We set initial conditions and expellee inflow rates to the historical values in the upper panel of Table 2. Relative regional population before the expellee inflow, $P_{-1}/P^{\star}_{-1}$, equals 54.4% in historical data, after adjusting this data for population changes between 1939 and 1950 that are unrelated to the expellee inflow (we describe the adjustment in Appendix A.3). Moreover, initial regional capital stocks per capita, K_{-1}/P_{-1} and $K^{\star}_{-1}/P^{\star}_{-1}$, start from below their steady-state values to account for war-related capital damage. According to Krengel (1958), 19% of the West German industrial capital stock was destroyed in the war. Regional expellee inflows are equal to the regional expellee population on 31 December 1949, as shown in column (2) of Table 1, after expressing the regional expellee population relative to the West German population. No expellees arrive after period $t = 0$ in the model, as the inflow was basically complete by the end of 1949 (see Section 2).

We set the parameters in the lower panel of Table 2 to values that are either conventional in the literature or taken from historical data. A time period corresponds to one quarter and hence the value of the discount factor β implies a 4% annual interest rate. The value of the depreciation rate δ implies a 10% annual capital depreciation rate. The values of workers' bargaining power α and the elasticity of matches to vacancies $1 - \xi$ are taken from Gertler and Trigari (2009).

Table 2: Parametrization

Parameter	Description	Value
$P_{-1}/P^{\star}_{-1}$	Relative regional population	54.4%
k_{-1}/k	War-related damage of K_{-1}	81%
$X_0/(P_0+P^{\star}_0)$	Expellee inflow in region H	9.9%
$X^{\star}_0/(P_0+P^{\star}_0)$	Expellee inflow in region L	6.4%
β	Discount rate	0.99
δ	Depreciation rate	0.025
χ	Labor income share	2/3
α	Worker's bargaining power	0.5
$1-\xi$	Weight on vacancies in $M(\cdot)$	0.5
λ	Separation rate	0.054
b	Investment adjustment costs	15

Notes: Initial condition $k_{-1} = K_{-1}/P_{-1}$ denotes the capital stock per capita before the expellee inflow and $k = K/P$ denotes the steady-state level of the capital stock per capita, which is the same in the initial and the terminal steady state. See Section 5 for further explanation.

The value of the magnitude of investment adjustment costs b falls into the range estimated in Christiano, Trabrandt, and Walentin (2010). The value of the separation rate λ yields the average monthly separation rate of 1.8% that we observe in historical data on West Germany for 1950-1963.[19]

5.2 Targeting steady-state values

We calibrate a second set of parameters, summarized in Table 3, by targeting steady-state values of endogenous variables. We consider a steady state that is symmetric in both regions (Appendix C.6 contains the steady-state solution). Therefore, parameters in Table 3 apply to either region.

To calibrate unemployment benefit z in Table 3, we equate the unemployment rate in steady state to its historical value in West Germany in 1963 and solve for z. We treat the 1963 value as steady state, because the West German unemployment rate was as low as 0.8% in 1963 and stayed almost constant until the early 1970s. To calibrate κ_1, which determines firms' expected costs to hire the marginal worker, $C_V/q = \kappa_1/\lambda$, we set the replacement ratio z/w to 51%. This value corresponds to the average earnings replacement ratio between 1950 and 1970 of a single unemployed beneficiary (Flora 1986). We calibrate κ_0, which equals average costs per worker C/N, by assuming that expected costs to hire the marginal worker equal average costs per newly

[19] We calculate the rate by dividing the number of persons who became newly unemployed in a given month by the number of employed persons in the previous months. Data come from the German employment agency and are available once per quarter (i.e., we use monthly data that we observe only once per quarter). From September 1955 onwards, the employment agency records inflows into the pool of job seekers instead of inflows into unemployment. Employment data are no longer available for 1964-70.

Table 3: Parameters calibrated by targeting steady-state variables

Variable (1)	Description (2)	Target (3)	Parameter (4)	Description (5)	Value (6)
L/P	Participation rate	100%	e_1	Maximum home benefit	0.6412
U/L	Unemployment rate	0.8%	z	Unemployment benefit	0.3286
z/w	Replacement ratio	51%	κ_1	Av. costs per worker	0.0194
C/M	Av. costs / new worker	C_V/q	κ_0	Av. costs per worker	0.0194
q	job-filling rate	68%	Ω	Matching efficiency	0.7692
Y/P	Output per capita	1	A	Productivity	0.4697

Notes: Columns (1) and (3) list endogenous variables along with their steady-state values that we target. The parameters in columns (4) and (6) follow from these targets. Parameter values in region L coincide with the parameter values in region H reported in the table. See Section 5 and Appendix C.6 for further explanation.

hired worker, $C_V/q = C/M$. This yields $\kappa_0 = \kappa_1$ and implies that average costs per newly hired worker equal 56% of the quarterly wage in steady state. This value aligns well with existing estimates.[20]

To calibrate the value of the matching efficiency Ω in Table 3, we target the quarterly job-filling rate in West Germany between 1950 and 1970 (see Appendix C.8). Finally, we normalize regional output per capita to unity and derive regional productivity A from this normalization.

5.3 Targeting adjustment dynamics

We calibrate the remaining three parameters by targeting a subset of the historical time series described in Section 3. These parameters are workers' propensity to participate in the labor market e_0, their propensity to migrate $1/a$, and firms' propensity not to adjust employment κ_2. These "propensity parameters" do affect the model's adjustment dynamics to the expellee inflow, but they do not affect the model's steady state. The steady state is independent of the propensity to participate e_0 and the propensity to migrate $1/a$, because we consider a steady state with full labor force participation and without expellee inflow and hence regional migration (see Appendix C.6). It follows from EACs in equation (10) that the steady state is also independent of κ_2.

We calibrate the propensity parameters by minimizing the distance between the model's simulated adjustment path after the expellee inflow and the historical time series (see Redding and Sturm (2008) for a similar calibration approach). We measure distance as $D = \Psi' W \Psi$. The vector Ψ is $n \times 1$, and each of its elements Ψ_j denotes the mean absolute difference between a

[20]Using US data, Silva and Toledo (2009) report average costs per newly hired worker of close to 60% of the quarterly wage in 1980. Using German data, Yaman (2011) estimates these costs at EUR 4,000 in the year 2000. Relating this estimate to a gross monthly wage of EUR 2,551 in Germany in the year 2000 yields a cost estimate of about 52% (computed as $4000/(3 \times 2551)$), which again is close to our calibration.

variable in the model and the historical data,

$$\Psi_j = \left(\frac{100}{T - t_0}\right) \sum_{t=t_0}^{T} \text{abs}(y_t - y_t^{data}) \ , \tag{11}$$

using y_t to denote a generic variable. W is a diagonal matrix that weighs the contribution of a variable to D by the inverse of this variable's mean in historical data (main diagonal elements of W are normalized to sum to unity). We describe in Appendix C.9 how we impose theory-implied parameter bounds in the optimization.

We use data on $n = 4$ variables, namely relative population $P_t/P_t^\star$, the average unemployment rate $(U_t + U_t^\star)/(L_t + L_t^\star)$, average labor force participation $(L_t + L_t^\star)/(P_t + P_t^\star)$ and relative GDP per capita $Y_t P_t^\star/(Y_t^\star P_t)$, for the period $t_0 = 1950.Q1$ to $T = 1962.Q4$. The relative population series abstracts from influences other than regional migration (see Section 3.2), since our model also abstracts from such influences. We also normalize the historical data on relative GDP per capita and labor force participation by dividing each time series by its 1963 value. Much like the unemployment rate, we thus treat these 1963 values as steady-state values.[21] We linearly interpolate all historical data from annual to quarterly frequency.

The propensity parameters that minimize distance D are $e_0 = 0.33$, $1/a = 0.065$ and $\kappa_2 = 5.06$. Appendix C.7 verifies that these parameter values are in line with existing estimates from the literature.

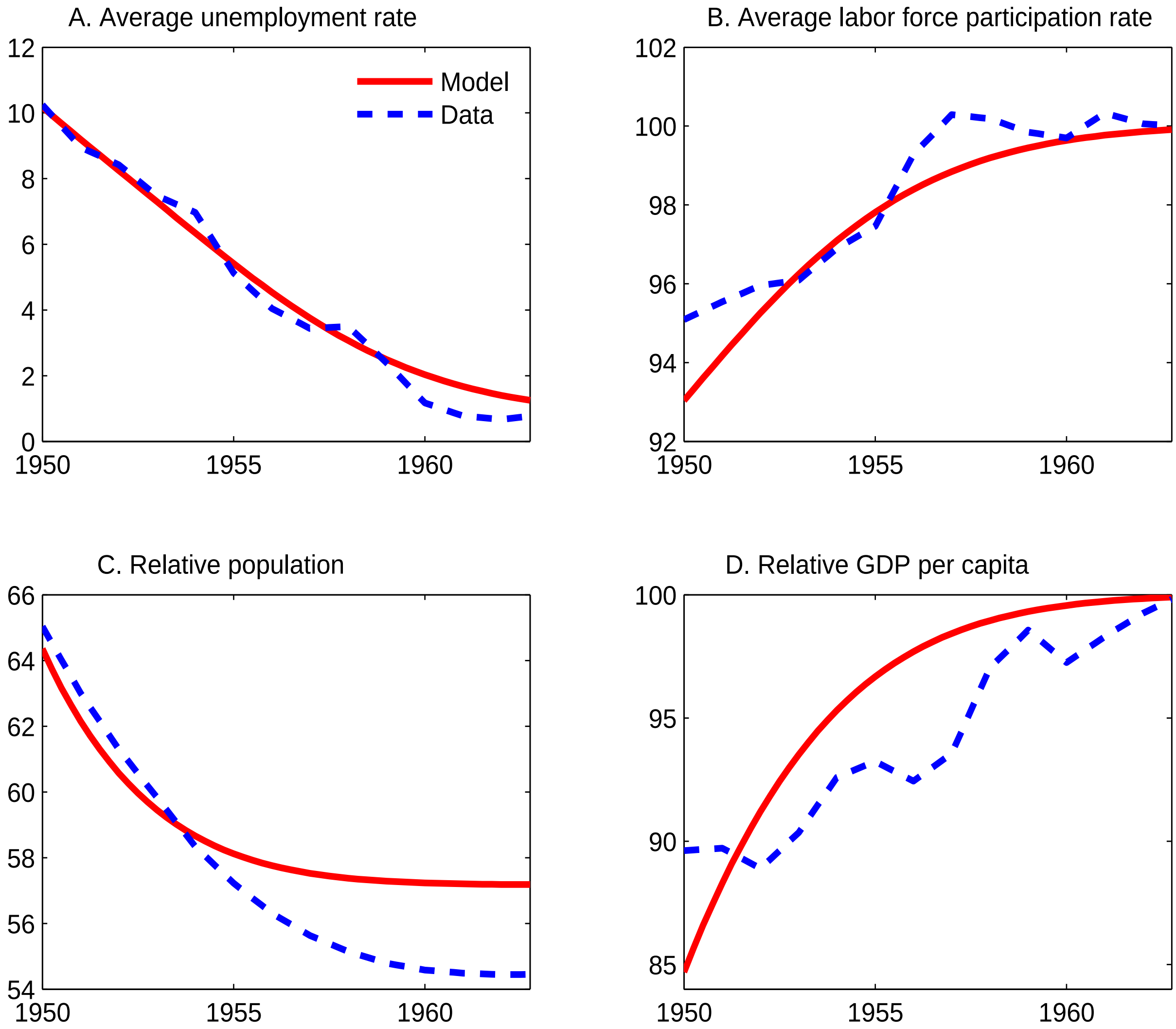
5.4 Model fit of targeted and non-targeted moments

Figure 6 compares the historical data, which we target to calibrate the three propensity parameters, to the adjustment paths implied by the calibrated model. The figure shows that the calibrated model fits the historical data remarkably well, both qualitatively and quantitatively, even though we use only three parameters to optimize fit.

In particular, the model fits the initial magnitude and persistent decline of the historical average unemployment rate (Panel A). Unemployment increases because expellees arrive in either region without a job, and unemployment remains persistently high because expellees and unemployed native workers only gradually move into employment. The persistence of unemployment

[21] Two observations suggest that relative GDP per capita had reached its steady-state value by 1963. First, relative GDP per capita stopped increasing by the end of the 1950s and stayed fairly constant throughout the 1960s (see Figure 5). Second, despite lower GDP per capita in region H than L, workers did not migrate from region H to L in the 1960s. Moreover, participation was arguably in steady state in 1963, because there was basically full employment at that time and the participation rate had hardly changed since 1957 (see Figure 2).

Figure 6: Model fit of targeted moments



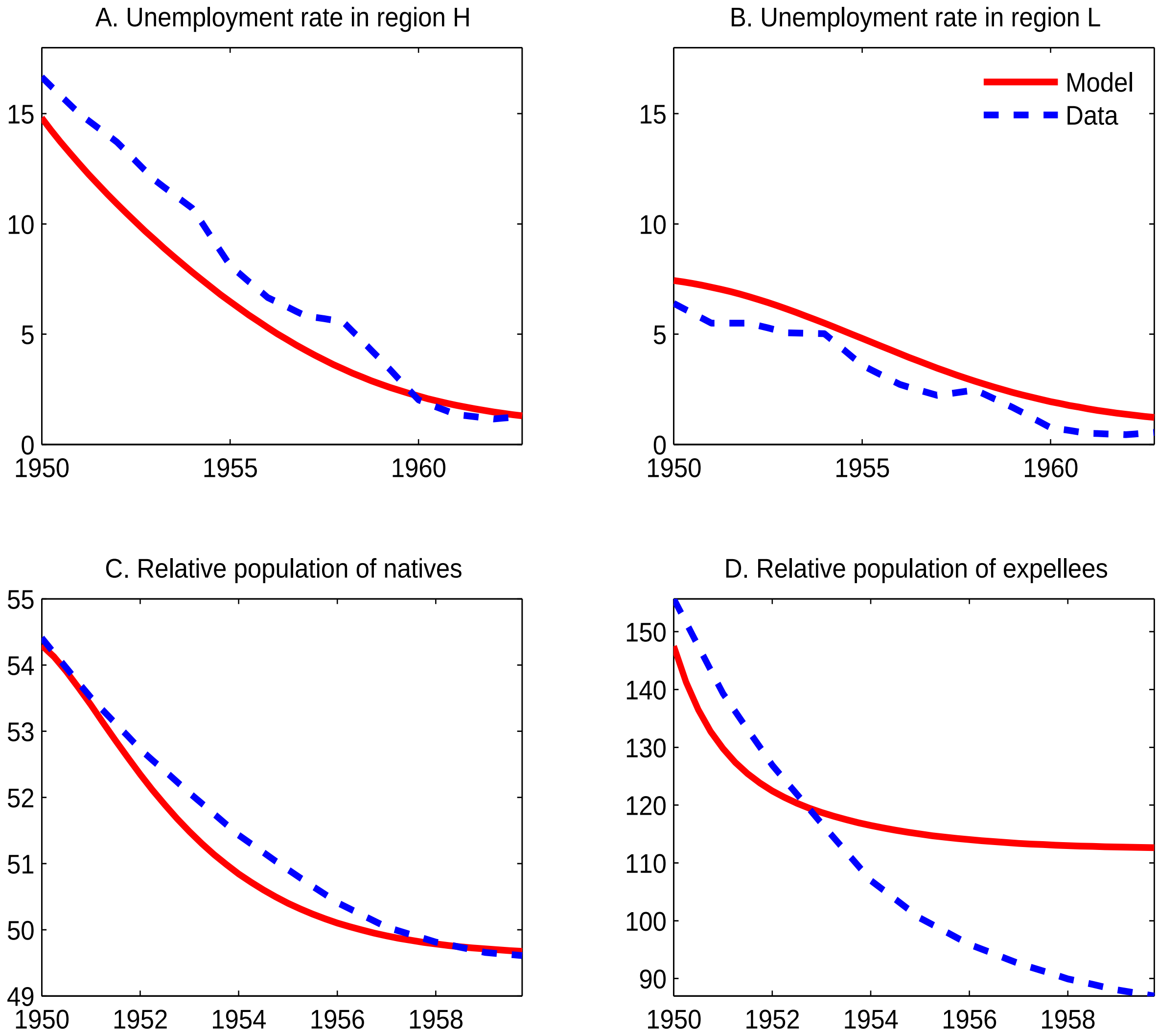
Notes: The figure compares the historical data (blue dashed line) to the adjustment paths predicted by our calibrated model (red solid line). See Section 5.4 for further explanation.

implied by the model depends, in particular, on firms' propensity not to adjust employment κ_2.

The model also fits the large discouraged worker effect (Panel B), which reduces the historical labor force participation rate to roughly 95% of its (calibrated) equilibrium rate. Labor force participation is slightly less persistent than the unemployment rate, again in line with the historical data. The evolution of labor market participation in the model depends to a large degree on workers' propensity to participate e_0.

Furthermore, the model captures the gradual decline in relative population of region H to L after the expellee inflow (Panel C). Relative population declines because non-employed workers, motivated by higher wages and job-finding rates in region L, migrate from region H to L. Ongoing migration along with faster capital accumulation in region H first attenuates regional differences

Figure 7: Model fit of non-targeted moments



Notes: The figure compares the non-targeted historical data (blue dashed line) to the adjustment paths predicted by our calibrated model (red solid line). Due to data availability, Panels C and D only show the time period between 1950 and 1958. See Section 5.4 for further explanation.

in wages and job-finding rates, and eventually eliminates migration incentives altogether.

The model also explains the quintessence of relative GDP per capita dynamics (Panel D). Upon impact, relative GDP per capita in region H decreases sharply as unemployment soars, and then slowly reverts to its pre-inflow level. Figure 6 shows, however, that the model tends to overestimate both relative population and relative GDP per capita in region H during transition. The model fit in Panels C and D depends on workers' propensity to migrate $1/a$. While a higher propensity improves the model's fit of relative population by increasing regional migration, it worsens the fit of the catch-up process in relative GDP per capita. We discuss this point in more detail in our robustness checks in Appendix D.

Figure 7 evaluates the model fit of the historical time series that we did not target to calibrate the propensity parameters. Evidently, the calibrated model fits the initial magnitude and persistent decline of both regional unemployment rates remarkably well (Panels A and B). The good fit of the regional dimension of the data is reassuring, given that this dimension takes center stage in our subsequent analysis. The model also portrays the relative native population remarkably well (Panel C). Again, this is reassuring since, below, we are mainly interested in the effects of the expellee inflow on labor market adjustments of native inhabitants.

The model also replicates the decline in the relative population of expellees qualitatively, but it falls short of replicating this decline quantitatively (Panel D in Figure 7). Effectively, as shown in Panel C of Figure 6, the model overestimates total relative population after the mid-1950s because it predicts too little regional migration of expellees for that period. Improving the model's fit of relative expellee population without compromising the fit of relative native population would require a more elaborate model, say one with differences in migration costs between native inhabitants and expellees. In our model, expellees are more likely to migrate than native inhabitants, because expellees are more likely to be unemployed at the beginning of the adjustment process.

6 Main results on the labor market effects of the expellee inflow

We have shown that our parsimonious model explains the empirical facts surprisingly well. In this section, we use this model to address our two research questions. Subsection 6.1 discusses how quickly and by what margins regions H and L adjust to the expellee inflow, and Subsection 6.2 quantifies the effect of the inflow on native labor income. Appendix D shows that our main results are robust to various changes in the model calibration. In particular, the robustness checks allow for asymmetric initial capital stocks and regional productivity gaps, consider alternative definitions of the high- and low-inflow region, and discount the relevance of the GDP per capita data in the model calibration.

6.1 Margins of labor market adjustment

This subsection shows that almost a third of the initial increase of the population in the high-inflow region H is eventually absorbed through migration to the low-inflow region L. We also show that the adjustment processes of native inhabitants and expellees differ strongly from each other because the two groups start from different labor market states.

We consider employment, unemployment, non-participation, and regional net migration as the adjustment margins in the labor market and measure the relative contribution of a margin by tracing out how the expellee inflow affects this margin in the course of time. Appendix E derives the model-implied decomposition

$$1 \quad = \quad \frac{N_T - N_{-1}}{X_0} + \frac{U_T - U_{-1}}{X_0} + \frac{R_T - R_{-1}}{X_0} + \frac{\sum_{t=0}^{T}(G_t - G_t^{\star})}{X_0} \ , \tag{12}$$

which expresses the cumulative change in employment, unemployment, non-participation, and net migration between the time period before the inflow and period T relative to the overall expellee inflow.

We can learn more about the economic adjustment mechanisms by splitting decomposition (12) into one decomposition for the native population and another decomposition for expellees. Computing the decomposition for the native population yields (see Appendix E):

$$0 \quad = \quad \frac{N_{NT} - N_{N,-1}}{X_0} + \frac{U_{NT} - U_{N,-1}}{X_0} + \frac{R_{NT} - R_{N,-1}}{X_0} + \frac{\sum_{t=0}^{T}(G_{Nt} - G_{Nt}^{\star})}{X_0} \ , \tag{13}$$

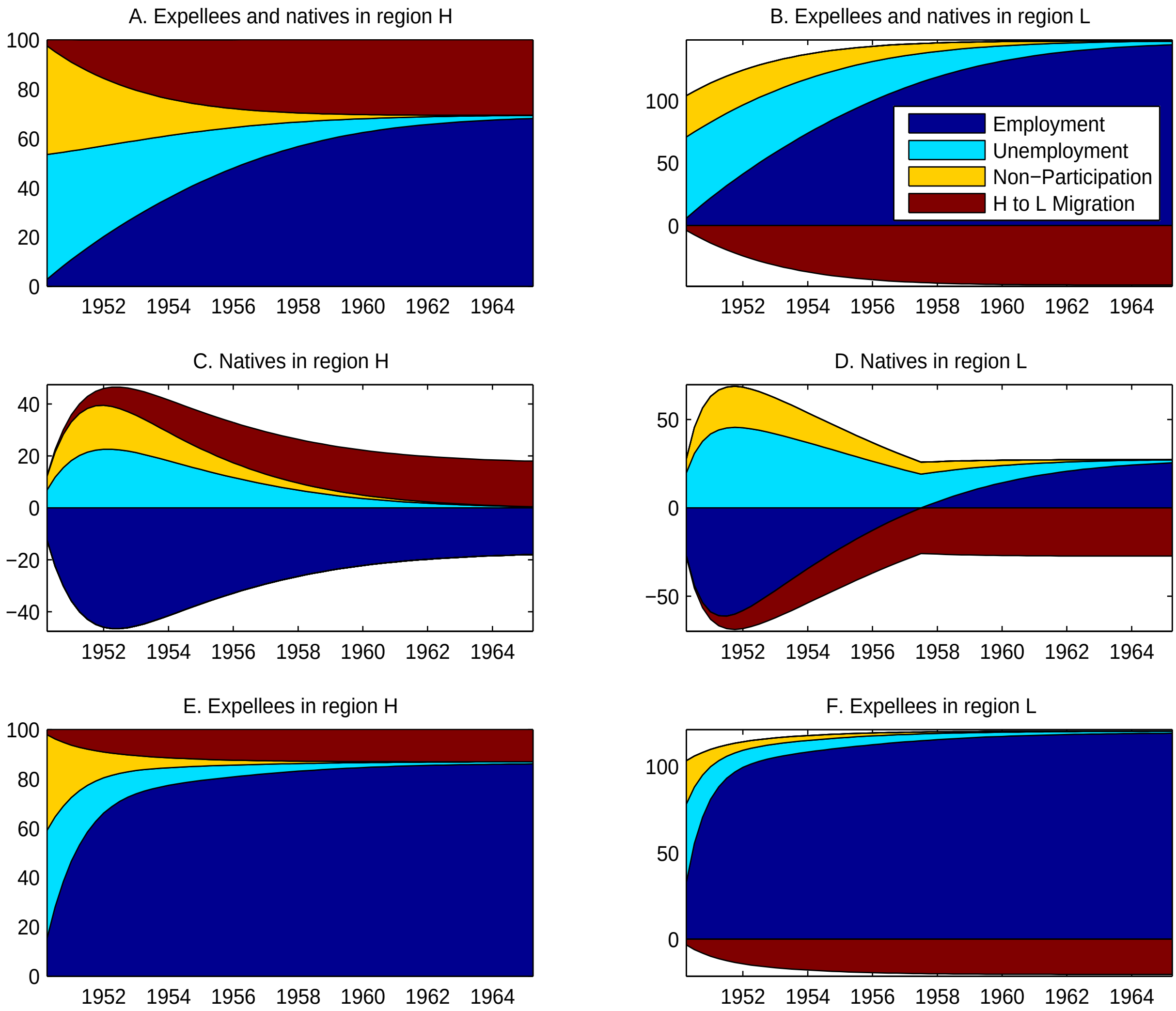
where N_{NT}, for instance, denotes native employment at time T. Since the native population experiences no exogenous inflow, the four adjustment margins on the right-hand side of equation (13) add up to zero. We obtain the decomposition for expellees by subtracting the decomposition for the native population (13) from decomposition (12) (see Appendix E).

Furthermore, we express each decomposition relative to its corresponding decomposition in a counterfactual scenario, in which we set the expellee inflow to zero. This isolates the effects of the expellee inflow from the effects of the war-related damage of regional capital stocks, which are still present in the counterfactual. Both data limitations and the difficulty to separate the effect of the expellee inflow from other developments in the economy prevent us from computing decompositions (12) and (13) directly in the raw data.

Figure 8 shows, separately for region H and L, the relative contribution of each adjustment margin in the overall population (Panels A and B), the native population (Panels C and D), and the expellee population (Panels E and F). Relative contributions are shown for each time horizon T from the time of the expellee inflow until 1965.

Three main findings emerge from the decompositions. First, the unemployment and non-participation margins dominate the adjustment process for the overall population in the early years after the shock, whereas the employment and migration margins dominate this process in

Figure 8: Cumulative contribution of adjustment margins over time, regions, and worker types



Notes: The figure shows, separately for region H and L, the relative contribution of each adjustment margin for the overall population (Panels A and B), for the native population (Panels C and D) and for expellees (Panels E and F). Each decomposition is expressed relative to the corresponding decomposition in a counterfactual scenario, in which we set the expellee inflow to zero. See Section 6.1 for further explanation.

later years. This is true for both regions (see Panel A for region H and Panel B for region L). In later years, the contribution of the migration margin is sizable. At the end of the adjustment process, migration has contributed about one-third to the cumulative labor market adjustment of region H.

Second, it takes regional labor markets at least a decade to approach the new steady state. Essentially, the adjustment of the unemployment margin to the expellee inflow was completed after ten years in region H and after 11.5 years in region L, i.e., when 90% of the gap between unemployment at the time of the inflow and unemployment in the terminal steady state has been closed. The adjustment process takes longer in region L, because the ongoing migration from

H to L constitutes another, endogenous, inflow into unemployment in region L. Monras (2018) also finds that it took about a decade before the labor reallocation across US Metropolitan areas triggered by the Great Recession were completed.

Third, the adjustment process of native workers differs strongly from the process of expellees (compare Panels C and E for region H and Panels D and F for region L). The reason for the markedly different adjustment processes of native workers and expellees is that both groups start from very different initial labor market states. While most native workers are initially employed, all expellees are initially non-employed. Our results show that the different initial conditions are crucial in shaping the labor market experiences of the two groups in the wake of the shock. Initial conditions also significantly affect the native income effects of the expellee inflow, as we show in Subsection 6.2 below.

In particular, native employment decreases in each region at the beginning of the adjustment process, with job separations of native workers outnumbering new matches in the first few quarters after the shock (see Panels C and D). Native employment in region H reaches a minimum nine quarters after the shock. When measured at that time, native employment decreases by 4.65 native workers for any ten expellees who arrive in region H. This minimum employment effect is robust to various modifications in our model calibration (see Appendix D). Of the 4.65 native workers who are out of employment, 1.59 leave the labor force, 2.23 enter the unemployment pool, and 0.83 leave region H for region L.[22] The unemployment rate of native workers equals 9.51%. The large negative employment effect that we find is broadly consistent with recent evidence in Glitz (2012). He studies the immigration of ethnic Germans from Eastern Europe and the former Soviet Union to Germany after the fall of the Berlin Wall and finds that in the short run, 3.1 native workers lose their jobs for every ten immigrants that find employment.

Furthermore, four years after the expellee inflow, migration accounts for one-third of the

[22] Native workers in our model adjust to the expellee inflow in a way that closely resembles the adjustment predicted by the literature on (negative) local labor demand shocks (see, for example, Blanchard and Katz (1992), Decressin and Fatas (1995), Lkhagvasuren (2012), Dao, Furceri, and Loungani (2017), Beyer and Smets (2015), Basso, D'Amuri, and Peri (2018)). The literature on labor demand shocks focuses on region-specific shocks. Our historical shock, in contrast, hits both regions, although to a very different degree, and thus convolutes aggregate and region-specific components (see, for example, Furlanetto and Ørjan Robstad (2018)) for responses to aggregate immigration shocks). In additional unreported work, we thus decompose the historical shock in a common and a region-specific component and quantify the relative contribution of the adjustment margins for the region-specific component. The decomposition, which can be obtained upon request, supports our conclusion: Native workers adjust to the region-specific component of the expellee inflow in a way that closely resembles the labor market adjustments after a negative labor demand shock. In general, our results add to the results in the literature on labor demand shocks, because our strategy for identifying the role of regional migration combines a natural experiment with dynamic search and matching theory and therefore differs from the predominant strategy in this literature, which relies on imposing exogeneity assumptions in time-series VAR models.

decrease in region H's native employment, and after 15 years it accounts for the entire decrease. The migration margin dominates the unemployment and non-participation margins after six years. At the end of the adjustment process, 1.75 native workers have left region H for any ten expellees who arrive.

Native migrants expand the labor market in region L (see Panel D). Since native migrants arrive without a job, they initially add to the unemployment and non-participation pools.[23] Over time, however, native migrants find jobs and eventually increase native employment in region L, whereas native employment in region H falls permanently.

In contrast to the native population, expellees are gradually absorbed into employment, with their inflows into employment exceeding their outflows from employment over the entire adjustment path (see Panels E and F). This process is faster in region L than in region H because the job-finding rate remains higher in the low-inflow region L. Two years after the shock, expellee employment already stands at 101% in region L but at only 69% in region H (relative to the initial regional expellee inflow).

6.2 The effects of the expellee inflow on native labor income

We have shown that native workers experience an increased probability of non-participation and unemployment along the adjustment path, and respond to the expellee inflow by moving from region H to L. These adjustment processes affect natives' expected lifetime labor income, and quantifying this income effect is the focus of this subsection.[24] We distinguish workers by their initial labor market status, and also compute the income effect for each point in time along the adjustment path. Therefore, we significantly extend the existing literature that mainly focuses on the effect of immigration on native workers' wages at a given point in time.

We find that the expellee inflow reduces expected discounted lifetime income of native workers by 1.38%, reflecting the large and long-lasting adjustment processes described in Section 6.1. Per-period income effects in the first years after the expellee inflow are up to four times larger than

[23]Panels C and D in Figure 8 show that the maximum decline in native employment is slightly larger in region L than region H when denominated by the initial regional expellee inflow. Alternatively, we can denominate the same cumulative change in regional native employment by the regional native population before the expellee inflow. This alternative denomination implies that out of one hundred native workers who lived in region H before the shock, 15.60 are out of employment nine quarters after the shock. The corresponding statistic for region L is much smaller and equals 7.18 native workers.

[24] In our partial equilibrium model, we implicitly divide a household into workers, consumers and shareholders and focus our analysis on workers, but not on consumers or shareholders. Accordingly, our analysis is silent about who owns what share of the economy-wide capital stock and, hence, about the effects of the expellee inflow on capital income.

the overall effect on lifetime income, reflecting mainly the negative wage effects of immigration on impact. Income losses are largest for native workers who are non-employed in region H at the time of the expellee inflow.

6.2.1 Overall treatment effect on expected discounted lifetime income

Table 4 reports the treatment effects of the expellee inflow on the expected discounted lifetime income (EDI) of native workers. The treatment effect, $\mathcal{T}_0$, is the percentage difference between a worker's EDI in the historical scenario, $\mathcal{Z}_0$, and her EDI in a counterfactual scenario without expellee inflow, $\widetilde{\mathcal{Z}}_0$, at the time of the shock:

$$\mathcal{T}_0 = 100(\mathcal{Z}_0 - \widetilde{\mathcal{Z}}_0)/\widetilde{\mathcal{Z}}_0 \ . \tag{14}$$

In both the historical and the counterfactual scenario, the economy starts from a capital stock below the steady state to account for war damage. Since a worker can be in one of six different states (employed, unemployed, or non-participating in region H or region L) at the time of the inflow, we compute six worker-specific treatment effects in Table 4. We augment the worker-specific treatment effects by the treatment effects for the average native worker in region H, the average native worker in region L, and the average native worker in both regions (Appendix G.2 explains how we calculate these average treatment effects).

The first main result in Table 4 is that the expellee inflow reduces the EDI of the average native worker by 1.38%. This value is robust to various modifications in our model calibration (see Appendix D). The predominant component of the decline in EDI is wage income in region H, which is more than twice as large as the overall decline, but is partly offset by the other income types available to workers (Appendix F decomposes the overall income decline by income type).

The decline of native income in our model arises only from the adjustment dynamics toward the new steady state. Once this steady state is reached, the expellee inflow no longer affects native income. In contrast, Battisti, Felbermayr, Peri, and Poutvaara (2018) quantify the steady-state income effect of exogenously given immigration rates in models with labor market frictions, fiscal redistribution and skill complementarities, but without internal migration. For Germany, they find that in a steady state with a migrant share of 15.3%, native income is 0.31% higher than in a no-migration steady state. While their income measure is more comprehensive than ours as it also includes fiscal and capital income, our results suggests that adjustment dynamics matter

Table 4: Treatment effect on expected discounted lifetime income of native workers

Worker type	Region H Income	Region H Treatment effect (in %)	Region L Income	Region L Treatment effect (in %)
Average	Z_N	−1.73	$Z_N^\star$	−1.19
Employed	W	−1.69	$W^\star$	−1.16
Unemployed	Q	−2.33	$Q^\star$	−1.57
Non-participant	H	−2.46	$H^\star$	−1.64
Average in both regions, $\overline{Z}_N$		−1.38		

Notes: The treatment effect is defined in equation (14) and described in Section 6.2.1. We distinguish native workers by their labor market status and their location at the time of the shock.

for the overall income effects of immigration.

The second main result in Table 4 is that income losses vary significantly with a worker's initial location. For the average native worker, losses are 45.4% larger in region H than region L (1.73% compared with 1.19%). However, regional losses are even more asymmetric in the counterfactual case without regional migration, namely 2.14% compared with 0.94% (see Table 5 below), reflecting the highly asymmetric inflow shock. Moving from the counterfactual case without regional migration to the historical case with regional migration essentially cuts in half the income loss asymmetry, as measured by the Gini coefficient, which declines from 19.5% to 9.25%.[25] Thus, the role of regional migration for native workers to insure against the asymmetric inflow shock is quantitatively important.[26] Monras (2018) also finds an important role for internal migration in the US as an insurance device in response to the Great Recession.

Income losses also vary significantly with a worker's initial labor market status. In both regions, losses are almost 40% higher for workers who are unemployed at the time of the shock rather than employed. This is because the expellee inflow decreases job-finding rates and hence the re-employment probability of unemployed native workers. In contrast, employed natives only suffer from lower job-finding rates if they lose their jobs in later periods. These results reflect the high unemployment rate of expellees upon arrival and hence the initial conditions imposed by the inflow shock. In contrast, steady state analysis ignores the role of initial conditions for the income effect of immigration.

[25] With two agents, the Gini coefficient corresponds to $\frac{1}{2}\frac{|Z_N - Z_N^\star|}{|Z_N + Z_N^\star|}$.

[26] Eliminating the participation margin leaves the Gini coefficient almost unaffected, hence this margin does not deliver such insurance.

6.2.2 Per-period and cumulative treatment effect

We analyze how income losses evolve over time by decomposing the overall treatment effect in the EDI of the average native worker in both regions, $\overline{Z}_{Nt}$, in two ways. The first decomposition is the per-period treatment effect and shows in which period the treatment effect is largest (in absolute terms); the second decomposition is the cumulative treatment effect and shows how long it takes for the overall treatment effect to be realized.

We denote the per-period treatment effect in period t by $\mathcal{PT}_t$ and define it as the difference between period t income in the historical scenario, $\mathcal{Z}_t - \beta\mathcal{Z}_{t+1}$, and period t income in the counterfactual scenario, $\widetilde{\mathcal{Z}}_t - \beta\widetilde{\mathcal{Z}}_{t+1}$, expressed in terms of the average counterfactual income:

$$\mathcal{PT}_t \quad = \quad 100\left(\frac{[\mathcal{Z}_t - \beta\mathcal{Z}_{t+1}] - [\widetilde{\mathcal{Z}}_t - \beta\widetilde{\mathcal{Z}}_{t+1}]}{(1-\beta)\widetilde{\mathcal{Z}}_0}\right) .$$

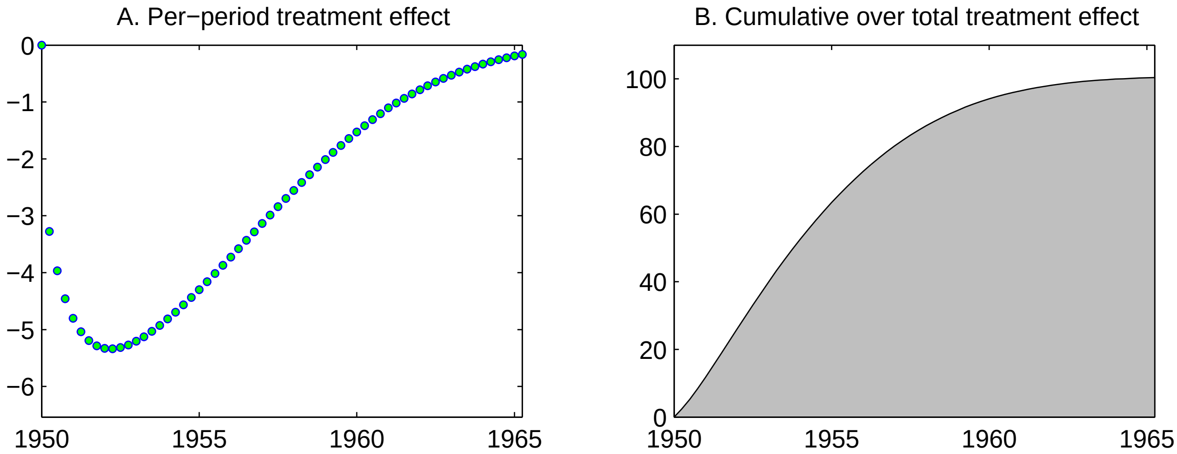
Panel A in Figure 9 shows that the per-period treatment effect in $\overline{Z}_{Nt}$ evolves non-monotonically over time. On impact, the expellee inflow reduces historical per-period income of the average native worker in both regions by 3.28% relative to counterfactual income. As more and more native workers become unemployed or leave the labor force over time (see Section 6.1), the per-period treatment effect declines even further, reaching a minimum value of −5.34% nine quarters after the shock, and slowly dissolves thereafter. The large (in absolute terms) per-period treatment effects in the early years after the expellee inflow are consistent with the considerably smaller overall treatment effect, since the latter averages the discounted per-period effects over a worker's lifetime, i.e., $\mathcal{T}_0 = (1-\beta)(\mathcal{PT}_0 + \beta\mathcal{PT}_1 + \beta^2\mathcal{PT}_2 + \dots)$.

Borjas (2017)'s re-analysis of the Mariel Boatlift–in which around 125,000 Cuban refugees arrived in Florida between April and October 1980–also suggests that the adverse wage effects of immigration initially increase over time.[27] The hump-shaped income loss dynamics we obtain are also predominantly governed by wage income. Two factors determine these dynamics. First, the (unconditional) employment probability of native workers declines gradually but also recovers only gradually (see Panel C in Figure 8). Natives losing their jobs find themselves in a massively expanded unemployment pool and hence face lower job finding rates along the adjustment path.[28] Second, firms accumulate capital to absorb the expellee inflow into employment. However, since firms face investment adjustment costs, employment rises faster than capital in the initial years

[27] The labor market effects of the Mariel Boatlift are still subject of academic debates. Peri and Yasenov (2017), for instance, find no wage and employment effects on low-skilled workers.

[28] This effect also persists because initially discouraged workers re-enter the unemployment pool over time.

Figure 9: Treatment effects over time



Notes: The figure depicts the per-period treatment effect (Panel A) and the cumulative overall treatment effect in expected discounted lifetime income (Panel B) of the average native worker. See Section 6.2.2 for further explanation.

thereby putting further downward pressure on wages.

Since it takes more than a decade for per-period treatment effects to vanish, it also takes a long time for the overall treatment effect to be realized fully. We summarize this speed of adjustment in a cumulative treatment effect for the average native worker in both regions. This cumulative treatment effect corresponds to the overall treatment effect truncated at date t,

$$\mathcal{CT}_t \quad = \quad 100 \left([\mathcal{Z}_0 - \beta^{t+1} \mathcal{Z}_{t+1}] - [\widetilde{\mathcal{Z}}_0 - \beta^{t+1} \widetilde{\mathcal{Z}}_{t+1}] \right) / \widetilde{\mathcal{Z}}_0 \ .$$

Truncation implies that historical and counterfactual income are compared up to date t only and that $\mathcal{CT}_t$ approaches the overall treatment effect $\mathcal{T}_0$ as t becomes large. The ratio of cumulative to overall treatment effect, $\mathcal{CT}_t/\mathcal{T}_0$, then yields the fraction of the overall treatment effect that is realized over a certain time horizon of the adjustment process, say within the first five years.

Panel B in Figure 9 plots $\mathcal{CT}_t/\mathcal{T}_0$ for the income of the average native worker, and shows that the overall treatment effect builds up only gradually over time. Five years after the expellee inflow, the cumulative treatment effect still amounts to less than two-thirds of the overall treatment effect, and it takes another ten years for the remaining effect to be fully realized. This result shows that per-period income has to be analyzed over a long period of time in order to obtain a full picture of the overall income effect of the expellee inflow.

6.2.3 Wage elasticity of immigration

Wage income is an important component of the overall income effect of immigration. Furthermore, the literature often focuses directly on the wage elasticity of immigration. Therefore, we now calculate the model-implied wage elasticity and compare it to empirical estimates of this elasticity.

The wage elasticity in our model, computed as $(d\log(w_t) - d\log(\widetilde{w}_t))/d\log(P_t)$, equals -0.12 and -0.16 in region H and L, respectively, when measured at the time of the shock. The elasticity decreases slightly in the first few quarters after the shock and gradually approaches zero thereafter.

Our short-run wage elasticities are slightly lower than most estimates in the literature and thus imply larger wage effects of immigration. In fact, Friedberg and Hunt (1995) and Kerr and Kerr (2011) report that most studies find wage elasticities of -0.1 or higher. However, Borjas (2003) finds much higher wage effects of immigration, pointing to a wage elasticity of between -0.3 and -0.4. Appendix B shows that the short-run wage elasticities in our model are broadly consistent with empirical estimates that we obtain from a large scale survey of West German employees' earnings in trade and industry in 1951. If anything, the empirical analysis in Appendix B suggests that the adverse wage effects of the expellee inflow were slightly larger than implied by our model. Either way, our analysis highlights the fact that estimates of the wage elasticity generally depend on the time elapsed since immigration.

7 Counterfactual immigration experiments

We conduct three counterfactual experiments, which explore the predictions of our structural model under different parameter calibrations. First, we vary the initial regional distribution of expellees.[29] Second, we vary the timing of the expellee inflow and spread it over time. Third, we change the propensity of workers to migrate between regions. The counterfactual experiments suggests that economic policies that change the timing and distribution of immigrant inflows can have important consequences for the magnitude of native income losses and labor market adjustments.

[29] Recently, Braun and Dwenger (2018) have used empirical reduced-form estimates to simulate the regional distribution of expellees that maximizes their participation in the labor force. In contrast to our work, Braun and Dwenger (2018) focus on expellee outcomes only and abstract from adjustment dynamics.

A. Counterfactual initial regional distribution of expellees. Counterfactual experiment A. distributes all expellees into one region, or distribute expellees so that regional inflow rates, X_0/P_{-1} and $X_0^\star/P_{-1}^\star$, are identical.[30] Identical inflow rates imply that $X_0/(X_0 + X_0^\star)$ equals $P_{-1}/(P_{-1} + P_{-1}^\star)$ and thus 0.35. In our model, the distribution with equal inflow rates mimics today's policy of distributing refugees across German states according to local population size. Similar distribution quotas are also the subject of animated debate within the European Union.[31]

The results in Panel A. of Table 5 suggest that unequal inflow rates benefit the average native worker at the expense of the average expellee worker (the first panel replicates the results of the historical scenario). In fact, the income loss of the average native worker in both regions, as measured by the overall treatment effect on the EDI, is *minimized* (at 1.24%) when all expellees are distributed to region H (see column (1)), the region with the smaller initial population size. This perhaps surprising result is due to the fact that with positive migration costs, native inhabitants in region L are partly shielded from the expellee inflow to region H. Distributing all expellees to region H, in which there are relatively few native inhabitants, maximizes the number of natives shielded from the negative effects of immigration. In contrast, the income loss of the average expellee, as measured by the percentage difference between the EDI of the average expellee (defined in Appendix G.3) and the EDI of the average native in the case without any expellees, is *maximized* (at −2.81%) when all expellees are distributed to region H (column (4)). This is because all expellees then start in the congested labor market of region H with a small probability of finding a job quickly.

The income loss of the average native worker in both regions is *maximized* (at 1.41%) when expellees are distributed in proportion to the initial native population in each region. The proportional distribution of expellees is thus the worst possible distribution from the perspective of the average native worker in our model.[32] The income loss of expellees, in contrast, is *minimized* (at 1.99%) in that case. Our results also show that a proportional distribution levels out regional differences in minimum per-period treatment effects (columns (6) and (7)) and unemployment

[30] We denominate regional inflow rates by P_{-1} and $P_{-1}^\star$ rather than P_0 and $P_0^\star$ to ensure that they are exogenous.

[31] In addition to population size, distribution quotas usually take economic indicators into account. The German quota, for instance, allocates more refugees to states with higher tax income. However, regions in our model are ex ante identical in per capita terms. Therefore, economic indicators do not carry additional information for the distribution of expellees in our model, once differences in population size are accounted for.

[32] Clearly, our analysis abstracts from a number of channels through which the regional distribution of expellees might affect native income. The extreme initial distribution of expellees, for instance, decreases the employment probability of expellees and hence increases their dependency on unemployment benefits. In general equilibrium, native workers will have to finance the benefits of unemployed expellees and thus have an interest in high expellee employment. Such interest is absent in our framework.

differentials (columns (8) and (9)).

Panel A. of Table 5 also shows that we observe the longest duration of adjustment when all expellees are distributed to region H, and the shortest duration when expellees are distributed proportionally (column (5)). The duration of adjustment is measured by the number of quarters that it takes for 90% of the overall treatment effect to be realized. Distributing all expellees to the less populous region H maximizes internal migration incentives, and thus increases the magnitude and persistence of regional migration flows. In fact, half of the initial increase in the population of region H is eventually absorbed through migration to region L if all expellees are distributed to region H (column (10)).

B. Gradual inflow of expellees over time. Instead of considering a one-off inflow, Counterfactual B. distributes the expellee inflow over either three or ten years, assuming that quarterly inflow rates, $X_t/(P_t + P_t^{\star})$ and $X_t^{\star}/(P_t + P_t^{\star})$, are constant over this period. Gradual intakes of refugees are common practice in many countries today. In 2015, for instance, the UK agreed to take in 20,000 Syrian refugees over a five-year period.

The results in Panel B. of Table 5 suggest that a more gradual inflow of expellees markedly reduces the income loss of native workers. The income loss decreases by almost 25% when the expellee inflow is distributed over three years, and it more than halves when the expellee inflow is distributed over ten years (see column (1)). A more gradual inflow has even stronger income effects for expellees, since they suffer most from a congested labor market. The income loss of the average expellee worker decreases by 35% and 62% when the expellee inflow is distributed over three and ten years, respectively (column (4)).

The counterfactual also shows that a more gradual inflow increases the minimum per-period treatment effect and keeps average unemployment rates down. Distributing the expellee inflow over ten years reduces the average unemployment rate in the first ten years of adjustment from 7.29% to 4.61% in region H and from 4.85% to 3.16% in region L (columns (8) and (9)).

Overall, the counterfactual suggests that a more gradual inflow of immigrants can effectively limit the negative effects of immigration. Of course, our model does not account for the–potentially large–costs of delayed entry for immigrants themselves.

Table 5: Counterfactual immigration experiments

	Overall treatment effect on EDI (in %) of native in			Income of avg. expellee[1] (in %)	Duration of adjustment[2] (# quarter)	Minimum per-period treatment effect[3] (in %) of average native in		Avg. unemployment rate 1950.Q1 to 1959.Q4 (in %)		Migration as adjustment margin[4]
	Both regions	Region H	Region L			Region H	Region L	Region H	Region L	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Historical scenario	−1.38	−1.73	−1.19	−2.14	35	−6.95	−4.43	7.29	4.85	30.60
A. Initial regional distribution of expellees										
$\frac{X_0}{X_0+X_0^\star}=0$	−1.35	−0.93	−1.58	−2.24	35	−3.57	−6.42	4.17	6.56	nd[5]
$\frac{X_0}{X_0+X_0^\star}=0.352$	−1.41	−1.41	−1.41	−1.99	34	−5.58	−5.58	5.69	5.69	0.00
$\frac{X_0}{X_0+X_0^\star}=1$	−1.24	−2.00	−0.82	−2.81	37	−7.91	−3.10	9.34	3.84	50.49
B. Gradual expellee inflow over time										
Over three years	−1.06	−1.38	−0.88	−1.39	39	−6.44	−4.00	6.37	4.25	28.55
Over ten years	−0.65	−0.86	−0.53	−0.81	54	−4.24	−2.63	4.61	3.16	25.42
C. Migration costs										
$a=1e+4$	−1.36	−2.14	−0.94	−2.33	36	−7.49	−4.10	9.26	3.76	0.17
$a=1e-4$	−1.41	−1.40	−1.42	−1.99	34	−5.53	−5.61	5.69	5.69	42.13

Notes: The table shows the effects on various outcome variables of varying the initial regional distribution of the expellee inflow (Panel A.), the timing of the expellee inflow (Panel B.) and migration costs (Panel C.). Each counterfactual varies only one parameter at a time, keeping all other parameters at the values described in Section 5. [1] The income of the average expellee is the percentage difference between the average expellee's EDI upon arrival and the EDI of the average native in the case without any expellee inflow. [2] The duration of adjustment is the number of quarters that it takes for 90% of the treatment effect in column (1) to be realized. [3] The minimum per-period treatment effect is the minimum of the per-period treatment effect on native income (as described in Section 6.2.2) over the adjustment path. [4] Migration as an adjustment margin is computed as cumulative net migration over the total expellee inflow into region H. [5] Not defined (division by zero).

C. Counterfactual migration costs. Counterfactual C. explores the effects of prohibitively high and very low costs of inter-regional migration. These costs are determined by a, i.e., the inverse propensity of workers to migrate. Varying these costs allows us to discern the role of labor mobility in insuring native inhabitants against asymmetric inflow shocks, and facilitates the extrapolation of our results to settings in which regional labor markets are more or less integrated than in our setting.

The results in Panel C. of Table 5 show that prohibitively high migration costs shield workers in region L from the negative income effects of regional migration from region H to L. Therefore, the income loss for the average native worker in region L decreases from 1.19% in the historical scenario to 0.94% (column (3)). Conversely, natives in region H suffer from high migration costs, as workers are no longer able to evade the poor labor market conditions in region H by moving to region L. Consequently, the income loss for the average native worker in region H increases from 1.73% to 2.14% (column (2)).

Under very low migration costs, in contrast, native income losses in both regions converge to 1.41%. Workers in region L no longer benefit from a less congested labor market, as unemployed workers in region H can move at no cost. The income loss for the average native worker in both regions is slightly higher for very low migration costs than for prohibitively high migration costs (1.41% vs. 1.36%). Expellees, however, benefit from lower migration costs, because their costs of bypassing the congested labor market in region H fall. These findings mirror our conclusion from counterfactual experiment A., i.e., shielding native workers in the low-inflow region L is beneficial for the average native worker but detrimental for the average expellee.

8 Discussion and conclusion

This paper has analyzed how regional labor markets in West Germany adjusted over a period of more than two decades to the inflow of eight million expellees after World War II. Three key findings emerge. First, it took regional labor markets more than one decade to absorb the expellee inflow. Second, the adjustment process was characterized by large differences in regional unemployment rates and strong migration from the high- to the low-inflow region. Third, the large and long-lasting adjustment dynamics in regional labor markets decreased the expected discounted lifetime labor income of the average native worker in West Germany by 1.38%. Per-period losses in native labor income are much larger and reach up to 5.34% in the short run.

These economic adjustment costs are not covered by conventional steady state analyses.

Counterfactual immigration experiments suggest that economic policy interventions that change the timing and distribution of immigration can have important consequences for native income losses and adjustment dynamics. We find that a more gradual inflow of immigrants significantly reduces the incomes loss of native workers. A more equal distribution of immigrants across regional labor markets, in contrast, benefits immigrants but increases the income loss of the average native worker.

Our results shed light on the dynamic labor market effects of one of the largest forced population movements in history. But they also provide relevant insights for the burgeoning–and largely static–empirical literature on the labor market effects of immigration. First, the time elapsed since immigration matters greatly for the results of empirical studies on the labor market effects of immigration. Not only do short-run effects of immigration differ greatly from longer-run effects. The effects can also evolve non-monotonically over time. Therefore, estimated short-run effects of immigration do not generally establish a bound on longer-run effects and vice versa.

Second, our dynamic analysis–and the large discrepancy between lifetime and per-period income effects that we find–reminds us of the simple fact that any static analysis will necessarily provide only an incomplete snapshot of the overall benefits and costs of immigration. A deeper understanding of the dynamic effects of immigration is, therefore, essential for informing the policy debate on immigration. Future research in this area might address several caveats of our analysis.

First, our analysis assumes that there are no long-run effects of immigration on wages and productivity, as we use a "standard" constant returns to scale production technology. Clearly, the long-run effects of immigration, and thus also transitional dynamics, may differ under either increasing or decreasing returns to scale. Economies of scale might, for instance, arise from high-skilled migration fostering firm innovation and productivity (Kerr, Kerr, and Lincoln 2014).

Second, our analysis abstracts from skill differences between native workers and immigrants, and thus from distributional consequences of immigration. This assumption is justified in our context, where native workers and expellees compete as close substitutes along the entire skill distribution. In contrast, today's migration flows are often concentrated in specific parts of the skill distribution, so that skill differences become an essential model ingredient.

Third, and related to the two previous points, our framework abstracts from potential positive effects of immigration for native workers. Such positive effects can arise if, say, natives and immigrants differ in their skills or in their search costs (see, for instance, Chassamboulli and Palivos (2014)). While our goal in this paper was to build the most parsimonious model that can explain the historical data, and our specific historical episode allows us to abstract from many differences between immigrants and native workers, some of the simplifications may not be warranted in other settings.

Fourth, our analysis has focused on the relocation of workers, abstracting from the entry and exit of firms in response to immigrant inflows (although we allow for capital accumulation). Dustmann and Glitz (2015) have recently highlighted the importance of this adjustment channel in a static framework, and it would be valuable to explore its dynamic implications.

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Online appendix – not meant for publication

A Data appendix

A.1 Socio-demographic characteristics of expellees and non-expellees

Table A1: Socio-demographic characteristics of expellees and non-expellees in West Germany, September 1950

	Expellees[a]	Rest of the population[b]
% females	52.9	53.2
Age structure		
% aged 0-17	29.7	27.7
% aged 18-24	11.3	10.1
% aged 25-44	30.0	27.9
% aged 45-59	17.9	19.9
% aged 60 and above	11.1	14.3
Marital status (aged 18 and above)		
% single	25.7	23.4
% married	60.4	64.0
% widowed or divorced	14.0	12.5
Education (born 1885-1927)[c]		
Years of schooling[d]	8.5	8.4
% vocational training	37.3	37.6
% university degree	3.5	2.9

Data sources: All data except for educational attainment are from the census of 13 September 1950, as published by the Statistisches Bundesamt (1952b). Figures on education are from our own calculations based on a 10% sample of the census of 27 May 1970 (FDZ der Statistischen Ämter des Bundes und der Länder 2008). The table is reproduced from Braun and Kvasnicka (2014).

Notes: [a] Expellees are defined as German nationals or ethnic Germans who on 1 September 1939 lived (i) in the former German territories east of the Oder-Neisse line, (ii) in Saarland or (iii) abroad, but only if their mother tongue was German. [b] The education statistics distinguish between expellees and native West Germans (excluding non-German foreigners). All other statistics distinguish between expellees and the rest of the population. [c] The education statistics are for those who were born between 1885 and 1927 (aged 23 to 65 in 1950). The overwhelming majority of these persons should have completed their education by 1950. [d] We only have data on the highest school degree. Years of schooling are inferred from the minimum years of schooling required to obtain a particular degree.

A.2 Regional differences in GDP per capita before the war

We use two proxies for regional differences in GDP per capita before the war. The first proxy, which we also report in Table 1, uses national income data from 1936, but is subject to the limitation that the states of the German Reich, for which the income data is available, do not correspond to the later West German states. We therefore had to approximate the values for the

H and L regions. We approximate 1936 national income in region H as the population-weighted average of income in Bavaria, Hanover, and Schleswig-Holstein. We then use the average national income in the rest of West Germany (excluding Hamburg and Bremen, Oldenburg, Braunschweig, Lippe, Schaumburg-Lippe) as a proxy for national income in region L. We discard the data for Bremen, Oldenburg, Braunschweig, Lippe, and Schaumburg-Lippe, as data for these regions are only reported as an aggregate figure.

The second proxy uses data on firm sales that come from published sales tax statistics (Statistisches Bundesamt 1955a, Statistisches Bundesamt 1955b). Total sales are defined as domestic deliveries and other services of a business for money and own consumption of the business. The sales data have two advantages over the national income data. First, comparable data on firm sales exist for both the pre- and the post-war periods (although, unfortunately, only until 1955). Second, sales data are available at district level and can thus be precisely aggregated to the federal state level (and thus also to the level of our two regions). On the downside, sales are not a direct measure of production value, and certain exemptions for businesses with low revenues apply. However, firm sales per capita correlate strongly with national income per capita.[33] The pre- to post-war *changes* in relative sales per capita between the two regions gives at least an indication of the *change* in relative GDP per capita. As sales statistics are not available for 1939, we use data for 1935, along with population figures for 1939.

A.3 Other drivers of Region H's relative population increase

The inflow of expellees was by far the most important driver of this dramatic increase in relative population (see Braun and Mahmoud (2014) for a comprehensive overview of regional population changes in West Germany between 1939 and 1950). However, it was not the only one. Even without the inflow of expellees, region H's population would have grown by more than 713,000 (or 5.4%) between 1939 and 1949. Region L's population, in contrast, would have decreased by 2.0%. There are two main reasons for this difference. First, the states of Lower Saxony and Schleswig-Holstein, both part of region H, bordered the Soviet zone of occupation, and, therefore, also received a disproportionately large share of migrants from what was to become the German Democratic Republic. Second, the number of civilian casualties was lower in rural areas than in urban areas, and therefore many city dwellers, especially from Bremen and Hamburg, were

[33]The correlation coefficient between sales per capita in 1935 and national income per capita in 1936 is 0.92 for the 19 regions of the German Reich, for which both types of data are available. And for 1950, the correlation coefficient between sales and GDP of the nine West German states is 0.99.

evacuated to more rural areas during the war.

Since we consider only the expellee inflow and endogenous regional migration as a sources of population change, we calibrate the model to an adjusted relative population of the two regions in 1939. The adjustment adds to the 1939 population of each region the residual population change between 1939 and 1950 that cannot be accounted for by the expellee inflow. We calculate the residual as the difference between the historical population change between 1939 and 1950 and the inflow of expellees. The adjusted relative population of region H is 54.4%.

A.4 Alternative regional data classification

This section shows that empirical facts are robust to the use of an alternative classification of federal states that levels out pre-existing differences between the high- and the low-inflow region. The alternative classification excludes Bremen, Hamburg, and North Rhine-Westphalia from region L, as these three states are responsible for the differences in agricultural employment and the degree of war damage that we observe for regions H and L (see Table 1).[34] In what follows, we will refer to the resulting geographical entity, which consists of Baden-Württemberg, Hesse, and Rhineland-Palatinate, as region L'. We will refer to the excluded states of Bremen, Hamburg, and North Rhine Westphalia as (L-L') region.[35]

Table 1 illustrates that regions H and L' are very similar not only in terms of pre-war population growth and unemployment but also in terms of agricultural employment and war damage. The agricultural employment share in region L' was only slightly lower than in region H in 1939 (32.1% vs. 36.5%). Likewise, the share of destroyed flats, our measure of wartime damage, was virtually identical in the two regions (12.1% and 12.8%). While regions H and L' were thus similar in their pre-war economic structure and their degree of war damage, region L' experienced a much smaller expellee inflow than region H (12.6% vs. 25.0%). The main problem with using the alternative classification is that it excludes almost one-third of the West German population.

Figure A1 shows that the empirical facts presented in Section 3 also prevail, at least quali-

[34] North Rhine-Westphalia comprises the Ruhr region, Germany's pre-war industrial center. Therefore, only 14.1% of North Rhine-Westphalia's labor force was in agriculture before the war (compared to a national average of 27.0%). North Rhine-Westphalia is not only highly industrialized but also highly urbanized and thus suffered over-proportionally from war damage. The same is true for the city states of Bremen and Hamburg, which comprise only urban areas, and had almost no agriculture in 1939.

[35] This alternative classification thus divides West Germany into three regions. In our two-region model, we treat migration between regions H and L' as endogenous. To account for net migration flows between region H and (L-L'), however, we treat them as exogenous and subsume them into X_t. Thus, X_t takes non-zero values also after the expellee inflow in $t = 0$. Likewise, we subsume flows between regions L' and (L-L') into $X_t^\star$.

tatively, when we compare the demographic and economic development of the H region to the L' region rather than to the L region. As before, we consider relative population, relative GDP per capita, and unemployment rates. On labor force participation, we use the same time series as in our baseline classification, since participation data is only available at the national level.

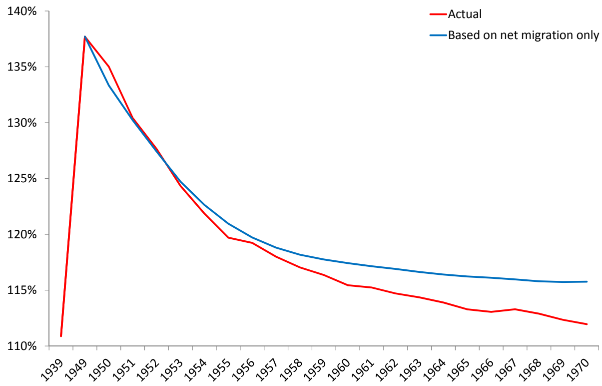
Panel (a) shows the population size of region H relative to region L' from 1939 to 1970 (red line). The graph also shows how the relative population size of the two regions would have evolved if the only reason for changes in the relative population size was regional migration within Germany (blue line). The relative population of H to L' increased markedly from 110.8% in 1939 to 137.7% at the end of 1949. It then gradually came down again and almost, but not completely, reached its pre-inflow value in 1970. Most of the fall in relative population took place in the early- to mid-1950s. The blue line shows that inner-German migration is responsible for most of the change in relative population in the 1950s (but not thereafter).

Panel (b) shows GDP per capita of region H relative to region L' between 1950 and 1970. Relative GDP per capita reached a trough in 1952, when GDP per capita in region H reached 83.3% of the level of region L'. The gap between the two regions then narrowed markedly in the 1950s, and relative GDP per capita stood at 88.5% in 1960. The 1960s saw no further improvement in region H's relative GDP per capita. If anything, the gap to region L' widened again. Unfortunately, we do not have a good measure of relative GDP per capita before the war. We can, however, again look at sales per capita between 1935 and 1955 (we discuss the pros and cons of using sales per capita as a proxy for production in Appendix A.2). Sales per capita of region H relative to region L' fell from 86.6% in 1935 to 77.6% in 1950, and then increased to 82.3% in 1955.

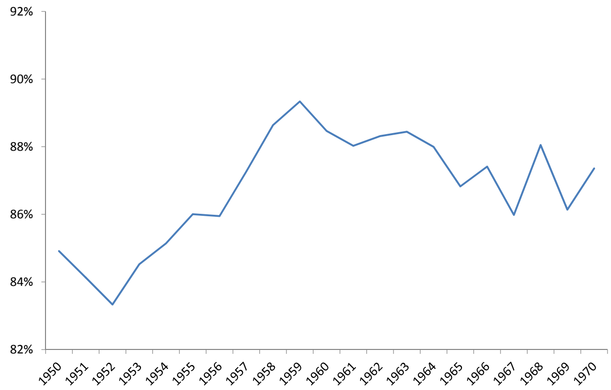
Panel (c) gives the unemployment rates of regions H and L' in 1938 and between 1950 and 1963. At 1.6%, unemployment rates of the two regions were identical before the war. Both regions then experienced a drastic increase in unemployment, which, however, was much more pronounced in H than in L'. In 1950, the unemployment rate was 16.7% in region H but only 6.8% in region L'. Unemployment then gradually decreased during the 1950s and regional unemployment rates were nearly identical by the beginning of the 1960s.

Overall, comparing the demographic and economic development of regions H and L' yields empirical facts that are very similar to those obtained by comparing region H and L. Nevertheless, two differences stand out. First, the population of H continues to fall in the 1960s relative to L' but not relative to L. The decline is, however, relatively modest compared to the decline in the

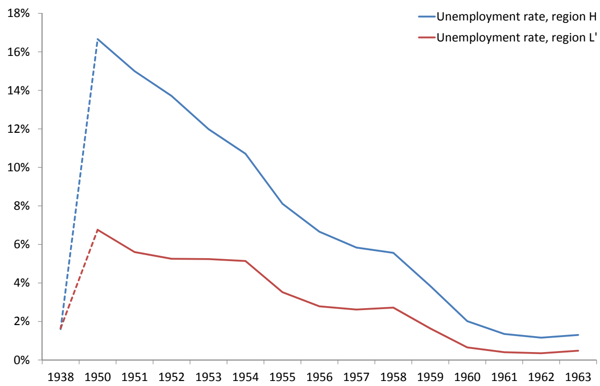
Figure A1: Empirical facts for region H and region L’



(a) Relative population H over L’, 1939-70



(b) Relative GDP per capita H over L’, 1950-70



(c) Unemployment rate in H and L’, 1938-63

Sources: Institut für Raumforschung, Statistisches Bundesamt, Länderrat des Amerikanischen Besatzungsgebiets (1949), Bundesanstalt für Arbeitsvermittlung und Arbeitslosenversicherung. See the notes on the corresponding Figures in Section 3 for details.
Notes: The population series in Panel (a), which is based on migration only, is calculated by adding to the actual population figure of the H and L’ region on 31 December 1949 (cumulated) net migration between the two regions. The unemployment rate in Panel (c) is expressed as a percentage of the dependent labor force. The unemployment rate of region H in 1938 is approximated by the (labor force-weighted) average of the 1938 unemployment rates of Bavaria, Lower Saxony, and the Nordmark. The unemployment rate of region L’ is approximated by the average of the unemployment rates of Hesse and Southwest Germany.

1950s and due to factors other than inner-German migration. Second, the catch-up in GDP per capita of region H is more pronounced when measured relative to region L than relative to L’. This might partly be due to the fact that the initial gap in GDP per capita between H and L is larger than between H and L’.

B Empirical evidence on the short-run wage effect of expellees

The short-run wage elasticities in our calibrated model are between -0.12 and -0.16. These elasticities are somewhat smaller–or the adverse wage effects of immigration somewhat larger–than most estimates in the literature. In fact, many studies–but by no means all–find the wage effects of immigration to cluster around zero. This section shows that the short-run wage elasticities in our calibrated model are broadly consistent with empirical evidence on the short-run effects of the expellee inflow.

Unfortunately, we do not know of any time series data on regional wage income in West Germany for the period of our analysis. Therefore, we cannot present empirical evidence on the evolution of regional wages in 1939-70 (akin to the other empirical facts in Section 3.2). Instead, we provide descriptive evidence on the short-run effects of the expellee inflow on wage earnings. We use data on weekly earnings of male blue- and white-collar workers in trade and industry from a large-scale survey conducted by the German Statistical Office in 1951 (Statistisches Bundesamt 1954b, Statistisches Bundesamt 1954c).[36] Based on employees' tasks and level of responsibility, the data groups white-collar workers into five performance groups and blue-collar workers into three performance groups. The data is further stratified by sector and federal state.

Let w_{ijkl} denote average weekly earnings of male employees in a labor market cell defined by occupational category i (either blue- or white-collar), performance group j, sector k, and federal state l. We stack the data across all labor market cells and estimate variants of the following regression model:

$$log(w_{ijkl}) = \beta m_{ikl} + \gamma_i + \delta_j + (\gamma_i \times \delta_j) + \upsilon_k + \phi_l \eta + \varepsilon_{ijkl}, \tag{15}$$

where m_{ikl} is the share of expellees among all male employees in cell (i,k,l) in September 1950 (as published in Statistisches Bundesamt (1952a)), γ_i is a dummy for blue-collar workers, δ_j is a vector of performance group dummies, υ_k is a vector of sector dummies, ϕ_l is a vector of state-specific control variables, and ε_{ijkl} is the error term.

Following Braun and Mahmoud (2014), state-specific controls include the share of housing units destroyed in the war, the 1939 share of agricultural workers, and a dummy for the city states Bremen and Hamburg. The share of destroyed housing captures war-related capital destruction and the availability of housing, which, in turn, affected the regional distribution of expellees (see Section 2). The 1939 share of workers in agriculture measures the importance of agriculture for a state and should correlate with pre-war economic development. Finally, a dummy variable captures the specific circumstances of the city states Bremen and Hamburg, which were both largely destroyed in the war and hosted relatively few expellees. In an alternative specification,

[36] The data surveyed 318,851 white-collar employees and 928,652 blue-collar employees. The data did not survey employees in agriculture and in the public sector.

we replace state-specific controls by a full set of state dummies to remove all (observed and unobserved) heterogeneity between states.

The linear fixed effects for blue collar worker, performance groups, and sectors control for systematic wage differences across occupational categories, performance groups, and sectors. The interaction between blue collar workers and performance groups allows for the possibility that wage differences across performance groups are not the same for blue- and white-collar workers. We run both unweighted and weighted regressions (where the sample sizes used to construct the average wage in a labor market cell serve as weights).

The results are in Panel A of Table A2. The result of the unweighted regression with state-specific controls in column (1) implies that a one percentage point increase in the expellee share in a labor market cell decreases wages in the same cell by 0.191%. This coefficient can be converted to a wage elasticity, defined as the percent change in wages associated with a 1% immigration-induced change in labor supply, by multiplying the coefficient estimate by $(1 - m_{ikl})^2$ (as shown by Borjas (2003)). Since the share of expellees in the male labor force was 16.1% in 1950, the elasticity implied by the regression result in column (1) is about -0.134 ($= -0.191(1 - 0.161)^2$). This is remarkably close to the short-run wage elasticities in our model. The estimated wage elasticity increases to -0.214 ($= -0.304(1 - 0.161)^2$) when we add a vector of state dummies to the regression. The coefficient estimates obtained in the weighted regression in columns (3) and (4) are generally slightly larger than those obtained in the unweighted regressions.

In an additional robustness check, we consider average weekly earnings of male employees in a occupational category-sector-state cell across all performance groups as the dependent variable, rather than stratifying wages also by performance groups. Unlike in equation (15), average wages and expellee shares are then measured at the same level of aggregation (we do not have data on the share of expellees by performance group). We then estimate the following regression:

$$log(w_{ikl}) = \beta m_{ikl} + s_{ikl}\psi + \gamma_i + \upsilon_k + \phi_l \eta + \varepsilon_{ijkl}, \qquad (16)$$

where s_{ikl} is a vector of control variables indicating the share of workers in labor market cell (i,k,l) belonging to the different performance groups.

The results of estimating equation (16) are in Panel B of Table A2. Again, we do find strong evidence for a negative effect of the expellee inflow on wages. The coefficient estimates are somewhat larger than those reported in Panel A in the unweighted regressions but somewhat

Table A2: Short-run wage effects of expellees

	Dependent variable: Log weekly earnings			
	Panel A: Stacked performance groups			
	(1)	(2)	(3)	(4)
Expellee Share	-0.191***	-0.304**	-0.293**	-0.344**
	(0.073)	(0.129)	(0.124)	(0.164)
State controls	yes	-	yes	-
State fixed effects	no	yes	no	yes
Weighted regression	no	no	yes	yes
N	381	381	381	381
R2	0.929	0.931	0.858	0.866
	Panel B: Averaged across performance groups			
	(1)	(2)	(3)	(4)
Expellee Share	-0.240**	-0.409**	-0.213***	-0.200
	(0.0945)	(0.187)	(0.0763)	(0.191)
State controls	yes	-	yes	-
State fixed effects	no	yes	no	yes
Weighted regression	no	no	yes	yes
N	99	99	99	99
R2	0.888	0.896	0.936	0.942

Notes: ***,** denote statistical significance at the 1%- and 5%-level, respectively. Robust standard errors are in parentheses. All regressions include a dummy for blue-collar workers and a vector of sector dummies. Regressions in Panel A include a vector of performance group dummies and interactions between the blue collar dummy and the performance group dummies. Regressions in Panel B include a set of control variables that indicate the labor market cell's share of workers in the different performance groups. Regressions in (3) and (4) are weighted by the sample sizes used to construct the average wage in a labor market cell.

smaller in the weighted regressions. Overall, however, the differences between the two sets of regressions in Panel A and B are small.

Across all eight specifications in Panel A and B, we do find an average wage elasticity of -0.191 (with estimates ranging from -0.134 to -0.288). The wage elasticity in our model is thus at the higher range of our empirical estimates. If anything, the adverse wage effects in our model may thus be considered a conservative estimate of the true effect.

C Model derivation and calibration

C.1 Labor market stocks and flows

Substitutions. Equations (1) to (4) can be condensed by substituting out for M_t and R_t. Rearranging labor force as $L_t = N_t + U_t = P_t - R_t$ and substituting for R_t using equation (2) yields

$$L_t = P_t - (1-\pi_t)[P_{t-1} + X_t - (1-\lambda)N_{t-1}] \ . \tag{17}$$

Also, substituting for R_t in equation (3) and rearranging yields

$$G_t = \gamma_t \pi_t [P_{t-1} + X_t - (1-\lambda)N_{t-1}] \ . \tag{18}$$

To substitute for M_t in equation (4), use the job-finding rate $\phi_t = M_t/(M_t + U_t)$ and the identity $P_t = N_t + U_t + R_t$. This yields $N_t = (1-\lambda)N_{t-1} + \phi_t(M_t + P_t - N_t - R_t)$. Substituting for R_t using equation (2) and for $M_t - N_t$ using equation (4) yields

$$N_t = (1-\lambda)(1-\pi_t\phi_t)N_{t-1} + \phi_t[P_t - (1-\pi_t)(P_{t-1} + X_t)] \ . \tag{19}$$

Equations (1), (17) to (19) and $L_t = N_t + U_t$ jointly determine P_t, L_t, G_t, N_t and U_t given $G_t^\star$, initial conditions, exogenous expellee inflow X_t, and transition probabilities. The stock flow system that describes the labor market in region L can be derived using analogous steps.

Transformations. Variables P_t, L_t, G_t, N_t and U_t evolve in a potentially non-stationary way. To solve the model, we transform these variables so that they evolve in a stationary way. Transformations are $p_t = P_t/P_{t-1}$, $n_t = N_t/P_t$, $g_t = G_t/P_t$, $\ell_t = L_t/P_t$, $u_t = U_t/L_t$. We also define relative population as $rp_t = P_t/P_t^\star$, which can be rearranged as $rp_t/rp_{t-1} = p_t/p_t^\star$. Furthermore, we transform regional expellee inflows as follows:

$$x_t = \frac{X_t}{P_t + P_t^\star} \ , \ x_t^\star = \frac{X_t^\star}{P_t + P_t^\star} \ .$$

This transformation ensures that x_t and $x_t^\star$ are exogenous, as is the case for X_t and $X_t^\star$. Transformed equations are shown in Appendix C.5.

C.2 Value functions

We use the migration probability γ_t and the definition of $\bar{\mu}_t$ in the main text to rewrite the inner max operator in values (5) and (6), denoted by $\mathcal{M}_{t+1}$, as

$$\mathcal{M}_{t+1} = (1-\gamma_{t+1})\big[\phi_{t+1}W_{t+1} + (1-\phi_{t+1})Q_{t+1}\big] + \gamma_{t+1}\big[\phi_{t+1}^\star W_{t+1}^\star + (1-\phi_{t+1}^\star)Q_{t+1}^\star - \bar{\mu}_{t+1}\big].$$

Furthermore, we use the participation probability π_t, the definition of $\bar{h}_t$ in the main text, and equation (7) to rewrite the outer max operator in values (5) and (6) as

$$E_h \max[H_{t+1}(h)\ , \mathcal{M}_{t+1}] \quad = \quad (1-\pi_{t+1})\big[\bar{h}_{t+1} - z + Q_{t+1}\big] + \pi_{t+1}\mathcal{M}_{t+1}. \tag{20}$$

Then, we combine the equation for $\mathcal{M}_{t+1}$ and equation (20) to rewrite values (5) and (6) in terms of transition probabilities. This yields

$$\begin{aligned} W_t = w_t + (1-\lambda)\beta W_{t+1} \quad &+ \quad \lambda\beta(1-\pi_{t+1})\big[\bar{h}_{t+1} - z + Q_{t+1}\big] \\ &+ \quad \lambda\beta\pi_{t+1}(1-\gamma_{t+1})\big[\phi_{t+1}W_{t+1} + (1-\phi_{t+1})Q_{t+1}\big] \\ &+ \quad \lambda\beta\pi_{t+1}\gamma_{t+1}\big[\phi^{\star}_{t+1}W^{\star}_{t+1} + (1-\phi^{\star}_{t+1})Q^{\star}_{t+1} - \bar{\mu}_{t+1}\big]\ , \end{aligned} \tag{21}$$

$$\begin{aligned} Q_t = z \quad &+ \quad \beta(1-\pi_{t+1})\big[\bar{h}_{t+1} - z + Q_{t+1}\big] + \beta\pi_{t+1}(1-\gamma_{t+1})\big[\phi_{t+1}W_{t+1} + (1-\phi_{t+1})Q_{t+1}\big] \\ &+ \quad \beta\pi_{t+1}\gamma_{t+1}\big[\phi^{\star}_{t+1}W^{\star}_{t+1} + (1-\phi^{\star}_{t+1})Q^{\star}_{t+1} - \bar{\mu}_{t+1}\big]\ . \end{aligned} \tag{22}$$

Using critical levels to simplify value functions. To transform equations (21) and (22) into values (25) and (26), we first use equation (8) to replace the value of searching for a job in region L, $\phi^{\star}_{t+1}W^{\star}_{t+1} + (1-\phi^{\star}_{t+1})Q^{\star}_{t+1}$, by the critical level of migration costs μ^c_{t+1} and the value of searching for a job in region H. Simplifying terms yields

$$\begin{aligned} W_t \quad &= \quad w_t + \beta W_{t+1} - \lambda\beta(1-\pi_{t+1}\phi_{t+1})[W_{t+1} - Q_{t+1}] + \lambda\beta(1-\pi_{t+1})[\bar{h}_{t+1} - z] \\ &+ \quad \lambda\beta\pi_{t+1}\gamma_{t+1}[\mu^c_{t+1} - \bar{\mu}_{t+1}]\ , \end{aligned} \tag{23}$$

$$\begin{aligned} Q_t \quad &= \quad z + \beta Q_{t+1} + \beta\pi_{t+1}\phi_{t+1}[W_{t+1} - Q_{t+1}] + \beta(1-\pi_{t+1})[\bar{h}_{t+1} - z] \\ &+ \quad \beta\pi_{t+1}\gamma_{t+1}[\mu^c_{t+1} - \bar{\mu}_{t+1}]\ . \end{aligned} \tag{24}$$

Second, we use equation (9) to replace the term $[\bar{h}_{t+1} - z]$ in these value functions by $[\bar{h}_{t+1} - h^c_{t+1} + \phi_{t+1}(W_{t+1} - Q_{t+1}) + \gamma_{t+1}(\mu^c_{t+1} - \bar{\mu}_{t+1})]$. Collecting terms yields

$$\begin{aligned} W_t \quad &= \quad w_t + \beta W_{t+1} - \lambda\beta(1-\phi_{t+1})(W_{t+1} - Q_{t+1}) + \lambda\beta(1-\pi_{t+1})(\bar{h}_{t+1} - h^c_{t+1}) \\ &\quad\ + \lambda\beta\gamma_{t+1}(\mu^c_{t+1} - \bar{\mu}_{t+1})\ , \end{aligned} \tag{25}$$

$$\begin{aligned} Q_t \quad &= \quad z + \beta Q_{t+1} + \beta\phi_{t+1}(W_{t+1} - Q_{t+1}) + \beta(1-\pi_{t+1})(\bar{h}_{t+1} - h^c_{t+1}) \\ &\quad\ + \beta\gamma_{t+1}(\mu^c_{t+1} - \bar{\mu}_{t+1})\ , \end{aligned} \tag{26}$$

where $\bar{h}_t$ is the expected home benefit conditional on non-participation, i.e., $\bar{h}_t = E_h[h|h \geq h_t^c]$.

C.3 Transition probabilities and conditional expectations

Assuming that migration costs are uniformly distributed with cdf Γ over $[0, a]$ with $a > 0$ yields

$$\gamma_t = \min[\max[0,\ \mu_t^c/a],\ 1]\ . \tag{27}$$

Uniform Γ also yields a closed form solution for conditional expected migration costs:

$$\bar{\mu}_t = \min[\max[0,\ \mu_t^c/2], 1]\ . \tag{28}$$

Home benefits that are uniformly distributed with cdf Ξ over $[e_0, e_1]$ with $e_0 < e_1$ imply

$$\pi_t = \min[\max[0,\ \frac{h_t^c - e_0}{e_1 - e_0}],\ 1]\ . \tag{29}$$

Distribution Ξ also yields a closed form solution for conditional expected home benefits:

$$\bar{h}_t = \max[e_1 + e_0,\ e_1 + h_t^c]/2\ . \tag{30}$$

We also used non-uniform distributions for Γ and Ξ but never found them to improve model fit significantly.

C.4 Firms' first-order optimality conditions

The firm's profit maximization problem yields the following first-order optimality conditions:[37]

$$J_{jt} = F_{Njt} - w_t - C_{Njt} + (1-\lambda)\beta J_{jt+1}\ , \tag{31}$$

$$J_{jt} = C_{Vjt}/q(\theta_t)\ , \tag{32}$$

$$\psi_{jt} = \beta F_{Kjt+1} + (1-\delta)\beta\psi_{jt+1}\ , \tag{33}$$

$$1 = \psi_{jt}\big[1 - B_{jt} - (I_{jt}/I_{jt-1})B'_{jt}\big] + \beta\psi_{jt+1}(I_{jt+1}/I_{jt})^2 B'_{jt+1}\ . \tag{34}$$

Lagrange multiplier ψ_{jt} denotes the value of one extra unit of capital, and multiplier J_{jt} denotes the value of one extra worker. Iterating equation (31) forward yields $J_{jt} = \sum_{k=0}^{\infty}[(1-\lambda)\beta]^k[F_{Njt+k} - w_{t+k} - C_{Njt+k}]$. Thus, J_{jt} is the change in the firm's market value from hiring

[37] Here, $C_{Vjt} = \partial C_t/\partial V_{jt}$, $C_{Njt} = \partial C_t/\partial N_{jt}$, $F_{Kjt+1} = \partial F(K_{jt}, N_{jt+1})/\partial K_{jt}$, $F_{Njt} = \partial F(K_{jt-1}, N_{jt})/\partial N_{jt}$, $B_{jt} = B(I_{jt}/I_{jt-1})$, and $B'_{jt} = \partial B(I_{jt}/I_{jt-1})/\partial(I_{jt}/I_{jt-1})$.

an extra worker. Equation (32) sets this "value of a job" equal to the expected costs of hiring one worker. These costs consist of marginal vacancy posting costs times the expected duration, $1/q(\theta_t)$, to fill a vacancy.

Iterating equation (33) forward yields $\psi_{jt} = \beta \sum_{k=0}^{\infty}[(1-\delta)\beta]^k F_{Kjt+k+1}$ and shows that the multiplier, i.e., the firm's marginal q, equals the change in the firm's market value from one extra unit of capital. Equation (34) sets the marginal costs of one extra unit of investment equal to the marginal value of installing this investment. In symmetric equilibrium, we employ the transformations $i_t = I_t/P_t$ and $k_t = K_t/P_t$ to solve the model.

C.5 Model equations

We consider an equilibrium with symmetric firms within each region and thus $V_t = V_{jt}, N_t = N_{jt}, I_t = I_{jt}, K_t = K_{jt}, J_t = J_{jt}$ and $\psi_t = \psi_{jt}$. We solve the model numerically using the deterministic extended path algorithm of Fair and Taylor (1983), as implemented in Adjemian, Bastani, Karamé, Juillard, Maih, Mihoubi, Perendia, Ratto, and Villemot (2018). This algorithm assumes perfect foresight and accounts for permanent shifts in variables and nonlinearities in the model.

With neither expellee inflow nor migration, population in region H is constant and hence its gross growth rate p equals one. No migration also implies a zero migration probability γ. Furthermore, full labor force participation in steady state, $\ell = 1$, requires that the maximum home benefit e_1 must not exceed h^c and hence we set $e_1 = h^c$. Full participation also yields a participation probability π of one.

To solve for the steady state, we target several variables and solve for parameters instead (see Section 5.2). Targets, which are marked by a bar, are $y = \bar{y},\ u = \bar{u},\ n = 1 - \bar{u},\ q = \bar{q}$. Equations belonging to firm's problem in Appendix C.5 yield $i = \delta k$, $\psi = 1$, $B = 0$, $B' = 0$ and

$$
\begin{aligned}
F_N &= \chi y/n \ , \\
F_K &= 1/\beta - (1-\delta) \ , \\
k &= (1-\chi)y/F_K \ , \\
A &= y/(k^{1-\chi} n^{\chi}) \ .
\end{aligned}
$$

The job-finding rate follows from the law of motion for employment, $\phi = \lambda n/(1-(1-\lambda)n)$. Firm equations further imply that $\theta = \phi/q$, $\Omega = q\theta^{\xi}$ and $C_N = 0$, which follows from $\kappa_0 = \kappa_1$ (see Section 5.2).

To solve for $C_V/q = \kappa_1/\lambda$, we determine κ_1 using the calibrated replacement ratio $z/w = R_z$. In particular, we combine the surplus-sharing rule $W - Q = \frac{\alpha}{1-\alpha} J$ with the job creation condition and the net value of work to obtain

$$
\begin{aligned}
w &= F_N - C_N - (1-(1-\lambda)\beta) J \ , \\
z &= w - (1-\beta(1-\lambda)(1-\phi)) \frac{\alpha}{1-\alpha} J \ .
\end{aligned}
$$

Then, we use $J = C_V/q$ to replace J, and $z = R_z w$ to replace z in these equations. Substituting for the wage yields $(1-\beta(1-\lambda)(1-\phi))\frac{\alpha}{1-\alpha} C_V/q = (1-R_z)[F_N - (1-(1-\lambda)\beta) C_V/q]$. We further substitute $C_V/q = \kappa_1/\lambda$ and solve for κ_1. This yields

$$
\kappa_1 = \frac{\lambda(1-R_z)F_N}{(1-\beta(1-\lambda)(1-\phi))\frac{\alpha}{1-\alpha} + (1-R_z)(1-(1-\lambda)\beta)} \ .
$$

From this, we obtain

$$\begin{aligned} J &= C_V/q \ , \\ W - Q &= \frac{\alpha}{1-\alpha} J \ , \\ w &= F_N - (1 - (1-\lambda)\beta) J \ . \end{aligned}$$

The equations in Appendix C.5 that belong to value functions imply

$$\begin{aligned} W &= (1-\beta)^{-1}[w - \lambda\beta(1-\phi)(W-Q)] \ , \\ Q &= (1-\beta)^{-1}[z + \beta\phi(W-Q)] \ , \\ h^c &= z + \phi(W-Q) \ , \\ \bar{h} &= \max[e_1 + e_0, e_1 + h^c]/2 \ . \end{aligned}$$

In steady state, regions are symmetric in per capita variables and hence $W = W^\star$, $Q = Q^\star$, $\mu^c = \bar{\mu} = 0$ and $\mu^{c^\star} = \bar{\mu}^\star = 0$.

C.7 Comparison of propensity parameter values to existing estimates

This subsection discusses the plausibility of calibrated propensity parameters in light of the existing literature. The propensity to participate e_0 that minimizes distance D is equal to 0.33 and implies a long-run labor supply elasticity at the extensive margin with respect to the real wage, $d\log(L/P)/d\log w$, of 0.14.[38] The value is at the lower range of existing estimates. In a meta-study of nine quasi-experimental studies, Chetty, Guren, Manoli, and Weber (2012) find a steady-state elasticity at the extensive margin of 0.25, with estimates ranging from 0.13 to 0.43. The authors also survey four macro studies that exploit cross-country variation in tax rates to estimate labor supply elasticities and find a mean steady-state elasticity of 0.17. This is very close to the long-run labor supply elasticity implied by our calibration of e_0.

Furthermore, we obtain a propensity to migrate $1/a$ of 0.065. This parameter implies that conditional migration costs $\bar{\mu}_t = E_\mu[\mu|\mu < \mu_t^c]$, which correspond to the average migration costs of those workers who actually move between regions, are equal to 10.4% of annual steady-state wage income when measured at the time of the expellee inflow. Lkhagvasuren (2012) reports

[38] In the model, this elasticity refers only to endogenous variables. Therefore, we consider a permanent reduction in exogenous aggregate productivity, which reduces w_t by 1% and also reduces L_t/P_t. In the short run, the reduction in L_t/P_t depends on many, if not all, model parameters, but it depends on only e_0 in the long run.

very similar moving costs equal to one-tenth of annual labor income. He obtains this value by targeting the gross mobility rate in US regional data in a multi-location migration model. Bayer and Juessen (2012) report higher costs of moving between US states of around two-thirds of an average annual household income.

Finally, we obtain a propensity of firms not to adjust employment κ_2 of 5.06. This parameter determines the elasticity of average costs per worker to (non-infinitesimal) deviations of the hiring rate $q_t\nu_t$ from its steady-state value λ.[39] This elasticity is equal to 1.43. We can use the value of this elasticity to back out the degree of cost convexity implied by our calibration for the alternative cost function $\kappa_0(q_t\nu_t/\lambda)^{\kappa_3}$, which is often estimated in related work.[40] This approach yields a value for the degree of convexity of the alternative cost function, κ_3, equal to 1.39. Mumtaz and Zanetti (2015) derive a DSGE model with EACs that depend on the hiring rate and estimate a degree of cost convexity of 1.16, which is close to the value implied by our calibration. Overall, therefore, our three calibrated propensity parameters are in line with existing estimates in the literature.

C.8 Calibrating job-filling rates

The job-filling rate equals the ratio of job-finding rate over labor market tightness, i.e., $q(\theta_t) = \phi_t/\theta_t$. As data on gross worker flows is not available for the historical time period, we follow Shimer (2005) and infer the job-finding rate from aggregate data on employment, unemployment and short-term unemployment. Let u_t be the number of workers unemployed at the end of month t (in contrast to the rest of the paper, t refers to a month rather than to a quarter in this appendix), and let u_t^N be the number of workers unemployed for less than one month at the end of the same month. Finally, let ϕ_t denote the probability of an unemployed worker finding a job during month t. If we further assume that no unemployed worker exits the labor force, the unemployment rate evolves according to

$$u_{t+1} = (1 - f_{t+1})u_t + u_{t+1}^N. \tag{35}$$

[39] With $\kappa_0 = \kappa_1$, we obtain that the elasticity $\frac{(C_t/N_t - C/N)/(C/N)}{(q_t\nu_t - \lambda)/\lambda} = \frac{(\exp[\kappa_2(q_t\nu_t - \lambda)/\lambda] - 1)/\kappa_2}{(q_t\nu_t - \lambda)/\lambda}$ and thus, for a given change in the hiring rate, is indeed determined by κ_2.

[40] The elasticity is $[(q_t\nu_t/\lambda)^{\kappa_3} - 1]/[(q_t\nu_t - \lambda)/\lambda]$ and, hence, determined by κ_3 (for a given change in the hiring rate).

The job-finding probability ϕ_t is given by

$$f_{t+1} = 1 - \frac{u_{t+1} - u_{t+1}^N}{u_t}. \tag{36}$$

Unfortunately, the German Federal Employment Agency does not provide data on short-term unemployment for the historical time period. However, it does provide data on total inflows into unemployment during a month, I_t. When a worker enters the unemployment pool, she has, on average, half a month to leave the unemployment pool before she is recorded as short-term unemployed at the end of the month. The number of short-term unemployed at the end of month t can then be approximated by $(1 - 0.5\phi_t)I_t$, and the job-finding probability can be expressed as:

$$\phi_{t+1} = \frac{u_t + I_{t+1} - u_{t+1}}{u_t + 0.5I_{t+1}}. \tag{37}$$

We use monthly West German data from July 1950 to December 1970 to calculate the job-finding probability for every month. Data is taken from various issues of the German Federal Employment Agency's *Amtliche Nachrichten*. Note that from September 1955 onwards, the employment agency records inflows into the pool of job seekers instead of inflows into unemployment. Therefore, we use data on job seekers to calculate the job-finding probability for this time period. The data indicate that the average monthly job-finding probability was 0.50.

Moreover, data from the German employment agency also indicates that between 1950 and 1970, the average monthly vacancy-unemployment rate in West Germany was 2.20. We thus approximate the quarterly job-filling rate as $(3 \times 0.50)/2.20 \approx 0.68$.

C.9 Imposing parameter bounds in the calibration

We allow the inverse propensity to migrate a to vary within $a \in (0, \bar{a})$, with $\bar{a}$ approaching ∞. We impose these bounds in the parameter estimation by computing a from $a = \bar{a}/(1+\exp(-\tilde{a}))$, where we optimize $\tilde{a}$ over the range $[-\infty, \infty]$ and set $\bar{a} = 100$. We use the same approach for $\kappa_2 \in (0, 400)$. Bounds on the propensity to participate correspond to $e_0 \in (-\infty, e_1)$. We impose the upper bound by computing e_0 from $e_0 = e_1 - 1/\exp(\tilde{e}_0)$, where we optimize $\tilde{e}_0$ over $[-\infty, \infty]$.

D Robustness checks

This section tests how plausible changes to our baseline calibration affect the model fit, the values of propensity parameters, and the effects of the expellee inflow on native income and employment. The robustness checks focus, in particular, on pre-existing differences between regions H and L that we have not incorporated in our baseline calibration. Robustness checks show that changes to our baseline calibration can slightly improve the model fit but typically have no marked effect on calibrated propensity parameters and also have no income and employment effects. If anything, we find that the adverse effects on native income and employment in our baseline calibration are conservative estimates.

We conduct five robustness checks and report for each check our distance measure of model fit, the calibrated propensity parameters, the treatment effect on native income (in %), and the minimum effect on native employment in region H along the adjustment path (for any ten expellees who arrive in region H). All statistics are in Table A3, along with the initial conditions on regional capital stocks and productivity (the first panel recalls the corresponding results for the baseline calibration).

A. Asymmetric initial capital stocks. Our baseline calibration abstracts from regional differences in war-related damage to the capital stock. However, such differences might provide an alternative explanation, other than asymmetric expellee inflows, for the regional adjustment dynamics observed historically. Robustness check A., therefore, accounts for regional differences in war damage, and sets initial regional capital stocks in region H and L to 88% and 77% of their steady-state values, respectively.[41]

Asymmetric initial capital stocks worsen model fit (see Panel A. of Table A3). Since region H suffered less from damage than region L (see Section 3), regional differences in war damage increase *ceteris paribus* relative GDP per capita in region H and generate regional migration from L to H. This is at odds with the empirical facts, such as migration from region H to region L, hence making it more difficult for the model to fit the data. Importantly, regional differences in capital destruction reduce the effects of expellees on native income and employment only marginally.

[41] We calculate these initial regional capital stocks by using the fact that damage d of the nationwide capital stock is a weighted sum of damage of regional capital stocks, i.e., $d(K + K^\star) = d_H K_{-1} + d_L K^\star_{-1}$. We transform this equation into per capita terms and solve it for d_H using the observation that $d_L = 2d_H$, which follows from the historical data on regional war damage in Table 1. This yields $d_H = d(1 + P_{-1}/P^\star_{-1})/(2 + P_{-1}/P^\star_{-1})$. Our calibration implies $d = 0.19$ and $P_{-1}/P^\star_{-1} = 0.544$.

B. Regional productivity gap. Our baseline calibration also abstracts from regional productivity differences. However, catch-up in productivity between regions H and L might be a plausible alternative explanation for the catch-up in GDP per capita that we observe in the data. Robustness check B., therefore, mimics productivity catch-up in the model by introducing a time-varying productivity shock A_t in region H, keeping productivity $A^{\star}$ in region L constant.

Unfortunately, reliable regional productivity data are unavailable for the historical time period but have to be inferred under strong assumptions (which is why we do not consider productivity differences in the baseline calibration). We use data reported in Waidlein (2013) and set the initial value of the productivity shock equal to the gap in total factor productivity between region H and L in 1950, normalized by the corresponding 1963 value.[42] This yields that initial productivity in region H is 5.2% lower than in region L. We assume that this gap closes linearly until 1963.

Regional productivity catch-up significantly increases model fit (see Panel B. of Table A3), because the negative productivity shock in region H constitutes another – and relatively persistent – motive for regional migration. Therefore, relative population declines more strongerly and thus moves closer to the data than in the baseline calibration. The migration propensity declines significantly from 0.065 to 0.037, since a lower migration propensity is now sufficient for the model to match the regional migration data. The effect on native income decreases from -1.38% to -1.75%, because productivity in region H is now temporarily lower than in the baseline. Firms in this region thus pay lower wages and have less incentive to hire new workers.

C. Alternative data classification. Robustness checks A. and B. directly incorporate regional differences into the model. Robustness check C., in contrast, maintains the symmetry assumption of the baseline calibration but uses an alternative data classification of federal states. This alternative classification levels out pre-existing differences in both the degree of industrialization and in war damage. It excludes Bremen, Hamburg and North Rhine-Westphalia from region L, as these three states are responsible for the observed pre-existing differences between regions H and L (see Table 1). Appendix A.4 documents the empirical facts for the alternative classification and shows that they are qualitatively similar to the facts for the baseline

[42]Waidlein (2013) reports data on two measures of total factor productivity for German states. We aggregate the data to the level of our regions H and L, using population as weights, and take the average of the two measures. Given data constraints, exact values should be interpreted cautiously. For instance, Waidlein (2013) has to approximate regional capital stocks from nationwide capital stocks and regional industry employment, as there exists no regional capital data before 1960.

classification.

The model fit improves considerably if we use the alternative classification of regions (see Panel C. of Table A3), and calibrated propensity parameters remain surprisingly close to the baseline calibration. The same is true of the effect of the expellee inflow on native income and employment. The income effect remains virtually unchanged despite the fact that significantly fewer native workers migrate endogenously from the high- to the low-inflow region than in the baseline classification (see Appendix A.4 for the details).

D. Initial capital stock at steady state. Our baseline calibration sets initial regional capital stocks 19% below their steady-state values to account for war-related damage of the capital stock. However, the Nazi era also witnessed massive investment in industrial capacity that partly made up for later war damage. In fact, the magnitudes of investment and war damage – and the degree to which the former out-weighted the latter – is still debated among economic historians (Eichengreen and Ritschl 2009, Vonyó 2012). Robustness check D., therefore, initializes capital stocks at their steady-state values rather than below them.

This change in calibration leads to a slight deterioration in model fit (see Panel D. of Table A3). While the migration propensity $1/a$ remains virtually unchanged, participation and employment adjustment propensities e_0 and κ_2 increase moderately. When firms maintain a higher capital stock, they absorb the expellee inflow faster and therefore unemployment declines relative to the baseline calibration. Lower unemployment also makes it more attractive for workers to participate in the labor market. The higher propensities e_0 and κ_2 offset both effects. However, a greater reluctance on the part of firms to adjust employment (higher κ_2) also increases the duration of native non-employment and therefore amplifies the effect on native income and employment.

E. Discount data on relative GDP per capita. Section 3 pointed out that measuring pre-war regional GDP per capita is fraught with problems. Robustness check E., therefore, recalibrates the propensity parameter by discounting the weight of relative GDP per capita in the distance function by 50%. This change in calibration increases the migration propensity $1/a$ from 0.065 to 0.080. Recall that in the baseline calibration, further increases in $1/a$ improve the model's fit of relative population but worsens the fit of relative GDP per capita. Therefore, when the GDP time series is discounted, a higher $1/a$ improves overall model fit. The effects of the expellee inflow on native income and employment remain virtually unchanged.

Table A3: Robustness checks

	Initial conditions and shocks[1]			Model fit[2]	Calibrated propensity parameters[3]			Model predictions[4]	
	k_{-1}/k	$k^\star_{-1}/k^\star$	$A_0/A^\star$	D	$1/a$	e_0	κ_2	$\mathcal{T}_{N0}$ (in %)	$\min N_N$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Baseline calibration	0.81	0.81	1	0.57	0.065	0.33	5.06	−1.38	−4.65
A. Asymmetric initial capital stocks	0.88	0.77	1	0.79	0.075	0.34	5.15	−1.40	−4.86
B. Regional catchup in productivity	0.81	0.81	0.95	0.27	0.037	0.28	4.20	−1.75	−4.79
C. Alternative data classification	0.81	0.81	1	0.37	0.060	0.39	4.66	−1.40	−4.87
D. Initial capital stock at steady state	1	1	1	0.58	0.063	0.42	5.77	−1.53	−4.92
E. Discount relative GDP/capita data	0.81	0.81	1	0.43	0.080	0.33	4.91	−1.37	−4.61

Notes: The table shows the effects of various changes in the baseline calibration on the model fit and the calibrated propensity parameters. The table also shows the effects of the expellee inflow on native income and employment. Each robustness check changes the baseline calibration in one dimension, keeping all other parameters at the baseline values discussed in Section 5. [1] Initial condition $k^\star_{-1} = K^\star_{-1}/P^\star_{-1}$ denotes the capital stock per capita before the expellee inflow, and $k^\star = K^\star/P^\star$ denotes the steady-state level of the capital stock per capita.[2] The distance of targeted moments D compares the model's simulated adjustment path in response to the expellee inflow to the historical time series on relative population, the average unemployment rate, average labor force participation, and relative GDP per capita (see Section 5). [3] Propensity parameters are workers' propensity to migrate $1/a$, workers' propensity to participate in the labor market e_0, and firms' reluctance to adjust employment κ_2. [4] Treatment effect $\mathcal{T}_{N0}$ denotes the percentage change in the expected discounted income of the average native worker as a result of the expellee inflow (see Section 6.2.1). $\min N_N$ denotes the minimum effect of the expellee inflow along the adjustment path on native employment in region H (for any ten expellees who arrive in region H).

E Labor market decompositions for native workers and expellees

Labor market experience of native workers versus expellees. To compute decompositions for native workers and expellees separately, we track each group over time through its own stock flow system. The native workers' stock flow system in region H resembles the stock flow system of the overall population in region H (equations (1) and (17) to (19)), but is not subject to an exogenous inflow of workers:

$$
\begin{aligned}
P_{Nt} &= P_{Nt-1} + G^{\star}_{Nt} - G_{Nt} \ , \\
N_{Nt} &= (1-\lambda)(1-\pi_t\phi_t)N_{Nt-1} + \phi_t[P_{Nt} - (1-\pi_t)P_{Nt-1}] \ , \\
G_{Nt} &= \gamma_t\pi_t[P_{Nt-1} - (1-\lambda)N_{Nt-1}] \ , \\
L_{Nt} &= P_{Nt} - (1-\pi_t)[P_{Nt-1} - (1-\lambda)N_{Nt-1}] \ , \\
U_{Nt} &= L_{Nt} - N_{Nt} \ , \\
P_{Nt} &= L_{Nt} + R_{Nt} \ .
\end{aligned}
$$

This system has initial conditions $P_{N,-1} = P_{-1}$ and $N_{N,-1} = N_{-1}$, which follow from the assumption that there are no expellees in the initial steady state. Stationary transformations of the variables in the stock flow system for native workers and in the corresponding system for expellees (see below) are, with $i = N, X$: $p_{it} = P_{it}/P_t$, $n_{it} = N_{it}/P_t$, $g_{it} = G_{it}/P_t$, $\ell_{it} = L_{it}/P_t$, $u_{it} = U_{it}/L_t$. Thus, the transformed stock flow system of native workers in region H reads

$$
\begin{aligned}
p_{Nt} &= p_{Nt-1}/p_t + g^{\star}_{Nt}/rp_t - g_{Nt} \ , \\
n_{Nt} &= (1-\lambda)(1-\pi_t\phi_t)n_{Nt-1}/p_t + \phi_t[p_{Nt} - (1-\pi_t)p_{Nt-1}/p_t] \ , \\
g_{Nt} &= \gamma_t\pi_t[p_{Nt-1}/p_t - (1-\lambda)n_{Nt-1}/p_t] \ , \\
\ell_{Nt} &= p_{Nt} - (1-\pi_t)[p_{Nt-1}/p_t - (1-\lambda)n_{Nt-1}/p_t] \ , \\
u_{Nt} &= (\ell_{Nt} - n_{Nt})/\ell_t \ .
\end{aligned}
$$

To compute expellees' distribution over labor market states, we exploit the fact that in a particular state, expellees and native workers amount to region H's population, e.g. $U_t = U_{Nt} + U_{Xt}$.

This yields

$$\begin{aligned}
p_{Xt} &= 1 - p_{Nt} \ , \\
n_{Xt} &= n_t - n_{Nt} \ , \\
g_{Xt} &= g_t - g_{Nt} \ , \\
\ell_{Xt} &= \ell_t - \ell_{Nt} \ , \\
u_{Xt} &= u_t - u_{Nt} \ .
\end{aligned}$$

Also, we denote the relative populations of native workers and expellees as $rp_{it} = P_{it}/P^{\star}_{it}$, which equals $rp_{it} = rp_t(p_{it}/p^{\star}_{it})$. Finally, we derive the stock flow system for native workers and expellees in region L using analogous steps.

Decomposition for native and expellee workers jointly. Recall that population in region H evolves as $P_t = P_{t-1} + X_t + G^{\star}_t - G_t$. Combining this equation with the identity $P_t = N_t + U_t + R_t$ and taking first differences yields

$$X_t \;=\; \Delta N_t + \Delta U_t + \Delta R_t + G_t - G^{\star}_t \ , \tag{38}$$

where Δ denotes the difference operator, i.e., $\Delta N_t = N_t - N_{t-1}$. Equation (38) shows that the expellee inflow X_t into region H can be decomposed into changes in employment N_t of both native workers and expellees, unemployment U_t, non-participation R_t, and into net migration $G_t - G^{\star}_t$. Cumulating equation (38) over the time horizon T yields $\sum_{t=0}^{T} X_t = \sum_{t=0}^{T} (\Delta N_t + \Delta U_t + \Delta R_t + G_t - G^{\star}_t)$. After simplifying this equation and dividing it by the cumulative expellee inflow (which reduces to X_0 as long as expellees enter only in period zero), we obtain equation (12) in the main text.

Decomposition for native workers. Recall that native population obeys the identity $P_{Nt} = N_{Nt} + U_{Nt} + R_{Nt}$ and evolves as $P_{Nt} = P_{Nt-1} + G^{\star}_{Nt} - G_{Nt}$. Combining both equations yields that $\Delta N_{Nt} + \Delta U_{Nt} + \Delta R_{Nt} + (G_{Nt} - G^{\star}_{Nt}) = 0$, because the native population in region H changes only as native workers move to region L. Cumulating this equation over the time horizon T and dividing it by the cumulative expellee inflow yields the native decomposition (13).

Decomposition for expellees. Subtracting the decomposition for native workers (13) from the decomposition for native workers and expellees (12) yields

$$1 \quad = \quad \frac{N_{XT} - N_{X,-1}}{X_0} + \frac{U_{XT} - U_{X,-1}}{X_0} + \frac{R_{XT} - R_{X,-1}}{X_0} + \frac{\sum_{t=0}^{T}(G_{Xt} - G^{\star}_{Xt})}{X_0} \ .$$

F Contribution of income types to the treatment effect

Workers receive their overall income from various income types, such as regional wages, unemployment benefits and home benefits. Accordingly, another decomposition of the overall treatment effect isolates the contribution of each income type to the overall effect.

To obtain this decomposition, we derive in Appendix G.1 the analytical result that the EDI of the average native worker in both regions, $\overline{Z}_{Nt}$ in equation (43), has a "direct form" that shows the contribution of each income type to overall income:

$$\begin{aligned}\overline{Z}_{N0} = \sum_{t=0}^{\infty} \beta^t \Bigg\{ \left(\frac{P_{Nt}}{P_{Nt} + P^{\star}_{Nt}}\right) \left[\left(\frac{N_{Nt}}{P_{Nt}}\right) w_t + \left(\frac{U_{Nt}}{P_{Nt}}\right) z + \left(1 - \frac{L_{Nt}}{P_{Nt}}\right) \bar{h}_t - \left(\frac{G_{Nt}}{P_{Nt}}\right) \bar{\mu}_t \right] \\ + \left(\frac{P^{\star}_{Nt}}{P_{Nt} + P^{\star}_{Nt}}\right) \left[\left(\frac{N^{\star}_{Nt}}{P^{\star}_{Nt}}\right) w^{\star}_t + \left(\frac{U^{\star}_{Nt}}{P^{\star}_{Nt}}\right) z^{\star} + \left(1 - \frac{L^{\star}_{Nt}}{P^{\star}_{Nt}}\right) \bar{h}^{\star}_t - \left(\frac{G^{\star}_{Nt}}{P^{\star}_{Nt}}\right) \bar{\mu}^{\star}_t \right] \Bigg\} \ . \qquad (39)\end{aligned}$$

According to equation (39), the EDI of the average native worker $\overline{Z}_{N0}$ is an infinite weighted sum of wages w_t and $w^{\star}_t$, unemployment benefits z and $z^{\star}$, average home benefits $\bar{h}_t$ and $\bar{h}^{\star}_t$, and migration costs. In each period t, weights on all income types (ignoring weights on migration costs) sum to unity. They can thus be interpreted as the unconditional likelihood of the average native worker receiving a particular income type at time t. The direct form equation allows us to compute the contribution of one specific income type, say, wage income, to the overall treatment effect as the difference in expected discounted lifetime wage income between the historical and the counterfactual scenarios as a percentage of the overall treatment effect.

Table A4 shows this decomposition. A striking result in this table is that the decline in expected lifetime wage income in region H amounts to 220% of the overall decline in native income. Expected wage income in region H decreases for two reasons. First, wages decrease temporarily in region H. Second, the likelihood of the average native worker being employed in region H decreases as well, because of migration to region L and because of temporarily higher unemployment and non-participation rates. Therefore, as shown in the table, the large decline in wage income in region H is partly offset by the other income types available to workers, namely by unemployment benefits, home benefits and wage income in region L.

Table A4: Decomposition of the treatment effect in native income

	Contribution (in %) to treatment effect		
	Region H	Region L	Both regions
Wage income	220.24	−21.40	198.84
Unemployment benefits	−20.83	−30.38	−51.21
Home benefits	−23.68	−24.28	−47.96
Migration costs	0.33	0	0.33
Total	176.06	−76.06	100

Notes: The table shows how different income components contribute to the overall treatment effect in EDI of the average native worker in both regions $\overline{Z}_{N0}$. The contribution of, say, wage income in region H to this overall treatment effect is $100\sum_{t=0}^{\infty}\beta^t(\zeta_t^w w_t - \widetilde{\zeta}_t^w \widetilde{w}_t)/(\overline{Z}_{N0} - \widetilde{\overline{Z}}_{N0})$, denoting by ζ_t^w the per-period weight attached to wages, $\zeta_t^w = N_{Nt}/(P_{Nt} + P_{Nt}^{\star})$, and by $\overline{Z}_{N0}$ income at the time of the shock. Variables without tilde refer to the historical scenario, and variables with tilde refer to the counterfactual scenario without expellee inflow. Contributions of other income types are computed correspondingly. All contributions are expressed relative to the overall treatment effect. See Section F for further explanation.

G Expected discounted lifetime labor income

G.1 The "direct form" of native labor income

The EDI of the average native worker in both regions in equations (42) and (43) depends on the values of being in the various labor market states. However, equations (42) and (43) mask the relation between EDI and other income measures, which are often used in empirical work, such as wage income. Therefore, we convert the EDI of the average native worker into a "direct form" that shows the contribution of regional wages, unemployment and home benefits to overall income. We start from equation (42) and replace the value of staying at home by equation (7). This yields

$$P_{Nt}Z_{Nt} \quad = \quad P_{Nt}Q_t + N_{Nt}(W_t - Q_t) + (P_{Nt} - L_{Nt})\left[\bar{h}_t - z\right] - G_{Nt}\bar{\mu}_t \; . \tag{40}$$

Replacing Q_t and $W_t - Q_t$ by the value functions (23) and (24) yields

$$\begin{aligned} P_{Nt}Z_{Nt} \quad &= \quad P_{Nt}z + N_{Nt}(w_t - z) + (P_{Nt} - L_{Nt})\left[\bar{h}_t - z\right] - G_{Nt}\bar{\mu}_t + P_{Nt}\beta Q_{t+1} \\ &+ \quad \left\{(1-\lambda)(1-\pi_{t+1}\phi_{t+1})N_{Nt} + \pi_{t+1}\phi_{t+1}P_{Nt}\right\}\beta(W_{t+1} - Q_{t+1}) \\ &+ \quad \beta(1-\pi_{t+1})\big[P_{Nt} - (1-\lambda)N_{Nt}\big](\bar{h}_{t+1} - z) + \beta\pi_{t+1}\gamma_{t+1}\big[P_{Nt} - (1-\lambda)N_{Nt}\big](\mu_{t+1}^c - \bar{\mu}_{t+1}) \; . \end{aligned}$$

Using $L_{Nt} = P_{Nt} - (1-\pi_t)[P_{Nt-1} - (1-\lambda)N_{Nt-1}]$ and $G_{Nt} = \gamma_t \pi_t [P_{Nt-1} - (1-\lambda)N_{Nt-1}]$ in Appendix E yields

$$\begin{aligned} P_{Nt}Z_{Nt} &= P_{Nt}z + N_{Nt}(w_t - z) + (P_{Nt} - L_{Nt})\,[\bar{h}_t - z] - G_{Nt}\bar{\mu}_t + P_{Nt}\beta Q_{t+1} \\ &+ \big\{(1-\lambda)(1-\pi_{t+1}\phi_{t+1})N_{Nt} + \pi_{t+1}\phi_{t+1}P_{Nt}\big\}\beta(W_{t+1} - Q_{t+1}) \\ &+ \beta(P_{Nt+1} - L_{Nt+1})(\bar{h}_{t+1} - z) + \beta G_{Nt+1}(\mu^c_{t+1} - \bar{\mu}_{t+1})\ . \end{aligned} \tag{41}$$

Combining $P_{Nt} = P_{Nt-1} + G^\star_{Nt} - G_{Nt}$ and $N_{Nt} = (1-\lambda)(1-\pi_t\phi_t)N_{Nt-1} + \phi_t[P_{Nt} - (1-\pi_t)P_{Nt-1}]$ in Appendix E yields $N_{Nt} = (1-\lambda)(1-\pi_t\phi_t)N_{Nt-1} + \phi_t\pi_t P_{Nt-1} + \phi_t[G^\star_{Nt} - G_{Nt}]$.Using this equation to replace the term in curly brackets in equation (41) yields

$$\begin{aligned} P_{Nt}Z_{Nt} &= P_{Nt}z + N_{Nt}(w_t - z) + (P_{Nt} - L_{Nt})\,[\bar{h}_t - z] - G_{Nt}\bar{\mu}_t \\ &+ \beta\left\{P_{Nt+1}Q_{t+1} + N_{Nt+1}(W_{t+1} - Q_{t+1}) + (P_{Nt+1} - L_{Nt+1})(\bar{h}_{t+1} - z) - G_{Nt+1}\bar{\mu}_{t+1}\right\} \\ &+ \beta G_{Nt+1}\mu^c_{t+1} - (P_{Nt+1} - P_{Nt})\beta Q_{t+1} - \phi_{t+1}[G^\star_{Nt+1} - G_{Nt+1}]\beta(W_{t+1} - Q_{t+1})\ . \end{aligned}$$

It follows from equation (40) that the term in curly brackets equals $P_{Nt+1}Z_{Nt+1}$. Thus,

$$\begin{aligned} P_{Nt}Z_{Nt} &= P_{Nt}z + N_{Nt}(w_t - z) + (P_{Nt} - L_{Nt})\,[\bar{h}_t - z] - G_{Nt}\bar{\mu}_t + \beta P_{Nt+1}Z_{Nt+1} \\ &+ \beta G_{Nt+1}\mu^c_{t+1} - (P_{Nt+1} - P_{Nt})\beta Q_{t+1} - \phi_{t+1}[G^\star_{Nt+1} - G_{Nt+1}]\beta(W_{t+1} - Q_{t+1})\ . \end{aligned}$$

Using $P_{Nt} - P_{Nt-1} = G^\star_{Nt} - G_{Nt}$ to rearrange this equation further yields

$$\begin{aligned} P_{Nt}Z_{Nt} &= P_{Nt}z + N_{Nt}(w_t - z) + (P_{Nt} - L_{Nt})\,[\bar{h}_t - z] - G_{Nt}\bar{\mu}_t + \beta P_{Nt+1}Z_{Nt+1} \\ &+ \beta G_{Nt+1}\big[\mu^c_{t+1} + Q_{t+1} + \phi_{t+1}(W_{t+1} - Q_{t+1})\big] - \beta G^\star_{Nt+1}\big[Q_{t+1} + \phi_{t+1}(W_{t+1} - Q_{t+1})\big]\ . \end{aligned}$$

Using equation (8) to replace the critical level of migration costs yields

$$\begin{aligned} P_{Nt}Z_{Nt} &= P_{Nt}z + N_{Nt}(w_t - z) + (P_{Nt} - L_{Nt})\,[\bar{h}_t - z] - G_{Nt}\bar{\mu}_t + \beta P_{Nt+1}Z_{Nt+1} \\ &+ \beta G_{Nt+1}\big[Q^\star_{t+1} + \phi^\star_{t+1}(W^\star_{t+1} - Q^\star_{t+1})\big] - G^\star_{Nt+1}\beta\big[Q_{t+1} + \phi_{t+1}(W_{t+1} - Q_{t+1})\big]\ . \end{aligned}$$

Since regions are set up symmetrically, corresponding steps yield native income in region L:

$$\begin{aligned} P^\star_{Nt}Z^\star_{Nt} &= P^\star_{Nt}z^\star + N^\star_{Nt}(w^\star_t - z^\star) + (P^\star_{Nt} - L^\star_{Nt})\,[\bar{h}^\star_t - z^\star] - G^\star_{Nt}\bar{\mu}^\star_t + \beta P^\star_{Nt+1}Z^\star_{Nt+1} \\ &- \beta G_{Nt+1}\big[Q^\star_{t+1} + \phi^\star_{t+1}(W^\star_{t+1} - Q^\star_{t+1})\big] + G^\star_{Nt+1}\beta\big[Q_{t+1} + \phi_{t+1}(W_{t+1} - Q_{t+1})\big]\ . \end{aligned}$$

Adding up native incomes in both regions, dividing by the total native population, which remains constant over time, and using equation (43) yields

$$\begin{aligned}\overline{Z}_{Nt} &= \left(\frac{P_{Nt}}{P_{Nt}+P^{\star}_{Nt}}\right)\left[z+\frac{N_{Nt}}{P_{Nt}}(w_t-z)+\left(1-\frac{L_{Nt}}{P_{Nt}}\right)[\bar{h}_t-z]-\frac{G_{Nt}}{P_{Nt}}\bar{\mu}_t\right] \\ &+ \left(\frac{P^{\star}_{Nt}}{P_{Nt}+P^{\star}_{Nt}}\right)\left[z^{\star}+\frac{N^{\star}_{Nt}}{P^{\star}_{Nt}}(w^{\star}_t-z^{\star})+\left(1-\frac{L^{\star}_{Nt}}{P^{\star}_{Nt}}\right)[\bar{h}^{\star}_t-z^{\star}]-\frac{G^{\star}_{Nt}}{P^{\star}_{Nt}}\bar{\mu}^{\star}_t\right]+\beta\overline{Z}_{Nt+1} \ .\end{aligned}$$

Finally, collecting all terms involving z and all terms involving $z^{\star}$ and iterating forward in $\overline{Z}_{Nt}$ yields equation (39).

G.2 Expected discounted lifetime income of the average worker

The EDI of the average native worker in region H, denoted by Z_{Nt}, weighs the value of working by the (regional) share of natives who are employed, $(L_{Nt}-U_{Nt})/P_{Nt}$; the value of unemployment by the share of natives who are unemployed, U_{Nt}/P_{Nt}; the value of non-participation by the share of native workers who are non-participating, $(1-L_{Nt}/P_{Nt})$; and migration costs, $\bar{\mu}_t$, by the native migration rate, G_{Nt}/P_{Nt}:

$$Z_{Nt}=\frac{L_{Nt}}{P_{Nt}}\left[\left(1-\frac{U_{Nt}}{L_{Nt}}\right)W_t+\frac{U_{Nt}}{L_{Nt}}\ Q_t\right]+\left(1-\frac{L_{Nt}}{P_{Nt}}\right)H_t(\bar{h}_t)-\frac{G_{Nt}}{P_{Nt}}\bar{\mu}_t \ . \tag{42}$$

We compute a corresponding measure, $Z^{\star}_{Nt}$, for the average native worker in region L. The EDI of the average native worker in both regions weighs Z_{Nt} and $Z^{\star}_{Nt}$ by their population shares:

$$\overline{Z}_{Nt} = (P_{Nt}Z_{Nt}+P^{\star}_{Nt}Z^{\star}_{Nt})/(P_{Nt}+P^{\star}_{Nt}) \ . \tag{43}$$

G.3 Expellee labor income

Akin to native labor income in equation (42), expellee labor income in region H is defined as

$$Z_{Xt}=\frac{L_{Xt}}{P_{Xt}}\left[\left(1-\frac{U_{Xt}}{L_{Xt}}\right)W_t+\frac{U_{Xt}}{L_{Xt}}\ Q_t\right]+\left(1-\frac{L_{Xt}}{P_{Xt}}\right)H_t(\bar{h}_t)-\frac{G_{Xt}}{P_{Xt}}\bar{\mu}_t \ .$$

We compute a corresponding measure, $Z^{\star}_{Xt}$, for the average expellee worker in region L. The EDI of the average expellee worker in both regions weighs region-specific expellee labor incomes by their population shares, $\overline{Z}_{Xt}=(P_{Xt}Z_{Xt}+P^{\star}_{Xt}Z^{\star}_{Xt})/(P_{Xt}+P^{\star}_{Xt})$.