Market Size and Spatial Growth - Evidence from Germany's Post-War Population Expulsions

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Abstract

Virtually all theories of economic growth predict a positive relationship between population size and productivity. In this paper I study a particular historical episode to provide direct evidence for the empirical relevance of such scale effects. In the aftermath of the Second World War about 8m ethnic Germans were expelled from their domiciles in Eastern Europe and transferred to West Germany. This inflow increased the German population by almost 20%. Using variation across counties I show that the settlement of refugees had a large and persistent effect on the size of the local population, manufacturing employment and income per capita. I show that these findings are quantitatively consistent with an idea-based model of spatial growth if population mobility is subject to frictions and productivity spillovers occur locally. The estimated model implies that the refugee settlement increased aggregate income per capita by about 12% after 25 years. Moreover, the historical settlement rule had persistent effects and triggered a process of industrialization in rural areas.

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1 Introduction

Can increases in the size of the population raise productivity? There are ample theoretical reasons to believe that the answer to this question ought to be yes. Most theories of growth predict a positive relationship between innovation incentives and population size, standard models of international trade imply that larger countries benefit from variety gains and many models of development and economic geography incorporate agglomeration forces, presumably as a reduced form for such considerations. This paper exploits a particular historical setting to provide direct evidence for the quantitative importance of such scale effects.

My analysis focuses on the forced population expulsions in post-war Germany. At the end of the Second World War, the Governments of the US, the UK and Russia expelled millions of ethnic Germans from their domiciles in Eastern Europe and transferred them to West Germany and the Soviet Occupied Zone. The ensuing expulsion was implemented between 1945 and 1948 and represents one of the largest forced population movements in world history. By 1950, about 8m people had been transferred to West Germany. Given the population at the time, this amounted to an increase in the population of more than 20%.

In order to use this historical setting to estimate the relationship between population size and productivity, I proceed in three steps. First, I provide direct evidence on the link between the settlement of refugees and subsequent income growth and industrialization. To do so, I exploit the fact that counties in West Germany differed vastly in their exposure to the inflow of refugees and that the specifics of the historical allocation rule allow me to address the obvious endogeneity concern that the incoming refugees might have settled in locations with favorable growth prospects. Second, motivated by the historical context, I build a model of spatial growth, where individuals are mobile across space (subject to frictions) and local productivity evolves endogenously. Third, I use the cross-sectional estimates from step one to estimate the structural parameters of my theory and to quantify the productivity effects of population inflows both at the regional and aggregate level.

To estimate the cross-sectional relationship between refugee inflow and local economic development, I constructed a novel panel dataset for more than 500 West German counties since the 1930s from original historical sources. Two features of the refugee settlement allow me to use it as a shifter of local labor supply. First, the refugees were not free to settle in the location of their choice, but the population transports were organized by the Military Governments of the US and the UK, the governing bodies of West Germany at the time. Second, the dominant consideration to allocate the inpouring refugees to particular regions was the availability of housing rather than future economic prospects. Because the Allied bombing campaign had reduced the housing stock by almost 25% on average and in many cities by more than 75%, refugees were assigned to rural, low population density localities where housing was relatively abundant. These aspects of the historical setting allow me to tease out the exogenous component of the initial refugee allocation both by directly controlling for the determinants of the allocation rule and by using an instrumental variable strategy, that exploits the distance to the pre-war population centers in Eastern Europe.

My results imply a positive relationship between population size, industrialization and local productivity. First, I show that the initial allocation of refugees was very persistent. Even decades after the settlement, counties that received more refugees in the immediate post-war period were still substantially larger and the share of refugees was still higher. Second, I establish a robust positive relationship between the allocation of refugees and manufacturing employment growth in the 1950s and 60s. Third, I document that the inflow of refugees raised local productivity and that such gains accrued slowly over time: while the effect of refugee inflows on income per capita in 1950 is statistically indistinguishable from zero, it is positive and large in later decades.

To rationalize these findings, I propose a model of spatial growth. I combine a canonical idea-based growth model with a standard model of economic geography. The growth-part of the theory delivers an explicit model of regional productivity, which is determined endogenously and responds positively to the size of the local workforce. The geography-part of the theory generates an endogenous law-of-motion for the spatial distribution of the population. If spatial mobility is subject to frictions, both local productivity and the regional population are slow-moving state variables that evolve jointly in equilibrium.

The model highlights an important distinction between the short-run and the long-run elasticity of productivity with respect to population size. The short-run elasticity describes the relationship between productivity and the local population holding current productivity constant. This elasticity depends on the elasticity of substitution across varieties and is isomorphic to exogenous agglomeration externalities commonly used in quantitative models of economic geography. By contrast, the long-run elasticity describes the relationship between local productivity and the local population along a spatial balanced growth path. The crucial parameter for the size of the long-run elasticity is the - what I call - inter-temporal knowledge externality, which determines how quickly the costs of creating new ideas decline in the existing stock of ideas. If this externality is positive, the long-run elasticity exceeds the short-run elasticity as the dynamic accumulation of local productivity acts as an amplifying force. Moreover, if this elasticity is sufficiently large and mobility is subject to frictions, population shocks can have persistent effects, whereby historical shocks determine equilibrium outcomes in the long-run and the economy displays path-dependence.

I structurally estimate the model using the empirical variation from the natural experiment.

The main moments of interest are the effects of refugee inflows on income per capita and population size at different time horizons, the spatial persistence of the refugee population, and the response of local manufacturing employment. My empirical estimates imply that moving frictions were substantial and that the dynamic amplification of the initial shock was powerful. The long-run scale elasticity is more then three times as large as the short-run elasticity. Even though the estimated knowledge externality is small enough so that I can comfortably reject the case of non-stationarity, my estimates imply that the refugee settlement had persistent effects: the economy converges to a unique stationary equilibrium, which, however, is determined by the initial allocation of refugees.

The estimated model allows me to quantify the aggregate and local consequences of the refugee settlement. The combination of decreasing returns to scale in the agricultural sector and increasing returns to scale in manufacturing imply that the effect is a priori ambiguous. It is also not identified from the cross-sectional estimates because of general equilibrium interactions. I find that the inflow of refugees reduced income per capita by about 3% in the short-run but increased it by about 12% after 25 years.

In terms of the local consequences, the model implies a persistent rise of manufacturing productivity in "treated" localities. This cross-sectional variation in productivity growth is mostly attributable to the increase in local labor supply. Demand-spillovers due to inter-regional trade are important for the economy-wide consequences of the refugee inflow, but account for the little of the cross-sectional variation in the long-run. This suggests that the policy of the Military Government to settle refugees in less developed, agriculturally specialized locations led to industrialization and rural development as an unintended consequence. This is exactly what I find. Under a counterfactual allocation of an equalized share of refugees, rural labor markets would have experienced a much smaller increase in manufacturing employment and would be relatively poorer in the long-run.

Related Literature The paper is related to a large literature on economic growth, which highlights the importance of market size effects (see, for example,Jones (2005) or Akcigit (2017)). Of particular relevance is Jones (1995), who uses time-series data to distinguish models of endogenous and semi-endogenous growth. My empirical results based on cross-sectional data are consistent with models of semi-endogenous growth where changes in population size affect the level of productivity but not the long-run growth rate. Recent papers that focus on the nexus between population and productivity growth are Jones (2019) and Peters and Walsh (2020).

The paper also contributes to a recent literature on dynamic models of trade, migration and economic geography. Desmet et al. (2018), Desmet and Rossi-Hansberg (2014), Nagy

(2017), Eckert and Peters (2020) and Walsh (2019) present models where local productivity is endogenously determined and responds to changes in local population size. The dynamic interaction between spatial mobility and local productivity, in particular the potential for shocks to have persistent effects, is also studied in Allen and Donaldson (2020), albeit in a more reduced form way. With respect to these studies, the main contribution of my paper is the explicit link to a natural experiment that generates large local changes in labor supply.[1]

There is also a close connection to the large economic geography literature that often relies on exogenous agglomeration economies - see for example Ahlfeldt et al. (2015), Ramondo et al. (2016), Faber and Gaubert (2019) or the recent survey by Redding and Rossi-Hansberg (2017). These reduced-form specifications imply that scale elasticities are stable and time-invariant. My results highlight that such elasticities might differ substantially in the short- and long-run. This finding is reminiscent of the literature on directed technological change, which also stresses the difference between short- and long-run elasticities (Acemoglu, 2002, 2007).

The paper also speaks to the literature on the long-run effects of immigration. The majority of contributions are concerned with the short-run impact of immigrants within local labor markets (see e.g. Card (1990), Burstein et al. (2017), Dustmann et al. (2017) or Peri (2016) for a survey). Exceptions are Sequeira et al. (2020), Burchardi et al. (2019), Bazzi et al. (2016), Bazzi et al. (2019) or Hornung (2014), which however are mostly empirical in nature and do not attempt a structural analysis.

Finally, various papers use the German context as a source of historical experiments - see, for example, Burchardi and Hassan (2013), Ahlfeldt et al. (2015) or Redding and Sturm (2008).[2] The post-war population expulsions, which are the focus of this paper, have also been analyzed in Braun and Mahmoud (2014) and Braun and Kvasnicka (2014). These contributions, however, do not focus on the effect on local productivity.

The remainder of the paper is structured as follows. In the next section I describe the historical setting and the initial settlement of refugees in West Germany. Section 3 contains the main empirical analysis. In Section 4 I develop the theoretical model, which I estimate in Section 5. Section 6 concludes. The Supplemental Material contains derivations of the main theoretical results, a variety of robustness checks and additional empirical results. Additional details can also be found in an Online Appendix.

[1] A dynamic model of trade and migration is also analyzed in Caliendo et al. (2019), who however assume that regional productivity is exogenous.

[2] See Fuchs-Schündeln and Hassan (2015) and Nakamura and Steinsson (2018) for recent surveys on the use of well-identified experiments to identify macroeconomic models.

2 The Historical Setting

The Presence of Ethnic Germans in Eastern Europe before 1939

The presence of ethnic Germans in Eastern Europe dates back to the Middle Ages.[3] As shown in Table 1, in 1939, on the eve of the Second World War, about 17m Germans inhabited regions to the east of what is Germany today. Roughly 13m people lived in the Eastern Territories of the German Reich and the so-called Sudetenland, a region located in the north of Czechoslovakia that has a long tradition of German settlements and was annexed by the Nazi Government in 1938. In addition, there were sizable German minorities in other countries of Eastern Europe like Poland, Hungary and Romania.

Eastern Territories	Czechoslovakia	Hungary	Romania	Poland	Others	Total
9.6m	3.5m	0.6m	0.8m	1m	1.4m	16.9m

Notes: The table shows the ethnic German population in different regions in Eastern Europe in 1939. The category "Others" comprises Danzig, the Baltic States and Yugoslavia. Source: Federal Statistical Office (1953, p. 3)

Table 1: The German Population in Eastern Europe in 1939

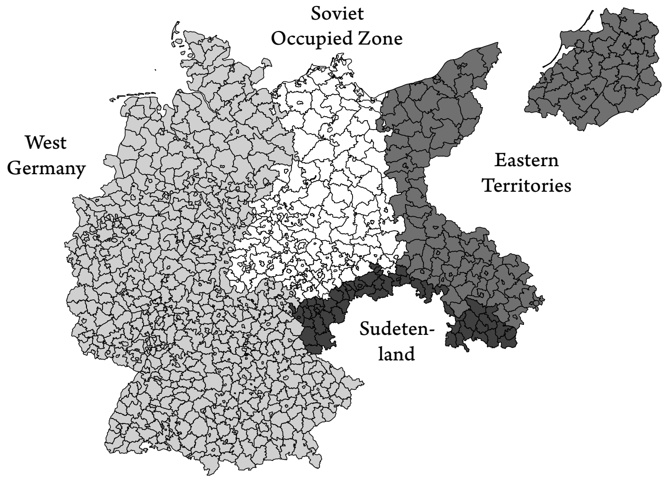
The geography of the German Reich in 1939 is shown in Figure 1. In the west, shown in a light shade, is the area which is going to become West Germany in 1949. In the far east, shown in medium dark, are the Eastern Territories that encompassed the regions of East Prussia and Silesia and are part of todays' Poland and Russia. In the south-east, shown in dark, is the Sudetenland. Finally, the light shaded area in the middle will become the Soviet Occupied Zone (in 1945) and then turn into the German Democratic Republic (in 1949).

In terms of their economic structure, West Germany and the areas in the East differed substantially, primarily because the East had a comparative advantage in agriculture due to the abundance of land. In 1939, West Germany had an agricultural employment share of 27% and more than 40% of the local population worked in manufacturing. In the East, the agricultural sector was still the dominant source of employment and comprised more than 37% of the workforce.

The Expulsions and the Potsdam Conference in 1945

The Second World War brought an abrupt end to the presence of ethnic Germans in Eastern Europe because the entire German population either fled or was expelled in the aftermaths of the war. This population transfer, where roughly 12 million ethnic Germans were forced to leave their domiciles, is one of the largest in world history.

[3]For recent historical treatments of this episode I refer to Douglas (2012) or Kossert (2008).



Notes: The figure shows the German Reich in the boundaries of 1939. The light grey shaded part in the west is the area of to-be West Germany. The medium-grey shaded parts in the east are the Eastern Territories of the German Reich. The dark shaded area in the south-east is the Sudetenland. The white shaded part is the area of the Soviet Occupied Zone. The intra-regional spatial units are counties.

Figure 1: The German Reich in 1939

The expulsion can be broadly divided into three phases. The first wave of refugees arrived in West Germany during the last months of the war when Soviet forces made their appearance at the eastern German border. After the German defeat in May 1945, the so-called wild expulsions started. These took place in the spring and summer of 1945 mainly in Poland and Czechoslovakia, where both the army and privately organized militias systematically expelled the remaining German population. It is only at the Potsdam Conference in the Summer of 1945, that the Military Governments of the US, UK and Russia tried to put an end to these unorganized expulsions and legalized them ex-post.[4] In the official protocol of the conference they noted that *"the Three Governments, having considered the question in all its aspects, recognize that the transfer to Germany of German populations, or elements thereof, remaining in Poland, Czechoslovakia and Hungary, will have to be undertaken. They agree that any transfers that take place should be effected in an orderly and humane manner."* Within the following two years, the majority of the ethnic German population was transferred from Eastern Europe to West Germany and the Soviet Occupied Zone.[5]

The timing of this population transfer is contained in Table 2, where I report the flow of

[4]The Potsdam Conference took place from 17 July to 2 August 1945. In addition to the expulsion of the German population, the governments of Russia, the US and the UK also decided on the redrawing of Germany's eastern border, the trials of the German war criminals, the division of Germany and Austria into different occupation zones and the payments of war reparations.

[5]Becker et al. (2020) study the impact of the population transfer in Poland. They focus on the polish population that was re-settled in the areas from which the Germans were expelled.

1945	1946	1947	1948	1949	1950	1946-1950
2.6m	3.6m	0.5m	0.6m	0.3m	0.3m	8m

Notes: The table reports the aggregate inflow by refugees arriving in West German between 1945 and 1950. Source: Federal Statistical Office (1953).

Table 2: The Settlement of Refugees in West Germany: 1945-1950

Population 1939	Population Losses 1939-50				Population Gains 1939-50			Population 1950
	Military Losses	Civilian Losses	Non-military Deaths	Others	Refugees	Inflows from SOZ	Births	
39.3m	2m	0.4m	5.2m	0.5m	7.9m	1.5m	7m	47.6m

Notes: The table reports aggregate population trends in West Germany between 1939 and 1950. "Inflows from SOZ" are individuals who fled the Soviet Occupied Zone. Source: Edding (1951, p. 2)

Table 3: The Population of West Germany: 1939 - 1950

refugees that arrived in West Germany for every year between 1946 and 1950. By the end of 1946, almost 6m refugees had arrived in West Germany. Between 1947 and 1950 another half million refugees arrived per year. By 1950, the inflow of refugees had increased the population in West Germany by about 8m individuals.

To put this population inflow into perspective, Table 3 contains a decomposition of the population dynamics in West Germany between 1939 and 1950. From the initial population of about 40m in 1939, West Germany suffered military and civilian losses of about 2.5m during the Second World War. At the same time, the country saw the arrival of 8m refugees and an additional 1.5m people fleeing the Soviet Occupied Zone. Hence, despite the casualties during the war, the population of West Germany increased by 20%, between 1939 and 1950.

In terms of their demographic characteristics, refugees and natives were very similar. The first two panels of Table 4 show that refugees and natives had the same share of males and that their age distribution was almost identical. In the third panel, I show that the distribution of educational attainment was also broadly comparable.

	Male share	Age distribution			Educational attainment			
		<15	20-65	65+	Elem. school	High school	Vocational school	College
Natives	46.5	20.4	68.5	11.1	66.8	26.3	4.9	1.9
Refugees	46.9	21.9	68.5	9.7	67.4	25.6	4.9	2.1

Notes: The first panels report the share of males and the age distribution in 1958. The last panel reports the distribution of educational attainment of the cohort born before 1920 as observed in the Census in 1970. These individuals were are at least 25 years old in in 1945 and hence completed their educational attainment prior to the expulsion. Source: Besser (2007).

Table 4: Characteristics of Refugees and Natives

The Initial Settlement in West Germany

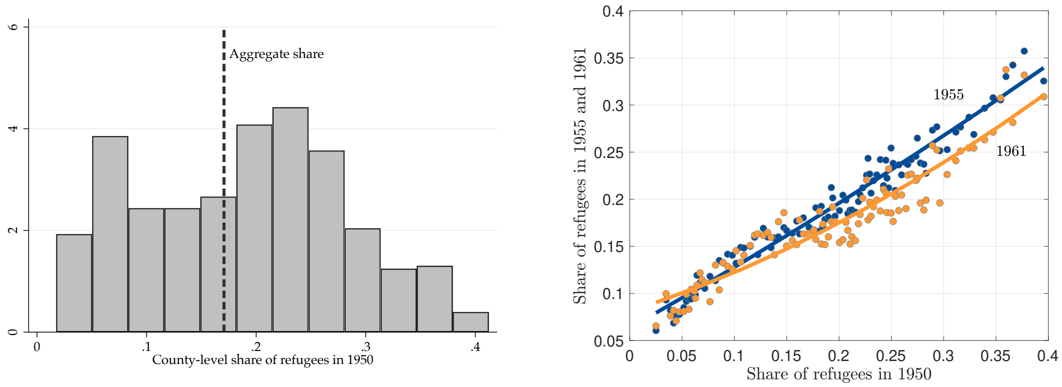
Upon their arrival in West Germany, the refugees were not free to settle where they wanted to, but their assignment was organized and implemented by the Military Governments of the US and the UK. They received the inflowing refugee treks, which arrived from Eastern Europe either by train or by foot, and allocated them across counties in West Germany. In addition, labor mobility was severely restricted in the immediate post-war period until the late 1940s and armed forces were deployed to prevent internal migration. William H. Draper, Director of the Economic Division of the Office of the Military Government of the US (OMGUS), observed that "Germany has been virtually cut into four Zones of Occupation - with the Zone borders not merely military lines, but almost air-tight economic boundaries" (Office of the Military Government for Germany, 1945, p. 10).

One consequence of these policies was that the settlement of refugees was strikingly unbalanced. According to the German historian Gerhard Reichling "there is no aspect where the Federal Republic of Germany shows a similar degree of heterogeneity as in the absorption and distribution of expellees" (Reichling, 1958, p. 17). This heterogeneity is depicted in the left panel of Figure 2, which shows the histogram of the local share of refugees across counties. In the aggregate, refugees amounted to roughly 18% of the population. However, this statistic hides substantial spatial heterogeneity: some counties received hardly any refugees and other counties received so many that their population almost doubled. In addition, and consistent with the above-mentioned restrictions to labor mobility, the initial allocation was highly persistent. As seen in the right panel of Figure 2, the correlation between the share of refugees in 1950 and 1955 and 1961 is large, highlighting that counties with a large initial share of refugees still featured a large share in the subsequent decade.[6]

To appreciate this unequal spatial distribution it is important to remember that an orderly settlement was an almost impossible task in war-torn Germany. A particular concern was the availability of housing as the rising population came hand in hand with a sharply diminished housing stock, which was heavily destroyed during the Allied Bombing Campaign.[7] Werner Nellner, one of the leading post-war economic historians, described the situation as follows: "In the midst of the chaotic post-war circumstances arrived the refugee transports. The entirely confusing political and economic situation paired with the abruptness of this pouring-in simply did not allow a sensible distribution of the expellees into areas where they could find work. The ultimate goal was to find shelter for those displaced persons" (Nellner, 1959,

[6]For a subset of counties I also observe the share of refugees in 1946. This share is also strongly correlated with the share in 1950. A bivariate regression yields a coefficient of 0.91 with an R^2 of 0.952.

[7]About 23% of the aggregate housing stock was damaged during the Allied bombing campaign. Moreover, there is considerable heterogeneity and a large share of urban counties saw more than 70% of their housing stock damaged during the war (see Section SM-2.1 in the Appendix).



Notes: The figure shows the correlation between the share of refugees in 1950 and 1955 (blue) and 1961 (orange) as binned scatter plots for 100 percentiles of the refugee share in 1950.

Figure 2: The Regional Persistence of Refugee Inflows

p. 73).

This uncoordinated settlement was already considered an enormous problem at the time. As early as in 1946, P.M. Raup, Acting Chief of the Food and Agricultural Division of the Office of the Military Government of the US (OMGUS) complained that "both the planning and the execution of the support measures for German expellees was conducted entirely under welfare perspectives. The people in charge at the Military Government are social service officials. ... Entire communities are moved so that the population of some counties is increased by 25-30% and the agency in charge was founded to support the elderly, disabled people and the poor. ... The whole problem has not been handled as one of settlements of entire communities but as an emergency problem supporting the poor." (Grosser and Schraut, 2001, p. 85).

These descriptions of the refugee settlement are strikingly visible in the data. In Table 5 I report the results of a set of bivariate regressions of the share of refugees in 1950 on different pre-war county characteristics and state fixed effects and report the coefficients on the respective characteristics. In column 1, I show that the share of refugees is strongly negatively correlated with the population-weighted distance to the expulsion region (the "expulsion distance" ED_c), which I calculate as

$$ED_c = \ln\left(\sum_{r \in ER} d_{c,r} \times pop_r^{1939}\right), \qquad (1)$$

where $d_{c,j}$ is the geographical distance between county j and r, ER denotes the set of expulsion regions, i.e. the Eastern Territories and the Sudetenland shown in Figure 1, and and pop_r^{1939} is the size of their population in 1939. Hence, counties that were closer to the population centers of ethnic Germans in the pre-war period, experienced larger refugee inflows. This is exactly

	Expulsion distance	ln pop dens 1939	War time destruction	Manufac. share 1939	Manufac. share 1933	Ag. share 1933	Rural share 1933	GDP pc 1935
β	-0.159***	-0.023***	-0.190***	-0.132***	-0.109***	0.087***	0.080***	-0.017***
	(0.026)	(0.002)	(0.011)	(0.022)	(0.020)	(0.011)	(0.008)	(0.005)
N	536	536	536	535	523	523	536	523
R^2	0.662	0.724	0.752	0.656	0.662	0.691	0.705	0.651

Notes: Standard errors are clustered at the level of 37 larger administrative units (Regierungsbezirke). *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively. Each column reports the coefficient β of a regression $\mu_r = \delta_s + \beta x_r + u_r$ where μ_r is the share of refugees in 1950, x_r are the different regional characteristics in the respective columns and δ_s is a set of state fixed effects. The wartime destruction in column 3 is measured as the share of the housing stock that was destroyed during the war.

Table 5: Spatial Correlates of Refugee Inflows

what one would expect if the Military Governments experienced an institutional overload in distributing the refugees, which kept pouring in at the eastern border. In columns 2 and 3 I focus on the availability of housing. The share of refugees was much larger in regions with a low population density in the pre-war period and in counties, that experienced less destruction of their housing stock during the war.

These patterns imply that refugees were not randomly assigned but were settled in rural and thus less developed locations. As seen in the remaining columns of Table 5, a county's share of refugees is negatively correlated with the share of manufacturing employment (both in 1933 and 1939) and positively correlated with its agricultural employment share. Moreover, counties with a larger share of refugees are more likely to be rural (as measured by the share of the population living in small cities) and have lower GDP per capita in 1935. My empirical strategy will take these systematic correlations into account.[8]

3 Refugees, Industrialization and Local Growth

How did local economies respond to these persistent shocks to the size of their population? In this section I estimate the effects of refugee inflows on population growth, changes in sectoral specialization and growth in income per capita. These cross-sectional estimates form the backbone of my structural analysis because I estimate the structural parameters of my theory

[8]Even though the size of the refugee settlement was systematically correlated with local characteristics, there is little evidence of spatial sorting of particular refugees into particular localities. If refugees had been spatially sorted by the government authorities, the composition of the settled refugees would vary systematically with the pre-war industrial make-up and one would expect refugees from the manufacturing-intensive Sudetenland to be sent to locations with a higher pre-war manufacturing share. This is not the case. As I show in Section SM-2.1 in the Appendix, neither the manufacturing share nor GDP per capita predicts the composition of the refugee population. Interestingly, this is not the case for individuals fleeing the Soviet Occupied Zone, who were not part of the organized refugee treks but were free to settle. These migrants do locate systematically in richer and more manufacturing intensive locations.

with indirect inference to fit these regression results.

3.1 Data

My empirical analysis relies on a variety of novel historical datasets, many of which were digitized for this project. Using this data I constructed a spatially harmonized panel dataset for more than 500 counties in West Germany spanning the time-period from 1933 to the end of the 20th century.[9] The basis of my dataset is comprised of the population censuses for the years 1933, 1939, 1950 and 1961, which are published individually for each of the nine states. For each of these years, the publications report a variety of outcomes at the county-level like the level of population, sectoral employment shares, occupational employment shares, sex ratios and various other characteristics

I augmented this dataset with six additional pieces of information. The first concerns the regional allocation of refugees, which I digitized from a special statistical publication published in 1955 (Statistisches Bundesamt, 1955b). Secondly, in the 60s, 70s, 80s and 90s, the statistical offices from the respective German states constructed measures of GDP at the county-level. These results were published and could be digitized (Statistische Landesämter, 1968, 1976, 1992). I was not able to find county-level GDP measures for the pre-war and immediate post-war period. As a substitute I digitized county-level information from tax records, which report value added taxes for each county in 1935 (Statistisches Reichsamt, 1938) and 1950 (Statistisches Bundesamt, 1955a). I take these measures as being proportional to local GDP. However, for the structural estimation of my model, I also present results that do not rely on this information.

Fourth, I digitized the county-level results for four waves of the manufacturing census in 1933, 1939, 1950 and 1956 (Statistisches Bundesamt, 1957). They report the number of plants at the county-level and hence allow me to directly measure plant entry, which is an important theoretical mechanism of my model. Fifth, I provide new measures of the extent of war time destruction and regional housing supply at the county-level, which I digitized from the historical housing census conducted in 1950 (Statistisches Bundesamt, 1950).[10] Finally, I digitized the historical migration census from 1955, which reports inflows and outflows for each of the 500 counties (Statistisches Bundesamt, 1955c). This information is useful to estimate the mobility costs in the quantitative model. To corroborate my county-level results, I also

[9] See Section OA-2.1 in the Online Appendix for the detailed references and Section OA-2.2 for details on the construction of time-invariant boundaries.

[10] This data is different from the one used in Brakman et al. (2004) and Burchardi and Hassan (2013) who focus on the extent of wartime destruction across cities. The housing census contains information on war damages for each county covering the entire landmass of Germany. Because refugees were predominantly allocated to rural areas, it is important to measure the extent of war-time destruction at the county level.

digitized data for all 6000 cities and villages for the state of Bavaria for the years 1939, 1950 and 1961 (Bayerisches Statistisches Landesamt, 1944, 1952, 1963a). Like for the county data, I observe population growth, the share of refugees and sectoral employment at this more granular level of aggregation.

I complement my analysis with two micro datasets. The first is the Mikrozensus Zusatzerhebung 1971 (MZU 71), a special appendix to the census conducted in 1971 to measure social mobility. It includes identifiers on individuals' refugee status and retrospective information about individuals' employment characteristics in 1939, 1950, 1960 and 1971. The MZU 71 has information for 160.000 natives and 40.000 refugees and thus allows me measure the employment life-cycle for both groups. The second is the Einkommens- und Verbrauchsstichprobe 1962/63 (EVS 62), which is a micro dataset conducted in 1962 to measure household expenditure and hence similar to the Consumer Expenditure Survey in the US. It has about 32,000 observations and allows me to measure relative earnings of refugees and natives.

3.2 The Economic Effects of Refugee Inflows

To estimate the effects of the refugee settlement on the local economy, I focus on six outcomes: population growth, changes in the sectoral employment shares (for manufacturing, agriculture and services), growth in income per capita, and growth in the number of industrial plants, both in the short run and the long-run. I consider a specification of the form

$$z_{rt} - z_{r,\text{pre-war}} = \delta_s + \beta\mu_{r1950} + \alpha z_{r,\text{pre-war}} + \phi \ln \ell_{r1939} + \varphi \text{wd}_r + x_r'\zeta + u_r, \qquad (2)$$

where z_{rt} and $z_{r,\text{pre-war}}$ denote the respective outcome of interest at time t and in the pre-war period and μ_{r1950} is the share of refugees in 1950. Furthermore, I control for a set of state fixed effects (δ_s), population density in 1939 (ℓ_{r1939}) and the extent of wartime destruction (wd_r), which are the important determinants of the housing supply (and hence refugee flows), and a set of additional spatial controls (x_r). I estimate this specification both via OLS and with an instrumental variable strategy (see Table 7 below). For brevity I only report the coefficient of interest β. In Section OA-2.5 in the Online Appendix I also report the full results for all covariates for completeness.

Consider first the OLS results reported in Table 6. The six different panels refer to the six different outcomes of interest. The first four columns capture the short-run effects in 1950. The last four columns focus on the long-run effects in 1961. The different specifications include a varying extent of regional controls. Columns 1 and 5 only control for state fixed effects (δ_s) and hence capture the unconditional correlation with refugee inflows. In columns 2 and 6 I control for initial population density, wartime destruction and the distance to the

Panel A: Population growth: $\ln L_{rt} - \ln L_{r1939}$								
	1939-1950				1939-1961			
Share of refugees in 1950	1.999***	1.359***	1.377***	1.428***	0.968***	1.029***	1.086***	1.219***
	(0.106)	(0.112)	(0.107)	(0.097)	(0.139)	(0.211)	(0.182)	(0.157)
N	526	526	509	463	526	526	509	463
R^2	0.760	0.825	0.834	0.859	0.256	0.299	0.397	0.486
Panel B: Manufacturing employment: $\pi^M_{rt} - \pi^M_{r1939}$								
	1939-1950				1939-1961			
Share of refugees in 1950	0.203***	0.317***	0.322***	0.353***	0.451***	0.241***	0.244***	0.255***
	(0.064)	(0.074)	(0.075)	(0.054)	(0.053)	(0.086)	(0.087)	(0.073)
N	535	535	519	472	535	535	519	472
R^2	0.301	0.390	0.420	0.572	0.230	0.352	0.356	0.451
Panel C: Agricultural employment: $\pi^A_{rt} - \pi^A_{r1933}$								
	1933-1950				1933-1961			
Share of refugees in 1950	-0.454***	-0.186**	-0.227***	-0.423***	-0.716***	-0.097	-0.151**	-0.326***
	(0.099)	(0.072)	(0.063)	(0.052)	(0.133)	(0.078)	(0.060)	(0.057)
N	523	523	519	472	523	523	519	472
R^2	0.091	0.701	0.776	0.865	0.122	0.761	0.818	0.877
Panel D: Service employment: $\pi^S_{rt} - \pi^S_{r1933}$								
	1933-1950				1933-1961			
Share of refugees in 1950	-0.089	0.014	-0.059	0.051	-0.098	0.017	-0.054	0.057
	(0.057)	(0.058)	(0.055)	(0.061)	(0.061)	(0.071)	(0.068)	(0.074)
N	523	523	519	472	523	523	519	472
R^2	0.211	0.363	0.442	0.618	0.053	0.186	0.283	0.468
Panel E: GDP per capita growth: $\ln y_{rt} - \ln y_{r1935}$								
	1935-1950				1935-1961			
Share of refugees in 1950	-1.219***	-0.083	-0.030	-0.017	1.159***	0.502**	0.656***	0.746***
	(0.296)	(0.382)	(0.385)	(0.323)	(0.419)	(0.227)	(0.213)	(0.199)
N	523	523	519	472	519	519	515	468
R^2	0.110	0.511	0.520	0.596	0.101	0.889	0.905	0.904
Panel F: Growth of industrial plants: $\ln N_{rt} - \ln N_{r1933}$								
	1933-1950				1933-1956			
Share of refugees in 1950	-0.450	0.726*	0.611	0.817***	-0.819	0.697	0.783	1.169***
	(0.383)	(0.410)	(0.432)	(0.247)	(0.744)	(0.756)	(0.591)	(0.353)
N	520	520	519	472	520	520	519	472
R^2	0.045	0.393	0.404	0.686	0.140	0.373	0.502	0.640
State FE	✓	✓	✓	✓	✓	✓	✓	✓
Pop. density (1939)		✓	✓	✓		✓	✓	✓
Wartime destr.		✓	✓	✓		✓	✓	✓
Geography		✓	✓	✓		✓	✓	✓
Levels of dep. variable		✓	✓	✓		✓	✓	✓
Pre-war controls			✓	✓			✓	✓
Addtl. pre-war controls				✓				✓

Notes: Standard errors are clustered at the level of 37 *Regierungsbezirke*. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively. The dependent variables are population growth (Panel A), changes in sectoral employment shares (Panels B - D), income per capita growth (Panel E) and the growth in the number of industrial plants (Panel F). The various specifications control for the share of the destroyed housing stock ("Wartime destr."), the distance to the inner German border and a fixed effect for whether a county is a border county ("Geography"), the respective dependent variable in levels in the pre-war period ("Levels of dep. variable"), all six dependent variable in levels in the pre-war period in Panels A-F ("Pre-war controls") and the population share in cities with less than 2000 inhabitants in 1939, population density in 1933, the manufacturing share in 1933 and the GDP share in manufacturing and agriculture in 1935 ("Addtl. pre-war controls").

Table 6: The Effects of Refugee Inflows on the Local Economy

inner German border. These variables are important determinants of the refugee allocation and could be directly correlated with regional growth. I also control for the initial level of the dependent variable, $z_{r,\text{pre-war}}$, to allow for mean reversion. In the third and seventh column I include the pre-war levels of all the six dependent variables on the right hand side. Finally, in the last columns, I control for a host of additional pre-war characteristics at the district level, such as the average urbanization rate, population density and the manufacturing share in 1933 (in addition to 1939) and the regional GDP share of agriculture and manufacturing in 1935.[11] Standard errors are clustered at the level of 37 *Regierungsbezirke,* the next larger administrative unit.

Table 6 paints a cohesive picture of the regional impact of refugee inflows. First, given the size and the persistence of the refugee settlement shown in Figure 2, one would expect the initial allocation of refugees to be an important determinant local population growth. Panel A shows that this is the case: the semi-elasticity of 1.3 implies that an increase in the share of refugees by 10 percentage points increases the local population by 13%. Note that the short run elasticity is much higher if the extent of war-time destruction is not controlled for (see column 1). This reflects the negative correlation between refugee inflows and war-time destruction. Interestingly, the long-run elasticities in columns 5 to 8 are statistically identical across specifications and do not depend on whether the extent of war-time destruction is controlled for. This is consistent with the results of Davis and Weinstein (2002) and Brakman et al. (2004), who show that war-time destruction had a transitory effect on population size.

The following three panels document the stark sectoral reallocation in response to refugee inflows. The manufacturing employment share increases, the agricultural employment share decreases and the share of service employment is not affected. Moreover, this reallocation is not a transitory phenomenon but the manufacturing employment share is still systematically higher in the 1960s. This pattern is exactly what one would expect if services are non-traded and agricultural production is subject to decreasing returns. In addition, as I will show below, refugees not only increased the size of the local population, but their labor supply was biased towards the manufacturing sector. Quantitatively, an increase in the share of refugees by 10 percentage points increases the manufacturing employment share by around 2.5 percentage points.

In panel E, I estimate the effect of the refugee settlement on income per capita growth. Columns 2 - 4 show that income per capita growth between 1935 and 1950 is essentially unrelated to the inflow of refugees. Columns 6 to 8 show that the relationship between

[11] By controlling for the sectoral GDP and employment shares at the county level, this specification also addresses the concern that the extent to which value added taxes are a valid proxy for economic activity varies across industries.

refugee inflows and long-run income per capita growth is positive, suggesting a form of dynamic agglomeration.[12] According to these estimates, an increase in the share of refugees by 10% increases income per capita by roughly 5-6% after 15 years.[13]

In the structural model presented in Section 4, the positive effect on long-run GDP pc is rationalized through dynamic variety gains in the spirit of Romer (1990). Coincidentally, this mechanism appears explicitly in the historical sources. In 1949, M. Bold, the Deputy Director of the US Military Government in Bavaria for example noted that "since refugees and bombed-out Bavarians now living in rural areas cannot move nearer to industrial jobs, such jobs must go to them. In fact many world famous industries wanting to reestablish in Bavaria have already sought locations in non-industrial areas near idle workers" (Office of the Military Government for Germany, 1949, p. 26). Panel F provides direct evidence for this mechanism by documenting that refugee inflows are correlated with an increase in the entry of manufacturing plants. Interestingly, and similar to the results for GDP pc in Panel E, the long-run elasticity is larger then the short-run elasticity. However, these differences are too small to detect statistically.

A causal interpretation of the results in Table 6 hinges on the assumption of parallel trends, i.e. local economic development would have been similar, conditional on the determinants of the refugee settlement. The stability of the coefficients across the different specifications is therefore reassuring. In Section SM-2.2.2 in the Appendix I provide additional evidence for the plausibility of this assumption. First, I show that (conditional on pre-war population density) the share of refugees in 1950 is uncorrelated with sectoral employment shares in 1933 and 1939 and with population growth and growth in the number of industrial plants between 1933 and 1939. Moreover, the correlation with the change in the manufacturing employment share between 1933 and 1939 is, if anything, negative. Hence, there is no indication that counties with higher refugee inflows were on a more promising trajectory in the pre-war period. I also address the concern that pre-war population density might have had non-linear effects on future population growth and industrialization (see, e.g., Desmet and Rossi-Hansberg (2009)).

[12]Note that the unconditional relationship between refugee inflows and income growth reported in columns 1 and 5 differ significantly to the other specifications with controls. The reason is that income growth is systematically related to pre-war population density and that local income shows mean reversion. The main difference between columns 1 and 2 (columns 5 and 6) is the inclusion of $\ln \ell_{r1939}$ and $\ln y_{r1935}$. The coefficient on the share of refugees in a regression that controls for log population density in 1939 and log income per capita in 1935 is given by -0.065 (with a standard error of 0.298) for 1950 and 0.343 (with a standard error of 0.2) in 1961.

[13]It is important to reiterate an important caveat for the interpretation of the results in Panel E. As highlighted above, because data on GDP per capita on the county level do not exist in 1950, I have to rely on value added taxes per capita. Hence, my measure of GDP capita differs between the long-run and the short-run specification. In Section 5.2 below I explicitly address this discrepancy by relying on additional data on GDP pc in the late 1950s, 1970s and 1980s.

The results in Table 6 are almost unchanged even when I control non-parametrically for pre-war population density and pre-war urbanization.

Instrumental Variable Estimates As complementary evidence that the results reported in Table 6 reflect the causal effect of refugee inflows, I now present an instrumental variable strategy that exploits the geographic variation between the share of refugees and the distance to the expulsion regions. More specifically, I estimate the same specification as reported in Table 6 but use the expulsion distance within states to instrument for the share of refugees in 1950. More specifically, I instrument the share of refugees with ED_c (see (1)) interacted with a state fixed effect. The results are contained in Table 7 whose structure exactly parallels the one of Table 6. For each of the six outcomes, I report the coefficient and standard error on the instrumented share of refugees in 1950 and the F-statistic. Again, I cluster standard errors at the level of the 37 Regierungsbezirke.

The results are very similar to the corresponding OLS estimates, both qualitatively and quantitatively. The semi-elasticity of population growth is slightly larger but not statistically different from the OLS estimates given the size of the standard errors. The effects on sectoral employment shares are also comparable: the manufacturing share increases, the agricultural share declines and the service-share is not significantly affected. As in the OLS, the IV strategy also finds a noisy and statistically insignificant effect on short-run income growth. The long-run effect is positive and the point estimate is - in the specifications with controls - similar to the OLS results.[14] Finally, the relationship between refugee inflows and plant entry is also positive, with the long-run elasticity generally exceeding the short-run elasticity.

The main concern with this identification strategy is that the distance to the expulsion regions is - by construction - correlated with the distance to the new inner German border. Hence, if regions closer to the border are directly affected by the German division through political uncertainty or - as argued by Redding and Sturm (2008) - through a larger loss in market access, the identification assumption would be violated. This concern is unlikely to affect the conclusions drawn from Table 7 for three reasons. First, note that I include in all specifications a fixed effect for whether or not a particular county is a border county and I also control for the geographical distance to the inner German border. Second, both of these arguments would imply a negative correlation between the instrument and regional income growth or the growth of the manufacturing sector that produces tradable goods, pushing against the main findings reported in Table 7. Third, in Section OA-2.7 of the Online Appendix I also offer

[14]The reason why the unconditional correlation in column 5 differs between the OLS and the IV is that the IV specification only exploits the variation in the refugee share that is explained by the distance to the expulsion regions. Because counties with low initial population density grow faster on average, this form of regional convergence is captured in the OLS but less so in the IV.

Panel A: Population growth: $\ln L_{rt} - \ln L_{r1939}$								
	1939-1950				1939-1961			
Share of refugees in 1950	1.897***	1.459***	1.563***	1.614***	1.018***	1.227***	1.450***	1.501***
	(0.191)	(0.159)	(0.189)	(0.158)	(0.207)	(0.253)	(0.255)	(0.234)
N	526	526	509	463	526	526	509	463
F-Stat	56.026	17.632	19.575	18.114	97.733	20.721	24.233	21.488
Panel B: Manufacturing employment: $\pi^M_{rt} - \pi^M_{r1939}$								
	1939-1950				1939-1961			
Share of refugees in 1950	0.124	0.271**	0.297**	0.406***	0.279***	0.199	0.222*	0.333***
	(0.114)	(0.118)	(0.122)	(0.064)	(0.082)	(0.135)	(0.134)	(0.098)
N	535	535	519	472	535	535	519	472
F-Stat	97.785	28.434	23.443	21.888	97.785	28.434	23.443	21.888
Panel C: Agricultural employment: $\pi^A_{rt} - \pi^A_{r1933}$								
	1933-1950				1933-1961			
Share of refugees in 1950	-0.337***	-0.441**	-0.573***	-0.607***	-0.261	-0.294	-0.449**	-0.472**
	(0.121)	(0.188)	(0.169)	(0.183)	(0.197)	(0.193)	(0.176)	(0.185)
N	523	523	519	472	523	523	519	472
F-Stat	92.790	27.365	23.443	21.888	92.790	27.365	23.443	21.888
Panel D: Service employment: $\pi^S_{rt} - \pi^S_{r1933}$								
	1933-1950				1933-1961			
Share of refugees in 1950	0.146	0.307	0.228	0.188	-0.007	0.271	0.202	0.143
	(0.097)	(0.219)	(0.203)	(0.183)	(0.089)	(0.227)	(0.220)	(0.198)
N	523	523	519	472	523	523	519	472
F-Stat	92.790	25.060	23.443	21.888	92.790	25.060	23.443	21.888
Panel E: GDP per capita growth: $\ln y_{rt} - \ln y_{r1935}$								
	1935-1950				1935-1961			
Share of refugees in 1950	-0.400	0.221	0.341	-0.003	-0.671	0.208	0.517*	0.471**
	(0.457)	(0.743)	(0.716)	(0.617)	(0.615)	(0.370)	(0.271)	(0.238)
N	523	523	519	472	519	519	515	468
F-Stat	92.790	22.366	23.443	21.888	82.777	23.307	24.381	22.087
Panel F: Growth of industrial plants: $\ln N_{rt} - \ln N_{r1933}$								
	1933-1950				1933-1956			
Share of refugees in 1950	-0.290	1.675**	1.553**	1.851***	1.449	1.583	2.097**	2.567***
	(0.653)	(0.678)	(0.622)	(0.516)	(1.116)	(1.270)	(0.900)	(0.741)
N	520	520	519	472	520	520	519	472
F-Stat	93.760	23.611	23.443	21.888	93.760	23.611	23.443	21.888
State FE	✓	✓	✓	✓	✓	✓	✓	✓
Pop. density (1939)		✓	✓	✓		✓	✓	✓
Wartime destr.		✓	✓	✓		✓	✓	✓
Geography		✓	✓	✓		✓	✓	✓
Levels of dep. variable		✓	✓	✓		✓	✓	✓
Pre-war controls			✓	✓			✓	✓
Addtl. pre-war controls				✓				✓

Notes: Standard errors are clustered at the level of 37 *Regierungsbezirke*. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively. The dependent variables are population growth (Panel A), changes in sectoral employment shares (Panels B - D), income per capita growth (Panel E) and the growth in the number of industrial plants (Panel F). The various specifications control for the share of the destroyed housing stock ("Wartime destr."), the distance to the inner German border and a fixed effect for whether a county is a border county ("Geography"), the respective dependent variable in levels in the pre-war period ("Levels of dep. variable"), all six dependent variable in levels in the pre-war period in Panels A-F ("Pre-war controls") and the population share in cities with less than 2000 inhabitants in 1939, population density in 1933, the manufacturing share in 1933 and the GDP share in manufacturing and agriculture in 1935 ("Addtl. pre-war controls"). The share of refugees is instrumented with the population-weighted distance to the expulsion regions (see (1)) interacted with state fixed effects.

Table 7: The Effects of Refugee Inflows on the Local Economy: IV Estimates

	1939-1950			1961	1939-1961		
	Pop.	Change ... share		Refugee	Pop.	Change ... share	
	Growth	Manuf.	Agric.	share	Growth	Manuf.	Agric.
Share of refugees (1950)	1.169***	0.224***	-0.326***	0.317***	0.583***	0.084***	-0.128***
	(0.056)	(0.020)	(0.038)	(0.022)	(0.061)	(0.023)	(0.041)
County FE	✓	✓	✓	✓	✓	✓	✓
Pre-war controls	✓	✓	✓	✓	✓	✓	✓
N	6035	6018	6035	5965	6018	6018	6021
R^2	0.541	0.508	0.122	0.302	0.389	0.174	0.120

Notes: Standard errors are clustered at the county level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively. All specifications control for county fixed effects, population density in 1939 and 1933 and the manufacturing employment share in 1939.

Table 8: The Effects of Refugee Inflows on the Local Economy: Variation Within Counties

an additional instrumental variable strategy, which is less subject to these concerns but also less precisely estimated.[15] For my structural estimation, I take these concerns into account by explicitly modeling the German division and the resulting loss in trading opportunities.

Within-County Evidence To further corroborate these results, I also collected data for all local communities ("villages") for the state of Bavaria. This village-level data contains information on the local population, sectoral employment shares and the presence of refugees for more than 6000 villages. By combining the historical village data for the years 1939, 1950 and 1961, I can perform the same analysis as reported in Table 6 using only variation *within* counties.[16] The results, shown in Table 8, confirm the results of Table 6 and show that refugees are an important source of population growth and that they shift the village-level employment share from agriculture to manufacturing. Moreover, in 1950, the estimated elasticities based on the within county variation are almost the same as the ones based on the cross-county variation in Table 6. In 1961 the effects, while still large and positive, are appreciably smaller. As I show in Section SM-2.1 in the Appendix, this is a consequence of spatial mobility: within counties, refugees leave the most rural locations and move into near-by towns that offer more opportunities for industrial jobs. This type of "short-distance" mobility is not visible in the cross county variation.

[15]This strategy exploits the fact that the inflowing refugees were often housed within the apartments of natives whenever housing was particularly scarce. Because doing so was easier if native homes were multi-room houses, the interaction between the expulsion distance and the supply of multi-room houses predicts the allocation of refugees.

[16]Expectedly, these villages are tiny: in 1950, the median village has a population of around 550. The allocation of refugees across villages within counties, however, is still very dispersed (see Section SM-2.1 in the Appendix). This high degree of variation in the initial allocation of refugees at very different levels of aggregation is consistent with the historical narrative of the non-organized "pouring-in" of refugees.

Robustness In Section SM-2.2.1 in the Appendix I report a battery of robustness checks for the results reported in Tables 6 and 7. In particular, (i) I control for spatial variation in labor supply (as proxied by the aggregate employment share and the share of males) and local demand for reconstruction (as proxied by the share of the housing stock built after 1945), (ii) I report the results when counties are weighted by their population size to ease the concern that small counties drive most of the variation, (iii) I use the refugee share as of 1946 (instead of 1950) as the dependent variable, (v) I show that the results are not driven by particular cities or states by controlling for a full set of city times state fixed effects and (vi) I replicate the results using robust instead of clustered standard errors.

Throughout these specifications I find that most results are essentially identical to the baseline results. In terms of the OLS estimates reported in Table 6, the main difference is that the long-run relationship between the refugee share in 1946 and population growth is not statistically significant. This is not entirely surprising given that a large number of refugees arrived only in 1946 and the following years (see Table 2). Similarly, the IV estimates are largely robust to these concerns. There are three instances where the results are qualitatively different. First, like for the OLS, focusing on the refugee share in 1946 renders the long-run impact on population growth insignificant. Second, if Bavaria, which is the largest state that accounts for almost 200 counties, is dropped from the analysis, the IV estimates for long-run income growth and plant entry cease to be significant. Third, if I allow the distance to the inner german border to have a state-specific coefficient, the IV estimates are relatively imprecise and become - with the exception of population growth - insignificant.

3.3 The Manufacturing Bias of Refugees' Labor Supply

One important reason for the stark expansion of the local manufacturing sector was that the incoming refugees themselves often ended up as manufacturing workers. In Table 9 I report the distribution of refugees' sectoral employment shares relative to natives *within* counties, i.e. $\pi_{rs}^{Ref}/\pi_{rs}^{Nat}$ where π_{rs}^{Ref} (π_{rs}^{Nat}) is the employment share of refugees (natives) in sector s in county r.[17] A value of unity indicates that refugees and natives have the same sectoral employment shares.

The table shows a clear pattern of comparative advantage: within local labor markets refugees are on average 36% more likely to work in manufacturing. In contrast, the average agricultural employment share among refugees is only 37% as large as the one of natives. The remaining columns show that these patterns hold throughout the entire distribution of counties. In less than 20% of counties are refugees less likely to work in manufacturing and

[17] I can only report these statistics for the state of Bavaria, which is the only state which published sectoral employment in each county separately for refugees and natives.

	Mean	Distribution of $\pi_{rst}^{Ref}/\pi_{rst}^{Nat}$ Quantiles 10%	25%	50%	75%	90%
Manufacturing	1.36	0.93	1.10	1.31	1.54	1.81
Agriculture	0.37	0.18	0.21	0.29	0.40	0.76

Notes: The table reports the distribution of refugees' relative sectoral employment shares $\pi_{rst}^{Ref}/\pi_{rst}^{Nat}$ across counties for the state of Bavaria.

Table 9: The Manufacturing Bias of Refugees' Labor Supply

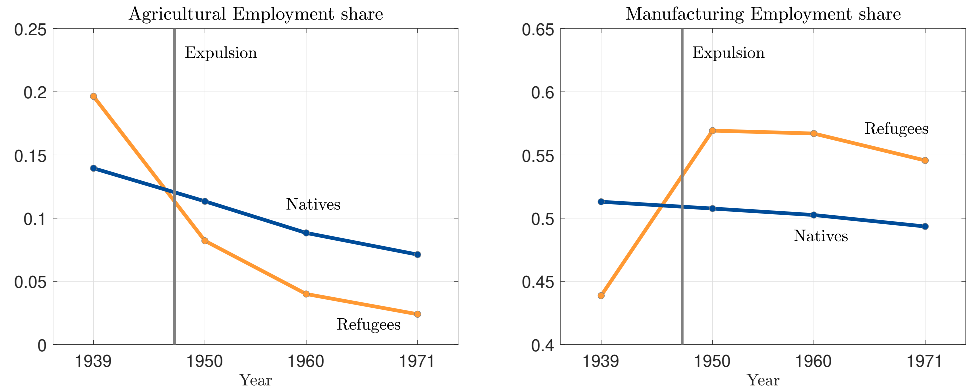
there is no instance for refugees to be more likely to work in the agricultural sector. Hence, the labor supply of refugees was biased towards the manufacturing sector.

This sectoral sorting is also apparent in the longitudinal microdata of the MZU 71. This unique supplement to the 1971 population census asked every respondent where he or she lived in 1939 and in which sector he or she worked in 1939, 1950, 1960 and 1971. By analyzing the time-series of these retrospective questions, I can measure snapshots of the employment life-cycle for both refugees and natives for a 40 year window. In Figure 3 I depict the sectoral life-cycle profile for the cohort of individuals born between 1915 and 1919. This cohort is 20-25 years old in 1939 and in their late twenties or early thirties at the time of the expulsion around 1947. In 1971, this cohort is 50-55 years old and thus still in the labor force. The two panels show the agricultural employment share (left panel) and the manufacturing employment share (right panel). The vertical line indicates the time of the expulsion.

The differential reallocation of refugees and natives is vividly apparent. Among refugees, 20% of the twenty year olds in 1939 used to work in the agricultural sector.[18] After the expulsion and their resettlement to West Germany, only 8% still did so. In contrast, the share of manufacturing employment, within the same cohort of individuals, increases from 44% to 57% after the settlement. The pattern for natives is strikingly different: the time period of the expulsion is hardly noticeable.[19]

[18]Note that this number is substantially smaller than the average agricultural employment share in 1939. This is consistent with Porzio et al. (2021) and Hobijn et al. (2018) who show that a large share of the structural transformation is accounted for by changes in employment shares across cohorts.

[19]The secular decline in agricultural and manufacturing employment for both natives and refugees in the post-war period reflects the process of structural change towards the service sector. In Section OA-2.4 in the Online Appendix I analyze this data in more detail. Interestingly, the patterns are different for young refugees that entered the labor market in Western Germany. This suggests an important role for social mobility across generations, a finding I also corroborate using self-reported data on social status.



Notes: The figure shows the agricultural employment share (left panel) and the manufacturing share (right panel) for the cohort of workers born between 1915 and 1919 by refugee status.

Figure 3: The Life-Cycle of the 1915-1919 Cohort

4 Theory: A Model of Spatial Growth

The settlement of refugees had three important consequences at the local level: (i) it had a large and persistent effect on the size of the local population, (ii) it was associated with industrialization at the local level and (iii) it led to increases in per-capita income, particularly in the long-run. In this section I develop a theory that can rationalize this evidence, both qualitatively and quantitatively.

4.1 Environment

I consider an economy with R regions (counties in the data). Individuals face a consumption choice, a sectoral labor supply choice, and a migration choice. For tractability I assume that individuals are myopic and take optimal actions to maximize per-period utility. They derive utility from consuming both agricultural and manufacturing goods according to a Cobb-Douglas utility function $u(c_A, c_M) = c_A^{\alpha} c_M^{1-\alpha}$. Both goods $s \in \{A, M\}$ are in turn CES aggregates from a set of differentiated, regional varieties that are tradable across space (subject to an iceberg trade cost τ_{rj}) and aggregated according to $Y_{st} = \left(\sum_r Y_{rst}^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}$. Letting P_{rst} denote the price of sector s goods from r in r, consumers in region j pay $\tau_{rj} P_{rst}$ for region r goods. The consumer price index of sector s goods in region j is therefore $\mathcal{P}_{jst} = \left(\sum_r (\tau_{rj} P_{rst})^{1-\sigma}\right)^{1/(1-\sigma)}$.

Production The agricultural good is produced using labor and land according to

$$Y_{rAt} = \mathcal{Q}_{rt} \mathcal{T}_r^{1-\gamma} H_{rAt}^{\gamma}, \tag{3}$$

where $\mathcal{T}_r$ denotes agricultural land in region r, H_{Art} denotes the total amount of labor employed for agricultural production and $\mathcal{Q}_{rt}$ is productivity in region r at time t. Agricultural land $\mathcal{T}_r$ is in fixed supply, so that agricultural production is subject to decreasing returns to scale. The returns to land accrue to a set of immobile land-owners that only consume.

The manufacturing good is subject to variety gains as in Romer (1990) and is produced according to

$$Y_{rMt} = \mathcal{Q}_{rt} \left(\int_0^{N_{rt}} x_{it}^{(\rho-1)/\rho} di \right)^{\rho/(\rho-1)},$$

where N_{rt} denotes the endogenous measure of varieties, x_{it} denotes the quantity of input i used and $\rho > 1$ is the elasticity of substitution across inputs. Such inputs are produced using only manufacturing labor, i.e. $x_{it} = h_{it}$.

The regional productivity term $\mathcal{Q}_{rt}$ evolves according to the persistent process

$$\ln \mathcal{Q}_{rt} = (1 - \varrho) \ln \mathcal{Q}_r + \varrho \ln \mathcal{Q}_{rt-1} + \varpi u_{rt},$$

where $\mathcal{Q}_r$ is a fixed, region-specific level of innate productivity, that determines the long-run level of exogenous productivity in region r, ϱ governs the auto-correlation and u_{rt} is a productivity shock, that is distributed iid with a unit variance.

Entry The measure of input varieties N_{rt} is determined endogenously and provides the link between local productivity and labor supply. At the end of each period (after production has taken place) an exogenous fraction δ of firms exits. Firm entry takes place in the beginning of the period. The labor requirement to start a new firm in region r at time t, h_{rt}^E, is given by

$$h_{rt}^E = f_E N_{rt-1}^{-\lambda}, \tag{4}$$

where $\lambda \leq 1$. The parameter λ governs the extent of dynamic spillovers as in Jones (1995) and, as I show below, is the crucial parameter to determine the long-distribution of economic activity across space and whether population shocks have persistent effects. Because λ determines how the existing state of knowledge N_{rt-1} affects the costs of creating new knowledge, I refer to it as the *inter-temporal knowledge externality.* The parameter f_E determines the size of entry costs.

Sectoral Labor Supply I model the sectoral supply of human capital using the usual Roy-type machinery. Individuals are characterized by a two-dimensional efficiency vector $z_{it} = (z_{iAt}, z_{iMt})$, where z_{ijt}, the number of efficiency units individual i can supply to sector j, is drawn from a Fréchet distribution, i.e. $F_j(z) = e^{-\phi_j z^{-\theta}}$.

To meaningfully talk about the composition of the local workforce, I allow for persistent differences in average human capital that is parametrized by ϕ_j. I assume there exist two latent types, "industrial workers" (I) and "farmers" (F), that have a comparative advantage in the respective sectors, $\phi_M^I/\phi_A^I > \phi_M^F/\phi_A^F$. The share of individuals of type $\nu \in \{F, I\}$ working in sector j in region r is then given by

$$\pi_{rjt}^{\nu} = \phi_j^{\nu}\left(w_{rjt}/\overline{w}_{rt}^{\nu}\right)^{\theta}, \quad \text{where} \quad \overline{w}_{rt}^{\nu} = \left(\phi_A^{\nu} w_{rAt}^{\theta} + \phi_M^{\nu} w_{rMt}^{\theta}\right)^{1/\theta}.$$

By allowing for the latent types I and F, the model provides a distinct role for the *composition* of the local population to determine labor supply. In particular, letting the share of industrialists among refugees and natives in region r be ω_{rt}^{IR} and ω_{rt}^{IN}, the manufacturing share among refugees relative to natives, $\pi_{rMt}^R - \pi_{rMt}^N$, is given by

$$\pi_{rMt}^R - \pi_{rMt}^N = \left(\pi_{rMt}^I - \pi_{rMt}^F\right) \times \left(\omega_{rt}^{IR} - \omega_{rt}^{IN}\right). \tag{5}$$

This expression highlights that refugees indeed have a manufacturing bias $\left(\pi_{rMt}^R > \pi_{rMt}^N\right)$, if the share of industrial workers among refugees exceeded the ones of natives in many localities $\left(\omega_{rt}^{IR} > \omega_{rt}^{IN}\right)$.[20]

To see why this would be the case, suppose that, as suggested by the similar educational distribution documented in Table 4, the *aggregate* share of industrial workers was given by χ for both refugees and natives. This implies that the *spatial* distribution of industrial types differs across groups if native workers are endogenously sorted but refugees are randomly assigned. In particular, within rural areas the average native who chose to remain in an agriculturally specialized labor market might have had a comparative advantage in the agricultural sector relative to a randomly selected refugee. Intuitively, the share of engineers within an arriving refugee trek might have been higher than in the rural native population. Refugee inflows thus increase both the size of the local population and change the composition of the workforce. This type of sorting has specific implications for the differential impact of refugee inflows across space and I show below that the model-implied sorting is consistent with the empirical relationship implied by (5).

Spatial Mobility Individuals are mobile across space, but subject to frictions. Individuals know their type before making their moving decisions, but do not observe their particular skill realization z_{it}. The utility for individual i of type ν who currently lives in region j and

[20] Note that $\pi_{rMt}^I > \pi_{rMt}^F$ because of the comparative advantage of industrial workers in the manufacturing sector.

moves to region r at time t is thus given by $\mathcal{U}^i_{jrt} = \mathcal{A}_{rt}\overline{u}^{\nu}_{rt}\eta_{jr}\xi^i_{rt}$. Here, $\mathcal{A}_{rt}$ denotes an amenity in region r, $\overline{u}^{\nu}_{rt} \propto \overline{w}^{\nu}_{rt}/\left(\mathcal{P}^{\alpha}_{rAt}\mathcal{P}^{1-\alpha}_{rMt}\right)$ is the expected utility an individual of type ν achieves in region r, η_{jr} parametrizes the moving costs from j to r and ξ^i_{rt} is a regional taste shock which is independent across individuals and locations and Fréchet distributed with shape parameter ε. The share of people of type ν moving from region j to region r, m^{ν}_{jrt}, is thus given by

$$m^{\nu}_{jrt} = \frac{\left(\mathcal{A}_{rt}\eta_{jr}\overline{u}^{\nu}_{rt}\right)^{\varepsilon}}{\sum_d \left(\mathcal{A}_{dt}\eta_{jd}\overline{u}^{\nu}_{dt}\right)^{\varepsilon}}. \tag{6}$$

Note that (6) encapsulates the economics of spatial sorting: because industrial types put a higher weight on manufacturing wages, they move towards locations with a comparative advantage in manufacturing.

Motivated by the high persistence of the spatial allocation of refugees, I allow for (in addition to the moving costs encapsulated in η_{jr}) a second mobility friction a la Calvo: at each point in time individuals have the option to move with probability $\psi > 0$. The combination of $\psi < 1$ and $\eta_{jr} \neq \eta_{kr}$ for $j \neq k$ parsimoniously captures the intensive and extensive margin of costly migration. The "Calvo shock" ψ mostly governs the persistence of the initial population distribution. The bilateral migration frictions η_{jr} govern the spatial proximity of moving flows conditional on moving. In my quantitative application I assume that $\eta_{jr} \propto d^{-\kappa}_{jr}$, where d_{jr} is the geographic distance between j and r and κ is a parameter, which I estimate. Similarly, I assume that local amenities are a power function of the local population, $\mathcal{A}_{rt} = \mathcal{A}_r L^{-\beta}_{rt}$. The parameter β captures congestion forces such as the scarcity of local housing or rivalries in the usage of public goods.

4.2 Equilibrium

The timing of events is as follows. At the beginning of period t, the set of state variables in region r is given by its exogenous productivity $\mathcal{Q}_{rt-1}$, the number of existing varieties N_{rt-1} and the local population of industrialists and farmers $\mathscr{L}_{rt-1} = \left(L^F_{rt-1}, L^I_{rt-1}\right)$.[21] Then the exogenous productivity shock $\mathcal{Q}_{rt}$ is realized, individuals make their mobility decision, and new firms decide whether or not to enter. These choices determine the future set of state variables $(\mathcal{Q}_{rt}, N_{rt}, \mathscr{L}_{rt})$. Production, consumption and factor prices are then determined as the outcomes of a static trade equilibrium.

[21] Note that, because refugees and natives are identical conditional on their type ν, the relevant state variable is only the local distribution of types $L^{\nu}_{rt-1} = L^{R\nu}_{rt-1} + L^{N\nu}_{rt-1}$.

Static Equilibrium To solve for the static equilibrium allocations, consider first the manufacturing sector.[22] Because the market for intermediate inputs is monopolistically competitive, firms charge a constant markup and receive a share $1/\rho$ of firm revenue as profits. Production workers thus receive a share $(\rho - 1)/\rho$ as labor payments. This implies that profits of firm i in region r are given by

$$\pi_{irt} = \frac{1}{\rho}\frac{P_{rMt}Y_{rMt}}{N_{rt}} = \frac{1}{\rho - 1}\frac{w_{rMt}H_{rPt}}{N_{rt}},$$

where $H_{rPt} = H_{rMt} - H_{rEt}$ is the mass of production workers in region r at time t and H_{rEt} the resources allocated to entry activities.

The mass of varieties N_{rt} is determined by free entry. As for workers, I assume that entering firms act myopically.[23] Free entry therefore requires that profits equal the cost of entry:[24]

$$\pi_{rt} = w_{rMt} f_E N_{rt-1}^{-\lambda}. \tag{7}$$

Using the expressions for profits π_{ir}, (7) yields a simple expression for the evolution N_{rt}:

$$N_{rt} = \frac{1}{f_E}\frac{1}{\rho - 1} \times \underbrace{H_{rPt}}_{\text{Market size}} \times \underbrace{(N_{rt-1})^{\lambda}}_{\text{Dynamic agglomeration}}. \tag{8}$$

Equation (8) is the key equation of the model as it highlights the two determinants of variety creation and hence productivity growth at the local level. The first term is the usual scale effect: a larger workforce H_{rPt} triggers the entry of new varieties because it goes hand in hand with larger profits. Note that H_{rPt} emerges as a sufficient statistic that summarizes all equilibrium effect of sectoral wages and aggregate demand, which are determined as part of the trade and spatial equilibrium. The second term captures the dynamic agglomeration force. As long as $\lambda > 0$, the equilibrium features persistence whereby the existing number of varieties positively predicts the future number of varieties.

Equation (8) nests three important benchmark models as special cases and the structural estimation allows me to distinguish between them. If $\lambda = 0$ and $\delta = 1$, the model is the static model of Krugman (1980): firms only live for a single period and the costs of entry do not depend on the past number of varieties. The case of $\lambda = 1$ is the specification of Romer (1990), where the costs of creating new varieties are inversely proportional to the level

[22] See Section SM-1.1 in the Appendix for details.

[23] As for the owners of land, I assume that firm profits accrue to a set of spatially immobile entrepreneurs.

[24] While the free entry condition always holds with equality in the steady-state, it might be slack during the transitional dynamics. To avoid a taxonomic presentation, I focus on the case where (7) holds with equality in the main text. In the quantitative application I, of course, allow for the general case where (7) might be slack.

of knowledge N_{rt-1}. This specification of the model leads to fully endogenous growth. The intermediate case of $0 < \lambda < 1$ is the semi-endogenous growth model of Jones (1995), where growth in the long-run is fully determined by population growth. As I discuss in detail below, these different parameterizations have strikingly different implications for the dynamic effects of refugee inflows on local income per capita and population size.

Armed with equation (8) I can also solve for the endogenous aggregate production function of the manufacturing sector, which is given by

$$Y_{rMt} = \varsigma_1 \mathcal{Q}_{rt} N_{rt}^{\frac{1}{\rho-1}} H_{rPt} = \varsigma_2 \mathcal{Q}_{rt} N_{rt-1}^{\lambda\vartheta} H_{rPt}^{1+\vartheta} \quad \text{where} \quad \vartheta = \frac{1}{\rho-1}, \tag{9}$$

and ς_1 and ς_2 are inconsequential constants. The first equality of equation (9) shows the usual variety gains: a larger mass of varieties N_{rt} increases productivity and given N_{rt} the manufacturing sector has constant returns to scale. The second equality exploits that N_{rt} is itself increasing in the size of the workforce H_{rPt}. This implies that the manufacturing sector has increasing returns holding a location's pre-determined state variables $(\mathcal{Q}_{rt}, N_{rt-1})$ fixed. I thus refer to ϑ as the *short-run scale elasticity.*[25]

Given the aggregate sectoral production functions in (3) and (9), the static equilibrium can be fully characterized given the vector of $(\mathcal{Q}_{rt}, N_{rt-1})$ and the population distribution $\mathscr{L}_{rt}$.

Definition 1. *Given $\{\mathcal{Q}_{rt}, N_{rt-1}, \mathscr{L}_{rt}\}_r$, a static equilibrium is a set of wages and land rents $\{w_{rAt}, w_{rMt}, R_{rt}\}_r$, intermediate varieties, input prices and quantities $\{N_{rt}, [p_{irt}, x_{irt}]_i\}_r$, sectoral employment allocations $\{H_{rAt}, H_{rPt}, H_{rEt}\}_r$ and quantities of tradable goods $\{Y_{rAt}, Y_{rMt}\}_{rt}$, such that (i) firms and consumers behave optimally and (ii) labor and good markets clear.*

Because this static trade equilibrium is characterized by the typical market clearing condition, I relegate the formal derivation to the Appendix (see Section SM-1.2). The only equation I want to highlight is the expression for equilibrium local market size H_{rPt}, which is given by

$$H_{rPt}\left(\{\mathcal{Q}_{rt}, N_{rt-1}, \mathscr{L}_{rt}\}\right) = \frac{\rho-1}{\rho}\left(\Gamma_\theta \sum_{\nu=I,F} L_{rt}^{\nu} \left(\phi_M^{\nu}\right)^{1/\theta} \left(\pi_{rMt}^{\nu}\right)^{\frac{\theta-1}{\theta}} + (1-\delta) f_E N_{rt-1}^{1-\lambda}\right), \tag{10}$$

Equation (10) highlights that local market size is affected both by local labor supply and aggregate demand. First, the sheer size of the population $\mathscr{L}_{rt} = \left(L_{rt}^F, L_{rt}^I\right)$ naturally affects the size of the manufacturing workforce. Second, the size of the local manufacturing sector, π_{rMt}^{ν}, is determined as part of the trade equilibrium and thus depends on $\{\mathcal{Q}_{rt}, N_{rt-1}, \mathscr{L}_{rt}\}_r$.

[25]Holding $(\mathcal{Q}_{rt}, N_{rt-1})$ fixed, the expression in (9) is isomorphic to a setting with exogenous agglomeration forces common in many models of economic geography (Redding and Rossi-Hansberg, 2017).

Dynamic Equilibrium The static equilibrium allocations determine the distribution of factor prices $\{w_{rAt}, w_{rMt}\}_r$ and depend on the population distribution $\mathscr{L}_{rt}$. Moreover, the evolution of regional varieties $\{N_{rt}\}$ also has to be consistent with firms' entry decisions. The dynamic equilibrium of this economy is thus defined in the following way:

Definition 2. *Given a path of exogenous productivity $\{\mathcal{Q}_{rt}\}_{rt}$ and an initial condition $\{\mathscr{L}_{r0}, N_{t0}\}_r$, a dynamic equilibrium is a path of local populations $\{\mathscr{L}_{rt}\}_{rt}$ and local varieties $\{N_{rt}\}_{rt}$, such that (i) $\{\mathscr{L}_{rt}\}_{rt}$ is consistent with individuals' optimal mobility decisions, (ii) $\{N_{rt}\}_{rt}$ is consistent with free entry and (iii) the resulting allocations represent a static equilibrium at each point in time.*

The laws of motion of the two endogenous state variables $\{\mathscr{L}_{rt}, N_{rt}\}_{rt}$ are given by

$$N_{rt} = \frac{1}{\rho-1}\frac{1}{f_E} \times H_{rPt}\left(\{\mathcal{Q}_{rt}, N_{rt-1}, \mathscr{L}_{rt}\}\right) \times N_{rt-1}^{\lambda} \tag{11}$$

$$L_{rt}^{\nu k} = (1-\psi)\, L_{rt-1}^{\nu k} + \psi \sum_{j=1}^{R} L_{jt-1}^{\nu k} m_{jrt}^{\nu}\left(\{\mathcal{Q}_{rt}, N_{rt-1}, \mathscr{L}_{rt}\}\right), \tag{12}$$

where the notation highlights that H_{rPt} (given in (10)) and the migration flows m_{jrt}^{ν} are functions of $\{\mathcal{Q}_{rt}, N_{rt-1}, \mathscr{L}_{rt}\}$ via equilibrium wages and prices.

Equations (11) and (12) are the key dynamic equations of my theory because they describe the joint evolution of local productivity N_{rt} and the local population $\mathscr{L}_{rt}$. Local productivity N_{rt} depends on the size of the local population $\mathscr{L}_{rt}$ through the size of the manufacturing workforce: a larger population raises H_{rPt} and thus triggers variety creation - see (10). Similarly, $\mathscr{L}_{rt}$ depends on the mass of local varieties through equilibrium factor prices and agents' migration choices.

4.3 Population Inflows and Persistent Local Productivity Dynamics

The joint dynamics of local variety creation and the local population depend crucially on the extent of spatial mobility and the knowledge externality λ. Equation (11) implies that the equilibrium process for N_{rt} is an AR(1) process,

$$\ln N_{rt} = \alpha_0 + \lambda \ln N_{rt-1} + \ln H_{rPt},$$

where $\alpha_0 = \ln\left(\frac{1}{\rho-1}\frac{1}{f_E}\right)$. Hence, λ emerges as the key parameter governing the persistence of changes in market size. For any $\tau \geq t_0$, the level of productivity $N_{r\tau}$ is given by

$$\ln N_{r\tau} \quad = \quad \Lambda\left(t, t_0\right) + \lambda^{\tau-(t_0-1)} \ln N_{rt_0-1} + \sum_{j=t_0}^{\tau} \lambda^{\tau-j} \ln H_{rPj}, \tag{13}$$

where $\Lambda\left(t, t_0\right) = \alpha_0 \sum_{j=t_0}^{\tau} \lambda^{j-t_0}$. Equation (13) highlights that local productivity depends on the entire *history* of the manufacturing workforce $\{H_{rPj}\}_{j=t_0}^{t_0+\tau}$ (discounted by λ) because past market size led to plant entry, which made the creation of future varieties easier. Hence, local labor supply shocks can have transitory effects, long-lasting effects or lead to persistence, where the long-run outcomes depend on the history of past shocks.

With free mobility, i.e. $\psi = 1$ and $\eta_{jk} = 1$, the distribution of people across space ceases to be a state variable and a population shock to an individual region lasts only for a single period. If in addition there are no dynamic spillovers, i.e. $\lambda = 0$, the model is a static model with agglomeration forces as in Allen and Arkolakis (2014) or Ahlfeldt et al. (2015). This parameterizations is at odds with my empirical findings that the population shock was persistent and that the effect on income per capita was increasing over time.

With frictions to spatial mobility and $0 < \lambda < 1$, the initial allocation of refugees has long-lasting effects. If $\lambda > 0$, even a one-time increase in H_{rPt} affects local productivity in all future periods. As long as $\lambda < 1$, the productivity response is long-lasting, but subsides eventually. For the limiting case of $\lambda = 1$, the productivity process is a random walk, shocks have permanent effects and the cross-sectional productivity distribution is not stationary. Furthermore, with frictions to spatial mobility, a population shock in t induces an increase in H_{rPt} for future periods and hence complements the long-lasting productivity response. However, as long as the shock does not increase H_{rPt} permanently, the productivity response is also not permanent.[26]

Finally, the model also admits the possibility of full persistence or, in the terminology of Allen and Donaldson (2020), path-dependence, where the initial allocation determines the allocation in the long-run. A temporary increase in labor supply triggers the creation of local varieties. This in turn raises local wages and can prevent individuals from leaving, leading to a permanent increase in H_{rPt}. This feedback-loop is more likely to occur if agglomeration forces are large (i.e. λ are large and ρ is small), spatial dispersion forces are limited (i.e. ε and

[26] As a specific example, suppose there is a positive shock to H_{rP} at t_0, which subsides at rate $p \leq 1$, that is $d\ln H_{rPd+t_0} = d\ln H_{rPt_0} \times p^d$. As I show in Section OA-1.2 in the Online Appendix, the elasticity of local varieties with respect to the initial shock is given by $d\ln N_{rd+t_0/}d\ln H_{rPt_0} = \Psi_d\left(p,\lambda\right) = \frac{\lambda^{d+1}-p^{d+1}}{\lambda-p}$. If the shock is transitory, $\Psi_d\left(0,\lambda\right) = \lambda^d \to 0$, i.e. the productivity response is long-lasting but declining over time. If the shock was permanent, $\Psi_d\left(1,\lambda\right) = \frac{1-\lambda^{d+1}}{1-\lambda} \to \frac{1}{1-\lambda}$, i.e. the effect is increasing over time. If $0 < p < 1$, the productivity response subsides in the long-run, but the impulse response $\Psi_d\left(p,\lambda\right)$ is hump-shaped if $\lambda + p > 1$.

σ are large and β is small) and mobility is subject to frictions (i.e. ψ is small). My structural estimation puts the model in the range of parameters, where such path-dependence occurs and the refugee settlement had persistent effects.

4.4 Balanced Growth and the Long-Run Scale Elasticity

To study the long-run implications of my theory, consider the behavior of the economy along a non-stochastic spatial balanced growth path (SBGP), which I define as an allocation where the population distribution is stationary and regional wages grow at a common rate. Along a SBGP innate productivity $\mathcal{Q}_{rt}$ is constant and equal to its long-run level $\mathcal{Q}_r$. With a stationary population, goods market clearing implies that regional varieties grow at a common rate:

$$g_N = \frac{N_{rt}}{N_{rt-1}} = \frac{1}{\rho - 1}\frac{1}{f_E} H_{rPt} N_{rt-1}^{\lambda-1}. \tag{14}$$

Equation (14) has obvious similarities to the growth equation analyzed in Jones (1995). For g_N to be constant across space, the local mass of varieties along a SBGP is given by

$$N_{rt} = \left(\frac{1}{g_N^{\lambda}}\frac{1}{\rho - 1}\frac{1}{f_E}\right)^{\frac{1}{1-\lambda}} H_{rPt}^{\frac{1}{1-\lambda}}, \tag{15}$$

and thus tied to local employment in the manufacturing sector. Hence, if $\lambda < 1$ this is the semi-endogenous growth model of Jones (1995), where, in the absence of population growth, income growth is bound to be zero in the long-run and the economy converges to a steady-state. Larger locations thus have a higher *level* of productivity but they do not grow at a faster rate.

The case of $\lambda = 1$ is qualitatively different. As is apparent from (14), generically there does not exists a SBGP as this would require the amount of human capital to be equalized across space. The linear relationship between growth and the level of population is of course exactly the case of "strong scale effects", which is at the heart of most models of endogenous growth. Equation (14) can therefore be read as the spatial analog of the distinction between endogenous and semi-endogenous growth: the spatial distribution of economic activity is stationary in the latter, but not stationary in the former.

Equation (15) highlights the importance of local scale effects: regions where H_{rPt} is large have high productivity. Crucially, the long-run relationship between productivity and the manufacturing workforce is fundamentally different from the short-run relationship. Combining the balanced growth relationship (15) with the equilibrium production function (9) yields

$$Y_{rMt}/H_{rPt} \propto \mathcal{Q}_{rt} N_{rt-1}^{\lambda\vartheta} H_{rPt}^{\vartheta} \propto \mathcal{Q}_r H_{rPt}^{\frac{\vartheta}{1-\lambda}}.$$

Thus, whereas the short-run elasticity ϑ describes the relationship between local productivity and local scale, holding N_{rt-1} constant, the long-run elasticity takes the endogeneity of N_{rt-1} into account and is given by $\vartheta/(1-\lambda)$. As long as $\lambda > 0$, the long-run scale elasticity exceeds the short-run elasticity and the dynamic accumulation of ideas amplifies the static differences in regional scale.

4.5 Taking Stock: Connecting the Theory to the Natural Experiment

The theory of this paper is deliberately constructed to capture the salient features of the historical settlement. An exogenous inflow of refugees increases the local population and has persistent effects if mobility frictions are important (ψ is small). This shock increases the size of the local manufacturing sector, H_{rPt}, both directly through an increase in L_{rt}^{ν} and indirectly through a sectoral reallocation of factors. In particular, because the agricultural sector has decreasing returns to scale, a larger population increases the employment share in manufacturing. The effects on local income are shaped through the interplay between decreasing returns in agriculture and increasing returns in manufacturing. In particular, if $\lambda > 0$ the long-run scale elasticity exceeds the short-run elasticity and the GDP impact can be small at first and grow over time.

5 Structural Estimation and Quantitative Analysis

I now estimate the structural parameters of my theory by fitting the empirical results of Section 3. This exercise has two main purposes. First, I show that the theory can quantitatively rationalize the empirical results presented in Section 3. Second, the model allows me quantify the effect of the refugee-settlement on aggregate income and to study how the government policy of sending refugees to the countryside ignited persistent rural industrialization.

5.1 Estimation and Identification Strategy

The model is fully parametrized by 17 structural parameters and a tupel of fundamentals $\{\mathcal{Q}_r, \mathcal{A}_r, \mathcal{T}_r\}_r$ per region. I calibrate 5 parameters externally and estimate the remaining 12 parameters within the context of this paper

$$\Omega = \left\{ \underbrace{\rho, \lambda}_{\text{Growth}}, \underbrace{\varepsilon, \psi, \kappa, \beta}_{\text{Spatial Mobility}}, \underbrace{\chi, \phi_M^I, \phi_A^I}_{\text{Skill distribution}}, \underbrace{\varpi}_{\text{Process of } \mathcal{Q}_{rt}}, \underbrace{\alpha}_{\text{Agricult. spending}}, \underbrace{\zeta}_{\text{Trade costs}} \right\}.$$

My empirical strategy to identify Ω and $\{\mathcal{Q}_r, \mathcal{A}_r, \mathcal{T}_r\}_r$, which I describe in more detail in Section SM-2.3 in the Appendix, relies on two steps. First, given the parameters Ω, I identify the time-invariant fundamentals $\{\mathcal{Q}_r, \mathcal{A}_r, \mathcal{T}_r\}_r$ by calibrating the model to the cross-regional data on GDP per capita, sectoral employment shares and population size in 1933, which I assume to correspond to a steady-state of the system.[27]

I then replicate the historical experiment of the refugee settlement in my model. To do so, I simulate the dynamic evolution of the economy starting in 1933 and "shock" the economy both with a sequence of local shocks to their productivity $\mathcal{Q}_{rt}$ and with the inflow of refugees in the post-war period. Because the majority of refugees arrived around the year 1947, I assume that all refugees arrived in 1947 and I allocate them according to the empirically observed share of refugees in 1950.[28] Hence, the model - by construction - replicates the empirical correlation between the share of refugees and population density, GDP per capita and sectoral employment shares in 1933. In terms of fundamentals, refugee-rich localities tend to have low permanent productivity $\mathcal{Q}_r$ and a comparative advantage in the productivity of agricultural goods (i.e. high $\mathcal{T}_r/\mathcal{Q}_r$).

Estimation Moments I estimate the 12 parameters Ω through a combination of calibration and indirect inference. In total I target 16 moments. Eleven of these moments directly exploit the variation induced by the historical experiment. First, I target six regression coefficients between the share of refugees in 1950 and population growth, income per capita growth and the growth of manufacturing employment in 1950 and 1961 reported in columns 2 and 6 of Table 6. By relying on a specification that controls for population density and economic outcomes in the pre-war period, the regressions implicitly control for the variation in fundamentals. And because the allocation of refugees is uncorrelated with the regional productivity shock u_{rt}, this specification is - in the context of my model - consistent with the identification assumptions

[27]Formally, given a set of structural parameters, there is a one-to-one mapping between $\{\mathcal{Q}_r, \mathcal{A}_r, \mathcal{T}_r\}_r$ and the three moments for each region. In principle, one could identify the fundamentals without the steady-state assumption. This would, however, require at least two periods where the above mentioned data was observed. I only have access to the data on GDP per capita for a single period prior to the war.

[28]Even though the model-implied refugee share in 1950 is therefore not exactly equal to the one in data, the difference is very small because the estimated mobility hazard ψ is small.

	Population growth	Long-run outcomes	
	1950-1955	Pop. growth: 1939-1980	GDPpc growth: 1935-1980
Share of refugees in 1950	-0.342***	1.041*	0.201
	(0.071)	(0.521)	(0.198)
State FE	✓	✓	✓
Pre-war controls & Geography	✓	✓	✓
N	526	331	329
R^2	0.756	0.228	0.919

Notes: Standard errors are clustered at the level of 37 *Regierungsbezirke*. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively. All specifications control for state fixed effects, the share of the destroyed housing stock, the distance to the inner German border, a fixed effect for whether a county is a border county and population density in 1939. The specification in column two (three) controls for the log of the size of the population in 1939 (log GDP pc in 1935).

Table 10: Additional Moments for Quantitative Analysis

underlying my OLS strategy.[29] Second, I target the correlation between the refugee share in 1950 and 1955 and 1961 depicted in Figure 2.

I augment this indirect inference strategy with three additional regressions that directly speak to the short-run dynamics of local population growth and the long-run response of local productivity and population size. Specifically, I target a regression between the share of refugees in 1950 and subsequent population growth between 1950 and 1955 and - in addition to 1950 and 1961 - the relationship between refugee inflows and income per capita and population size in 1980. As seen in the first column of Table 10, refugee-rich counties in 1950 experience slower population growth between 1950 and 1955, indicating that local congestion plays an important role. The remaining two columns of Table 10 show that refugee-rich counties in 1950 are still larger and richer in 1980. Economically, these patterns points towards a parametrization where the initial population shock was very persistent. In Table SM-9 in the Appendix I summarize all the regression moments above in a unified table

I utilize five additional moments to identify the model. First, I discipline the average earnings premium in manufacturing relative to agriculture, i.e. the "agricultural productivity gap". In my theory, this gap reflects both differences in the human capital between industrialists and farmers and differences in local factor prices because, empirically, agriculturally specialized locations are on average poor. Because my data does not contain direct information on local earnings by sector, I target a value of 1.5, which is in line with the results reported in Gollin et al. (2014). Second, I measure differences in earnings between refugees and natives at the micro-level by estimating a Mincer-type regression. Empirically, refugees earn about 7.5% less than natives.

[29]By focusing on the OLS estimates, I can directly use the observed share of refugees and hence ensure that the model matches the cross-sectional distribution of refugees and its correlation with other county characteristics. If I had opted to use the IV estimate as a moment for identification, I would have had to model the first stage explicitly. Given that the OLS and the IV estimates are quite similar, I chose to target the OLS results.

To estimate the size of spatial trade and migration frictions, I first use a historical migration survey in 1955 that reports - for each county - the share of out-migrants that remains in their state. Empirically, 2/3 of migration flows occur within the same state and I target this number to discipline the extent to which migration costs are increasing in distance. I model trade costs as a power function of distance, i.e. $\tau_{rj} \propto d_{rj}^{\zeta}$ and recover ζ from the gravity relationship of within-country trade flows. Because I do not have access to historical trade flow data from Germany at the county-level, I target the moment reported in Monte et al. (2018), who use data on shipments within the US and estimate a distance elasticity of -1.29.[30] Finally, to estimate the dispersion of productivity shocks ϖ, I run the county-level panel regression of log GDP pc $\ln y_{rt} = \delta_r + \beta \ln y_{rt-1} + v_{rt}$ both in the model and the data and target the dispersion of the estimated residuals, i.e. $sd(\hat{v}_{rt})$.

Mapping to Parameters Even though I estimate all moments jointly, they map directly to the main parameters of interest. The two scale parameters ρ and λ are mostly identified by the response of income per capita and manufacturing employment at different horizons. The Calvo-type mobility friction ψ, the labor supply elasticity ε and the strength of congestion in local amenities β are important determinants of the extent of spatial mobility and are informed by the spatial auto-correlation of refugee shares and the correlation between refugee inflows and population growth. The data on earnings across sectors and between refugees and natives aid in identifying the human capital parameters. Holding ϕ_A^I fixed, ϕ_M^I increases relative human capital of industrialists and hence the measured agricultural gap. And the extent of sorting, which is influenced by the share of industrial workers χ, affects relative earnings because refugees are, on average, located in rural locations that feature lower factor prices.

Estimation I minimize the distance between these empirically observed moments and the moments in the model using Sobol grids. To account for the sampling variation induced by the stochastic productivity process, I replicate this entire analysis 50 times and calculate the average of all moments and regression coefficients. The five parameters I set externally are the trade elasticity σ, the labor share in the agricultural sector γ, the dispersion of skills θ, the correlation of the productivity process ϱ and the exogenous exit rate δ. I assume that $\sigma = 5$, $\gamma = 0.5$, $\theta = 2$, $\varrho = 0.9$ and $\delta = 0.1$. The fixed cost of entry f_E can be normalized by an appropriate choice of units for N_{rt}.

[30] This elasticity is consistent with the findings reported in Wolf (2009), who analyzes data on trade flows across 21 regions in Germany in the pre-war period. He estimates a distance elasticity of around -1.4.

The German Division and the Loss of Market Access Finally, I augment my estimation strategy by one additional important historical feature. As highlighted in my empirical analysis and stressed in Redding and Sturm (2008), the spatial allocation of refugees is correlated with a second "spatial shock": the division of Germany also represented a loss of market access for counties closer to the inner German border. To capture this correlation in my quantitative analysis, I allow for trade between Western and East Germany in the pre-war period and then model the German division (and the resulting loss in market access) as a prohibitive increase in both trade and mobility costs.[31] Because trade costs prior to the war are a function of distance, counties that are closer to the border are more affected by this shock. To implement this shock, I model East Germany as an "$R+1$"th region in the pre-war period and estimate its economic size by targeting the regression coefficient on the distance to the inner German border and local income growth between 1939 and 1961 corresponding to my main specification in column 6 of Table 6. Intuitively, I discipline the amount of trade there must have been between East and West to force the model to replicate the positive cross-sectional correlation between distance and income growth once trade is prohibited.[32] By explicitly modeling this shock, my estimation and counterfactual analysis take the correlation of refugee inflows and the loss of market size into account.

5.2 Estimation Results and Model Fit

In Table 11 I report the estimated structural parameters and the fit of the model. The model is able to replicate the targeted moments well. In particular, it matches the persistent positive correlation between refugee inflows and population growth (rows 1 - 3) and manufacturing employment (rows 4 and 5), and the fact that the short-run effect on GDP per capita is small (row 6) but the long-run effect is robustly positive (rows 7 and 8). It also matches the spatial persistence of refugee flows (rows 9 and 10) and the correlation between refugee inflows and subsequent population outflows (row 11). Finally, the model also features a positive correlation between income growth and the distance to East Germany due to the loss of market access.

As a visual description of the fit of the model, in Figure 4 I report the regression coefficients

[31] This assumption is consistent with Wolf (2009, p. 876) who finds that "the nearly impregnable border between East and West that existed between about 1946 and 1989 was therefore hardly predictable in 1939."

[32] Another potential correlated "spatial shock" would be government policies that are directed towards localities that experienced large refugee inflows. While it would not invalidate my empirical results if such policies were enacted in response to the arrival of refugees, it would bias my structural estimates. For example, the effect of refugees on local income could partly reflect the policy and not the endogenous productivity response as stipulated by my theory. Because I do not have systematic data on the presence of such policies, I cannot rule out this concern entirely. However, because my analysis always controls for war-time destruction, it would need to be a policy, which is solely targeted towards the arrival of refugees and not driven by other forms of war-time related re-construction.

Structural Parameters			Moments	Data	Model
	Scale Elasticities		*Experimental Moments*		
λ	Inter-temporal elasticity	0.71	Pop growth 39-50 (Table 6)	1.36	1.19
ρ	Elasticity of substitution	5.02	Pop growth 39-61 (Table 6)	1.029	0.934
	Human Capital		Pop growth 39-80 (Table 10)	1.06	0.914
ϕ^I_M	HC of industrialists in manuf.	13.61	Manuf. growth 39-50 (Table 6)	0.317	0.272
ϕ^I_A	HC of industrialists in agric.	0.84	Manuf. growth 39-61 (Table 6)	0.241	0.299
χ	Share of industrial workers	0.58	Income growth 39-50 (Table 6)	-0.083	-0.003
	Spatial Mobility		Income growth 39-61(Table 6)	0.502	0.358
ε	Spatial labor supply elasticity	2.12	Income growth 39-80 (Figure 10)	0.201	0.388
ψ	Frequency of mobility shocks	0.07	Refugee share 1955 (Figure 2)	0.735	0.763
β	Congestion elasticity of amenities	-0.16	Refugee share 1961 (Figure 2)	0.586	0.556
κ	Dist. elasticity of moving costs	-1.09	Pop growth 50-55 (Figure 10)	-0.342	-0.183
	Other		Distance and income growth (Tab SM-9)	0.06	0.012
ϖ	Disp. of prod. shocks	0.05	*Additional Moments*		
y^{East}_{33}	Rel. income in East Germany	2.4	Agricultural productivity gap	1.5	1.516
α	Spending share on agricult.	0.24	Earnings diff. of refugees	-0.075	-0.0729
ξ	Dist. elasticity of trade costs	0.32	Share of outflows within states	0.67	0.611
			Distance elasticity of trade	-1.29	-1.29
			Std. dev. of resid. of regional y growth	0.041	0.037

Notes: The table reports the structural parameters and the targeted moments in both the data and the model. The exogenously set parameters are $\sigma = 5$, $\gamma = 0.5$, $\theta = 2$, $\varrho = 0.9$ and $\delta = 0.1$.

Table 11: Structural parameters & Model Fit

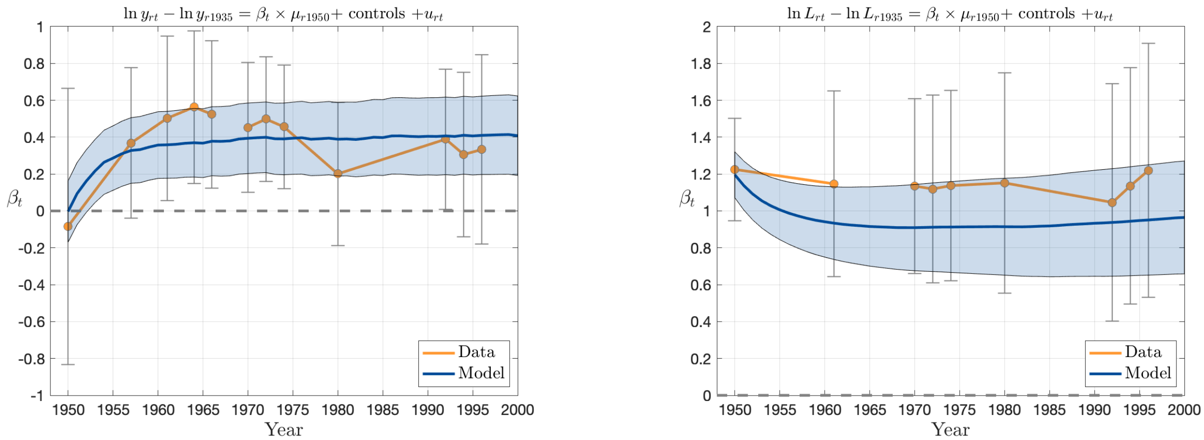
of income growth (left panel) and population growth (right panel) on the refugee share (and the usual controls as in specifications 2 and 6 in Table 6) at different time horizons. The blue line stems from the calibrated model, the orange line depicts the data. For both the model and the data I also plot the respective 95% confidence intervals. Figure 4 highlights that the model captures the main features of the persistent effects on income and population growth.

In terms of structural parameters, I estimate the knowledge externality λ to be 0.71 and the elasticity of substitution ρ to be 5. Hence, the short-run scale elasticity in the non-agricultural sector is equal to $\vartheta = \frac{1}{\rho-1} = 0.25$ and the long-run scale elasticity is $\frac{1}{1-\lambda} \approx 3.5$ times as large.[33]

As highlighted above, the estimate of λ is tightly linked to the importance of scale effects at the aggregate level. My finding of $\lambda < 1$ implies that growth is semi-endogenous so that population shocks increase the level of productivity but not the long-run growth rate. This is consistent with existing empirical work, that has mostly relied on time-series data and also points towards models of semi-endogenous growth (Jones, 1995; Bloom et al., 2020).[34]

[33]Note that $\vartheta \approx 0.25$ is not directly comparable to typical estimates of regional agglomeration as it applies only to the manufacturing sector. Given the decreasing returns in agriculture, the "overall" short-run scale elasticity at the local level is below 0.25.

[34]Note, however, that this cross-sectional evidence is not necessarily conclusive. If ideas were to diffuse across space, the cross-sectional evidence could underestimate the aggregate scale elasticity. Alternatively, the cross-



Notes: The figures report the coefficient β of the regression $y_{rt} = \beta_t \mu_{r1950} + x'_{rt}\gamma + u_{rt}$ for different time horizons and for income growth (left panel) and population growth (right panel) as dependent variables. The vector x_{rt} controls for state fixed effects, population density in 1939, war-time destruction, log income per capital (population) in 1939 and the distance to the inner German border (see columns 2 or 6 of Table 6). For both the model and the data I also report 95% confidence intervals.

Figure 4: Model Fit: The Dynamic Effects on Income and Population Growth

To match the persistence of the refugee settlement, the model implies a moving hazard of $\psi = 0.07$. The remaining parameters are also in line with existing estimates. The migration elasticity $\varepsilon \approx 2.12$ is consistent with Allen and Donaldson (2020) and Monte et al. (2018), who report estimates between 2 and 4 and the distance elasticity of migration cost $\kappa = -1.1$ is in the ballpark of the findings of Allen and Donaldson (2020) and Bryan and Morten (2019), whose estimates are between -0.7 and -2.

Persistence and Path Dependence As highlighted by Allen and Donaldson (2020), population shocks can have persistent effects if they endogenously lead to higher productivity. Environments particularly prone to such effects feature strong degrees of agglomeration and small spatial dispersion forces. In the context of my model, persistence thus requires λ, ϑ and σ to be large and β , ψ and $1/\varepsilon$ to be small.

As I show in detail in Section SM-2.4 in the Appendix, the estimated parameters reported in Table 11 put the model in a range, where such persistence occurs. More specifically, for any history of shocks, the model converges to a steady state but this steady-state depends on initial conditions. The main data moment that pushes towards a parametrization with persistent effects is the large long-run elasticity between refugee inflows and population size. This feature of the model implies that the historical policy of settling refugees in rural locations might have affected the long-run path of industrialization in rural labor markets, a topic I will

sectional elasticity could be an overestimate, if local population shocks were to lead to a spatial reallocation of firms rather than new firm creation. Both of these channels are mute in my theoretical framework.

come back to in Section 5.5.

The Assumption of Myopic Agents My estimation methodology requires me to solve the model's transitional dynamics for different histories of shocks and to then run the empirical regressions of Section 3. A key feature of my theory that facilitates the computational implementation is that the difference equations that describe the evolution of the endogenous state vector $\{N_{rt}, \mathscr{L}_{rt}\}$ are backward looking - see (11) and (12). This property is a direct consequence of my assumption that individuals behave myopically.

In Section OA-4 in the Online Appendix I characterize my model with forward-looking agents and solve for the analogues to (11) and (12). In that case, the equilibrium mobility and entry decisions depend on the entire distribution of future wages. This makes estimating the model while still preserving the rich spatial heterogeneity to connect the theory to my empirical analysis challenging. However, for the questions of interest of this paper, my estimation based on short-lived agents might still lead to informative results. Because the static equilibrium is not affected by the myopia assumption, a model with forward-looking agents would have the same implications for local income and employment shares if it were to match the same path of state variables $\{N_{rt}, \mathscr{L}_{rt}\}$. Many of my targeted moments, in particular the estimated response of population growth and income growth shown in Figure 4, are of course tightly linked to precisely these state variables. Of course, the implied structural parameters would be different and a fully forward-looking model would respond differently to other shocks (e.g. the announcement of a refugee inflow in the future) and have different welfare consequences.

Robustness of Quantitative Results In Section SM-2.6 in the Appendix I discuss two important extensions for the robustness of my results. First, as highlighted above, in 1950 I had to rely on data for value added taxes because data on local GDP per capita only starts in 1957. This naturally raises the concern that the discrepancy between the short- and the long-run effects are in part driven by the differences in income growth measures. I therefore re-estimated the model without relying on income growth in 1950 as an estimation moment. Secondly, I also extend the model by allowing for innate human capital differences between refugees and natives. If, for example, refugees' skills had only been partly transferable, such differences could account for their lower earnings and might change the mapping between refugee inflows and local income growth because of a deterioration of the local human capital stock. The re-estimated model shows that, quantitatively, both of these concerns are not very important. The estimated parameters are very similar and so is the match with the targeted moments.

5.3 Non-targeted Moments: Refugees' Manufacturing Bias

An interesting empirical feature of this study is the manufacturing bias of refugees' labor supply. Because my estimation did not utilize any information on the relative employment share between refugees and natives, I can validate the model along this dimension. Because the local population of refugees was not selected on their skills, the type composition did not vary across space, i.e. $\omega_{rt}^{RI} = \chi$. By contrast, the theory implies that the native population was spatially sorted whereby industrial types located in regions that have a comparative advantage in the production of manufacturing goods. Hence, ω_{rt}^{NI} is positively correlated with the local manufacturing share in 1933. This has two testable implications. First, refugees' manufacturing bias, i.e. $\pi_{rMt}^{R} - \pi_{rMt}^{N}$, should be particularly large in rural locations where ω_{rt}^{NI} is low (see (5)). Second, as a consequence, the effect of refugee inflows on manufacturing employment should be especially large in such areas.

In Table 12 I document these predictions both in the model and in the data. In the first four columns I report regressions run in the model for a particular realization of productivity shocks. The first column documents the sorting of the native population: there is a strong correlation between the pre-war manufacturing share π_{r1939}^{M} and the share of industrialists ω_{r1939}^{I}. Column two implements (5) and regresses the refugee bias $\pi_{rMt}^{R} - \pi_{rMt}^{N}$ on the pre-war manufacturing share. The refugee bias is particularly high in rural areas. Finally, the last two columns focus on the spatial heterogeneity of the impact of refugee inflows on local manufacturing growth. For comparison, column three reports the basic cross-sectional relationship and in column four I allow the effect of the share of refugees μ_{r1950} to vary with the pre-war manufacturing share. The model implies that the effect is *stronger* the lower the initial manufacturing share because refugees' manufacturing bias is particularly large in rural areas.

The three remaining columns run the same specifications in the data. Of course, column one does not have an empirical counterpart, because the type composition of the local workforce is unobserved. However, the remaining patterns between the local refugee bias and the heterogenous impact of the refugee settlement are qualitatively and quantitatively very similar although none of these aspects was targeted in the estimation.[35]

[35] Recall that I only observe the refugee bias for the state of Bavaria, hence the smaller number of observations. However, for these 167 counties, the bias in the model and the data is highly correlated. A simple cross-sectional regression between data and model yields a coefficient of 0.38 with a standard error of 0.045. In Section OA-2.8 in the Online Appendix, I provide additional evidence for this pattern of spatial sorting using the expenditure micro data from 1962.

	Model				Data		
	Ind. share ω^I_{r1939}	Refugee bias	Manufac. growth $\pi^M_{r1950}-\pi^M_{r1939}$		Refugee bias	Manufac. growth $\pi^M_{r1950}-\pi^M_{r1939}$	
π^M_{r1933}	0.654***	-0.249***	-0.052***	0.070***	-0.145**	-0.129***	-0.005
	(0.009)	(0.010)	(0.008)	(0.011)	(0.041)	(0.044)	(0.059)
μ_{r1950}			0.354***	0.616***		0.292***	0.482***
			(0.019)	(0.020)		(0.081)	(0.110)
$\mu_{r1950}\times\pi^M_{r1939}$				-0.567***			-0.692**
				(0.042)			(0.325)
Controls		✓	✓	✓	✓	✓	✓
N	500	500	500	500	174	499	499
R^2	0.986	0.935	0.823	0.938	0.267	0.386	0.403

Notes: Standard errors are clustered at the level of 37 *Regierungsbezirke*. *, ** and *** denote statistical significance at the 10%, 5% and 1% level respectively. All specifications control for state fixed effects, population density in 1939, the share of the destroyed housing stock, the distance to the inner German border and a fixed effect for whether a county is a border county.

Table 12: Spatial Sorting and Rural Industrialization

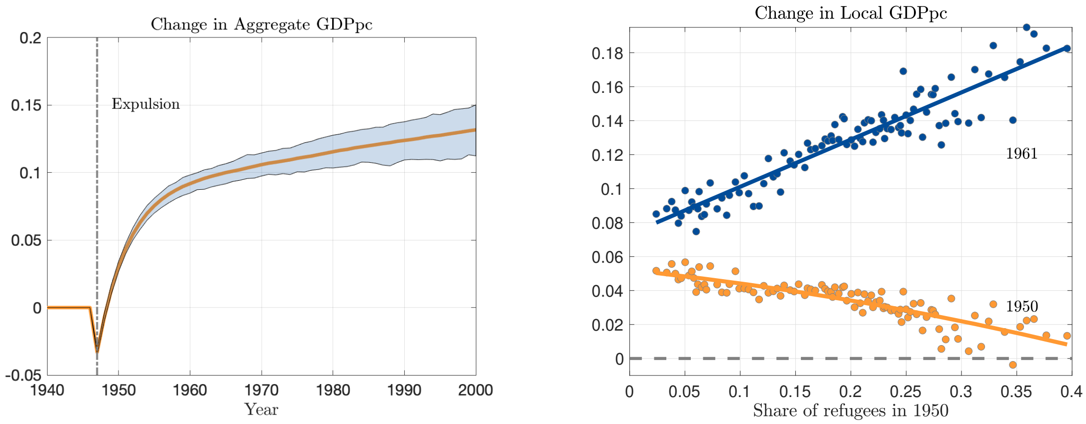
5.4 The Aggregate and Local Effects of the Refugee-Settlements

How large was the aggregate impact of the refugee settlement on economic activity in West Germany? This object is not identified from the cross-sectional regression due to the usual "missing-intercept" problem (see, for example Adao et al. (2021) and Wolf (2019)). However, it can be computed in the calibrated model by comparing the equilibrium with refugee inflows with a counterfactual West Germany where the refugees did not arrive.

In the left panel of Figure 5 I plot the time path of the percentage change in aggregate income per capita due to the refugee settlement. More precisely, for a given sequence of regional productivity shocks, I compute the effect of the refugee settlement on aggregate income. Redoing this experiment for a different sequence of local productivity shocks allows me to estimate the distribution of this aggregate impact and I plot both the average effect in orange and a 95% confidence interval in light blue.

The graph shows that the influx of refugees initially reduced GDP per capita by about 3%. This is mostly due to the fact that agricultural production is subject to decreasing returns. Due to the endogenous nature of technological progress this initial drop is short-lived and the population increase causes income per capita to increase. Given the estimated parameters, the average effect rises to about 8% in 1961 and reaches 12% by 2000.[36]

[36] To put these numbers into perspective, if there was only a single region, the elasticity of long-run income per capita with respect to population size would be given by $d\ln y/d\ln L=(1-\alpha)\vartheta/(1-\lambda)-\alpha\gamma$. Hence, the aggregate scale elasticity is an $\alpha-$weighted average between the long-run scale elasticity in manufacturing $\vartheta/(1-\lambda)$ and the returns to scale in agriculture $-\gamma$. The estimated parameters in Table 11 imply an elasticity of 0.53 in the long-run. The inflow of refugees, which increased the aggregate population by around 18%, should thus have increased income per capita by about 10% in the long-run.



Notes: The left panel shows aggregate GDP per capita for the model with refugee inflows relative to a counterfactual economy without the refugee inflow. The orange line shows one particular sample path of the productivity process $\mathcal{Q}_{rt}$. The shaded area displays a 95% confidence interval from the bootstrap distribution. The right panel shows the spatial impacts in 1950 (orange) and 1961 (blue) as binned scatter plots for 100 percentiles of the refugee share in 1950. I calculate the spatial impact as $\left(y_{rt}^{with} - y_{rt}^{no}\right)/y_{rt}^{no}$, where y_{rt}^{with} and y_{rt}^{no} denote income per capita in the equilibrium with and without the refugee settlement.

Figure 5: The Aggregate and Spatial Impact of the Refugee Settlement

Note that the confidence interval around the aggregate GDP effect reflects two sources of uncertainty. First, the presence of productivity shocks implies that the aggregate impact of refugee inflows is a random variable. Intuitively, the aggregate impact of refugee inflows is larger along a sample path where locations with lots of refugees happen to receive positive productivity shocks. Second, as discussed above, my model features persistence, where the initial allocation potentially affects long-run outcomes. Because the confidence interval is computed from the distribution of outcomes of solving the model repeatedly with different histories of shocks, they capture both these sources of uncertainty. Quantitatively, they can change the aggregate GDP impact by about one percentage point at the 50 year horizon.

These results highlight that the cross-sectional estimates provide a misleading answer for the aggregate impact of the refugee settlement. Not only is the cross-sectional estimate between refugee inflows and GDP per capita in 1950 negative (even though the aggregate effect is positive) but the long-run estimates are also downward biased. The point estimate of 0.2 in 1980 for example suggests that a 18% increase in the share of refugees increases GDP per capita by 3.6%, even though the true aggregate impact is around 10%.

The reason is, of course, that non-treated regions also benefited from the refugee inflow in general equilibrium. This is shown in the right panel of Figure 5, where I depict the correlation between the counterfactual percentage change in income per capita and the share of refugees, both in 1950 (orange dots) and 1961 (blue dots).[37] In 1950 there is a negative correlation, in

[37] I compute the equilibrium path for a given realization of exogenous productivity shocks with and without refugee inflows and calculate the percentage difference between income capita for region r, i.e. $\ln\left(y_{rt}^{with}/y_{rt}^{no}\right)$, where y_{rt}^{with} $\left(y_{rt}^{no}\right)$ denotes income per capita in the equilibrium with (without) the refugee settlement.

line with the negative cross-sectional estimate. However, the entire locus is shifted upwards due to general equilibrium effects that are differenced out in the empirical cross-sectional estimates. If we fast-forward by a decade and look at the impact on income per capita in 1961, we see a different picture. First, the relationship is now strongly positive, reflecting the slow accumulation of local productivity. Empirically, this slope reflects the positive cross-sectional relationship between refugee inflows and income per capita in the long-run. Second, the entire locus is further shifted upwards because regions that were initially non-treated benefit both from refugees' migration response and through trade linkages.

One way to rationalize these patterns is as the combination of supply and demand forces. In order to decompose the importance of these two effects, I define the supply effect for region r as the counterfactual change in income per capita if *only* region r experienced an inflow of refugees. Conversely, I define the demand effect for region r as the counterfactual change if every region *but* region r experienced an inflow of refugees. In the first scenario, demand is - almost - unaffected if region r is small. In the second scenario, region r directly benefits from "foreign" demand and only experiences changes in labor supply dynamically once the inflowing refugees start relocating within Germany.

In Figure 6 I depict the results of conducting these experiments for each of the 500 regions in my sample. The demand effect is depicted in orange, the supply effect is depicted in blue. For comparison I also depict the total effect shown in Figure 5.[38] In the short-run, shown in the left panel, the supply effect is negative and explains most of the cross-sectional variation. Expectedly, the supply effect is zero for a county that did not receive any refugees. By contrast, the demand effect is positive, only weakly correlated with the refugee-share and thus plays the role of the "missing intercept".[39] The right panel, which focuses on the long-run implication, shows that the supply effect also explains the regional differences in income *growth* between 1950 and 1961, while the demand effect lifts all boats.[40]

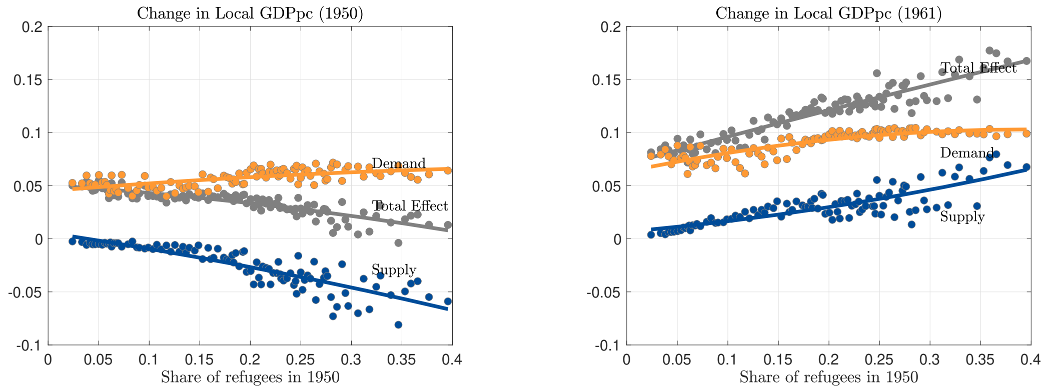
5.5 Persistence of Policy and Rural Industrialization

The persistent consequences of the refugee settlement raise the intriguing possibility that the government policy of settling refugees in rural labor markets might have changed the path of

[38]Due to non-linearities, the sum of the supply and the demand effect is not numerically equivalent to the total effect. In practice, however, they are almost indistinguishable.

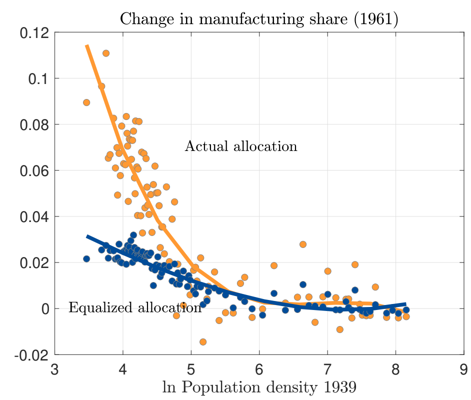
[39]The main reason why the demand effect is weakly positively correlated with the refugee share is that empirically the allocation of refugees is spatially correlated. In the presence of trade costs, this implies that refugee-rich counties experienced a slightly larger demand shock.

[40]See also Section SM-2.5 in the Appendix where I provide more details for this exercise. There I also show that the effect on manufacturing employment is fully captured by the supply force. The demand effect is negative because other regions increase their supply of manufacturing products but is quantitatively very small.



Notes: The figure shows the change in income per capita in 1950 (left row) and 1961 (right row) as binned scatter plots for 100 percentiles of the refugee share in 1950. In each case it displays the total effect, the supply effect (i.e. if refugees had only arrived in the particular region) and the demand effect (i.e. if refugees had only arrived in all other regions).

Figure 6: The Spatial Impact of Refugee Inflows: Demand vs Supply



Notes: The figure shows the change in the local manufacturing employment share, relative to an allocation without refugee inflows, for the historical allocation (orange) and a counterfactual allocation policy that equalizes the initial share of refugees across counties.

Figure 7: Persistent Effects of the Refugee Settlement: Rural Industrialization

local industrialization in West Germany. In particular, could it be that the refugee settlement played the role of a "prime mover" to ignite the process of industrialization in agricultural communities?

To study the quantitative importance of this form of path dependency, I compare the equilibrium with a counterfactual allocation rule where the initial share of refugees was equalized in 1950 but the size of the aggregate inflow is held constant. In Figure 7 I report - for both scenarios - the change in the local manufacturing share in 1961 relative to an allocation without the refugee settlement as a function of pre-war population density.

Figure 7 vividly shows how the specific historical allocation rule affected the process of industrialization in rural Germany. Under the actually implemented allocation rule, low-density, rural communities were the dominant receivers of the inflowing refugee population and industrialized as a consequence. Quantitatively, the model implies that these inflows raised the local manufacturing share by around 5-7% in traditional rural communities.

This specific form of rural industrialization would not have happened with a more equitable refugee allocation in 1950. If the US and the UK Government had been able to equalize the share of refugees in 1950 across counties, rural areas would have only experienced a 2% increase in their manufacturing share. The specific rural nature of the historical allocation rule thus acted as a form of place-based policy that triggered local industrialization and might have played an important role in the emergence of the German manufacturing base that even today is often found in the countryside outside the large cities.[41]

6 Conclusion

The positive relationship between population size and productivity is at the heart of virtually all theories of economic growth. In this paper I analyzed a particular historical setting to provide direct evidence for the empirical relevance of such scale effects. I focused on the expulsion of 8m ethnic Germans in the aftermath of the Second World War that was implemented by the Military Governments of the US, the UK and Russia.

Because regions in West Germany differed substantially in the extent to which they were exposed to the refugee settlement, I use the cross-sectional variation in refugee inflows to estimate the relationship between changes in population size, income per capita and industrialization in both the short- and long-run. I find that the refugee settlement led to persistent increases in the local population, the manufacturing share and income per capita. I then propose a parsimonious idea-based model of spatial growth and estimate its parameters by using the cross-sectional regression results of the natural experiment as identified moments. The model can rationalize the empirical findings both qualitatively and quantitatively and delivers a persistent effect of the refugee settlement if spatial mobility is subject to frictions and dynamic productivity spill-overs occur at the local level and are sufficiently potent. At the aggregate level, the settlement of refugees increased income per capita by about 12% after 25 years. Moreover, the government policy of settling refugees predominantly in the countryside had long-run effects and markedly increased rural industrialization.

A natural question is of course whether these results are quantitatively portable to predict the consequences of immigration episodes today. While I expect the basic mechanism to apply more generally, there are at least three aspects of this study that seem particularly context-

[41] In Section OA-2.9 in the Appendix I analyze these two allocation rules in more detail. There I show that rural counties, in line with their faster industrialization, also experience faster income and population growth and that these effects are still visible 50 years after the initial settlement.

specific. First and foremost, the German economy just emerged from the Second World War and firm creation might have been particularly mobile across space. Second, the refugees were allocated to rural areas and not to urban centers. This is in stark contrast to most episodes of voluntary migration both in the modern era and in the past. Finally, the 1950s and 1960s were characterized by a secular rise in the manufacturing sector. To the extent that the mechanisms highlighted in this paper are less potent in services, the productivity effects of changes in population size might be smaller today.

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