labor&welfareSTATE

Missing Men:
World War II Casualties and Structural Change

by

Christoph EDER*)

Working Paper No. 1403

February 2014

Supported by the Austrian Science Funds

FWF

The Austrian Center for Labor Economics and the Analysis of the Welfare State

JKU Linz
Department of Economics
Altenberger Strasse 69
4040 Linz, Austria
www.labornrn.at

Corresponding author: christoph.eder@jku.at
Phone: +43 (0)732 2468 8246

Missing Men:
World War II Casualties and Structural Change

Christoph Eder*

February 2014

Abstract

This paper investigates the long-term consequences of violent conflict and the associated human casualties on economic development. Using the World War II casualties suffered in Austrian municipalities as a natural experiment, I find a significant negative causal effect of human losses on economic activity, as measured by the current total wage bill in the affected communities today. The underlying determinants of this reduction in output are traced back to a lower number and density of firms, along with a smaller work force. However, this is only true for the service sector and not the manufacturing sector. As I demonstrate, the likely channel through which the effect persisted over time is through its impact on the structural composition of the work force. Specifically, greater human losses increased the fraction of employment in manufacturing at the expense of agriculture until the 1970s and services from then onwards. A simple model shows that structural change can translate a lower labor share in agricultural production into less participation of service sector growth at a later time.

*Department of Economics, Johannes Kepler University Linz, Altenberger Str. 69, 4040 Linz-Auhof, Austria (e-mail: christoph.eder@jku.at) and Simon Fraser University, BC, Canada. I thank Anke Kessler for helpful discussion and encouragement. Fernando Aragón, Michele Battisti, Chris Muris, Simon Woodcock, participants of seminars at SFU, JKU (lunch time seminar), and the University of Vienna provided valuable comments. Thanks for support by the Austrian FWF (NFN Labor Economics and the Welfare State). All remaining errors are mine.

1 Introduction

World War II (WWII) caused enormous losses of human life in many countries, with an estimated death count of over 60 million people (Beevor 2012). What is the effect on long-term economic development of fatalities in an event like this? Even though WWII was the largest shock to human population in history, we know relatively little of its economic impact over time in highly affected areas. This is at least partly due to the difficulty in answering this question credibly via a country level analysis: decisions to enter the war, being attacked, the extent of the damage, or the degree of resistance are likely correlated with country characteristics to which subsequent economic performance is endogenous. Hence, such an estimate of the consequences of war casualties could not be interpreted in a causal way.

In this paper I address the question of long-term effects of human loss of life due to WWII and shed light on the underlying channel of persistence in the post-war period. To this end, I exploit WWII as a natural experiment for military war casualties at the municipality level in Austria. The municipalities I consider share the same history and institutions and exhibit a large degree of ethnic, linguistic, cultural, geographic and economic homogeneity. Moreover, conscription and location of deployment of Austrian men was based on birth cohort rather than municipality characteristics. Thus, the relative number of casualties that a municipality suffered during the war was arguably random.

To conduct the analysis, I employ a novel data set on war casualties that I have collected. I find a strong and robust negative long-term effect of casualties on subsequent economic output, measured by the total wage bill, in the affected municipalities today. Within-district estimates rule out many political and geographic confounding factors. The results prove robust to the inclusion of various control variables. Falsification tests show that high-casualty municipalities did not experience different economic development before the war, strengthening the causal interpretation of the result. To understand the mechanism through which war casualties cause the difference in the output measure, I next take a closer look at the various determinants of economic activity at the municipality level. I find that the primary difference between high- and low-casualty municipalities today is the number and density of firms and a higher number of in-commuters. Interestingly, war casualties only affect the firm environment in the service sector, however, not in the manufacturing sector.

As a second step, I identify a possible channel of persistence, using municipality-level census data since the 1950s. In particular, an analysis of the sector composition of the labor market reveals that the transition from agriculture to the service sector followed differential paths depending on the share of dead WWII combatants. After the war more people are employed in the manufacturing sector in high-casualty municipalities, while fewer work in agriculture until the 1970s and fewer in the service sector since then. The initial sorting to manufacturing in highly affected municipalities is consistent with labor shortage and hence productivity reduction experienced in agriculture due to the perished male household heads.

I develop a simple model of structural change where WWII casualties reduce productivity in agriculture. High-casualty municipalities sort into manufacturing while low-casualty municipalities are in agriculture to exploit the productivity advantage. Income growth through an increase in total factor productivity shifts consumer demand away from agricultural products towards service sector goods. Marginal transition costs to switch between sectors ensure that the labor demand in services is satisfied from the agricultural sector. The low-casualty municipalities are therefore over-represented in the service sector. When the service sector grew substantially since the 1970s, people already working in the service sector established firms in their home municipalities, and hence the output difference today. To my knowledge, a labor shortage in agriculture and a consequently different path of structural change has not been identified as a link between violent conflict and long-term economic development.

The findings in this paper relate to a broader literature on the long-term effects of historic events. This literature was recently surveyed by Nunn (2014), who addresses a wide array of historic events and mechanisms underlying historic persistence. This paper is most closely related to a contribution by Acemoglu et al. (2011) on the effects of the Holocaust in Russia on subsequent economic and political development. They document a negative relationship between the reduction of the Jewish population and subsequent population growth, wages and political development. However, Acemoglu et al. (2011) focus on the reduction of a narrow subgroup of the population, a feature I extend upon by looking at a lack of men of all social classes.

A number of other papers study the persistent effects of forced population movements through channels different from structural change. Nunn (2008) focuses on slave extraction in Africa and shows a large and negative effect on today's economic development. Nunn and Wantchekon (2011) show that persistence can emerge through a culture of mistrust generated through the slave trades. Dell (2010) studies the mining *mita*, an extensive forced labor system established in the 16th century in Peru, and finds negative long-term effects through fewer formations of *haciendas*, large land holdings with an attached labor force, which in turn were responsible for providing education and the road network. A number of contributions have identified labor shortages in agriculture as the driving force behind adjustment processes to historic events. Chaney and Hornbeck (2013) find increased per capita output due to the adaption of different agricultural technology in response to the 1609 expulsion of Moriscos from Spain. A more recent event, the 1927 Great Mississippi Flood, caused black out-migration and subsequent increased capital intensity in agriculture in affected areas (Hornbeck, Naidu (forthcoming)). Conversely, I find that in times of rapid structural change labor shortage in agriculture can have a detrimental effect on long-run development.

Finally, the literature on the long-run consequences of wars include Davis and Weinstein (2002 and 2008), Brakman, Garretsen, and Schramm (2004), and Miguel and Roland (2011). These papers analyze bombings of Japanese or German cities in WWII and bombings during the Vietnam War, respectively, and find no long-term effects on a range of outcome measures. My findings stand in contrast to the results of this line of research, which suggests the relative importance of human versus physical capital.

The paper is organized as follows: Section 2 gives an overview of the history of Austria in WWII and Austrian municipalities in general. In Section 3 the identification strategy and the data are described, while Section 4 gives the main empirical results on the relationship between output and WWII casualties and performs robustness checks and falsification tests. The next section explores the determinants of the estimated difference in output, Section 6 looks at the process of divergence since the 1950s, while Section 7 concludes.

2 World War II and Austrian Municipalities

2.1 Austria and World War II

The annexation of Austria through Germany in March 1938, generally referred to as *Anschluss*, meant the temporary disappearance of Austria as a nation state. The union with Germany, which was preparing for war, brought both positive and negative economic shocks, but led to a great reduction of unemployment in Austria (Thalmann 1954, p.500).

When WWII broke out in the summer of 1939, Austrian forces were already fully integrated in the German army (Morawek, Neugebauer 1989, p.43). On June 15, 1938 compulsory military service was introduced and 95,000 Austrian men were drafted before the outbreak of war. Austrian soldiers were recruited into two regional divisions, which were employed in all major attacks throughout the war side by side with German forces. Over time, additional cohorts were drafted at a less than yearly intervals (Morawek, Neugebauer 1989, p.43f). Few cases of refusal to be drafted are known among the Austrian army (Morawek, Neugebauer 1989, p.49).

Over the course of the war, an estimated 1.2 million Austrian men were drafted, of which about 250,000 died (Hagspiel 1995, p.329). More than 100,000 returned with severe injuries, and estimates of Austrian prisoners of war are between 500,000 and 600,000 (Vocelka 2010, p.110; Hagspiel 1995, p.329). About 24,300 civilians died due to air raids (Bukey 2000, p.227). Nevertheless, the population of Austria increased from 6.7 million to 7 million between 1938 and 1945, mostly due to increased birth rates before and during the first years of the war (Hagspiel 1995, p.57f).

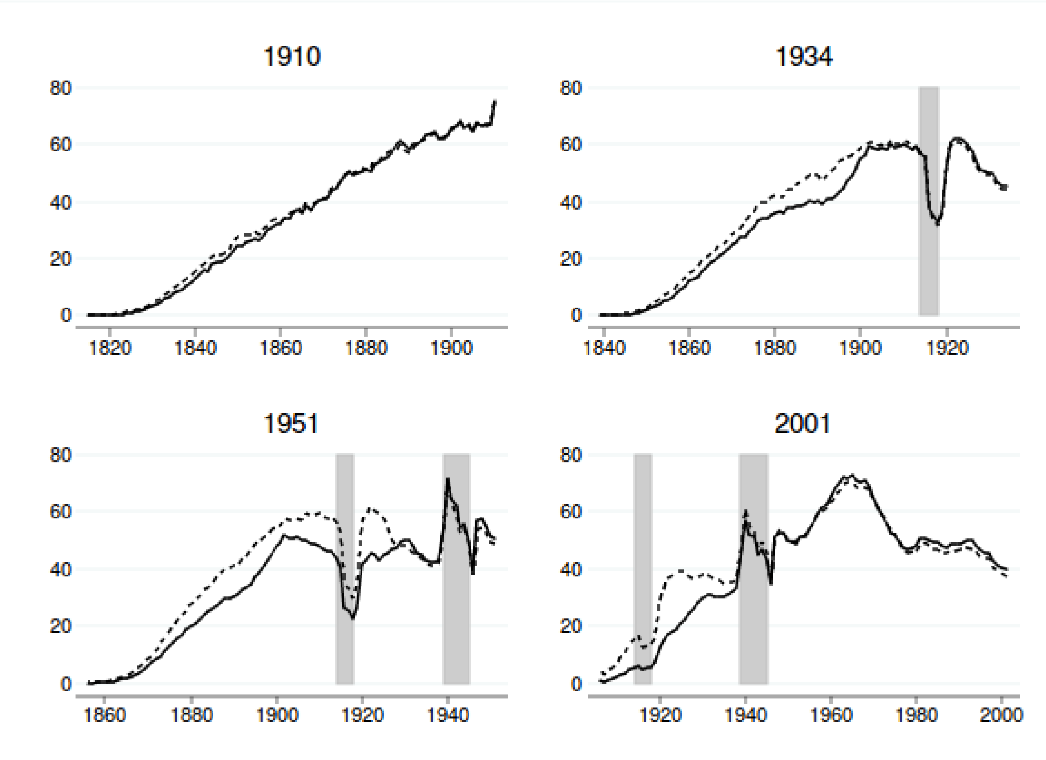
Just how large the demographic impact of the two world wars is, shows Figure 1, which depicts cohort sizes of males (solid line) and females (dashed line) by birth cohort in 1910, 1934, 1951 and 2001. The horizontal axis measures the birth year, while on the vertical axis the cohort size is shown. The grey bars mark the years of the first and second world war. The panel for 1910 on the top left shows almost identical profiles of men and women, while in 1934 the effect of WW1 is clearly visible. The fallen men of the cohorts 1870-1900 and the reduction in births during the war left its marks. After WWII there are additional cohorts of men missing from the cohorts 1900-1930 and the sharp upward and then downward spikes in births during the war years are visible. The data from the 2001 census still show a large difference between men and women for older cohorts.

Already before the end of the war, Austria was reinstated as a sovereign state. However, Austria was occupied until 1955 by the four Allied forces, who split up the territory along provincial borders. The main problems of that time were food shortages and lack of intact physical capital. The Austrian government was required to implement a series of long-term investment projects. By 1950, the Austrian GDP reached twice its 1946 level and exceeded the 1937 level by about 10% (Thalmann 1954, p.503f). The Austrian economy grew at an average annual rate of around 2.5% in the following decades.

2.2 Austrian Municipalities

Austria's current population is 8.4 million. It is a federal democracy organized in its nine provinces, each with their own parliament. The provinces are subdivided into 98 districts,

Figure 1: Male and Female Population by Cohort in Austria



Birth cohorts are measured on the horizontal axis and the cohort size is on the vertical axis. The headline of each diagram reports the time of measurement. The male population is drawn with the solid line, while the dashed line marks the female population. Data come from the Austrian population censuses.

which do not have any elected body. The lowest administrative units are the 2,357 municipalities. Municipality sizes vary greatly from 54 people in Gramais, Tyrol, to Vienna with a population of 1.7 million.

Originally founded in 1849 as an administrative unit to replace the feudal system, the municipalities have always been the government offices with the most contact to citizens. The municipalities have an elected mayor and municipal council, which is elected every 5 or 6 years, depending on the province. The responsibilities of a municipal government include land use planning, energy and water supply, provision of schools and homes for the elderly etc. (Bauer, Paleczny, Schulmeister 1977, p.65f).

3 Identification and Data

This section will shortly introduce the econometric framework employed and discuss the necessary assumptions to estimate the causal effect of WWII casualties on economic outcomes. A description of the data and the employed sample selection follows.

3.1 Identification

In general, the estimated equation is of the following form:

$$\log Y_{i,j} \quad = \quad \beta S_{i,j}^{WW2} + X_{i,j}\delta + \mu_j + \varepsilon_{i,j}, \tag{1}$$

where $Y_{i,j}$ is the outcome variable in municipality i and district j. $S_{i,j}^{WW2}$ is the measure of WWII casualties, $X_{i,j}$ is a set of municipality-level covariates which includes a dummy variable of the market status of the municipality in 1945, the log. of population in 1939, the share of the population employed in agriculture in 1934, and the share of men in 1934. μ_j is a set of district fixed effects and $\varepsilon_{i,j}$ is an error term.

The main problem in this general specification is a possible correlation of $S_{i,j}^{WW2}$ and $\varepsilon_{i,j}$ that would bias the OLS estimate of β in (1). An example for this is the Allied advance in Austria towards the end of the war. Air raids and the progress of ground forces claimed civilian lives in many municipalities, while these actions possibly also had effects on future economic growth. Consider Allied air bombings that killed civilians and destroyed physical capital at the same time or the well documented harshness of Russian forces in the East on civilians, who at the same time dismantled machinery to be transported to the Soviet Union (Bukey 2000, p.216f; Hagspiel 1995, p.91f).

A way around this problem is the use of a subset of casualties in the variable $S_{i,j}^{WW2}$ that are actually orthogonal to the error term $\varepsilon_{i,j}$. In this study, war casualties are measured as the the number of men who served in the military and did not return from war. These soldiers either died in battle, as prisoners of war in a detention camp, of a disease, or due to an accident. Importantly, they did not die in their home town, but rather, as faraway as the Soviet Union, France or Africa.

Austrian men were drafted by cohort and employed alongside German soldiers in all major battles. Initially, men could get an exemption from military service if they could prove their importance in agriculture or industrial production. However, by the time the attack against the Soviet Union started in the summer of 1941, most exemptions were canceled and additional older and younger cohorts were recruited (Morawek, Neugebauer 1989, p.46f). At that time millions of prisoners of war had been brought into Germany and Austria to reduce labor shortages in agriculture and industrial production (Hagspiel 1995, p.66f). Finally, with the formation of the *Volkssturm* in September 1944 all men of age 16 to 60 years were drafted and deployed in the defense against approaching Allied forces. In February 1945 the cohort of 1929 was drafted (Hagspiel 1995, p.84f). Many men found their death in these last months of WWII.

The employed variable of WWII casualties is defined as:

$$S_{i,j}^{WW2} = \frac{DEAD\_SOLDIERS_{i,j}}{POPULATION\_1939_{i,j}}, \quad (2)$$

where $DEAD\_SOLDIERS_{i,j}$ measures the number of dead soldiers with municipality of residence i in district j before the war and $POPULATION\_1939_{i,j}$ is the total population of the municipality as counted in the census of May 1939.

In conclusion, I argue that almost the entire male population of certain birth years was drafted to serve in WWII. The municipality of residence did not play a role in the drafting process and location of deployment and consequently the probability of death is uncorrelated with pre-war municipality characteristics. I come back to this claim empirically after the data description.

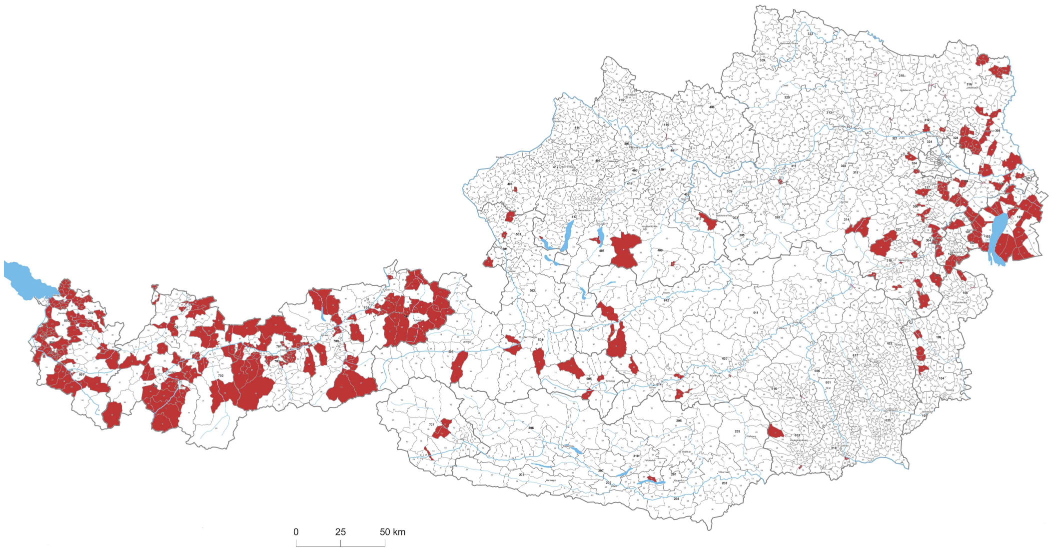
3.2 Data

The data for this paper come mostly from two sources. The number of dead WWII combatants was collected from war memorials in each municipality. The outcome data are provided by *Statistik Austria*, the federal statistical agency, in various publications.

WWII Casualties

As described above, the war casualty variable is measured as the share of the municipality's 1939 population who served in the military and did not return from war. To the best of my knowledge, a death registry for soldiers of Nazi-Germany is not available with the location of residence before the war.

Figure 2: Sample Municipalities



The municipalities in the sample are mostly from four provinces: Tirol (38%), Vorarlberg (21%), Niederösterreich (20%), and Burgenland (12%).

Given the lack of a data set of war casualties, I take another avenue to get data. Most municipalities have constructed a memorial to remember their dead and missing soldiers, of which most list the names of the dead and sometimes also date/location of birth and/or death. I use the number of names from these war memorials as the source of the casualty data. Various websites for genealogist provide photographs and transcripts of these memorials from many places in Austria.[1]

Two issues arise from this approach. First, I need to ensure that civilian casualties are not included in the list of names on the memorial for the reason discussed above. The memorials are usually divided in fallen or dead, missing and sometimes civilian casualties. I never include the civilian casualties and do not use the data from a memorial if there is a female name among the list of dead, as this indicates that civilian casualties are included. The war memorials should be a complete list of all dead and missing soldiers from a municipality, because relatives of non-returning soldiers had an interest in ensuring that their fathers, sons and husbands were honored on the memorial. Often names were added to the end of the list, when missing soldiers did not return from war captivity after a number of years. In other cases names were erased when the person unexpectedly returned. In one instance a note was added to a name when the person returned in 1958 from imprisonment.

[1] The websites I have used are `www.denkmalprojekt.org` and `www.kriegerdenkmal.co.at`

Table 1: Descriptive Statistics

	Obs.	**Mean**	**Std. Dev.**	**Min**	**Max**
Share Dead Soldiers WWII	300	0.058	0.016	0.027	0.120
Number Dead Soldiers WWII	300	66.9	57.6	5	483
Population in 1939	300	1,162.6	995.4	70	8,773
Population in 2011	300	2,146.5	2435.6	53	21,181

The second issue with these data is how to link a war memorial to a municipality and avoid double counting. The municipalities are subdivided into one or more localities, which can range from a cluster of houses to a city. In most cases, the largest locality has the same name as the municipality, so it is not entirely clear if the municipality or the locality is meant by a memorial. There are also memorials that refer to the area that belongs to a rectorate of the church. To reduce measurement error in the casualty rate variable, I make three restrictions. First, I restrict attention to municipalities whose borders have not changed since 1934, since I do not know if the war memorial corresponds to the old borders of a municipality or the one after the merging. Second, I drop municipalities with city status in 1945 since those often have several memorials with a different number of names on it. Finally, I focus on municipalities that have only one locality, to ensure that the soldier casualty data correspond to the whole municipality. These restrictions reduce the number of municipalities to 300 out of 2,357 available by January 1, 2013.[2]

This sample selection leave me with soldier casualty data for 301 municipalities, which include about 20,100 dead soldiers. Table 1 describes the war casualty data. An average of 5.8% of the 1939 population died as soldiers, with a standard deviation of 1.6%. The total number of deaths ranges between 5 and 483, with a mean of 67 soldiers. The population size of these mostly small municipalities is on average 1,163 in the year 1939 and by 2011, the average municipality in the sample has grown to 2,136 people.

Economic Outcomes

The outcome variables come from detailed information on Austrian municipalities from

[2] Although the census was in 2011, the reported results are based on municipality borders on January 1, 2013.

Table 2: Descriptive Statistics

	Obs.	**Mean**	**Std. Dev.**	**Min**	**Max**
Total Wage Bill in 2011 (in EUR 1,000)	300	18106.111	30754.054	66.667	187133.33
Total Wage Bill pc in 2011 (in EUR 1,000)	300	6.973	7.573	0.212	55.134
Number of Firms 2011	300	151.983	181.157	2	1475
Number of Firms - Manufacturing Sector	300	24.003	29.006	0	309
Number of Firms - Service Sector	300	127.980	154.745	2	1166
Firm Density 2011 (per 1,000 inhabit.)	300	70.334	34.968	20.444	321.429
Share of In-Commuters 2011	300	0.375	0.374	0.000	2.978
Share of Out-Commuters 2011	300	0.728	0.127	0.168	0.900
Total Participation Rate 2011	300	0.493	0.036	0.321	0.586
Share of Employed in Agriculture 1934	300	0.524	0.234	0.022	0.932
Share of Employed in Agriculture 1951	300	0.520	0.236	0.029	0.974
Share of Employed in Agriculture 1961	300	0.386	0.220	0.018	0.875
Share of Employed in Agriculture 1971	300	0.206	0.166	0.006	0.797
Share of Employed in Agriculture 1981	300	0.118	0.110	0.000	0.603
Share of Employed in Agriculture 1991	300	0.081	0.078	0.007	0.443
Share of Employed in Agriculture 2001	300	0.055	0.061	0.000	0.510
Share of Employed in Agriculture 2011	300	0.049	0.047	0.005	0.357
Share of Employed in Manufact. Sec. 1934	300	0.251	0.163	0.000	0.764
Share of Employed in Manufact. Sec. 1951	300	0.329	0.178	0.026	0.861
Share of Employed in Manufact. Sec. 1961	300	0.369	0.176	0.032	0.806
Share of Employed in Manufact. Sec. 1971	300	0.424	0.155	0.042	0.782
Share of Employed in Manufact. Sec. 1981	300	0.413	0.130	0.074	0.730
Share of Employed in Manufact. Sec. 1991	300	0.370	0.109	0.067	0.637
Share of Employed in Manufact. Sec. 2001	300	0.299	0.090	0.053	0.498
Share of Employed in Manufact. Sec. 2011	300	0.251	0.077	0.000	0.441
Share of Employed in Service Sector 1934	300	0.131	0.084	0.019	0.688
Share of Employed in Service Sector 1951	300	0.151	0.088	0.000	0.447
Share of Employed in Service Sector 1961	300	0.236	0.114	0.025	0.755
Share of Employed in Service Sector 1971	300	0.353	0.132	0.107	0.846
Share of Employed in Service Sector 1981	300	0.469	0.123	0.180	0.881
Share of Employed in Service Sector 1991	300	0.549	0.108	0.264	0.903
Share of Employed in Service Sector 2001	300	0.642	0.095	0.406	0.899
Share of Employed in Service Sector 2011	300	0.644	0.084	0.452	0.879

Sector shares in 1934 report the economic affiliation of the resident population, not the working population. There is a share of 9.6% reporting no economic affiliation. The share of of in-/out-commuters are the number of commuters in each group divided the working population in the municipality.

Statistik Austria. The available data were constructed from the censuses between 1934 and 2001 and various other registers and surveys. Of particular interest to this project are variables about the economic activity in a municipality. Table 2 describes the outcome variables, while Table 11 in the Appendix describes some additional control variables.

Total Wage Bill

Of particular interest to this project is a measure of the total wage bill in a municipality. The *Kommunalsteuer* is a tax on the sum of gross salaries and wages and has a uniform rate of three percent all over Austria. The salaries and wages of all employees of a firm located within a municipality are subject to this tax. Public administration is not included, but firms owned by the government are. Given the received tax within a year, in this case 2011, one can calculate the total wage bill for each municipality. Under the assumption of a constant capital-labor productivity across municipalities and no or uniform tax evasion per municipality, the total wage bill can be interpreted as an output measure of each municipality. The total wage bill calculated in this way for all of Austria constitutes about 31% of GDP in 2011. The correlation coefficient between the total wage bill of each province and the GDP by province is 0.998 and 0.982 when measured in per capita terms. I use the total wage bill as an approximation of total output produced within the borders of a municipality.

Census Data

Population censuses since WWII are collected in 10 year intervals. The data include the industry of employment, labor market participation, commuting patterns etc. While the outcome measures since 2001 come from the *Statistik Austria* website, the older variables are taken from print copies of the census results.

The variables on commuting pattern are the number of people commuting in and out of the municipality. The share of out-commuters indicate that about 73% of the working population do not find work within their municipality of residence. There are on average 38% of in-commuters relative to the working population residing in a municipality.[3] Total participation rate in 2010 is 49.3% and ranges between 32 and 59% in various municipalities.

The population censuses also report the number of people working in agriculture, manufacturing, and the service sector. As in most industrialized countries, the share of people working in agriculture decreased sharply over the period 1934 to 2010, while the service sector increased in size at the same time period. The relative size of the manufacturing sector

[3]Note that this figure number can exceed 100% by construction. Within Austria the share of in- and out-commuters should be about equal, but since cities are dropped in the sample, there is a higher share of out-commuters.

remained relatively stable, peaking in 1971 at 42% of total employment.

Firm Census Data
Another source of data is the firm census (*Arbeitsstättenzählung*) conducted in 2011, which report the number of non-agricultural firms by firm size and industry. The average number of firms per municipality in the sample is 152 in 2001, and the mean number of firms per 1,000 inhabitants is 70. There are on average four times as many service sector firms as there are manufacturing firms.

3.3 WWII Casualties and Pre-War Municipality Characteristics

Given the municipality data, I am now able to test the correlation between the available pre-war municipality characteristics and the WWII casualty rate. If municipality characteristics influence the casualty rate, we would suspect that the identification strategy is not valid as the same municipality characteristic could influence post-war economic development and create a spurious correlation. Table 3 shows the regression result of the share of dead soldiers of the 1939 population on various municipality variables. District fixed effects are always included. The result shows only one explanatory variable with a point estimate significantly different from zero: the population in 1939. This is not surprising as the 1939 population is used to construct the dependent variable. Any shock to the demography of the population that affects the number of conscripts differently than the rest shows up with a negative effect in this regression.

The pre-war or time invariant municipality characteristics in the regression include the elevation of the municipality, employment shares in agriculture, manufacturing, and services, the market status of the municipality, the share of the male population, a set of political variables from the last pre-war federal election, and the share of the Jewish population. Table 3 shows that none of these variables shows a significant correlation with the WWII casualty rate. A test for joint significance of these ten variables in column 7 results in a F-value of 1.61 and a p-value of 0.104. The separate regressions of the casualty rate on these variables controlling for 1939 population in columns 1-6 do not produce significant results either.

Even though the finding shows that the WWII casualty rate is not driven by municipality characteristics, this does not establish that the measure of WWII casualties is orthogonal to the error term in equation (1). Unobservable characteristics could still drive WWII casualties and post-war economic development. Robustness checks and falsification tests after the main

Table 3: WWII Casualties and Pre-War Municipality Characteristics

	WWII Casualty Rate of 1939 Population						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log. Population in 1939	-0.005***	-0.004**	-0.004***	-0.004***	-0.005***	-0.004***	-0.005**
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Log. of Elevation	-0.006						-0.007
	(0.004)						(0.005)
Share in Agriculture in 1934		0.017					0.035*
		(0.019)					(0.021)
Share in Manufacturing in 1934		0.025					0.034
		(0.022)					(0.022)
Share in Services in 1934		0.001					0.016
		(0.027)					(0.029)
Market Status Dummy in 1945			0.002				0.003
			(0.003)				(0.003)
Share of Male Population in 1934				0.007			0.005
				(0.042)			(0.042)
Vote Share of NSDAP in 1930					0.063		0.071
					(0.047)		(0.044)
Vote Share of Social Democrats in 1930					0.013		0.020
					(0.011)		(0.013)
Vote Share of Christian Democrats in 1930					0.007		0.006
					(0.009)		(0.010)
Share of Jewish Population in 1934						-0.108	-0.096
						(0.113)	(0.088)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	300	300	300	300	300	300	300
R-squared	0.25	0.25	0.24	0.24	0.25	0.24	0.27

Significance Levels: $*$: 10% $**$: 5% $***$: 1%
Robust standard errors in parenthesis.
Sector shares in 1934 report the economic affiliation of the resident population. The employment category not included in the regression is the share of the population reporting no economic affiliation with an average of 9.6%.

results elaborate on this issue.

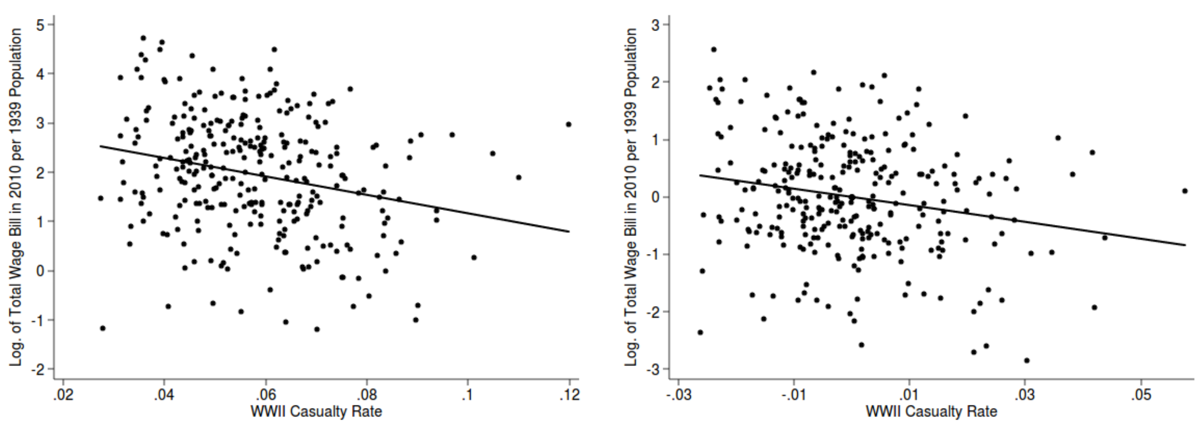
4 WWII Casualties and Economic Output

This section describes the relationship between economic outcomes and casualties in WWII. The main interest of this paper lies in whether economic activity in a municipality today is affected by the number of dead soldiers during WWII. Economic activity is measured by the total wage bill paid within the borders of a municipality. The total wage bill can be interpreted as an approximate output measure for each municipality in the year 2010.

Figure 3 shows a scatter plot of the log. of the total wage bill per capita and the WWII casualty rate. The total wage bill is divided by the 1939 population to avoid eliminating a potential effect of WWII deaths on subsequent population growth. Panel A shows the unconditional correlation with a clear negative relationship. Deviations from district means are used in Panel B, which shows a very similar picture.

Figure 3: Total Wage Bill per Capita and WWII Casualties

(a) Unconditional Relationship (b) Within-District Relationship



The set of regressions reported in Table 4 shows a strong negative relationship between WWII casualties and total municipality output in 2011. Column 1 reports a rather large unconditional correlation. The point estimates decrease slightly by controlling for the population size in 1939 in column 2. The effect decreases further as municipality level control variables for the market status of a municipality in 1945, the share of employment in agriculture in 1934, and the share of males in the population in 1934 are included.

Table 4: Total Wage Bill by Municipality in 2011

	Log. of Total Wage Bill in 2011								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
WWII Casualty Rate of 1939 Population	-20.31***	-19.02***	-14.36***	-10.05**	-9.30**	-9.63**	-8.74**	-8.06**	-10.22*
	(6.286)	(4.858)	(4.338)	(4.403)	(4.447)	(4.297)	(4.439)	(4.044)	(5.447)
WWII Casualty Rate* Russian Occupation Zone									3.68
									(8.879)
Log. Population in 1939		1.22***	0.90***	1.10***	1.11***	1.13***	1.09***		1.10***
		(0.079)	(0.092)	(0.093)	(0.096)	(0.103)	(0.095)		(0.097)
Log. Population in 2011								1.22***	
								(0.080)	
Market Status Dummy in 1945			-0.21	0.14	0.20	0.15	0.19	0.12	0.19
			(0.167)	(0.159)	(0.169)	(0.152)	(0.167)	(0.148)	(0.169)
Share in Agriculture in 1934			-2.35***	-2.39***	-2.15***	-1.88***	-2.04***	-1.25***	-2.16***
			(0.299)	(0.295)	(0.334)	(0.320)	(0.331)	(0.313)	(0.335)
Share of Male Population in 1934			-1.02	2.22	0.97	1.10	1.18	3.67	1.00
			(3.102)	(3.094)	(3.085)	(3.250)	(3.056)	(2.761)	(3.077)
Province FE				Yes					
District FE					Yes	Yes	Yes	Yes	Yes
Population 1939 Weights						Yes			
Adjusted Total Wage Bill							Yes		
No. Observations	300	300	300	300	300	300	300	300	300
R-squared	0.04	0.45	0.55	0.64	0.70	0.79	0.69	0.77	0.70

Significance Levels: $*$: 10% $**$: 5% $***$: 1%
Robust standard errors in parenthesis.
The adjusted output takes into account that people employed in agriculture and publicly employed are not subject to the tax on salaries, which is the basis for the output measure. The adjusted variable is the log. of total output as defined before divided by the share employed outside of agriculture and the public sector in 2011.

In columns 4 and 5 geographic fixed effects, either for the province or the district, are added which reduces the point estimate further. In the eight provinces of the sample there were 98 districts in total in 2010, out of which 43 are represented in the sample. District fixed effects take out much of the geographic variation, administrative differences and other unobservable characteristics within Austria. In what follows, all results are based on within-district variation.

Column 5 is the preferred specification. The estimated effect is -9.62 and is significantly different from zero with a p-value of 0.032. A one percentage point increase in the share of dead soldiers is associated with about a 9.5% reduction of the total wage bill more than 60 years later. Note that the standard deviation of the share of dead soldiers is 1.6%, which implies that the effect of on the municipality wage bill is far from trivial.

In column 6, I weight the observations by population size in 1939 to place higher importance on more populous municipalities. The point estimate remains almost unchanged. Column 7 uses an adjusted version of the output variable to account for the fact that wages paid in agriculture and the public sector are not subject to the *Kommunalsteuer*, which is the basis for the calculated wage bill. A lower wage bill measure could therefore be due to a higher share of employees in agriculture or the public sector. However, the estimated effect decreases only sightly compared to the preferred specification in column 6 and remains significant at the 5% level.

The next column (8) tests an obvious explanation for the large negative effect found above: a different population growth pattern since WWII. If a higher casualty rate translates into lower population growth in the affected municipalities, it would not be a surprise if those municipalities have a lower total wage bill in 2011. The estimated effect reduces to -8.24, but remains significant at the 5% level. This shows that a changed population growth pattern is not the driving force behind the results.

One could argue that the Russian occupation in the east of Austria has left a mark on the economic landscape and the estimated effect is entirely driven by those eastern districts. Column 9 shows that this was not the case. The interaction of the dummy variable for the Russian occupation zone with the war casualty measure shows no significantly different pattern than in the rest of Austria. The point estimate for the base group (central and western Austria) increases slightly to -10.62 and looses slightly in significance (p-value: 0.053).

In summary, the negative estimated effects of WWII casualties are large. A one percentage point increase in the casualty rate of a municipality reduces the total wage bill in 2011 by 9.5% in the preferred specification. I interpret the total wage bill as an approximate output measure, that is, at least at the provincial level, highly correlated with GDP. When, for purely illustrative purposes, these numbers are interpreted as a reduction in production without spillovers to other municipalities, a counterfactual of no deaths during WWII would increase output by 55.6%. The reduction in output per capita would be slightly lower, but still large.

A more realistic interpretation takes into account that WWII casualties influenced the development of commercial hubs in which economic activity is clustered. In an extreme case of this interpretation, the estimated effect does not translate into an aggregate reduction of output at all, but a clustering of economic activity into certain municipalities.

4.1 Robustness Checks

Before exploring the channels through which the established effect could emerge, I first run a series of robustness checks and falsification tests to confirm that the effect of casualties on the total wage bill is a causal one. This section tries to rule out a number of observed municipality characteristics to drive both, WWII casualties and post-war economic development. In Table 5, I include several additional control variables to the preferred specification to check if the estimated effect of WWII casualties disappears.

In column 1, the log. of population of 1939 is included in a non-linear fashion to allow for a more general population growth pattern. Column 2 includes the employment shares in 1934 for the three sectors agriculture, manufacturing, and services to take into account the pre-war industry composition, which might had an effect on the casualty pattern during WWII and post-war economic growth. The excluded group are the unemployed who never had work before. However, the estimated effect of WWII casualties remains of the same qualitative level and significantly different from zero at the 5% level.

Another hypothesis concerns the political environment of the municipality. Increased support for the NSDAP, the party of Hitler, in a municipality could act as a confounding factor. Resource allocation decisions could have been in favor of highly supporting municipalities, whose soldiers were also more fanatic in the battlefield. Support for the NSDAP is measured here as the vote share in the 1930 federal election, the last free election before the *Anschluss*. The other included parties are the Social Democratic Party and the Christian Democratic Party. As column 3 shows, a higher vote share does not change the effect of WWII casualties

Table 5: Total Wage Bill by Municipality in 2011 - Robustness Checks

	Log. of Total Wage Bill in 2011					
	(1)	(2)	(3)	(4)	(5)	(6)
WWII Casualty Rate of 1939 Population	-9.21**	-9.30**	-8.88*	-9.29**	-10.93**	-10.66**
	(4.431)	(4.375)	(4.523)	(4.456)	(4.290)	(4.235)
Log. Population in 1939	1.91**	1.10***	1.10***	1.11***	1.07***	1.25
	(0.909)	(0.096)	(0.100)	(0.097)	(0.097)	(0.926)
Market Status Dummy in 1945	0.24	0.19	0.16	0.20	0.26	0.19
	(0.178)	(0.175)	(0.177)	(0.170)	(0.161)	(0.184)
Share in Agriculture in 1934	-2.17***	-0.29	-2.74***	-2.15***	-1.68***	0.55
	(0.337)	(1.741)	(0.420)	(0.341)	(0.368)	(1.577)
Share of Male Population in 1934	1.22	1.28	2.31	0.97	1.74	3.26
	(3.111)	(3.228)	(3.170)	(3.092)	(2.895)	(3.170)
Log. of Population in 1939 squared	-0.06					-0.01
	(0.068)					(0.069)
Share in Manufacturing in 1934		1.96				2.60
		(1.880)				(1.686)
Share in Services in 1934		2.88				4.55**
		(2.471)				(2.257)
Vote Share of NSDAP in 1930			3.58			4.23
			(3.380)			(2.723)
Vote Share of Social Democrats in 1930			-1.22			-0.56
			(0.784)			(0.771)
Vote Share of Christian Democrats in 1930			0.04			0.49
			(0.611)			(0.586)
Share of Jewish Population in 1934				0.27		1.41
				(3.795)		(4.609)
Log. of Elevation					-1.00***	-1.20***
					(0.308)	(0.305)
District FE	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	300	300	300	300	300	300
R-squared	0.70	0.71	0.71	0.70	0.72	0.73

Significance Levels: $*$: 10% $**$: 5% $***$: 1%
Robust standard errors in parenthesis.

on the total wage bill.

Acemoglu et al. (2011) show that the reduction of the Jewish population during the Holocaust had long-lasting effects on Russian cities. In this spirit, I test the effect of the share of the Jewish population before the war. The share of Jews was very low in rural Austria in 1934 with an average of 0.2% in the sample municipalities. As can be seen in column 4, the inclusion of this variable does not change the main result.

The elevation of the municipality could plausibly have an effect on both the casualty rate through increased hiding possibilities and post-war economic development, for example through tourism. In column 5, I include the log. of elevation of the municipality and find that the effect of interest does increase and decrease the standard error at the same time.

In column 6, all the above variables are included. This leads to a small change of the estimated effect to -10.10. These findings show that the negative effect of WWII casualties on the approximate output measure is robust to the inclusion of observable municipality characteristics. Further indication of a causal relationship is presented in the next section that performs falsification tests.

4.2 Falsification Tests

I now focus on some falsification tests, which test the correlation of pre-war economic development with the WWII casualty measure. There is still the possibility that an omitted variable drove both economic development and WWII casualties. If this is the case, the omitted variable could have also driven pre-war economic development and hence a correlation between the WWII casualty rate and economic variables measured before the war should be existent.

Unfortunately, there are very limited information on pre-war development available to me. The LHS variables I use are the share of the resident population affiliated to agriculture, manufacturing, and services, the share of residents who never worked before (a proxy for unemployment with an average of 9.1% in 1934)[4], as well as the population growth between 1900 and 1934. Additionally there is a small set of economic variables from the year 1900: the number of large land holdings and the number of factories in each municipality.

The results are presented in Table 6, with the columns 1-4 testing the relationship between employment shares in 1934 and the WWII casualty variable. The share in the service sector in 1934 is significantly correlated with the casualty rate at the 10% level, but dropping two massively outlying observations, the point estimate shrinks and turns insignificant.[5] Considering also regression 2 of the robustness checks in Table 5 with the full set of sector shares as control variables included, where the estimated effect on the output measure in 2011 decreases only slightly, the negative relationship found here does not seem to drive the effect on the total wage bill.

[4]Not working family members are affiliated in the sector of the household head. The 9.1% are therefore the share of the population where the household head has never been employed before.

[5]The municipalities are "Lech" and "Semmering", both known for large ski resorts.

Table 6: Falsification Tests

	Share in Agricultural Sector in 1934	Share in Manufacturing Sector in 1934	Share in Service Sector in 1934		Share Never Employed in 1934	Log. Number of Large Land Holdings in 1900	Log. Number of Factories in 1900	Log. of Population in 1939
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WWII Casualty Rate of 1939 Population	0.29	0.49	-0.52*	-0.34	-0.21	-0.56	0.91	-1.09
	(0.662)	(0.484)	(0.302)	(0.267)	(0.162)	(3.024)	(1.350)	(0.767)
Log. Population in 1939	-0.18***	0.11***	0.04***	0.04***	-0.00	0.13*	0.16***	
	(0.018)	(0.013)	(0.007)	(0.007)	(0.004)	(0.078)	(0.050)	
Log. Population in 1900								0.95***
								(0.031)
Market Status Dummy in 1945	0.01	-0.05*	0.03**	0.04***	0.01*	-0.06	-0.02	-0.04
	(0.035)	(0.028)	(0.015)	(0.012)	(0.007)	(0.209)	(0.135)	(0.039)
Share in Agriculture in 1934					-0.16***	0.06	-0.58***	-0.53***
					(0.020)	(0.227)	(0.146)	(0.086)
Share of Male Population in 1934	1.12**	-0.74**	-0.33	-0.40**	0.13	1.91	2.36**	0.19
	(0.489)	(0.313)	(0.208)	(0.203)	(0.181)	(1.633)	(0.970)	(0.565)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Outliers Dropped				Yes				
No. Observations	300	300	300	298	300	242	242	300
R-squared	0.58	0.52	0.38	0.44	0.60	0.58	0.57	0.96

Significance Levels: $*$: 10% $**$: 5% $***$: 1%

Robust standard errors in parenthesis.

The sector employment shares in 1934 measure the affiliation of the resident population with each sector. Each persons in a household who has never worked, is affiliated to the sector of employment of the household head. The share of is the share of household heads including his/her family who has never been employed relative to the total population in 1934, which underestimates the unemployment rate at that time.

Column 5 uses the share of people who never worked before in 1934, which I use as a proxy for unemployment. However, there is no significant correlation with the war casualty measure. Columns 6 and 7 tests the relationship the number of large land holdings and factories, both measured in 1900.[6] There is also no correlation between the 1900 economic landscape and the variable of interest. A proxy for pre-war economic development is population growth between 1900 and 1939. But as column 8 shows there is again no significant relationship with the war casualty variable.

In summary, this section established a strong negative and robust relationship between the output generated within the borders of a municipality and the share of the population of 1939 that died during WWII as soldiers. The robustness checks and falsification test suggest that this is a causal relationship and not a mere correlation. Causality implies that the human loss of life caused by the war has a significant impact on today's economic landscape. The question why this difference exists is what I explore in the following sections.

5 Where Does the Effect Come From?

In this section I try to identify the determinants of the output difference. To this end, I look at contemporary measures of inputs into a hypothetical production function to identify why high-casualty municipalities produce less output today.

5.1 Population, Employment, and Commuting Pattern

Table 7 reports the direct effect of WWII casualties on the population size in 2011 in column 1. The effect is insignificant, which confirms the finding in Table 4 with the control variable for population in 2011. Column 2 shows that there is also no effect on the working population of a municipality, while columns 3 and 4 find no difference in male and female employment rate. These findings all suggest, that WWII casualties did not affect aggregate statistics of the resident population.

If there is no difference in the resident population, could it be a difference of people working in specific municipalities, but living in another one? Column 5 tests this hypothesis, which

[6] Observations are lost since only municipalities with unchanged borders since 1900 can be used. Also the province of Burgenland was not included in the Austrian census in 1900.

Table 7: Population, Work Force, and Commuting Pattern in 2011

	Log. Total Pop.	Log. Working Pop.	Employment Rate Male	Employment Rate Female	Log. Employed in Munic.	Log. Out- Commuters	Log. In- Commuters
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
WWII Casualty Rate of 1939 Population	-0.67	-0.54	0.09	0.05	-6.92**	1.34	-8.53**
	(1.318)	(1.389)	(0.155)	(0.181)	(2.790)	(1.801)	(4.171)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	300	300	300	300	300	300	300
R-squared	0.91	0.90	0.28	0.40	0.81	0.85	0.73

Significance Levels: $*$: 10% $**$: 5% $***$: 1%
Robust standard errors in parenthesis.
Control variables include the log. population in 1939, an indicator variable for market status in 1945, the share of population in agriculture in 1934 and the share of the male population in 1934.

uses the number of people employed within the borders of a municipality as the dependent variable. The result shows that the number of employed people within the borders of a municipality is vastly reduced by WWII casualties. A one percentage point increase in the share of dead soldiers reduces the number of jobs in a municipality by 7.13%, which is of a similar magnitude than the total effect on the total wage bill.

If there are more people working within the borders of a municipality, there could be two reasons: ceteris paribus, there could be more in-commuters or fewer out-commuters. Columns 6 and 7 focus on commuting streams, where the effect on in-commuters clearly dominates the effect on out-commuters. In section B in the Appendix, I estimate a gravity model with municipality fixed effects, which gives more precise estimates. Those results clearly show that the large effect of WWII casualties on total employment in a municipality is due to a difference in the number of in-commuters.

5.2 Number and Density of Firms

There are more people working within municipalities with fewer WWII casualties. A natural next step is to ask where they work. I use data from the *Arbeitsstättenzählung* of 2011, a firm census conducted by the national statistical agency, to explore the firm landscape by municipality. The scope of the survey are non-agricultural employers and it contains data on the number of employers by industry and size, grouped into intervals of number of people employed.

In a set of regressions, the outcome variables are the log. of the total number of firms of

Table 8: Number, Density, and Size of Firms in 2011

	Log. of Number of Firms		Log. of Number of Firms per 1,000 Inhabitants		Size of Firms by Number of Workers (grouped)		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
WWII Casualty Rate of 1939 Population	-5.74*** (2.044)	-5.48** (2.120)	-4.98*** (1.677)	-4.57*** (1.513)	-0.40** (0.191)	-0.97 (0.618)	-0.65** (0.310)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population 1939 Weights		Yes		Yes			
Ordered Probit						Yes	
Interval Regression							Yes
No. Observations	300	300	300	300	53,536	53,536	53,536
(Pseudo) R-squared	0.84	0.88	0.29	0.42	0.02	0.02	.

Significance Levels: * : 10% ** : 5% *** : 1%
Robust standard errors in parenthesis.
Control variables include the log. population in 1939, an indicator variable for market status in 1945, the share of population in agriculture in 1934 and the share of the male population in 1934.

any size, the log. of firm density, defined as the total number of firms by 1,000 inhabitants in 2001, and measures of firm size. The results in Table 8, columns 1-4, show a negative relationship between WWII casualties and the total number of firms and the firm density in the weighted and unweighted regressions. The number for firms is reduced by 4 to 6% if WWII casualties increases by one percentage point. This number is smaller than the effect on total output and the number of employed people in a municipality, but complimentary to those findings, as more in-commuters need to be employed somewhere.

However, a larger number of firms is not the only way to employ more people, as larger firms could produce the same result. I find some evidence that the size of firms, measured by the number of employees, is correlated with WWII casualties as can be seen in the regression of columns 5-7. The firm size is grouped into intervals of 0-4, 5-19, 20-99, 100-250, and more than 250 employees. A regression using OLS on the bins (numbered 1 to 5) in column 5, ordered probit in column 6, and an interval regression model with frequency weights by number of firms in the interval in the last column, produce negative point estimates with two of them significantly different from zero at the five percent level.

The data in the firm census of 2011 groups them into a number of industries. Dividing them into manufacturing and services gives further insights. The results in Table 9 show clearly that the effect on the number and density of firms stems entirely from the service sector. The manufacturing sector produces point estimates close to zero, while the effect of WWII casualties on the number of service sector firms is very similar to the effect on the total number of firms. Neither in the manufacturing nor the service sector an effect on firm size is found (not shown in paper).

Table 9: Firms by Sector in 2011

	Log. of Firms by Sector			Log. of Firms by Sector per 1,000 Inhabitants		
	Manufacturing	Service	Service	Manufacturing	Service	Service
	(1)	(2)	(3)	(4)	(5)	(6)
WWII Casualty Rate of 1939 Population	-1.62	-5.72***	-5.75***	-0.95	-5.05***	-4.88***
	(2.286)	(2.086)	(2.159)	(1.847)	(1.849)	(1.591)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Population 1939 Weights			Yes			Yes
No. Observations	300	300	300	300	300	300
R-squared	0.81	0.83	0.87	0.31	0.26	0.41

Significance Levels: $*$: 10% $**$: 5% $***$: 1%
Robust standard errors in parenthesis.
Control variables include the log. population in 1939, an indicator variable for market status in 1945, the share of population in agriculture in 1934 and the share of the male population in 1934. Manufacturing Sector includes mining, manufacturing, energy and water supply, and construction industries. Service Sector category is made up of commerce, tourism, IT and communication, banking and insurance, real estate, public administration, education, health industry, and personal services.

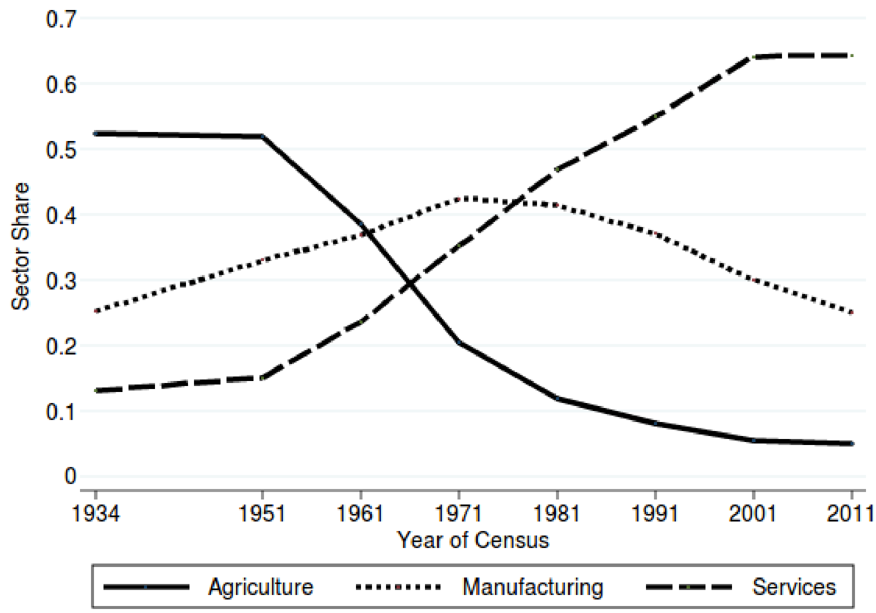
The results in Table 9 are surprising insofar as the manufacturing sector does not exhibit any difference in high-casualty and low-casualty municipalities. In contrast, the service sector does account for all of the difference found earlier. Considering the relatively small share of the service sector in the years following WWII is not likely that the difference set in right after the war and remained constant. Instead, it seems more likely that a dynamic effect has been at play and the effect on output emerged at a later time, which will be explored next.

In summary, the difference in the total wage bill between high-casualty and low-casualty municipalities can likely be explained by the number of people being employed in the municipalities, which in turn stems from a higher number and density of firms located in the low-casualty municipalities. More workers and firms also produce more output. Moreover, the difference in firms can be attributed to service sector firms, while there is no difference in the manufacturing sector. A closer look at the sector composition of employment can give further insights into the channel of persistence.

6 The Process of Divergence

To better understand the process of divergence between municipalities with high and low human losses during WWII, I now turn to a dynamic investigation.

Figure 4: Evolution of Sector Shares in the Sample Municipalities



The sector composition of the labor market has changed dramatically since the 1950s in Austria. Figure 4 plots the share of workers employed in agriculture, manufacturing, and the service sector for the municipalities of the sample.[7] In 1951, more than half the population was working in the agricultural sector, while only 15% was working in the service sector. By 2010, the share of workers in agriculture slumped to 6%, while services grew to 68%. The share of the manufacturing sector follows a hump shaped path, peaking in 1971 at 43%. As we will see, the differences in transition patterns between high-casualty and low-casualty municipalities are a probable channel that produced the difference found in the current economic landscape.[8]

Sector shares of the labor market are correlated between sectors (as they always sum to one) and over time. I therefore employ a GLS model that takes these correlations into account.

[7] The numbers are taken from the Austrian population censuses, where the working population was divided into several industries. The number of reported industries increased every decade, but were put into those three broad categories to be comparable over time. In the sector classification used in 2001, the sector "Agriculture" includes agriculture, forestry and fishing, while "Manufacturing Sector" includes mining, manufacturing, energy and water supply, and the construction industry. The "Service Sector" category is made up of commerce, tourism, IT and communication, banking and insurance, real estate, public administration, education, health industry, and personal services. The numbers from the census of 1934 divides the resident population into sectors, not the working population, and the unknown classification was ignored.

[8] Appendix C discusses another channel, the influx of foreigners and sorting into high-casualty municipalities to replace the missing workforce. However, there is no change in the share of foreign population in 1951, 1971, 2001 and 2011 due to WWII casualties.

All the error terms within a municipality are allowed to be correlated with each other, but not between municipalities. I also use the pre-war sector share of the outcome variable as a control variable to make the point estimates between sectors more comparable. This also explains why the point estimates do not sum exactly to zero for each year.

Table 10: Sector Shares

PANEL A	Share Working in Agricultural Sector in						
	1951	1961	1971	1981	1991	2001	2011
WWII Casualty Rate	-0.71**	-0.44	-0.79**	-0.08	-0.23	0.02	0.14
of 1939 Population	(0.276)	(0.337)	(0.376)	(0.271)	(0.193)	(0.167)	(0.126)
PANEL B	**Share Working in Manufacturing Sector in**						
	1951	1961	1971	1981	1991	2001	2011
WWII Casualty Rate	0.39	0.74**	1.10***	0.90***	1.06***	0.71***	0.55**
of 1939 Population	(0.259)	(0.323)	(0.379)	(0.336)	(0.307)	(0.270)	(0.226)
PANEL C	**Share Working in Service Sector in**						
	1951	1961	1971	1981	1991	2001	2011
WWII Casualty Rate	0.30	-0.22	-0.04	-0.75**	-0.77**	-0.70**	-0.28
of 1939 Population	(0.195)	(0.256)	(0.340)	(0.321)	(0.313)	(0.279)	(0.205)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	300	300	300	300	300	300	300

Significance Levels: $*$: 10% $**$: 5% $***$: 1%
Standard errors incorporate correlation between sectors and over time.
The reported estimates are based on a GLS model that allows for within municipality correlation of the error terms between sectors and over time. District fixed effects are always included. The usual control variables are included, except the sector share of 1934 of the outcome variable is used instead of the share of the agricultural sector in 1934.

The result of the regressions paint an interesting picture of the differential patterns of divergence between high-casualty and low-casualty municipalities during the post-war period, shown in Table 10. In Panel A the size of the agricultural sector is the dependent variable. There is a large negative relation between WWII casualties and the share working in agriculture in 1951 and 1971. Afterwards no sizable difference can be detected.

Conversely, Panel B shows that the share of workers in the manufacturing sector is significantly higher in high-casualty municipalities in all the decades except the 1950s. Interestingly, the increased share of the manufacturing sector comes at the expense of the agricultural sector until 1971 (not significant in 1961) and at the expense of the service sector thereafter. The size of the effect is not trivial, as a one percentage point increase in WWII casualties results in a one percentage point increase in the share of manufacturing sector in 1971. Panel

C investigates the service sector and finds that highly affected municipalities had a lower share of workers employed in the service sector from 1981 onwards.

In summary, residents of high-casualty municipalities are more likely to find work in the manufacturing sector and conversely less likely to be in agriculture until 1971 and less likely to be in services since the 1981 census.

These results suggest that people in high-casualty municipalities sorted initially from the agricultural sector into the manufacturing sector. Bellou and Cardia (2013) document increased employment in the manufacturing sector in 1960 for men and women in the US in states with higher mobilization rates during WWII. This is consistent with my findings as higher mobilization rates likely translate into more casualties.

Labor shortage can explain the initial sorting from agriculture to manufacturing. Given the technology used in agriculture at that time, men had a comparative advantage in agriculture, while women were comparatively more productive in manufacturing. A household affected by a war casualty was less productive and had to give up the farm and likely ended up in manufacturing, as this was the next largest sector after the war.

The model in the next section explores the dynamics of a labor shortage in agriculture in combination with structural change that is able to explain the pattern found in the data.

6.1 A Model of Structural Change and WW2 Casualties

The regression results in Table 10 pose the question how a initial reduction of employment in agriculture in high-casualty municipalities can translate to lower service sector employment decades later. One prominent feature of the Austrian economy at that time was structural change as already shown in Figure 4. The following model of structural change illustrates a way to make sense of the regression results.

Structural change is modeled as a demand side phenomenon following Kongsamut, Rebelo, Xie (2001), so that growing income lets consumers reduce the fraction of income spent on agricultural goods and increase their relative spending on service sector goods. The casualty rate enters the model only through its negative impact on agricultural productivity. Municipalities are small and trade is performed at the national level, so that prices are determined at the aggregate.

Household Decision

Preferences of the representative household in a municipality are given by the utility function

$$u(c_a, c_m, c_s) = (c_a - \delta)^{\alpha} (c_m)^{\beta} (c_s + \delta)^{\gamma}.$$

Without loss of generality let $\alpha + \beta + \gamma = 1$. The parameter δ can be thought of as a subsistence level of consumption, so that up to a certain threshold no services are consumed. Households provide one unit of labor inelastically and receive a wage w in return. Let there be a measure one of households.

Production Decision

The production technology is linear with respect to labor input L. The WWII casualty rate enters the model only through its impact on agricultural productivity. A higher casualty rate reduces agricultural productivity as fewer men are available, who are relatively more productive in agriculture than women. Let the casualty rate in municipality i be d_i, which is measured as deviations from the mean, such that $E[d] = 0$. Let $F(d)$ be the cdf of d. Total factor productivity (TFP) in all sectors is described by the parameter B and the production functions are:

$$\begin{aligned} y_{i,a} &= B(1 - d_i)L_{i,a} \\ y_{i,m} &= BL_{i,m} \\ y_{i,s} &= BL_{i,s} \end{aligned}$$

Price Determination

The service sector good is used as the numeraire good. Then the first order conditions for profit maximization ($w = p_a B(1 - d) = p_m B = B$), market clearing conditions, and the definition of d such that $E[d] = 0$ imply that $w = B$ and $p_a = p_m = p_s = 1$.[9]

Shares

To connect the model with the regression results, I now look at the sectors of employment.

[9] I also assume that $Var[d]$ is small. Since there will be sorting of high-productivity (low-casualty) municipalities into the agricultural sector, the average productivity in that sector will increase leading to a lower market clearing price than $p_a = 1$. The market clearing price can not be solved for without distributional assumptions on d. I ignore this price adjustment under that premise that $Var[d]$ is small and therefore the price change is small.

Below a critical TFP level B^* the demand for service sector goods is zero. The sector employment shares are therefore divided into two segments.

1. If $B \leq B^* = \frac{\delta}{\gamma}$ and therefore $c_s = 0$, there exists a critical casualty rate $d_1^* = F^{-1}(1-\beta)$ such that

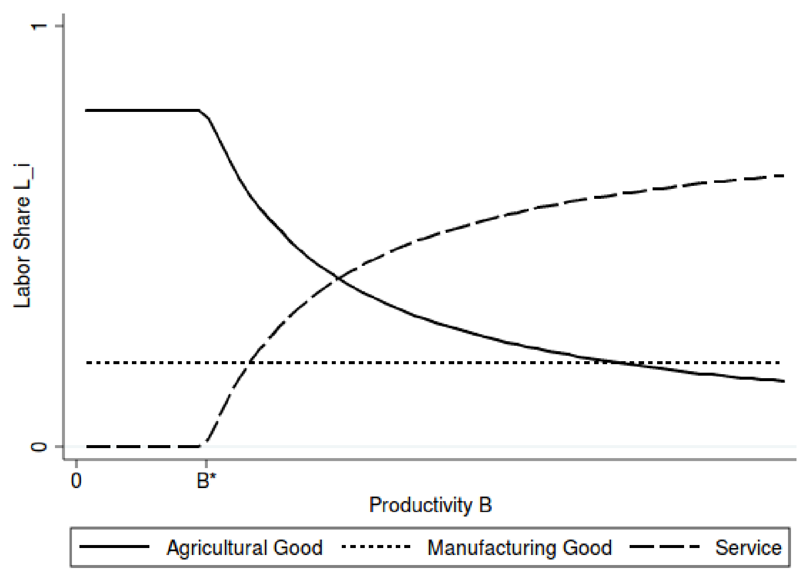
$$\begin{aligned} L_a &= 1 \quad \text{if} \quad d \leq d_1^* \\ L_a &= 0 \quad \text{if} \quad d > d_1^*. \end{aligned}$$

2. If $B > B^* = \frac{\delta}{\gamma}$ and therefore $c_s > 0$, there exists a function $d_2^*(B) = F^{-1}\left(\alpha + \frac{\delta}{B}\right)$ such that

$$\begin{aligned} L_a &= 1 \quad \text{if} \quad d \leq d_2^*(B) \\ L_a &= 0 \quad \text{if} \quad d > d_2^*(B). \end{aligned}$$

The model predicts initial sorting of low-casualty municipalities into the agricultural sector to exploit a productivity advantage.

Figure 5: Sector Shares



Productivity Growth and Sectoral Adjustment

Over time TFP increases which causes household income and demand for service sector goods to grow. Labor input shifts from the agricultural sector towards the service sector. Figure

5 illustrates an example of sector shares of total employment over a range of productivity levels.

In a frictionless world, workers from manufacturing might switch to the service sector. However, marginal sector transition costs of ε ensure that the sectoral transfer of labor takes place between agriculture and the service sector only, as a worker in manufacturing has no benefit from a sector transfer but faces a cost of ε. These transition costs could be a lack of inter-generational mobility, sector specific human capital, or uncertainty concerning a sector transition.

The sector of employment is a deterministic function of the casualty rate d: high-casualty municipalities are in manufacturing, medium-casualty municipalities in the service sector, and low-casualty municipalities in the agricultural sector. This kind of sorting results in $E[d|L_m = 1] > E[d|L_s = 1]$ after an extended period of productivity growth: the pattern found in the data.

Labor shortage in agriculture in combination with structural change is therefore able to convert a negative shock of a municipality into a long-lasting effect. This finding stands in strong contrast to Chaney and Hornbeck (2013) and Hornbeck and Naidu (forthcoming) who find positive effects on income per capita due to labor shortage in agriculture and hence adjusted production technology.

7 Conclusion

This paper exploits WWII as a natural experiment for war casualties at the municipality level in Austria. I find a large negative effect of war casualties on current economic activity, as measured by the total wage bill. The effect is far from trivial, as a one percentage point increase in the WWII casualty rate decreases the local output by about 9.5%. Robustness checks and falsification test suggest a causal relationship. The underlying determinants of this reduction in output are a smaller number and density of firms and a smaller work force in highly affected municipalities. However, this is only true for the service sector and not in the manufacturing sector.

In a dynamic investigation I identify a differential path of the sectoral composition of the labor market in the post-war period. Municipalities with a high casualty rate in WWII have a higher share of workers in the manufacturing sector. Until 1971 the reduction can be found in the agricultural sector and from then onwards in the service sector.

The proposed channel of persistence is a sorting into manufacturing jobs from agriculture in highly affected municipalities after the war, due to a labor shortage in agriculture and hence lower agricultural productivity. When the labor demand in agriculture decreased due to structural change in the 1970s, workers in low-casualty municipalities (with a higher agricultural share) were more likely to switch to the, then quickly growing, service sector.

References

Acemoglu, Daron, Tarek Hassan, James Robinson. (2011.) "Social Structure and Development: A Legacy of the Holocaust in Russia." *Quarterly Journal of Economics*, 126(2): 895-946.

Bauer, Helfried, Alfred Paleczny, Agnes Schulmeister. (1977.) *Aufgaben der Gemeinden.* (Wien: Institut fr Stadtforschung).

Beevor, Antony. (2012.) *The Second World War.* (New York: Little, Brown and Co).

Bellou, Andriana, Emanuela Cardia. (2013.) "Occupations after WWII: The Legacy of Rosie the Riveter." *IZA Discussion Paper*, No. 7615.

Bolognese-Leuchtenmller et al. (1985.) *Frauen der ersten Stunde 1945-1955.* (Wien: Europaverlag).

Bukey, Evan Burr (2000.) *Hitler's Austria: Popular Sentiment in the Nazi Era, 1938-1945.* (Chapel Hill, N.C.: University of North Carolina Press.).

Brakman, Steven, Garretsen, Harry, Schramm, Marc. (2004.) "The strategic bombing of cities in Germany in World War II and its impact on city growth." *Journal of Economic Geography*, 4(1): 118.

Chaney, Eric, Hornbeck Richard. (2013.) "Economic Growth in the Malthusian Era: Evidence from the 1609 Spanish Expulsion of the Moriscos." *mimeo.*

Davis, Donald, and David Weinstein. (2002.) "Bones, Bombs, and Break Points: The Geography of Economic Activity." *American Economic Review*, 92(5): 1269-1289.

Davis, Donald, and David Weinstein. (2008.) "A Search for Multiple Equilibria in Urban Industrial Structure." *Journal of Regional Science*, 48(1): 29-65.

Dell, Melissa. (2010.) "The Persistent Effects of Peru's Mining Mita." *Econometrica*, 78(6): 1863-1903.

Grosfeld, Irena, Alexander Rodnyansky, Ekaterina Zhuravskaya. (2013.) "Persistent Antimarket Culture: A Legacy of the Pale of Settlement after the Holocaust." *American Economic Journal: Economic Policy*, 5(3): 189-226.

Hagspiel, Hermann. (1995.) *Die Ostmark: Österreich im Grossdeutschen Reich 1938 bis 1945.* (Wien: Braumüller).

Hornbeck, Richard, Suresh Naido. (2014.) "When the Levee Breaks: Black Migration and Economic Development in the American South." *American Economic Review*, 104(3): 963-990.

Kongsamut, Piyabha, Sergio Rebelo, Danyang Xie. (2001.) "Beyond Balanced Growth." *Review of Economic Studies*, 48(4): 869-882.

Miguel, Edward, Gérard Roland. (2011.) "The long-run impact of bombing Vietnam." *Journal of*

Development Economics, 96(1): 1-15.

Morawek, Elisabeth, Wolfgang Neugebauer. (1989.) *Österreicher und der Zweite Weltkrieg.* (Wien: Österreichischer Bundesverlag).

Nunn, Nathan. (2008.) "The Long-term Effects of Africa's Slave Trades." *Quarterly Journal of Economics*, 123(1): 139-176.

Nunn, Nathan. (2014.) "Historical Development." in *Handbook of Economic Growth*, Vol. 2A, ed. Philippe Aghion and Steven Durlauf (Elsevier): 347-402.

Nunn, Nathan, Wantchekon Leonard. (2011.) "The Slave Trade and the Origins of Mistrust in Africa." *American Economic Review*, 101(7): 3221-3252.

Thalmann, Friedrich. (1954.) "Die Wirtschaft in Österreich." in *Geschichte der Republik Österreich*, ed. Heinrich Benedikt (Wien: Verlag für Geschichte und Politik).

Vocelka, Karl. (2010.) *Österreichische Geschichte.* (München: C.H. Beck).

Data Sources

The data for the economic variables come from various publications of *Statistik Austria*, the Austrian statistical agency (earlier names of the agency: *K. K. Statistischen Zentralkommission*, *Bundesamt für Statistik*, and *Österreichisches Statistisches Zentralamt*): "Gemeindelexikon der im Reichsrate vertretenen Königreiche und Länder: Bearbeitet auf Grund der Ergebnisse der Volkszählung vom 31. Dezember 1900", "Die Ergebnisse der österreichischen Volkszählung vom 22. März 1934", "Die Ergebnisse der österreichischen Volkszählung vom 1. Juni 1951", "Die Ergebnisse der österreichischen Volkszählung vom 21. März 1961", "Die Ergebnisse der österreichischen Volkszählung vom 12. Mai 1971", "Arbeitsstättenzählung 1973", "Volkszählung 1981", "Arbeitsstättenzählung 1981", "Volkszählung 1991", "Arbeitsstättenzählung 1991", "Ein Blick auf die Gemeinde" (`www.statistik.at/blickgem`).

A Descriptive Statistics of Robustness Variables

Table 11: Descriptive Statistics

	Obs.	Mean	Std. Dev.	Min	Max
Share of Market Status 1945	300	0.167	0.373	0	1
Share of Males in 1934	300	0.501	0.025	0.395	0.593
Vote Share of NSDAP 1930	300	0.012	0.025	0	0.247
Vote Share of Social Dem. 1930	300	0.197	0.189	0	0.710
Vote Share of Christian Dem. 1930	300	0.636	0.241	0	1
Share of Jewish Population 1934	300	0.001	0.007	0	0.117
Elevation of Municipality	300	621.4	346.7	117	1628

B Gravity Model of the Commuting Pattern

Statistik Austria also publishes commuting streams between two municipalities for each census. For the 2011 census, I prepared the data to estimate a gravity model, which provides more detail on the determinants of commuting streams as the previous regressions in Table 7. An observation is a pair of municipalities if the share of dead soldiers is available for both locations and there are at least 20 people commuting in one direction, as the number of commuters is left-censored. This requirement creates 437 pairs out of the 300 municipalities available. Since there are several destination municipalities for some municipalities of origin and vice versa, I am able to include municipality of destination/origin fixed effects. The basic estimated equation is

$$\log C_{o,d} \quad = \quad \beta_o S_o^{WW2} + \beta_d S_d^{WW2} + M_{o,d}\gamma + X_o\delta_o + X_d\delta_d + \varepsilon_{o,d}, \qquad (3)$$

where $C_{o,d}$ is the number of people commuting from municipality o (origin) to municipality d (destination), S^{WW2} is the share of dead soldiers in WWII in each municipality, $M_{o,d}$ contains the log. of the distance between the two locations and an indicator whether the municipalities are in different districts, X is the set of control variables of each municipality, and $\varepsilon_{o,d}$ is an error term. A district of origin fixed effect is included in column 1, while there are municipality of origin or destination dummies in columns 2-5. Of course multi-collinear control variables are dropped when municipality fixed effects are included. Columns 4 and 5 use a Tobit model to acknowledge the left-censoring of the dependent variable.

Table 12: Commuting Pattern in 2011 - Gravity Model

	Log. Number of Commuters				
	(1)	(2)	(3)	(4)	(5)
WWII Casualty Rate in Destination Municipality	-10.28*** (2.537)	-13.58*** (3.244)		-14.43*** (2.604)	
WWII Casualty Rate in Origin Municipality	1.80 (1.882)		0.09 (1.838)		0.17 (1.629)
Control Variables	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes				
Municipality FE		Yes	Yes	Yes	Yes
Tobit Model				Yes	Yes
No. Observations	437	437	437	437	437
R-squared	0.58	0.72	0.75		

Significance Levels: $*$: 10% $**$: 5% $***$: 1%
Robust standard errors in parenthesis.
Control variables include the log. population in 1939, an indicator variable for market status in 1945, the share of population in agriculture in 1934 and the share of the male population in 1934.

The results in Table 12 present a clear picture: municipalities with many casualties during WWII attract fewer commuters, while there is no significant effect on the out-commuting pattern. This finding confirms the results from Table 7.

C Share of Foreigners

During and after WWII Austria experienced a large influx of foreigners. These includes displaced people who settled in or transited through Austria, or guest workers looking for employment in the booming Austrian economy of the 1950s and 60s. Foreigners could have selected into municipalities where the workforce has reduced through war casualties. If foreigners were less likely to establish new firms in the service sector, the large output reduction found in this paper could be explained by the influx of foreigners to replace war casualties.

The population censuses of 1951, 1971, 2001, and 2011 record the number of non-Austrian citizens of each municipality. In Table 13 the share of foreigners of the total population in each year is regressed on the war casualties and the usual control variables to test this hypothesis. None of the estimated effects is significantly different from zero and the point estimates are much smaller than the standard errors. Based on these results, I reject the hypothesis that selection of foreign settlement into high-casualty municipalities can explain the total effect on output.

Table 13: Share of Foreigners

	Share of Foreigners in			
	1915	1971	2001	2011
	(1)	(2)	(3)	(4)
WWII Casualty Rate of 1939 Population	-0.00	-0.06	-0.11	-0.14
	(0.117)	(0.123)	(0.233)	(0.194)
Control Variables	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
No. Observations	300	300	300	300
R-squared	0.35	0.42	0.37	0.38

Significance Levels: * : 10% ** : 5% *** : 1%
Robust standard errors in parenthesis.
Control variables include the log. population in 1939, an indicator variable for market status in 1945, the share of population in agriculture in 1934 and the share of the male population in 1934.