The Spoils of War: Trade Shocks during WWI and Spain's Regional Development

Job Market Paper *

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Abstract

This paper contributes new evidence on how labor market frictions can inhibit regional economic development and how a foreign demand shock can overcome them. Exploiting newly digitized trade and labor market data, I examine a trade shock to the Spanish Economy due to the participation of Spain's key trading partners in World War I (1914-18) while Spain remained neutral. I document that, firstly, WWI induced a large, temporary and sectorally heterogeneous demand shock that originated in belligerent countries, particularly France. Secondly, provincial income growth exhibited a spatial gradient, decreasing on average by 4% for each additional 100km distance to Paris. Finally, provinces with a favorable industry composition in light of the shock grew faster than their pre-trend. To quantify the role of frictions in input and output markets, I build and estimate a quantitative multi-sector economic geography model that allows for sectoral and spatial labor market frictions as well as external scale economies. Estimated labor market frictions are high and the parameters suggest decreasing returns to be present in some industries, limiting gains from reallocation. The model is used to calculate the unobserved reallocation patterns during the shock. Spatial frictions dominated with an estimated 83 percent of reallocation of labor happening *within* provinces rather than between. I then simulate labor reallocation patterns in the absence of the WWI trade shock. The shock increased the overall manufacturing sector by 14 percent, while shifting the national industry composition towards more advanced industrial sectors.

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1 Introduction

Why might an economy be trapped at a low level of economic development? Why is the adjstument to trade liberalization slow and often does not seem to effectively equilibrate local labor markets across space?[1] A common explanation to these questions is that high labor market frictions and low initial gains from migration to the worker might prevent labor reallocation towards higher productivity sectors and regions. Spatial and sectoral frictions might inhibit economic development or prevent an efficient response to an external shock. Understanding and quantifying these frictions is of primary importance to understanding the obstacles to growth and structural change in developing countries. However, empirically verifying and quantifying these frictions is challenging, since neither labor market frictions nor the counterfactual gains from reallocation are directly observed. This paper overcomes this problem by using a natural experiment where a foreign demand shock reallocates labor across sectors and across space. Using the shock in tandem with an economic geography model, I show how to estimate the gains from reallocation as well as the labor market frictions. The key point of this paper is to illustrate how a temporary foreign demand shock can overcome labor market frictions and reallocate labor across space and sectors by creating temporary gains that offset adjustment costs. An additional point is that the effect of the shock depends on the relative size of spatial versus sectoral labor market frictions as well as competition between regions and sectors in input markets. This points towards labor market frictions as a key factor in determining the patterns or - lack thereof - of development.

This study examines a trade shock to the Spanish economy that was caused by the participation of Spain's key trading partners - in particular France - in the first World War (1914-1918), while Spain remained neutral. Prior to the shock, Spain had experienced a prolonged period of low GDP growth with little structural change (de la Escosura; 2017). Using newly collected trade data on Spanish product level exports between 1914-1919, as well as labor market data on wages and employment across 48 different provinces and 24 different sectors before and after the war, I document five stylized facts about the shock and its impact. Firstly, the trade shock was large, increasing aggregate exports by 40% at constant prices, and additionally the shock was spatially biased with most of the aggregate increase being due to higher volumes of trade with belligerent countries - in particular France. Secondly, the trade shock was asymmetric across sectors. Comparing the trade increase between belligerent and non-belligerent countries before and during the war, I find that exports to belligerent countries increased in particular for garments, textiles, paper and products from the heavy industry. Thirdly, sector-level income growth was spatially tilted towards the French boarder, with each additional 100km distance to the French boarder decreasing - on average - the growth rate by 4 percent. Fourthly, provinces with a higher specialization in industries favored by the shock experienced faster population growth compared to their pre-trend, with the opposite being true for provinces with less favorable industrial composition. Finally, regional industry dynamics depended on the tightness of the local labor market, indicating an important role for spatial frictions in preventing arbitrage between geographically

[1]The empirical finding that local labor markets only adjust slowly to shocks goes back to Blanchard and Katz (1992). Dix-Carneiro and Kovak (2017) show that labor market frictions and slow adjustment processes can permanently prevent spatial arbitrage.

segregated labor markets.

The general point that provinces with a prior specialization in sectors that benefited from the war shock had an opportunity to expand their production can be illustrated with an example: The *Sociedad Minera y Metalurgica de Penarroya* who operated a factory for fertilizer and other chemical goods in Cordoba. While the factory faced higher labor and input prices, they also faced a substantial increase in both domestic and foreign demand, and increased their output of superphosphate - a fertilization agent - by 30 percent while expanding their workforce by 20 percent between 1914 and 1917 (de Reformas Sociales; 1916). Such industries with prior industrial capacity in place were well positioned to benefit from the shock, but had to attract labor from other provinces and sectors. In doing so, provinces found themselves competing with each other to attract workers from other areas of the economy and in particular from the agricultural hinterland.

I develop a quantitative economic geography model to understand the *aggregate* impact of that shock, accounting for the *disaggregated* geographical margins of adjustments. The models is consistent with the stylized facts focuses on taking explicitly into account the spatial linkages across provinces in the labor market, the sectoral switching costs within local labor markets, as well as differences in comparative advantage across provinces. I build on the existing quantitative economic geography literature model - as recently surveyed by Redding and Rossi-Hansberg (2016) - and extend a baseline model into several directions. Labor demand is determined by a framework where multiple sectors conduct intra-national and international trade subject to geographical frictions. Differently to most of the commonly used models in the literature, I do not take a stance on the strength of external scale economies. Rather, the patterns of comparative advantage across space and sectors are partially endogenous, with higher labor densities translating into productivity gains, depending on the strength of a set of sector specific parameters that determine industry level scale economies. The adopted models - first introduced into the international trade literature by Kucheryavyy et al. (2016) - can be represented by a log linear gravity formulation and is consistent with a Ricardian multi sectoral trade model with external scale economies, but also nests multiple other canonical models currently used in the literature, depending on the interpretation and values of the parameters.

Labor supply is determined by a nested discrete choice framework where workers first make a decision about reallocating across space subject to incurring switching costs, and then upon arrival in the new province sort into sectors. A two staged sequence of preference shocks from a Frechet distribution make the framework tractable. Two kinds of switching costs are introduced: Firstly, workers who leave a sector incur a switching cost that is specific to the sector and proportional to the expected utility of its destination, secondly, a worker who reallocates to a different province incurs a switching cost that scales with distance. This framework extends the commonly used economic geography models by allowing for stickiness in employment at the sectoral and provincial level - a key feature of the data. At the same time the number of parameters that is being introduced is limited.

I then show how the structure of the model and the exogenous variation due to the natural experiment can be combined to obtain credible estimates for structural parameters that pin down the gains from reallocation. Conditional on specifying the strength of geographical frictions in input markets, the structure of the model together with income data can be used to solve for the origin-specific prices. The strategy behind this is that economic geography models allow to decompose total sectoral income into two parts, a first determinant of income that is due to proximity to lucrative destination markets, and a second part that describes how given market acess lower marginal costs translates into a higher captured trade share across all locations, with this part being theoretically interpreted as an origin-specific price and is empirically related to the origin fixed effect in a gravity equation. These origin specific prices can be regressed on (log) wages and employment sizes of sectors to obtain elasticities how wage changes and changes in sectoral employment size translate into higher trade shares. The elasticity with regard to wage changes is commonly referred to as trade elasticity, while the other elasticity determines scale effects. I will refer to it as *scale elasticity* in the remainder of the text.[2] An obvious problem in this estimation is the endogeneity of wages and labor densities. I utilise instruments that effectively exploit differential shock exposure across provinces interacted with differences in labor market tightness to estimate the parameters.

The estimated parameters point to the presence of *decreasing* returns to scale in the medium run, effectively limiting the immediate gains from reallocating labor in the absence of the shock. Similar estimates for scale economies over a 10-year horizon indicate that decreasing returns vanish over the long run. The estimation also gives insights into the performances of a broad class of economic geography models in capturing adjustment patterns. Specifically, the fit of the regression expresses how much of the observed variation in residual income shifters can be explained by the endogenous mechanism provided by the model. The model can explain around a half of that residual variation.

Estimating labor market frictions usually requires flow data, across space and sectors. However, in a historical context this type of data is rarely available. I show how to estimate labor market frictions in the absence of such data. The structure of the model allows for a conveniently separable estimation of geographical and sectoral frictions. Geographical frictions are being estimated by fitting the model to data on net migration between provinces in the 1920s. This data is convenient since it conveys origin data for stocks of residents within provinces and across time, thus providing geographical information to estimate the impact of distance on migration flows. In order to estimate sectoral switching costs I fit the model to changes in labor market conditions at the province-sector level from before to after the war. A key concern is that migration decisions were made during the war based on wage dynamics that are not part of the available data. I overcome this data limitation by using the estimated labor demand model together with the trade shock to simulate unobserved wages during the war and estimate sectoral frictions consistent with those wages. As has been pointed out by Silvestre (2005), levels of internal migration during that period were markedly low, amounting to net flows of less than 5 percent of the population over a decade. Consistent with that, the estimated model indicates high frictions to labor mobility both across space and across sectors.

[2] Note that this elasticity does not correspond to an output scale elasticity, but rather combines how scale translates into productivity gains and thus into income gains.

As a by-product of the estimation I obtain simulated reallocation patterns of labor that are consistent with the changes in labor market conditions due to the war. The simulated reallocation patterns strongly suggest that spatial frictions dominate sectoral adjustment frictions, with most of the adjustment happening across sectors *within* provinces, rather than *between* provinces. Finally, I use the estimated model to obtain the counterfactual evolution of the Spanish economy in the absence of the World War shock and to indicate the aggregate treatment effect the allocation of labor across provinces and sectors. The comparison between the counterfactual and the observed data shows substantial reallocation across sectors and provinces due to the trade shock.

The current setting has three distinct advantages that make the analysis possible. Firstly, the shock is large as well spatially and sectorally asymmetric. This provides a large amount of variation that helps to identify parameters across all sectors. Secondly, there is prior substantial variation in sectoral specialisation across cities, allowing for an uneven impact of the shock across space. Finally, the policy response was limited. During the War the central government in Madrid was dominated by the land-based oligarchy, who took little interest in the economic needs of the business community in Catalonia or the Basque country (Harrison; 1978). Policy remedies only came late and in a limited form.[3]

Related literature This paper contributes to a growing literature that looks at how industries and regions within countries might respond to an external shock. What sets the current paper apart is that it looks at a large external shock that was asymmetric across sectors and space that affected directly or indirectly the whole Spanish economy, thus providing sufficient variations to estimate the key parameters that pin down the gains from reallocating labor across multiple industries, as well as a careful estimation of the labor market frictions. In doing so, this paper brings together different aspects that have been looked at separately before. One of these aspects is the endogenous productivity response to trade changes and how that in turn affects industry dynamics as in Juhasz (2017) who looks at how temporary import protection can induce import substitution and productivity improvements in the textile industry during the Napoleonic blockade. In the current setting the model allows for endogenous productivity responses as a function of the observable scale of the industry, which can be related to import substitution as observed by Juhasz, but crucially the current study is not only focused on a single sector but captures these individual sector dynamics *as well as* reallocation across multiple industries in a spatial equilibrium setting. Another aspect is how trade shocks can fuel differential population dynamics between cities and provinces creating persistent differences, something that has been explored before by Hanlon (2014) in the case of a negative supply shock caused by the U.S. Civil War (1861-1865) that affected the English cotton textile industry and differentially affected cities that were more specialised in that industry compared to those that were not. The same effect is present in the current setting, but the shock is more general in that it affects a large range of sectors, providing sufficient variation to look at the interaction of different provinces across

[3]For example only in 1917 did the Spanish government introduce a *law for the protection of new industries and the extension of existing ones* earmarking 10 million pesetas for the use of industries falling far short of the demand of the industry lobby to establish a foreign exchange bank and a commission house to faciliate the financing of exports instead.

multiple sectors in both the input and output market.

This paper also contributes to the literature on regional dynamics as a response to trade shocks. Closest in spirit is the analysis by Dix-Carneiro and Kovak (2017). They examine Brazil's regional dynamics as a result of trade reforms and trade liberalization and find slow adjustment and steadily increasing divergent trade effects driven by a mechanism where high labor market frictions and slow capital accumulation drive the adjustment pattern. Their empirical and theoretical setting is very different, while they focus on a permanent change in the trade environment of a country, I focus on how a temporary shock can reallocate inputs across provinces and sectors. Furthermore, my study contributes to the literature by carefulling estimating both labor market frictions and scale economies in the medium and long run within a coherent theoretical economic geography framework.

Finally, the papers adds to the literature on Spanish economic history by showing that the WW1 shock had an important impact on the Spanish economy, not necessarily by creating large output gains directly, but by reallocating factors across space and sectors to provide the preconditions for an economic take-off in the 1920s. As such it is a middle ground between the two opposing views in the literatue. The established view, represented by Roldan and Delgado (1973), interprets the war as a large turning point for economic development. Using his own constructed GDP series, de la Escosura (2016) emphasises that the World War shock actually decreased GDP per head and instead he points towards the 1920s as a much more important decade for Spain's development. My analysis implicitly connects the two events by pointing towards the reallocation of labor across sectors and provinces as a fertile ground for capital fuelled growth in the 1920s.

The remainder of the paper is structured as follows. Section 2 discusses the historical background, describing both the situation in Spain before the War and during the War. Section 3 describes the various data sources as well as the construction of the labor market panel that underlies most of the analysis. Section 4 gives reduced form evidence on the trade shock and its effect on regional population dynamics. Section 5 describes the theoretical model that guides the estimation and analysis. Section 6 then proceeds with describing the estimation procedure. In Section 7 I then use the quantatitative model to simulate Spain in the absence of the War before discussing the results. Finally, in section 8, I conclude.

2 Historical Background

This section describes the historical circumstances. The first part gives an overview of the state of the Spanish economy towards the beginning of the war. The second section gives an overview of the historical circumstances of the World War itself and how Spain itself was connected to it.

2.1 Spanish Economy at the beginning of the 20th century

After missing the first wave of the industrial revolution in the first half of the 19th century (Harrison; 1978), the Spanish economy underwent a period of rapid industrialization in the second half of the 19th century, fuelled by market integration due to the expansion of the railroad network which in turn resulted in the devolution of industrial capacity to the peripheral provinces with the cotton industry in Catalonia and Metallurgy in the Basque country developing especially rapidly (Nadal; 1975). However, industrialisation soon came to an early halt with the census data showing little increase in industrial employment from 1887 onwards. This is also mirrored by very low GDP per head growth rates averaging 0.6 percent between 1883-1913 (de la Escosura; 2017). Some authors attribute the low levels of growth to limited demand for manufacturing goods domestically as well as little capacity to compete with goods from early industrializing countries such as Germany, France and the UK (Harrison; 1978).

As a result, at the beginning of the 20th century, the industrial sector barely continued to expand and Spain remained at a low level of industrial development. According to census data, in 1900 roughly 70% of the working population worked in agriculture and only 12.5% worked in industrial/manufacturing sectors. Industrialisation only proceeded slowly, with the industrial sector only growing marginally in total employment by 3%, adding a little bit less than 40,000 jobs nation-wide in the first decade of the century. At that time, the largest share of the industrial sector was made up by sectors associated with primary goods, such as the exploitation of mines or the production of construction material as can be seen from the employment shares of individual industries depicted in figure 19.

In terms of the spatial distribution of the population, most of the population was still concentrated in predominantly rural and agricultural areas such as Andalucia[4] or Castilla y Leon[5] (cp. figure 20). However, looking beyond the larger regional aggregation and looking at individual provinces, it is precisely such major urban centres such as Oviedo, Valencia, Vizcaya, Madrid and Barcelona that increasingly attracted and concentrated the Spanish population as can be seen by their population dynamics shown in figure 21. The provinces that contained these urban centres tended to concentrate most of the industrial activity as can be seen by the map in figure 3 indicating the spatial distribution of manufacturing employment. While internal migration was perenially low, with net migration amounting to less than 5% of the population before 1920, the two largest cities, Barcelona and Madrid, tended to nevertheless attract a large share of agricultural workers from other provinces, making them unique magnets for migrants around 1900 (Silvestre et al.; 2015).

The industrial structure of those urban centres was heterogenous. For example, Barcelona was highly specialised in the cotton textile industry, while Valencia specialized in garments. Because of natural endowments mining and associated downstream industries dominated in Oviedo and Jaen. The Basque country had an early advantage in the heavy metal industries, featuring numerous Martin-Siemens open hearth furnaces for steel production as well as other installations. This degree of agglomeration of specific industries even at this early stage of industrialisation suggests some degree of agglomeration externalities.

In terms of external markets, at the end of the 19th century, (former) colonies and other Latin

[4]Andalucia comprises eight provinces: Almería, Cádiz, Córdoba, Granada, Huelva, Jaén, Málaga and Seville, with major industrial activity located in Seville and Mining employment in Huelva

[5]Castilla y Leon comprises nine provinces: Avila, Burgos, Leon, Palencia, Salamanca, Segovia, Soria, Valladolid and Zamora with major industrial activity centred in Valladolid.

American Market played a particularly important role, while after the loss of the colonies Spain's exports shifted more towards European countries with France and Great Britain taking up the biggest share of exports as can be seen in figure 22. Most of the exports were raw materials or agricultural products consistent with the low developmental status of Spain at the time as depicted in figure 7. In general Spain ran a trade deficit for most of the beginning of the 20th century except for the short period under consideration in this paper as seen in the aggregate exports and imports values depicted in figure 4.

In summary, it can be stated that at the beginning of the 20th century Spain was a predominantly agricultural economy with a low level of industrial activity and while there was some rural urban migration, there was in general little dynamism towards further industrialisation.

2.2 The Spanish Economy and World War I

The assassination of the Austrian Archduke Franz Ferdinand on 28 June 1914 by Yugoslavist revolutionaries, triggered a series of declarations of Wars that set off the first World War on 28 July 1914, with the allied powers spearheaded by France, the British Empire, Russia, and later on the United States, fighting the central powers, composed of the German Empire, Austria-Hungary, the Ottoman Empire and other co-belligerents. The consensus is that a conflict limited in terms of duration and extent was expected, but instead it would become one of the largest wars in history, spreading across all major populated continents and lasting until 11 November 1918.

At the onset of the war Spanish society was divided into two opposing camps, with liberal fractions supporting the allied powers, and the remainder of the population supporting the central powers. However, a participation in the war itself was not considered feasible (Harrison; 1978), so Spain remained neutral throughout the war.

The effects of the first World War on the Spanish economy are well documented in the reports by the *Instituto de Reformas Sociales* (de Reformas Sociales; 1916). They can be broadly summarised into two categories. Firstly, the war brought about opportunities to provide war materials to the belligerent nations. This spawned increased demand for textiles, garments, and for the heavy metal industry. Secondly, a lack of British, French and German competition in the home market provided an opportunity for domestic producers to produce import substitutes. The report mentions new factories that produced goods as varied as supplies for cars, paper folders, perfumes, small machinery, lightbulbs and others. I will examine the effect in more detail in the reduced form section below.

3 Data

Labor Market Panel Data The main source for labor market data is an industry survey that covers the years 1914, 1920, 1925 (Ministerio de Trabajo; 1927). This industry survey was published by the Ministery for Labor and Industry and is based on surveys conducted at all public firms and large private enterprises in cities that are larger than 20,000 inhabitants (Casanovas

2004). It covers 23 different industries[6] and 48 different provinces.[7]

While the industry survey covers a large range of the manufacturing sector, it does not give further information on the remaining economy. As mentioned before, a crucial feature of the Spanish economy was a large agricultural sector. In order to account for that, I digitized the occupation-province specific section of the census for 1900, 1910, 1920 and 1930. I use the 1920 data on agricultural employment[8] to augment the 1920 data.[9] For the 1914 data, I use the 1910 province specific agricultural employment data and extrapolate by calculating province specific fertility trends until 1914. Finally, I use data contained in the official Spanish statistical yearbooks on province specific agricultural mean wages for 1915 and 1920.

Trade Data The trade data is taken from annual trade records released by the Spanish custom agency. Using crowdsourcing services, I digitized the trade statistics for the years 1910 and 1914-1919. For those years, the quantity of exports in 383 product categories across 77 different destination countries are available. Furthermore, the border agency uses a system of product level prices to obtain total export values. These prices do not vary throughout the period of consideration and can be interpreted to give the relative pre-war prices across goods.

Correspondence In order to construct a correspondence between product level trade data and industry-level labor market data, I used an additional publication that lists the official correspondence between industries and occupations (de Prevision Social; 1930), often explicitly stating the associated product as occupation name for an industry. From that I constructed a correspondence table that matches products to industries. While some products can be uniquely associated to one industry, others can be at least matched with two industries. In matching exports to industry levels, I add the export values for those products to both relevant industries.

Migration Data In order to infer labor mobility costs, data on migration flows is necessary. I follow Silvestre (2005) and use the province level data on inhabitants that are *Born in Another Province* which is contained in the censuses. For 1920 and 1930 additional information is available listing not only the stock of migrants which were born in another province, but their origin

[6]The industries included are called: Books, Ceramics, Chemicals, Construction, Decoration, Electricity, Food, Forrest, Furniture, Garments, Glass, Leather, Metal Works, Metallurgy, Mines, Paper, Public, Public Industry, Textiles, Tobacco, Transport, Varias, Wood. The appendix gives the matching of the industry with the product level trade data and thus a better idea of the hidden heterogeneity within the industries.

[7]The census for 1910 lists 49 different provinces. They mostly correspond to the modern administrative units called *provincias* - which are in turn roughly the NUTS3 level administrative units of Spain. There are some minor differences, e.g. in how different off-continental administrative units are being treated. For my analysis I drop the canary islands from the sample since their distance from the mainland makes it hard to argue that they are similarly integrated as other provinces. A complete list of the different provinces, the corresponding modern administrative unit, their capital city, population sizes and area can be seen in the appendix.

[8]More specifically I add the Agriculture (Owner) section and the workers in fishery, forrest and agriculture together to obtain an aggregate size of the agricultural sector at the time in each province

[9]When merging the census data with the industry survey, I adjust for the fact that the survey does not cover the universe of workers, while the census does. In order to maintain the correct relative size of agriculture to manufacturing sector, I compare the total size of industry employment in the survey data with the census - with the census potentially accounting for informal employment as well as industries in smaller villages. On average, the manufacturing employment size of the survey data represents at least 44% of the manufacturing sector in the census data. I scale the agricultural employment accordingly when merging the census and survey data.

province as well. The difference between 1930 and 1920 in the stock of migrants - adjusted for decennial survivability rates - is informative about net migration. In order to construct net migration, I follow Silvestre (2005) and use the decennial census survivability rate between 1921-1930, $S \equiv 0.86$. Net internal migration can be obtained by constructing the survivability adjusted change in stock of migrants, i.e.

$$\text{Internal migrations}_{1920,1910,i,j} = BAP_{i,j,1920} - S \times BAP_{i,j,1910}$$

where $BAP_{i,j,1910}$ refers to the stock of residents in i who where born in province j in 1910.

Distance Using GIS software I georeferenced the Spanish railroad network in 1920. Then, using MATLAB's internal shortest path function, I obtain bilateral distances between provincial capitals along the shortest path of the railroad network. In order to obtain distances to Paris, I augmented the graph with the French railroad network and further added maritime linkages between important ports in France and Spain. Again using the shortest path functionality of Matlab I can obtain the shortest distance between provincial capitals in Spain and Paris.

4 Reduced form evidence

In this section I develop five stylized fact that characterize the nature of shock, as well as the impact it had on regional development within Spain. The stylized facts will guide the choice of the model and will inform the empirical estimation.

Stylized fact 1: The trade shock was large & spatially biased The export shock was large from an aggregate point of view. In 1915 aggregate exports increased by 40% compared to 1914 and stayed at a high level for as long as the war lasted.[10] Most of the increase was due to differential increase of belligerent countries compared to non belligerent countries as shown in figure 5: The trade to belligerent countries tripled, while trade with non-belligerent countries remained at a relatively low level and only grew in the later war years above pre-war levels. Most of the increase in trade with belligerent country stems solely from export increases to France as can be seen in the destination composition of exports depicted in figure 22. Since the trade shock originated mostly from France, provinces close to the French boarder had a more favorable position since they faced lower transport costs when shipping towards France. This effectively created a spatial bias in the shock.

Stylized fact 2: The trade shock was asymmetric across sectors Most of the increased demand can be associated with war needs, such as textiles, garments, metal works and leather goods which can be seen from the shift in sectoral exports to France as shown in figure 23. However, it is not clear whether these changes in sectoral trade flows are driven by plausibly exogenous

[10] This increase is probably underestimated since official statistics kept the price for the calculation of values of exported goods at a constant level during the decade under consideration, while it is plausible that increased demand has further increased the price.

demand side effects or by potentially endogenous domestic supply side trends. In order to obtain a sector specific measure of the foreign demand shock, I construct a theoretically consistent measure by leveraging a standard gravity trade equation,

$$X_{od,s} = \tau_{od}^{-\epsilon_s} w_{o,s}^{-\epsilon_s} A_{o,s}^{\epsilon_s} P_{d,s}^{\epsilon_s} E_{d,s}$$

where $X_{od,s}$ denotes the export level from origin (o) to destination (d) in sector s which depends on bilateral resistance term, τ_{od}, as well as the marginal cost of production in the origin country, $w_{o,s}/A_{o,s}$, positively on the sectoral expenditure in the destination country, $E_{d,s}$ and the price index, $P_{d,s}$, measuring the competitiveness in the destination market, and where ϵ_s denotes the sector specific trade elasticity. Constructing the growth of exports, $\hat{X}_{od,s,t} \equiv \frac{X_{od,s,t}}{X_{od,s,t-1}}$, and comparing the growth rate across destination countries, one can obtain the following expression,

$$\Delta_{o,s} \equiv \frac{\hat{X}_{od,s,t}}{\hat{X}_{od',s,t}} = \left(\frac{\hat{P}_{d,s,t}}{\hat{P}_{d',s,t}}\right)^{\epsilon_s} \times \left(\frac{\hat{E}_{d,s,t}}{\hat{E}_{d,s,t}}\right)$$

where hat variables refer to changes. In words, this double difference states, that export growth from origin o to destination d compared to export growth from o to some other destination d', $\frac{\hat{X}_{od,s,t}}{\hat{X}_{od',s,t}}$, is a function of relative changes in the price index in the two destination countries, $\left(\frac{\hat{P}_{d,s,t}}{\hat{P}_{d',s,t}}\right)$, as well as relative growth in their expenditure levels $\left(\frac{\hat{E}_{d,s,t}}{\hat{E}_{d,s,t}}\right)$. This double difference can be used to isolate destination specific effects, in particular, the relative changes in the expenditure and competitiveness of one desitnation market compared to some other, plausibly unaffected, comparison group.

When calculating this measure, I compare sectoral export growth to belligerent countries to non-belligerent countries. However, some adjustments are necessary to account for secondary effects of the war. First of all, the war made trade across the frontline and maritime trade after 1917 difficult. Therefore the sample of belligerent countries that I focus on only includes France, Italy and the United Kingdom and I construct export growth by comparing the mean export levels for 1915/1916 with the baseline export in 1910, thus avoiding additional distortions after 1916 and the partial-year war effect of 1914. For the non-belligerent comparison group I exclude belligerent countries as well as the United States, to avoid any war preparations to pollute the measure. The increase in the aggregate export levels can be seen in figure 5. The sectoral results can be found in the appendix in table **??**. The sectors that benefited from particularly high levels of demand during the war are Garments, Glass, Metal Works, Mines, Paper and Textiles. These sectors experienced between 5-20 times more growth in demand from belligerent countries than they do from non-belligerent countries.[11]

Stylized fact 3: Regional Dynamics exhibited a Spatial Gradient The shock induced a demand shock that had spatial and sectoral characteristics, but how did the shock affect regional

[11] As can be seen in the table Mining exports to non-belligerent countries all but disappeared in the period under considerations. According to the historical reports, this is not due to demand factors, but capacity constraints in Spain, a feature that is not inherent in the standard gravity approach.

dynamics? I use the labor market data introduced in the previous section to construct income growth at the sector-province level. In order to examine whether the spatially biased shock induced regional development that was spatially tilted, I run the following regression,

$$\frac{Y_{i,s,1920}}{Y_{i,s,1910}} = \alpha + \beta_1 distance_{i,Paris} + \epsilon_{i,s}$$

where $Y_{i,s,1920}$ is the total labor income of sector s in province i in 1920, that is $Y_{i,s,1920} = w_{i,s,1920}L_{i,s,1920}$ with $w_{i,s,1920}$ referring to the wage in that province-sector and $L_{i,s,1920}$ referring to the total number of employees, and finally $distance_{i,Paris}$ refers to the shortest distance along the railroad network or maritime linkages between the capital of province i and Paris. The fitted line is depicted in figure 1. I find that each additional 100km distance to Paris translates into 4 percent lower income growth. This stylized fact is also robust at the sectoral level and controlling for labor market tightness - as proxied by the own sector size relative to the province size - as well as initial differences in comparative advantage - as proxied by the sectoral employment share in the national industry - as can be seen in regression table 5.

Stylized fact 4: Regional Dynamics depended on Industrial Specialization To understand the differential impact that the shock had at the province level, I use the sectoral shocks to construct an exposure measure to the shock, that is i define,

$$ExpExposure_i \equiv \sum_s \pi_{i,s,1914} \times \Delta_s$$

where $\pi_{i,s,1914} \equiv \frac{L_{i,s,1914}}{\sum_k L_{i,k,1914}}$ refers to the share of industry s in province i in terms of numbers of workers in 1914 and where Δ_s refers to the export shock measure defined above. Figure 11 plots the average population growth for the bottom quartile and the top quartile of export exposure, as well as the trend lines for 1900/1910 growth before the war. Controlling for pre-war differences, the highest quartile of export exposure features 4% faster population growth, reversing a lower initial trend growth. It is apparent that the shock has reallocative features affecting the lowest exposed provinces negatively and the most exposed provinces positively, hinting at an important margin for competition for inputs in the labor market.

Stylized fact 5: Local Labor Supply can inhibit Regional Dynamics In the presence of spatial labor market frictions, which given the low level of decennial internal migration at the time in Spain - as pointed out by Silvestre (2005) - are clearly present, labor supply is partially localized and must be sourced from other sectors within the same province. This implies that the larger your own share in the local labor market the more limited the pool of workers you can obtain - relatively speaking. Regressing (nominal) income growth on the sectoral share of total provincial employment before the war which is defined as Employment Share of Sector in Province) $\equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$, I find that an increase by 1 log point translates into .1 log points lower nominal growth rates. The linear fitted line can be seen in figure 9. This finding is robust to controlling for comparative advantage as proxied by the size of the province-sector in the national industry, and level size affect as proxied for by (log) employment in 1914 of that industry as can be seen in table 5.

5 Theoretical Framework

The theoretical framework is informed by the stylized facts shown above. As indicated by the spatial gradient, spatial frictions in the output market will play a prominent role, thus shifting the attention towards economic geography models. Furthermore, the setting requires a multi-sectoral model to account for the sectoral heterogeneity of the shock. Finally, the last two stylized facts suggest that provinces compete for labor inputs and that labor supply can be - to some extent - localized. In order to accommodate that, I will extend the standard economic geography model to account for a fairly general set of labor market frictions, introducing switching costs that make labor sticky at the provincial and the sectoral level.

5.1 Setting

Consider an economy with multiple locations indexed by $n, i \in \mathcal{N}$. Locations are heterogeneous in their exogenously fixed housing supply, $\overline{H}_n$, and their geographical location relative to one another. Each location produces goods in multiple sectors $r, s \in \mathcal{S}$. Total population at time t is exogenously fixed at L_t and there is an initial distribution at time 0 of the population across locations and sectors, $[L_{i,s,0}]_{\forall i,s}$.

5.2 Labor demand

Labor demand is being determined by a multi-industry Ricardian model with industry level economies of scale along the lines of Kucheryavyy et al. (2016), that allows for intranational trade between provinces within a country and international trade with foreign countries. The only factor of production is labor. Each country has a representative consumer with upper tier Cobb Douglas preferences across housing - with an expenditure share δ - and industry bundles, with industry specific expenditure shares given by $\beta_r \in (0,1)$, such that $\sum_r \beta_r = 1 - \delta$. Trade costs are of the standard iceberg type so that delivering a unit of any industry-k-good from country i to country n requires shipping $\tau_{ni,k} \geq 1$ units of the good, with $\tau_{ii,k} = 1$. Trade shares take on the following functional form,

$$\lambda_{ij,s}(\mathbf{w}_s, \mathbb{L}_s) = \frac{S_{i,s} L_{i,s}^{\alpha_s} (w_{i,s}\tau_{ij,s})^{-\epsilon_s}}{\sum_k S_{k,s} L_{k,s}^{\alpha_s} (w_{k,s}\tau_{kj,s})^{-\epsilon_s}}$$

where $\mathbf{w}_s, \mathbb{L}_s$ refers to the vector of sectoral wages and employment levels across provinces respectivly, $S_{i,s}$ is a province-sector specific productivity shifter, $w_{i,s}$ are the province-sector specific wages, and $L_{i,s}$ the quantity of labor employed, and $\tau_{ij,s}$ refers to the iceberg trade cost as defined above. Higher labor densities increase productivity via the scale elasticity ψ_s, which in turn increases trade shares mitigated via the trade elasticity ϵ_s, formally being defined as

$\epsilon_k \equiv -\frac{\partial ln(\lambda_{ni,k}/\lambda_{nn,k})}{\partial ln \tau_{ni,k}}$. Together the effect can be summarised as $\alpha_s \equiv \psi_s \times \epsilon_s$ which is the elasticity of changes in trade flows as a response to changes in employment size of a sector. Finally, the trade elasticity ϵ_s also governs the sensitivity of trade flows with regard to changes in the marginal cost of production, in particular if they are driven by changes in the input cost, that is the local wage, $w_{i,s}$.

The current framework, which allows for industry level economies of scale, is consistent with a Ricardian model with external scale economies but is also sufficiently general to nest multiple other trade models including trade models that feature internal scale economies as pointed out by Kucheryavyy et al. (2016).[12] Within a given period the labor allocation is fixed. The static equilibrium can be defined as follows,

Definition 1 (Static Equilibrium)**.** *The static equilibrium within each period, given the labor distribution, is given by goods market clearing, balanced trade and housing market clearing.*

$$w_{is} L_{is} = \sum_j \lambda_{ij,s} \beta_s Y_j \qquad \forall (s,n) \in \mathcal{S} \times \mathcal{N} \tag{1}$$

$$E_{is} = \sum_j \lambda_{ji,s} \beta_s Y_i \qquad \forall (s,n) \in \mathcal{S} \times \mathcal{N} \tag{2}$$

$$r_n = \frac{\delta Y_n}{H_n} \qquad \forall (n) \in \mathcal{N} \tag{3}$$

5.3 Labor Supply

Workers live for two periods only. In the first period they are born and "inherit" their parents employment in province i and sector s, earning the same wage, $w_{i,s}$. In the second period they can make a decision to move across provinces and sectors. The moving decision is based on a nested discrete choice, where workers first decide which province to move to - and implicitly to leave their own sector - and then upon arrival in the province decide which sector to work in. Indirect utility is given by

$$V_{j,s,t} = \left(\frac{\rho_j w_{j,s,t}}{P_{j,t}^{1-\delta} r_{j,t}^{\delta}} \right) \times \kappa_{j,t} \times \iota_{s,t}$$

where ρ_j represent location specific amenities, $r_{j,t}$ the market clearing rental rate for housing, $P_{j,t}$ represents a local price index which aggregates sector level local price indices according to the Cobb Douglas preferences specified above, that is $P_n = \tilde{\beta}_n \prod_{k=1}^{K} P_{n,k}^{\beta_{n,k}}$ and where the sectoral price index $P_{n,k}$ is defined as follows,

$$P_{n,k} = \mu_{n,k} \left(\sum_{k \in \mathcal{N}} S_{i,s} L_{i,s}^{\alpha_s} (w_{i,s} \tau_{ij,s})^{-\epsilon_s} \right)^{-1/\epsilon_k}$$

where $\mu_{n,k}$ and $\tilde{\beta}_n$ are some constants, where $S_{i,s}$ is a province-sector specific productivity shifter, $w_{i,s}$ is the province-sector specific wage, and $L_{i,s}$ the quantity of labor employed, and $\tau_{ij,s}$

[12] As Kucheryavyy et al. (2016) show, the framework can map into multi-sector variants of Eaton and Kortum (2002), Krugman (1979) and Melitz-Pareto type trade models (Chaney; 2008)

refers to the bilateral iceberg trade cost, α_s is the scale elasticity and ϵ_s the trade elasticity.[13] Finally, $\kappa_{j,t}$ and $\iota_{s,t}$ represent idiosyncratic preference shocks that capture preference heterogeneity at the micro-level. They are assumed to be independently drawn from a Frechet distribution,

$$F(\kappa_{j,t}) = e^{-\kappa_{j,t}^{-\nu}}, \quad \nu > 1, \quad F(\iota_{s,t}) = e^{-\iota_{s,t}^{-\gamma}}, \quad \gamma > 1$$

where ν and γ are the respective dispersion parameters and will pin down the migration elasticities.In the first stage the worker decides whether to leave its current sector, conditional on observing the location specific vector of preference shocks, $\boldsymbol{\kappa}_t$, but not yet knowing the vector of sector specific preference shocks, $\boldsymbol{\iota}_t$. Leaving the current sector implies either reallocating to a different province or reallocating across sectors within the current province based on some index of the utility in the destination province. A worker currently residing in province i and working in sector s faces the following problem,

$$\max \left[\mathbb{E}_t V_{i,s,t+1}, \mathbb{E}_t \frac{\widetilde{V}_{i,t+1}}{\mu_s}, \mathbb{E}_t \frac{\widetilde{V}_{1,t+1}}{\mu_{ij}}, \ldots, \mathbb{E}_t \frac{\widetilde{V}_{I,t+1}}{\mu_{ij}} \right]$$

where the worker is choosing the optimal reallocation choice conditional on knowing the preference province specific sector shocks and forming expectations over uncertain future wages and the sector specific preference shock, to be drawn in a second stage from the Frechet distribution with dispersion parameter γ defined above. The properties of the Frechet distribution imply that the expected indirect utility from remaining in province i and working in sector s corresponds to $\mathbb{E}_t V_{i,s,t+1} \propto \mathbb{E}_t \left(\frac{\rho_j w_{j,s,t}}{P_{j,t}^{1-\delta} r_{j,t}^{\delta}} \right)^{\gamma}$. Similarly, applying the properties of the Frechet distribution, the expected indirect utility of reallocating and living in province j at time $t+1$ is given by, $\mathbb{E}_t \widetilde{V}_{j,t+1} \propto \mathbb{E}_t \left(\frac{\rho_j}{P_{j,t}^{1-\delta} r_{j,t}^{\delta}} \right) \left(\sum_k w_{j,k,t+1}^{\gamma} \right)^{\frac{1}{\gamma}}$ here.[14]

Effectively, the worker compares the indirect utility of remaining in the current province-sector with the expeceted indirect utility of reallocating to any other sector subject to incurring a switching cost, where μ_{ij} and μ_r are the geographical and sector specific switching costs that capture the difficulty of switching sectors and provinces.[15] The population that population that remains in a province is pinned down by the geographical mobility cost μ_{ij} effectively discounting options that involve out migration. The remaining population is the share for which the highest indirect utility is being obtained by staying in the current sector, that is $\mathbb{E}_t V_{i,s,t+1}$ or by reallocating within the province to another sector, $\mathbb{E}_t \frac{\widetilde{V}_{i,t+1}}{\mu_s}$, subject to sectoral switching costs, with the size of the switching cost determining the share of the workers who choose to remain in the sector. As this makes clear, the key determinant is the relative size of different switching

[13] The constant $\mu_{n,k}$ depends on the specific model being adopted. $\tilde{\beta}_n$ is the standard Cobb Douglas term

[14] In the current setting the Frechet dispersion parameter γ is symmetric across locations, therefore we can abstract from additional multiplicative term that determines the scale of the expectation, $\Gamma(1 - \frac{1}{\gamma})$. However, one can easily extend the current setting to account for heterogeneity of local sectoral labor supply elasticities.

[15] Different interpretations are possible: For agriculture the sectoral switching cost might absorb some of the cost of moving to a major urban center, for other sectors they might simply signify the loss of sector specific human capital. For the geographical part the reallocation cost might absorb the lost utility due to disrupted social connections or the actual moving cost.

costs. I will return to this point during the quantitative analysis. Given the Frechet distributed error terms, standard properties imply the following closed form for the shares of workers who move across provinces,

$$\sigma_{ij,s}(\widetilde{V}) = \frac{\left(\widetilde{V}_{j,t+1} \times \frac{1}{\mu_{ij}}\right)^{\nu}}{\Omega_{i,s}}$$

where $\Omega_{i,s} \equiv \mathbb{E}_t \left(\frac{\rho_i w_{i,s,t+1}}{P^{1-\delta}_{i,t+1} r^{\delta}_{i,t+1}}\right)^{\gamma} + \mathbb{E}_t \sum_j \left(\frac{\rho_j}{P^{1-\delta}_{j,t} r^{\delta}_{j,t}}\right) \times \left(\sum_k w^{\gamma}_{j,k,t+1}\right)^{1/\gamma}$ summarises the option value of the worker currently working in sector s and residing in province i, where μ_{ij} refers to the geographical switching cost, μ_s refers to the sectoral switching cost, ν defines the elasticity with regard to changes in the indirect utility or alternatively the switching cost and finally, $\widetilde{V}_{j,t+1}$ refers to the expected indirect utility forming expectations over the unobserved sectoral preference shock. Conditional on reallocating and upon arrival in the province the worker uncovers his vector of sector specific preference shocks, $\boldsymbol{\iota}_t$ and makes a choice selecting a sector. Again assuming Frechet distributed preference shocks whose with dispersion parameter γ, one can obtain the following closed form for the share of workers that flow into industry r in province i,

$$\sigma_{i,r}(\mathbf{w}_i) = \frac{w^{\gamma}_{i,r}}{\sum_k w^{\gamma}_{i,k}}$$

where $\mathbf{w}_i$ is the vector of wages in province i and $w_{i,r}$ refers to the wage in sector r and in province i. Since the other determinants of indirect utility enter symmetrically across all options, they do not affect the sectoral shares. Finally, one can state the flows from province i and sector r to province j and sector s, as,

$$\sigma_{ij,rs}(\widetilde{\mathbf{V}}, \mathbf{w}) = \sigma_{i,r}\sigma_{ij,s}$$

where $\widetilde{\mathbf{V}}$ represents the vector of expected indirect utilities across provinces, and where province-sector specific flows are separable between, $\sigma_{ij,s}$, that is the bilateral flows between province i and province j, and the sorting into sector r within province i, $\sigma_{i,r}$. Total labor supply is then given by a market clearing condition, that is,

$$L_{i,s,t+1} = \sum_{j,r} \sigma_{ji,rs}(\widetilde{\mathbf{V}}, \mathbf{w}) L_{j,r,t}$$

6 Estimation

In order to use the model described in the previous section for a quantitative analysis of the World War I shock, one needs to obtain estimates of the key parameters. On the labor demand side, we need to obtain trade elasticities, $\{\epsilon_s\}\forall s \in S$, scale elasticities, $\{\alpha_s\}\forall s \in S$, and productivity shifters, $\{A_{i,s}\}\forall(i,s) \in S \times N$. On the labor supply side we need to estimate switching costs and geographical and sectoral supply elasticities. The estimation of the parameters determining labor demand can be done separately, since changes in the spatial equilibrium are sufficiently informative to estimate them. Given those estimates we can then estimate the parameters associated with the labor supply model.

6.1 Labor demand

The estimation of the key parameters that determine labor demand relies mainly on the labor market data - that is wages and employment size for each province-sector. I demonstrate how to use that in conjunction with the model structure in order to estimate the key parameters that determine the labor demand. In the first step I use a structural approach to separate out origin specific marginal cost prices and market access. In a second step, I then regress the obtained prices on wages and labor densities to obtain the structural parameters.

6.1.1 Obtaining Origin-Prices

From the spatial equilibrium, one can obtain the following two equations,

$$Y_{i,s} = \sum_j X_{ij,s} = \sum_j \tau_{ij}^{-\epsilon_s} p_{is}^{-\epsilon_s} P_{js}^{\epsilon_s} E_{js}$$

$$E_{i,s} = \sum_j X_{ji,s} = \sum_j \tau_{ji}^{-\epsilon_s} p_{js}^{-\epsilon_s} P_{is}^{\epsilon_s} E_{is}$$

where the first equation states that total income in province i and sector s, $Y_{i,s}$, must equal the cumulative export sales for that sector, that is the sum of all export flows from the origin province i to any province j, i.e. $\sum_j X_{ij,s}$. Since export flows follow the gravity structure the second equality follows. The second equation states that total expenditure in province i on goods from sector s, must equal total incoming export flows from all origin provinces j, that is $\sum_j X_{ji,s}$. Combining and rearranging, one can obtain a system of equations in terms of prices only,

$$p_{is}^{\epsilon_s} = \sum_j \tau_{ij}^{-\epsilon_s} \left(\sum_k \tau_{kj}^{-\epsilon_s} p_{ks}^{-\epsilon_s} \right)^{-1} \frac{E_{js}}{Y_{is}}$$

where $p_{i,s}^{\epsilon_s}$ refers to the origin prices introduced above. Standard results in economic geography imply that this equation can be solved to find the unique vector of provincial origin prices (up to normalization) for each sector, $\mathbf{p}_s^{\epsilon_s}$.

Using the labor market data before and after the war - that is for 1914 and 1920 - and using the housing market data to construct disposable income across provinces, $E_{is} \equiv \beta_s Y_i$, one can implement the inversion described in the previous paragraph. In the implementation I use the shortest distance along the railroad graph between Spanish provincial capitals and furthermore add France as an additional location, where the distance to France is the shortest distance to Paris across railroad and maritime linkages. The iceberg transport cost is calibrated to be, $\tau_{ij} = distance_{ij}^{-1}$, calibrating the distance elasticity to the canonical value of -1 (Head and Mayer; 2013). Since I do not have coherent labor market data for France, I only include the total value of sectoral exports[16] as additional demand into the economic geography system.

6.1.2 Price Regression

In the second step, I can use marginal cost pricing, which implies that $p_{i,s} = \frac{w_{i,s}}{A_{i,s} L_{i,s}^{\alpha_s}}$, to obtain a log-linear expression of prices as a function of sector-province employment levels and wages. Taking the first difference, I obtain the following equation,

$$\epsilon_s \log \frac{p_{is,t+1}}{p_{is,t}} = \epsilon_s \log \frac{w_{is,t+1}}{w_{is,t}} - \alpha_s \log \frac{L_{is,t+1}}{L_{is,t}} - \log \frac{A_{is,t+1}}{A_{is,t}} \tag{4}$$

where relative changes in origin-prices of sector s in province i, $\frac{p_{is,t+1}}{p_{is,t}}$, are a function of relative changes in wages and employment levels in that sector-province. The responsiveness of origin prices with regard wages and employment levels is pinned down by the trade elasticity, ϵ_s, and the scale elasticity α_s, respectively. The scale elasticity itself is combination of productivity externalities and how these productivity externalities in turn translate into income gains, that is $\alpha_s = \psi_s \times \epsilon_s$. We can define the structural residual as $\eta_{i,s,t} \equiv \log \frac{A_{is,t+1}}{A_{is,t}}$, which is the unobserved productivity evolution at the sector-province level.

Endogeneity A natural concern is the endogeneity of both wages, $w_{i,s}$, and employment, $L_{i,s}$. The model implies that as a result of increases in productivity, $\frac{A_{is,t+1}}{A_{is,t}} > 0$, labor demand will increase and move along the upward sloping labor supply curve, with increases in wages and employment levels as a result. This implies that the model structure indicates a positive correlation between the residual, $\eta_{i,s,t}$, and the wages and employment levels, which will in turn induce an upward bias for the estimation of α_s and a downward bias for the estimation of ϵ_s. The naive OLS results depicted in table 3 shows theoretically invalid negative trade elasticities and large estimates for the external scale parameter, consistent with the model implied bias. An instrument is therefore necessary to remedy the situation. The exclusion restriction for any instrument is that

$$E\left[\eta_{is,t} | \mathbf{z}_t\right] = E\left[\log \frac{A_{is,t+1}}{A_{is,t}} | \mathbf{z}_t\right] = 0$$

where $\mathbf{z}_t$ denotes the vector of instruments and $\eta_{is,t} = \log \frac{A_{is,t+1}}{A_{is,t}}$ denotes the structural error as discussed above. The setting is more challenging than a standard endogeneity problem because of the presence of two - potentially correlated - endogenous variables. An appropriate instrument needs to induce sufficient independent and differential variation in the endogenous variables to separately identify their impact on the dependent variable. The model suggests that labor supply shifters interacted with the incidence of the shock can serve as a source of such variation. Intuitively, while the foreign demand shock translates into a labor demand shock that stems from the industries desire to expand their production, the curvature of local labor supply

[16] French exports are at the yearly level while the labor market data is in terms of the hourly wage and only covers a subset of the overall economy of Spain. When introducing the exports into the model I divide the total value by 54×50 to translate the value into hourly exports. Then I multiply it by the share of the industry that is represented in the sample, that is .44.

Figure 1: Inelastic Labor Supply

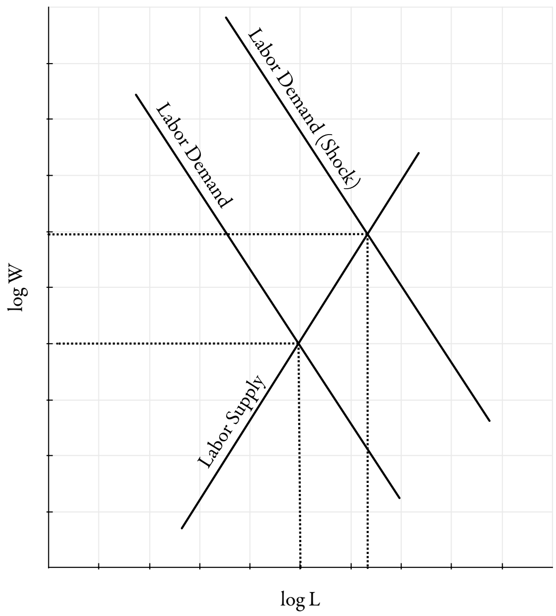
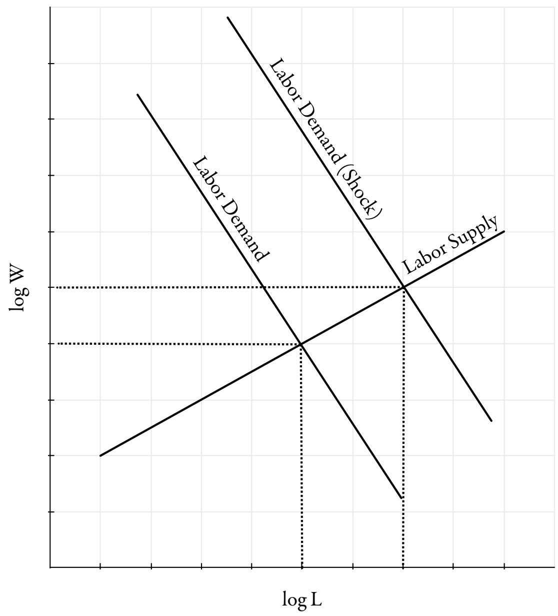


Figure 2: Elastic Labor Supply



Notes: The figure illustrates the underlying premise of the instrument. In the presence of two endogenous - potentially correlated - variables, independent variation is needed that differentially shifts the two variables. In the current setting a labor demand shock induces an outward shift of the labor demand curve from L_d to L'_d, inducing an increase in both wages in industry s and province n, $w_{n,s}$, as well as employment size, $L_{n,s}$. The extent to which the shock is being absorbed by prices or quantities depends on the curvature of labor supply. If labor supply is tight - due to frictions in the labor market - the curve will be upward sloping and wages will increase rather employment size. The opposite is true if labor supply is highly elastic.

will determine whether the additional demand is being absorbed mostly into higher wages or larger sectoral size as measured by employment. As illustrated in the figures below.

Historical evidence as well as the stylized facts suggest that spatial frictions are high and that labor supply is highly localized. I exploit this by using the (log) distance to Paris interacted with the (log) employment share of a sector within a province as a first instrument, where $log(\text{Employment Share of Sector in Province}) \equiv log\frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ acts as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. A second instrument is given by a Harris Market Potential measure for the input market leaving own size out as a labor supply shifter, constructed as $LMA_{i,s} = \sum_{j \neq i, r \neq s} \frac{1}{distance_{i,j}} L_{j,r}$. The first stages are reported separately in table 4.

Results The results can be seen in the table here. The trade elasticity is lower than the usual estimates, while the α_s parameters are very imprecise. In the case of several sectors α_s is negative, indicating decreasing returns to scale. The R squared is a natural measure of the fit of the model. To understand why, recall that prices solve the spatial equilibrium conditions, thus effectively functioning as residual income shifters, once one controls for market access differences. The R squared then measures how much of the variation can be explained by the log linear regression. The fit indicates that the model can explain half of the variation in the residual income shifter.

Additionally, the model including labor densities performs much better than the model that only accounts for wage effects - as would be the case in the absence of any scale effects. That model can only account for a quarter of the observed variation.

6.2 Labor supply

The estimation of the labor supply parameters proceeds in two steps and each step relies on different data sources.

6.2.1 Step 1: Geographical frictions

In the first step, I rely on data that shows the decennial change in the number of workers who live in a certain province but were born in another province, that is $L_{in,t}$ for a worker who was born in province i but now lives in province n. The difference in this stock of foreign born workers, $L_{in,t} - L_{in,t-1}$, is informative about the net inflow of foreign born workers, either directly from the province under consideration or indirectly from other provinces. The data is adjusted so that the 1920s data shows the same number of total inhabitants born in a given province as the 1930s data, adding the additional population in their origin provinces. Using the closed forms from the previous section I can construct the model equivalent of this moment. The (estimated) stock of workers born in province j and currently residing in province n is given by,

$$\widehat{L}_{j,n,1930} = \sum_{j,r} \sigma_{ij,s}(\widetilde{\mathbf{V}}, \mathbf{w}) \pi_{j,r,1920} L_{j,n,1920}$$

where $\widehat{L}_{j,n,1930}$ refers to the simulated stock of workers born in province j and currently residing in province j, $\pi_{j,r,1920}$ refers to the industry share of industry r in province j in 1920 and where the closed form for the share of flows between province i and province j originating from sector s is given by $\sigma_{ij,s}(\widetilde{V}) = \frac{\left(\widetilde{V}_{j,t+1} \times \frac{1}{\mu_{ij}}\right)^{\nu}}{\Omega_{i,s}}$. Implicitly, this is assuming that there is no sorting across industries of different groups of inhabitants, which in the absence on additional information is a necessary assumption. In the baseline estimation, I assume that wages and price indices follow a random walk. The geographical switching cost is calibrated as a function of distance that is

$$\mu_{ij} = \zeta_{cons} \times \zeta_i^1 \times distance_{ij}^{\zeta^2}$$

where $distance_{ij}$ is the shortest distance across railroad and maritime travelling routes from the province capital in i to the province capital in j in km. The structural estimation chooses the parameter vector $\beta = (\zeta_1^1, \ldots, \zeta_1^I, \zeta^2, \nu, \gamma)$ to match the observed moments, that is minimizing the error between imputed and observed quantities of workers born in another province,

$$\eta_{j,n}(L_{j,n,1930}, \boldsymbol{\beta}) = L_{j,n,1930} - \widehat{L}_{j,n,1930}$$

$$\hat{\boldsymbol{\beta}} = \arg\min_{\beta \in B} \boldsymbol{\eta}\left(w_{i,s}, L_{i,s}, \boldsymbol{\beta}\right)' \boldsymbol{\eta}\left(w_{i,s}, L_{i,s}, \boldsymbol{\beta}\right)$$

Notice that since data is more informative about geographical mobility costs rather than sectoral mobility cost, I abstract from sectoral switching costs in this step and introduce instead an origin varying scalar for the bilateral mobility cost, ζ_i^1, that accounts for differences in the average scale of the option value across regions.

Identification The average level of the geographical friction determines the out-province migration share. The distribution across destinations determines the distance elasticity. The incoming migration to specific provinces above and beyond what is justified by wage differences informs the province specific amenities. The persistence of sector specific employment determines the sector specific out migration cost.

6.2.2 Step 2: Sectoral switching costs

In order to estimate sectoral switching costs I fit the model to changes in labor market conditions at the province-sector level from before to after the war. A key concern is that migration decisions were made during the war based on wage dynamics that are not part of the available data. In order to overcome this limitation I propose to use the estimated labor demand model together with sectoral trade data from 1915 to simulate the market clearing wages in the presence of the World War shock. I proceed by first using the 1914 data to impute the residual productivities, $\{A_{i,s,1914}\}$, and then feed in the trade shock to back out the simulated market clearing sectoral wage vectors, $\hat{\mathbf{w}}_{s,1915}$. Using these sectoral wage vectors as expected wages, and calibrating the spatial friction to the estimated values from the previous section, I use the closed forms to match the observed changes in employment size between 1914 and 1920,

$$\widehat{L}_{i,s,1920} = \sum_{j,r} \sigma_{ji,rs}(\widehat{\mathbf{w}}) L_{j,r,1914}$$

where $\widehat{L}_{i,s,1920}$ refers to the estimated stock of workers in province i and sector s in 1920, and $L_{j,r,1914}$ refers to the observed size of industry r and province j, and $\sigma_{ji,rs}(\widehat{\mathbf{w}})$ is the closed form for migration flows between province j to province i and sector r to sector s. Recall that,

$$\sigma_{ij,rs}(\widehat{\mathbf{w}}) = \sigma_{i,r}\sigma_{ij,s}$$

that is the bilateral migration flows between sectors and provinces is a composite between outgoing migration between province i and province j in sector s and workers who upon arrival in province i sort into sector r. The structural error is given by,

$$\eta_{j,n}(L_{i,s,1920}, \boldsymbol{\beta}) = L_{i,s,1920} - \widehat{L}_{i,s,1920}$$

$$\hat{\boldsymbol{\beta}} = \arg\min_{\beta \in B} \boldsymbol{\eta}\left(w_{i,s}, L_{i,s}, \beta\right)' \boldsymbol{\eta}\left(w_{i,s}, L_{i,s}, \beta\right)$$

where the structural procedure chooses $\boldsymbol{\beta} = (\mu_1, \ldots, \mu_S, \gamma)$ minimises the distance between the observed and the estimated employment size of each sector-province observation.

Identification Conditional on geographical frictions being calibrated, the size of the sectoral switching cost is informed by the persistence of sectoral employment size in the presence of local wage disparities between sectors. An important caveat is that sectoral switching costs can only be identified in a scenario where workers do not reallocate despite a positive wage differential. If in the sample a sector consistently experiences strong growth as a result of favorable wages vis-a-vis the local labor market, then switching costs cannot be inferred. In these cases the switching cost is calibrated to the mean switching cost.

7 Quantitative Analysis: Spain without WW1

Implementation Having estimated the parameters that determine both labor supply and demand, one can now use the model to determine the counterfactual evolution of the Spanish economy in the absence of the WW1 shock. Since labor flows depend on the expectations of utilities across province-sectors, and since those utilities themselves depend on the migration choices - via the scale economies - there is a potential for multiple equilibria in this class of model, and a necessity for equilibrium selection when conducting the counterfactual.[17] The baseline results presented here assume that wages and price indices follow a random walk and therefore are expected to remain at the level of the initial equilibrium observed in 1914. That is, workers coordinate using the current wages and price indices. Alternatives to that baseline can be explored.

Reallocation Patterns Bilateral reallocation patterns for the period are unknown. The only data that is available is on sectoral employment sizes. The estimated model be used to obtain simulated flows that are consistent with the observed stocks. When simulated such flows indicate little reallocation across provinces with a gross flow of less than 3 percent of the population, but much reallocation taking place within provinces, in particular between agriculture and the manufacturing sector but also within the manufacturing sector.

Sectoral Growth The results, presented at the sectoral level in figure 17 show strong reallocation across industries, with industries affected by the shock growing and other industries shrinking. Reallocation is towards higher productivity sectors such as garments, chemicals, textiles, metal works, metallurgy, mines and textiles. The most striking pattern is a reallocation from the agricultural sector towards the manufacturing sector as a whole.

8 Conclusion

My primary interest was to examine to what extent labor market frictions can inhibit economic development of a country. I used a newly collected historical dataset that combines trade and

[17] An alternative approach is to bound the possible outcomes by setting up the counterfactual problem as an MPEC Reguant (2016). This approach is currently being examine but the results are not yet available.

labor market data, to examine a unique historical episode: A temporary trade shock to a developing economy that prior to the shock only underwent slow structural transformation. I demonstrated the key features of the shock and its impact on regional development within Spain: The shock was temporary, sectorally heterogeneous, large and spatially biased. It induced spatially tilded regional development and affected provinces heterogeneously depending on their initial industrial specialization. I built a quantitative economic geography model that can account for the dynamic response to the temporary shock. In this setting I extend a baseline economic geography model to be better suited to match the regional dynamics of a temporary shock, by introducing and estimating labor market frictions that make employment sticky at the sectoral and provincial level as well as allowing for endogenous productivity feedbacks to determine the immediate productivity gains from reallocation.

An interesting aspect of the current work is that limited historical data can be complemented with structural models to improve both the estimation of objects of interest - as was done in the current setting by simulating unobserved wages for the estimation of labor market frictions - and in order to get further insights into phenomena that are not directly observed - as was done in this paper by obtaining sector-province labor reallocation patterns consistent with estimated migration costs and observed sectoral employment sizes.

The analysis suggests that high levels of labor market frictions and low immediate returns to reallocation due to the absence of scale economies and even the presence of decreasing returns in some industries prevented the Spanish economy from developing further. The shock induced reallocation across space and particularly between sectors within provinces, thus creating the fruitful preconditions for an economic take off in the following decade.

This suggests four important conclusions: Firstly, labor market frictions are of primary importance for analysing (spatial) development of a country. Secondly, the relative size of different labor market frictions determines the pattern of development. Thirdly, productivity gains due to scale economies which loom large in cross-sectional studies might only materialise slowly as shown in the current setting, making the challenge to exploit them effectively via labor reallocation so much more daunting, and shifting the focus towards understanding the frictions that inhibit scale at the sector level. Finally, in order to study the spatial development process within a country a new class of economic geography models is needed that accounts both for labor market frictions and - potentially endogenous - adjustment frictions at the sector level.

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A Tables

Table 1: Results from the Stuctural Estimation: Labor Demand

Industry	α_s	Std Err	ϵ_s	Std Err
Agriculture	1.20^{***}	(0.60)	2.71^{**}	(1.19)
Books	-1.12^{*}	(1.28)	3.91^{**}	(1.55)
Ceramics	-0.37	(0.85)	4.06^{***}	(1.42)
Chemicals	-1.72^{***}	(0.80)	3.18^{**}	(1.39)
Construction	-0.73	(0.96)	2.83^{**}	(1.30)
Decoration	-0.67	(1.67)	3.35^{**}	(1.49)
Electricity	-0.15	(1.03)	3.99^{**}	(1.51)
Food	-1.09	(1.11)	2.90^{**}	(1.32)
Forest	-12.27	(9.92)	8.02^{**}	(4.60)
Furniture	-0.49	(1.21)	3.60^{**}	(1.42)
Garments	-1.12	(1.02)	3.16^{**}	(1.31)
Glass	-0.22	(1.58)	3.43^{**}	(1.55)
Leather	1.24	(0.95)	4.57^{**}	(1.45)
Metal works	-1.87^{***}	(0.86)	2.96^{**}	(1.33)
Metallurgy	-2.73^{***}	(0.96)	4.15^{*}	(1.41)
Mines	-2.63^{***}	(1.11)	5.21^{**}	(1.31)
Paper	-3.26	(2.46)	1.82^{**}	(1.32)
Public	1.10	(1.58)	3.86^{**}	(1.66)
Textiles	-1.50^{**}	(0.88)	2.79^{**}	(1.28)
Tobacco	3.14	(6.45)	2.03	(2.98)
Transport	-0.83	(0.79)	3.42^{**}	(1.33)
Wood	-0.53	(0.90)	3.22^{**}	(1.35)

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports the results from the structural estimation of the labor demand parameters. The parameter ϵ_s refers to the trade elasticity, α_s for the composite external economies of scale parameter as discussed in the theory section. The estimates are obtained via 2SLS instrumenting for employment size of sector s in province i, $L_{i,s}$ and wages $w_{i,s}$, using $logdistance_{i,Paris} \times log$(Employment Share of Sector in Province) as a first instrument, where log(Employment Share of Sector in Province) $\equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ works as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. A second instrument is given by a Harris Market Potential measure for the input market leaving own size out as a labor supply shifter, constructed as $LMA_{i,s} = \sum_{j \neq i, r \neq s} \frac{1}{distance_{i,j}} L_{j,r}$. The first stages are reported separately in table 4. The estimation is obtained on the sample that drops the 1% smallest industries, thus avoiding large leverage of outliers on estimates due to small measurement error in employment sizes and wages. Standard errors are obtained via bootstrap.

Table 2: Spatial Gradient: Sectoral Estimates

	$\frac{Y_{i,s,1920}}{Y_{i,s,1910}}$	
sector=1 × log(DistanceParis)	-0.619***	(-3.49)
sector=2 × log(DistanceParis)	-0.754***	(-4.01)
sector=3 × log(DistanceParis)	-0.671***	(-3.55)
sector=4 × log(DistanceParis)	-0.647***	(-3.44)
sector=5 × log(DistanceParis)	-0.650***	(-3.59)
sector=6 × log(DistanceParis)	-0.717***	(-3.76)
sector=7 × log(DistanceParis)	-0.695***	(-3.66)
sector=8 × log(DistanceParis)	-0.671***	(-3.70)
sector=9 × log(DistanceParis)	-0.793***	(-4.20)
sector=10 × log(DistanceParis)	-0.737***	(-3.90)
sector=11 × log(DistanceParis)	-0.669***	(-3.70)
sector=12 × log(DistanceParis)	-0.723***	(-3.70)
sector=13 × log(DistanceParis)	-0.697***	(-3.70)
sector=14 × log(DistanceParis)	-0.675***	(-3.71)
sector=15 × log(DistanceParis)	-0.668***	(-3.57)
sector=16 × log(DistanceParis)	-0.653***	(-3.60)
sector=17 × log(DistanceParis)	-0.700***	(-3.58)
sector=18 × log(DistanceParis)	-0.735***	(-3.66)
sector=19 × log(DistanceParis)	-0.713***	(-3.64)
sector=20 × log(DistanceParis)	-0.678***	(-3.72)
sector=21 × log(DistanceParis)	-0.802***	(-4.19)
sector=22 × log(DistanceParis)	-0.664***	(-3.66)
sector=23 × log(DistanceParis)	-0.737***	(-3.98)
sector=24 × log(DistanceParis)	-0.684***	(-3.73)
log(ShareInSector)	0.0624	(1.02)
log(ShareInProvince)	-0.218**	(-2.79)
Constant	6.741***	(5.18)
Observations	685	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table reports the results of a regression correlating nominal income growth between 1920 and 1910 at the sector province level with the (log) distance from the provincial capital to Paris. The distance measure is the shortest path along the railroad network and maritime linkages in kilometers. The regression allows for different intercepts for each sector. Additionally, the regression controls for the (log) employment share of sector *s* in province *i* in the national industry as a proxy for comparative advantage, as well as the (log) employment share of the sector within the province as a proxy for local labor market tightness.

Table 3: Structural Estimation: Naive OLS

Industry	α_s	T-Stats	ϵ_s	T-Stats
Agriculture	0.91***	(6.97)	−1.20***	(35.61)
Books	1.00***	(8.39)	−0.99***	(13.16)
Ceramics	1.07***	(9.08)	−0.59***	(6.95)
Chemicals	0.85***	(9.79)	−0.37***	(5.35)
Construction	1.18***	(11.89)	−1.34***	(23.71)
Decoration	1.10***	(12.71)	−1.07***	(16.33)
Electricity	0.90***	(8.12)	−0.61***	(6.99)
Food	1.15***	(10.28)	−1.29***	(24.86)
Forest	0.87***	(9.83)	−3.30***	(22.60)
Furniture	1.04***	(9.86)	−0.98***	(16.02)
Garments	1.09***	(8.09)	−1.20***	(16.36)
Glass	0.99***	(5.80)	−1.05***	(12.06)
Leather	1.03***	(13.11)	−0.93***	(13.77)
Metal works	1.04***	(10.69)	−1.08***	(16.20)
Metallurgy	0.90***	(14.32)	−0.03	(0.46)
Mines	1.13***	(23.13)	0.77***	(13.56)
Paper	1.22***	(4.56)	−1.24***	(14.34)
Public	0.99***	(5.31)	−1.81***	(11.19)
Public Industry	0.61***	(6.26)	−2.80***	(25.83)
Textiles	1.06***	(9.65)	−1.24***	(17.07)
Tobacco	1.02***	(8.02)	−1.29***	(14.60)
Transport	1.06***	(10.10)	−1.06***	(15.39)
variants	0.98***	(3.61)	−0.89***	(6.91)
Wood	0.97***	(10.07)	−1.29***	(22.04)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table reports the results of estimating the structural equation 4 without correcting for the endogeneity of wages and employment size of a sector. The estimation procedure is OLS. The dependent variable lprice refers to $\log \frac{p_{is,1920}}{p_{is,1914}}$ and the explanatory variables lwage and llabor refer to $\frac{w_{is,1920}}{w_{is,1914}}$ and $\frac{L_{is,1920}}{L_{is,1914}}$ respectively.

Table 4: Labor Demand estimation: First stage

	(1) $\log \frac{w_{is,1920}}{w_{is,1914}}$		(2) $\log \frac{L_{is,1920}}{L_{is,1914}}$	
log(DistancetoParis) x log(ShareinProvince)	0.00569***	(4.81)	-0.0133***	(-8.86)
Log(LMA)	-0.0159	(-1.71)	0.0488***	(4.13)
Constant	0.827***	(11.55)	-0.386***	(-4.24)
Observations	657		657	
F Stat	15.53		46.08	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table reports the results of the first stage for estimating the structural equation 4. The first stage predicts the endogenous variables $\log \frac{w_{is,1920}}{w_{is,1914}}$, denoting (log) wage changes between 1920 and 1914 at the province-sector level, and $\log \frac{L_{is,1920}}{L_{is,1914}}$, denoting employment changes for the same time period at the province sector level. The first instrument is $logdistance_{i,Paris} \times log(\text{Employment Share of Sector in Province})$, where $log(\text{Employment Share of Sector in Province}) \equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ works as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. A second instrument is given by a Harris Market Potential measure for the input market leaving own size out as a labor supply shifter, constructed as $LMA_{i,s} = \sum_{j \neq i, r \neq s} \frac{1}{distance_{i,j}} L_{j,r}$.

Table 5: Local Labor Supply and Income Dynamics

	$\frac{Y_{i,s,1920}}{Y_{i,s,1910}}$	
log(ShareInSector)	-0.0629	(-1.30)
log(ShareInProvince)	-0.173*	(-2.25)
log(EmploymentSize)	0.0933	(1.10)
Constant	0.860	(0.88)
Observations	637	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table reports the results from a regression of nominal income growth between 1920 and 1910 at the sector-province level on three different variables. $log(\text{Employment Share of Sector in Province}) \equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$
This table reports the results of the first stage for estimating the structural equation 4. The first stage predicts the endogenous variables $\log \frac{w_{is,1920}}{w_{is,1914}}$, denoting (log) wage changes between 1920 and 1914 at the province-sector level, and $\log \frac{L_{is,1920}}{L_{is,1914}}$, denoting employment changes for the same time period at the province sector level. The first instrument is $logdistance_{i,Paris} \times log(\text{Employment Share of Sector in Province})$, where $log(\text{Employment Share of Sector in Province}) \equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ works as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. A second instrument is given by a Harris Market Potential measure for the input market leaving own size out as a labor supply shifter, constructed as $LMA_{i,s} = \sum_{j \neq i, r \neq s} \frac{1}{distance_{i,j}} L_{j,r}$.

Table 6: Sectoral Trade Growth: Belligerent vs Non Belligerent

g_X^{NonWar}	g_X^{War}	Industry	$\Delta_s \equiv \frac{g_X^{War}}{g_X^{NonWar}}$	Sector id
2.35	1.26	Agriculture	0.54	1
0.68	1.79	Books	2.61	2
1.05	2.62	Ceramics	2.50	3
1.49	2.50	Chemicals	1.68	4
0.94	2.37	Construction	2.52	5
12.72	0.17	Decoration	0.01	6
6.23	6.98	Electricity	1.12	7
1.07	1.72	Food	1.61	8
0.91	0.90	Forrest	0.99	9
1.37	1.38	Furniture	1.01	10
1.08	21.04	Garments	19.50	11
1.89	15.10	Glass	7.99	12
1.11	3.30	Leather	2.98	13
0.46	3.73	Metal Works	8.16	14
2.28	5.81	Metallurgy	2.55	15
0.08	1.09	Mines	13.08	16
1.13	10.67	Paper	9.41	17
23.70	2.29	Public Industry	0.10	19
1.60	10.67	Textiles	6.65	20
5.43		Tobacco		21
0.65	49.05	Transport	75.41	22
1.81	1.62	Varias	0.90	23
0.73	1.13	Wood	1.53	24

Notes: This table reports the differential sectoral export growth between non belligerent destination countries and belligerent destination countries. The product level trade has been aggregated to sector level trade data to match the level of aggregation of the labor market panel. Growth rates are constructed by comparing the 1910 benchmark with average export values in 1915 and 1916, that is $g_X^{War} \equiv \frac{1/2 X_{Spain,War,1915} + X_{Spain,War,1916}}{X_{Spain,War,1910}}$ and correspondingly for non belligerent destinations. As discussed in the text I abstract from later years to avoid additional spatial frictions that perturbed international trade, in particular increased maritime warfare. To adjust for additional spatial disruptions of the frontline the belligerent countries are made up of France, Italy and the United Kingdom. The Non-belligerent countries exclude the United States and other later participants of WWI. The shock is being calculated using the official annual trade data in constant prices.

Table 7: Estimation Results - Labor demand parameters - Long Run

Industry	α_s	Std Err	α_s^{LR}	Std Err	ϵ_s	Std Err
Agriculture	1.20***	(0.60)	−0.93	(1.55)	2.71**	(1.19)
Books	−1.12*	(1.28)	0.10	(1.54)	3.91**	(1.55)
Ceramics	−0.37	(0.85)	2.04**	(0.91)	4.06***	(1.42)
Chemicals	−1.72***	(0.80)	−0.97	(1.09)	3.18**	(1.39)
Construction	−0.73	(0.96)	0.11	(0.80)	2.83**	(1.30)
Decoration	−0.67	(1.67)	−0.49	(1.51)	3.35**	(1.49)
Electricity	−0.15	(1.03)	−0.17	(1.01)	3.99**	(1.51)
Food	−1.09	(1.11)	0.72	(1.25)	2.90**	(1.32)
Forest	−12.27	(9.92)	−6.10	(10.16)	8.02**	(4.60)
Furniture	−0.49	(1.21)	0.21	(1.19)	3.60**	(1.42)
Garments	−1.12	(1.02)	0.41	(0.97)	3.16**	(1.31)
Glass	−0.22	(1.58)	0.78	(1.42)	3.43**	(1.55)
Leather	1.24	(0.95)	1.58	(1.52)	4.57**	(1.45)
Metal works	−1.87***	(0.86)	0.39	(1.43)	2.96**	(1.33)
Metallurgy	−2.73***	(0.96)	−0.85	(1.75)	4.15*	(1.41)
Mines	−2.63***	(1.11)	2.80	(4.95)	5.21**	(1.31)
Paper	−3.26	(2.46)	−6.86	(4.07)	1.82**	(1.32)
Public	1.10	(1.58)	1.61	(1.61)	3.86**	(1.66)
Public Industry	18.47***	(3.48)	1.18	(1.34)	1.36	(1.44)
Textiles	−1.50**	(0.88)	0.48	(1.39)	2.79**	(1.28)
Tobacco	3.14	(6.45)	2.78	(5.55)	2.03	(2.98)
Transport	−0.83	(0.79)	0.71	(1.37)	3.42**	(1.33)
Varias	−6.52***	(2.48)	−3.36	(3.77)	4.14**	(1.66)
Wood	−0.53	(0.90)	1.00	(1.26)	3.22**	(1.35)

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports both the short run and long run results from the structural estimation of the labor demand parameters. The parameter ϵ_s refers to the trade elasticity, α_s for the composite external economies of scale parameter as discussed in the theory section. Additionally, α_s^{LR} is reported, which is the corresponding scale elasticity if estimated for the 1914/1925 time frame instead of the 1914/1920 timeframe. The estimates are obtained via 2SLS instrumenting for employment size of sector s in province i, $L_{i,s}$ and wages $w_{i,s}$, using $logdistance_{i,Paris} \times log(\text{Employment Share of Sector in Province})$ as a first instrument, where $log(\text{Employment Share of Sector in Province}) \equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ works as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. A second instrument is given by a Harris Market Potential measure for the input market leaving own size out as a labor supply shifter, constructed as $LMA_{i,s} = \sum_{j \neq i, r \neq s} \frac{1}{distance_{i,j}} L_{j,r}$. The first stages for the 1914/1920 estimates are reported separately in table 4. The estimation is obtained on the sample that drops the 1% smallest industries, thus avoiding large leverage of outliers on estimates due to small measurement error in employment sizes and wages. Standard errors are obtained via bootstrap.

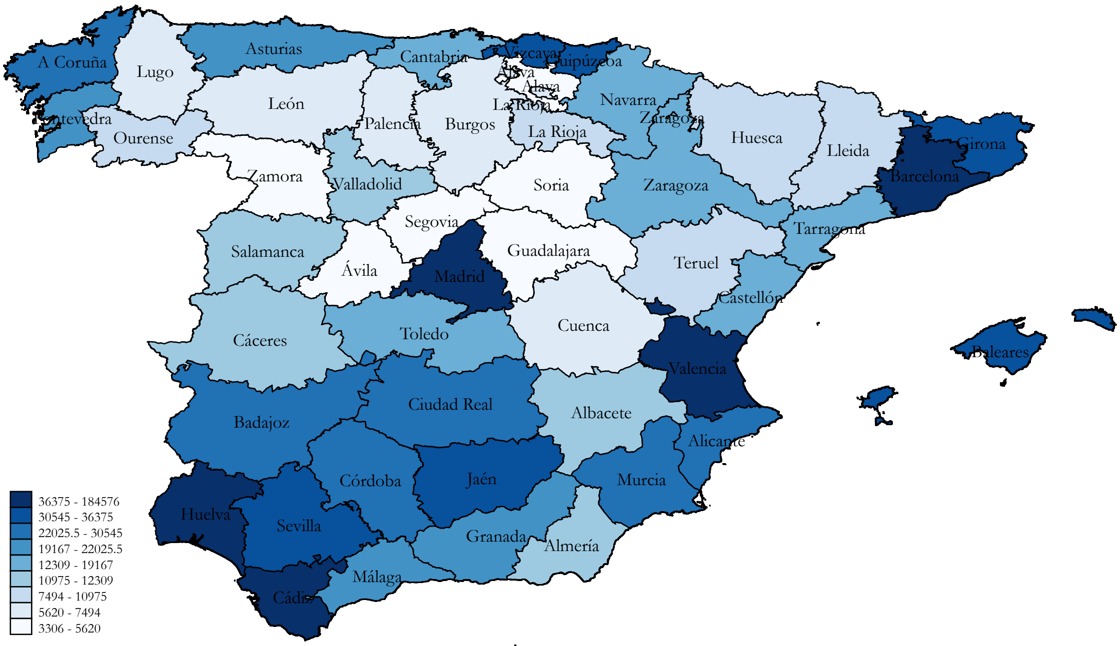
Table 8: Results: Migration Cost Estimation

Province	ρ_i	ρ_i	Industries	μ_s
Alava	0.09	0.09	Agriculture	1
Albacete	0.12	0.09	Books	1
Alicante	0.16	0.09	Ceramics	1
Almeria	0.04	0.09	Chemicals	1
Avila	0.08	0.09	Construction	1
Badajoz	0.07	0.09	Decoration	1
Baleares	0.13	0.09	Electricity	1
Barcelona	1.00	0.09	Food	1
Burgos	0.05	0.09	Forrest	1
Caceres	0.12	0.09	Furniture	1
Cadiz	0.13	0.09	Garments	1
Castellon	0.08	0.09	Glass	1
Ciudad Real	0.16	0.09	Leather	1
Cordoba	0.12	0.09	Metal Works	1
Coruna	0.12	0.09	Metallurgy	1
Cuenca	0.07	0.09	Mines	1
Gerona	0.25	0.09	Paper	1
Granada	0.09	0.09	Public	1
Guadalajara	0.13	0.09	Public Industry	1
Guipuzcoa	0.40	0.09	Textiles	1
Huelva	0.09	0.09	Tobacco	1
Huesca	0.06	0.09	Transport	1
Jaen	0.06	0.09	Varias	1
Leon	0.09	0.09	Wood	1
Lerida	0.10	0.09		
Logrono	0.09	0.09		
Lugo	0.07	0.09		
Madrid	0.69	0.09		
Malaga	0.13	0.09	Estimate for distance elasticity	
Murcia	0.12	0.09	ζ_1	12.72
Navarra	0.10	0.09	ζ_2	0.78
Orense	0.08	0.09	ν(calibrated)	2
Oviedo	0.30	0.09		
Palencia	0.08	0.09		
Pontevedra	0.10	0.09		
Salamanca	0.14	0.09		
Santander	0.10	0.09		
Segovia	0.11	0.09		
Sevilla	0.35	0.09		
Soria	0.06	0.09		
Tarragona	0.16	0.09		
Teruel	0.06	0.09		
Toledo	0.14	0.09		
Valencia	0.19	0.09		
Valladolid	0.08	0.09		
Vizcaya	0.21	0.09		
Zamora	0.07	0.09		
Zaragoza	0.10	0.09		

Notes: This table reports the results of the migration cost estimation. In the left column the amenity shifters associated with the different provinces are reported. Barcelona is normalized to 1, with the other provinces being expressed relatively to Barcelona. In the right column the sectoral switching cost parameter μ_s is reported as well as the key elasticities pinning down spatial migration cost $\mu_{ij} = \zeta_1 distance_{ij}^{\zeta_2}$. The parameters are obtained via minimum distance estimation and the procedure is described in detail in section 6.2.

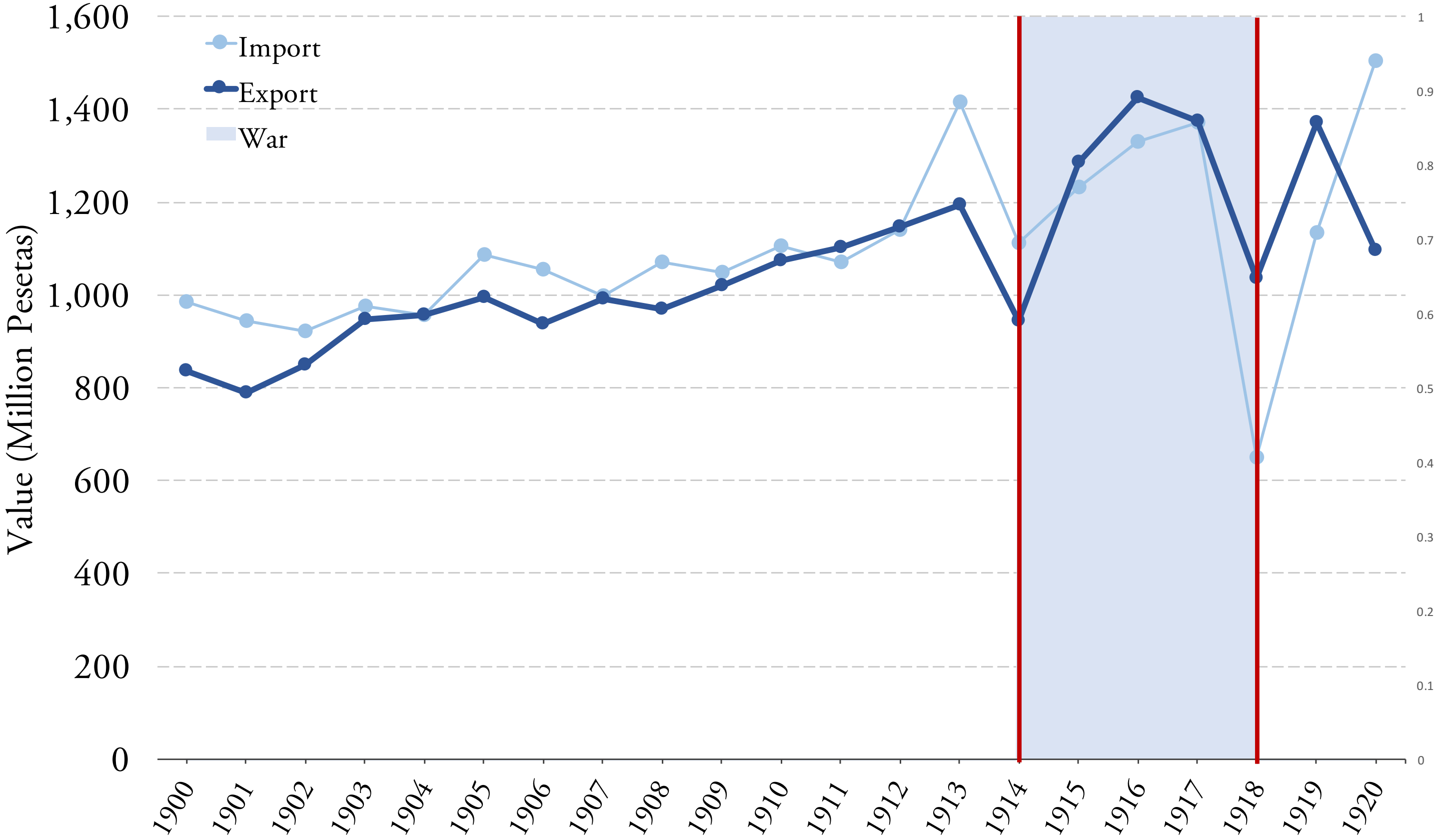
B Figures

Figure 3: Spatial Distribution of Manufacturing Employment



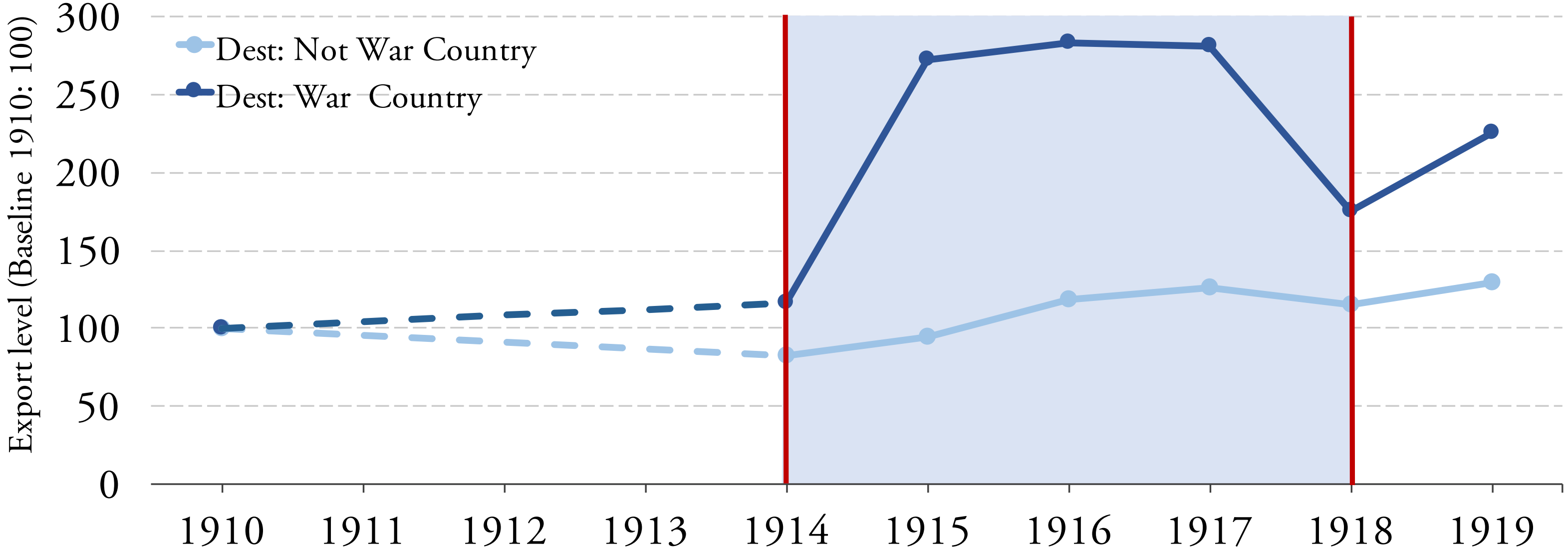
Notes: The map depicts total Manufacturing and Mining employment in the provinces in 1910 across Spain (without Canary Islands and North African possessions). The map is a chloropleth with darker shaded colors depicting higher absolute numbers. The data is obtained from the Population census from 1910.

Figure 4: Exports and Imports of Spain between 1900-1920



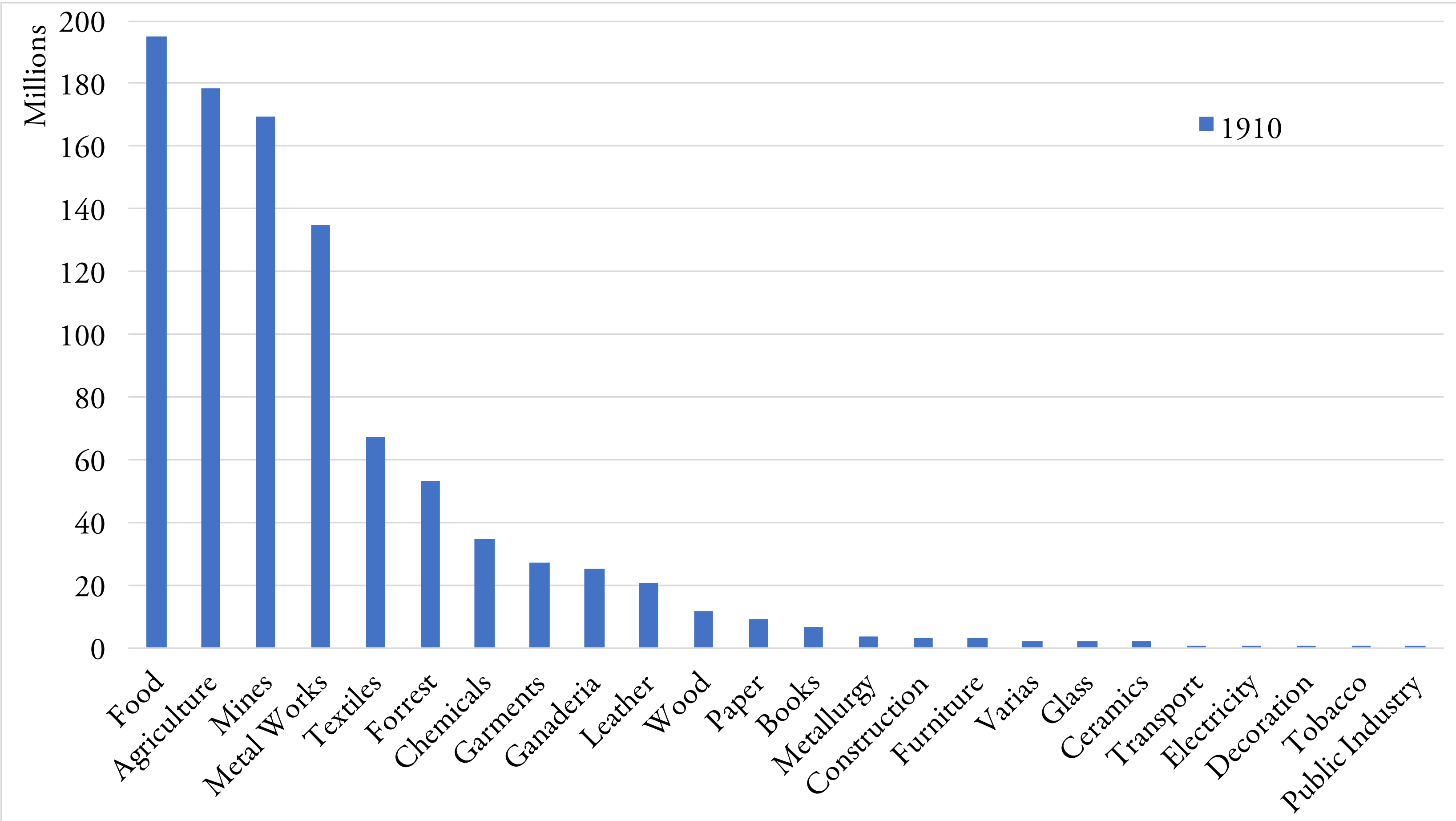
Notes: This figure depicts the aggregate exports and imports for Spain at constant pre war prices for the period between 1900 and 1920 as reported by statistical yearbooks. Aggregate exports are depicted in dark blue while imports are reported in light blue. The period of the war is indicated by the blue shaded area and the red lines indicate starting and end year for the War.

Figure 5: Aggregate Trade levels



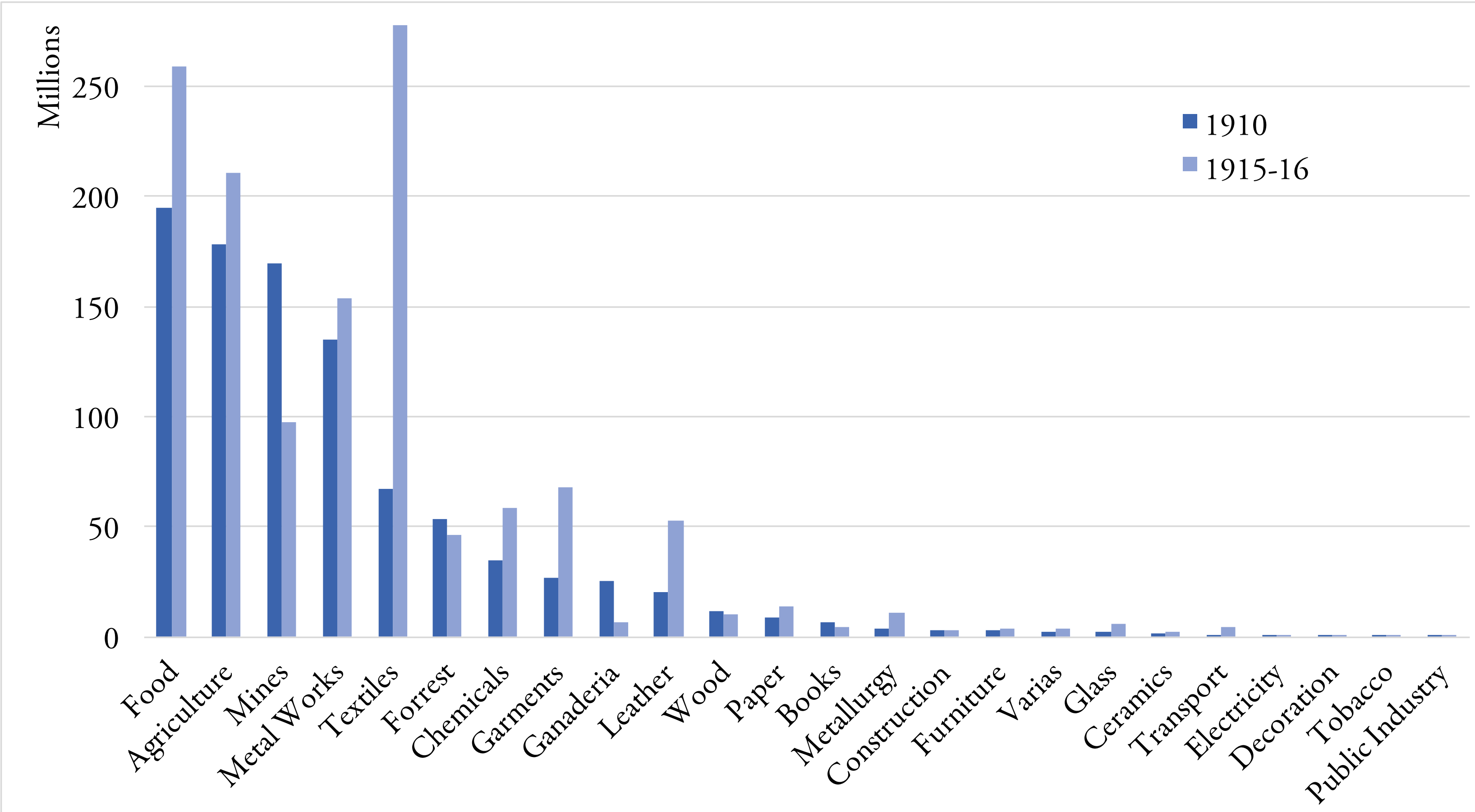
Notes: This figure compares aggregate export levels in constant pre-war prices between destination countries that participated in WWI and those that did not. To adjust for additional spatial disruptions of the frontline the belligerent countries are made up of France, Italy and the United Kingdom. The Non-belligerent countries exclude the United States and other later participants of WWI. Data is not available for the years between 1910 and 1914 therefore a trend line is imputed. The blue shaded area indicates the period of WWI. The source data are the digitized product-destination level trade statistics.

Figure 6: Sectoral Export Composition (1910)



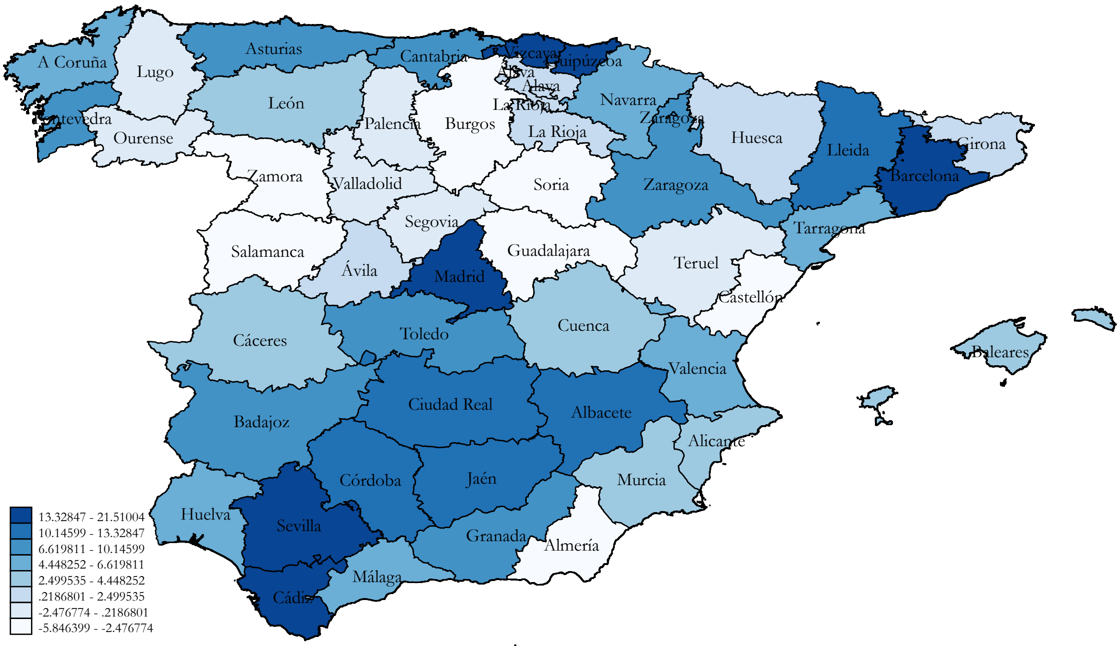
Notes: This figure reports the aggregate export composition in sectoral terms. The product level trade has been aggregated to sector level trade data to match the level of aggregation of the labor market panel. The total value of exports for each section in 1910 is reported. The source data are the digitized product-destination level trade statistics.

Figure 7: Sectoral Export Composition (1910, 1915/1916)



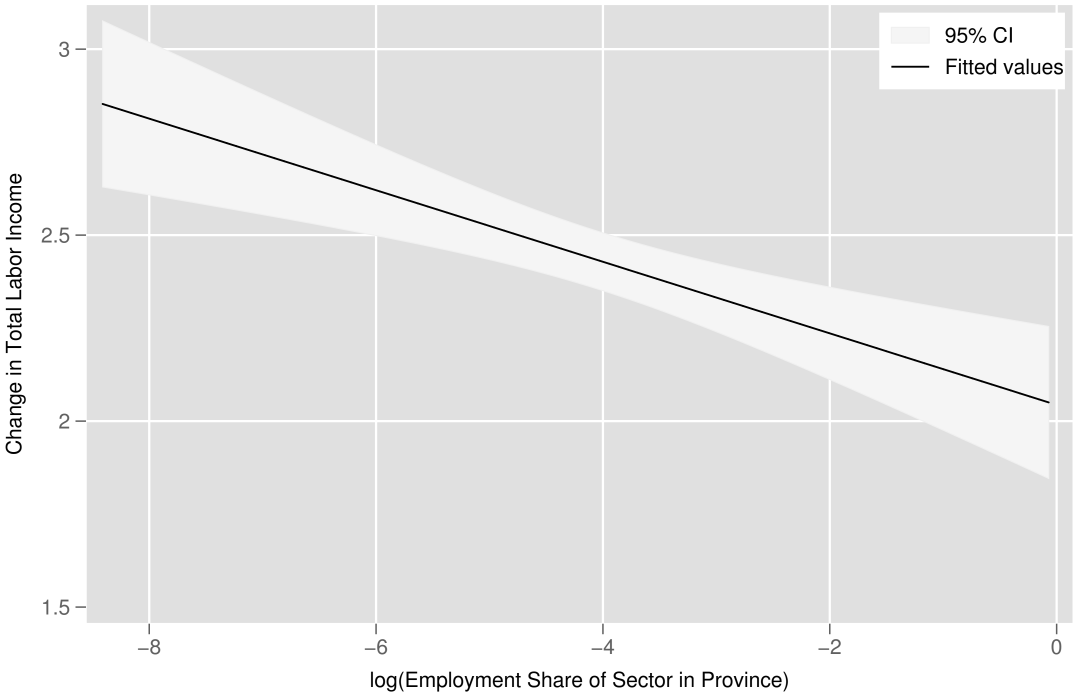
Notes: This figure reports the aggregate export composition in sectoral terms. The product level trade has been aggregated to sector level trade data to match the level of aggregation of the labor market panel. The total value of exports for each section in 1910 as well as the mean exports for 1915/1916 is reported. The source data are the digitized product-destination level trade statistics.

Figure 8: Regional Dynamics



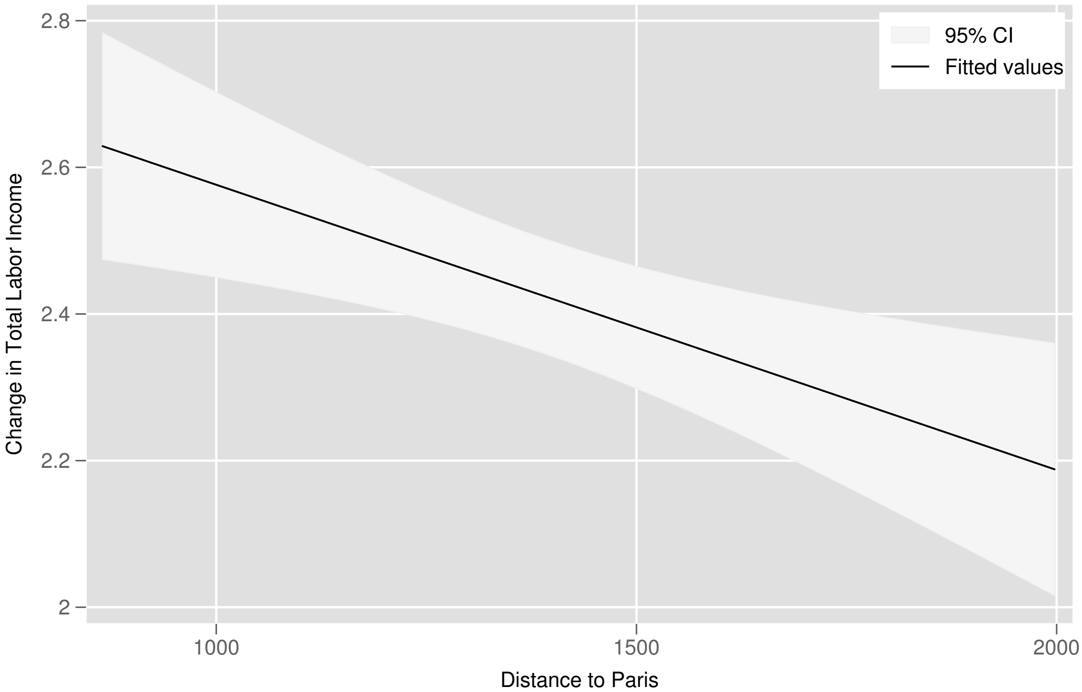
Notes: The map depicts provincial population growth in percentage terms across the provinces of Spain (without Canary Islands and North African possessions). The map is a chloropleth with darker shaded colors depicting higher percentage growth. Population growth is calculated using the total population in the 1910 and 1920 census, that is for each province i, the growth rate $g_i \equiv \left(\frac{Population_{i,1910}}{Population_{i,1900}} - 1\right) * 100$ is shown.

Figure 9: Local Labor Supply and Income Growth



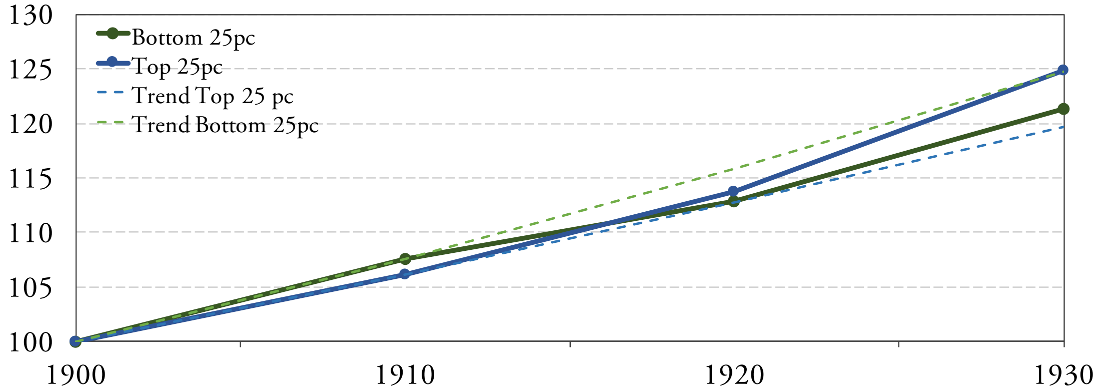
Notes: The graph shows the fitted line of a regression correlating (nominal) income growth at the sector province level between 1920 and 1914 with the log of the share of that sector in the total employed population in that province in 1914. Specifically, the variable on the x-axis is defined as $log(\text{Employment Share of Sector in Province}) \equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$. The data being used is the labor market panel introduced in the data section.

Figure 10: Spatial Gradient in Income Growth



Notes: This figure reports the results of a regression correlating nominal income growth between 1920 and 1910 at the sector province level with the (log) distance from the provincial capital to Paris. The distance measure is the shortest path along the railroad network and maritime linkages in kilometers.

Figure 11: Regional Dynamics and Specialization

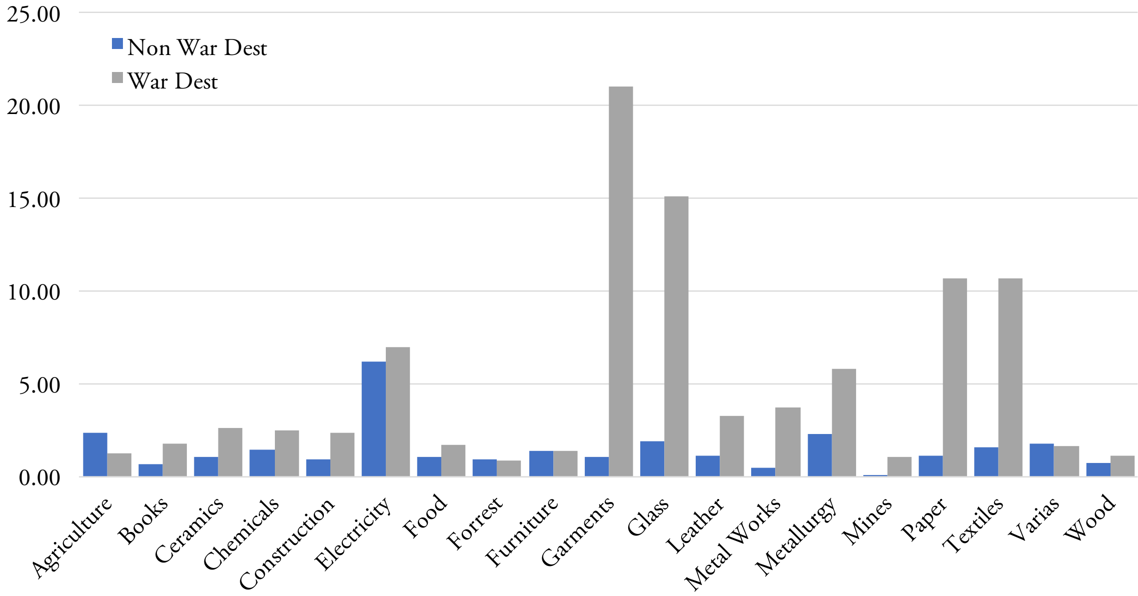


Notes: This figure shows the average population growth at the province level of provinces with different industrial compositions and thus different exposure to the shock. As described in section 4, a measure of export exposure is constructed

$$ExpExposure_i \equiv \sum_s \pi_{i,s,1914} \times \Delta_s$$

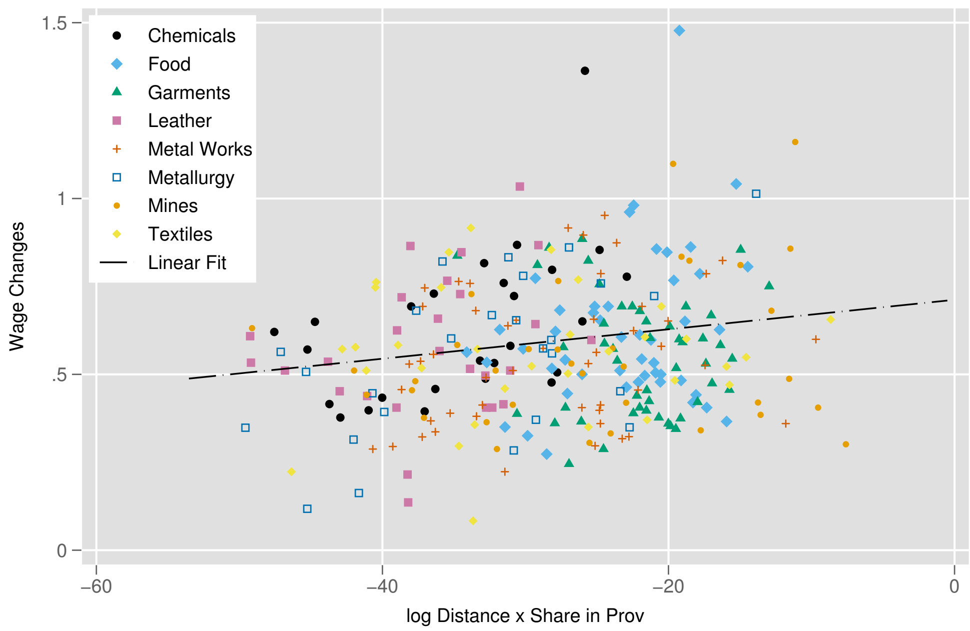
where $\pi_{i,s,1914} \equiv \frac{L_{i,s,1914}}{\sum_k L_{i,k,1914}}$ refers to the share of industry s in province i in terms of numbers of workers in 1914 and where Δ_s refers to the export shock as defined in the section. The figure then plots the average population growth for the bottom quartile and the top quartile of export exposure, as well as the trend lines for 1900/1910 growth before the war. Pre 1910 population trends are indicated by the dashed lines while observed population changes are indicated by the solid line. The data used is the census data.

Figure 12: Sectoral Trade Growth: Belligerent vs Non Belligerent



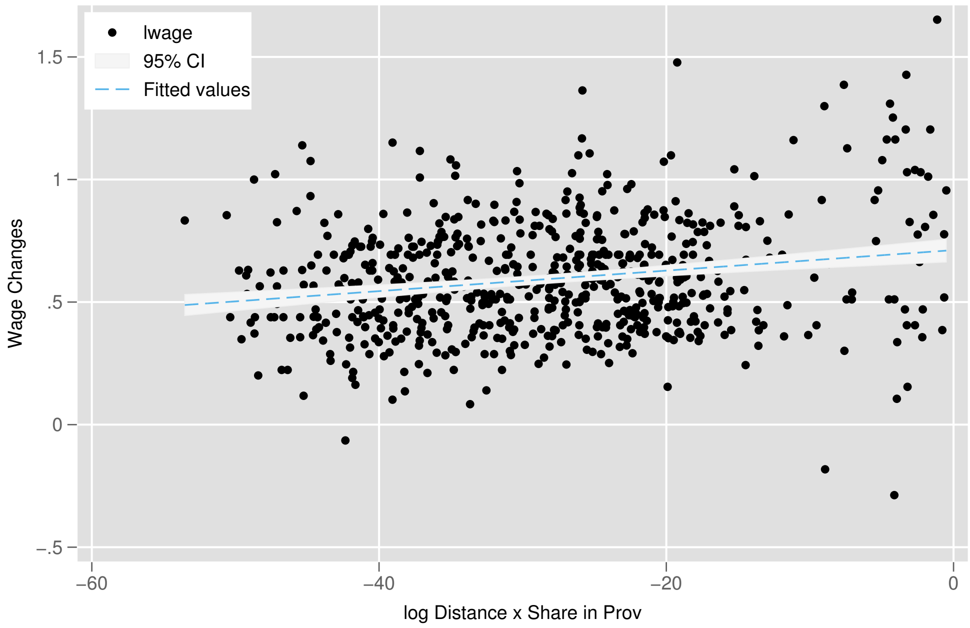
Notes: This figure reports the sectoral export growth for non belligerent destination countries - in blue - and belligerent destination countries in grey. The product level trade has been aggregated to sector level trade data to match the level of aggregation of the labor market panel. Growth rates are constructed by comparing the 1910 benchmark with average export values in 1915 and 1916, that is $g_X^{War} \equiv \frac{1/2X_{Spain,War,1915}+X_{Spain,War,1916}}{X_{Spain,War,1910}}$ and correspondingly for non belligerent destinations. As discussed in section 4 I abstract from later years to avoid additional spatial frictions that perturbed international trade, in particular increased maritime warfare. To adjust for additional spatial disruptions of the frontline the belligerent countries are made up of France, Italy and the United Kingdom. The Non-belligerent countries exclude the United States and other later participants of WWI. The shock is being calculated using the official annual trade data in constant prices.

Figure 13: First stage for structural estimation (selected industries)



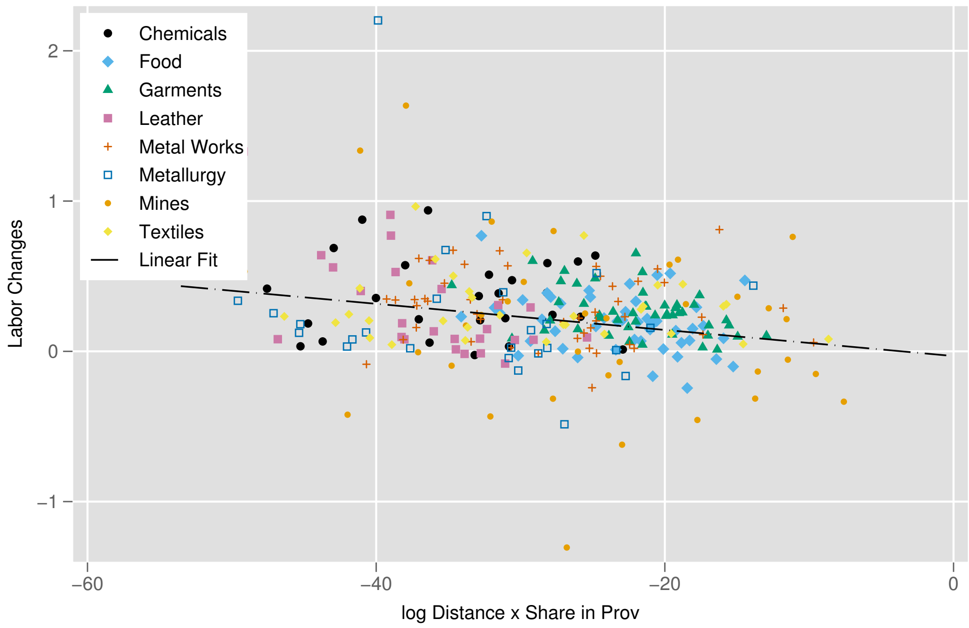
Notes: This figure shows the first stage regression predicting wage changes, $\frac{w_{i,s,1920}}{w_{i,s,1914}}$ at the province-sector level, using $logdistance_{i,Paris} \times log(\text{Employment Share of Sector in Province})$ as an instrument, where $log(\text{Employment Share of Sector in Province}) \equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ works as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. Distance is calculated using the shortest path along a network of railroads and maritime linkages between province capitals in Spain and Paris in France. The figure depicts selected industries. The data being used is the labor market panel introduced in section 3.

Figure 14: First stage for structural estimation (all industries)



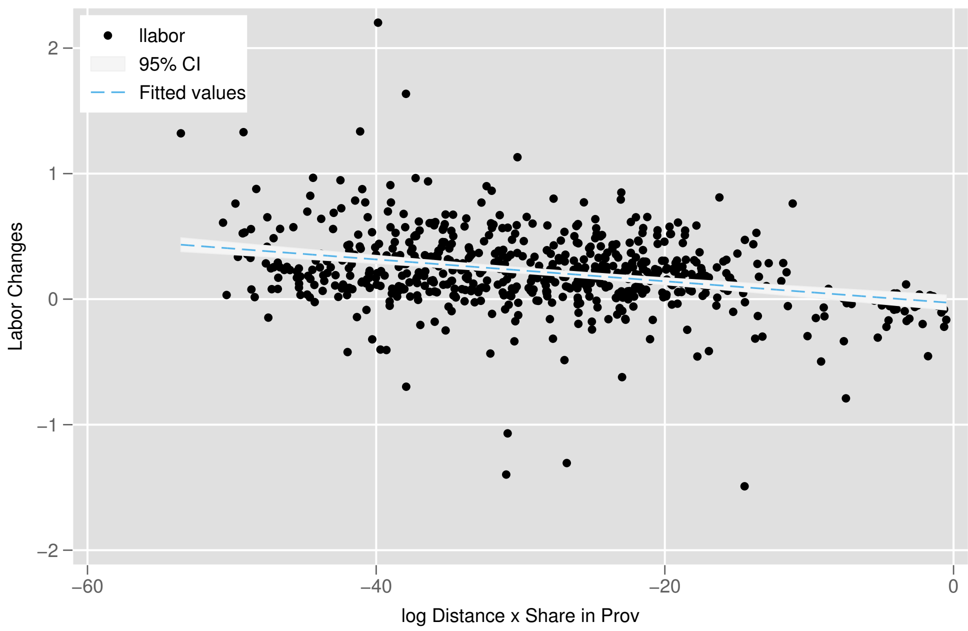
Notes: This figure shows the first stage regression predicting wage changes, $\frac{w_{i,s,1920}}{w_{i,s,1914}}$ at the province-sector level, using $logdistance_{i,Paris} \times log(\text{Employment Share of Sector in Province})$ as an instrument, where $log(\text{Employment Share of Sector in Province}) \equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ works as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. Distance is calculated using the shortest path along a network of railroads and maritime linkages between province capitals in Spain and Paris in France. The figure depicts all industries. The data being used is the labor market panel introduced in section 3.

Figure 15: First stage for structural estimation (selected industries)



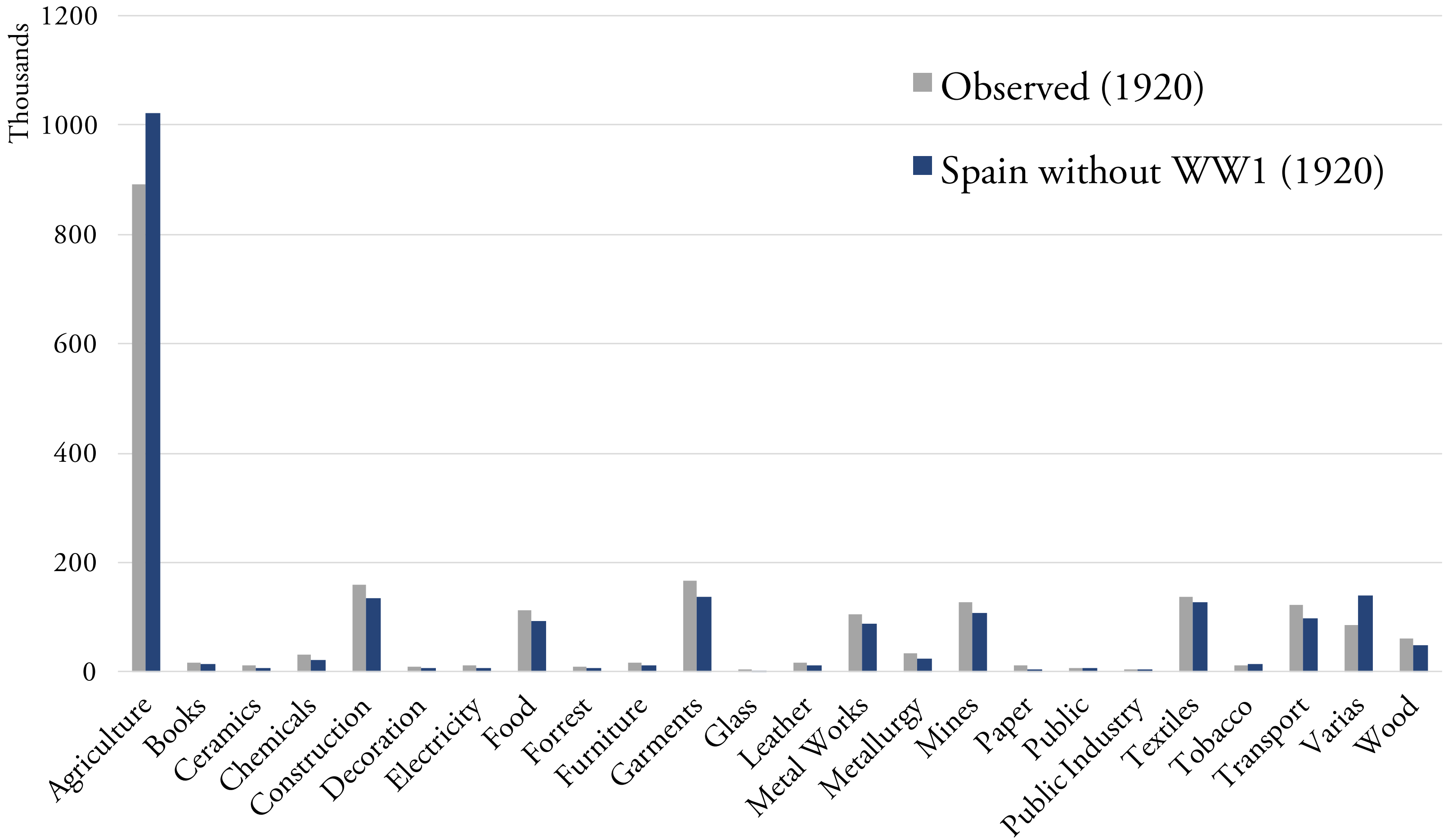
Notes: This figure shows the first stage regression predicting changes in employment size, $\frac{L_{i,s,1920}}{L_{i,s,1914}}$ at the province-sector level, using $logdistance_{i,Paris} \times log$(Employment Share of Sector in Province) as an instrument, where log(Employment Share of Sector in Province) $\equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ works as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. Distance is calculated using the shortest path along a network of railroads and maritime linkages between province capitals in Spain and Paris in France. The figure depicts all industries. The data being used is the labor market panel introduced in section 3.

Figure 16: First stage for structural estimation (selected industries)



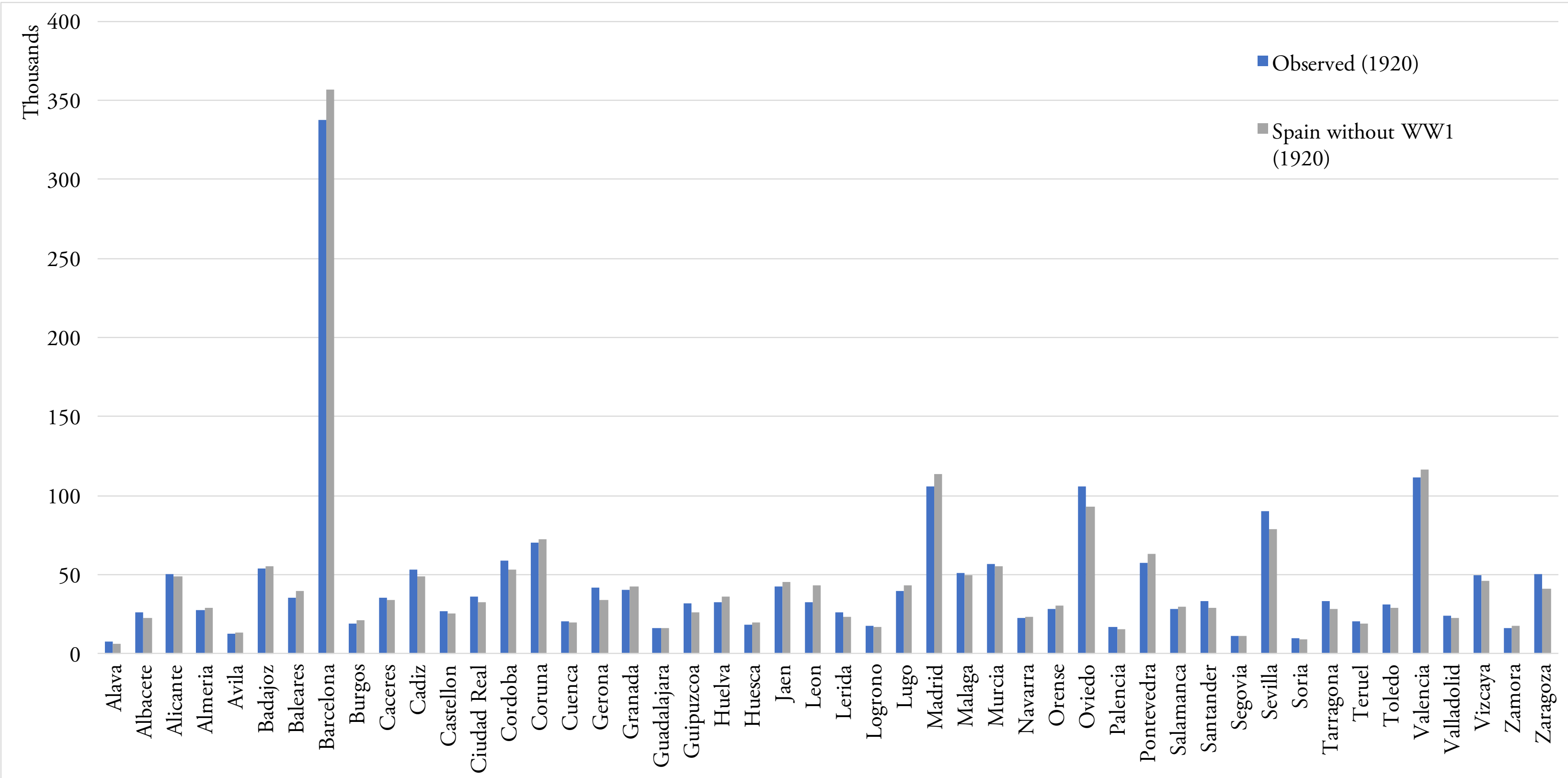
*Notes:*This figure shows the first stage regression predicting changes in employment size, $\frac{L_{i,s,1920}}{L_{i,s,1914}}$ at the province-sector level, using $logdistance_{i,Paris} \times log(\text{Employment Share of Sector in Province})$ as an instrument, where $log(\text{Employment Share of Sector in Province}) \equiv \frac{L_{i,s,1914}}{\sum_r L_{i,r,1914}}$ works as a labor supply shifter and is interacted with distance to Paris as a reduced form proxy for differences in geographical advantages vis-a-vis the French destination market. Distance is calculated using the shortest path along a network of railroads and maritime linkages between province capitals in Spain and Paris in France. The figure depicts selected industries. The data being used is the labor market panel introduced in section 3.

Figure 17: Counterfactual: Sectoral change in aggregate employment



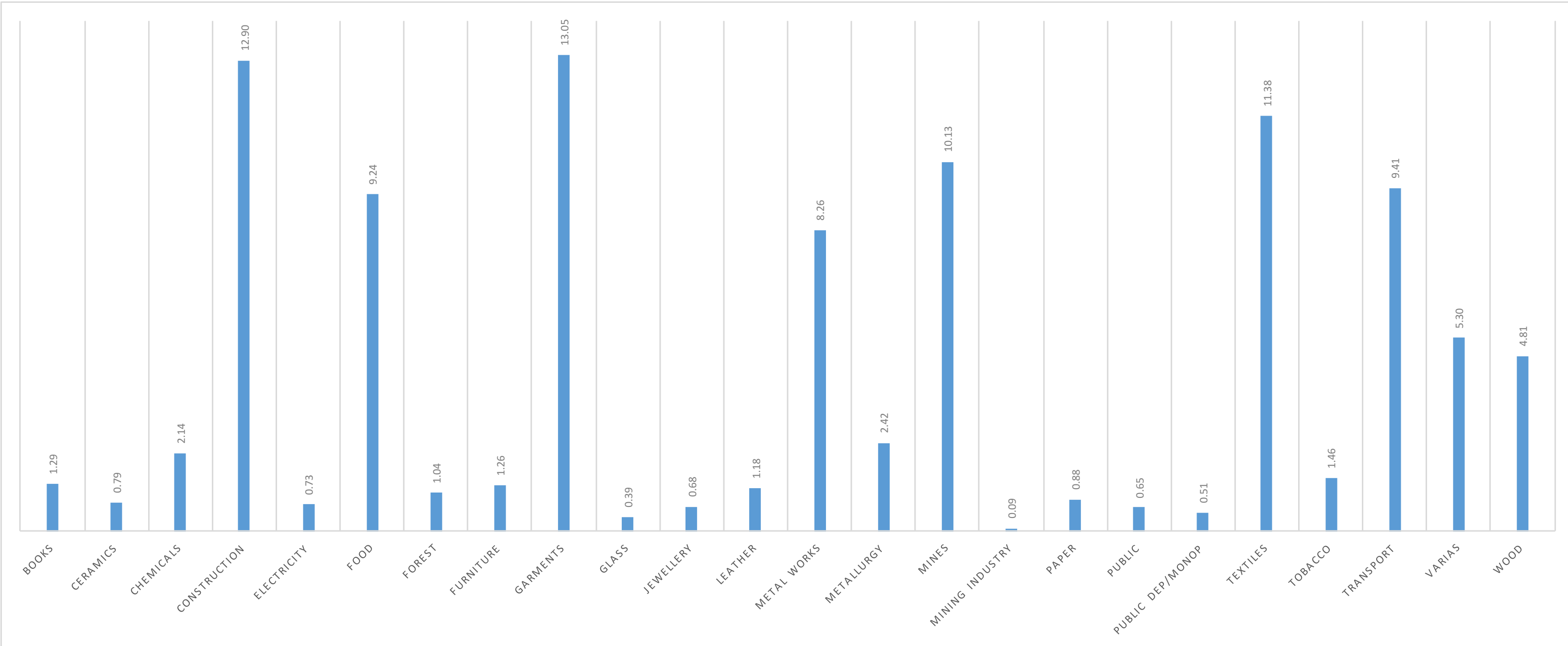
Notes: The graph depicts the aggregate sectoral employment for the observed data and the counterfactual simulation of Spain in the absence of WWI. The values are constructed in the following way, $L_s \equiv \sum_i L_{i,s,1920}$ where $L_{i,s,1920}$ refers to the observed employment size in province i and sector s. Similarly for the counterfactual, $L_s^{CF} \equiv \sum_i L_{i,s,1920}^{CF}$ where $L_{i,s,1920}^{CF}$ is the simulated counterfactual sectoral employment size using the estimated model as described in section 7.

Figure 18: Counterfactual: Change in Provincial Size



Notes: The graph depicts the aggregate provincial employment for the observed data and the counterfactual simulation of Spain in the absence of WWI. The values are constructed in the following way, $L_s \equiv \sum_s L_{i,s,1920}$ where $L_{i,s,1920}$ refers to the observed employment size in province i and sector s. Similarly for the counterfactual, $L_s^{CF} \equiv \sum_s L_{i,s,1920}^{CF}$ where $L_{i,s,1920}^{CF}$ is the simulated counterfactual sectoral employment size using the estimated model as described in section 7.

Figure 19: National Industry Shares

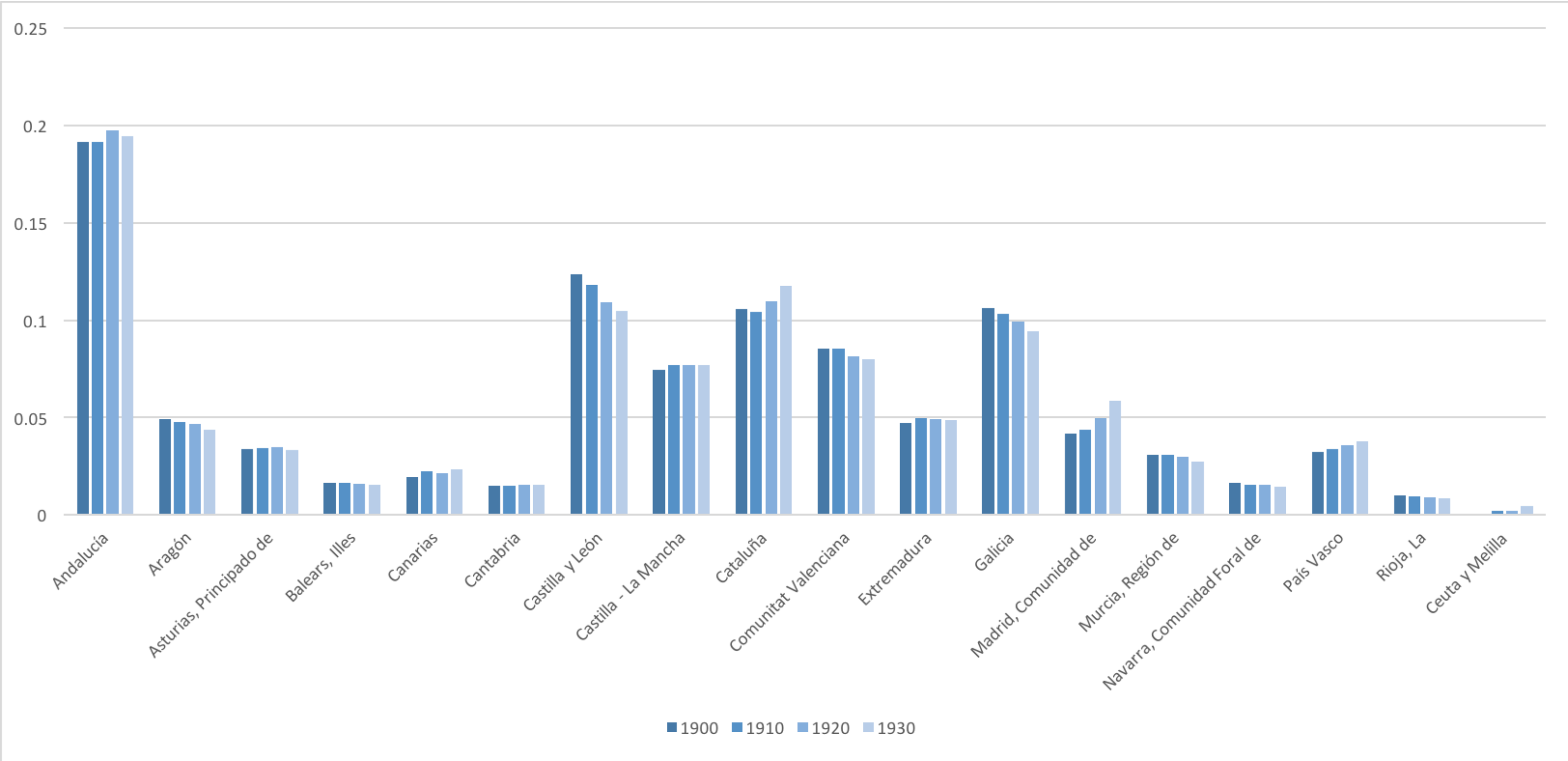


Notes: This figure indicates the sectoral shares in total national employment within the manufacturing sector - that is excluding agriculture. Each share is calculated in the following way:

$$IndShare_s = \frac{\sum_i L_{i,s,1914}}{\sum_i \sum_s L_{i,s,1914}}$$

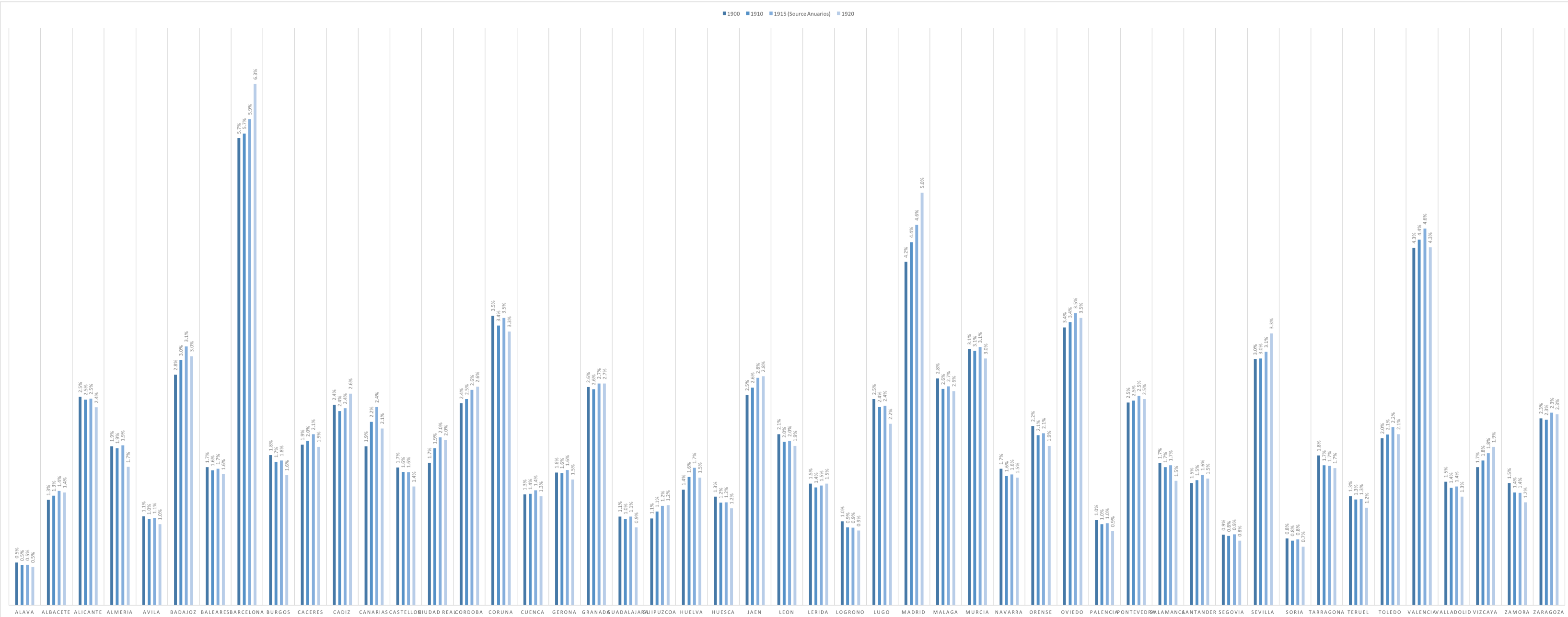
The data being used is the labor market panel introduced in section 3

Figure 20: Regional Population shares (1900-1930)



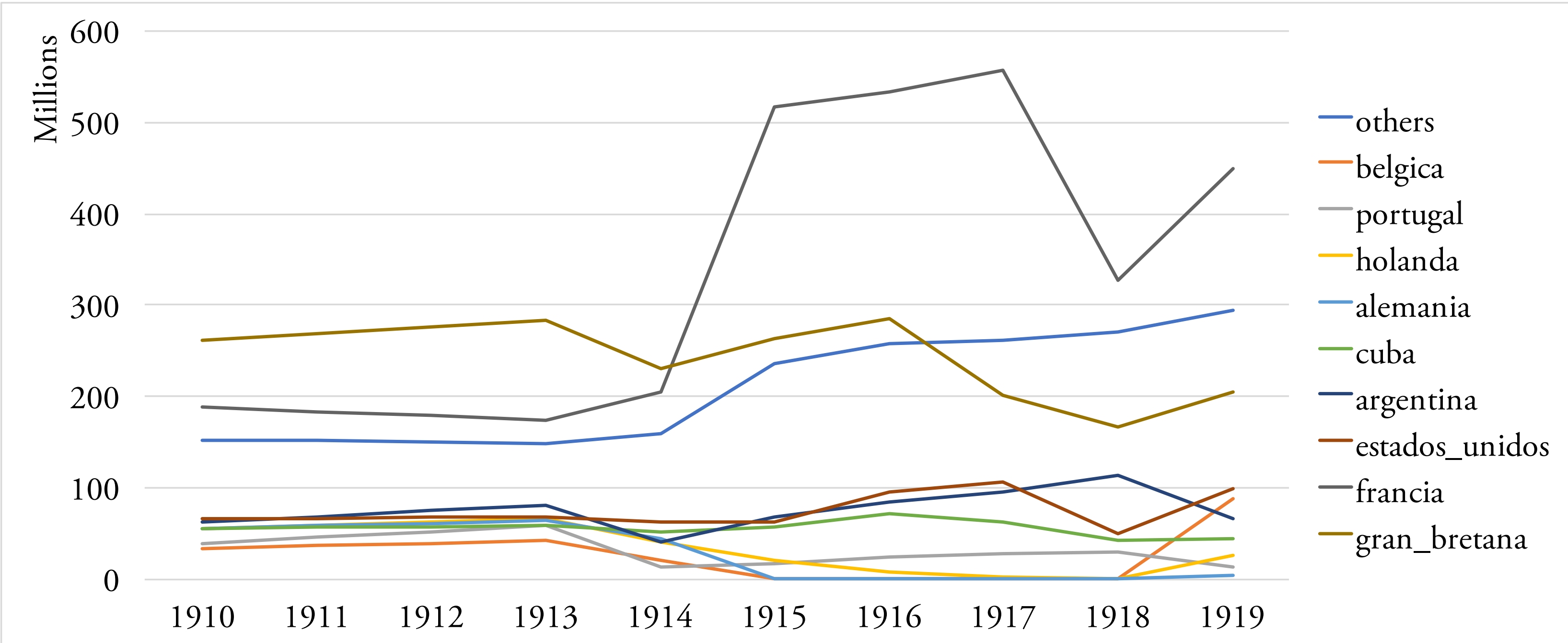
Notes: This figure depicts the population shares of the 18 autonomous regions of Spain, showing long-term trends in regional dynamics. Population shares are being calculated using the census data and calculating the regional share of the total population at a given time. The regions contain the provinces that are discussed in this paper. Andalucia comprises: Almería, Cádiz, Córdoba,[g] Granada, Huelva, Jaén, Málaga and Seville. Aragon comprises Huesca, Teruel and Zaragoza. Asturias contains Asturias, the Balearic Islands also only contains the Balears. The Basque country contains Álava, Viscay and Gipuzkoa. The Canary islands correspond to the Canary islands. Same for Cantabria, La Rioja, Madrid, Murcia and Navarra. Castile and Leon comprises Ávila, Burgos, León, Palencia, Salamanca, Segovia, Soria, Valladolid and Zamora. Castilla La Mancha includes Albacete, Ciudad Real, Cuenca, Guadalajara and Toledo. Galicia: A Coruña, Lugo, Ourense and Pontevedra. Catalonia: Barcelona, Girona, Lleida and Tarragona. And finally, Valencia: Alicante, Castellón and Valencia.

Figure 21: Provinicial Population shares (1900-1930)



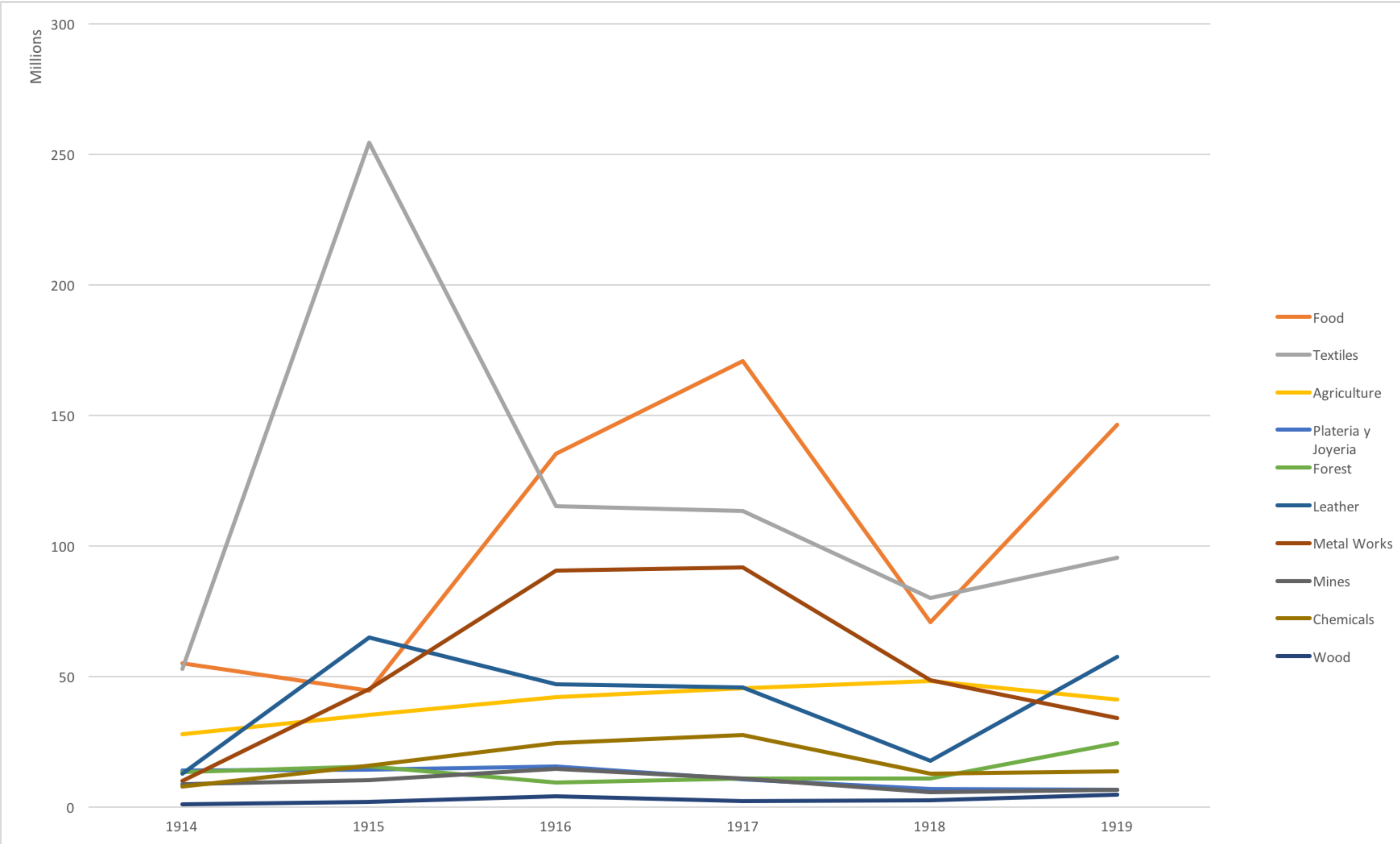
Notes: This figure depicts the population shares of the individual provinces, showing long-term trends in regional dynamics. Population shares are being calculated using the census data and calculating the regional share of the total population at a given time.

Figure 22: Aggregate exports to destination countries (1913-1919)



Notes: This figure shows the composition of aggregate exports in terms of their destination. It shows the aggregate export value for the 9 most import export destinations as calculated in 1910 and the evolution of their export values until 1919. The remaining export destinations are aggregated in the category others. The source data are the digitized product-destination level trade statistics.

Figure 23: Sectoral Exports to France from 1914-1919



Notes: test

C Data Sources

- *Censo de la población de España según el empadronamiento hecho en la península e islas adyacentes el 31 de diciembre de 1910* (Instituto Geográfico; 1912)
  - This publication contains wage and quantity data by profession for each province of Spain in 1910.
- *Censo de la población de España según el empadronamiento hecho en la península e islas adyacentes el 31 de diciembre de 1920* (Instituto Geográfico; 1922)
  - This publication contains wage and quantity data by profession for each province of Spain in 1920.
- *Censo de la población de España según el empadronamiento hecho en la península e islas adyacentes el 31 de diciembre de 1930* (Instituto Geográfico; 1932)
  - This publication contains wage and quantity data by profession for each province of Spain in 1930.
- *Estadística general del comercio exterior de España con sus posesiones de ultramar y potencias extranjeras* (de Aduanas; 1910-1930)
  - This publication contains trade records decomposed along destination countries and product type.
- *Estadistica de salarios y jornadas de trabajo referida al periodo 1914-1925* (Ministerio de Trabajo; 1927)
  - This publication contains wage and quantity data by profession between 1914 and 1925
- *Clasificación general de industrias, oficios y comercios 1931* (de Prevision Social; 1930)