Macroeconomic Development, Rural Exodus, and Uneven Industrialization*

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Abstract

Economic development and industrialization are typically led by a few regions within a country. The initially laggard regions may catch up and industrialize —as in the U.S. 1880 to 1940— or they may fail to industrialize, experience a population exodus, and help industrialization elsewhere —as in Spain 1940 to 2000. To understand the emergence and consequences of each pattern, we build a simple model of structural change with multiple locations and sectors where both internal migration and internal trade are costly. In the model, internal migrations change the relative labor demand across sectors at the local level and hence act as a force of within-region structural change and uneven paths to industrialization. We calibrate our economy to the development experience of Spain, and find that its large rural exodus and uneven regional industrialization were originated by the combination of a decline in migration costs towards the most industrial areas together with an early divergence in sectoral productivities across regions. More importantly, internal migrations fully explain the lack of industrialization in laggard areas, and accelerated growth and structural change at the aggregate level. Finally, we show how variation in changes of migration costs and in patterns of convergence of sectoral productivities across locations help explain cross-country heterogeneity in development patterns.

JEL classification: O41, O11, F16, N10, R11

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1 Introduction

The economic development of nations is characterized by a shift of employment away from agriculture and a slow cycle of industrialization and de-industrialization, see Herrendorf et al. (2014) for details. A salient feature of this process is that, at its early stages, agricultural and non-agricultural activities tend to happen in different locations within a country. For instance, industrialization was initially more intense in the North of France, the Northeast of the US, the Basque Country and Catalonia in Spain, or the Guangdong, Jiangsu, and Shanghai regions in China.

As a few regions in a country start to industrialize, two different patterns of development may follow. In the first one, the initially agrarian regions experience large outmigrations flows towards the leading industrial hubs —a rural exodus— and fail to industrialize. We show this to be the case for Spain between 1940 and 2000, and we additionally document other development episodes with a large rural exodus like France (1872-1975) or China (2000-2015). In the second one, the initially agrarian regions do not suffer systematically larger outmigration flows, manage to catch up with the leaders, and also industrialize. Eckert and Peters (2022) show this to be the case for the US between 1880 and 1940, and we additionally document other development episodes without any rural exodus like Indonesia (1971-2010) or the Dominican Republic (1960-2010). In between these two polar patterns, one can also find intermediate cases like India (1987-2011) or Brazil (1980-2010), where more rural areas also lost population but not as much as in Spain, France, or China.

The goal of this paper is (a) to uncover the economic forces shaping the emergence of these different patterns of development in terms of migrations and local industrialization, and (b) to examine their aggregate implications. In particular, we show how internal migrations —arising from changes in spatial frictions or in region-specific sectoral productivities— are a key determinant of the structure of the local economy and have important macroeconomic consequences.

Our case of study is the relatively recent development experience of Spain, which provides invaluable sector- and location- specific data over a complete process of economic development. We start by documenting that, from the 1950's, Spain experienced fast growth in income per capita, a strong reallocation of employment across sectors and space, a lack of industrialization in many regions, and an inverted-U shape evolution of spatial inequality. In particular, initial rural regions lost population in net terms (while the country almost doubled in size) and failed to create industrial jobs. At the same time, these initial rural regions created jobs outside agriculture in the (less tradable) services sector, and they eventually (partially) converged in income per capita with the rest.

Next, we build a model of structural change with multiple locations and sectors, where both the reallocation of workers across regions and the trade of goods and services are costly. In particular, we start from a simple model of structural change similar to Duarte and Restuccia (2010) where we add costly migration as in Artuç et al. (2010) and costly trade as in Eaton and Kortum (2002). This framework provides a high degree of tractability and is amenable to quantitative work. When spatial frictions tend to infinity, each region is like an independent closed economy. Sectoral reallocation at the regional level is driven by the standard income and price effects due to symmetric and asymmetric sectoral productivity growth within the region.[1] Sectoral reallocation at the country level is the sum of what happens in all its independent regions. Outside this limit case, different regions specialize in the production of different sectors following their comparative advantage and people move towards the most prosperous regions. Costly migration prevents a frictionless reallocation of workers across sectors by distorting *labor supply* across locations. Costly trade prevents a frictionless reallocation of workers across sectors by distorting *labor demand* across locations. Importantly, spatial frictions and productivity growth interact with each other in a non-trivial way.

We use the model to uncover how internal migration flows may act as a source of structural change at the local level and hence help explain uneven industrialization across regions. Outmigration from a region generates a decline in local labor supply (people go elsewhere to work). In the presence of costly trade across regions, local labor demand depends on the expenditure of both local consumers and country-wide consumers. Then, outmigration from a region also generates a decline in local labor demand (people go elsewhere to consume). This has two important implications. First, we prove that the fall in labor demand after an outmigration flow is asymmetric across sectors, with labor being reallocated away from sectors that are more dependent on local consumers (those in which the region is less competitive or that are less tradable). Second, the fall in labor demand is smaller than the fall in labor supply. As a consequence, the local wage increases to restore the equilibrium. We prove that this wage increase harms competitiveness and reduces labor demand in all sectors, but more so in sectors more exposed to trade, which again induces reallocation of employment across sectors.

We bring the model to the data through the development experience of Spain. We have time series data at the province and sector level for value added, prices, and employment, plus data on bilateral migration flows across provinces. These data allow to recover the time paths for sector-province productivity; sector, province-of-origin, and province-of-destination trade costs; and bilateral migration costs. Our strategy to achieve this identification represents a methodological contribution. The use of models with costly internal trade in the macro-development literature has been halted by the lack of time series data for internal bilateral trade flows, which is the information typically used to recover bilateral trade costs through gravity equations. We argue that in multi-sector models, the difference between sectoral employment shares and sectoral expenditure shares at the regional level reveals information, other things equal, about the tradability of each sector. Our strategy, similar to Eckert (2019), builds on Gervais and Jensen (2019), who show how to use region-industry trade surpluses to infer the trade costs for different goods and services in the US. We extend this logic to identify both sector-specific and region-specific trade costs that vary over time. Absent time series data for sectoral expenditure shares at the regional level, one can use the

[1] See Kongsamut et al. (2001) for the income effect and Baumol (1967), Ngai and Pissarides (2007) for the price effect. Duarte and Restuccia (2010), Herrendorf et al. (2013), Boppart (2014), Comin et al. (2021), and García-Santana et al. (2021) combine both mechanisms as we do here.

predictions from an estimated demand system, which is what we do. We complement this strategy with actual data on bilateral trade flows for agriculture and manufacturing in the year 2000, which adds extra discipline to the estimation.

The calibrated model for Spain between 1940 and 2000 displays four main aggregate trends: an increase in sectoral productivities, a decline in trade costs, a non-monotonic evolution of spatial inequality in sectoral productivities, and a non-monotonic evolution of migration costs. The growth in productivity, mostly between 1950 and 1990, is largest in agriculture and smallest in services. The decline in trade costs is more apparent for agriculture and manufactures than for services. These two patterns together generate an increase in aggregate productivity, a trend increase in the price of services relative to manufactures, and a trend decline in the price of agriculture relative to manufactures, which combined account for the bulk of structural change and aggregate growth. Sectoral productivities in manufacturing and services diverged across regions during the first decades and started to converge afterwards. This pattern led the inverted-U shape evolution of income inequality across regions and contributed to the rural exodus by amplifying inequalities in the first half of the process. Migration costs towards regions with most population gains fell during the 1950's, 1960's, and 1970's. This was a driver of the rural exodus, as differences in income per capita across regions were not enough to explain the large population movements. After that, migration costs increased everywhere, suggesting that there were still differences in real incomes across provinces which were not arbitraged away. Finally, an important result from our quantitative exercise is that interactions between productivity growth and spatial frictions are quantitatively important. In particular, we find that the de-industrialization experienced during the second half of the development process cannot be generated by either productivity growth or changes in spatial frictions alone.

Next, we show that the large rural exodus of workers looking for better economic opportunities had a first order impact in the development process of each province as well as sizeable aggregate effects. To do so, we solve for two counterfactual economies without migration (infinite migration costs over all the period). In the first one, sector- and region- specific productivity paths remain as in the benchmark economy and do not react to population movements. In the second one, we allow for agglomeration economies in industry and decreasing returns to scale in agriculture such that sector- and region- specific productivity paths are affected by migrations.

Starting with the simpler case, we find that absent migrations, lagging regions do industrialize and leading regions specialize less in manufacturing. Indeed, there is structural change everywhere and the economic structure of regions looks more similar to each other. This result implies that the evolution of sector- and region- specific productivity and trade costs was conductive to industrialization in the initially rural areas, but that the rural exodus impeded it. The reason is twofold. On the one hand, the relatively unproductive manufactures of laggard areas were very much dependent on local demand, which declined due to the outmigrations. On the other hand, migrations reduced the wage gap between leading and laggard regions, which allowed leading areas to remain competitive in the highly tradable manufacturing sector. This result is amplified when we allow for non-constant returns to scale in production because the rural exodus enhances industrial productivity in the leading regions at the expense of the laggard ones, an advantage that is inverted when there are no migrations. The aggregate effects of labor reallocation through the rural exodus are also relevant. In the counterfactual economy with no migration, GDP per capita would have increased 38 percentage points less, agriculture employment would have declined 3.5 percentage points less, services employment would have increased 8.8 percentage points less, and there would have not been a period of de-industrialization. These numbers are for the case with exogenous productivity paths. When we allow productivity to react to migrations, the aggregate effects are similar. Therefore, we conclude that outmigrations were the key determinant of the lack of industrialization in laggard regions, but accelerated growth and structural change at the aggregate level.

Finally, we revisit the cross-country heterogeneity in development experiences through the lens of our analysis for Spain. We find that if either the migration costs had not changed over time (instead of falling) or sectoral productivities had converged across regions since 1940 (instead of diverging), the pattern of migrations in Spain would have been close to the "intermediate" cases of India (1987-2015) or Brazil (1980-2010), industrialization would have been less uneven across regions, and the economy would have grown somewhat less. If instead both migration costs had not changed and sectoral productivities had converged across regions, then the pattern of migrations would have been similar to the US (1880-1940) —with initial agrarian regions not losing population in a systematic manner, industrialization would have been homogenous across regions —as it happen in the US (1880-1940), and GDP growth would have been lower. The reasons are as follows. Absent the fall in migration costs, more people remain in laggard areas. This favors their industrialization through the effects on local demand (which does not fall) and equilibrium prices (which prevent leading regions to exploit their productivity advantage), but limits aggregate growth. Convergence in manufacturing productivities reduces the industrial comparative advantage of leading regions, which generates a less uneven industrialization but has little impact on migrations due to the relatively small size of the sector. If convergence extends to services productivities, income per capita does converge and hence there is no rural exodus, which in turn helps industrialization in the laggard regions.

1.1 Related literature

Our work relates to the literature on growth and structural change with spatial frictions. This literature has traditionally focused on frictions to either internal migration —see Garriga et al. (2017) or Ngai et al. (2019)— or internal trade —see Adamopoulos (2011), Herrendorf et al. (2012), or Gollin and Rogerson (2014)— by use of stylized models with two sectors (agriculture and non-agriculture) and two locations (rural and urban). Compared to this literature, we emphasize the interactions between migration and trade frictions and consider a quantitative exercise with multiple regions, three sectors, and lack of full sectoral specialization across regions. Caselli and Coleman (2001) analyzed the structural transformation of the US between 1880 and 1950, being the first paper in this literature to focus on spatial frictions. In their model, agricultural workers need to acquire costly education to work in manufacturing. The decline in education costs acts as a decline in migration costs, promoting migration and structural change, a mechanism also highlighted by Porzio et al. (2022). We document that changes in education were not an important driver of rural migrations in Spain, see Appendix C.

Two recent papers are very much related to our research. First, Hao et al. (2020) study the growth episode in China between 2000 and 2015, which was characterized by large migrations from rural to urban locations and the reallocation of employment away from agriculture. Building on Tombe and Zhu (2019), they set up a model with both internal trade and migration costs as well as multiple locations. They show that the reduction in migration costs (the *hukou* system reform) and internal trade costs account for a substantial fraction of macroeconomic changes and spatial location of economic activity. Compared to this paper, we explore the impact of spatial frictions in the long run following a complete process of economic modernization (with a full cycle of industrialization and de-industrialization), and we emphasize the effects of migrations on the sectoral composition of local employment. The second one is Eckert and Peters (2022), who explore the role of migrations across counties in the US between 1880 and 1940. Different from Spain, they find that migration flows in the US do not follow any sectoral pattern. They write a model with spatial frictions that are constant over time and focus on the productivity catch up between locations, such that rural areas are able to industrialize instead of losing population.

Our paper highlights the effects of migration on equilibrium regional wages and prices, and hence on the sectoral specialization of regions. In an extension to our main exercise, we also allow for regional migrations to affect sectoral productivity through decreasing returns to scale in agriculture and agglomeration economies in industry. Starting from Krugman (1991), many authors have used agglomeration economies to help explain spatial concentration of economic activity, see for instance Puga (1999). The literature on growth and structural change is starting to make some inroads in the study of how agglomeration economies in urban locations increase the productivity of certain sectors, see for instance Michaels et al. (2012), Desmet and Rossi-Hansberg (2014), Eckert (2019), or Nagy (2020). Different from ours, these papers put their focus on urbanization and/or the raise of the modern service economy.

In terms of methodology, our work connects with two different literatures. First, Uy et al. (2014), Świecki (2017), Sposi (2019), or Lewis et al. (2021) among others use the Eaton and Kortum (2002) framework to study the effects of international trade on structural change. The effects of asymmetric trade costs reductions across sectors on relative prices and hence on structural change are already highlighted in these papers. We use this same framework to study internal trade and explore the interaction of trade and migration frictions, which these papers do not consider. And second, we relate to the literature that looks at the local labor market effects of aggregate shocks, say international trade shocks —see Artuç et al. (2010), Caliendo and Parro (2014), or Caliendo et al. (2019)— or changes in migration costs —see Morten and Oliveira (2018), Bryan and Morten (2019), or Zerecero (2021). All these papers feature costly trade and/or costly migration across different locations within a country. Our work is different because it focuses on the long run process of macroeconomic development.

Lastly, our paper also relates to a recent strand of work zooming into the development experience of selected countries. These country studies are useful to understand specific factors affecting economic development, and to draw lessons for current developing economies. For instance Song et al. (2011) study the case of China; Uy et al. (2014) the case of South Korea; Cheremukhin et al. (2017) the case of Russia; Fajgelbaum and Redding (2022) the case of Argentina; and Fan et al. (2021) the case of India. The development experience of Spain is one of the few success stories in the second half of the XXth Century outside Asia, and yet it has attracted little attention.

2 The Spanish development experience

Our period of study is 1940 to 2000. Spain started its industrialization process well before this, but it was only after 1950 that the process accelerated to become an episode of fast economic development leading to convergence with Europe.[2] Between 1850 and 1935, real GDP per capita increased steadily at a modest average rate of almost one percent per year, while the share of employment in agriculture fell from 63.3 to 41.2 percent, see Panels (a) and (b) in Figure 1. The Civil War between 1936 and 1939 interrupted this process. Economic development regained vigour in the 1950s: between 1950 and 2000 the average rate of growth increased to 3.88% per year, the share of employment in agriculture dropped from 50.5 to 5.9 percent, the share of employment in services increased from 29.1 to 63.5 percent, and the share of industrial employment experienced a classic hump over time, with an increase from 20.4 to 36.3 percent between 1940 and 1977. Despite the Spanish political idiosyncrasies of the period, this pattern of sectoral reallocation is standard among development episodes, see Herrendorf et al. (2014).[3,4]

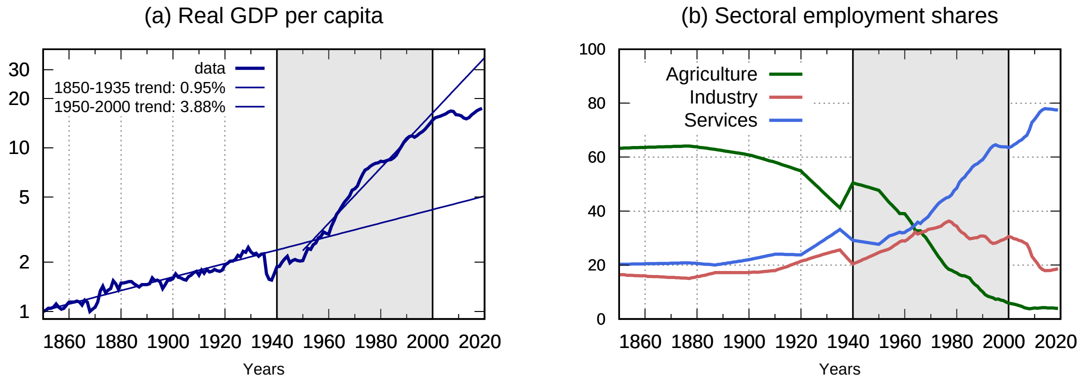
Next, we zoom in the spatial dimension of the development process. To do so we consider data at the province level, which is the smallest administrative unit for which we can gather information

[2] We stop our analysis in 2000 because the process of economic modernization was already completed, and because of the peculiar characteristics in the years that followed, with the twin credit and housing booms and the ensuing severe recession. For the post-2000's growth process in Spain, see Díaz and Franjo (2016), Gopinath et al. (2017), García-Santana et al. (2020), Martín et al. (2021), and Almunia et al. (2021).

[3] See Prados de la Escosura and Rosés (2021) for a detailed account of the growth process in Spain since 1850.

[4] A salient feature of our period of study is a gradual opening to international trade. The process started in 1953 with the imports of machinery to modernize the industrial sector. In 1959, the "*Plan de Estabilización*" implemented a set of structural reforms, including the lifting of several restrictions to international trade. However, the recent work by Campos et al. (2022) estimates that the effective pace of trade liberalization in Spain between 1948 and 1985 was no different from the one experienced by the rest of European countries, and in terms of levels the Spanish border effect was comparable to the countries in the communist bloc. See Conesa et al. (2021) for a study of the role of international trade on the industrialization process of Spain since 1850.

Figure 1: The Spanish development experience



Notes: Panel (a) reports GDP per capita in real terms, normalized to 1 in 1850, and in log scale. Panel (b) reports the share of employment in each sector. Data from Prados de la Escosura (2017). The grey areas represent our period of study.

on employment, productivity, and prices at the sectoral level.[5] We identify three main facts. First, between 1940 and 2000 the country experienced massive migrations across provinces, mainly from poor agrarian provinces towards richer and more industrial or service-intensive ones.[6] In Figure 2, we plot the relative increase in employment between 1940 and 2000 against its sectoral composition and income per capita in 1940. On the vertical axis of any Panel we can see that there was a large heterogeneity in employment growth across provinces. Some provinces like Madrid, Alava, or Barcelona multiplied their total employment by a large factor, between two and four (employment grew between 100 and 150 log points), while others like Jaén or Teruel lost population over these 60 years.[7] The correlation between the initial sectoral employment composition and subsequent employment growth is strong: provinces with a larger share of agrarian employment lost population (Panel a) while provinces with a larger share of manufacturing or services grew in size (Panels b and c). Our estimated relationships imply that a province with 10 percentage points higher share of employment in agriculture in 1940 experiences a 20% smaller population growth between 1940 and 2000. Remarkably, 63% of the variance in employment growth across provinces is related to the initial share of employment in agriculture. We also note that the correlation between initial income per capita and employment growth is strong (Panel d), which should not be surprising given the correlation between income per capita and sectoral specialization in 1940.

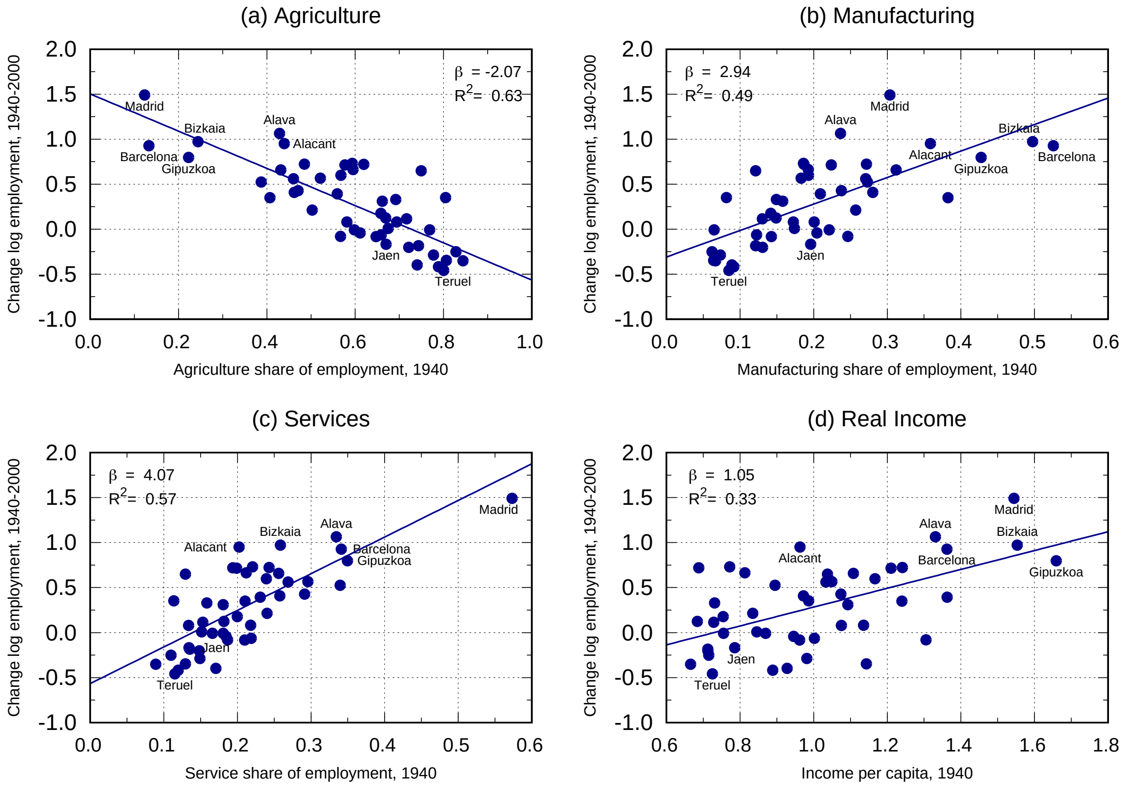
We can compare this pattern of internal migration to that of the development experience of other countries. To do so, we resort to the IPUMS International Census Database (and other

[5]The territorial division of Spain into provinces dates back to 1833, with minimal changes since then. It is roughly equivalent to NUTS3 classification of Eurostat. The median employment of Spanish provinces was 135,000 workers in 1940 (9.2 million for the whole country) and 208,000 in 2000 (16.3 million for the whole country). To be consistent with the calibrated model later on, we use data for the 47 mainland provinces in the Iberian Peninsula (i.e. dropping data for the Canary and Balearic islands). Provinces are hence larger than local labor markets, and rural to urban migrations also happened within provinces. This is a dimension that we overlook in our study.

[6]Richer provinces in 1940 had more labor in industry and services and less in agriculture, see Panels (a) to (c) in Figure G.1. We also note that in 1940 there was little relationship between income per capita and total employment across provinces, see Panel (d) in Figure G.1.

[7]The process of internal migration in Spain over this period is well documented in Bover and Velilla (2005).

Figure 2: Employment growth and initial sectoral composition

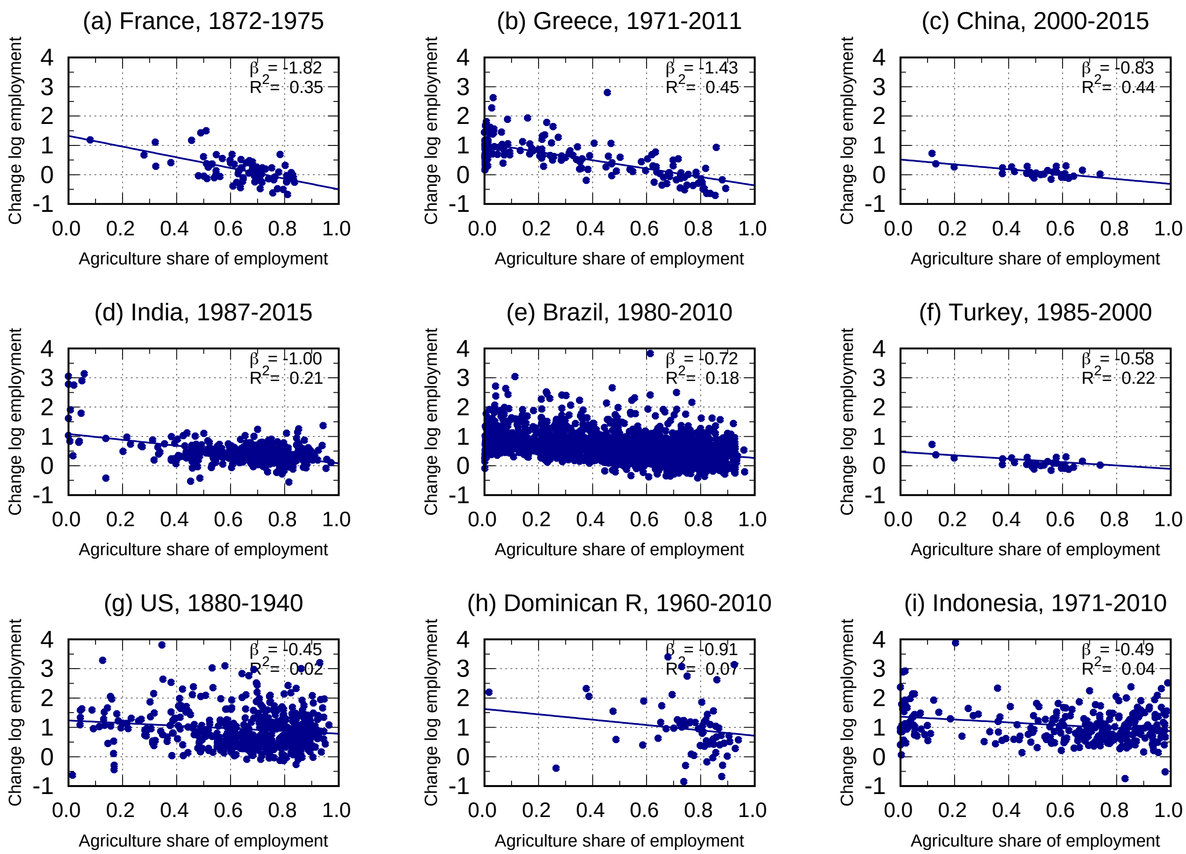


Notes: This figure plots the relative increase in employment between 1940 and 2000 (in logs) for all provinces, against the 1940 sectoral shares of employment, Panels (a) to (c), and against real income per capita (relative to the country average), Panel (d). Income per capita at province level deflated with the provincial price indices obtained with the model calibration of Section 4. Each panel also reports the slope of the relationship (β) and the share of variance in log employment growth explained by the corresponding x-axis variables (R^2).

sources) and gather data on employment at the region-sector level for 27 countries that experience a development episode.[8] We then regress, separately for each country, log employment growth at the regional level against the initial share of employment in agriculture (as we do in Panel (a) of Figure 2 for Spain). We find several development episodes with a rural exodus similar to Spain, like France (1872 to 1975), Greece (1971 to 2011) and China (2000 to 2015) —see Panels (a)-(c) in Figure 3. In contrast, in salient development episodes like the US (1880 to 1940), the Dominican Republic (1960 to 2010) or Indonesia (1971 to 2010), the initial sectoral composition of regions, while negatively related to regional employment growth, only explains 2%, 7%, and 4% respectively of its variation —see Panels (g)-(i) in Figure 3. In between, we have intermediate cases like India (1987 to 2015), Brazil (1980 to 2010), or Turkey (1985 to 2000) —see Panels (d)-(f) in Figure 3. Results for other countries and further details can be found in Appendix D.

[8]We include countries that (i) we observe for at least 10 years, (ii) display an initial share of employment in agriculture of at least 25%, and (iii) experience a fall of the agricultural share of at least 10 percentage points. We complement the IPUMS data with our own data for Spain, data from Hao et al. (2020) for China, data from García-Peñalosa and Bignon (2022) and Franck and Galor (2021) for France, data from Fan et al. (2021) for India, and data from Eckert and Peters (2022) for the US.

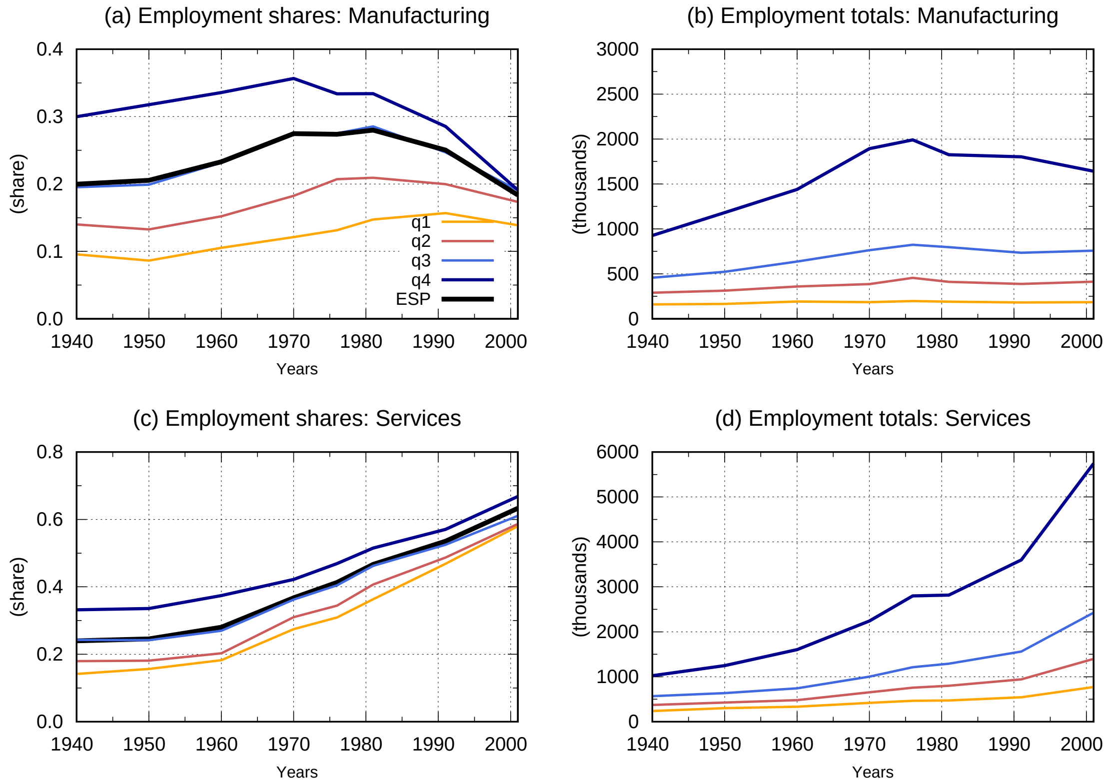
Figure 3: Rural exodus across development episodes



Notes: This figure plots the relative increase in employment (in logs) across sub-national divisions against the initial sectoral shares of employment in agriculture for several countries. Each panel also reports the slope of the relationship (β) and the share of variance in log employment growth explained by the corresponding x-axis variables (R^2). See Appendix D for details.

Second, the country experienced a process of industrialization that was largely uneven across regions. It is easy to overlook this fact because the evolution of relative industrial employment within every province mimics the classic hump-shaped pattern. Yet, when one looks at total and not relative employment by sector, it turns out that the initially agrarian regions did not industrialize: they just lost agrarian population who moved to the non-agrarian sectors in other provinces. This is illustrated in Figure 4. We classify all provinces in four groups according to the change in their relative size (employment) within the country between 1940 and 2000, see Appendix B for details. The provinces in the bottom quartile (q1) almost halved their size (shrinking from 26.7% to 14.2% of total employment in the country), while provinces in the top quartile (q4) experienced a large increase (from 37.1% to 56.7%). In Panel (a) we see how the four groups of provinces experienced a hump in the *share* of employment in manufacturing similar to the one for the overall country. Yet, in Panel (b) we see that provinces in the q1 and q2 groups hardly experienced any increase in the *levels* of manufacturing employment, so these provinces did not really industrialize. It is important to note that regions in the q1 and q2 groups did create non-agriculture jobs in net terms despite the outmigrations, though job creation was concentrated in the much less tradable construction

Figure 4: Industrialization and lack thereof, 1940-2000

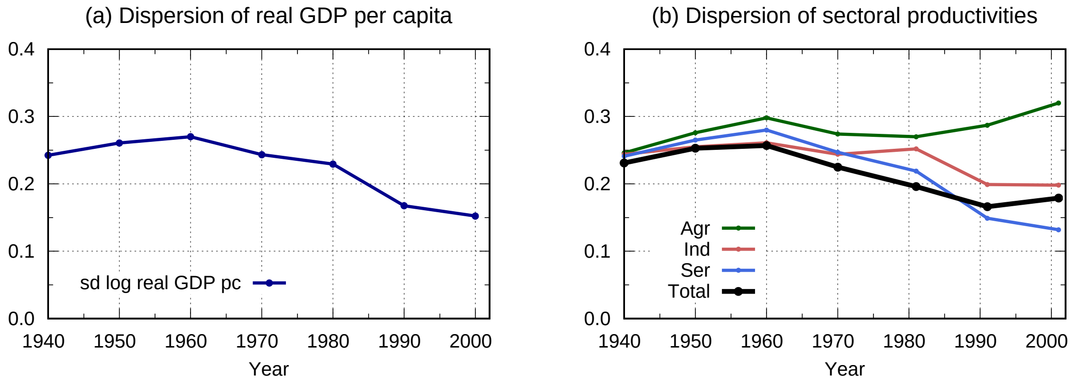


Notes: Panels (a) and (c) report the evolution of sectoral shares of employment in Manufacturing and Services while Panels (b) and (d) report the evolution of the number of workers in the same sectors. Provinces are grouped in four quartiles in terms of the change in their relative employment size within the country between 1940 and 2000. q1 corresponds to the bottom quartile (these provinces moved from 26.7% to 14.2% of total employment), q2 to the second (from 17.1% to 11.2%), q3 to the third (from 19.1% to 17.7%), and q4 is the top quartile (from 37.1% to 56.8%).

and service sectors. For instance, Panels (c) and (d) in Figure 4 show the evolution of relative and total employment in services. This shows net employment growth in services, even in provinces in the q1 and q2 groups. Figure G.6 in Appendix G shows the same pattern for selected provinces within q1 and q2.

Finally, spatial inequality in income per capita followed a classic inverted-U shape over time, increasing until 1960 and declining afterwards, see Panel (a) in Figure 5. This path of inequality was first conjectured by Kuznets (1955) for individual income and later documented by Williamson (1965) or Lessmann (2014) among others for regional income. We also find that measured sectoral productivity diverged across provinces in the early decades, but it started to converge in 1970. This was mostly apparent in aggregate and services productivity, while agricultural productivity started to diverge again in the 1990's, see Panel (b) in Figure 5.

FIGURE 5: Dispersion of income and productivity across provinces, 1940-2000



Notes: Panel (a) reports the standard deviation of the log of real income per capita. Panel (b) reports the standard deviation of the log of provincial productivities in each sector. Income per capita at province level is deflated with the provincial price indices obtained with the model calibration of Section 4.

3 Model

We consider an economy with three sectors $j = a, m, s$ (agriculture, manufacturing, and services), and several regions $r = 1, 2, ..., R$. Within each sector there is a continuum of varieties indexed by $x \in [0, 1]$, which can be produced in any region by competitive producers that use labor L as the only input of production. Productivity is region-, sector-, and variety- specific, and varieties are tradable between regions subject to transport costs. Labor can be costlessly reallocated across varieties and sectors within a region, but not across regions because migration entails costs. This implies that there is a unique labor market within regions but segmented labor markets across regions. The model is static except for the law of motion of labor supply, which relates the distribution of population across regions at $t-1$ and t through the bilateral migration flows between the two periods. In addition, in the quantitative exercise of Section 4 we will allow several parameters to change over time, which will hence carry a t subindex that we omit in this Section unless necessary.

3.1 Consumption and migration

At the beginning of every period, workers decide their region of work based on regional differences in wages and consumption prices, bilateral migration costs, and their idiosyncratic location preferences. Once established in a region, they work and consume in that region. We can characterize their choices in a two-stage optimization problem, which we solve by backwards induction.

Consumption decisions. Workers in region r have preferences over consumption c_{rj} of goods in each sector j. In particular, preferences are represented by a CRRA utility function with curvature parameter $\sigma > 0$ over the following consumption basket c_r:

$$c_r = \left[\omega_a^{1/\nu}(c_{ra} + \bar{c}_a)^{\frac{\nu-1}{\nu}} + \omega_m^{1/\nu}(c_{rm} + \bar{c}_m)^{\frac{\nu-1}{\nu}} + \omega_s^{1/\nu}(c_{rs} + \bar{c}_s)^{\frac{\nu-1}{\nu}}\right]^{\frac{\nu}{\nu-1}} \tag{1}$$

where $\omega_a^{1/\nu} + \omega_m^{1/\nu} + \omega_s^{1/\nu} = 1$. The parameter $\nu > 0$ is the asymptotic elasticity of substitution across goods and drives the effect of relative prices on relative sectoral expenditure.[9] The terms $\bar{c}_a$, $\bar{c}_m$, and $\bar{c}_s$ introduce non-homotheticicities in the sectoral demands and drive the effect of real wages on relative sectoral expenditures. The consumption choice problem is static and hence workers cannot save. Then, the budget constraint for a worker living in region r is simply

$$P_{ra}c_{ra} + P_{rm}c_{rm} + P_{rs}c_{rs} \leq w_r \tag{2}$$

where P_{rj} is the price index in region r for sector j composite good c_{rj} and w_r is the nominal wage in region r. Consumers maximize utility defined over (1) subject to their budget constraint (2). This implies individual-level demands for each region r and sector j:

$$P_{rj}c_{rj} \quad = \quad \omega_j \left(w_r + P_{ra}\bar{c}_a + P_{rm}\bar{c}_m + P_{rs}\bar{c}_s\right) \left(\frac{P_{rj}}{P_r}\right)^{1-\nu} - P_{rj}\bar{c}_j \tag{3}$$

where the aggregate price index P_r in region r is defined as

$$P_r \equiv \left(\omega_a P_{ra}^{1-\nu} + \omega_m P_{rm}^{1-\nu} + \omega_s P_{rs}^{1-\nu}\right)^{\frac{1}{1-\nu}} \ . \tag{4}$$

Given these demand functions, the indirect utility that agents in region r derive from consumption is:

$$\mathcal{V}(w_r, P_{ra}, P_{rm}, P_{rs}) = \frac{\left[\frac{w_r}{P_r} + \frac{P_{ra}\bar{c}_a + P_{rm}\bar{c}_m + P_{rs}\bar{c}_s}{P_r}\right]^{1-\sigma} - 1}{1-\sigma} \ . \tag{5}$$

Migration decisions. Workers choose their region of work. In particular, we define the value of migrating from region ℓ to region r for individual i as $V_{\ell r}^i = \mathcal{V}(w_r, P_{ra}, P_{rm}, P_{rs}) - mc_{\ell r} + \kappa\epsilon_r^i$, where $mc_{\ell r}$ is a fixed *route*-specific migration cost, capturing a notion of connectivity between regions, and ϵ_r^i is the taste shock that individual i experiences for region r. The idiosyncratic taste shock is i.i.d. across regions and individuals, and captures the idea that agents may decide to live in a region for non-economic reasons. The extent to which idiosyncratic preferences determine spatial sorting is controlled by parameter κ. At the beginning of each period, every agent decides to locate in the region that offers her the highest migration value given her current location ℓ and the realizations of the idiosyncratic taste shock ϵ_r^i for all regions. We follow the literature and assume that this shock is drawn from a Gumbel distribution, which implies that the share of workers $\rho_{\ell rt}$ of region ℓ that move to region r between $t-1$ and t is given by

$$\rho_{\ell rt} = \frac{\exp\left\{\frac{1}{\kappa}\left(\mathcal{V}(w_{rt}, P_{rat}, P_{rmt}, P_{rst}) - mc_{\ell rt}\right)\right\}}{\sum_k^R \exp\left\{\frac{1}{\kappa}\left(\mathcal{V}(w_{kt}, P_{kat}, P_{kmt}, P_{kst}) - mc_{\ell kt}\right)\right\}} \ . \tag{6}$$

[9] Asymptotic in the sense that ν is exactly the elasticity of substitution when consumption expenditure tends to infinity (or when all $\bar{c}_j = 0$).

This expression illustrates that workers move towards regions offering them higher wages, lower consumption prices, and lower migration costs. It also shows that κ limits the extent to which these economic forces determine the population in each region by increasing the importance of idiosyncratic reasons as determinants of the distribution of workers across space. From (6) we obtain the law of motion for the number of workers in each region

$$L_{rt} = (1 + n_t) \sum_{\ell}^{R} \rho_{\ell rt} L_{\ell t-1}. \tag{7}$$

where L_{rt} denotes region r population at time t, $L_{\ell t-1}$ denotes region ℓ population at time $t-1$, and n_t is population growth between $t-1$ and t. Hence, the labor supply in region r is simply given by the total immigrant inflows from all regions (including itself) that optimally choose to work on it plus population growth.

3.2 Production and trade

The (non-tradable) sector j final good consumed by region r workers c_{rj} comes from the aggregation of (tradable) intermediate varieties $q_{rj}(x)$ available in the region. We consider a standard CES aggregator with an elasticity of substitution parameter $\eta > 0$. One can microfound this with a final good production sector, but we can as well think of it as a preference aggregator.

Production of varieties. Within each sector j of region r, varieties are produced under perfect competition with a constant returns to scale technology that only uses labor, $y_{rj}(x) = A_{rj}(x)L_{rj}(x)$, where $A_{rj}(x)$ denotes the productivity of region r at producing variety x of sector j. Taken as given the price $p_{rj}(x)$ at which region r producers of variety x in sector j sell their output, the FOC of the firm is given by $p_{rj}(x)A_{rj}(x) = w_r$. Following Eaton and Kortum (2002), productivity is a random variable drawn from an independent region- and sector-specific Fréchet distribution with c.d.f. $F_{rj}(A) = \exp\{-T_{rj}A^{-\theta_j}\}$. The shape parameter θ_j is sector-specific and common across regions, and governs the (inverse of) dispersion of productivity in the production of sector j varieties. The scale parameter T_{rj} is region- and sector-specific and controls the average level of regional efficiency in the production of sector j varieties. Producers in regions with higher T_{rj} will have, on average, higher productivity in the production of sector j varieties. Due to specialization, region r will tend to be a net exporter of sector j goods if T_{rj} is high relative to T_{rk} for $k \neq j$. Within each sector, more dispersion (lower θ_j) in productivity will provide room to further specialization, increasing intra-sectoral trade across regions.

Firm optimization and trade. Regional trade is subject to iceberg transport costs. This means that $\tau_{r\ell j} \geq 1$ units of sector j varieties must be shipped from region r to region ℓ such that one unit arrives to ℓ. As goods markets are perfectly competitive, cost minimization by firms implies that the price of variety x in sector j that is offered by region r producers to region ℓ consumers is $p_{r\ell j}(x) = \frac{w_r}{A_{rj}(x)}\tau_{r\ell j}$ — the marginal cost of production times the cost of shipping sector j goods from r to ℓ. However, consumers in region ℓ only purchase variety x of sector j from the region that can provide it at the lowest price, so the price $p_{\ell j}(x)$ they actually pay is $p_{\ell j}(x) = \min_{r\in\{1,\dots R\}} p_{r\ell j}(x)$. Hence, the distribution of sector j variety prices paid by region ℓ consumers is a distribution over minimum prices, i.e. an extreme value distribution. Taking advantage of the properties of the Fréchet distribution, Eaton and Kortum (2002) show that the price P_{rj} of the sector j composite good (the price index of sector j varieties) in region r is given by

$$P_{rj} = \gamma_j \left[\sum_{\ell}^{R} \left(w_\ell \tau_{\ell r j} \right)^{-\theta_j} T_{\ell j} \right]^{-1/\theta_j} \tag{8}$$

where $\gamma_j = \Gamma\left(\frac{\theta_j+1-\eta}{\theta_j}\right)^{1/(1-\eta)}$, and $\Gamma(.)$ is the gamma function. It can be shown that the share of region ℓ sector j expenditure that is spent in region r varieties is given by

$$\pi_{r\ell j} = \frac{\left(w_r \tau_{r\ell j} \right)^{-\theta_j} T_{rj}}{\sum_k^R \left(w_k \tau_{k\ell j} \right)^{-\theta_j} T_{kj}} \,. \tag{9}$$

Region ℓ's expenditure in sector j varieties produced by region r is higher if region r has a low wage w_r, low trade costs $\tau_{r\ell j}$ or higher productivity T_{rj}.

3.3 Equilibrium

Definition. Given an initial distribution of workers across locations, L_r^0, a static equilibrium consists of region-specific wages $\{w_r\}$; bilateral migration flows $\{\rho_{r\ell}\}$; bilateral sector-specific trade flows $\{\pi_{r\ell j}\}$; and sector- and region-specific prices $\{P_{ra}, P_{rm}, P_{rs}\}$, per-capita consumption $\{c_{ra}, c_{rm}, c_{rs}\}$ and employment allocations $\{L_{ra}, L_{rm}, L_{rs}\}$ such that: (a) workers and firms make optimal decisions (equations (3), (6), (8), (9) hold); (b) sector-region goods markets clear:

$$P_{rj} Y_{rj} = \sum_{\ell}^{R} \pi_{r\ell j} P_{\ell j} C_{\ell j} \quad \forall r, j \,, \tag{10}$$

(c) regional labor markets clear:

$$L_r = L_{ra} + L_{rm} + L_{rs} \quad \forall r \,, \tag{11}$$

where labor supply L_r is given by equation (7) and labor demands are implied by equation (10), see below; and (d) trade balances in each region:

$$\sum_{j\in\{a,m,s\}} \sum_{\ell\neq r}^{R} \pi_{r\ell j} P_{\ell j} C_{\ell j} = \sum_{j\in\{a,m,s\}} (1-\pi_{rrj}) P_{rj} C_{rj} \quad \forall r \,. \tag{12}$$

Discussion. The goods market clearing in equation (10) requires that the value of sector-j output produced in region r equals the value that all regions, including itself, purchase from region r, where aggregate consumption of sector j good in region r is defined as $C_{rj} \equiv c_{rj} L_r$. The labor market clearing in equation (11) requires that the labor supply in each region r, as given by equation (7), equals the labor demanded by region r producers of all three sectors. The labor demand in each region r and sector j can be easily characterized as follows. First, note that constant returns to scale and perfect competition in the production of varieties imply that total revenues must equal total costs for all firms in each sector and region. As labor is the only input of production, total costs are simply labor costs and we can write

$$P_{rj} Y_{rj} = w_r L_{rj} \, . \tag{13}$$

Next, one can use equation (13) to substitute total revenues by labor income in the goods market clearing condition (10) and obtain an expression for labor demand in sector j and region r as,

$$L_{rj} = \frac{1}{w_r} \sum_{\ell}^{R} \pi_{r\ell j} P_{\ell j} c_{\ell j} L_{\ell} \quad \forall r, \forall j. \tag{14}$$

Finally, the trade balance in equation (12) states that the total value of exports must equal the total value of imports for every region, which allows for trade imbalances at sectoral level in each region. The trade balance condition arises from the static nature of the consumer problem (workers in region r can neither save nor borrow so $\sum_j P_{rj} Y_{rj} = \sum_j P_{rj} C_{rj}$) and the goods market clearing conditions.

The Macroeconomy. In order to study the growth process, we need to obtain production functions at the sector-province level. In equilibrium, the average sectoral productivity in each region is given by the average over those varieties that survive country-wide competition, and it can be written as

$$B_{rj} = \gamma_j^{-1} \left(\frac{T_{rj}}{\pi_{rrj}} \right)^{1/\theta_j} . \tag{15}$$

This expression highlights two components of productivity. The first component is the exogenous T_{rj}, which determines the average productivity of region r in producing goods in sector j. This would be the only relevant term if the region was closed to trade ($\pi_{rrj} = 1$) because region r would need to produce all varieties on its own. As trade increases (π_{rrj} declines) more goods are sourced from other regions, region r can specialize in the subset of intermediate varieties for which it has a comparative advantage, and productivity increases due to selection.[10] Next, given the constant returns to scale in production, average sectoral output can be written as $Y_{rj} = B_{rj} L_{rj}$, which

[10] See Finicelli et al. (2013), Sposi (2019) and our own derivations in Appendix E.1.

combined with equation (13) delivers an expression for equilibrium prices:

$$P_{rj} = \frac{w_r}{B_{rj}}. \tag{16}$$

Therefore, relative sectoral prices P_{rj}/P_{rk} within region r are given by the inverse of the ratio of sectoral productivities, and are hence determined by the ratio of exogenous T_{rj} and the ratio of endogenous π_{rrj}.

3.4 Structural change with spatial frictions

When our model economy is closed to internal trade and migration, each region is a closed economy independent from each other. Structural change within each region arises from the standard income and price effects due to symmetric and asymmetric sectoral productivity growth. Structural change for the country is the sum of what happens in all its independent regions, while spatial income inequality is the result of asymmetric productivity growth across regions. Internal migration and internal trade bring new forces of growth and structural change, and provide important interactions between them and with sectoral productivity growth.

The effects of trade on structural change are well studied in the literature of international trade and structural change cited in the Introduction. A decline in trade costs allows for regional specialization, which increases productivity due to selection and hence generates structural change through income effects. When the decline in trade costs is asymmetric across sectors, relative prices change and structural change follows as long as substitution elasticities are different from one.

The effects of migration on structural change are far less studied. In our model, migrations generate structural change both at the aggregate and at the local level. At the aggregate level, there is the mechanical composition effect of moving people from agrarian regions to industrial ones. This would be captured by the between-region component of a simple decomposition of the evolution of country-wide sectoral shares, see Appendix F.

At the local level, things are more interesting because population movements between locations change the sectoral composition of labor demand in each region, which induces local structural change. To see why, recall that labor demand of sector j in region r is given by equation (14). A fraction of this demand is local (the term $\ell = r$ in the right hand side) and a fraction is country-wide (the terms $\ell \neq r$). Suppose there is an outmigration from region r (led by changes in either migration costs, trade costs, or productivity) and that R is large enough such that we can abstract from the direct effect of outmigration on the country-wide fraction of labor demand. Then, keeping prices fixed, labor demand L_{rj} in region r declines mechanically in all sectors j due to the fall in population L_r. Indeed, the elasticity of this fall is given by

$$\frac{\partial L_{rj}}{\partial L_r}\frac{L_r}{L_{rj}} = \frac{\pi_{rrj} P_{rj} C_{rj}}{P_{rj} Y_{rj}} \leq 1 \tag{17}$$

and hence it is larger in sectors where local demand $\pi_{rrj}P_{rj}C_{rj}$ represents a larger fraction of total production $P_{rj}Y_{rj}$. In particular, local employment is reallocated towards (away from) sectors where this elasticity is smaller (larger). On aggregate, the fall in total labor demand in region r is smaller than the fall in its labor supply, that is, $\sum_j \frac{\partial L_{rj}}{\partial L_r} < 1$ (except in the no trade case, where the fall is of the same size). These results are formally shown in Proposition 1 of Appendix E.1. To restore the equilibrium in the labor market, the regional wage w_r must increase. In turn, this increase in the regional wage does two things. First, it lowers $\pi_{r\ell j}$ $\forall \ell$ in equation (14), as the local economy becomes less competitive. This effect is larger when sectoral trade costs are smaller, that is, the increase in regional wages lowers demand relatively more in sectors that are more tradable, see Proposition 2 in Appendix E.1 for details. Second, it makes region r richer, which triggers changes in the composition of the local demand (the terms $P_{\ell j}c_{\ell j}$ in the right hand side of equation (14) for $\ell = r$) due to the standard income effects. For instance, if agriculture is more tradable than services and its income-elasticity of demand is lower, outmigration will shift local employment from agriculture to services through this general equilibrium effects.

When R is not large —or some regions are particularly well connected to region r— two additional things will happen. First, the country-wide component of labor demand in equation (14) will also change. Second, the opposite sectoral reallocation will happen in the regions receiving the migration flows. In general, this migration-led sectoral reallocation of employment does not cancel across regions and has aggregate consequences. Hence, it appears in the within-region component of a mechanical decomposition of the evolution of country-wide sectoral shares, incorrectly downplaying the role of migrations for aggregate structural change (see Appendix F).

4 Calibration

The calibration of the model requires choosing values for many parameters. For a given period, we have 9 preferences parameters (σ, ν, η, $\bar{c}_j$, and ω_j); R^2+1 migration parameters ($mc_{r\ell}$ and κ); $3R^2$ trade costs parameters ($\tau_{r\ell j}$); $3(R+1)$ productivity parameters (θ_j and T_{rj}); and the rate of population growth n.

We choose $R = 47$ (the 47 contiguous Spanish provinces within the Iberian Peninsula) and we want to match data at 7 different points in time (from 1940 to 2000 every ten years). The model is static conditional on the initial geographical distribution of labor, but the endogenous evolution of population plus time changing parameters can generate rich dynamics. Hereafter, we will explicitly add a time subscript to the relevant parameters and variables of interest. We hold constant all the preference parameters plus the migration and productivity elasticity parameters κ and θ_j. Instead, we allow the bilateral migration costs $mc_{r\ell t}$, the bilateral sector-specific iceberg transport costs $\tau_{r\ell jt}$, and the sector- and region-specific productivity index T_{rjt} to vary over time, some of them freely and some of them with some structure. We also allow the rate of population growth n_t to vary over time. For 1940 we solve and calibrate a restricted version of our economy in which the migration costs tend to infinity and the geographical distribution of workers is exogenous to the model.[11]

We start by setting $\sigma = 1$, $\theta_a = \theta_m = \theta_s = 4$, and $\eta = 4$. The curvature of the utility function does not play much of a role in a static model without uncertainty, so we use log for simplicity. Simonovska and Waugh (2014) estimate $\theta_m \simeq 4$ from data on bilateral trade flows and product prices across countries, and this is a common value used in the literature. We impose θ_j to be equal across sectors for simplicity. The value of η does not play any significant quantitative role, so we choose it such that it satisfies the technical condition $1 + 1/\theta_j (1 - \eta) > 0$. Next, we normalize $mc_{rrt} = 0$ and $\tau_{rrt} = 1$ $\forall r$, t. Finally, we choose n_t to match aggregate employment growth across all provinces between $t-1$ and t. Then, the calibration proceeds in three steps. In the first step, we estimate the preference parameters to match the aggregate evolution of sectoral employment over time. In the second step, trade costs and productivity parameters are calibrated jointly to match, every period, data on employment and productivity at the sector-region level, plus bilateral trade data in the year 2000. Finally, in a third step, we calibrate the migration costs parameters from the observed migration flows. In principle, one would need to use κ and the migration cost parameters $mc_{\ell rt}$ to compute the labor supply for given wages in Step 2. Yet, the combination of the structure of the model and our calibration strategy (targeting employment at region-sector level) allows this separation. This lessens the computational burden of the calibration.

4.1 Data

We have data on (a) employment, nominal value added, and prices at region-sector level from 1940 to 2000 in 10-year periods; (b) bilateral migration flows between all provinces from 1960 to 2000, also in 10-year periods (which we extend back to 1940, see Appendix A.2); and (c) bilateral trade flows between all provinces for agriculture and manufacturing only for the year 2000. All the data sources are detailed in Appendix A.1. We note that sectoral employment and value added shares at the province level are different from each other in the data, while in the model they are restricted to be the same. For consistency between model and data, we keep the sectoral split of employment and ignore the one of value added. Hence, we redefine the sectoral value added in each province as $P_{rjt}Y_{rjt} = \frac{L_{rjt}}{L_{rt}} P_{rt}Y_{rt}$, where $P_{rt}Y_{rt}$ is the provincial value added in our data. Then, using equation (13) we can infer data on regional wages as $w_{rt} = P_{rjt}Y_{rjt}/L_{rjt} = P_{rt}Y_{rt}/L_{rt}$. Additionally, using equation (16) we can infer data on sector and region specific productivities as $B_{rjt} = w_{rt}/P_{rjt}$.

[11] Because 1940 is our first year of data, this assumption is a necessity. However, it also makes sense given the historical context. The Spanish Civil War, which took place between 1936 until 1939, generated large population movements for reasons unrelated to the forces described in our model. First, it is estimated that around 500,000 people died during the conflict and an equal number out-migrated from the country for fear of political repression. And second, many people changed province during the war either because they were mobilized by the war effort or because they voluntarily switched to an area controlled by their preferred warring side. It is not clear how many of these people returned to their home provinces.

Table 1: Parameters demand system

ω_a	ω_m	ω_s	ν	$\bar{c}_a$	$\bar{c}_m$	$\bar{c}_s$	$\frac{\sum_r L_{r40} P_{ri40} \bar{c}_i}{VA_{40}}$		
							a	m	s
0.156	0.499	0.345	1.0e-6	-0.000671	0.00222	0.001386	-0.188	0.667	0.465

Notes: Parameters of the utility function estimated with equation (18) by non-linear least square. The last three columns report the total value of $\bar{c}_a$, $\bar{c}_m$, and $\bar{c}_s$ in relation to GDP in 1940.

4.2 First step: preferences

The preference parameters ν, $\bar{c}_j$, and ω_j drive the sectoral composition of expenditure in each region, see equations (3). We do not have data on sectoral composition of expenditure by province and, due to internal trade, the sectoral composition of employment or value added in each region will be different from the sectoral composition of expenditure. Therefore, we choose the preference parameters to match the time evolution of the sectoral composition of value added at the national level. This follows from treating the Spanish economy as a closed economy such that sectoral value added and expenditure shares equalize each other in the aggregate.[12] In particular, multiplying both sides of (3) by L_{rt}, aggregating over provinces, and applying the equilibrium condition (10), the value added share of sector j in year t is given by,

$$\frac{\mathrm{VA}_{jt}}{\mathrm{VA}_t} = \omega_j \left(\sum_r \left(\frac{\mathrm{VA}_{rt}}{\mathrm{VA}_t} + \left(P_{rat}\bar{c}_a + P_{rmt}\bar{c}_m + P_{rst}\bar{c}_s\right) \frac{L_{rt}}{\mathrm{VA}_t} \right) \left(\frac{P_{rjt}}{P_{rt}} \right)^{1-\nu} \right) - \frac{\sum_r P_{rjt}\bar{c}_j L_{rt}}{\mathrm{VA}_t} \tag{18}$$

where $\mathrm{VA}_{jt} \equiv \sum_r \left(\frac{L_{rjt}}{L_{rt}} P_{rt} Y_{rt} \right)$, $\mathrm{VA}_{rt} \equiv P_{rt}Y_{rt}$, and $\mathrm{VA}_t \equiv \sum_r P_{rt}Y_{rt}$ is GDP. This expression gives 2 independent equations per time period (so, 14 equations) to estimate 9 parameters. Given data on L_{rjt}/L_{rt}, $P_{rt}Y_{rt}$, and P_{rjt}, it can be easily estimated by non-linear least squares.[13] In terms of identification, the ν and the $\bar{c}_j$ are inferred from the co-variation of the sectoral shares with sectoral prices and aggregate income, while the ω_j will be determined by the average sectoral shares.

Estimated parameters and model fit. The estimated demand system reproduces well the aggregate sectoral shifts of the Spanish economy between 1940 and 2000, see Figure G.2. The parameter estimates are reported in Table 1. We find that value added from different sectors are poor substitutes ($\nu \simeq 0$), which means that changes in relative prices translate one to one into changes in relative expenditures. We also find that $\bar{c}_a < 0$, $\bar{c}_m > 0$, and $\bar{c}_s > 0$. This means that the

[12] The equality of sectoral value added and expenditure shares further requires that value added shares in investment are similar to those in consumption. See García-Santana et al. (2021) and Herrendorf et al. (2021) for recent examples of model economies where the sectoral shares of consumption and investment differ.

[13] Regional data is necessary to estimate preference parameters because costly internal trade prevents price equalization across provinces. With free trade across regions we would have,

$$\frac{\mathrm{VA}_{jt}}{\mathrm{VA}_t} = \omega_j \left(1 + \frac{P_{at}\bar{c}_a + P_{mt}\bar{c}_m + P_{st}\bar{c}_s}{\mathrm{VA}_t/L_t} \right) \left(\frac{P_{jt}}{P_t} \right)^{1-\nu} - \frac{P_t\bar{c}_j}{\mathrm{VA}_t/L_t}$$

which is the standard expression estimated in papers like Herrendorf et al. (2013).

income elasticity of agricultural goods is less than one and hence the income effects are important drivers of the transition out of agriculture at early stages of development (the values of $\bar{c}_a$, $\bar{c}_m$, and $\bar{c}_s$ are quantitatively large relative to value added per capita in 1940, in particular they represent 18.8%, 66.7%, and 46.5% respectively). Also, the fact that $\bar{c}_m > \bar{c}_s$ implies that as the country gets richer, income effects push non-agricultural employment from services to manufacturing. This force is more than offset by the decline in the price of manufactures relative to services, which pushes non-agriculture labor from manufactures towards services.[14]

4.3 Second step: trade costs and productivities

Trade costs. The standard way to calibrate the iceberg transport costs $\tau_{r\ell jt}$ is by the use of equation (9) with data on bilateral trade flows. Unfortunately, data on internal trade flows for Spain are only available for the year 2000 and only for two sectors. Therefore, we follow a different strategy that does not require data on trade flows, but we enrich our identification by adding the available trade flows data as extra moments conditions. Our empirical strategy exploits data on sectoral employment in each region plus the model-implied sectoral expenditure in each region to recover intersectoral trade in each region, which in turn is informative of trade costs for given productivities. In particular, using equation (9) to substitute away trade flows in the labor demands (equation 14) we obtain,

$$L_{rjt} = \frac{1}{w_{rt}} \sum_{\ell}^{R} \left(\frac{(w_{rt}\tau_{r\ell jt})^{-\theta_j} T_{rjt}}{\sum_k^R (w_{kt}\tau_{k\ell jt})^{-\theta_j} T_{kjt}} \right) P_{\ell jt} c_{\ell jt} L_{\ell t} \quad \forall r, \forall j. \tag{19}$$

We have data on sectoral employment L_{rjt} and on wages w_{rt} for each region. Sectoral expenditure per capita in each region $P_{\ell jt}c_{\ell jt}$ is given by equations (3) and the estimated preference parameters in the first stage together with price and wage data. Hence, equation (19) gives $3R$ calibration equations, while we have $3R(R-1)$ bilateral trade costs $\tau_{r\ell jt}$ and $3R$ productivity parameters T_{rjt} to recover. We will deal with the T_{rjt} using $3R$ extra equations in the next paragraph, but we still have more trade costs parameters than equations. This happens because the full matrix of bilateral trade costs is not necessary to determine labor demands at the sector-region level. Therefore, we reduce the dimensionality of the matrix of trade costs as follows. First, we parameterize the iceberg costs as $\log \tau_{r\ell jt} = (\hat{\tau}_{jt} + \hat{\tau}^e_{rt} + \hat{\tau}^m_{\ell t})\, d_{r\ell}$, where $\hat{\tau}_{jt}$ captures the average tradability of sector j, $\hat{\tau}^e_{rt}$ is a region of origin (or export) effect, $\hat{\tau}^m_{\ell t}$ is a region of destination (or import) effect, and $d_{r\ell}$ is a time-invariant term capturing origin-destination fixed effects. This means that we allow the trade costs (a) to be asymmetric between origin-destination routes, $\tau_{r\ell jt} \neq \tau_{\ell rjt}$, and (b) to vary over

[14] Preference estimates with sectoral value added data tend to find $\nu \simeq 0$ as we do here, see Herrendorf et al. (2013). Several papers find $\bar{c}_s > \bar{c}_m$ whereby the income effect reallocates employment from manufacturing to services, while papers like Uy et al. (2014) or Święcki (2017) cannot reject that $\bar{c}_s$ and $\bar{c}_m$ are equal to each other. Instead, we find $\bar{c}_m$ slightly larger than $\bar{c}_s$.

time by sector, by region of origin, and by region of destination.[15] And second, we use data on road distance (normalized between 0 and 1) between r and ℓ capital cities in the year 2000 to calibrate the $d_{r\ell}$ outside the model. All in all, for every period t, equation (19) gives $3R$ conditions and we have $3+2R$ trade cost parameters $\hat{\tau}_{jt}$, $\hat{\tau}^{e}_{rt}$, and $\hat{\tau}^{m}_{\ell t}$ to pin down.

Productivity. Absent data on internal trade flows, our data on average sectoral productivity by region B_{rjt} is not enough to directly recover T_{rjt} from equation (15). Hence, we need to plug equation (9) into (15) to obtain

$$B_{rjt} = \gamma_j^{-1} \left(\sum_{k}^{R} \left(\frac{w_{rt}}{w_{kt}\tau_{krjt}} \right)^{\theta_j} T_{kjt} \right)^{1/\theta_j} \qquad \forall r, \forall j \tag{20}$$

which gives $3R$ non-linear equations in as many unknowns T_{rjt} for every time period t given the trade costs $\tau_{r\ell jt}$ and the wage and average productivity data, w_{rt} and B_{rjt}.

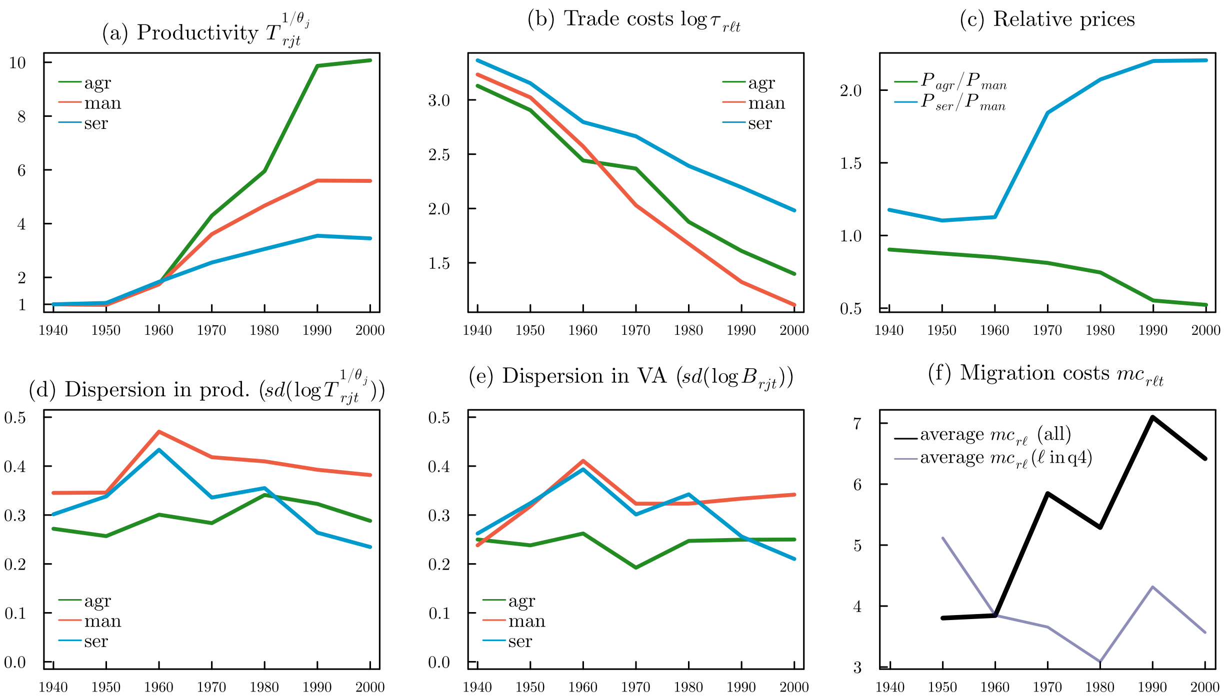
Trade flows. Finally, we can use our data on internal bilateral trade flows for agriculture and manufacturing for the year 2000 to add equations (9) for $j = a, m$ and $t = 2000$ as $2R(R-1)$ extra moment conditions.

Algorithm and model fit. Given the estimates of ν, $\bar{c}_j$, and ω_j from the first step, at every period of time t we need to find parameters $\hat{\tau}_{jt}$, $\hat{\tau}^{e}_{rt}$, $\hat{\tau}^{m}_{\ell t}$, and T_{rjt} to match the moment conditions given by equations (19) and (20) (plus conditions (9) in year 2000). We calibrate the parameters *separately for every period* to minimize the sum of squared errors of our moment conditions. We place more weight on the employment moments (equations 19). There are two reasons for this. First, our main outcome of interest is the allocation of employment across sectors and across space, so we want the model to do particularly well in this dimension such that the counterfactual exercises can be compared to data. Second, the data quality for (sector-region) employment is arguably better than for (sector-region) prices, so it makes sense to put more confidence in the former. We find that the model matches well the employment and productivity data at every decade, see for instance Figures G.3 and G.4 in Appendix G providing the model fit for the years 1950 and 1990.

Identification. The mismatch between the production and consumption provincial sectoral shares reveals the existence of inter-sectoral trade and, other things equal, gives information on trade costs, see Gervais and Jensen (2019). Intuitively, if the economy is closed to trade, all consumption is local, and the sectoral shares in expenditure and in production are equal to each other in all provinces. With low trade costs, instead, provinces consume according to their local prices and wages and produce according to their comparative advantage. More precisely, on the one hand,

[15] However, as a result of keeping the bilateral structure $d_{r\ell}$ constant, we do not allow trade costs to vary over time by sector-origin, sector-destination, or sector-origin-destination.

Figure 6: Estimated trends



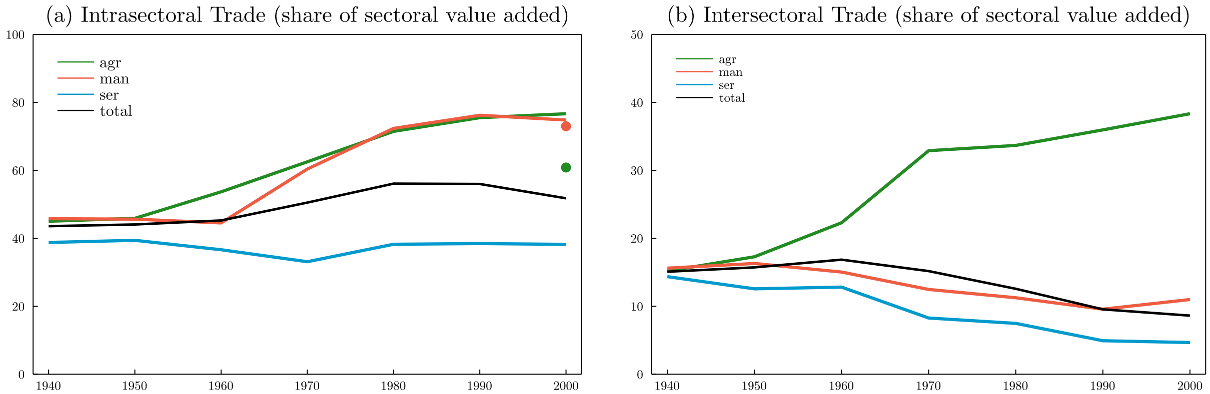
Notes: Panel (a) displays the estimated sectoral productivity parameters averaged across all provinces, normalizing 1940 to 1 in each sector. Panel (b) reports the estimated trade costs parameters $\log \tau_{r\ell j} = \left(\hat{\tau}_{jt} + \hat{\tau}^e_{rt} + \hat{\tau}^m_{\ell t}\right) d_{r\ell}$ averaged across all origin-destination pairs for each sector. Panel (c) shows the implied relative price of agriculture and services to manufacturing averaged across provinces. Panels (d) and (e) report the standard deviation across regions of the log of sectoral productivities T_{rjt} and the log of sectoral labor productivity B_{rjt}. Panel (f) reports the estimated migration cost parameters averaged across all origin-destinations –black line– and averaged across destinations in the top quartile of relative employment growth between 1940 and 2000.

the correlation of expenditure and production sectoral shares across provinces for each sector j reveals information about $\hat{\tau}_{jt}$ (given T_{rjt}, $\hat{\tau}^e_{rt}$, and $\hat{\tau}^m_{\ell t}$). In the data there is a steady decline in the correlation between employment and expenditure shares across regions for the three sectors after 1950, which will help recover declining sectoral trade costs (see Table G.1 in Appendix G). On the other hand, the correlation of expenditure and production sectoral shares across sectors for each region r reveals information on $\hat{\tau}^e_{rt}$ and $\hat{\tau}^m_{rt}$ (given T_{rjt} and $\hat{\tau}_{jt}$). That is, other things equal, provinces with similar expenditure and production shares in all sectors are inferred to face higher trade costs.

Estimated parameters. In order to summarize all the information of the estimated parameters, we report the average (across all provinces r) of T_{rjt} for every sector j and year t in Panel (a) of Figure 6, and the average (across all origin-destination pairs $r\ell$) of $\left(\hat{\tau}_{jt} + \hat{\tau}^e_{rt} + \hat{\tau}^m_{\ell t}\right) d_{r\ell}$ for every sector j and year t in Panel (b) of Figure 6. The estimated parameters display two important trends: an increase in sectoral productivities (mostly between 1950 and 1990) and a decline in trade costs.[16] The productivity growth is largest in agriculture and smallest in services, while the

[16] The productivity stagnation in the 1940's is consistent with the lack of economic development in that decade, see Figure 1 in Section 2. The productivity slowdown in the 1990's (and beyond) is already documented by García-

Figure 7: Trade across provinces



Notes: Panel (a) reports predicted intra-sectoral trade as a share of sectoral value added. For the year 2000, the dots represent intra-sectoral trade in manufacturing (red) and agriculture (green) in the data. Panel (b) shows predicted inter-sectoral trade as a share of sectoral value added.

decline in trade costs is more apparent for agriculture and manufactures than for services. Both changes in productivity and trade costs affect relative sectoral prices, as reported in Panel (c) of Figure 6. The asymmetric productivity growth and the asymmetric decline in trade costs contribute to the increase in the price of services relative to manufactures (roughly 2/3 *vs.* 1/3 respectively), while the asymmetric productivity growth is the main responsible for the decline in the price of agriculture relative to manufactures, see Figure 8. These patterns summarized by averages are common to most provinces, see Figure G.5 in Appendix G.

Implied trade volumes. The decline in trade costs generates a rise in trade volumes. We define intra-sectoral trade as the fraction of sectoral expenditure not produced locally, $\sum_r (1 - \pi_{rrjt}) P_{rjt} C_{rjt}$, see Appendix E.1. This is the notion of trade in Eaton and Kortum (2002) whereby intra-sectoral heterogeneity of productivities across provinces allows for Ricardian trade. We observe intra-sectoral trade only for agriculture and manufactures in 2000, but the estimated model delivers unique predictions for all periods and sectors. For the year 2000, we can compare our model predictions with the data. As we can see in Panel (a) in Figure 7, the model matches very well the amount of intra-sectoral trade in manufacturing, while it overpredicts trade in agriculture by 14 percentage points.[17] Panel (a) in Figure 7 also shows a substantial increase in intra-sectoral trade (relative to sectoral value added) in agriculture and manufacturing starting in 1940 and 1960 re-

Santana et al. (2020) among others. The fall in trade costs can be understood as a result of large investments in transport equipment and infrastructure. For instance, a publicly-funded program to improve the surface and increase the width of the most-used 5,000 km of the road network was in place between 1967 and 1974, while the construction of the first highways (6,000 km) connecting the main cities of the country kick started in 1968, see Ventosa (2017).

[17]The reason why the fit for trade volumes is poorer in agriculture than in manufacturing is that our data on trade flows in the year 2000 does not predict our data on agricultural employment in the year 2000 as well as it does for manufacturing. That is, if we plug in $\pi_{r\ell j2000}$ in equation (14), we obtain $\hat{L}_{rj2000}$ which is similar to our data L_{rj2000} for $j = m$ but not so much for $j = a$. This is the case because $\pi_{r\ell j}$ and L_{rj} in the data depend also on factors not included in our model. As in our calibration we prefer to match data on employment, we need to sacrifice some goodness of fit on our trade moments.

spectively, which stabilizes in 1990. Instead, intrasectoral trade in services, which is smaller than in agriculture and manufactures, does not increase as a share of its value added over our period of study. This is the case because (a) the decline in trade costs for services is smaller than in the other two sectors and (b) the increase in sectoral value added (due to the reallocation of economic activity) is much larger, which leaves the trade to value added ratio unchanged. We can additionally define inter-sectoral trade for sector j as the difference between sectoral expenditure and sectoral value added, $\sum_r \frac{1}{2}|P_{rjt}C_{rjt} - P_{rjt}Y_{rjt}|$, see Appendix E.1. In Panel (b) of Figure 7 we see how intersectoral trade declines relative to sectoral value added in manufacturing and services, which reflects growing convergence between sectoral expenditure and value added shares across provinces in these sectors. Instead, intersectoral trade increases in agriculture due to the fact that the declining production of agriculture gets concentrated over time in fewer, specialized regions.

4.4 Third step: migration costs

In order to recover the migration elasticity κ and the bilateral migration costs $mc_{r\ell t}$ we use our data on the bilateral migration flows $\rho_{r\ell t}$ for each decade. Many papers in the migration literature parameterize $mc_{r\ell t}$ as a function of distance between regions. We prefer to keep these costs non-parametric for two reasons. First, while transport costs matter, there may be other factors influencing connectivity between regions. For instance, existing networks of previous migrants from the same home town and the availability of cheap housing or other amenities at destination are typically important. Likewise, availability of public subsidies in poorer regions, the strength of family networks, or other amenities at origin may be relevant too.[18] And of course, all these aspects may vary over time. Second, by keeping migration costs non-parametric, we can match the migration flows exactly, which allows to separate this part of the calibration from the GMM algorithm in Step 2.

As it is common in this literature —see for instance Artuç et al. (2010)— we start by estimating κ from the observed correlation between migration flows and differences in regional value functions. In particular, using equation (6) we can write,

$$\log \rho_{r\ell t} - \log \rho_{rrt} = \frac{1}{\kappa}\big(\mathcal{V}(w_{\ell t}, P_{\ell at}, P_{\ell mt}, P_{\ell st}) - \mathcal{V}(w_{rt}, P_{rat}, P_{rmt}, P_{rst})\big) - \frac{mc_{r\ell t}}{\kappa} \tag{21}$$

where mc_{rrt} is normalized to 0 and the non-linear part of equation (6) (the denominator) is differenced away. This expression shows that κ regulates how many people move from r to ℓ (as compared to those that stay in r) given the difference in values between locations ℓ and r. With data on wages and prices, and with the utility function parameters obtained before, we can construct the value of living in each location. Then, we can recover κ by estimating this relationship in the data by OLS. Next, the residuals of this regression identify the bilateral migration costs $mc_{r\ell t}$.[19]

[18] This argument is reinforced by the fact that the correlation between bilateral migration flows and distance is quite weak in the Spanish data, between -0.28 and -0.30 depending on the year.

[19] OLS may lead to biased estimates for κ because of possible correlation between the right-hand-side variable and

We estimate $\kappa = 0.434$. As we are using log utility, this corresponds to an elasticity of migration flows to real income of 2.3 for the case in which the $\bar{c}_j$ tend to zero.[20] The time evolution of the bilateral migration costs that we recover is reported in Panel (f) of Figure 6. We report the average for every period t of the $mc_{r\ell t}$ over all routes $r\ell$ (black line). The migration costs increase all over the period. However, many of these terms are economically irrelevant because the associated bilateral routes are insignificant in terms of population movements. For this reason, we also report the average of the $mc_{r\ell t}$ for all the routes $r\ell$ whose destination ℓ is one of the provinces in the top quartile of the distribution of relative employment growth over the 1940-2000 period (blue line). We can see that the migration costs towards these high-growth provinces fell sharply in 1960 (corresponding to the migration flows between 1950 and 1960), declined slowly in the next two decades, and increased in 1990 (corresponding to the migration flows between 1980 and 1990). This means that internal migrations towards the most dynamics areas between 1950 and 1980 —the time of the rural exodus— were partly fuelled by a decline in migration costs. One possible explanation for this decline is the government-led construction of cheap housing for migrant workers in the (then) outskirts of cities like Barcelona, Bilbao, or Madrid.[21] Another one is the accumulation of migrant networks from the same location. Later on, the increase in migration costs from the 1980's reveals that, despite differences in real wages across provinces persisted, workers were not moving. We interpret this post 1980 increase in the migration costs towards the most dynamic areas as the result of the development of the welfare state in Spain, which equalized after tax-transfer incomes.[22] In our model, this would show up as in increase in the migration costs from poor areas to richer ones.

the regression errors. That is, whenever $mc_{r\ell t}$ is high, fewer people choose to migrate from r to ℓ, which tends to keep wages low in r and high in ℓ, and as a consequence $\mathcal{V}(w_{\ell t}, P_{\ell at}, P_{\ell mt}, P_{\ell st}) - \mathcal{V}(w_{rt}, P_{rat}, P_{rmt}, P_{rst})$ tends to be large. In practice, we have tried to instrument the value functions with the exogenous productivities T_{rjt} and $T_{\ell jt}$ and the results are very similar. We believe that this is because the wages w_{rt} and $w_{\ell t}$ are affected by all bilateral migration cost parameters, not only $mc_{r\ell t}$, so with 47 regions the potential endogeneity due to $mc_{r\ell t}$ is diluted.

[20]This elasticity is in the same order of magnitude as similar estimates for other countries. For instance, Morten and Oliveira (2018) estimate an elasticity of 1.91 for Brazil by use of 10-year migration flows, Tombe and Zhu (2019) estimate an elasticity of 1.5 for China by use of 5-year migration flows, and Imbert et al. (2022) recover an elasticity of 2.7 also for China with 5-year migration flows.

[21]In the early 1950's, migrants to the big cities settled in self-built shanty towns. In 1957, the newly created *Ministerio de la Vivienda* approved the *Plan de Urgencia Social*, with the explicit objective of building cheap (legal) housing for the migrants arriving to big cities. Construction was done by the private sector, fuelled by public subsidies and cheap land provided by the government through selected rezoning, see López Simón (2022) for details. Between 1950 and 1980, the number of residential dwellings in the provinces of Barcelona, Madrid, and Vizcaya multiplied by a factor of 3.5 or more, as compared to a factor of 2 for the rest of the country. See Table 6.7 in Carreras and Tafunell (2005).

[22]Bentolila (1997) documents that social protection expenditures rose from 18% in 1980 to 24% of GDP in 1993. In addition, a special transfer system was implemented to protect unemployed workers in agriculture in provinces of Andalucía and Extremadura paying 75% of the minimum wage for up to 300 days to individuals having worked for at least 40 days within the year.

4.5 The calibrated economy *vs* the data

We report a selection of development statistics for the benchmark economy in Column (2) of Table 2. By construction of our estimation strategy, they are very close to the actual data, see Column (1). GDP per capita grows by a factor of 5.3. The employment shares of agriculture and services decline and increase in 45 and 39 percentage points respectively, while the employment share of manufacturing follows a hump shape, increasing 14 percentage points until 1970 and declining by 7.6 percentage points afterwards. The uneven industrialization across provinces can be seen by comparing the increase in manufacturing employment between 1940 and 1970 for q1 provinces (those that lose most population) and q4 provinces (those that gain most population). While for the q1 group this increase is only 7% of its total employment in 1940, it amounts to 44% for the q4 group. The rural exodus is summarized by three statistics: the increase in the standard deviation of employment across provinces of 40 log points, the regression coefficient of log regional employment growth between 1940 and 2000 on initial agricultural share of -2.26 (which corresponds to the slope of Panel (a) in Figure 2), and the R^2 of this regression of 0.53. The hump-shaped evolution of spatial inequality is described by the increase in the standard deviation of regional income of 10 log points until 1960 and the subsequent decline of the same magnitude after that.

5 Results

Given our calibrated model, we first analyze the sources of growth in Spain (Section 5.1); we next study how the development process is shaped by the rural exodus (Section 5.2) and the asymmetry of productivity growth across regions (Section 5.3); and we finally look at the international evidence through the lens of our calibrated model for Spain (Section 5.4).

5.1 Engines of development

Our model economy features three engines of development: the change in the sector and province specific productivities, the change in the matrices of sector specific bilateral trade costs, and the change in the matrix of bilateral migration costs. In addition, even if parameters remain constant for the whole period, the economy experiences some changes over time due to the fact that the initial distribution of employment across provinces is not the steady state one. In this Section we quantify the role of each of these forces in the development experience of Spain between 1940 and 2000, reporting the main outcomes in Table 2.[23]

[23] We proceed as follows. First, we solve for a counterfactual economy in which all parameters stay constant at their 1940 values, such that model dynamics only come from the reallocation of population in the transition towards the steady state (Column 3). Then, we allow for productivity, trade costs, and migration costs to vary over time one by one, and report how allocations change with respect to the economy in which parameters remain constant (Columns 4-6). We also solve for an economy that keeps productivity constant but allow for changes in both trade costs and migration costs, that is, changes in spatial frictions together (Column 7). Finally, the difference between the benchmark economy and the addition of results in Columns (3) to (6) gives us the strength of the interactions,

Table 2: Main results (changes between 1940 and 2000)

	Data	Bench.	Engines of development: Δ Pop.	Δ T_{rj}	Δ $\tau_{r\ell j}$	Δ $mc_{r\ell}$	both	Inter.	Rural exodus: CRS	Non-CRS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GDP pc	5.38	5.30	1.03	4.78	1.14	1.06	1.20	0.89	4.92	4.86
Agr share	-45.4	-45.3	-0.9	-39.4	-6.3	-0.1	-6.8	1.3	-41.9	-42.7
Man share: 40-70	14.0	14.1	-0.2	12.1	-1.8	0.4	-1.4	3.6	8.9	12.7
Man share: 70-00	-7.6	-7.6	-0.0	2.9	2.1	0.1	2.4	-12.6	3.0	1.3
Ser share	39.0	38.8	1.1	24.4	6.0	-0.4	5.9	7.7	30.0	28.8
Man emp q1: 40-70	0.07	0.08	0.04	0.12	-0.01	-0.03	-0.04	-0.04	0.17	0.28
Man emp q4: 40-70	0.44	0.44	0.12	0.19	-0.05	0.06	-0.00	0.12	0.17	0.15
Sd(log emp)	0.459	0.402	0.161	0.055	0.001	0.106	0.11	0.078	-	-
$\hat{\beta}$	-2.07	-2.26	-0.15	-1.03	-0.13	-1.56	-1.55	0.61	-	-
R^2	0.63	0.53	0.01	0.18	0.00	0.42	0.39	-	-	-
Sd(log inc): 40-60	0.027	0.099	0.002	0.137	-0.019	-0.005	-0.024	-0.017	0.111	0.101
Sd(log inc): 60-00	-0.118	-0.110	0.004	-0.130	0.021	-0.016	0.013	0.010	-0.128	-0.127

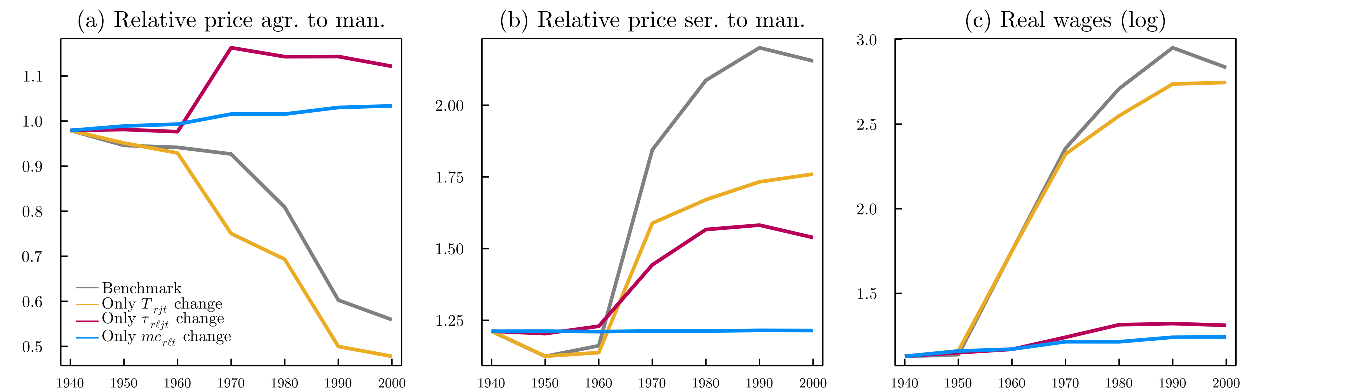
Notes: Each column reports level changes in the corresponding variable between 1940 and 2000, except other time frame indicated in the corresponding row. For GDP pc we report the ratio. "$\hat{\beta}$" and "R^2" are the coefficient and the share of explained variance of a regression of employment growth on initial agriculture share. "Man emp q1: 40-70" is employment change in manufacturing in q1 provinces relative to total employment of those provinces in 1940. Columns (1) and (2) are the data and the benchmark calibrated economy. Column (3) is an economy in which all parameters stay put at their 1940 values. Columns (4)-(6) report the difference between economies in which only one engine (productivity, trade costs or migration costs) changes with respect to Column (3). Column (7) reports the same differences for the case in which both trade and migration costs are allowed to change. Column (8) reports the difference between Column (3) and the sum of Columns (4) to (6). Columns (9) and (10) correspond to economies without migration flows, with constant and non-constant returns to scale respectively.

Population dynamics due to the non-steady state distribution of population across space in 1940 play a minor role in the aggregate, despite generating some spatial reallocation. In particular, keeping all parameters constant, population moves from poorer to richer areas over time, increasing the dispersion of employment across provinces by 16 log points (compared to 40 in the benchmark economy) and with little sectoral bias, as the predictive effect of initial agricultural share on log employment changes is only -0.15 (-2.26 in the benchmark economy). This population movement has negligible effects in terms of aggregate output (a 3% increase overall) and structural change.

Productivity growth is the main engine of development in Spain between 1940 and 2000: it explains most of the growth in GDP (it increases output by a factor of 4.78, 5.3 in the benchmark economy) and most of the reallocation of economic activity across sectors (it produces a decline in the agriculture share of 39.4 percentage points, 45.3 in the benchmark economy, and a rise of services of 24.4 percentage points, 38.8 in the benchmark economy). Despite its asymmetries across regions, observed productivity growth contributes little to the overall reallocation of workers across space, as the standard deviation of employment across provinces only increases by 6 log points (compared to 40 in the benchmark economy). However, this predicted population movement goes in the same direction as in the data: the relationship between employment growth and the initial agricultural share is -1.03 (-2.26 in the calibrated model). Finally, it is worth noting that the divergence of productivity across regions in the period 1940-1960 and the convergence afterwards is

see Column (8).

Figure 8: Forces of structural change



Notes: Relative price of agriculture with respect to manufacturing –Panel (a)–, of services with respect to manufacturing –Panel (b)–, and the real wage –Panel (c)– for our Benchmark economy and counterfactual economies in which only one engine of growth is allowed to change. Each line plots the population-weighted average across provinces.

the main driver of the Kuznets curve of inequality. Indeed, the evolution of productivity generates a sharper inverted-U shape of income inequality over time than the one of the calibrated model: the standard deviation of productivity increases by 13.7 log points until 1960 (10 in the benchmark economy) and declines by 13 log points after that (11 in the benchmark economy).

The change in spatial frictions also plays a relevant role in the Spanish development episode. It adds sizable output growth (20 percentage points) and helps reallocating employment across sectors in the same direction as observed in the data: it produces a decline in agriculture of 6.8 percentage points and a rise of services of 5.9 percentage points. These results are driven by the sectoral asymmetries in the fall of trade costs —which reduce the price of agriculture and manufacturing relative to services, see Panels (a) and (b) in Figure 8— and from the increase in productivity (and hence income) generated by increased specialization, see Panel (c) in Figure 8. The change in spatial frictions explains most of the rural exodus, with a slope of the regression of log employment change on the initial agricultural share of -1.56 (-2.26 in the benchmark) and an increase in the dispersion of employment of 11 log points (40 in the benchmark). These effects come mostly from the decline in migration costs towards the most prosperous regions between 1950 and 1980. Instead, the decline in trade costs has virtually no effects in the reallocation of workers across space. Finally, the change in spatial frictions partly offsets the increase in spatial income inequality generated by productivity growth between 1940 and 1960, as it induces a decline of 2.4 log points in the standard deviation of productivity until 1960.

To finish this decomposition, it is important to note that interactions between productivity growth and changes in spatial frictions are important for several outcomes. Among them, it stands out that the interactions are the sole driver of the de-industrialization of the country after the manufacturing peak in 1970, that is, the interaction between changes in productivity and spatial frictions generates a decline in the employment share of manufacturing of 12.6 percentage points, much larger than the 7.6 decline predicted by the calibrated model. To understand why, we note the following. First, if trade and migrations costs vary over time but productivity stays constant, structural change is very limited as relative prices and income change little. As a consequence, the country is poorer, much more agrarian, and the manufacturing sector never thrives. Second, if productivity and trade costs change but migration costs remain at their 1940 values, industrial provinces are not able to attract enough workers to exploit their comparative advantage. This slows down industrialization, the manufacturing share peaks later in time and thus it does not show a hump before the year 2000. Lastly, if productivity and migration costs change but trade costs remain constant, the relative price of manufacturing with respect to services does not fall enough in the second half of the development process such that employment can shift from manufacturing to services (see Figure 8), which prevents the manufacturing share to decrease.

5.2 The role of a rural exodus

Next, we explore the role of the rural exodus in the development experience of Spain. To do so, we solve for a counterfactual economy in which workers cannot migrate (migration costs tend to infinity) and hence the relative size of provinces remains as in 1940. The main challenge in this exercise is what to assume about the evolution of labor productivity when the economy faces substantially different migration flows. In our first exercise we assume that the sector- and region-specific productivity paths T_{rjt} evolve as in the calibrated economy and hence do not react to population movements. This is a strong assumption, but one that allows to focus on the partial effect of migration flows on development. Second, we allow for agglomeration economies in industry and decreasing returns in agriculture, which results in industrial productivity growing more in areas receiving more population. Our results below show that the main insights for the effects of migration on development are already apparent in the first case, although there are some interesting quantitative differences in the second one.[24]

5.2.1 Exogenous productivity paths

When productivity paths T_{rjt} are independent from population movements, we find that without migrations the initially lagging regions do industrialize, while the initially leading regions specialize much less in manufacturing. In particular, absent migrations, provinces in the q1 and q4 groups would have increased their manufacturing employment between 1940 and 1970 in the same proportion, 17% of their initial population size, while in the benchmark economy this increase is 7%

[24] Migrations may affect labor productivity for other reasons too. First, the allocation of capital across regions and time may depend on the allocation of labor, see for instance Kleinman et al. (2021). In this situation, capital stocks may follow population changes, increasing the labor productivity in regions attracting more migrants. Second, there may be selection of individuals of better skills into migration as in Lagakos and Waugh (2013) such that regions attracting migrants receive more skilled workers (although for the case of Spain we show very little selection on education, see Appendix C). Considering any of these extensions comes at the cost of a more complicated model. The results in this Section show that most of the interesting action already happens with productivity paths that are invariant to population movements.

Table 3: Different speeds of productivity convergence (changes between 1940 and 2000)

	Data (1)	Benchmark (2)	Man conv (3)	Man, Ser conv (4)	Initial $mc_{r\ell}$ (5)	Man, Ser conv. and initial $mc_{r\ell}$ (6)
GDP pc	5.38	5.30	4.80	4.63	5.24	4.66
Agr share	-45.4	-45.3	-42.1	-42.2	-41.6	-42.2
Man share: 40-70	14.0	14.1	6.0	11.0	8.6	11.2
Man share: 70-00	-7.6	-7.6	3.7	0.4	3.2	0.6
Man emp q1: 40-70	0.07	0.08	0.04	0.18	0.10	0.23
Man emp q4: 40-70	0.44	0.44	0.28	0.24	0.26	0.17
Ser share	39.0	38.8	32.4	30.8	29.8	30.4
Sd(log emp)	0.459	0.402	0.241	0.222	0.190	0.134
$\hat{\beta}_{(\log \Delta \text{emp, Agr sh}_{40})}$	-2.07	-2.26	-1.51	-1.20	-0.82	0.44
R^2	0.63	0.53	0.44	0.32	0.17	0.05
Sd(log inc): 40-60	0.027	0.099	0.037	-0.026	0.106	-0.024
Sd(log inc): 60-00	-0.118	-0.110	-0.148	-0.138	-0.129	-0.136

Notes: Columns (1) and (2) correspond to the data and the calibrated economy respectively. Columns (3) and (4) show the outcomes of economies in which productivity converges across regions since 1940 in the manufacturing sector and in manufacturing and services respectively. Column (5) is the result of an economy with migration costs fixed at their 1940 values. Column (6) represents an economy with constant migration costs and productivity convergence in manufacturing and services. See footnote in Table 2 for details on the outcomes shown here.

and 44% respectively (Figures G.6 and G.7 in Appendix G provide a few province by province examples). Therefore, we can conclude that the evolution of productivities and trade costs in the Spanish development episode was conductive to industrialization in the initially rural areas, but migration prevented this from happening. The rural exodus is behind the uneven industrialization of Spanish regions. We discussed the economic mechanisms in Section 3.4. First, manufactures in initially laggard areas were not very competitive and hence depended very much on local demand, which the rural exodus depressed. Second, migration flows limited the wage gap between leading and laggard regions, which made the manufactures of leading regions much more competitive country-wide, eventually taking most of the market.

In the aggregate, the rural exodus helped increase the speed of structural change and overall growth, see Column (9) in Table 2. In particular, GDP per capita increases 38 percentage points more in the calibrated economy than in the no migration counterfactual, agriculture employment declines 3.4 percentage points more, and manufacturing and services employment increase 5.4 and 8.8 percentage points more respectively. It is interesting to note how the hump-shaped evolution of manufacturing would have disappeared without migrations. Despite lagging areas generating manufacturing employment in the first half of the development process, this would not have compensated for the number of jobs that the industrial regions create in the benchmark economy, and consequently the overall industrialization until 1970 would have been lower (8.9 percentage points increase in manufacturing between 1940 and 1970 *vs.* 14.1 in the benchmark economy). After 1970 the relative size of the industrial sector keeps growing in this counterfactual exercise, instead of falling as in the benchmark economy. Consistent with the interaction results in Section 5.1, this shows how the migration flows were needed to reinforce the comparative advantage of regions in order to create the de-industrialization process. Finally, we find that without migrations spatial inequality would have increased more during the first half of the development process, because absent migrations there are no changes in regional labor supply that help arbitrage away differences across provincial wages.

5.2.2 Non-constant returns to scale

In this Section we allow for non-constant returns to scale in sectoral production functions. Our quantitative model can easily accommodate this exercise. In particular, we can redefine the scale parameter T_{rjt} in the distribution of productivities as $T_{rjt} \equiv \widetilde{T}_{rjt} L_{rj}^{\theta_j \alpha_j}$, where $\widetilde{T}_{rjt}$ reflects the exogenous component of productivity and $L_{rjt}^{\theta_j \alpha_j}$ reflects departures from constant returns to scale whenever $\alpha_j \neq 0$. Then, the average sectoral output Y_{rjt} can be written as $Y_{rjt} = B_{rjt} L_{rjt}^{1+\alpha_j}$. With an estimate of α_j for each sector, the estimated productivity paths T_{rjt} from Section 4.3, and the observed allocation of workers L_{rjt}, we can recover the time paths $\widetilde{T}_{rjt}$ that are invariant to population changes. This allows to separate productivity T_{rjt} between a "fundamental" exogenous component $\widetilde{T}_{rjt}$ and a component that varies with L_{rjt} in counterfactual exercises.

Estimating values for α_j is notoriously difficult as good instruments are needed to isolate exogenous variation in population. Lacking such instruments, we take some values from outside sources. In the macro-development literature it is quite standard to set $\alpha_a = -0.3$ in agriculture, reflecting decreasing returns to scale due to the fixed land factor (see for instance Gollin et al. (2007) or Restuccia et al. (2008), who use themselves estimates from Hayami and Ruttan (1985)). For manufacturing, we resort to the recent paper by Bartelme et al. (2021), that estimates agglomeration economies for several manufacturing industries by use of sectoral data on international trade, production, and employment. They find an average agglomeration parameter within manufacturing equal to $\alpha_m = 0.17$. Finally, for lack of a better alternative, we leave $\alpha_s = 0$ in services. In Appendix E.3 we discuss the difference between the calibrated productivity paths T_{rjt} and the ones inferred with non-constant returns to scale production functions, $\widetilde{T}_{rjt}$.

Next, we revisit our counterfactual exercise of no migration with non-constant returns to scale production functions, see Column (10) in Table 2. Overall, we find that the qualitative effects are the same and that the quantitative results get reinforced. The initially laggard (industrial) regions experience a stronger (weaker) industrialization when there is no migration compared to the CRS case because the increase (decrease) in manufacturing employment in these provinces improves (worsens) their manufacturing comparative advantage. Indeed, with agglomeration economies and no migration q1 provinces experience a stronger industrialization process than q4 provinces, as the manufacturing employment increase between 1940 and 1970 equals 28% and 15% of initial employment respectively. This can be seen by comparing Figure G.8 (G.9) in Appendix G for the case with agglomeration with Figure G.6 (G.7) for the case with CRS. In terms of aggregates, we see that with agglomeration economies the rural exodus becomes a slightly larger contributor to overall growth, with a 44 percentage points increase in GDP per capita (38 in the benchmark case).

5.3 Alternative productivity paths: early convergence

Labor productivity in manufacturing and services diverged across provinces during the first two decades of the Spanish development episode, and only started to converge after 1960 (see Panel (b) in Figure 5). This pattern increased the gap between leading and lagging regions at the start of the developing process, generating the inverted-U shaped profile of inequality across provinces documented in Panel (a) in Figure 5. Our calibrated economy recovers productivity paths T_{rjt} generating a similar pattern of regional inequality, see Panel (d) in Figure 6. In this Section, we want to quantify the role played by the initial divergence of sectoral productivities across provinces in the development process of Spain. To do so, we generate counterfactual sector-specific productivity paths T'_{rjt} for manufacturing and services in each Spanish province such that sectoral productivities start converging in 1940 —at the same rate as aggregate productivities converged between 1970 and 2000— while aggregate sectoral productivity grows as in the data, see Appendix E.4 for details. We leave the evolution of productivity in the agriculture sector as in the calibrated economy.

We start by considering convergence only in manufacturing productivity —while letting service and agriculture productivities evolve as in the calibrated economy— and report the main results in Column (3) of Table 3. The convergence in manufacturing productivity is able to substantially diminish the divergence in real income per capita across provinces until 1960 (the standard deviation of income per capita increases by 3.7 log points, 10 log points in the benchmark) but not to generate convergence in real income per capita, as the manufacturing sector does not represent a large share of the economy. Indeed, with the convergence in manufacturing productivities employment in manufacturing grows less than in the benchmark economy, both in the aggregate (the share of employment in manufacturing increases by 6 percentage points between 1940 and 1970, 14.1 percentage points in the benchmark economy) and in the leading provinces (the increase in manufacturing employment between 1940 and 1970 represents 28% of total employment in q4 provinces, 44% in the benchmark). Part of this is due to the fact that as income per capita diverges less across provinces there is a smaller rural exodus: the dispersion of population across provinces grows less (24 log points, 40 log points in the benchmark) and the effect of initial share of agriculture on employment changes is smaller (the slope of the relationship is -1.51 and the R^2 0.44, -2.26 and 0.53 respectively in the benchmark). Overall, convergence in manufacturing productivities across provinces means that industrial leaders do not increase their manufacturing productivity further, industrial production fails to concentrate in the most productive areas, the country industrializes at a much lower pace, and GDP per capita grows 50 percentage points less.

When we allow convergence in both manufacturing and service productivity these results are amplified. First, real income per capita does converge across provinces until 1960 (the standard deviation of income per capita declines by 2.6 log points). This further diminishes the incentives to outmigrate from the initially rural areas, producing an even smaller increase in dispersion of population across provinces (22 log points) and a smaller correlation between initial agriculture shares and employment growth (the slope of the relationship is -1.2 and the R^2 0.32). The reduced population movements help reduce the asymmetry in the industrialization patterns across provinces. The increase in manufacturing employment in q1 provinces represents 18% of their initial population (only 4% if convergence is limited to manufacturing productivities), compared to 24% (28% if only manufacturing converges) in q4 provinces.

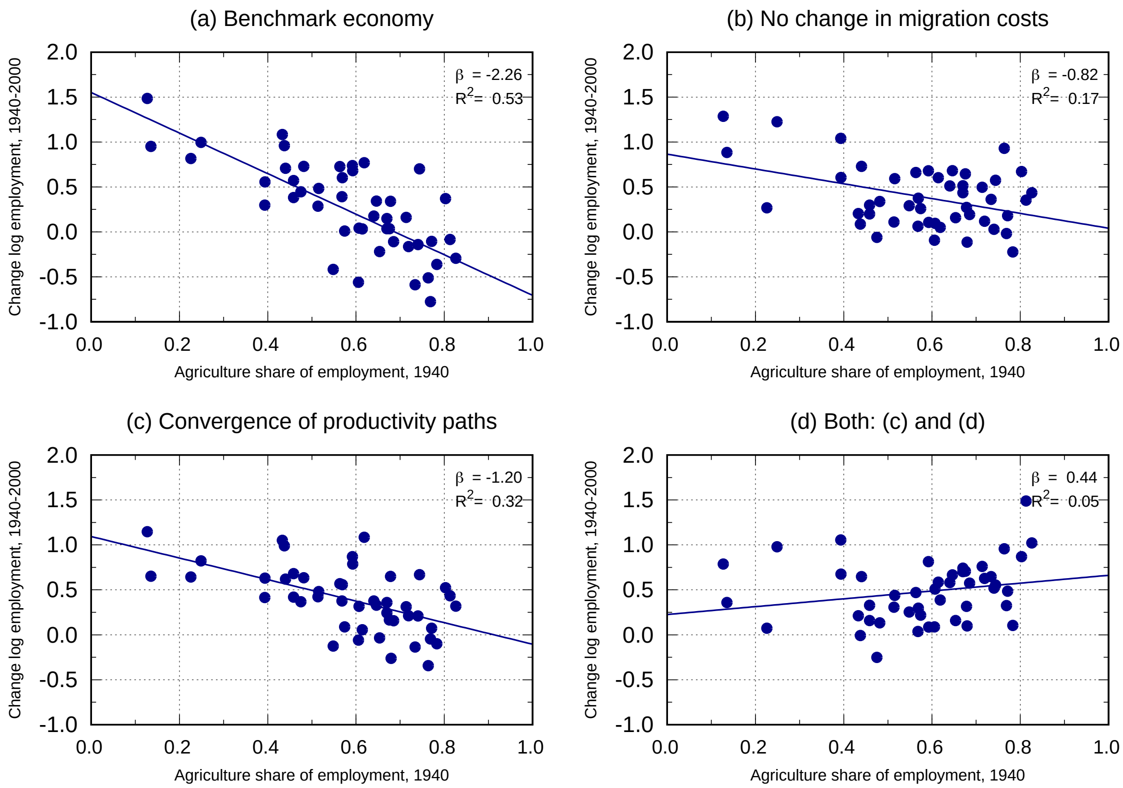
5.4 Back to cross-country evidence

Finally, we revisit the cross-country heterogeneity in development experiences documented in Figure 3 and ask which features of the development process in Spain may help explain it.

The experiments in Section 5.1 show that the decline in the migration costs towards the most prosperous regions explains part of the rural exodus. To put this more clearly, in Figure 9 we plot the regional employment growth against the initial share of agricultural employment in the benchmark economy (Panel a) and in an otherwise-identical economy where migration costs remain constant at their 1940 value (Panel b). The relationship between employment growth and agriculture share becomes weaker, with the slope falling from -2.26 to -0.82 and the R^2 from 0.53 to 0.17. This pattern of migrations resembles more the "intermediate cases" of India (1987-2015) or Brazil (1980-2010) in Figure 3 than the sharp rural exodus of Spain (1940-2000), France (1872-1975), or China (2000-2015). The result for Spain is consistent with the findings of Hao et al. (2020) showing that the reform of the *hukou* system in China was an important driver of the Chinese rural exodus between 2000 and 2015. On the aggregate, we find that the weaker rural exodus does not affect the structural transformation away from agriculture but it does slow down the transition from manufacturing to services (the increase in the share of service employment is 29.8 percentage points, 38.8 in the calibrated economy). This is due to the difficulty of concentrating employment in the leading industrial hubs. In particular, the increase in industrial employment represent 24 and 18 percent of initial employment in the q4 and q1 provinces respectively instead of 44 and 8 percent in the calibrated economy. That is, the economy with constant migration costs displays a more even industrialization across provinces. Overall, GDP grows 6 percentage points less.

The experiments in Section 5.3 show that early cross-region divergence of labor productivity in manufacturing and services also help explain part of the rural exodus. In Panel (c) of Figure 9 we plot the migration pattern of the experiment in which manufacturing and services productivities start converging in 1940. As shown in Section 5.3, the relationship between employment growth and agriculture share becomes weaker than in the benchmark economy, with the slope falling from -2.26 to -1.20, the R^2 falling from 0.53 to 0.32, and the increase in population dispersion across provinces being halved. As with the experiment with constant migration costs, the pattern of migrations in this counterfactual economy resembles more the "intermediate cases" of India or Brazil than the Spanish, French, or Chinese ones. Eckert and Peters (2022) argue that early convergence of productivities across counties explains the lack of rural exodus and homogenous

Figure 9: Employment growth and initial sectoral composition: counterfactual economies



Notes: This figure plots the relative increase in employment between 1940 and 2000 (in logs) for all provinces, against the 1940 agriculture share of employment for different model economies. Panel (a): the calibrated economy; Panel (b): an economy with migration costs constant to their 1940 values; Panel (c): an economy where sectoral productivities start converging across regions since 1940; Panel (d): an economy with both migration costs constant to their 1940 values and sectoral productivities converging across regions since 1940. Each panel also reports the slope of the relationship (β) and the share of variance in log employment growth explained by the corresponding x-axis variables (R^2).

industrialization in the US. Our results here show that early convergence of sectoral productivities may have reduced the rural exodus in Spain —as well as made the patterns of industrialization less uneven across locations— but not to the point of the US case.

Finally, we combine both experiments and solve for an economy with constant migration costs and convergence in sectoral productivity across provinces since 1940. With both changes at the same time, the rural exodus disappears: the dispersion in population across provinces increases by only 13 log points (compared to 40 log points in the benchmark) and the R^2 of the relationship of employment changes with initial sectoral composition is virtually zero, see Panel (d) of Figure 9. Furthermore, the heterogeneity in the industrialization process across provinces disappears, with industrial employment increasing by 0.23 and 0.17 in q1 and q4 regions as opposed to 0.08 and 0.44 in the benchmark economy, see Column (6) in Table 3. At the aggregate level, the absence of a rural exodus and the loss of high productivity regions results in a slower structural change (the share of employment in services increases by 8.4 percentage points less) and slower output growth (with GDP per capita growing 64 percentage points less).

Therefore, we conclude that both the decline in migration costs towards more prosperous regions and the divergence of productivities across regions help generate a sharp rural exodus, an uneven pattern of industrialization across provinces, and faster aggregate structural change and growth. Absent both ingredients –and its concurrence– the Spanish experience would have resembled more the cases of US or Indonesia. Absent any one of them, the Spanish experience would have resembled more the cases of India or Brazil.

6 Conclusions

As countries develop, their regions industrialize at an uneven pace. We have shown how migrations from laggard to leading regions help explain the lack of industrialization of the former and the fast path of industrialization of the latter. More generally, we have shown how these migrations contribute to the overall process of growth and macroeconomic development of a country.

We have started by looking at the development experience of Spain between 1940 and 2000, characterized by fast growth in income per capita, a large structural transformation, and mass migration from rural areas, which failed to industrialize, to early industrial hubs. Our simple model of structural change with multiple locations and sectors shows that the large rural exodus in Spain was originated by both a decline in the migration costs towards the most prosperous regions during the 1950's, 1960's, and 1970's and a divergence of sectoral productivities across regions during these same decades. The rural exodus completely explains the lack of industrialization in laggard areas, which shows how population movements can be a relevant force of local structural change. Additionally, we find that the de-industrialization of the country in the second half of the development process is the result of interactions between productivity growth and the fall in trade and migration costs.

We think of our paper as a first step towards understanding the role of the heterogeneous incidence of spatial frictions on economic development and structural change across countries. In this sense, this research agenda can help shed light on the heterogeneous paths of development documented by Rodrik (2016) and Huneeus and Rogerson (2020), among others. Our results focus on how population movements change local wages and prices, which in turn change the patterns of comparative advantage across regions. A limitation is that we take the estimated time paths of productivity, migration costs, and trade costs as exogenous. Further research can explore how to endogeneize them, which would affect the counterfactual analyses. We took a first step in this direction by exploring how the time paths of sector-region productivity vary with employment due to agglomeration economies in manufacturing or decreasing returns to scale in agriculture. While qualitative results do not change, the quantitative effects of a rural exodus on the local development experience of regions are amplified. Future research could endogeneize the joint evolution of migration costs and regional productivities, which is a promising explanation for the cross-country differences in development patterns.

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Appendix A: Data

A.1 Data sources

Our analysis combines data from different sources, which we detail in the following paragraphs.

Employment. Data on regional employment for each sector between 1940 and 2000 comes from the Spanish Population Census, conducted every ten years by the National Statistics Office (*Instituto Nacional de Estadística*). We aggregate employment in agriculture, hunting, forestry and fishing and classify it as agriculture; employment in manufacturing, mining, construction and utilities and classify it as manufacturing; and employment in trade, transport, business, government and personal services and classify it as services.[25] In Figure 1 Panels (a) and (b) we use historical data from Prados de la Escosura (2017), which can be accessed here.

Migration flows. Information on bilateral migration flows is retrieved as well from the Census, which reports, for each province, the number of people that lived in a different province in the previous census wave, separating this number by migrants' region of origin since 1960 (i.e. we know, for instance, the number of people living in Barcelona in 1970 who were living in València in 1960, and the same for every pair of provinces). The procedure we follow to go from observed bilateral migration flows to our model-consistent bilateral migration flows is discussed in detail in Section A.2 of the Appendix.

Value added and prices. Data on regional value added and price indices by sector are obtained from the regional accounts prepared by the research department of BBVA.[26] To get a time series of regional price levels, we combine the regional price indices, which tell us how prices changed over time for each province and sector, with a cross-section of regional price levels for 1930. The latter is obtained from micro data on the prices of a common basket of goods across Spanish provinces, and were gathered by the *Instituto de Reformas Sociales*, a government institution in charge of assessing the material living conditions of the labor force at the time. We direct the interested reader to Gómez-Tello et al. (2019), to whom we are thankful for kindly sharing the data with us.

Trade flows. We have some data on bilateral trade flows for agriculture and manufacturing for the year 2000. This data comes from the C-Intreg database.[27] C-Intreg is a micro-database of shipments of goods by roads and railways across Spanish provinces. Despite we do not have access

[25] For most years, we obtain the data at four-sector level (agriculture, manufacturing, construction, and services) directly from INE, which follows the aggregation criteria outlined above.

[26] Starting in 1957, the research department of BBVA published, every two years, a volume with the main economic aggregates of Spanish regions. In 2003, they released a volume with revised information and longer time coverage, with information dating back to 1930, which can be downloaded here.

[27] See the website of the project here.

to the micro data, we obtained bilateral province trade flows in million euros, which we use to compute the $\pi_{r\ell j}$ in the year 2000 that is used in the calibration. The interested reader should consult Llano et al. (2010) for details on the construction of the data set. We thank Carlos Llano for providing the data to us.

A.2 From data on migration flows to model counterparts

Our data on inter-regional migration flows $\hat{\rho}_{\ell rt}$ spans 1960 to 2000. We make two corrections to these data.

The first one comes from the fact that the observed migration flows $\hat{\rho}_{\ell rt}$ do not perfectly square with the data on employment, that is, L_{rt} is not exactly equal to $(1+n_t)\sum_{\ell}^{R}\hat{\rho}_{\ell r}L_{\ell t-1}$.[28] To find the migration flows $\rho_{\ell rt}$ that are consistent with the data on employment, we simply minimize the Euclidean distance with respect to the observed $\hat{\rho}_{\ell rt}$ subject to the law of motion of employment being satisfied. In other words, we search for the most similar matrix to the observed matrix of bilateral migration flows that replicates the observed changes in the distribution of labor across regions. We further impose the constraints that the entries in $\rho_{\ell rt}$ are non-negative and that the elements in each row add up to 1. Then, the problem we solve is:

$$\begin{aligned}
\min_{\rho_{\ell rt}\,\forall r,\ell} \quad & \sqrt{\sum_{r=1}^{R}\sum_{\ell=1}^{R}(\rho_{\ell rt}-\hat{\rho}_{\ell rt})^2} \\
\text{s.t.} \quad & L_{rt} = (1+n_t)\sum_{r=1}^{R}\rho_{\ell rt}L_{\ell t-1} \quad \forall r, \\
& \sum_{r=1}^{R}\rho_{\ell rt} = 1 \quad \forall \ell, \\
& \rho_{\ell rt} \geq 0 \quad \forall \ell, r.
\end{aligned} \tag{A.1}$$

The second correction comes from the fact that data on bilateral migration flows $\hat{\rho}_{\ell rt}$ is only available from 1960 onward, as in previous Census waves there is no question regarding workers' region of previous residence. Therefore, we cannot retrieve $\rho_{\ell rt}$ for 1950 and 1940 by solving (A.1). Instead, we look for $\rho_{\ell r1950}$ that minimize the Euclidean distance with $\rho_{\ell r1960}$ (which is based on observed migration flows), and similarly for $\rho_{\ell r1940}$ with $\rho_{\ell r1950}$ as target; with constraints as in (A.1). Additionally, we refine our strategy using data on net migration in each region for both 1950 and 1940, such that $\rho_{\ell r1950}$ and $\rho_{\ell r1940}$ are consistent with the volume of internal migration

[28] This is for two reasons. First, there may be possible measurement error in either the migration flows or the employment stocks. Second, regional employment growth in the model only depends on net internal migration and aggregate population growth. However, in the data it also depends on additional factors as for instance regional differences in the unemployment rate, in the fertility and mortality rates, or in the incidence of international migrations. Foreign immigration is Spain started in the 00's, which does not affect our period of study. However, a significant number of workers in rural areas migrated abroad between 1960 and 1973 (mostly to Germany, France, and Switzerland). The exact numbers are unclear, see Bover and Velilla (2005) for details.

in Spain in 1940 and 1950.[29] Specifically, we solve the following problem for $t = 1950$ and $t = 1940$

$$
\begin{aligned}
\min_{\rho_{\ell rt}\,\forall r,\ell} \quad & \sqrt{\sum_{r=1}^{R}\sum_{\ell=1}^{R}(\rho_{\ell rt} - \hat{\rho}_{\ell rt+1})^2} & & \\
\text{s.t.} \quad & L_{rt} = (1+n_t)\sum_{r=1}^{R}\rho_{\ell rt}L_{\ell t-1} & & \forall r, \\
& \sum_{r=1}^{R}\rho_{\ell rt} = 1 & & \forall \ell, \\
& \rho_{\ell rt} \geq 0 & & \forall \ell, r, \\
& NM_{rt} = \sum_{\ell=1,\ell\neq r}^{R}\rho_{\ell rt}L_{\ell t-1} - (1-\rho_{rr})L_{rt-1} & & \forall r\,.
\end{aligned}
\tag{A.2}
$$

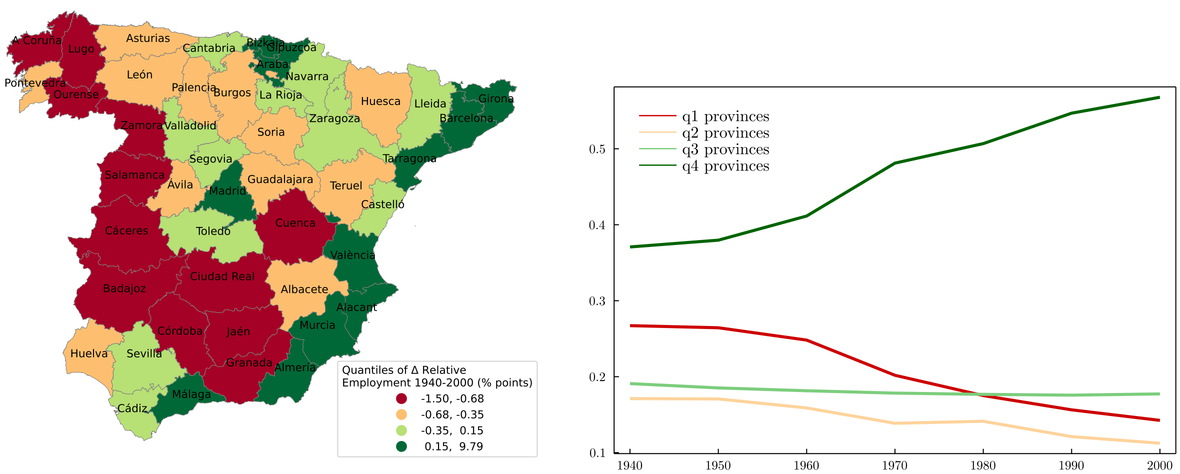
where NM_{rt} is the net migration in each region in period t.

[29] Net migration is defined as the difference between total immigrants inflows and outflows. The data comes from the Census and is retrieved as a residual, given that for 1940 and 1950 we have information on births, deaths and population stocks for each province.

Appendix B: Regional employment growth in Spain, 1940-2000

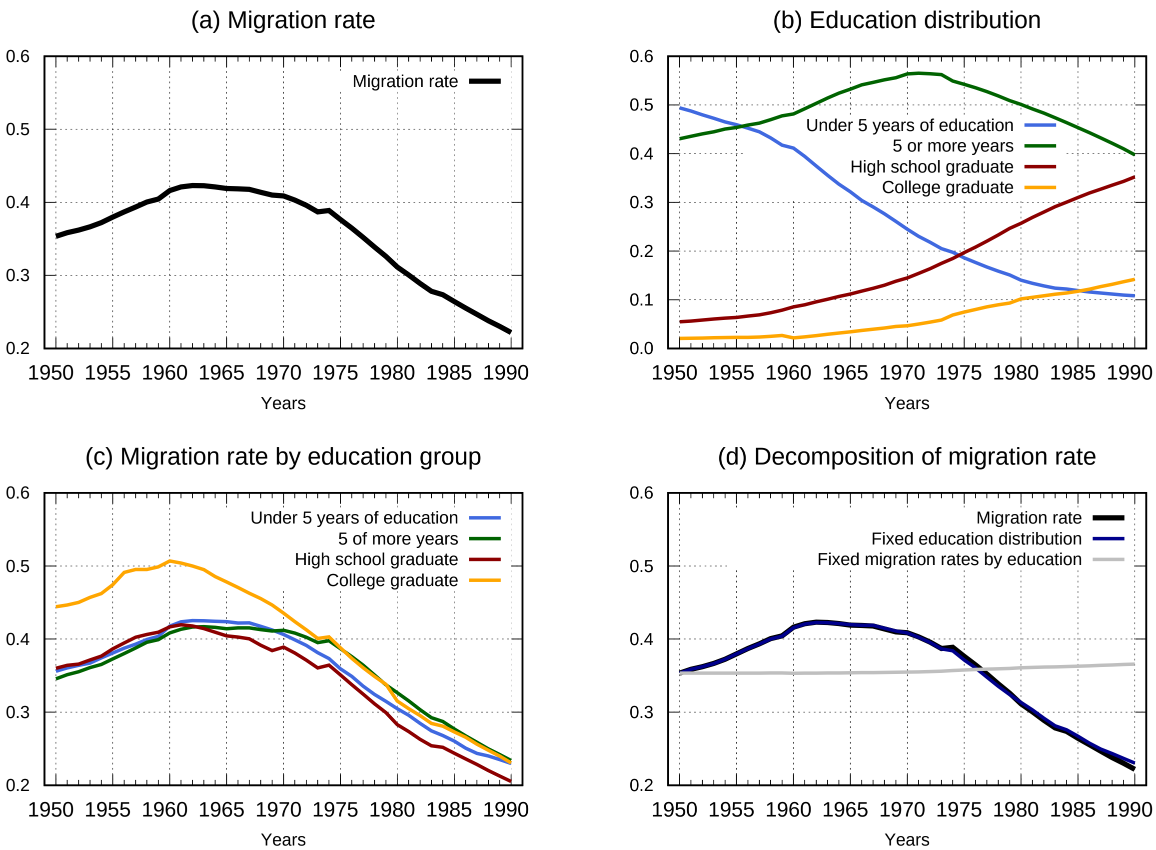
Throughout the paper we stress the heterogeneity in employment growth across provinces and how this relates to the sectoral composition of regional employment in 1940 (Figure 2). For many statistics, we classify provinces in four quartiles based on the change in their relative size within the country (measured as the province share of total employment) over the period 1940-2000. The provinces corresponding to each group are shown in the left panel of Figure B.1. The share of total employment represented by each group over time is shown in the right panel of Figure B.1.

Figure B.1: Regional employment growth 1940-2000



Notes: provinces in red are part of the first quartile of relative employment growth (q1), in yellow of the second quartile (q2), in light green of the third quartile (q3), and in dark green of the fourth quartile (q4).

Figure C.1: Migration and education, 1950-1979



Notes: Panels (a), (c), and (d) plot the fraction of people aged 18-25 year old in the given year that were observed as living in a province different from their birth province in some of the subsequent censuses (when they were aged between 26 and 56 years of age). Panel (b) plots the fraction of 18-25 year old in the given year that hold each education level, also according to the subsequent censuses.

Appendix C: Education changes and migrations in Spain

In this Appendix we document the small role played by changes in education on the rural exodus in Spain. To do so, we use micro-data for the censuses of 1981, 1991, 2001, and 2011 (the only available ones).[30] From each census we select individuals that were aged 18 to 25 years old for each year between 1950 and 1979. We only use individuals that are observed in the census with ages between 26 and 56.[31] We classify these individuals as migrants if, when observed in the census, they reside in a different province from birth (and as non-migrants otherwise). The assumption is that most migrants moved in the age range 18 to 25 and hence the comparison of the two groups reveals differences between migrants and non-migrants. We collect education data in four categories: less

[30]The microdata comes from the IPUMS International Census Database. All cases corresponds to 5% samples of the census, with the exception of 2011 that is a 10% sample.

[31]We do not use older individuals to limit biases due to differential mortality across education or migration groups, and also to minimize the incidence of return migrations, which in Spain is typically linked to retirement.

than five years of education (50% of 18-25 year olds in 1950), 5 or more years of education but no high school degree (43%), high school or vocational school degree (5%), and college degree (2%).

In Panel (a) of Figure C.1 we plot the migration rate for 18-25 year old individuals between 1950 and 1979. We see how the migration rate increases until the early 1960's and declines afterwards. In Panel (b) we observe a clear educational transition over the period. The share of 18-25 year old individuals with less than 5 years of schooling falls steadily, the share of 18-25 year old individuals with 5 or more years but no high school degree increases first and declines later, and the shares of high school graduates and college graduates increase. Additionally, we note that the share of 18-25 year old college educated individuals is still very small in 1980, around 10% of the population in that age group. In Panel (c) we see that over this period migration rates were only partially linked to education: while the migration rate of college graduates is substantially larger than for the other education groups, there is no clear education gradient of migration among the non college educated (the vast majority of young population). In particular, individuals with less than 5 years of schooling migrated at least as much (if not more than) more educated individuals without college. As a result, the educational transition did not produce mechanically a large change in migration rates. In Panel (d) we decompose the migration rate for the 18-25 year old individuals by isolating changes coming from changes in education while keeping migration rates by education constant, and changes in migration rate by education while keeping the education distribution constant. We see that if we keep the migration rates by education at their 1950 level and only let the distribution of education change over time, there is no increase in migration over the period. Rather, the change in migration comes from the change in migration within education groups.

Appendix D: International evidence on rural exodus

We use census data from several countries to explore the relationship between regional employment growth and the initial sectoral composition of regions. Our main data set is the IPUMS International Census Database. We complement these data with our own data for Spain, data from Hao et al. (2020) for China, data from García-Peñalosa and Bignon (2022) and Franck and Galor (2021) for France, data from Fan et al. (2021) for India, and data from Eckert and Peters (2022) for the US. We want to focus on development episodes, so we restrict the sample to countries such that (i) the time span between the first and the last year observed is larger than 10 years, (ii) the initial share of employment agriculture is at least 25% and (iii) the fall in the country-level agricultural share in the period considered is larger than 10 percentage points. This gives us 27 development episodes. Then, for every country we run the regression,

$$\Delta \log L_r = \alpha + \beta \frac{L_{ra}}{L_r} + \varepsilon_r$$

where L_{ra}/L_r is the share of region r employment in sector a in the first year of the development episode and $\Delta \log L_r$ is total employment growth in region r between the first and last year of observation.

Table D.1 reports the results. For most countries $\beta < 0$, which means that more agrarian regions tend to lose population in relation to the rest (the only exceptions being Haiti, 1982-2003, and Honduras, 1961-2001). However both the magnitudes of β and the R^2 vary substantially across countries. The magnitude of β is largest for Spain (1940-2000), with a value of -2.07, which means that a province with 10 percentage points higher share of employment in agriculture in 1940 experiences a 20% smaller population growth between 1940 and 2000. Remarkably for the case of Spain, 63% of the variance in employment growth across provinces is related to the initial share of employment in agriculture. Other development episodes where the initial share of agriculture across locations is strongly related to employment growth are France (1872-1975), Greece (1971-2011), Bangladesh (1991-2011), Senegal (1988-2013), and China (2000-2015), with slopes equal to -1.82, -1.43, -1.36, -1.27, and -0.83, and R^2 equal to 34%, 45%, 44%, 60%, and 44% respectively. Some intermediate cases are India (1987-2011), Brazil (1980-2010), and Turkey (1985-2000) with slopes equal to -1.00, -0.72, and -0.58, and R^2 equal to 21%, 18%, and 22% respectively. In contrast, in some salient development episodes like the US (1880-1940), Indonesia (1971-2010), Dominican Republic (1960-2010), or Costa Rica (1963-2011) migration flows are scarcely related to initial sectoral composition. For instance, the slope for these four countries is -0.45, -0.49, -0.91, and -0.70 respectively but the R^2 of the regression is only 2%, 6%, 3%, and 9% respectively.

Table D.1: Rural exodus across development episodes

Country (1)	Period (2)	Ini Agr Sh (3)	Δ Agr Sh (4)	N (5)	$\hat{\beta}$ (6)	R^2 (7)
Bangladesh	1991-2011	69.8	25.1	64	-1.36^{***}	0.44
Benin	1979-2013	59.4	16.8	77	-0.05	0.00
Bolivia	1976-2012	45.3	18.8	80	-0.83^{***}	0.15
Brazil	1980-2010	29.1	15.1	2040	-0.72^{***}	0.18
Cambodia	1998-2013	76.5	13.9	141	-0.40^{***}	0.05
China	2000-2015	52.9	24.6	30	-0.83^{***}	0.44
Costa Rica	1963-2011	48.1	35.1	55	-0.70^{*}	0.09
Dominican Rep.	1960-2010	62.1	52.8	65	-0.91	0.03
Ecuador	1962-2010	58.1	36.4	77	-1.74^{***}	0.21
El Salvador	1992-2007	35.0	18.5	103	-0.54^{***}	0.20
France	1872-1975	57.6	47.7	85	-1.82^{***}	0.34
Greece	1971-2011	38.7	30.1	156	-1.43^{***}	0.45
Guatemala	1964-2002	65.0	25.8	191	-1.27^{***}	0.14
Haiti	1982-2003	33.7	14.0	19	0.84^{**}	0.20
Honduras	1961-2001	66.2	24.6	96	1.20	0.05
India	1987-2011	63.9	16.9	368	-1.00^{***}	0.21
Indonesia	1971-2010	64.6	26.4	268	-0.49^{***}	0.06
Malaysia	1970-2000	52.5	37.3	101	-0.72^{***}	0.12
Mali	1987-2009	81.0	13.8	47	-0.40	0.08
Mexico	1970-2015	40.6	30.4	2321	-1.17^{***}	0.11
Nicaragua	1971-2005	48.1	14.4	68	-0.26	0.01
Panama	1960-2010	46.3	34.5	35	-1.14^{*}	0.11
Paraguay	1962-2002	54.1	28.1	60	-1.00^{**}	0.05
Senegal	1988-2013	61.5	35.2	27	-1.27^{***}	0.60
Spain	1940-2001	51.9	45.4	47	-2.07^{***}	0.63
Turkey	1985-2000	55.8	12.3	114	-0.58^{***}	0.22
United States	1880-1940	51.2	33.3	506	-0.45^{***}	0.02

Notes: this table shows the relationship between the initial agricultural share of regional employment and subsequent regional employment growth for a group of selected countries. Selected countries meet the following criteria: (i) the time span between the first and the last year observed is larger than 10 years, (ii) the initial share of employment agriculture is at least 25% and (iii) the fall in the country-level agricultural share in the period considered is larger than 10 percentage points. For all countries except China, France, India, Spain and the US (see main text) data comes from IPUMS International Census Database. Regional-level employment is constructed by aggregating microdata on employed individuals between ages 20 and 59. The coefficient $\hat{\beta}$ reported in Column (6) is the point estimate of a regression of log employment growth at the regional level on the initial agricultural share of regional employment.

Appendix E: Details

E.1 Analytic results

Productivity. In Section 3.3 we have seen that the aggregate productivity in region r to produce sector j goods, B_{rjt}, is equal to,

$$B_{rjt} = \frac{w_{rt}}{P_{rjt}}$$

We can define a measure of average regional productivity as follows,

$$B_{rt} \equiv \left[\sum_j \omega_{rj} B_{rjt}^{\nu-1} \right]^{\frac{1}{\nu-1}}$$

Then, substituting equation (16) into the definition of aggregate price in equation (4) we get,

$$B_{rt} = \frac{w_{rt}}{P_{rt}}$$

which says that real wages are equal to average regional productivity. Finally, note that using equation (8) for sectoral prices and substituting in equation (9) we can write prices as,

$$P_{rjt} = \gamma_j w_{rt} \left(\frac{T_{rjt}}{\pi_{rrjt}} \right)^{-1/\theta_j}$$

Hence,

$$B_{rjt} = \gamma_j^{-1} \left(\frac{T_{rjt}}{\pi_{rrjt}} \right)^{1/\theta_j}$$

which says that real wages depend on the sectoral productivities T_{rjt} and on the amount of intra-sectoral trade π_{rrjt}.

Intersectoral and intrasectoral trade. The goods market clearing condition, equation (10), can be rewritten as

$$P_{rj} Y_{rj} - \pi_{rrj} P_{rj} C_{rj} = \sum_{\ell \neq r}^{R} \pi_{r\ell j} P_{\ell j} C_{\ell j} \quad \forall r, j \tag{E.1}$$

giving us the gross exports of sector-j goods by region r. Note that the gross imports of sector-j goods by region r is given by $(1 - \pi_{rrj}) P_{rj} C_{rj}$ (the fraction of sector-j expenditure sourced from other regions). We can define intrasectoral trade as the sum of sectoral gross imports or exports across regions: $\sum_r (1 - \pi_{rrj}) P_{rj} C_{rj}$ or $\sum_r [P_{rj} Y_{rj} - \pi_{rrj} P_{rj} C_{rj}]$, which are equal to each other because there is no international trade ($\sum_r P_{rj} C_{rj} = \sum_r P_{rj} Y_{rj}$). Then, net exports of sector-j goods by region r is given by the difference of gross exports and gross imports of that sector,

$$NX_{rj} = \left[P_{rj}Y_{rj} - \pi_{rrj}P_{rj}C_{rj}\right] - \left[(1-\pi_{rrj})\,P_{rj}C_{rj}\right] = P_{rj}Y_{rj} - P_{rj}C_{rj}$$

which equals the difference between production and expenditure in that region-sector. We define intersectoral trade as the sum across regions of the positive sectoral net exports, which equals the sum of positive sectoral net imports because there is no international trade ($\sum_r P_{rj}C_{rj} = \sum_r P_{rj}Y_{rj}$). In particular, this would be $\sum_r \frac{1}{2}\left|P_{rj}Y_{rj} - P_{rj}C_{rj}\right|$

Trade balance equation. To derive the equilibrium condition (12), note that the budget constraint of the households in equation (2) can be aggregated at the region level as

$$\sum_j P_{rj}C_{rj} = \sum_j w_r L_{rj} = \sum_j P_{rj}Y_{rj} \Rightarrow \sum_j \left[P_{rj}Y_{rj} - P_{rj}C_{rj}\right] = 0 \tag{E.2}$$

which says that sectoral net exports have to add up to zero at the regional level. Plugging the definition of net exports as the difference of gross exports and gross imports into equation (E.2), we obtain the equilibrium equation (12).

Proposition 1. *Holding prices fixed and assuming R is large enough, a decline in population L_r in region r leads to:*

(a) A lower labor demand L_{rj} in all sectors j.

(b) More so, in sectors j where local purchases represent a larger fraction of value added.

(c) A decline in aggregate labor demand $\sum_{j\in\{a,m,s\}} L_{rj}$ that is lower than the decline in population L_r.

Proof. Holding prices fixed and assuming that R is large enough to dismiss the effects of changes in demand coming from other regions, the derivative of L_{rj} in equation (14) with respect to L_r can be written as

$$\frac{\partial L_{rj}}{\partial L_r} = \frac{\pi_{rrj}P_{rj}C_{rj}}{P_r Y_r} > 0 \tag{E.3}$$

which proves (a) as both numerator and denominator are strictly positive. To prove (c) we need to add up equation (E.3) over all sectors j to get,

$$\frac{\partial}{\partial L_r}\sum_j L_{rj} = \frac{\sum_j \pi_{rrj}P_{rj}C_{rj}}{P_r Y_r} < 1$$

where the inequality follows from the trade balance condition, $\sum_j P_{rj}C_{rj} = P_r Y_r$ and the presence of trade across regions, that is, $\pi_{rrj} < 1\ \forall j$. Indeed, note that without trade $\pi_{rrj} = 1\ \forall j$ and the decline in labor demand would be equal to the decline in labor supply, preventing changes in the equilibrium wage w_r. Finally, to prove (b) note that multiplying and dividing the right-hand-side of equation (E.3) by $P_{rj}Y_{rj}$ easily gives us equation (17). Equation (17) shows that the elasticity $\epsilon_{jr} \equiv \frac{\partial L_{rj}}{\partial L_r}\frac{L_r}{L_{rj}}$ of changes in the sector j labor demand L_{rj} with respect to changes in the population L_r is given by the ratio of $\pi_{rrj}P_{rj}C_{rj}$ to $P_{rj}Y_{rj}$. Actually, note that labor reallocation can we written as

$$\frac{\partial}{\partial L_r}\left(\frac{L_{rj}}{L_{ra}+L_{rm}+L_{rs}}\right) \propto \epsilon_{jr} - \bar{\epsilon}_r$$

where $\bar{\epsilon}_r \equiv \sum_i \epsilon_{ir}\frac{L_{ri}}{L_r}$, such that sectors where ϵ_{jr} is larger than the average elasticity $\bar{\epsilon}_r$ increase their relative size when there is a population inflow.

□

Proposition 2. *Holding expenditure shares constant, an increase in region r wage w_r decreases labor demand in all sectors j in region r, more so in those that are more tradable, that is, those with lower trade costs.*

Proof. The fraction of sector j goods that region ℓ buys from region r is given by the $\pi_{r\ell j}$ in equation (9). An increase in region r wage, w_r, will decrease this fraction $\forall \ell$ (including $\ell = r$) because region r becomes less competitive (the prices it offers to all regions ℓ are larger). To see this note that we can rewrite $\pi_{r\ell j}$ as $\pi_{r\ell j} = [1 + A_{r\ell j}]^{-1}$ where

$$A_{r\ell j} \equiv \sum_{k\neq r}\left(\frac{w_r}{w_k}\frac{\tau_{r\ell j}}{\tau_{k\ell j}}\right)^{\theta_j}\frac{T_{kj}}{T_{rj}} \tag{E.4}$$

is the inverse of how competitive is region r in selling sector j goods to region ℓ in relation to all other regions (including ℓ itself). Now, we can show that

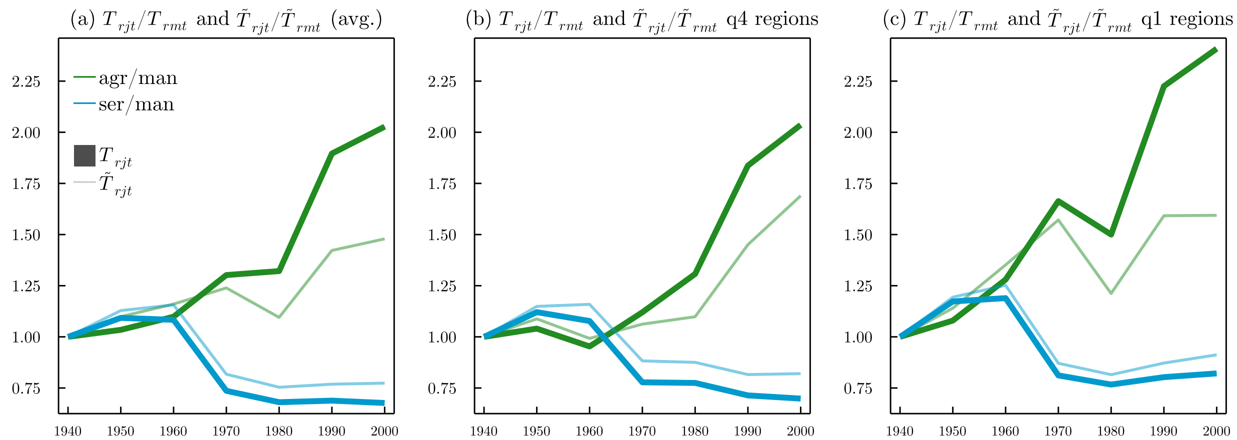
$$\frac{\partial \pi_{r\ell j}}{\partial w_r} = -\theta_j\left[1 + A_{r\ell j}\right]^{-2} A_{r\ell j}\frac{1}{w_r} < 0$$

In addition, we can show that the loss of market share is larger in sectors that are more tradable. To see this, let's first decompose $\tau_{r\ell j} = \tau_j \tau_{r\ell}$ into a sector-specific term τ_j and a bilateral term $\tau_{\ell r}$. Then,

$$\frac{\partial^2 \pi_{r\ell j}}{\partial w_r \partial \tau_j} = \frac{\partial^2 \pi_{r\ell j}}{\partial w_r \partial A_{r\ell j}}\frac{\partial A_{r\ell j}}{\partial \tau_j} \propto -\left(1 - A_{r\ell j}^2\right)\frac{\partial A_{r\ell j}}{\partial \tau_j}$$

Now, to sign this derivative we need two pieces. First, $\frac{\partial A_{r\ell j}}{\partial \tau_j} > 0$ because the effect of an increase in τ_j cancels in all ratios $\frac{\tau_{r\ell j}}{\tau_{k\ell j}}$ in equation (E.4) except for the case $k = l$ where $\frac{\tau_{r\ell j}}{\tau_{k\ell j}} = \tau_{r\ell j}$ because $\tau_{\ell\ell j} = 1$. That is, an increase in τ_j decreases the ability of region r to sell sector j goods in region ℓ because the competition with local goods ℓ is tougher. Second, we have that $A_{r\ell j} > 1$ whenever

Figure E.1: Relative sectoral productivities



Notes: Panel (a) plots the average (across provinces) relative productivity of agriculture and services with respect to manufacturing. The thick line corresponds to the calibrated productivity parameters T_{rjt} under the CRS assumption, while the thin line corresponds to the underlying productivity $\widetilde{T}_{rjt}$ when we allow for non-constant returns to scale. Panels (b) and (c) report the same averages for provinces within the q4 (highest population growth) and q1 (lowest population growth) groups respectively.

$\pi_{r\ell j} < 1/2$. Hence, with R large enough this will be the case and hence we will have $\left(1 - A^2_{r\ell j}\right) < 0$. Therefore, whenever $\pi_{r\ell j} < 1/2$, the decline of $\pi_{r\ell j}$ with a wage increase is larger in sectors where trade costs are lower, that is, in sectors with lower τ_j. $\square$

E.2 Solving for the equilibrium.

The problem of finding equilibrium prices and allocations can be simplified to finding the vector of regional wages $\{w_r\}_{r=1}^R$ that clears the regional labor markets in equation (11). Once the equilibrium wages are pinned down, the rest of equilibrium objects obtains easily. Note that labor demand in (14) only depends on wages $\{w_r\}_{r=1}^R$ and on the supply of workers in each region $\{L_r\}_{r=1}^R$ because $c_{\ell j}$, $P_{\ell j}$, and $\pi_{r\ell j}$ are all functions of wages given by equations (3), (8), and (9) respectively. The labor supply in equation (7) depends only on wages too as the $\rho_{r\ell j}$ are characterized by equation (6) and depend only on prices and wages.

E.3 Productivity paths with non-CRS production functions.

Here we compare the exogenous $\widetilde{T}_{rjt}$ with the calibrated productivity paths T_{rjt}. In Figure E.1, we plot the time paths of the relative sectoral productivity parameters for both cases, aggregated over all provinces (Panel a) and also aggregated over q4 and q1 provinces (Panels b and c), which are the 12 provinces with highest and lowest population growth respectively. We observe two patterns. First, the exogenous productivity of services relative to manufactures, $\widetilde{T}_{rst}/\widetilde{T}_{rmt}$, declines more than the endogenous one, T_{rst}/T_{rmt}. This happens due to the increase in manufacturing employment, which raises T_{rmt} over time. We also observe that this pattern is stronger in q4 than in q1 provinces due to the stronger industrialization in the provinces within the q4 group. Second, the endogenous productivity of agriculture relative to manufacturing, T_{rat}/T_{rmt}, grows more than the exogenous one, $\widetilde{T}_{rat}/\widetilde{T}_{rmt}$. This happens because the decline of employment in agriculture raises T_{rat} more than the increase in employment in manufacturing raises T_{rmt}.[32] The pattern here is stronger for q1 provinces, which are the ones with a stronger decline in agriculture employment.

E.4 Convergence of sectoral productivities.

Sectoral productivity diverged across provinces until 1960 and converged afterwards. A natural question is whether the patterns of migration could have been reverted had regional productivities started to converge since 1940. To explore this scenario, we want to generate alternative productivity paths T'_{rjt} in each region r and for each sector j that preserve the evolution of average sectoral productivity across provinces as in the calibrated economy, but with a different evolution of dispersion across provinces. Of course, there are multiple ways of doing so. We proceed as follows. First, we parameterize the transformation from the calibrated T_{rjt} to the counterfactual T'_{rjt} with this simple function:

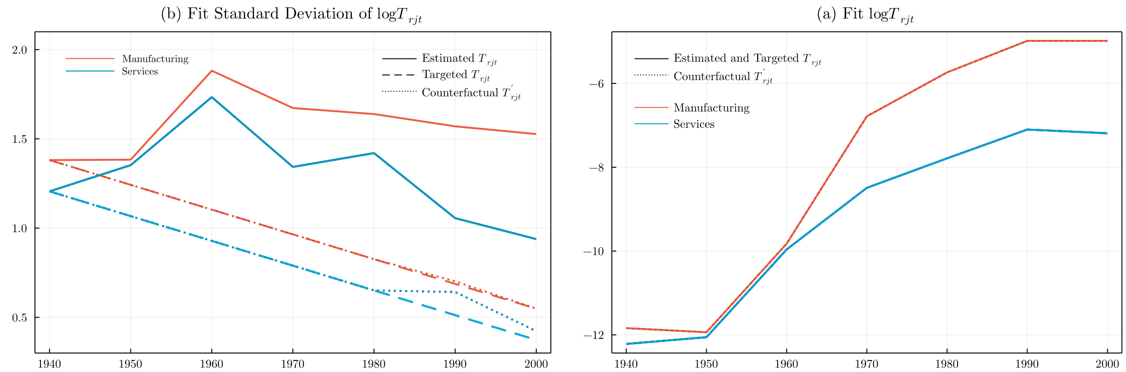
$$T'_{rjt+1} = T_{rjt+1}\,\lambda_{1jt}\left(\frac{T_{rjt}}{\bar{T}_{jt}}\right)^{\lambda_{2jt}} \tag{E.5}$$

where $\bar{T}_{jt} = \sum_{r=1}^{R} T_{rjt}/R$. With this formulation, $\lambda_{1jt} > 0$ controls the average of T'_{rjt+1} and λ_{2jt} the dispersion. With $\lambda_{1jt} = 1$ and $\lambda_{2jt} = 0$ we recover the original productivity paths $T'_{rjt+1} = T_{rjt+1}$. With $\lambda_{2jt} < 0$, T'_{rjt+1} is relatively lower (higher) for high (low) productivity regions, which generates convergence across provinces and lowers dispersion. With $\lambda_{2jt} > 0$ the opposite is true. We then choose the time sequence of λ_{1jt} and λ_{2jt} for each sector j to match the desired counterfactual evolution of the average and the dispersion of sectoral productivity paths across provinces. In particular, for sectors $j = m, s$, we target (i) the actual time evolution of the average of sector j productivities across regions (solid lines in Figure E.2 Panel (b))[33]; and (ii) the counterfactual time evolution of the dispersion of sector j productivity across regions. This arises from starting with the actual dispersion in sector j productivities in 1940 and letting it decline at the same average rate as the dispersion of average productivity T_{rt} between 1970 and 2000 (dashed lines in Figure E.2 Panel (a)). The choice of λ_{1jt} and λ_{2jt} does an almost perfect match of the targets (see dotted lines in Figure E.2).

[32] This result comes from the facts that (a) $|\alpha_a| > |\alpha_m|$ and (b) employment loss in agriculture is larger than the employment growth in manufacturing.

[33] We compute aggregate productivity at the regional level as $T_{rt} = \left[\sum_j \omega_j T_{rjt}^{\nu-1}\right]^{\frac{1}{\nu-1}}$.

Figure E.2



Notes: Left panel shows the standard deviation of $\log T_{rjt}$ in the calibrated economy (solid lines), the targeted standard dispersion of $\log T_{rjt}$ (dashed lines), and the dispersion of $\log T'_{rjt}$ (dotted line) obtained using equation (E.5) for manufacturing and services. Right panel shows the level of mean $\log T_{rjt}$ (solid lines) and the level of mean $\log T'_{rjt}$ (dotted line) for manufacturing and services.

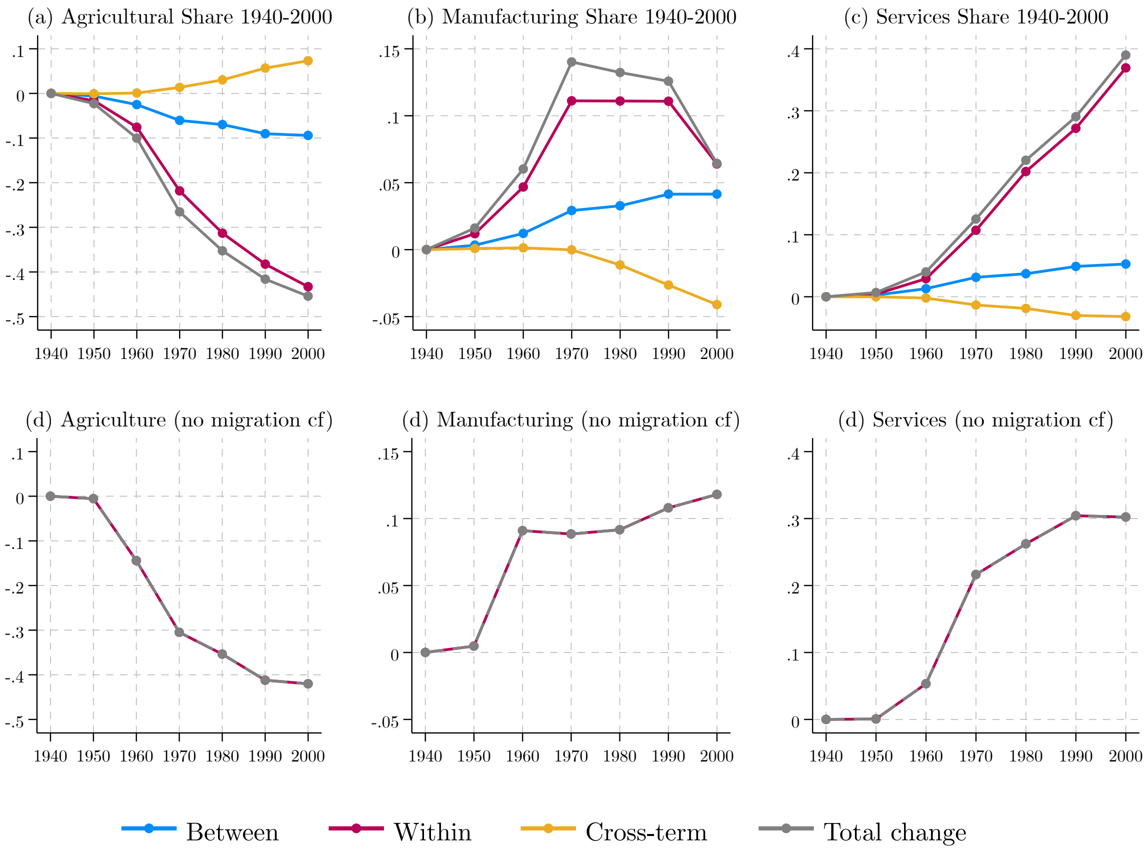
Appendix F: A simple decomposition of the time evolution of sectoral shares

The time evolution of the employment share in a given sector, say agriculture, can be easily decomposed into a between-region term, a within-region term, and a cross-term:

$$l_{jt} - l_{j0} = \underbrace{\sum_{r=1}^{R} (l_{rt} - l_{r0})\, l_{rj0}}_{\text{between-region}} + \underbrace{\sum_{r=1}^{R} (l_{rjt} - l_{rj0})\, l_{r0}}_{\text{within-region}} + \underbrace{\sum_{r=1}^{R} (l_{rjt} - l_{rj0})\,(l_{rt} - l_{r0})}_{\text{cross-term}} \tag{F.1}$$

where $l_{rjt} = L_{rjt}/L_{rt}$ and $l_{rt} = L_{rt}/L_t$, see for instance Eckert and Peters (2022). The between-region term captures the change in the aggregate share of employment in a sector j that comes from movements of population across regions of different sectoral composition. For instance, a rural exodus moving people from agrarian regions to industrial regions will mechanically generate an increase in aggregate industrial employment. The within-region term captures the change in the aggregate share of employment in sector j that comes from changes in the sectoral composition of employment within each region r. It has been conventionally assumed that only the former term is related to migrations, and that a large within-region component dismisses the importance of migration for structural change. Yet, as we argue in this paper, the within-region term may also contain variation driven by migrations. For instance, the within-region term accounts for 20 percentage points in the fall of the share of employment in agriculture between 1940 and 1970, see Panel (a) in Figure F.1. Yet, in the counterfactual economy with no migration the share of employment in agriculture falls by 30 percentage points during the same period, see Panel (d) in Figure F.1. That is, the within-region component term of agriculture differs from the actual evolution of the share of agriculture in an economy without migrations by as much as one third.

Figure F.1: Decomposition of sectoral employment shares



Notes: Panels (a), (b), and (c) plot the change in sectoral employment for agriculture, manufacturing, and services, plus the "between", "within", and "cross-term" corresponding to the three components in the right hand side of equation (F.1). Panels (d), (e), and (f) plot the change in sectoral employment for the same sectors in the counterfactual economy without migrations.

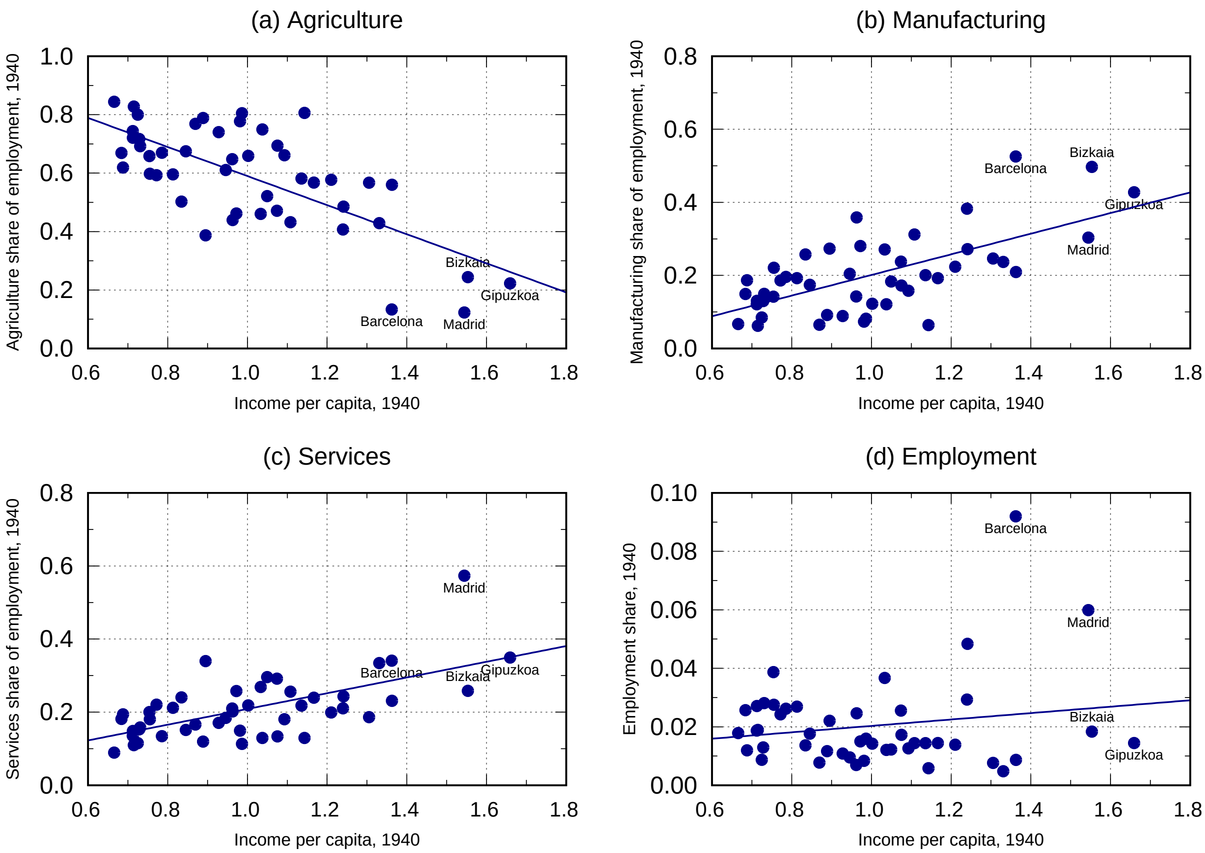
Appendix G: Extra Figures and Tables

Table G.1: Correlation of Employment and Expenditure Shares over Time

	1940	1950	1960	1970	1980	1990	2000
Agriculture	0.63	0.64	0.59	0.29	0.15	-0.10	-0.14
Manufacturing	0.56	0.61	0.58	0.31	-0.32	-0.61	-0.50
Services	0.55	0.52	0.44	0.21	0.08	0.15	0.13

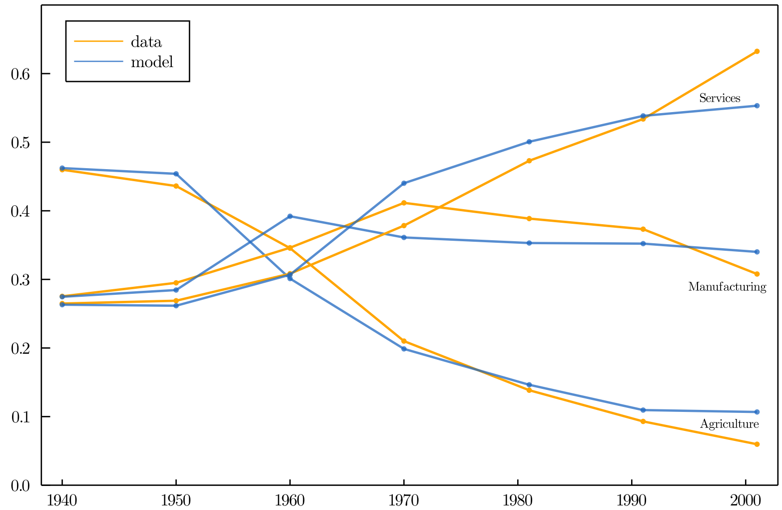
Notes: Each entry is the correlation of sectoral employment end expenditure shares across provinces for every year and sector.

Figure G.1: Sectoral shares, 1940



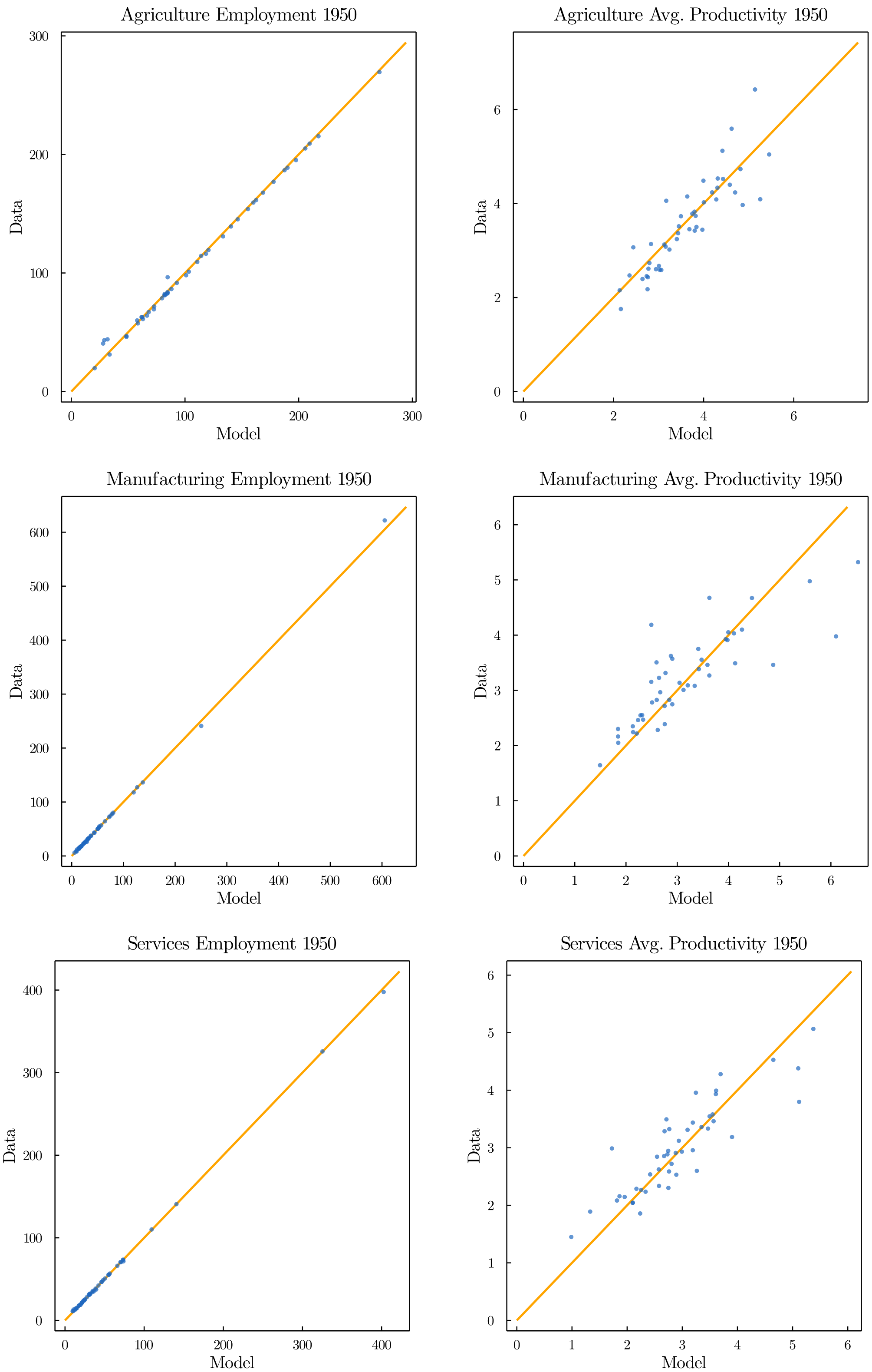
Notes: Panels (a) to (c) plot the employment shares in Agriculture, Manufacturing, and Services against real income per capita in each province (relative to the country average). Panel (d) reports the relative size of each province (in terms of employment) against provincial income per capita. All panels for 1940.

Figure G.2: Aggregate sectoral evolution



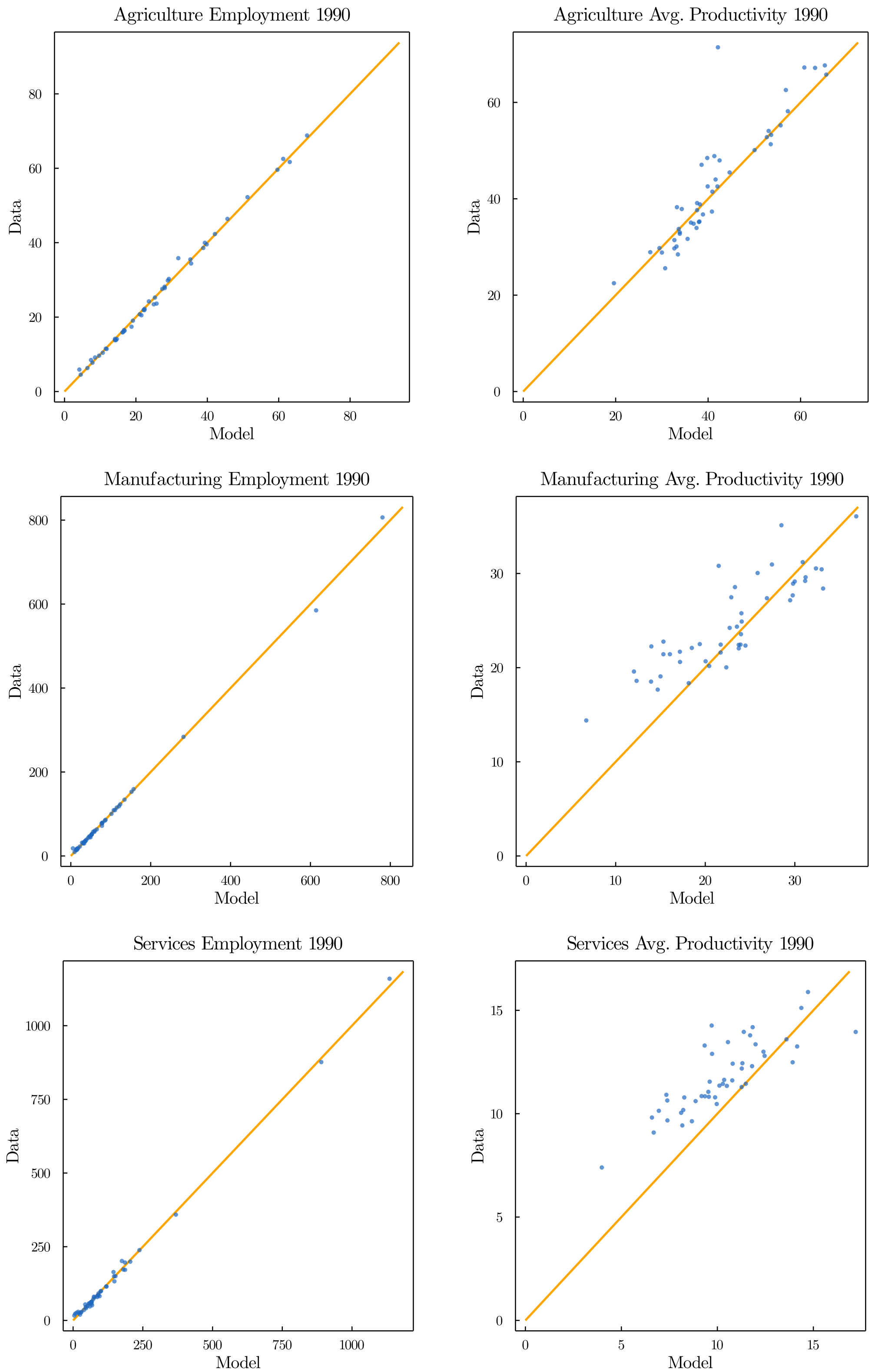
Notes: This figure plots the employment shares in each sector in the data (yellow) alongside the predictions of the estimated demand system (blue) according to equation (18).

FIGURE G.3: Model Fit: 1950



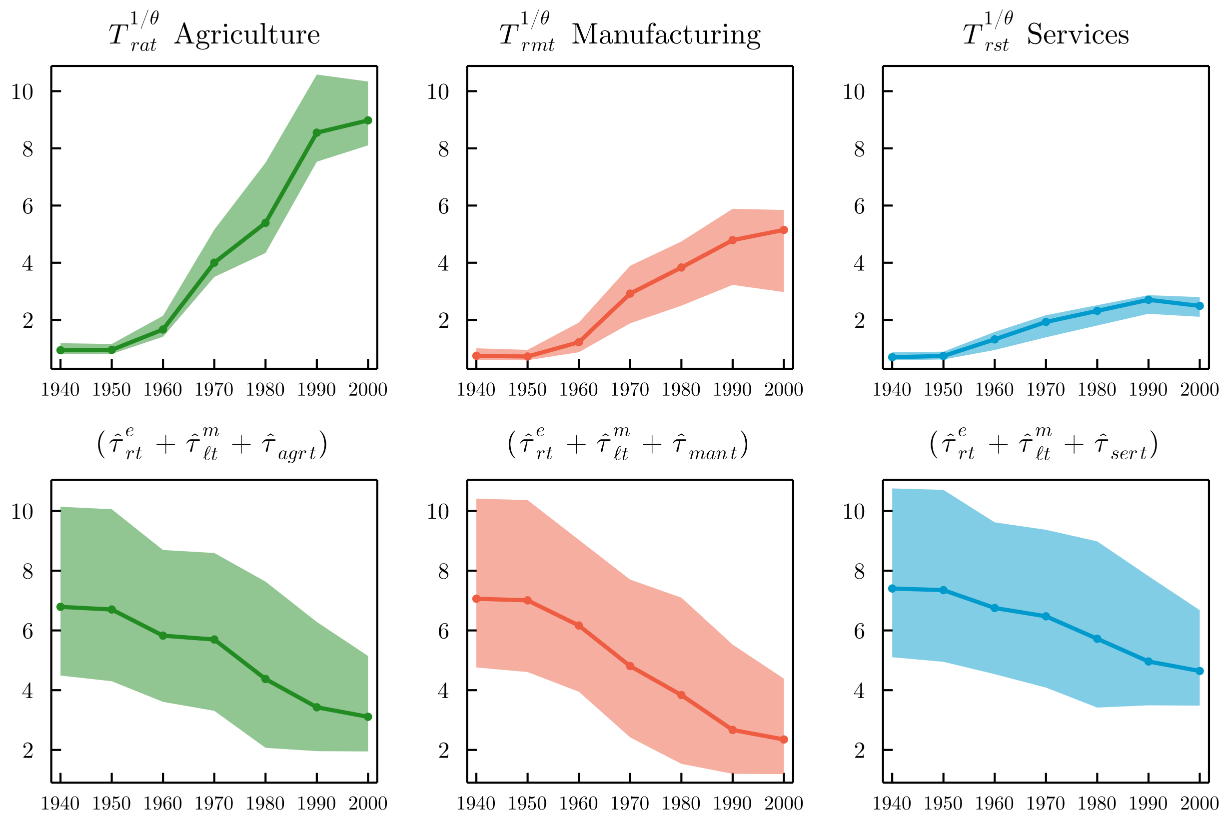
Notes: This Figure represents the data vs model-predicted values for employment (left column) and productivity (right column) in each sector in 1950. Each dot represents a province. These are the moment conditions in the SMM algorithm in the Second Step of the calibration, see Section 4.3.

Figure G.4: Model Fit: 1990



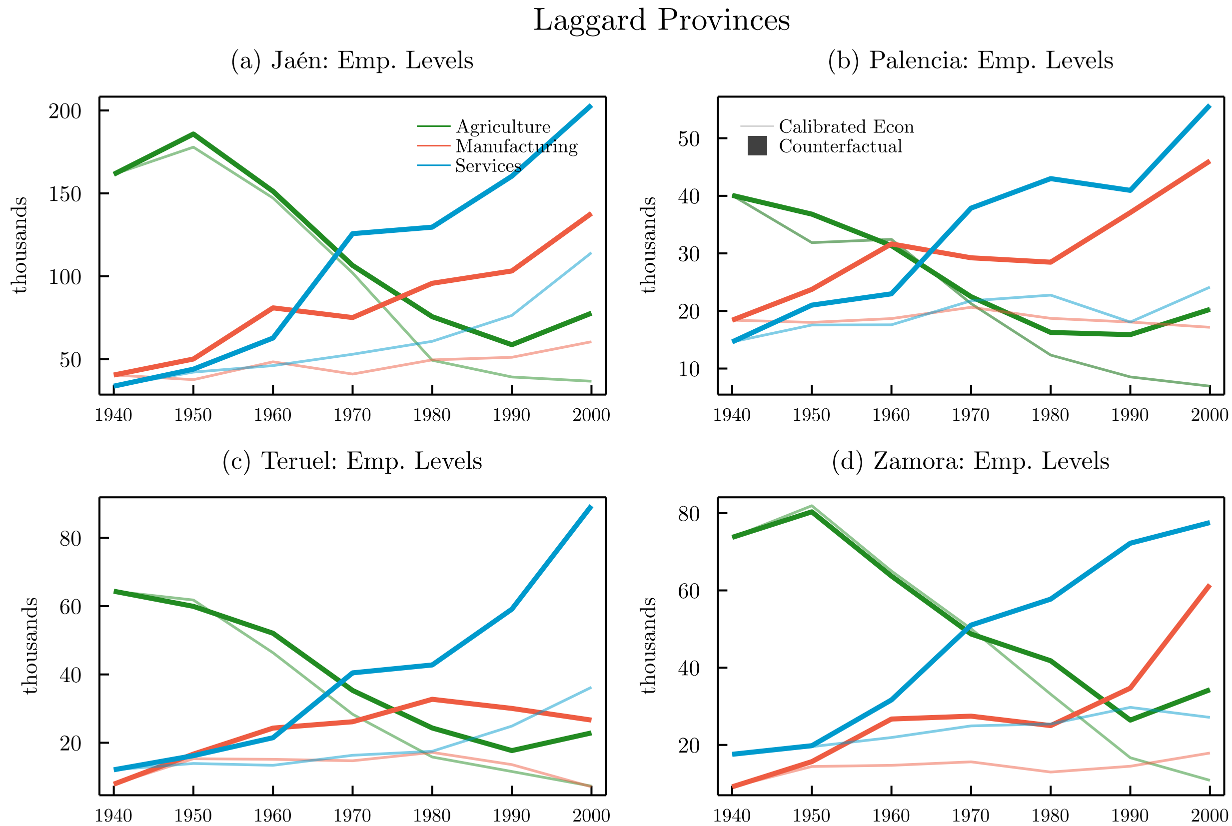
Notes: This Figure represents the data vs model-predicted values for employment (left column) and productivity (right column) in each sector in 1990. Each dot represents a province. These are the moment conditions in the SMM algorithm in the Second Step of the calibration, see Section 4.3.

Figure G.5: Evolution of productivity and trade costs over time



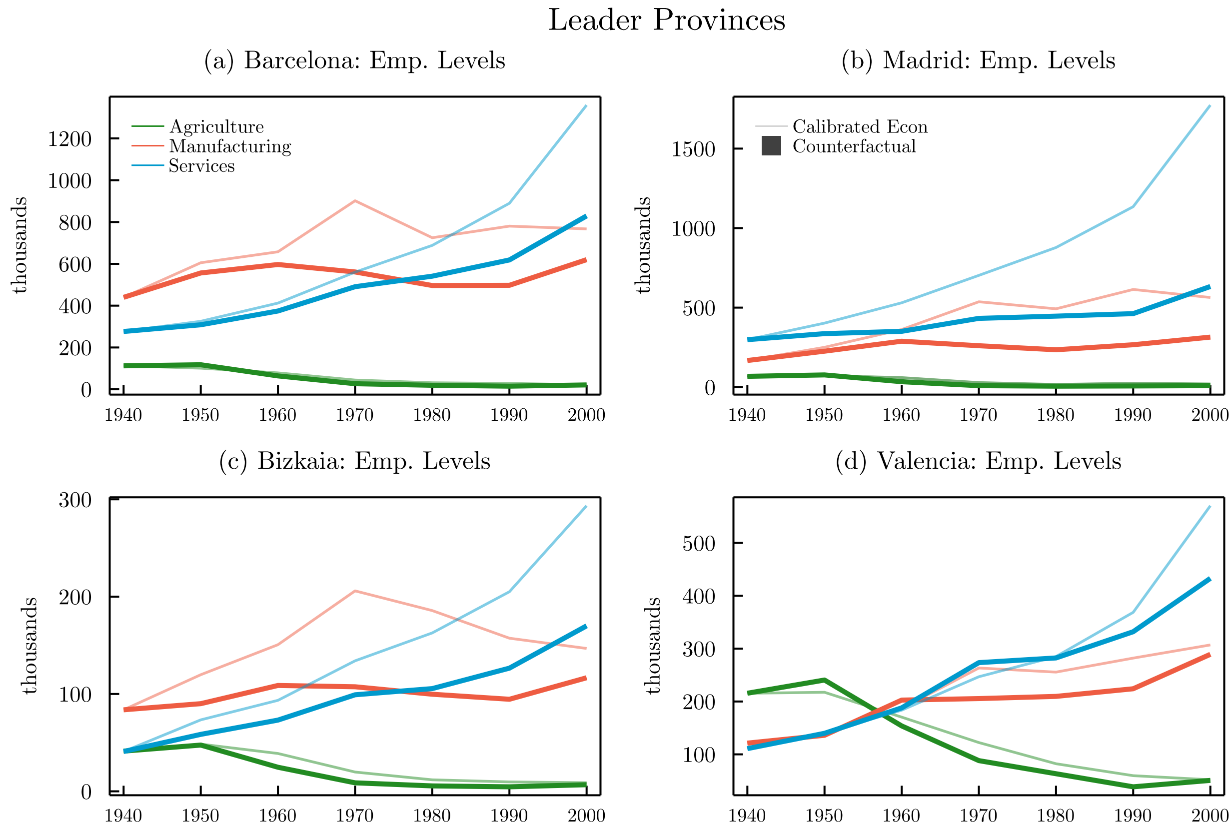
Notes: The thick dotted lines in each panel represent the evolution of the average across all provinces of the productivity (top row) and trade cost (bottom row) parameters. The bands represent the 25th to 75th percentiles of the distribution of the same parameters.

Figure G.6: Counterfactual exercises: no migrations



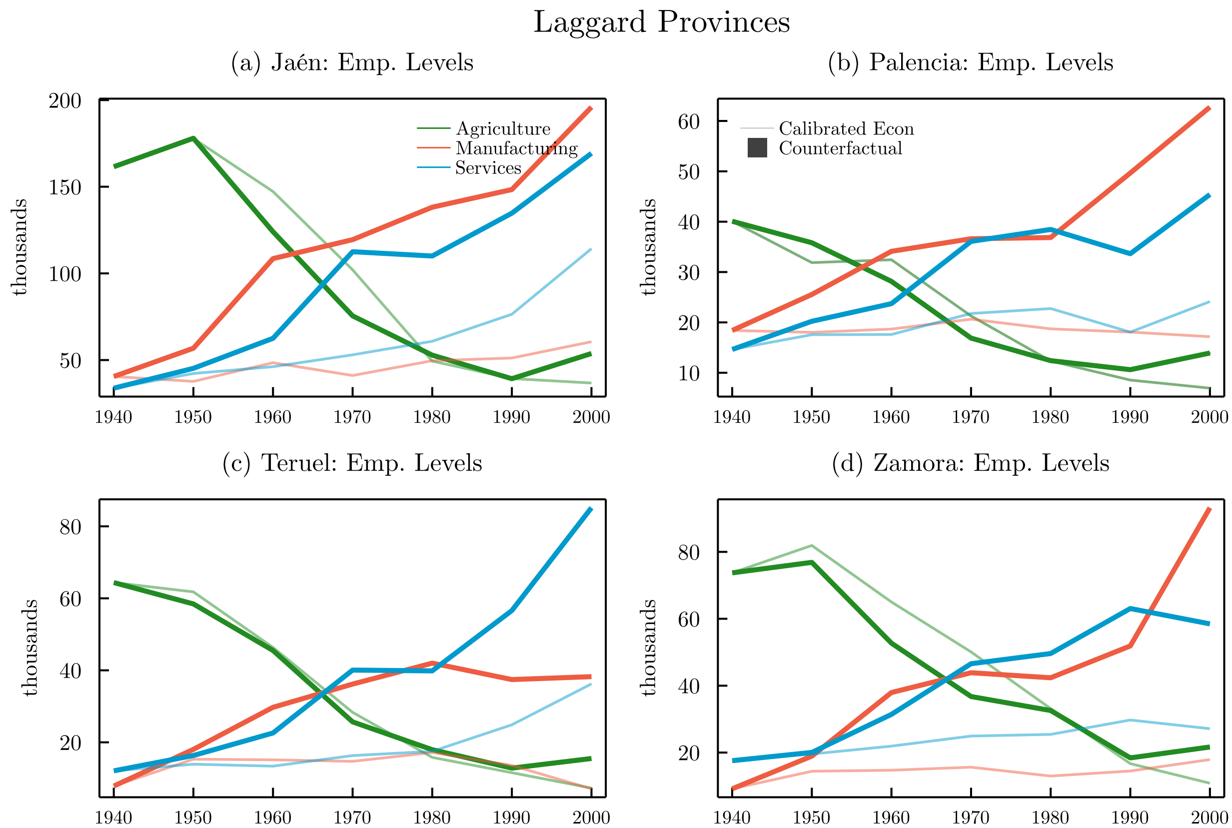
Notes: This Figure represents the time series evolution of employment levels in each sector for a group of selected provinces that lost population between 1940 and 2000. The thin lines correspond to the calibrated economy and the thick lines correspond to the counterfactual economy with no migration.

Figure G.7: Counterfactual exercises: no migrations



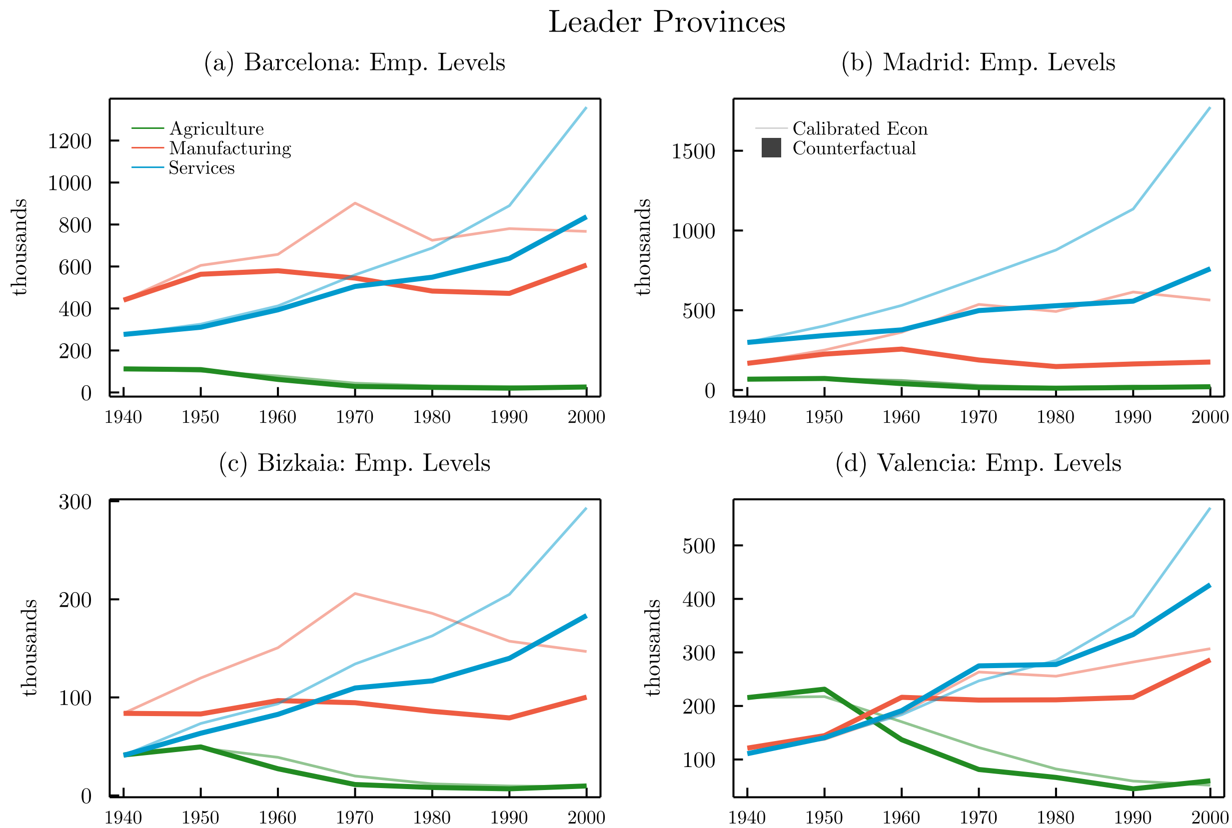
Notes: This Figure represents the time series evolution of employment levels in each sector for a group of selected provinces that gained population between 1940 and 2000. The thin lines correspond to the calibrated economy and the thick lines correspond to the counterfactual economy with no migration.

Figure G.8: Counterfactual exercises with agglomeration economies: no migrations



Notes: This Figure represents the time series evolution of employment levels in each sector for a group of selected provinces that lost population between 1940 and 2000. The thin lines correspond to the calibrated economy and the thick lines correspond to the counterfactual economy with no migration and agglomeration economies.

Figure G.9: Counterfactual exercises with agglomeration economies: no migrations



Notes: This Figure represents the time series evolution of employment levels in each sector for a group of selected provinces that gained population between 1940 and 2000. The thin lines correspond to the calibrated economy and the thick lines correspond to the counterfactual economy with no migration and agglomeration economies.