The cost of trade disruptions at different stages of development*

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Abstract

We study the impact of trade disruptions at different stages of development. We calibrate our two-country, three-sector model to Spain and the United Kingdom from 1850 to 2000, accounting for the inter-war trade collapse (IWTC) and the subsequent catch-up by Spain. In our model, trade disruptions have a stronger impact on the country that is catching-up (Spain), with more distance to the technological leader (U.K.) and more trade openness. A collapse today (less distance, more openness) similar to the IWTC (more distance, less openness) decreases the capital stock threefold (12% instead of 4%). Furthermore, although the IWTC supported industrialization in Spain, higher costs today would lead to deindustrialization.

Keywords: Trade disruption, International Trade, Structural transformation.
JEL Codes: F11, F12, N10, N60.

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1 Introduction

We quantify the impact of trade disruptions at different stages of development. A trade disruption today is not simply a theoretical curiosity but a real possibility (e.g., Brexit, tariffs imposed by the Trump administration, COVID-19). Therefore, understanding the costs to different countries and how they differ depending on the countries' stage of development is a first-order question. We build a quantitative theory of an economy (Spain) catching up to and trading with the industrial leader (the United Kingdom). Our period of interest spans from 1850 until today. During this time period, Spain catches-up to the U.K., experiences a process of structural transformation, and faces the three canonical trade regimes of the industrialized world: the first and second waves of globalization, and in between the inter-war trade collapse (1913-1946; henceforth IWTC).

We calibrate our model to match the evolution of Spain's exports to GDP and the evolution of Spain and the U.K.'s GDP per working-age person. The transition path in our model rationalizes non-targeted moments such as the evolution of investment and capital in Spain, sectoral GDP in Spain and the U.K., and bilateral trade patterns during the period from 1850 to 2000. Our main counterfactual exercise is to compare the effects of the IWTC to a similar trade collapse today. We find that the capital stock falls three times more with a collapse today than it did during the IWTC (12% instead of 4%). This is mainly because the economies are substantially more open today. The pattern in consumption is similar. Furthermore, the model predicts that during the IWTC, the increase in trade barriers would have contributed to Spanish industrialization, whereas today it would have the opposite effect. Although a trade disruption might stimulate industrialization, that process is detrimental to welfare.

Our paper makes several contributions. First, we provide a detailed series of bilateral trade flows between Spain and the U.K., starting in 1850. We do so by digitizing and categorizing the information obtained in historical customs data from the "General Ledger of the Foreign Trade of Spain with its Overseas Possessions and Foreign Powers" for the years 1849-1855 and "General Statistical Report of the Foreign Trade of Spain with its Overseas Possessions and Foreign Powers" for the years 1856 and after. We manually assign each of these trade flows to SITC Rev.1 categories. This allows us to observe the changes in trade patterns along with structural transformation during a period spanning one and a half centuries in Spain. We use these series to validate our model with regard to patterns observed in Spain's trade flows.

Our second contribution is to build a dynamic general equilibrium, two-country model of trade and structural transformation. Households accumulate capital and have Stone-

Geary preferences over agriculture (modeled as a necessity), manufacturing, and services. Trade only occurs in intermediate goods, with agriculture and services trade happening à la Armington (1969; one domestic and one foreign variety produced with constant returns to scale), and manufacturing trade happening à la Krugman (1980; many differentiated varieties produced with increasing returns to scale). We incorporate differentiated varieties into only manufacturing and none of the other sectors because we have data to calibrate parameters related to manufacturing varieties but not the other sectors. Furthermore, we assume balanced trade motivated by the fact that Spain's trade was almost balanced in most periods from 1850 to 2000.

We calibrate the model targeting a number of moments of the Spanish economy in the years 1850 and 2000; and match the entire path of exports to GDP in Spain and GDP per working-age population in Spain and the U.K from 1850 to 2000. We validate our calibrated model by looking at a number of non-targeted moments along the transition path. On the macro side, the model correctly predicts a declining agricultural sector, a moderate increase in the manufacturing sector, and a secular increase in the services sector. It also captures the evolution of capital stock and investment: Spain went from investing a small fraction of GDP to investing a much larger fraction. Furthermore, the model does qualitatively well in rationalizing the observed behavior of relative prices in Spain and the structural transformation in the U.K. from 1850 to 2000. On the trade side, the model correctly predicts the evolution of the number of varieties that Spain imports and exports, as well as the shares of imports and exports that are accounted for by agriculture and manufacturing.

Our third contribution is to compare the effects of the IWTC, captured by a rise in trade iceberg costs, to a similar trade collapse today. To do that, we perform the two main exercises of our paper. In the first exercise, we compare the benchmark economy, which experiences the IWTC, with a counterfactual in which the trade collapse does not happen. In the second exercise, we compare the benchmark economy, which assumes low trade costs after 2000 and into the future, with a counterfactual where a trade collapse similar to the IWTC happens today. We ensure that the relative increase in the trade iceberg costs is the same in both periods. We find that the IWTC caused a decrease in Spanish capital stock of about 4% at its trough, whereas today it would fall by up to 12%. The pattern in consumption is similar, with consumption of manufacturing falling the most, agriculture falling the least, and services in between the two. As in the case of capital, the drop in consumption is much larger today than during the IWTC. Taken as a whole, these results imply that a trade collapse today would be significantly more costly than the IWTC.

Having illustrated our main result using the two exercises discussed above, we explore the economic intuition for the difference in effects across the two episodes. In the first exercise, Spain's productivity is far from the technological frontier and trade costs are large. In contrast, in the second exercise, today, the distance in productivities and trade costs is small. Using several numerical exercises, we show that the larger the distance to the leader and the more open the economy, the larger the negative impact of trade disruptions on the country that is catching up. Therefore, for Spain, the IWTC should generate a greater cost because the distance to the technological frontier was larger, and a collapse today should generate a greater cost because trade is more open. Our two exercises show that the latter effect is quantitatively more important in the case of Spain. An important corollary is that a trade disruption would be very costly for a country at a very early stage of the development process and that is very open to trade with countries at the technological frontier.

Our quantitative results from the two main exercises also imply that the number of Spanish manufacturing varieties would decrease today, whereas they increased during the IWTC. Again, using numerical exercises, we show that in general, increases in trade costs lower the number of varieties. The mechanism is as follows: expensive foreign inputs lower the capital stock. With less capital, countries can afford to produce fewer varieties. However, when the technological leader is sufficiently more productive, increases in trade costs generate an increase in the number of varieties in the catching up country. This happens because the technological asymmetry puts the catching up country at a comparative disadvantage at building varieties domestically. When trade costs are low enough, the catching up country benefits from the varieties built by the technological leader. When there is a spike in trade costs, foreign varieties become too expensive, and the catching up country industrializes. Therefore, this mechanism is reminiscent of import substitution policies. However, despite the increase in industrialization, trade barriers are detrimental to the welfare of the catching up country.

Finally, after illustrating and providing economic intuition for our two main results, we show that our main results are robust to two important alternative specifications of our model. First, in our benchmark exercises, we assume sector-neutral productivities but show that the calibrated model rationalizes the non-targeted evolution of value-added shares and relative prices by sector reasonably well. Nevertheless, existing studies in the literature have emphasized the importance of sector-specific productivities (see, Ngai and Pissarides (2007)). Therefore, we perform robustness exercises in which we calibrate sector-specific productivities to match the evolution of value-added shares by sector in one exercise and relative prices by sector in another exercise. Second, our benchmark exercises assume a relatively weak complementarity between consumption goods by sector. Herrendorf, Rogerson, and Valentinyi (2013) show that in a model of structural transformation, weak complementarity between consumption goods generates the observed structural transformation in the U.S.

economy when looking at final expenditure per sector. However, they also find that more complementarity is needed when looking at value-added per sector. Therefore, we redo our benchmark exercises in a model with stronger complementarity between consumption goods by sector. The two main results from our benchmark exercises discussed above are robust to these alternative specifications.

Related literature: Our paper shares a methodological approach with several papers that build structural models to analyze the impact of a trade collapse. Steinberg (2019) and McGrattan and Waddle (2020) build structural models to analyze the impact of Brexit. Steinberg (2020) analyzes the impact of a potential termination of NAFTA. In a similar vein, our paper contributes to a growing literature that assesses the impact of trade policy changes in dynamic models with factor accumulation. Ravikumar, Santacreu, and Sposi (2019) study trade liberalizations in a model with capital accumulation and find large dynamic gains. Perri and Quadrini (2002) analyze the impact of the trade collapse in Italy during the Great Depression. They find that the trade collapse was a major cause of the economic downturn and emphasize its impact on investment. Crucini and Kahn (1996, 2007) argue that the global tariff war during Great Depression contributed to a fall in international output and investment because of its persistence and impact on capital accumulation. Alessandria and Choi (2007, 2014), Ruhl and Willis (2017), and Brooks and Pujolas (2018) focus on capital accumulation and firm creation. Kehoe, Ruhl, and Steinberg (2018) build a model of structural transformation and trade but focus on the U.S. economy from 1992 to 2012.

The process of structural transformation has been widely studied since Kuznets (1973), with Kongsamut, Rebelo, and Xie (2001) showing how to rationalize structural transformation by introducing non-homothetic preferences, and Ngai and Pissarides (2007) doing so with differential productivity growth by sector. See Herrendorf, Rogerson, and Valentinyi (2014) for a thorough overview of the literature.[1]

The recent literature linking trade and structural transformation, which began with seminal contributions by Matsuyama (1992) and Echevarria (1995), has usually been confined to the analysis of a single open economy. Stokey (2001), Desmet and Parente (2012), and Ferreira, Pessôa, and dos Santos (2016) focus on the role of trade during the Industrial Revolution in England. Teignier (2018) builds a two-sector, small open economy model with capital accumulation to compare the cases of Great Britain and South Korea. Uy, Yi, and Zhang (2013) build a two-country, three-sector model with trade as in Eaton and Kortum

[1] Buera and Kaboski (2012) pioneered the introduction of sophisticated services into the analysis. Following Buera and Kaboski (2009) and Dennis and Iscan (2009), there has been a surge in the literature testing the model against observed historical patterns in the data. Some examples of this literature include Boppart (2014), Comin, Mestieri, and Lashkari (2020), and García-Santana, Pijoan-Mas, and Villacorta (2018).

(2002) without capital accumulation to also study South Korea's case.[2] Apart from the technical differences (we build a two-country, three-sector model with capital accumulation and trade in varieties à la Krugman, and we focus on the bilateral relationship between Spain and the U.K.), what most distinguishes our paper is that we study the impact of trade disruptions at different stages of the development process. That is, our longer time horizon allows us to validate our model against both key macro and trade patterns observed for Spain from 1850 to 2000 and make comparisons across different stages of the development process. Furthermore, our emphasis on the rise in the number of varieties in manufacturing complements Kehoe and Ruhl (2013), who argue that the extensive margin growth of least-traded varieties is brought about by structural change and moves little in response to business cycles.

Finally, in our model, we capture the IWTC through a rise in trade iceberg costs. This approach is supported by findings in Jacks, Meissner, and Novy (2008). They derive a micro-founded measure to estimate trade costs (e.g., tariffs, transportation costs, and other frictions that dampen trade) from 1870 to 2000 for France, the U.S., and the U.K. They find that the rise in trade costs explains the entire inter-war trade collapse.

2 Data

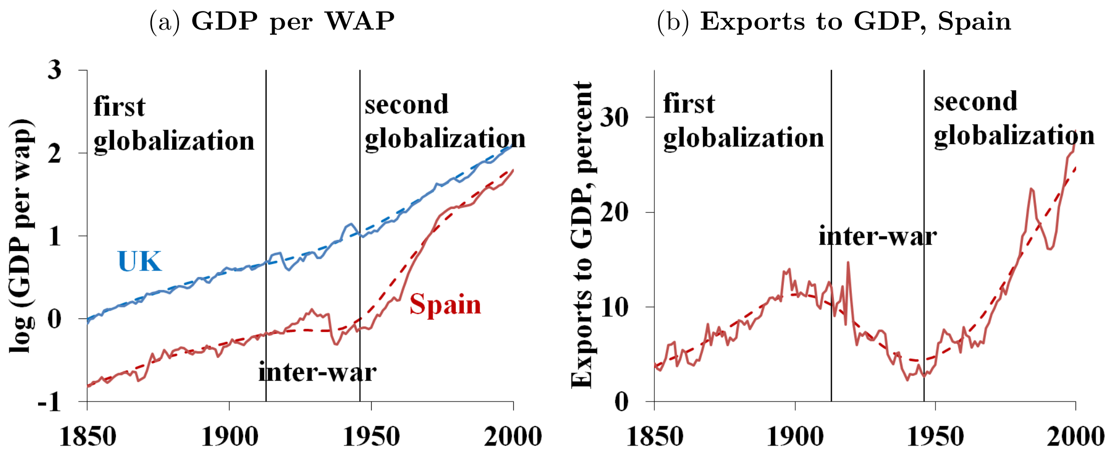
We first look at GDP per working-age person for both Spain and the U.K. from 1850 to 2000. We use GDP data provided in the Maddison Project (2013), expressed in Geary-Khamis dollars. The World Bank's World Development Indicators provides data on the working-age population starting in 1960. To back out estimates for the period before 1960, we make the assumption that the working-age population as a share of the total population prior to 1960 is constant and equal to the estimate from 1960. Then we use the total population reported in the Maddison Project (2013) to back out estimates for the total working-age population prior to 1960. The two solid lines in Figure 1a plot GDP per working-age person for Spain (red line) and the U.K. (blue line). Since we focus on long-run trends in this paper, we also present the GDP estimates using the Hodrick-Prescott filter (after Hodrick and Prescott, 1997, the dashed lines in the figure). In 1850, Spain's GDP per working-age person is significantly below that of the U.K. but catches up rapidly during the second wave of globalization.

In Figure 1b, we plot the evolution of Spanish exports to GDP (the solid line is raw data, and the dashed line is the trend). The figure displaying imports to GDP (Appendix A.1,

[2] Betts, Giri, and Verma (2017) perform an analysis similar to Uy, Yi, and Zhang (2013), but in their model trade happens à la Armington.

Figure 15a) is very similar. Figure 1b shows that trade grows during the first and second waves of globalization; and experiences a major drop during the inter-war period. The source for this series is the Historical National Accounts dataset from Prados de la Escosura (2015), available only for Spain.

Figure 1: GDP and exports



Notes: Figure 1a plots GDP per working-age person (WAP) for both Spain (red line) and the U.K. (blue line) from 1850 to 2000. Sources: Maddison Project (2013) and World Bank's World Development Indicators. Figure 1b plots Spain's exports to GDP from 1850 to 2000. Source: Historical National Accounts dataset from Prados de la Escosura (2015). In both figures, the solid lines are the raw data. The dashed lines are the trends computed using the HP filter with a penalty parameter of 100.

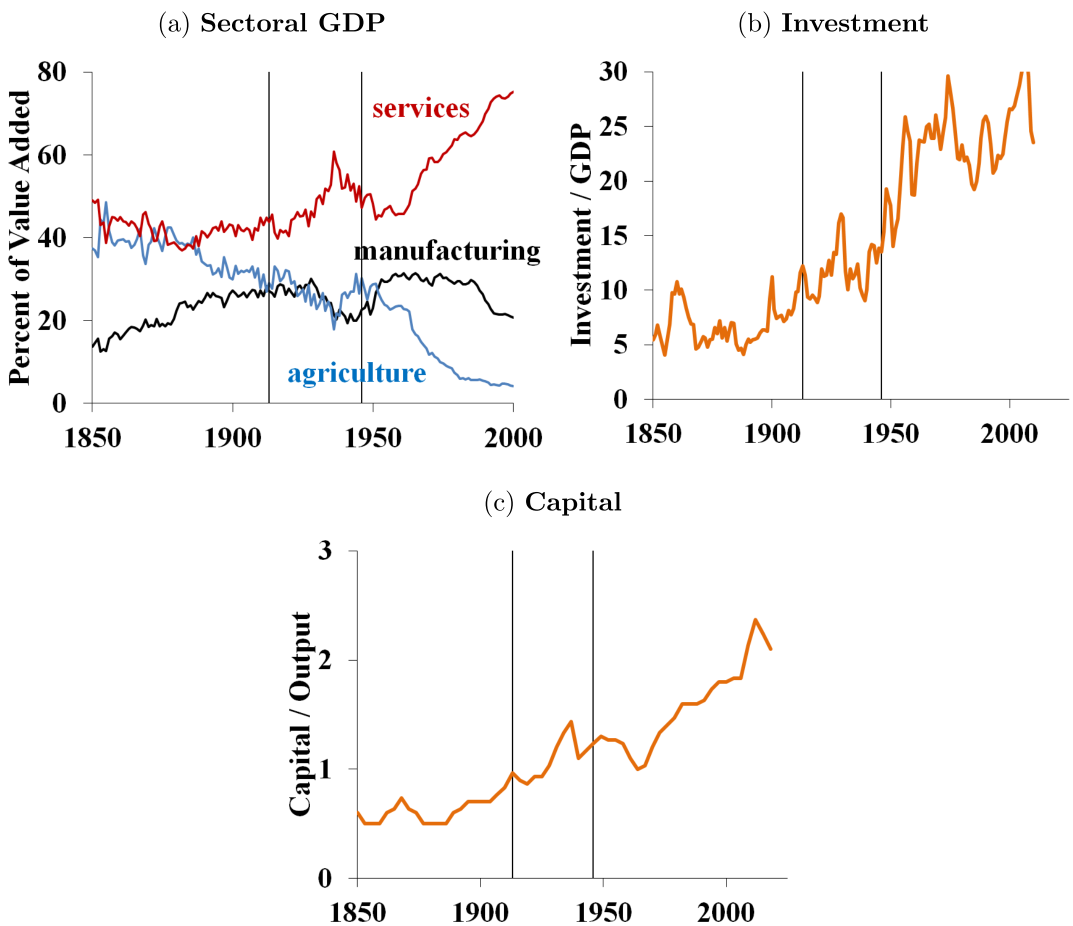
In Figure 2a, we show that agriculture's share of value-added in Spain decreased over time, whereas the opposite happened to services.[3] Importantly, manufacturing increased to roughly 25% of GDP and stayed there during the second globalization and decreased marginally after the 1990s. Another relevant empirical observation for the Spanish economy is the evolution of investment as a percentage of GDP (Figure 2b). Starting from a low level of roughly 5% of GDP in 1850, investment increased consistently over time to more than 20% by the year 2000. Figure 2c shows that the Spanish capital-to-GDP ratio follows a similar pattern. The data source for these figures is also Prados de la Escosura (2015).

Finally, we turn to the evolution of bilateral trade patterns between Spain and the U.K. from 1850 to 2000. To do that, we digitize historical trade data between Spain and Great Britain for the years between 1849 and 1913. The historical data is taken from the yearly statistical publications of the Spanish Customs Agency, the "General Ledger of the Foreign Trade of Spain with its Overseas Possessions and Foreign Powers" for the years 1849-1855[4]

[3]To be specific, we add construction to services.

[4]Original, in Spanish: "Cuadro General del Comercio Exterior de España con sus Posesiones Ultramarinas y Potencias Estrangeras," Dirección General de Aduanas de España (1849–1855).

Figure 2: Sectoral GDP, investment, and capital in Spain



Notes: Figure 2a plots value-added shares by sector for Spain (1850-2000). Figure 2b plots investment as a percentage of GDP for Spain (1850-2000). Figure 2c plots the capital-to-GDP ratio for Spain (1850-2000). Source: Prados de la Escosura (2015).

and "General Statistical Report of the Foreign Trade of Spain with its Overseas Possessions and Foreign Powers" for the years 1856 and after.[5] The trade patterns after 1962 are directly reported in SITC Rev. 1 4-digit categories. To have a consistent measure of trade patterns for the entire period, we manually assigned each ledger prior to 1962 to the 4-digit SITC Rev. 1 code that provides the best match.[6]

Based on the data we constructed, we report facts about the composition of trade between agriculture and manufacturing and the count number of traded varieties. Note that neither

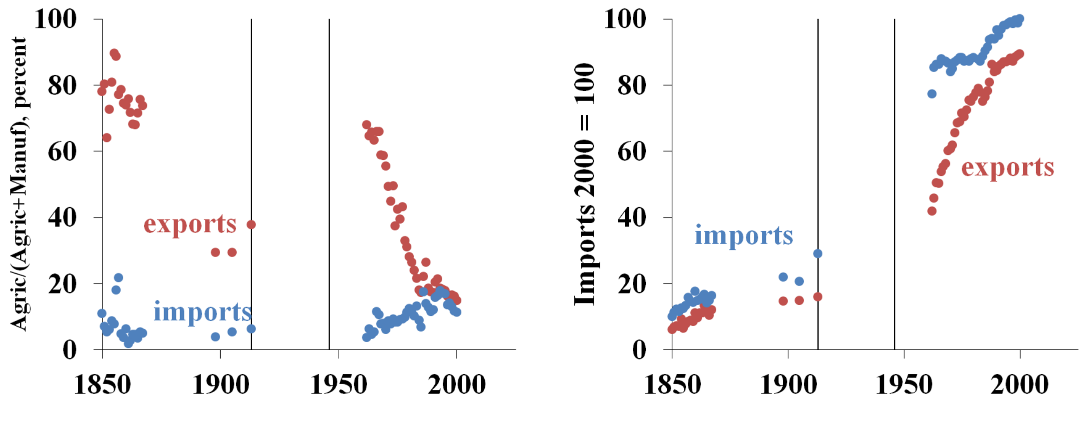
[5] Original, in Spanish: "Estadística General del Comercio Exterior de España con sus Posesiones Ultramarinas y Potencias Extranjeras," Dirección General de Aduanas de España (1856–1867,1898,1905,1913).

[6] In some instances, when the categories in the ledgers are less specific than the 4-digit SITC categories, 3-digit codes are used or customized categories are created by combining two or more 4-digit categories.

the historical accounts nor the SITC Rev. 1 data contain information about trade in services. In Figure 3a, we plot Spain's share of exports (red dots) and imports (blue dots) accounted for by agricultural goods. The pattern that emerges is the following. Spain did not import many agricultural goods during this time period. However, Spain's agricultural share of exports was large at the beginning of both the first and second waves of globalization (around 80% in 1850 and 70% in 1960) and small at the end of these time periods (around 30% in 1900 and 20% in 2000).

Figure 3: Trade between Spain and the U.K.

(a) **Share of agriculture** (b) **Number of traded varieties**



Notes: Figure 3a plots exports (imports) of agriculture as a share of agriculture plus manufacturing exports (imports) for Spain with the U.K. Analogously, Figure 3b plots the number of traded varieties, measured by the count number of non-empty, non-agricultural SITC codes each year. Sources: "General Ledger of the Foreign Trade of Spain with its Overseas Possessions and Foreign Powers" for the years 1849-1855 and "General Statistical Report of the Foreign Trade of Spain with its Overseas Possessions and Foreign Powers" for the years 1856 and after.

Regarding the number of varieties traded, we use the count number of non-empty, non-agricultural SITC codes each year. We plot the series in Figure 3b. Over time, the number of varieties has increased consistently.

The overall picture that emerges for Spain is that of a country catching up to a more technologically advanced trading partner. Over this very long period of time, Spain undergoes a standard structural transformation, accompanied by large changes in trade patterns. Our objective is to build a model exploring the interaction between the stages of development and trade patterns and use such a model to quantify the impact of trade disruptions at different stages of the development process.

3 Model

Based on the discussion in the previous section, we develop a two-country model with trade, capital accumulation, and Stone-Geary preferences (after Stone, 1954; and Geary, 1950) over agriculture, manufacturing, and services. The final agricultural good is only used for consumption. Its production uses one type of domestic and one type of foreign intermediates, and trade happens à la Armington (1969). The intermediate agricultural good is produced using land and labor. The final manufacturing good can be either consumed or used for capital accumulation. Its production uses many domestic and foreign intermediates, combined with a Dixit and Stiglitz (1977) aggregator, and trade happens à la Krugman (1980). The producers of intermediate manufacturing varieties operate in a monopolistically competitive environment, have an increasing returns to scale technology, and use capital and labor as inputs. Finally, the services good is also used for consumption only. Its production uses one type of domestic and one type of foreign intermediates, and again trade happens à la Armington (1969). The intermediate services good is produced using capital and labor. We incorporate differentiated varieties into only manufacturing and none of the other sectors because we have data to calibrate parameters related to manufacturing varieties but not the other sectors.

Each country's productivity changes over time, and it is sector neutral. As in Kongsamut, Rebelo, and Xie (2001), with Stone-Geary preferences and sector neutral productivity growth, our model generates an evolution of sectoral GDP that is roughly consistent with the data. This is in contrast to Ngai and Pissarides (2007), who show that allowing for differential productivity per sector generates structural change in the model that is consistent with the data. Our benchmark model is simpler along this dimension. Nevertheless, in Appendices A.4 and A.5, we perform robustness exercises with sector-specific productivities. The results from the robustness exercises do not alter the conclusions of our paper.

Finally, we assume that trade in both countries is subject to the same iceberg transportation cost across sectors and trade balances every period. Even with iceberg costs that are the same across sectors, we show that our model generates observed patterns in the composition of trade by sector. The assumption about balanced trade is motivated by the empirical observation that Spain's trade was almost balanced in most years between 1850 and 2000, which we show in Figure 15b in Appendix A.1.

3.1 Households

We start by describing the problem of the household in country h (with the household in country f facing an analogous problem, with appropriate changes to f and h). The household maximizes the discounted flow of utilities by choosing consumption of agriculture, $c_{a,h,t}$, consumption of manufacturing, $c_{m,h,t}$, consumption of services, $c_{s,h,t}$, and next period assets, $a_{h,t+1}$. The problem is given by

$$\begin{aligned}
&\max_{c_{a,h,t},c_{m,h,t},c_{s,h,t},a_{h,t+1}} \sum_{t=0}^{\infty} \beta^t \frac{\left(\mu_a(c_{a,h,t}-\bar{c}_a)^{\epsilon}+\mu_m(c_{m,h,t})^{\epsilon}+\mu_s(c_{s,h,t})^{\epsilon}\right)^{\frac{\sigma-1}{\epsilon}}}{\sigma-1} \\
&\text{subject to:} \\
&\quad p_{a,h,t}c_{a,h,t}+p_{m,h,t}(c_{m,h,t}+a_{h,t+1}-(1-\delta)a_{h,t})+p_{s,h,t}c_{s,h,t} \\
&=r^K_{h,t}a_{h,t}+w_{h,t}+r^L_{h,t}L_{h,t}+\pi_{h,t},
\end{aligned} \tag{1}$$

where $p_{a,h,t}$ is the price of agriculture, $p_{m,h,t}$ is the price of manufacturing, $p_{s,h,t}$ is the price of services, $r^K_{h,t}$ is the return on savings, $w_{h,t}$ is the wage rate, $r^L_{h,t}$ is the return on land, $\pi_{h,t}$ is the sum of all the profits that all firms in the three sectors make (in equilibrium, these profits are zero), and $L_{h,t}$ is land. The parameters governing the household problem are the following: β is the discount factor, δ is the depreciation rate of capital, σ is the intertemporal elasticity of substitution, ϵ determines the elasticity of substitution across sectors, and μ_a, μ_m, and μ_s determine the expenditure on agriculture, manufacturing, and services, respectively. Finally, within-period utility exhibits preferences of the Stone-Geary form, where $\bar{c}_a$ is the minimum consumption requirement for agriculture, making it a necessity.

3.2 Production of agriculture

The agricultural sector consists of final producers selling the final good, a CES aggregate of domestic and foreign intermediates, to households, and intermediate producers selling both domestically and abroad. We now discuss the problems for the producers in country h (with the producers in country f facing an analogous problem, with appropriate changes to f and h).

The final agricultural good firm produces $y_{a,h,t}$ units of the good for price $p_{a,h,t}$ combining $x_{a,h,h,t}$ units bought from intermediate producer in h for price $q_{a,h,h,t}$ and $x_{a,h,f,t}$ units from intermediate producer in f for price $q_{a,h,f,t}$. The problem is given by

$$\begin{aligned}
\max_{y_{a,h,t},x_{a,h,h,t},x_{a,h,f,t}} \quad & p_{a,h,t}y_{a,h,t}-q_{a,h,h,t}x_{a,h,h,t}-q_{a,h,f,t}x_{a,h,f,t} \\
\text{s.t.} \quad & y_{a,h,t}=\left(\nu_a x^{\rho_a}_{a,h,h,t}+(1-\nu_a)x^{\rho_a}_{a,h,f,t}\right)^{1/\rho_a},
\end{aligned} \tag{2}$$

where parameter ν_a is a measure of the home bias in agricultural consumption and ρ_a governs the agricultural trade elasticity.

Given aggregate productivity, $Z_{h,t}$, the intermediate agricultural producer, chooses labor, $\ell_{a,h,t}$, and land, $L_{h,t}$, to maximize profits. The intermediate good is produced using a Cobb-Douglas technology with land share parameter α_a and is sold both to h, $x_{a,h,h,t}$, and to f, $x_{a,f,h,t}$. Because the production function is Cobb-Douglas, in equilibrium, intermediate agricultural producers make zero profits. The problem of the intermediate agricultural producer is given by

$$\begin{aligned} \max_{x_{a,h,h,t},x_{a,f,h,t},L_{h,t},\ell_{a,h,t}} \quad & q_{a,h,h,t}x_{a,h,h,t} + q_{a,f,h,t}x_{a,f,h,t} - r^M_{h,t}L_{h,t} - w_{h,t}\ell_{a,h,t} \\ \text{s.t.} \quad & x_{a,h,h,t} + (1+\tau_t)x_{a,f,h,t} = Z_{h,t}L^{\alpha_a}_{h,t}\ell^{1-\alpha_a}_{a,h,t}. \end{aligned} \tag{3}$$

Note that to ship one unit of the good to country f, the producer needs to ship $1+\tau_t$ units of the good.

3.3 Production of manufacturing

The manufacturing sector is similar to the agricultural sector in that it consists of final producers selling the final good to households and intermediate producers selling both domestically and abroad.

The final manufacturing good firm produces $y_{m,h,t}$ units of the good for price $p_{m,h,t}$ by using as inputs intermediate goods from the $i \in N_h$ domestic producers (she purchases $x_{m,h,h,t}(i)$ units from producer i for price $q_{m,h,h,t}(i)$) and also from the $j \in N_f$ foreign producers (she purchases $x_{m,h,f,t}(j)$ units from producer j for price price $q_{m,h,f,t}(j)$). The problem is given by

$$\begin{aligned} & \max_{y_{m,h,t},x_{m,h,h,t}(i),x_{m,h,f,t}(j)} \quad p_{m,h,t}y_{m,h,t} - \int_{i\in N_h} q_{m,h,h,t}(i)x_{m,h,h,t}(i)di \\ & - \int_{j\in N_f} q_{m,h,f,t}(j)x_{m,h,f,t}(j)dj \\ & \text{s.t. } y_{m,h,t} = \left(\nu_m \int_{i\in N_h} x_{m,h,h,t}(i)^{\rho_m}di + (1-\nu_m)\int_{j\in N_f} x_{m,h,f,t}(j)^{\rho_m}dj\right)^{1/\rho_m}, \end{aligned} \tag{4}$$

where parameter ν_m is a measure of the home bias in manufacturing consumption and ρ_m governs the manufacturing trade elasticity. The solution to this maximization problem gives demand functions for each intermediate variety that are taken into account by the producer when deciding how much to produce.

Intermediate manufacturing producer i chooses capital to rent, $k_{m,h,t}(i)$, and labor to hire, $\ell_{m,h,t}(i)$. The intermediate good is produced using a Cobb-Douglas technology with capital share parameter α_m and sold both to h, $x_{m,h,h,t}(i)$, and to f, $x_{m,f,h,t}(i)$. Operating this technology entails a fixed cost F_h, paid in units of final manufacturing good. We assume that no firm operates with negative profits, and hence, $\pi_{m,h,h,t}(i) \geq 0$. The problem of the intermediate manufacturing producer is thus given by

$$\pi_{m,h,h,t}(i) = \max \left[\max_{\substack{q_{m,h,h,t}(i),\, q_{m,f,h,t}(i),\\ k_{m,h,t}(i),\, \ell_{m,h,t}(i)}} \begin{pmatrix} q_{m,h,h,t}(i) x_{m,h,h,t}(i) + q_{m,f,h,t}(i) x_{m,f,h,t}(i) \\ -w_{h,t}\ell_{m,h,t}(i) - r_{h,t}k_{m,h,t}(i) - p_{m,h,t}F_h \end{pmatrix}, 0 \right] \tag{5}$$

$$\text{s.t. } x_{m,h,h,t}(i) + (1+\tau_t) x_{m,f,h,t}(i) = k_{m,h,t}(i)^{\alpha_m} \left(Z_{h,t}\ell_{m,h,t}(i)\right)^{1-\alpha_m},$$

where $x_{m,h,h,t}(i)$ and $x_{m,h,f,t}(i)$ are the demand functions taken as given.

3.4 Production of services

The service sector is very similar to the agricultural sector, with the difference that intermediate producers use capital rather than land to produce the good.

The final service good firm produces $y_{s,h,t}$ units of the good for price $p_{s,h,t}$ combining $x_{s,h,h,t}$ units bought from intermediate producer in h (with price $q_{s,h,h,t}$) and $x_{s,h,f,t}$ units from intermediate producer in f (with price $q_{s,f,h,t}$). Their problem is given by

$$\begin{aligned} \max_{y_{s,h,t}, x_{s,h,h,t}, x_{s,h,f,t}} \quad & p_{s,h,t} y_{s,h,t} - q_{s,h,h,t} x_{s,h,h,t} - q_{s,h,f,t} x_{s,h,f,t} \\ \text{s.t.} \quad & y_{s,h,t} = \left(\nu_s x_{s,h,h,t}^{\rho_s} + (1-\nu_s) x_{s,h,f,t}^{\rho_s}\right)^{1/\rho_s}, \end{aligned} \tag{6}$$

where the parameter ν_s is a measure of the home bias in services consumption and ρ_s governs the services trade elasticity.

The intermediate service producer chooses capital to rent, $k_{a,h,t}$, and labor to hire, $\ell_{a,h,t}$. The good is produced using a Cobb-Douglas technology with capital share parameter α_s and is sold to both h, $x_{s,h,h,t}$, and to f, $x_{s,f,h,t}$. The problem of the intermediate service producer is given by

$$\begin{aligned} \max_{x_{s,h,h,t}, x_{s,f,h,t}, k_{s,h,t}, \ell_{s,h,t}} \quad & q_{s,h,h,t} x_{s,h,h,t} + q_{s,f,h,t} x_{s,f,h,t} - r^K_{h,t} k_{s,h,t} - w_{h,t}\ell_{s,h,t} \\ \text{s.t.} \quad & x_{s,h,h,t} + (1+\tau_t) x_{s,f,h,t} = k_{s,h,t}^{\alpha_s} \left(Z_{h,t}\ell_{s,h,t}\right)^{1-\alpha_s}. \end{aligned} \tag{7}$$

3.5 Market clearing and feasibility

Finally, we write all the market clearing and feasibility conditions for this economy. We start with the final production of both agriculture and services. Note that all the production of the final good can only be consumed by the household of that country. Hence, $c_{a,h,t} = y_{a,h,t}$ and $c_{s,h,t} = y_{s,h,t}$. In the case of manufacturing, the final good can be consumed, used to pay the fixed cost to operate intermediate manufacturing varieties, or saved by the household. Hence, $c_{m,h,t} + F_h N_h + a_{h,t+1} - (1-\delta)a_{h,t} = y_{m,h,t}$.

We assume that there is free entry of intermediate manufacturing varieties, which means that $\pi_{m,h,t}(j) = 0$, an equation that is key to solving for the equilibrium number of varieties, N_h. Labor is used in all three sectors, implying that $\ell_{a,h,t} + \int_{i \in N_h} \ell_{m,h,t}(i)di + \ell_{s,h,t} = \ell_{h,t}$. Similarly, all the savings in the country are used by manufacturing or services, $\int_{i \in N_h} k_{m,h,t}(i)di + k_{s,h,t} = a_{h,t}$.

Finally, trade balances every period:

$$\begin{aligned} & q_{a,f,h,t}x_{a,f,h,t} + \int_{i \in N_h} q_{m,f,h,t}(i)x_{m,f,h,t}(i)di + q_{s,f,h,t}x_{s,f,h,t} \\ =& q_{a,h,f,t}x_{a,h,f,t} + \int_{i \in N_f} q_{m,h,f,t}(i)x_{m,h,f,t}(i)di + q_{s,h,f,t}x_{s,h,f,t}. \end{aligned} \tag{8}$$

4 Calibration and model validation

We calibrate the home country, h, to be Spain. Our paper's main focus is on the catching up country. Hence, we choose the foreign country, f, to look like the Spanish foreign sector. At the same time, our paper focuses on catching up to the industrial leader. Hence, we chose the foreign country to also look like the U.K. We combine these two needs by setting the trade volume to match that of Spain and the foreign country's GDP and trade composition to match that of the U.K. As a result, f is a scaled-up version of the U.K. that accounts for the overall Spanish foreign sector. Importantly, throughout the years of our exercise, the U.K. is not only one of Spain's main trading partners, but also its trade composition is similar to that of Spanish trade with other major trading partners (at least in the last part of our sample period).[7] Therefore, we do not view the treatment of the U.K. as a trading partner that encompasses the rest of the world from Spain's perspective as a major concern for our results.

The economy starts in 1850, and given the computational burden of the model, we assume a period is three years. The economy is calibrated such that in 1850, it is in a steady state. When the economy starts, agents are informed of new trajectories in productivity and iceberg costs. We assume that the transition is unexpected in 1853, but agents have perfect foresight thereafter.[8]

[7] The U.K. is either the first or second trading partner with Spain during the 19th century, the other one being France.

[8] To solve the model, we derive a non-linear system of equations using the first-order conditions and use

The calibration exercise consists of two parts. First, we calibrate a number of parameters outside the model equilibrium. Then, we jointly calibrate a number of parameters so that the model matches aggregate moments in both 1850 and 2000, and also the entire evolution of GDP in Spain and the U.K. and the evolution of Spain's exports to GDP from 1850 to 2000. Although we discuss a relationship between each parameter and a moment, it is important to note that all parameters are estimated jointly because they also affect the other target moments.

We start by describing the parameters that are determined outside the model equilibrium. We set $\beta = 0.885$, which implies an annual interest rate of 4%. Following Herrendorf, Rogerson, and Valentinyi (2013), we take the approach of focusing on the final consumption expenditure and set $\epsilon = -0.176$, which implies an elasticity of substitution across goods of 0.85.[9] We set $\sigma = 1$ and $\delta = 0.129$, which imply an intertemporal elasticity of substitution of 1 and an annual depreciation rate of 4.5%.

Table 1: **Parameters determined outside of the model equilibrium**

Parameter		**Description**	**Value**
β	Discount rate	Annual interest rate 4%	0.885
ϵ	Final goods elasticity parameter	Final goods elasticity = 0.85	-0.176
σ	Intertemporal elasticity	Intertemporal elasticity = 1	1.000
δ	Depreciation rate	Annual depreciation = 4.5%	0.129
α_a	Land share agriculture	Labor share agriculture = 39.8%	0.602
α_m	Capital share manufacturing	Labor share manufacturing = 69.1%	0.309
α_s	Capital share services	Labor share services = 68.5%	0.315
ρ_a	Production elasticity parameter: agriculture	Agriculture elasticity = 2.7	0.631
ρ_m	Production elasticity parameter: manufacturing	Manufacturing elasticity = 7.5	0.866
ρ_s	Production elasticity parameter: services	Services elasticity = 7.5	0.866
F_f	Fixed cost U.K.	Normalization	1.000
τ_T	Final iceberg	Normalization	0.000

Using labor compensation from the input-output tables from Spain in 2000, we compute sector-specific labor shares. We estimate $\alpha_a = 0.602$, $\alpha_m = 0.309$, and $\alpha_s = 0.315$. We set $\rho_a = 0.631$ and $\rho_m = \rho_s = 0.866$, which imply an agricultural trade elasticity of 2.7 and a manufacturing and services trade elasticity of 7.5. Our choice for the agricultural trade elasticity is within the range of estimates on trade elasticities for agriculture (1.08 to

the Newton-Raphson method.

[9]In our model, final expenditure per sector and value-added per sector are very similar. Herrendorf, Rogerson, and Valentinyi (2013) point out that the parameter we use is appropriate to match U.S. structural transformation when the model is calibrated to final expenditure, but that the parameter should approach negative infinity (preferences should be Leontief) when calibrated to the percentage of value-added. In Appendix A.6, we redo the exercise with $\epsilon = -10$ (implies an elasticity of substitution across goods of 0.09) and find that our results are robust to the alternative specification.

2.71; Bas et al. (2017)). Similarly, Bas et al. (2017) estimate an average trade elasticity (including agriculture) between 4.74 and 5.71. These estimates are on the lower end of what the literature uses as a trade elasticity. Anderson and van Wincoop (2003) summarize the range to be between 5 and 10. We choose 7.5 for the manufacturing elasticity because it is within the range of these estimates. We are not aware of good estimates for services trade. We choose to set it equal to 7.5 because estimates for the aggregate trade elasticity of modern rich economies are closer to the manufacturing elasticity than to the agricultural elasticity.

Next, we do two normalizations. First, we set the fixed cost of producing a variety in the U.K. to $F_f = 1$. In our model, a change in this number would only change the measure of varieties in operation, but everything else scales up. Later on, we calibrate its Spanish counterpart to be consistent with the ratio of varieties observed in the data. Second, we normalize the final iceberg cost, $\tau_T = 0$, which gives a relative baseline for trade costs before 2000. Given $\tau_T = 0$, we calibrate the home bias parameters to target the observed volume of trade in the year 2000 and the evolution of τ_t to target the observed volume of total trade over time.[10] Table 1 summarizes parameter estimates for this part of the calibration.

The second set of parameters are jointly determined in equilibrium. We calibrate the following parameters to target moments in 1850. We set the consumption floor for agriculture $\bar{c}_a = 0.607$ and manufacturing utility share parameter $\mu_m = 0.098$ to match the sectoral composition of Spanish GDP. Similarly, we set Spain's home bias agriculture $\nu_{h,a} = 0.866$ to match agricultural imports as a fraction of output and the U.K.'s home bias for agriculture $\nu_{f,a} = 0.611$ for its exports counterpart. We calibrate the remaining parameters to target moments in 2000. We set the agriculture utility share parameter $\mu_a = 0.027$ to match the percentage of agriculture in GDP. Given that the manufacturing utility share parameter μ_m has already been calibrated, μ_s is left as a residual to ensure that the sum of the three parameters is 1. We set Spain's home bias for manufacturing $\nu_{h,m} = 0.513$ to match Spanish exports over GDP in 2000 (we set its U.K. counterpart, $\nu_{f,m}$, to be the same value) and Spain's home bias for services $\nu_{h,s} = 0.575$ to target the fraction of Spanish exports in services (again setting its U.K. counterpart, $\nu_{f,s}$, to be the same value). Finally, we calibrate the fixed cost of operating a manufacturing variety in Spain, $F_h = 0.739$, to match the observed ratio of Spanish varieties over U.K. varieties in 2000. All these parameters are reported in Table 2. The last two columns of Table 2 show the values for the targeted moments in both the data and the model. In short, our calibration matches all the target moments.

The last part of the calibration consists of jointly targeting three sequences of macroe-

[10] In this class of trade models, both home bias parameters and iceberg trade costs jointly determine trade volumes.

conomic aggregates between 1850 and 2000 (Spanish exports over GDP, Spanish GDP per working-age population, and U.K. GDP per working-age population) using three series of parameters: (1) iceberg costs $\{\tau_t\}_{t=1850}^{2000}$; (2) Spanish productivities $\{Z_{h,t}\}_{t=1850}^{2000}$; and (3) U.K. productivities $\{Z_{f,t}\}_{t=1850}^{2000}$. In our model, we load all of the trade expansions and disruptions in iceberg costs. While this abstraction captures all changes to policies and technologies, it allows us to parsimoniously compare trade disruptions at different stages of development.

Table 2: **Parameters determined jointly in model equilibrium**

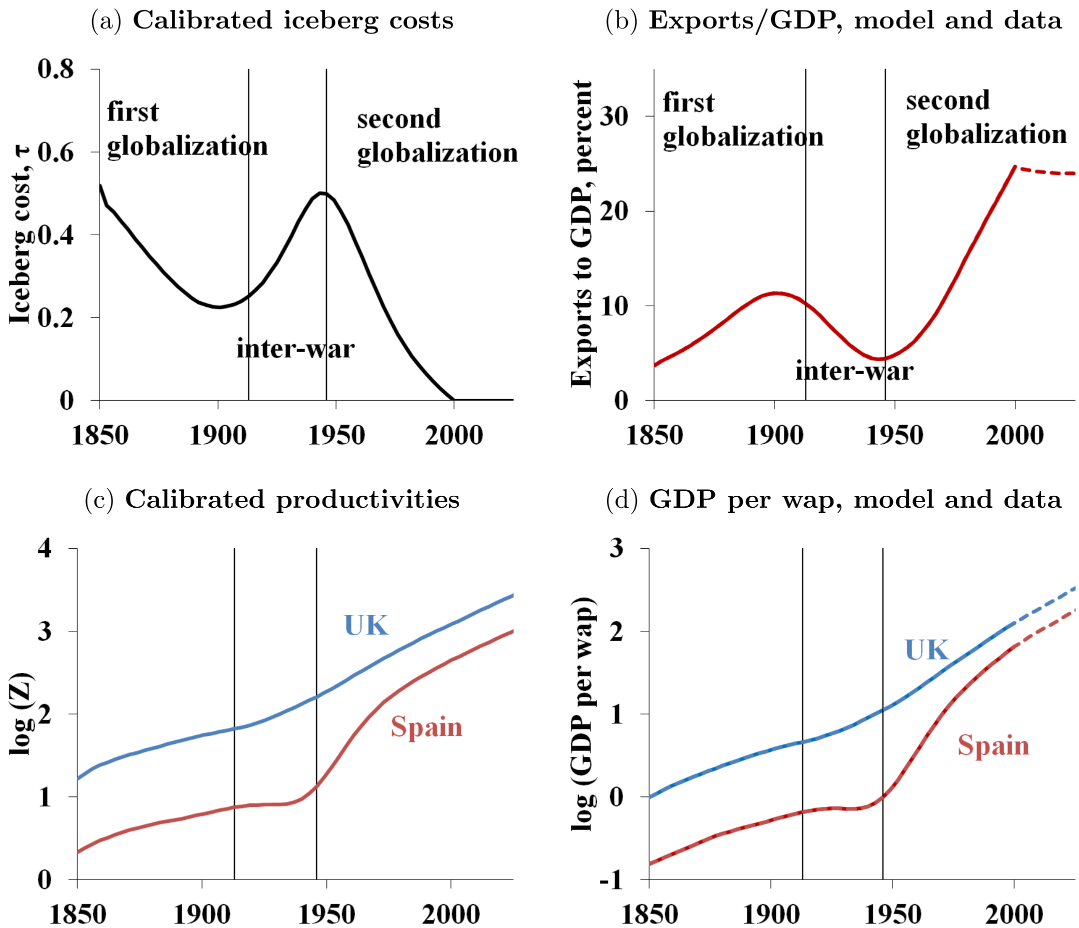
Parameter		**Value**	**Target**	**Year**	**Model**	**Data**
$\bar{c}_a$	Agri cons floor	0.607	% Agri in GDP	1850	*0.402*	*0.402*
μ_m	Manu utility share	0.098	% Manu in GDP	1850	*0.150*	*0.150*
$\nu_{h,a}$	Spain Agri home bias	0.866	Spain Agri Imp/GDP	1850	*0.085*	*0.085*
$\nu_{f,a}$	U.K. Agri home bias	0.611	Spain Agri Exp/GDP	1850	*0.778*	*0.778*
μ_a	Agri utility share	0.027	% Agri in GDP	2000	*0.040*	*0.040*
μ_s	Serv utility share	0.875	$1-\mu_a-\mu_m$	–	–	–
$\nu_{h,m}$	Spain manu home bias	0.513	Spain Exp/GDP	2000	*0.247*	*0.247*
$\nu_{f,m}$	U.K. manu home bias	0.513	$\nu_{f,m}=\nu_{h,m}$	–	–	–
$\nu_{f,s}$	U.K. serv home bias	0.575	Spain Serv Exp/GDP	2000	*0.310*	0.*310*
$\nu_{h,s}$	Spain serv home bias	0.575	$\nu_{h,s}=\nu_{f,s}$	–	–	–
F_h	Spain fixed cost	0.739	Spain/U.K. varieties	2000	*0.878*	*0.879*

In Figure 4a, we plot the calibrated series for the iceberg cost, τ_t, since 1850. This series is calibrated such that the model matches the evolution of exports over GDP in Spain (Figure 4b). Note that Figure 4b has two series: a solid line, the trend data (as discussed in Section 2) and a dashed line, the predicted series by the model. Even with iceberg costs that are the same across sectors, below we show that our model generates observed patterns in the composition of trade by sector. Therefore, we do not view the abstraction from sector-specific iceberg costs as a major concern for our results.

In Figure 4c, we plot the calibrated productivity series, in red, for Spain, $Z_{h,t}$, and, in blue, for the U.K., $Z_{f,t}$. Again, these series are calibrated such that the model matches the observed evolution of GDP per working-age population in Spain and the U.K. This can be seen in Figure 4d. It has four series: two in red for Spain and two in blue for the U.K. In both cases, the solid line is the trend data and the dashed line is the predicted series by the model. As was the case in Figure 4b, the dashed lines lie on top of each other because the model exactly matches the data.

Model validation: We have calibrated the model to reproduce the composition of trade and output in 1850 and 2000 and to match the evolution of both GDP per capita in the two countries and the aggregate volume of trade from 1850 to 2000. However, we did not target

Figure 4: Calibration of iceberg costs τ_t and productivity $Z_{i,t}$

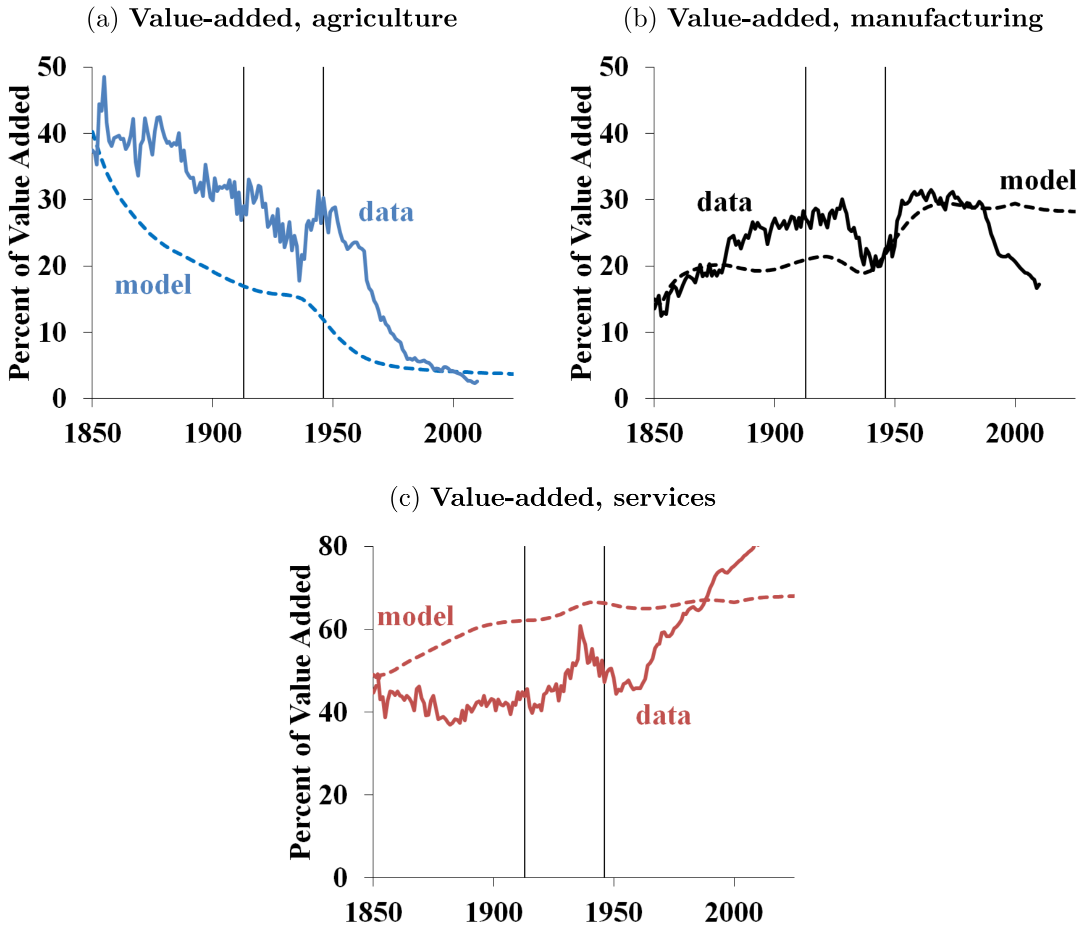


Notes: Figure 4a plots the calibrated series for the iceberg cost, τ_t. Figure 4b plots the evolution of exports over GDP for Spain in model (dashed line) and data (solid line). Figure 4c plots the calibrated productivity series for Spain, $Z_{h,t}$, in red, and for the U.K., $Z_{f,t}$, in blue. Figure 4d plots GDP per working-age person (WAP) for Spain, $Z_{h,t}$, in red, and for the U.K., $Z_{f,t}$, in blue, in both model (dashed line) and data (solid line).

the time series for the composition of output, total investment, and composition of trade between 1850 and 2000. That is exactly the data of interest for us, which we use to validate the model.

In Figures 5a, 5b, and 5c, we plot the share of output accounted for by agriculture, manufacturing, and services both in the data (solid line, using the accounts from Prados de la Escosura, 2015) and the model (dashed line). The model does reasonably well in accounting for the composition of Spanish GDP over time given that these moments were not targeted in our calibration. In the case of agriculture, both the model and the data exhibit a remarkably similar pattern. In both cases there is a fall, which is more pronounced at the beginning of the second globalization. For the manufacturing sector, again model and

Figure 5: Non-targeted moments: value-added shares in Spain

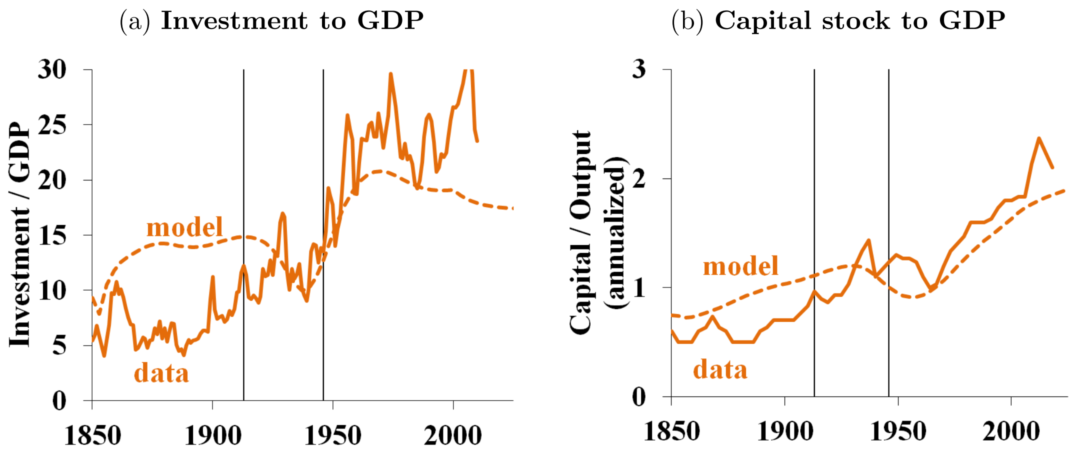


Notes: Figures 5a, 5b, and 5c plot the share of output accounted for by agriculture, manufacturing, and services both in the data (solid line, using the accounts from Prados de la Escosura, 2015) and the model (dashed line) for Spain.

data exhibit similar patterns except in the last two decades of the 20th century. For the services sector, both in the model and data, we observe an increase over time. The series from the model grows consistently at a similar rate, but the series from the data exhibits a flatter behavior throughout the first century and rapidly grows during the second wave of globalization. In Appendices A.2 and A.3, we show that the model also qualitatively accounts for the structural transformation of the U.K. and the evolution of relative prices in Spain, respectively.

In Figure 6a, we plot the percentage of Spanish GDP that is used for investment in the data (solid line) and the model (dashed line). Although the model slightly over-predicts the level of investment in the first half of our period and under-predicts it in the second half, it is nonetheless able to reproduce the transition from a low-investment to a high-investment economy. It is remarkable how well the model captures the fall and spike in investment that occurred in the second half of the inter-war period and the beginning of the second wave of globalization. In Figure 6b, we show that the model also accounts for the level of and changes in Spain's capital-to-GDP ratio.

Figure 6: Non-targeted moments: investment and capital in Spain

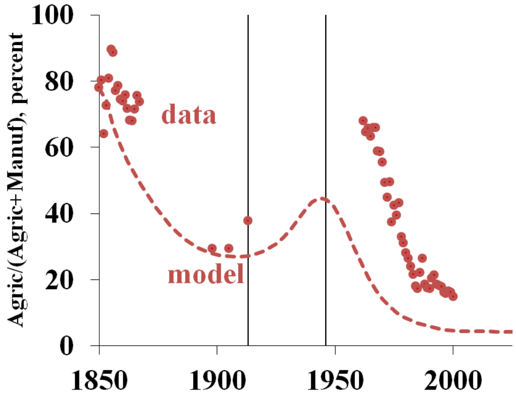


Notes: Figure 6a plots investment as a share of GDP in the model and data for Spain. Figure 6b plots capital as a share of data for Spain.

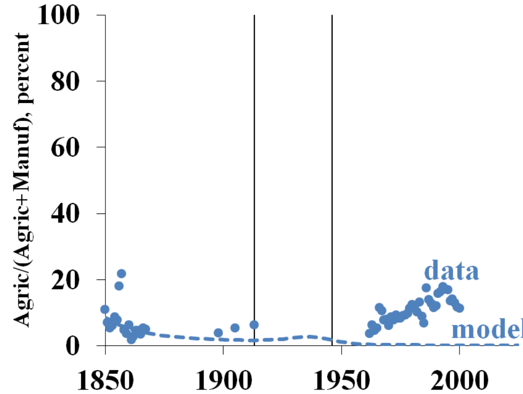
Having shown that our model rationalizes observed patterns related to the sectoral composition of GDP and total investment from 1850 to 2000 in Spain, we now validate the model against observed trade patterns in the same time period. In Figures 7a and 7b, we plot Spain's exports (imports) in agriculture normalized by the sum of exports (imports) in agriculture and manufacturing. The scattered dots are the data and the dashed lines are the model. Importantly, the only values that are targeted are those in 1850. For Spain's agricultural exports to the U.K. (Figure 7a), the model rationalizes the observed fall from 1850 to the early 1900s. Unfortunately, data are not available for the inter-war period, and they do not start again until the 1960s. In the 1960s, the share of agriculture is again very high in the data but it decreases sharply again. The model generates a similar pattern, with the hump peaking right before the 1950s and a pronounced decline afterward. While this result implies that the model generates the second fall in the share of agriculture a bit prematurely, the similarity between the data and model is remarkable, especially taking into consideration that we did not target these moments. Regarding Spain's imports of agriculture (Figure 7b), both the model and the data are consistent in that agricultural import shares are small over the whole time period. The main difference arises closer to the 2000s, when the share of agricultural imports converges to zero in the model because of Stone-Geary preferences.

Figure 7: Non-targeted moments: trade variables

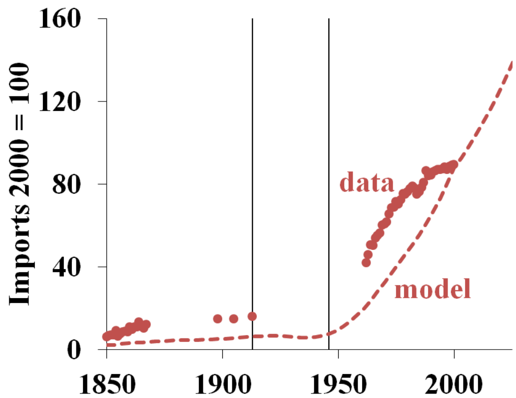
(a) **Spain's trade in agriculture, exports**



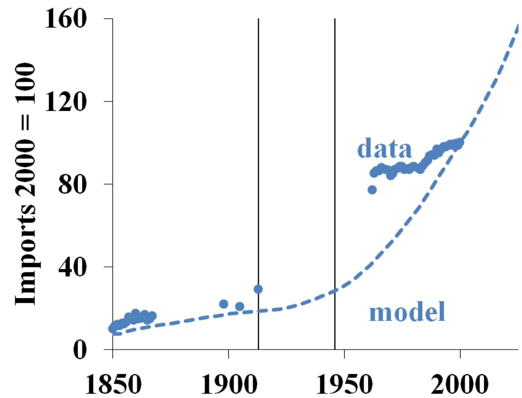
(b) **Spain's trade in agriculture, imports**



(c) **Num. varieties exported by Spain**



(d) **Num. varieties imported by Spain**



Notes: Figures 7a and 7b plot Spain's exports (imports) in agriculture normalized by the sum of exports (imports) in agriculture and manufacturing in the model (dashed line) and data (scattered dots). Figures 7c and 7d plot Spain's number of traded varieties for both exports and imports in the model (dashed line) and data (scattered dots).

In Figures 7c and 7d, we show that the model does a good job at replicating the path of the number of traded varieties for both exports and imports. Recall that the only calibration target is the number of varieties in the year 2000. Despite having only calibrated that year, our model accounts for the fact that there are more varieties imported than exported, and that both series grow over time, especially during the second wave of globalization.

Given the model's success in accounting for the evolution of sectoral shares of output, total investment, and composition of trade between 1850 and 2000, we use it to study the impact of trade disruptions. In the following section, we compare the IWTC to a similar collapse today.

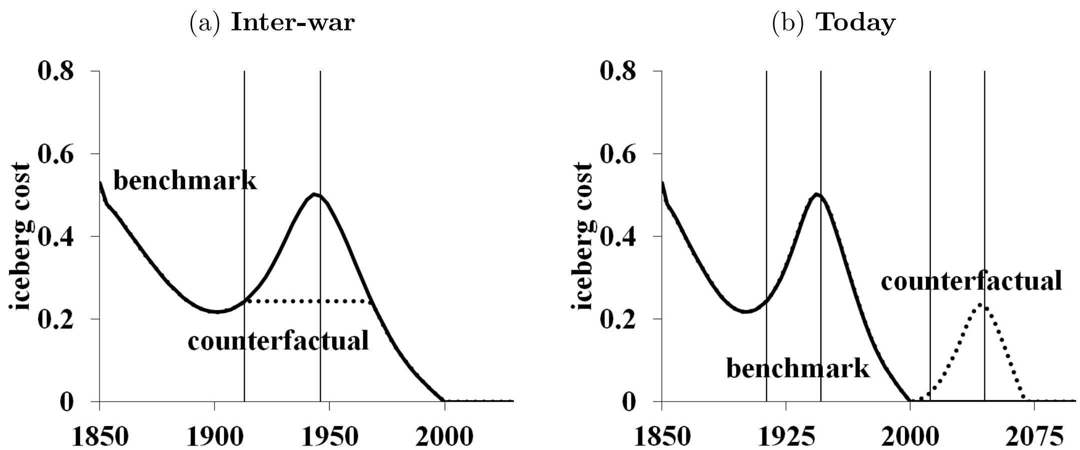
5 Cost of trade disruptions

In this section, we compare the IWTC to a similar collapse today. To do that comparison, we perform two experiments. Our calibration implies a spike in trade costs during the IWTC (Figure 4a). Therefore, in our first experiment, we compare the benchmark economy to a counterfactual economy (counterfactual-1) in which the spike does not happen. For counterfactual-1, we assume that trade costs for $t > 1913$ are the minimum of the calibrated trade costs at the beginning of the IWTC (τ_{1913}) and the calibrated trade costs in period t (τ_t). Let τ_t^{cf1} denote the trade costs for counterfactual-1. For $t > 1913$, the trade costs are given by

$$\tau_t^{\mathrm{cf1}} = \min[\tau_{1913}, \tau_t].$$

In Figure 8a, we plot the counterfactual trade costs (dashed line) along with the calibrated trade costs in our benchmark model (solid line).

Figure 8: Iceberg costs



Notes: Figure 8a plots the trade costs in counterfactual-1 (dashed line) along with the calibrated trade costs in our benchmark model (solid line). Figure 8b plots the trade costs in counterfactual-2 (dashed line) along with the calibrated trade costs in our benchmark model (solid line).

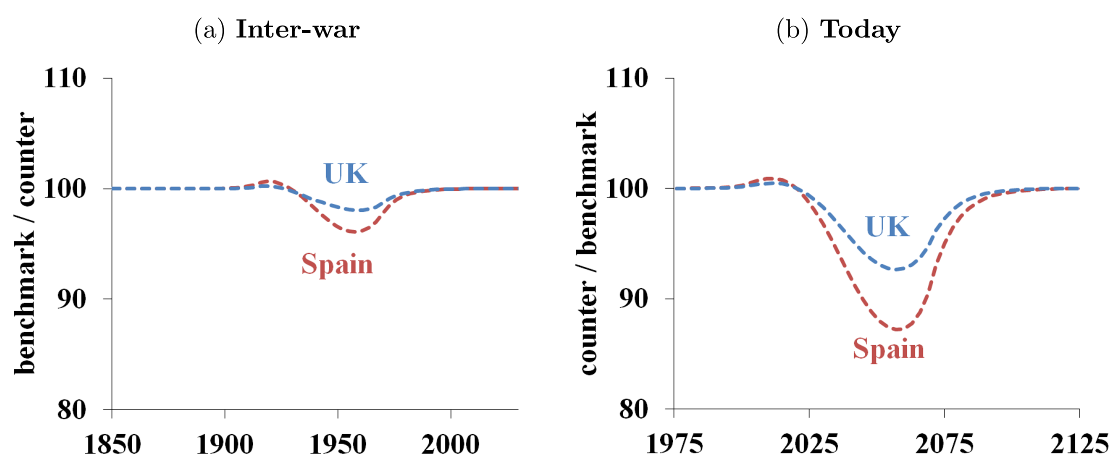
In the second experiment, we compare the benchmark to a counterfactual economy (counterfactual-2) that faces a trade collapse today (starting in the year 2000). To maintain comparability between a trade collapse today and the trade collapse during the inter-war period, we make sure that the relative increase in the cost is the same in both periods. That is, we ensure that the percentage increase in trade costs since 2000 is the same as the percentage increase in trade costs since 1913. Thus, trade costs for counterfactual-2, τ_t^{cf2}, satisfy

$$\frac{1+\tau^{\text{cf2}}_{2000+t}}{1+\tau_{2000+t}} = \frac{1+\tau_{1913+t}}{1+\tau^{\text{cf1}}_{1913+t}},$$

where τ^{cf1}_t are the iceberg trade costs in counterfactual-1 and $\tau_{2000+t} = 0$ (Figure 4a). We plot the trade costs for counterfactual-2 as the dashed line in Figure 8b (again, the solid line is the benchmark).

In Figure 9a, we plot the evolution of capital $(a_{h,t}, a_{f,t})$ in the benchmark (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs; Figure 8a). The red line plots the ratio for Spain, and the blue line plots the ratio for the U.K. We see that right before trade costs increase, the capital stock increases, albeit marginally, so that consumers can benefit from temporarily cheaper inputs. After that, more expensive inputs yield a lower capital stock. The capital stock in Spain falls by around 4% at the trough. In the U.K., the magnitude of the fall is smaller. In Figure 9b, we plot the evolution of capital in counterfactual-2 (where there now is a trade collapse; Figure 8b), as a percentage of the benchmark (where there is no spike in trade costs in the 2000s). Again, the red line plots the ratio for Spain and the blue line for the U.K. Qualitatively, the picture in Figure 9b is the same as in Figure 9a. However, the magnitudes differ substantially. In fact, the trough of the fall is at 12% in Spain. The fall in the U.K. is smaller than in Spain but much larger than it was during the IWTC.

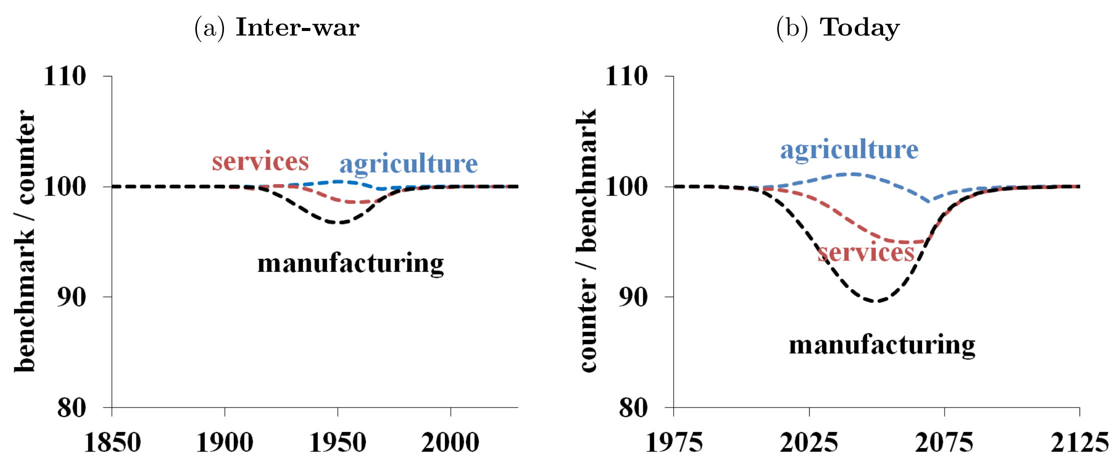
Figure 9: Capital



Notes: Figure 9a plots the evolution of capital in the benchmark (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs; Figure 8a) for both Spain (red line) and the U.K. (blue line). Figure 9b plots the evolution of capital in counterfactual-2 (where there is a new trade collapse; Figure 8b) as a percentage of the benchmark (where there is no spike in trade costs in the 2000s) for both Spain (red line) and the U.K. (blue line).

Figure 10a plots the change in consumption by sector during the IWTC. The fall is roughly 4% in manufacturing around the trough. Services fall less, and agriculture increases for most of the period. Figure 10b, on the other hand, shows that the fall in consumption today in Spain is roughly 12% in manufacturing around the trough. As with the case of the fall in the capital stock, this fall is roughly three times larger than during the IWTC. Services fall more and agriculture increases marginally more compared to the IWTC. The larger fall in the consumption of manufacturing and services showcases that the cost of a trade collapse today is larger than during the inter-war period. The increase in agricultural consumption is driven by a lower capital stock. That is, less capital implies that the marginal product of labor is largest in agriculture (which only uses land), and hence, output and consumption in that sector grow (although not very much). Although we do not show the consumption series for the U.K., they are similar to that of Spain but of smaller magnitudes.

Figure 10: Consumption by sector in Spain

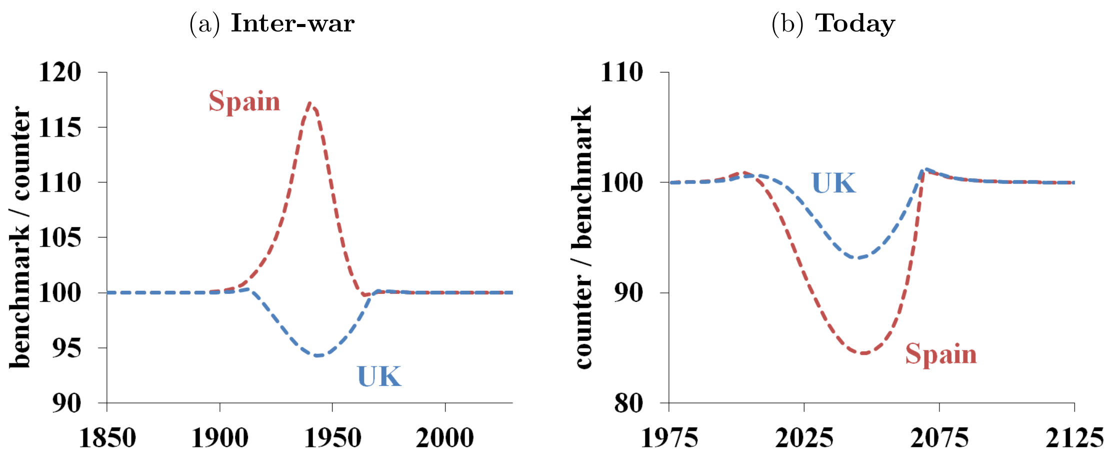


Notes: Figure 10a plots the evolution of consumption by sector in the benchmark (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs; Figure 8a) for Spain. Figure 10b plots the evolution of consumption by sector in counterfactual-2 (where there is a new trade collaps; Figure 8b) as a percentage of the benchmark (where there is no spike in trade costs in the 2000s) for Spain.

To summarize, the IWTC generated a drop in capital and consumption smaller than what could happen in a similar collapse today. Another result that we highlight in our study is the impact of trade costs on the number of varieties. In Figure 11a, we plot the evolution of the number of varieties in Spain (red) and the U.K. (blue) during the IWTC. Likewise, in Figure 11b, we do the same for the collapse today.

The most striking pattern is that the number of varieties falls for the U.K. in both scenarios and falls in Spain during the collapse today, whereas it increases during the IWTC for Spain. In both cases, the U.K. is the richer economy. When hit by a spike in trade costs, it loses access to the Spanish market, and hence, building varieties becomes more expensive.

Figure 11: Number of varieties in Spain and the U.K.



Notes: Figure 11a plots the evolution of the number of varieties in the benchmark (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs; Figure 8a) for both Spain (red line) and the U.K. (blue line). Figure 11b plots the evolution of the number of varieties in counterfactual-2 (where there is a new trade collapse; Figure 8b) as a percentage of the benchmark (where there is no spike in trade costs in the 2000s) for both Spain (red line) and the U.K. (blue line).

The fall of varieties in Spain in today's collapse happens for a very similar reason — after all, Spain is technologically very close to the U.K. today. However, the number of varieties increases in Spain during the IWTC. This result is caused by the dire need to accumulate capital in Spain when it is very poor. When trade costs are low, capital is accumulated by using cheap U.K. varieties. With a trade cost increase, however, the country uses more resources toward building its own varieties to increase the capital stock. The logic behind this result is very similar to that of import substitution.

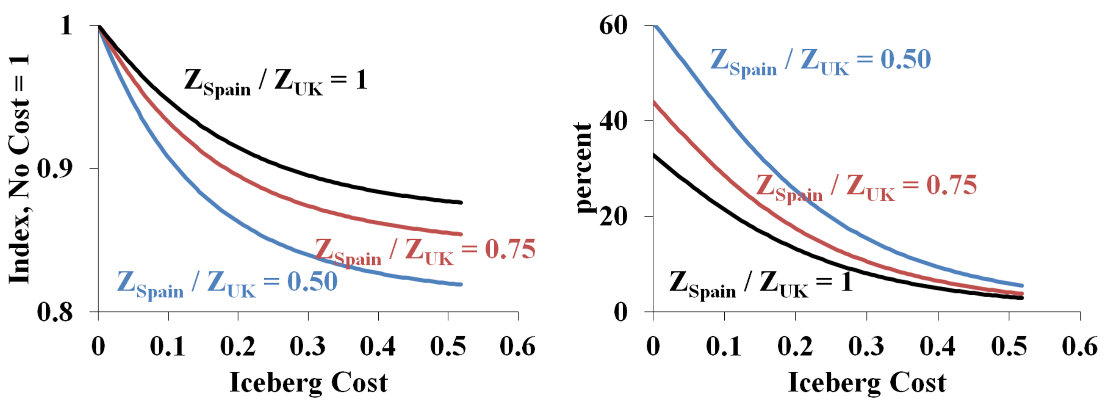
6 Technology, openness, and varieties

The counterfactual exercises presented in the previous section yield two main results. First, an increase in trade frictions today of relatively the same magnitude as the IWTC would have a larger effect on the capital stock (Figure 9). Second, the IWTC led to an increase in the number of varieties consumed in Spain, but a similar collapse today would lead to a decrease (Figure 11). In this section, we use additional simulations to highlight the key model mechanisms responsible for these two results.

From the perspective of Spain, the two trade collapses differ in two respects: distance to the frontier ($Z_{h,t}/Z_{f,t}$) and the overall level of trade frictions (τ_t). Today, Spain is both closer to the frontier (high $Z_{h,t}/Z_{f,t}$, Figure 4c) and enjoys a lower level of trade costs than just prior to the IWTC (low τ_t, Figure 4a). In what follows, we show that a smaller distance to the frontier decreases the impact of a trade collapse on the capital stock, and a lower level of trade frictions increases it. Therefore, when comparing the two trade collapses, both effects are active, but the second effect quantitatively dominates the first.

Figure 12: The effects of trade costs and distance to the frontier

(a) **Spain's Capital Stock** (b) **Spain's share of foreign interm. manuf.**



Notes: Figure 12a plots Spain's steady state capital stock when Spain's productivity is the same as that of the U.K. (black line), when Spain's productivity is 75% of the productivity in the U.K. (red line), and when Spain's productivity is 50% of the productivity in the U.K. (blue line). Each line consists of all the steady states associated with different levels of iceberg costs, which range from 0 (when trade costs are at their level in the year 2000) to 0.6 (the peak of calibrated trade costs). For comparability, the three lines are normalized to 1 when iceberg costs are zero. Analogously, Figure 12b plots Spain's foreign manufacturing intermediates as a share of total manufacturing.

We are also able to show that if the distance to the frontier is sufficiently large, an increase in trade frictions leads to an increase in the number of manufacturing varieties produced in the catching-up country. In other words, trade barriers, though they reduce consumption, could promote industrialization if the distance to the frontier is sufficiently large.

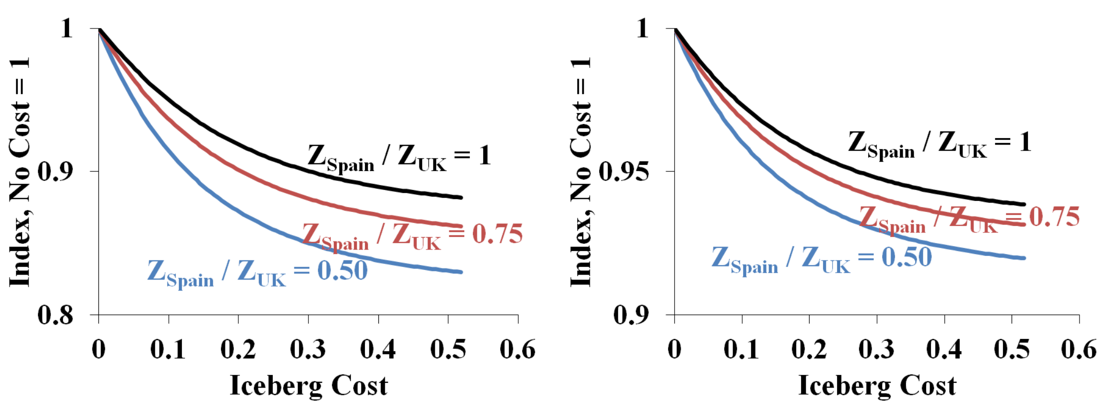
We solve the model at multiple steady states with different levels of iceberg costs and relative productivities ($Z_{\text{Spain}}/Z_{\text{U.K.}}$) and plot comparative statics on the steady state level of capital, consumption, and the number of varieties. In Figure 12a, we plot Spain's capital stock when Spain's productivity is the same as that of the U.K. (black line), when Spain's productivity is 75% of the productivity in the U.K. (red line), and when Spain's productivity is 50% of the productivity in the U.K. (blue line). Each line consists of all the steady states associated with different levels of iceberg costs, which range from 0 (when trade costs are at their level in the year 2000) to 0.6 (the peak of calibrated trade costs). For comparability, the three lines are normalized to 1 when trade is costless. We find that increases in trade costs make the capital stock fall the most when Spain is at a greater distance from the U.K. (the black line is above the red, which is above the blue). At the same time, the fall is more pronounced when the economy is more open, that is, when the iceberg costs are lower (the three lines are concave).

In our model, the catching-up country benefits from openness to the industrial leader because trade provides access to differentiated, cheaper goods. The catching-up country both consumes these goods and uses them to build up its capital stock. The catching-up country benefits relatively more from foreign goods if the country is more open because these goods are cheaper. That is, a smaller τ boosts development. Similarly, the benefits are also larger if the industrial leader is relatively more developed because foreign goods become cheaper. Hence, a larger distance between Z_h and Z_f also boosts development in the catching-up country. In Figure 12b, we plot foreign manufacturing intermediates as a share of total manufacturing for Spain. We find that foreign intermediates in manufacturing are more prominent when trade is cheaper. Furthermore, this is more important when the distance to the industrial leader is larger. Hence, we find that the more open and the larger the distance, the larger the (negative) effect of a (negative) trade shock on the capital stock.

Next, we look at the effect on consumption. In Figure 13a, we plot manufacturing consumption, and in Figure 13b, we plot services consumption. The picture that emerges is qualitatively similar to that of capital: higher trade costs and higher distance to the leader lower consumption. The key difference is in the magnitudes, where the fall in services is less pronounced. This happens because manufacturing is used for both consumption and investment, whereas services are not.

Figure 13: Spanish consumption manufacturing and services

(a) **Manufacturing** (b) **Services**

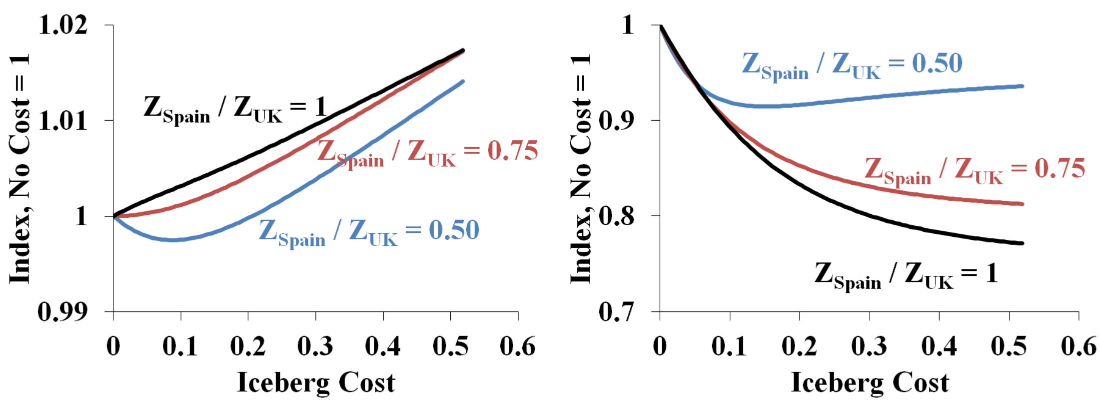


Notes: Figure 13a plots the level of Spain's steady state manufacturing consumption when Spain's productivity is the same as that of the U.K. (black line), when Spain's productivity is 75% of the productivity in the U.K. (red line), and when Spain's productivity is 50% of the productivity in the U.K. (blue line). Each line consists of all the steady states associated with different levels of iceberg costs, which range from 0 (when trade costs are at their level in the year 2000) to 0.6 (the peak of calibrated trade costs). For comparability, the three lines are normalized to 1 when iceberg costs are zero. Analogously, Figure 13b plots Spain's steady state services consumption.

Although magnitudes are small, we find an interesting pattern with agricultural consumption, which we plot in Figure 14a. Spanish consumption of agriculture goes up with increases in trade costs. As trade costs increase and the U.K.'s demand for Spanish goods decreases, the three intermediate sectors in Spain need to produce less output. Manufacturing and services can adjust using less capital; the adjustment in agriculture can only come from using less labor because land is fixed. This, in turn, disproportionately reduces the price of intermediate agriculture in Spain, and Spanish consumers can expand their agricultural consumption. While this mechanism partially offsets the cost of higher trade costs, its effect is less strong when Spain is at a greater distance from the U.K.

Figure 14: Agriculture consumption and number of varieties in Spain

(a) **Agriculture** (b) **Varieties**



Notes: Figure 14a plots the level of Spain's steady state agriculture consumption when Spain's productivity is the same as that of the U.K. (black line), when Spain's productivity is 75% of the productivity in the U.K. (red line), and when Spain's productivity is 50% of the productivity in the U.K. (blue line). Each line consists of all the steady states associated with different levels of iceberg costs, which range from 0 (when trade costs are at their level in the year 2000) to 0.6 (the peak of calibrated trade costs). For comparability, the three lines are normalized to 1 when iceberg costs are zero. Analogously, Figure 14b plots Spain's steady state number of varieties.

Finally, we analyze the role that varieties play in our model. As we showed in the previous section, the number of varieties in the U.K. falls in both exercises (Figure 11). This also happens in Spain with a trade cost occurring today. During the IWTC, however, Spanish varieties increase. In Figure 14b, we plot the number of varieties at the steady state under different iceberg cost and productivity differences. The number of varieties monotonically falls with increased trade costs when the distance in technologies is small (black and red lines). This happens because larger costs reduce the ability of both countries to sell to the foreign market, thereby limiting how many varieties can be produced. When the distance is large (blue line) and trade costs are large enough, the number of varieties grows with increased trade costs. The reason is that the less productive country wants to accumulate capital and relies on cheaper inputs from the more productive trading partner. A spike in trade costs in that case forces the poorer country to start producing those (imperfectly substitutable, expensive) varieties domestically. This result is consistent with import substitution policies in which the poor country loses access to trade, and as a result, has a spike in its industrialization.

7 Concluding remarks

In this paper, we constructed a model to understand the implications of trade disruptions at different stages of the development process from the perspective of the catching up country. The key element highlighted in our analysis is the interaction between technological development and trade openness. While we focus on Spain catching up to and trading with the U.K., we believe our analysis is a step toward understanding the same phenomenon for different countries at different points in time. For example, this type of analysis could be used in the case of countries that start the catching up process further away from the frontier and whose catching up process is still ongoing (e.g., India or China with respect to the United States).

Finally, our exercise suggests caution regarding industrialization policies. In our model, trade disruptions may stimulate manufacturing production for countries that are far from the technological frontier, but that process is costly.

References

Alessandria, G. and Choi, H. (2007). 'Do Sunk Costs of Exporting Matter for Net Exports Dynamics?' *Quarterly Journal of Economics*, volume 122, no. 1, 289–336.

Alessandria, G. and Choi, H. (2014). 'Establishment Heterogeneity, Exporter Dynamics, and the Effects of Trade Liberalization'. *Journal of International Economics*, volume 94, no. 2, 207–223.

Anderson, J. E. and van Wincoop, E. (2003). 'Gravity with Gravitas: a Solution to the Border Puzzle'. *American Economic Review*, volume 93, no. 1, 170–192.

Armington, P. S. (1969). 'A Theory of Demand for Products Distinguished by Place of Production'. *IMF Staff Papers*, volume 16, no. 1, 159–178.

Bas, M., Mayer, T., and Thoenig, M. (2017). 'From Micro to Macro: Demand, Supply, and Heterogeneity in the Trade Elasticity'. *Journal of International Economics*, volume 108, 1–19.

Betts, C., Giri, R., and Verma, R. (2017). 'Trade, Reform, and Structural Transformation in South Korea'. *IMF Economic Review*, volume 65, no. 4, 745–791.

Boppart, T. (2014). 'Structural Change and Kaldor Facts in a Growth Model with Relative Price Effects and Non-Gorman Preferences'. *Econometrica*, volume 82, 2167–2196.

Brooks, W. J. and Pujolas, P. S. (2018). 'Capital Accumulation and the Welfare Gains from Trade'. *Economic Theory*, volume 66, no. 2, 491–523.

Buera, F. J. and Kaboski, J. P. (2009). 'Can Traditional Theories of Structural Change Fit the Data?' *Journal of the European Economic Association*, volume 7, 469–477.

Buera, F. J. and Kaboski, J. P. (2012). 'The Rise of the Service Economy'. *American Economic Review*, volume 102, 2540–2569.

Comin, D., Mestieri, M., and Lashkari, D. (2020). 'Structural Change with Long-run Income and Price Effects'. Econometrica, *forthcoming*.

Crucini, M. J. and Kahn, J. (1996). 'Tariffs and Aggregate Economic Activity: Lessons from the Great Depression'. *Journal of Monetary Economics*, volume 38, 427–467.

Crucini, M. J. and Kahn, J. (2007). 'Tariffs and the Great Depression Revisited'. *Great Depressions of the 20th Century*.

Dennis, B. N. and Iscan, T. B. (2009). ‘Engel bersus Baumol: Accounting for Structural Change Using Two Centuries of U.S. Data’. *Explorations in Economic History*, volume 46, 186–202.

Desmet, K. and Parente, S. L. (2012). ‘The Evolution of Markets and the Revolution of Industry: a Unified Theory of Growth’. *Journal of Economic Growth*, volume 17, 205–234.

Dirección General de Aduanas de España (1849–1855). ‘Cuadro General del Comercio Exterior de España con sus Posesiones Ultramarinas y Potencias Estrangeras’.

Dirección General de Aduanas de España (1856–1867,1898,1905,1913). ‘Estadística General del Comercio Exterior de España con sus Posesiones Ultramarinas y Potencias Extranjeras’.

Dixit, A. K. and Stiglitz, J. E. (1977). ‘Monopolistic Competition and Optimum Product Diversity’. *American Economic Review*, volume 67, no. 3, 297–308.

Eaton, J. and Kortum, S. S. (2002). ‘Technology, Geography, and Trade’. *Econometrica*, volume 70, no. 5, 1741–1779.

Echevarria, C. (1995). ‘Agricultural Development versus Industrialization: Effects of Trade’. *Canadian Journal of Economics*, volume 28, no. 3, 317–334.

Ferreira, P. C., Pessôa, S., and dos Santos, M. R. (2016). ‘Globalization and the Industrial Revolution’. *Macroeconomic Dynamics*, volume 20, 643–666.

García-Santana, M., Pijoan-Mas, J., and Villacorta, L. (2018). ‘Investment and Structural Change’. Working paper.

Geary, R. C. (1950). ‘A Note on ‘A Constant-Utility Index of the Cost of Living”. *Review of Economic Studies*, volume 18, no. 2, 65–66.

Herrendorf, B., Rogerson, R., and Valentinyi, A. (2013). ‘Two Perspectives on Preferences and Structural Transformation’. *American Economic Review*, volume 103, no. 7, 2752–2589.

Herrendorf, B., Rogerson, R., and Valentinyi, A. (2014). ‘Growth and Structural Transformation’. In Aghion, P. and Durlauf, S. N., editors, ‘Handbook of International Economics’, volume 2, chapter 6, pages 855–941. Elsevier.

Hodrick, R. and Prescott, E. C. (1997). 'Postwar U.S. Business Cycles: An Empirical Investigation'. *Journal of Money, Credit, and Banking*, volume 29, no. 1, 1–16.

Jacks, D. S., Meissner, C. M., and Novy, D. (2008). 'Trade Costs, 1870-2000'. *The American Economic Review, Papers and Proceedings of the One Hundred Twentieth Annual Meeting of the American Economic Association*, volume 98, no. 2, 529–534.

Kehoe, T. J. and Ruhl, K. J. (2013). 'How Important Is the New Goods Margin in International Trade?' *Journal of Political Economy*, volume 121, no. 2, 358–392.

Kehoe, T. J., Ruhl, K. J., and Steinberg, J. B. (2018). 'Global Imbalances and Structural Change in the United States'. *Journal of Political Economy*, volume 126, no. 2, 761–796.

Kongsamut, P., Rebelo, S., and Xie, D. (2001). 'Beyond Balanced Growth'. *Review of Economic Studies*, volume 68, 869–882.

Krugman, P. R. (1980). 'Scale Economies, Product Differentiation, and the Pattern of Trade'. *American Economic Review*, volume 70, no. 5, 950–59.

Kuznets, S. (1973). 'Modern Economic Growth: Findings and Reflections'. *American Economic Review*, volume 63, 247–258.

Maddison Project (2013). 'http://www.ggdc.net/maddison/maddison-project/home.htm'. 2010 and 2013 versions.

Matsuyama, K. (1992). 'Agricultural Productivity, Comparative Advantage, and Economic Growth'. *Journal of Economic Theory*, volume 58, 317–334.

McGrattan, E. R. and Waddle, A. (2020). 'The Impact of Brexit on Foreign Investment and Production'. *American Economic Journal: Macroeconomics*, volume 12(1), 76–103.

Ngai, L. R. and Pissarides, C. A. (2007). 'Structural Change in a Multisector Model of Growth'. *American Economic Review*, volume 97, 429–443.

Perri, F. and Quadrini, V. (2002). 'The Great Depression in Italy: Trade Restrictions and Real Wage Rigidities'. *Review of Economic Dynamics*, volume 5, 128–151.

Prados de la Escosura, L. (2015). 'Spain's Historical National Accounts: Expenditure and Output, 1850-2015'. EHES Working Papers in Economic Hisotry, no. 103.

Ravikumar, B., Santacreu, A. M., and Sposi, M. (2019). 'Capital Accumulation and Dynamic Gains from Trade'. *Journal of International Economics*, volume 119, 93–110.

Ruhl, K. J. and Willis, J. L. (2017). 'New Exporter Dynamics'. *International Economic Review*, volume 58, no. 3, 703–725.

Steinberg, J. B. (2019). 'Brexit and the Macroeconomic Impact of Trade Policy Uncertainty'. *Journal of International Economics*, volume 117, 175–195.

Steinberg, J. B. (2020). 'The Macroeconomic Impact of NAFTA Termination'. *Canadian Journal of Economics*, volume 53, 821–865.

Stokey, N. L. (2001). 'A Quantitative Model of the British Industrial Revolution, 1780-1850'. *Carnegie Rochester Conference Series on Public Policy*, volume 55, 55–109.

Stone, R. (1954). 'Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand'. *Economic Journal*, volume 64, no. 255, 511–527.

Teignier, M. (2018). 'The Role of Trade in Structural Transformation'. *Journal of Development Economics*, volume 130, 45–65.

Uy, T., Yi, K.-M., and Zhang, J. (2013). 'Structural Change in an Open Economy'. *Journal of Monetary Economics*, volume 60, no. 6, 667–682.

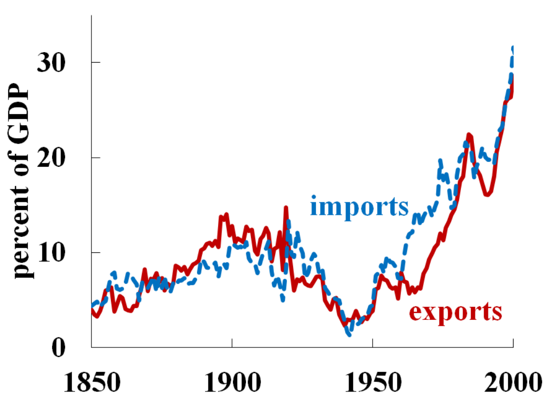
A Appendix

A.1 Spain's exports, imports, and trade balance

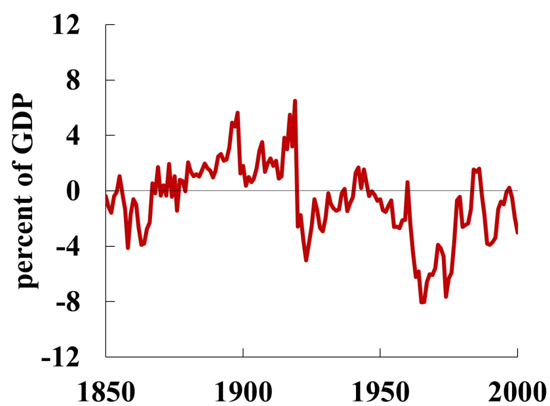
Figure 15a plots Spain's exports and imports as a percentage of GDP from 1850 to 2000. Figure 15b plots Spain's trade balance as a percentage of GDP from 1850 to 2000. Spain's trade is almost balanced in most periods. It ranges from -8.1 to 6.5% of GDP, and the average in this period is -0.8% of GDP. This empirical observation motivates our assumption of balanced trade in our model.

Figure 15: Spain's exports, imports, and trade balance (percentage of GDP)

(a) **Exports and imports**



(b) **Trade balance**



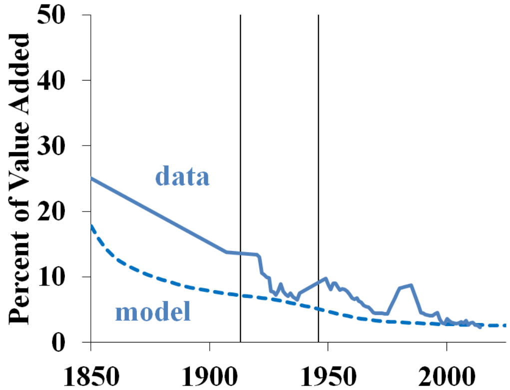
Notes: Figure 15a plots Spain's exports and imports as a percentage of GDP from 1850 to 2000. Figure 15b plots Spain's trade balance as a percentage of GDP from 1850 to 2000. Source: Historical National Accounts dataset from Prados de la Escosura (2015).

A.2 Structural transformation for the U.K. in benchmark exercise

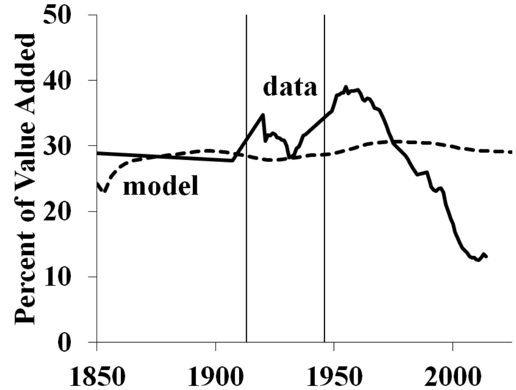
Figure 16 compares the evolution of value-added shares by sector in the benchmark model (dashed lines) with data (solid lines) for the U.K. from 1850 to 2000 (relevant exogenous changes are presented in Figures 4a and 4c). The model does reasonably well in rationalizing the data except for the recent decline in the share of manufacturing.

Figure 16: Non-targeted moments: U.K.'s value-added shares by sector in benchmark model

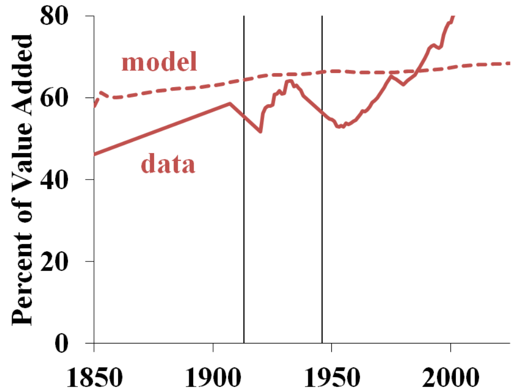
(a) **Value-added, agriculture**



(b) **Value-added, manufacturing**



(c) **Value-added, services**

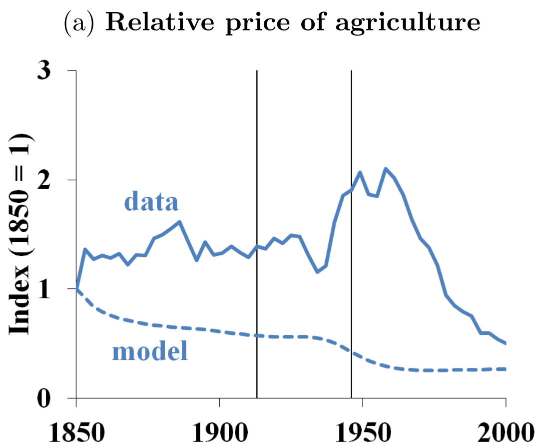


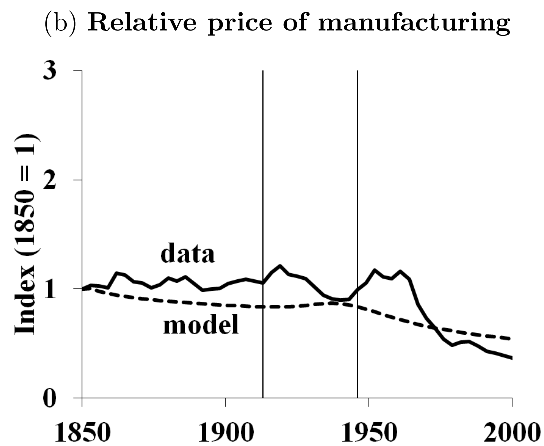
Notes: Figure 16 plots the evolution of value-added shares by sector in the benchmark model (dashed lines) and data (solid lines) for the U.K. from 1850 to 2000. The exogenous changes that lead to this transition are presented in Figures 4a and 4c.

A.3 Spain's relative prices in benchmark exercise

Figure 17 compares the evolution of the relative price of agriculture to services and the relative price of manufacturing to services in the benchmark model (dashed line) with data (solid line) for Spain from 1850 to 2000 (relevant exogenous changes are presented in Figures 4a and 4c). The model does remarkably well in accounting for the evolution of the relative price of manufacturing (right panel). For the relative price of agriculture, the model accounts for the long-run decline but falls short in accounting for the evolution over time (left panel). In Appendix A.5, we consider a robustness exercise in which we target the changes in relative prices. The main results are not sensitive to this shortcoming of the model.

Figure 17: Non-targeted moments: Spain's relative prices



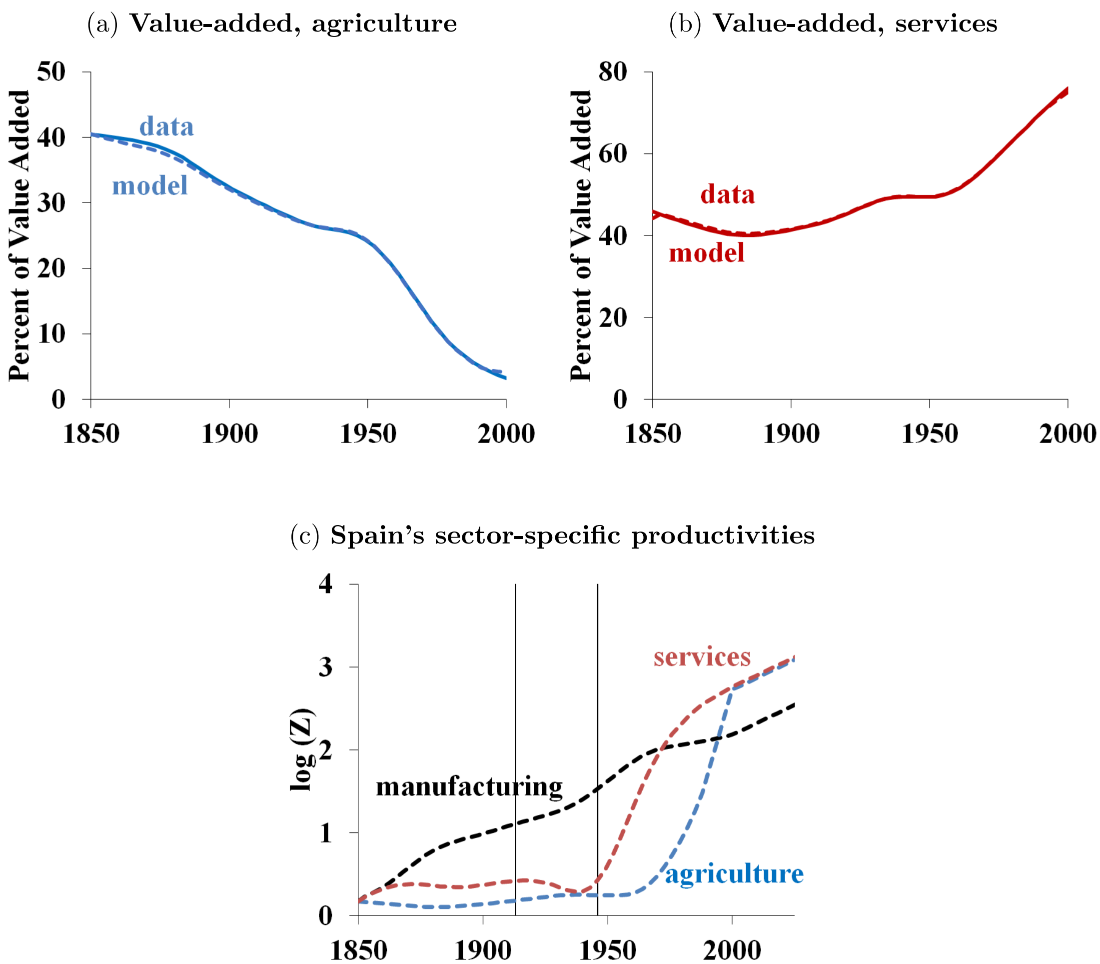


Notes: Figure 17 plots the evolution of Spain's relative price of agriculture to services and relative price of manufacturing to services in the benchmark model (dashed lines) and data (solid lines) from 1850 to 2000. The exogenous changes that lead to this transition are presented in Figures 4a and 4c. Data source: Historical National Accounts dataset from Prados de la Escosura (2015).

A.4 Sector-specific productivities targeting value-added shares

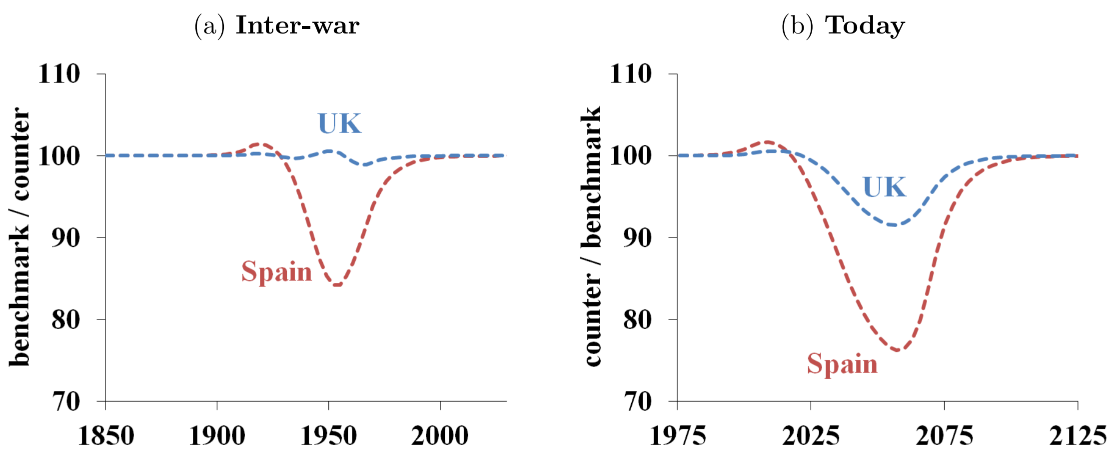
Our benchmark does not allow for sector-specific productivities. In this section, we recalibrate the model with sector-specific productivities to target the value-added shares over time and all other target moments used in the benchmark calibration. The top two panels of Figure 18 plot value-added shares in agriculture and manufacturing in model (dashed lines) and data (filtered, solid line). The bottom panel of Figure 18 plots calibrated sector-specific productivities for Spain. Figure 19 shows that a trade disruption now leads to a significantly larger drop in the capital stock today compared to the inter-war period. Figure 20 shows similar implications for consumption by sector.

Figure 18: New calibration targets and sector-specific productivities for Spain



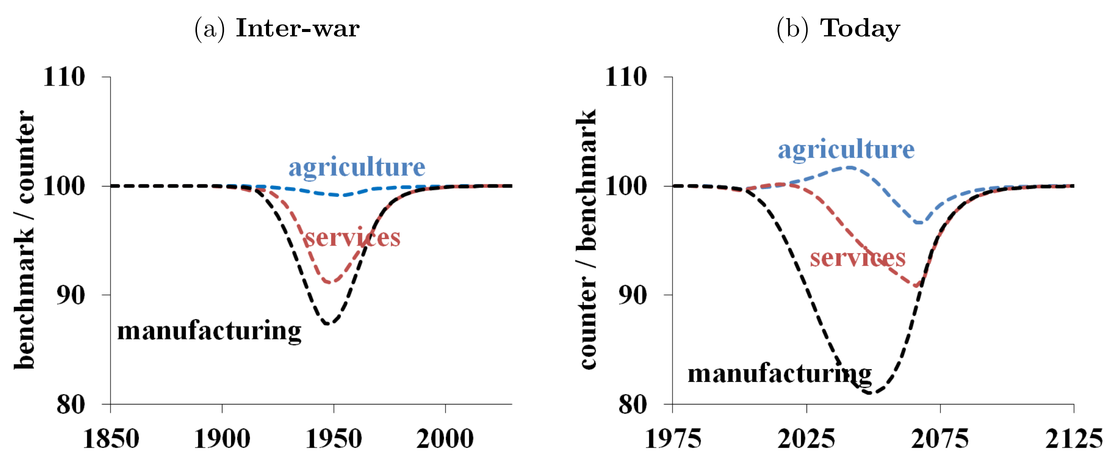
Notes: The top two panels of Figure 18 plot the value-added shares in agriculture and manufacturing in model (dashed lines) and data (filtered, solid line) for Spain. The bottom panel of 18 plots the calibrated sector-specific productivities for Spain.

Figure 19: Capital



Notes: Figure 19a plots the evolution of capital in the benchmark model, with sector-specific productivities calibrated to match value-added shares by sector, (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs) for both Spain (red line) and the U.K. (blue line). Figure 19b plots the evolution of capital in counterfactual-2 (where there is a new trade collapse), as a percentage of the benchmark model, with sector-specific productivities calibrated to match value-added shares by sector, (where there is no spike in trade costs in the 2000s) for both Spain (red line) and the U.K. (blue line).

Figure 20: Consumption by sector in Spain



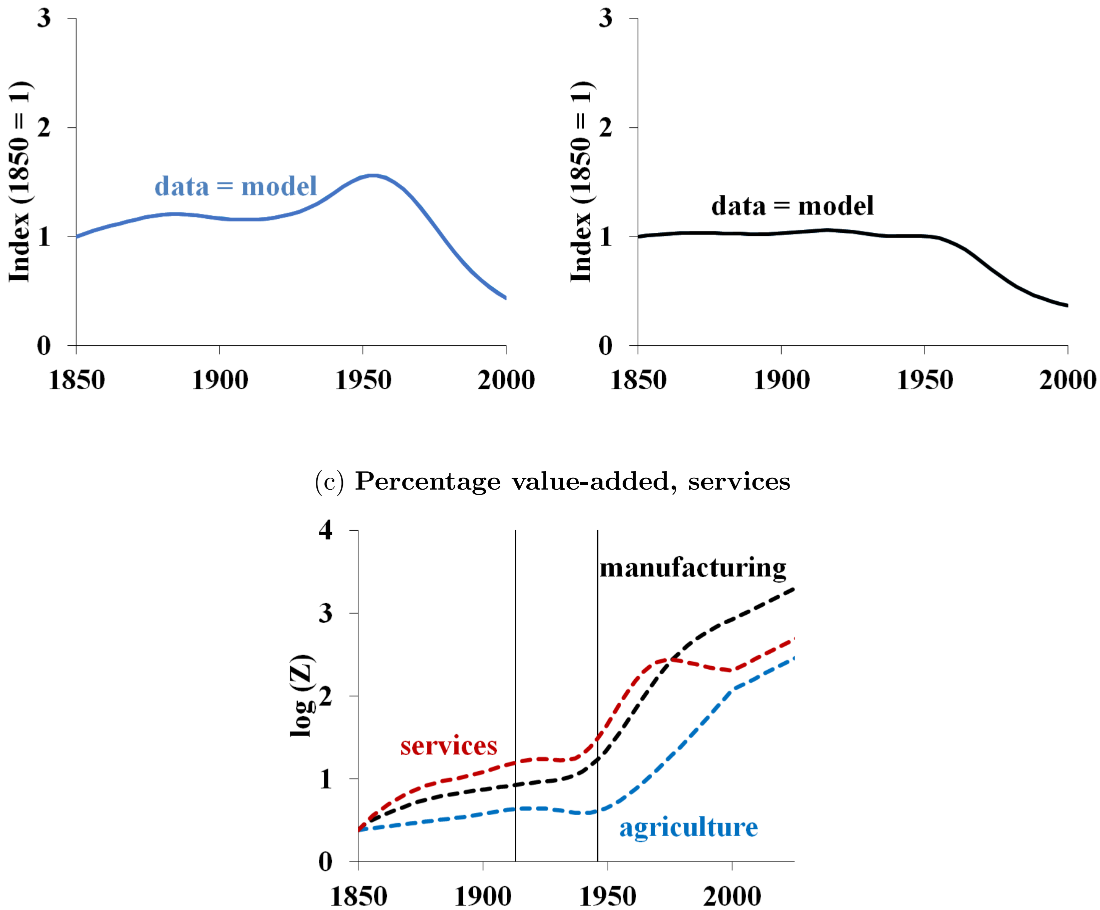
Notes: Figure 20a plots the evolution of consumption by sector in the benchmark model, with sector-specific productivities calibrated to match value-added shares by sector, (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs) for Spain. Figure 20b plots the evolution of consumption by sector in counterfactual-2 (where there is a new trade collapse), as a percentage of the benchmark, with sector-specific productivities calibrated to match value-added shares by sector, (where there is no spike in trade costs in the 2000s) for Spain.

A.5 Sector-specific productivities targeting relative prices

In this section, we recalibrate the model with sector-specific productivities to target the relative prices over time and all other target moments used in the benchmark calibration. The top two panels of Figure 21 plot the prices agriculture and manufacturing relative to services in the model (dashed lines) and data (filtered, solid line). The bottom panel of Figure 21 plots the calibrated sector-specific productivities for Spain. Figure 22 shows that a trade disruption now leads to a significantly larger drop in the capital stock today compared to the inter-war period. Figure 23 shows similar implications for consumption by sector.

Figure 21: New calibration targets and sector-specific productivities for Spain

(a) **Relative price of agriculture** (b) **Relative price of manufacturing**

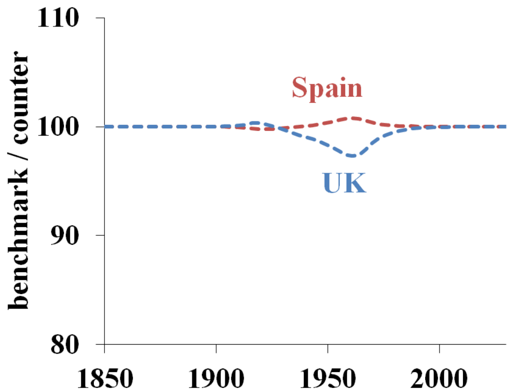


(c) **Percentage value-added, services**

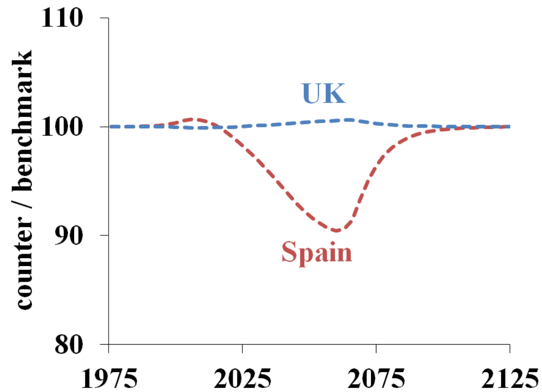
Notes: The top two panels of Figure 21 plot the prices of agriculture and manufacturing relative to services in the model (dashed lines) and data (filtered, solid line) for Spain. The bottom panel plots the calibrated sector-specific productivities for Spain.

Figure 22: Capital

(a) **Inter-war**



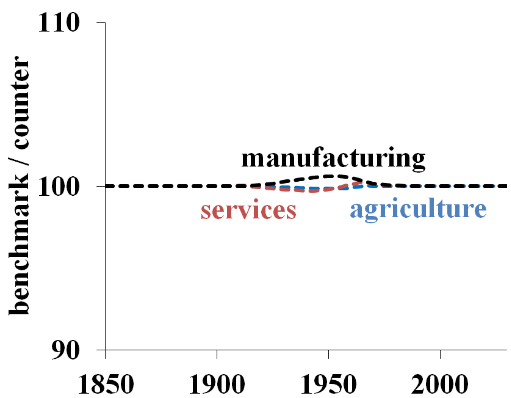
(b) **Today**



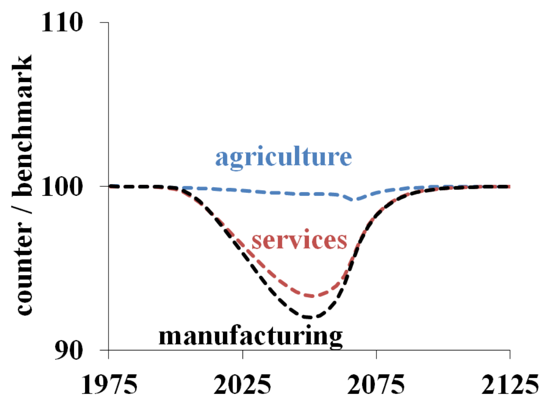
Notes: Figure 22a plots the evolution of capital in the benchmark model, with sector-specific productivities calibrated to match relative prices by sector, (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs) for both Spain (red line) and the U.K. (blue line). Figure 22b plots the evolution of capital in counterfactual-2 (where there is a new trade collapse), as a percentage of the benchmark model, with sector-specific productivities calibrated to match relative prices by sector, (where there is no spike in trade costs in the 2000s) for both Spain (red line) and the U.K. (blue line).

Figure 23: Consumption by sector in Spain

(a) **Inter-war**



(b) **Today**



Notes: Figure 23a plots the evolution of consumption by sector in the benchmark model, with sector-specific productivities calibrated to match relative prices by sector, (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs) for Spain. Figure 23b plots the evolution of consumption by sector in counterfactual-2 (where there is a new trade collapse), as a percentage of the benchmark, with sector-specific productivities calibrated to match relative prices by sector, (where there is no spike in trade costs in the 2000s) for Spain.

A.6 Preferences with stronger complementarity

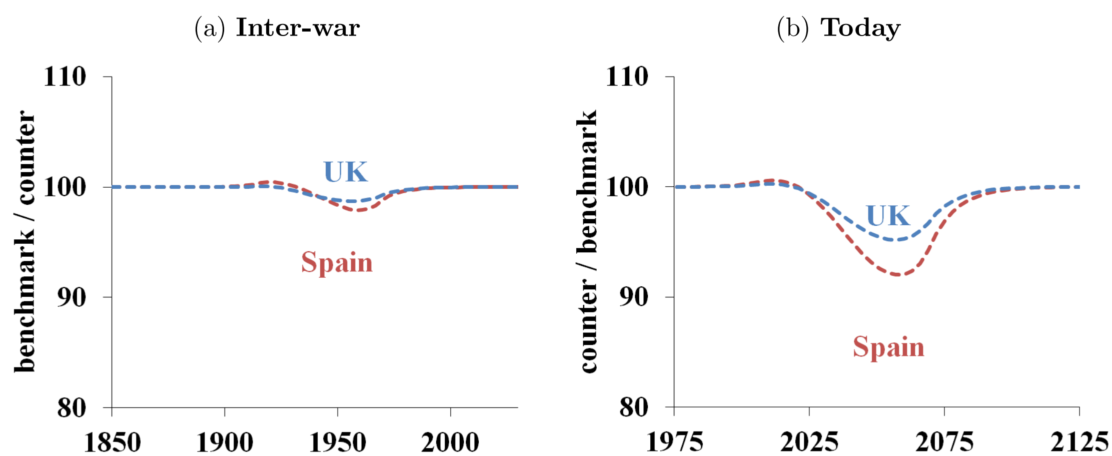
Our benchmark calibration relies on an elasticity of substitution across consumption goods of 0.85, which implies parameter $\epsilon = -0.176$. This parameter is taken from Herrendorf, Rogerson, and Valentinyi (2013). They show that in a model of structural transformation, this value broadly generates the observed structural transformation in the U.S. economy when looking at final expenditure per sector. On the other hand, they also find that more complementarity is needed to rationalize patterns observed in value-added per sector.

While we show that our calibrated model is validated using the sectoral composition of the Spanish economy, it is nonetheless important to perform a robustness check regarding the parameter ϵ. In this section, we recalibrate the model using $\epsilon = -10$, which implies an elasticity of substitution of 0.09.

Besides the important change in ϵ, our calibration is exactly the same as the one in the benchmark calibration (Section 4), and we are able to match the moments and validate the model again. In what follows, we show the similarities and differences between this calibration and the benchmark calibration with regard to the results.

We start with the experiments regarding the fall in the capital stock in the two counterfactual scenarios. In Figures 24a and 24b, we plot the capital stock counterparts to Figures 9a and 9b.

Figure 24: Capital

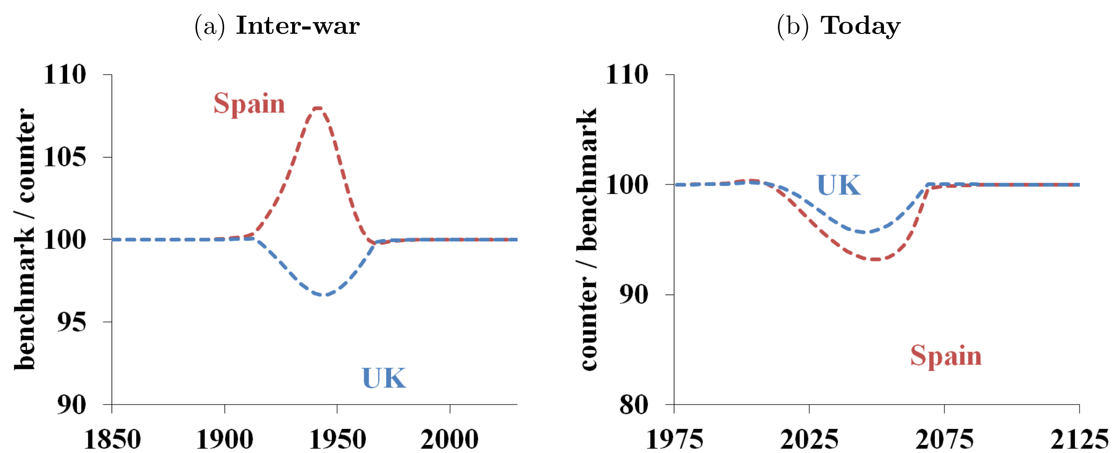


Notes: Figure 24a plots the evolution of capital in the model with stronger complementarity in preferences (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs) for both Spain (red line) and the U.K. (blue line). Figure 24b plots the evolution of capital in counterfactual-2 (where there is a new trade collapse), as a percentage of the model with stronger complementarity in preferences (where there is no spike in trade costs in the 2000s) for both Spain (red line) and the U.K. (blue line).

Our main result regarding the trade shock today being more costly in terms of capital than it was during the IWTC remains the same. However, the magnitude of the fall is larger in the benchmark (Figure 9).

The above result is similar to the one we obtain when we look at the change in varieties. In Figures 25a and 25b, we plot the counterparts to Figures 11a and 11b. Again, we find the same qualitative result under this calibration as we did in the benchmark: the number of varieties increased during the IWTC; at the same time, that number would decrease if there were a similar trade disruption today. As in the case of capital, the magnitudes of the increase in the IWTC and the fall today are smaller than in the benchmark.

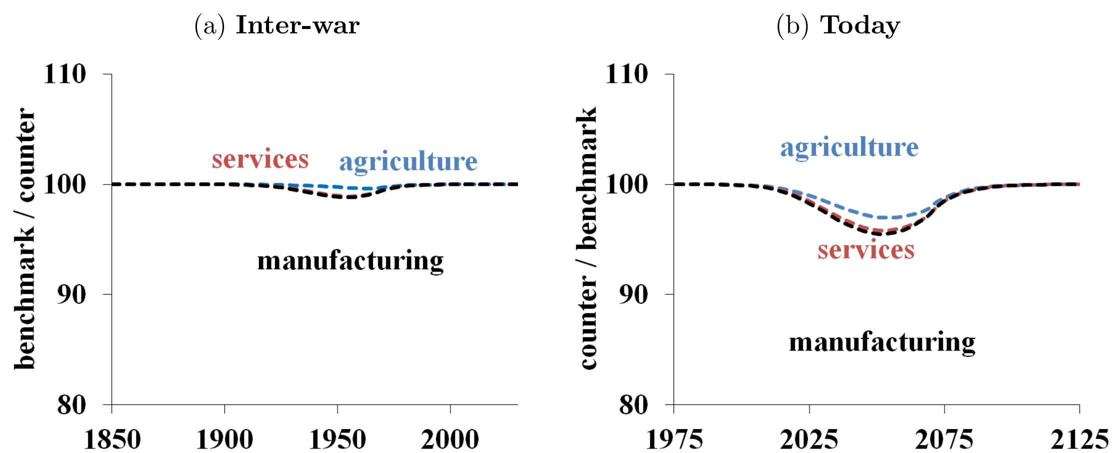
Figure 25: Number of varieties



Notes: Figure 25a plots the evolution of the number of varieties in the model with stronger complementarity in preferences (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs) for both Spain (red line) and the U.K. (blue line). Figure 25b plots the evolution of the number of varieties in counterfactual-2 (where there is a new trade collapse), as a percentage of the model with stronger complementarity in preferences (where there is no spike in trade costs in the 2000s) for both Spain (red line) and the U.K. (blue line).

Finally, the main difference between the benchmark and this robustness check has to do with consumption by sector. In Figures 26a and 26b, we plot the counterparts to Figures 10a and 10b. In the benchmark exercise, we found that each sector exhibited a different behavior in the presence of trade disruptions. We found that manufacturing decreased the most, followed by services, and agriculture barely falls (it even increases for some period of the trade disruption). This result is different in this robustness exercise: the three sectors fall, and their behavior is much more similar. This result is not surprising. The three sectors are now more complementary, and hence, if consumption in one sector falls, then consumption in the other sectors must fall too.

Figure 26: Consumption by sector in Spain



Notes: Figure 26a plots the evolution of consumption by sector in the model with stronger complementarity in preferences (where there is an IWTC) as a percentage of counterfactual-1 (where there is no spike in trade costs) for Spain. Figure 26b plots the evolution of consumption by sector in counterfactual-2 (where there is a new trade collapse), as a percentage of the model with stronger complementarity in preferences (where there is no spike in trade costs in the 2000s) for Spain.