Trade and Structural Transformation in Spain since 1850*

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Abstract

Merging historical customs data with modern SITC Rev. 1 data, we document the changing composition of Spanish trade while the economy underwent a process of structural transformation. Our calibrated model featuring Stone-Geary preferences and capital accumulation is consistent with the patterns we find. The model predicts that trade matters for capital accumulation and the consumption of manufacturing and services, but less so for agriculture. In counter-factual exercises we find that disrupting trade today as it was disrupted during the Inter-war period would entail a cost twice as large.

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

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1 Introduction

Most developed countries' structural transformation has consisted of a very-large-turning-very-small agricultural sector, a growing-then-decaying industrial sector, and a small-turning-very-large services sector. This well-established pattern of development lacks a counterpart in the foreign sector — we do not know what happens to the composition of imports and exports during a period of structural transformation. The reason for this is simple: structural transformation typically started in the XIX Century, and it is rare to find historical datasets containing disaggregated trade data that goes that far back in time.

In this paper we first establish how trade and structural transformation are connected. We do so using the case of Spain (a poster-boy for structural transformation and trade in the developed world) because this type of data does exist for that country. Then, we build a dynamic model of international trade that replicates the patterns we find. Finally, we use the model to evaluate the cost of trade disruptions. Interestingly, we find that a trade disruption today would be more costly than the trade disruption that occurred during the Inter-war period.

Spain is a poster-boy for structural transformation. In 1850, agriculture represented more than 60% of GDP; in 2000, this figure was less than 5%. Services (including construction) increased from roughly 25% to over 80% during the same time period. Finally, industry started and finsihed at about 12% of GDP, having grown to about 25% by the mid-1970s. Spain is also a poster-boy for trade in the developed world. It underwent a trade expansion during the First Golden Age of Globalization (until about 1913). This was followed by a trade collapse during the Inter-war period (unitl the mid-1940s). Finally, trade grew dramatically during the Second Golden Age of Globalization (until nowadays).[1]

More importantly however, the Spanish Customs Agency recorded trade flows for many years of the second half of the XIX Century (from 1849 to 1867 and also in 1898), and for two years in the early XX Century (1905 and 1913).[2] We start by digitizing the trade flows between Spain and the UK (as the XIX Century industrial leader and Spain's main trading partner during that time), and classify all the products therein according to how they would have been classified, had the SITC Revision 1 rules been in place. Then, we merge our digitized dataset with modern day SITC Revision 1 trade flows between Spain and the UK.[3] As a result, we get all the recorded trade flows between Spain and the UK, between 1849 and 2015, in a unified dataset. Exploration of our dataset reveals the following facts: the count number of categories that Spain imports and exports grows over time — and the number of

[1] All these figures are taken from the Historical National Accounts of Prados de la Escosura (2015).

[2] See the Data section of this paper for details of this data.

[3] We download this last data from the World Integrated Trade Solution database.

imported categories is always larger than the number of exported ones. Second, the fraction of exports accounted for by agriculture is very large at the beginning of the period, it falls by the early XX Century, it is very large again in the early 1960s, and dramatically falls again until 2000 — interestingly, this pattern somewhat mirrors the pattern of exports over GDP. On the other hand, the fraction of imports accounted for by agriculture is low throughout the period.

To reconcile these facts we build a dynamic, two-country model of capital accumulation and trade. The model features households with Stone-Geary preferences over agriculture (modelled as a necessity), manufacturing, and services (modelled as a luxury). Trade only occurs in intermediate goods, with agriculture and services trade happening à la Armington (one domestic, one foreign varieties produced with constant returns to scale technology), and manufacturing trade happening à la Krugman (many differentiated varieties produced with increasing returns to scale technology).[4] We calibrate the model targeting a number of moments in years 1850 and 2000, and then get the sequence of Spanish and UK productivity to match GDP per working age population of both countries, and the sequence of trade costs to match exports over GDP of Spain.

Our model does a remarkable job at getting a number of non-targeted moments. First, it correctly predicts the evolution of the count number of varieties that Spain imports and exports, as well as the fraction of imports and exports that is accounted for by agriculture. We believe this is a great accomplishment of the model: the historical patterns that we find in the data we digitize are replicated by our simple model. Second, it correctly predicts the evolution of the sectoral composition of Spain. We believe this is a great accomplishment too, especially given that we only have one equal productivity for the three sectors. Last, the model also does a very good job at replicating the evolution of the investment series in Spain. We take these model predictions as validation that our model is useful to think about the evolution of the Spanish economy and its trade.

We then move on to explore the role that trade plays in structural transformation. Our first experiment consists of comparing the benchmark economy — which replicates the evolution of exports and has trade costs being smallest by year 2000 — with an economy were trade costs become smallest in 1850. We find that trade is particularly important for capital accumulation around the mid-XX Century, a period with very high calibrated trade costs. Consumption of the three goods, particularly manufacturing and, especially, services, is up to 80 percent higher around that time.

Finally, we compare two different scenarios: the cost of the trade collapse that occurred during the Inter-war period (1913-1946) with a similarly disruptive episode occurring nowa-

[4] After Armington (1969) and Krugman (1980), respectively.

days (after 2000). We find that getting a trade disruption today is twice as costly. This may come as a surprise: recall that Households have Stone-Geary preferences, meaning that after a negative income shock, they are relatively worse off when poor than when rich. The reason for our finding is that trade is much more important today than it was in the early XIX Century, and disrupting trade today has a larger (negative) impact on the capital stock.

Literature Review

Economists have long recognized the centrality of structural transformation to the process of economic development and the role that trade may play in facilitating this process over the long run. A large literature has investigated structural transformation, but mostly in a closed-economy context. See Herrendorf, Rogerson, and Valentinyi (2014) for a thorough overview of the literature. Following early contributions such as Matsuyama (1992) and Echevarria (1995), there has been growing interest in studying structural transformation in open economy settings where trade can play a role. Starting with the structural transformation of the leading economy of the Industrial Revolution, quantitative studies by Stokey (2001), Desmet and Parente (2012) and Ferreira, Pessôa, and dos Santos (2016) all find that international trade plays an important role in facilitating the reallocation for Britain's economy from agriculture to manufacturing. Furthermore, Matsuyama (2009) argues that international trade and specialization are essential to understanding more recent patterns of structural change.

Among the recent papers studying the interaction of trade between international trade and structural transformation, two are particularly related to our study. Uy, Yi, and Zhang (2013) model structural transformation as a process driven by exogenous shocks to sectoral productivity and homothetic preferences, and find that international trade is quantitatively important in accounting for South Korea's transformation during the second half of the XX Century. Teignier (2018) compares the XIX Century structural transformation of Great Britain to the XX Century structural transformation of South Korea, and highlights the importance of industrial policy in accounting for differences in the two transitions.[5] Kehoe, Ruhl, and Steinberg (2018) also build a model with structural transformation and trade, focusing on the U.S. from 1992 to 2012. Our paper builds on these contributions by measuring the importance of a single trading relationship for the development of a single country over a span of time that encompasses both the First and the Second Golden Ages of Globalization. This allows us to measure the impact of trade cost shocks at different stages of structural transformation on development outcomes and welfare.

[5] Betts, Giri, and Verma (2017) and Święcki (2017) also study the interaction between structural transformation and international trade in the South Korean context.

Our paper also contributes to a growing literature which assesses the impact of trade policy changes in dynamic models with factor accumulation. Alessandria and Choi (2007, 2014), Ruhl and Willis (2017) and Alessandria, Choi, and Ruhl (2018) analyze cases in which entering firms are the factor which is accumulated. In a similar vein, Brooks and Pujolas (2018) compute the welfare gains from trade both in a model with firm dynamics and in a model with capital accumulation. Ravikumar, Santacreu, and Sposi (2018) extend the welfare analysis of capital accumulation to an environment with multiple countries and capital flows. Finally, Anderson, Larch, and Yotov (2015) analyze the role that capital accumulation and trade play in growth. Our paper takes a long view of the welfare impact of trade friction changes, and uncovers an important interaction between structural transformation and capital accumulation. We find that a sharp increase in trade frictions while a country is at a late stage of structural transformation has a larger welfare impact than the same magnitude of shock at an earlier stage in development. This is mainly because the shock to the more developed country has a larger negative effect on capital accumulation.

The remainder of this paper is organized as follows. Section 2 describes the construction of the dataset we use. Section 3 develops the theoretical framework. Section 4 presents the calibration of the model, and Section 5 discusses the model's performance in matching the data. Section 6 explores the role that has for structural transformation and vice versa. Section 7 compares the Inter-war trade cost with a similarly costly experience nowadays. Last, Section 8 concludes.

2 Data

In this Section we first explain the two trade datasets used in this paper and how we merge them. Then, we briefly review the National Accounts datasets. Last, we establish the patterns that we observe in our data.

Historical Data, 1849–1913

Data on trade between Great Britain and Spain for years between 1849 and 1913 is taken from the yearly statistical publications of the Spanish Customs Agency which are titled "General Ledger of the Foreign Trade of Spain with its Overseas Possessions and Foreign Powers" for years 1849-1855,[6] and "General Statistical Report of the Foreign Trade of Spain

[6] 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)

with its Overseas Possessions and Foreign Powers" from 1856 onwards.[7] All of the entries for goods imported from and exported to Great Britain are transcribed, and the goods categories described in the ledgers are assigned to the 4-digit SITC Rev. 1 code that provides the best match. 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. Table 3 lists the thirty-one 3-digit and custom categories used for this case. The ledgers include some entries for "miscellaneous items," which cannot be assigned to any specific SITC category. These entries make up less than 1% of all recorded imports and exports and are excluded from the analysis. In all, a total of 546 distinct categories of goods, some of which are not traded during the period from 1849-1913, are allowed.

Trade Data, 1962-2015

Yearly data on trade between Spain and Great Britain in SITC Rev. 1 4-digit categories for the period 1962-2015 is taken from the World Bank's World Integrated Trade Solution.[8] The category aggregations listed Table 3 are then applied to these data as well, so that 546 categories are allowed in total.

National Accounts for Spain and the UK, 1850-2015

Finally, we use the historical National Accounts dataset that Prados de la Escosura (2015) put together for Spain. This dataset contains information on real GDP throughout the period of interest, as well as its components. In particular, we are interested in the fraction of exports over GDP, and the importance of agriculture in the economy.

For the United Kingdom we need information on its GDP per capita, and we use the database of Thomas and Dimsdale (2016) to that effect.

Patterns

We should report facts on structural transformation and facts on trade patterns. We should report GDP (the original series, and the smoothed one that we use), sectoral composition, and trade patterns (number of varieties). Also a bit of explanation of what they actually are (what was Spain exporting in 1850?), even though the model can't say anything about that.

[7] 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)

[8] http://wits.worldbank.org/. Date of download: 31 January 2017.

3 Model

We develop a two-country trade model with capital accumulation and Stone-Geary preferences over agriculture, manufacturing, and services. The agricultural good is only used for consumption. Its production uses one type of domestic and one type of foreign intermediates, implying Armington (1969) trade. These intermediates are produced using land and labor.

The manufacturing good can be either consumed or used for capital accummulation. Its production uses domestic and foreign differentiated varieties with a Dixit and Stiglitz (1977) aggregator, implying that there is Krugman (1980) trade in the varieties of the good. The producers of these varieties operate in a monopolistically competitive environment, have an increasing returns to scale technology, and use capital and labor as inputs.

Last, the service good is again only used for consumption. Its production uses one type of domestic and one type of foreign intermediates, also implying Armington (1969) trade. These intermediates are produced using capital and labor.

Each country's productivity changes over time, and is the same in the three sectors. Finally, both countries' trade is subject to the same iceberg transportation cost.

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 of f and h). The Household maximizes the discounted flow of utilities choosing how much consumption of agriculture, $c_{a,h,t}$, manufacturing, $c_{m,h,t}$, and services, $c_{s,h,t}$, to purchase as well as next period assets, $a_{h,t+1}$. The problem is described by

$$\begin{aligned} &\max \sum_{t=0}^{\infty} \beta^t \left[\mu_a \log(c_{a,h,t} - \bar{c}_a) + \mu_m \log(c_{m,h,t}) + \mu_s \log(c_{s,h,t} + \bar{c}_s)\right] \\ &\text{subject to:} \\ &p_{a,h,t}c_{a,h,t} + p_{m,h,t}(c_{m,h,t} + a_{h,t+1} - (1-\delta)a_{h,t}) + p_{s,h,t}c_{s,h,t} = r_{h,t}a_{h,t} + w_{h,t} + \pi_{h,t}, \end{aligned} \tag{1}$$

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, $r_{h,t}$ is the return on investment, $w_{h,t}$ is the wage, and $\pi_{h,t}$ is the sum of all the profits that all firms in the three sectors make (in equilibrium, these profits become only land rents). The parameters governing the model are the following: β is the discount factor, δ is the depreciation rate of capital, μ_a governs the expenditure on agriculture, μ_m governs the expenditure on manufacturing, and μ_s governs the expenditure on services. Last, within-period utility exhibits preferences of the Stone-Geary form (after Stone, 1954; and

Geary, 1950), where $\bar{c}_a$ is the minimum consumption requirement for agriculture, making it a necessity, and $\bar{c}_s$ represents the opposite for services, making it a luxury.

Agriculture

The agricultural sector consists of intermediate producers selling both domestically and abroad, and final producers selling the final good (which is a CES-aggregate of domestic and foreign varieties) to households. As before, we now discuss the producers in country h, with country f producers facing an analogous problem.

The final agricultural producer builds (and sells) $y_{a,h,t}$ 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 $q_{a,f,h,t}$). Namely, the problem is

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

Parameter ν_a is a measure of the home-bias in agricultural consumption, and ρ_a governs the agricultural trade elasticity.

The intermediate agricultural producer, given productivity, $Z_{h,t}$, and land, $L_{h,t}$, chooses how much labor, $\ell_{a,h,t}$, to hire to produce the good. The good, which is sold both to h, $x_{a,h,h,t}$, and to f, $x_{a,f,h,t}$, is produced using a Cobb-Douglas technology with land share parameter α_a. As a result, intermediate agricultural producers make pure profits that are distributed back to the households. Namely, the problem of the intermediate agricultural producer is

$$\begin{aligned} \max\ & q_{a,h,h,t}x_{a,h,h,t} + q_{a,f,h,t}x_{a,f,h,t} - w_{h,t}\ell_{a,h,t} \\ \text{s.t. }\ & x_{a,h,h,t} + (1+\tau_t)x_{a,f,h,t} = L_{h,t}^{\alpha_a}\left(Z_{h,t}\ell_{a,h,t}\right)^{1-\alpha_a}. \end{aligned} \tag{3}$$

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

Manufacturing

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

The final manufacturing producer builds (and sells) $y_{m,h,t}$ units of the good for price $p_{m,h,t}$ buying intermediate goods from the $j \in N_h$ domestic producers (she purchases $x_{m,h,h,t}(j)$

units to producer j for price price $q_{a,h,h,t}(j)$), and also from the $j \in N_f$ foreign producers (she purchases $x_{m,h,f,t}(j)$ units to producer j for price price $q_{a,h,f,t}(j)$). The problem is

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

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 j, given productivity, $Z_{h,t}$, chooses how much capital, $k_{m,h,t}(j)$, to rent and how much labor, $\ell_{m,h,t}(j)$, to hire to produce the good. The good, which is sold both to h, $x_{m,h,h,t}$, and to f, $x_{m,f,h,t}$, is produced using a Cobb-Douglas technology with capital share parameter α_m. 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, $\pi_{m,h,h,t}(j) \geq 0$. Namely, the problem of the intermediate manufacturing producer is

$$\begin{aligned} \pi_{m,h,h,t}(j) = & \max \left(0, \max \begin{pmatrix} q_{m,h,h,t}(j) x_{m,h,h,t}(j) + q_{m,f,h,t}(j) x_{m,f,h,t}(j) \\ - w_{h,t} \ell_{m,h,t}(j) - r_{h,t} k_{m,h,t}(j) - p_{m,h,t} F_h \end{pmatrix} \right) \\ \text{s.t.} \; & x_{m,h,h,t}(j) + (1+\tau_t) x_{m,f,h,t}(j) = k_{m,h,t}(j)^{\alpha_m} \left(Z_{h,t} \ell_{m,h,t}(j) \right)^{1-\alpha_m} \\ & \text{Given demand functions for } x_{m,h,h,t}(j) \text{ and } x_{m,h,f,t}(j). \end{aligned} \tag{5}$$

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

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 producer builds (and sells) $y_{s,h,t}$ 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 $q_{s,f,h,t}$). Namely, they solve

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

Parameter ν_s is a measure of the home-bias in services consumption, and ρ_s governs the services trade elasticity. In effect, we assume that there is trade in services too, as others have done in the literature (e.g. Kehoe et al., 2018)

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

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

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

Market clearing

Last, 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 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 either be consumed, or used to pay the fixed cost to operate intermediate manufacturing varieties, or saved by the household. Hence, $c_{m,h,t} + F_h \times N_h + a_{h,t+1} - (1-\delta) a_{h,t} = y_{m,h,t}$.

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 solve for the equilibrium number of varieties producing, N_h. The total amount of labor in the country is used in either of the three sectors, implying that $\ell_{a,h,t} + N_h \ell_{m,h,t} + \ell_{s,h,t} = \ell_h$. Similarly, all the savings in the country are used by manufacturing or services, $k_{s,h,t} + N_h \times k_{m,h,t} = a_{h,t}$.

Finally, trade balances every period, which implies that

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

4 Calibration

We calibrate the model setting a period in the model to be three years, the home country, h, be Spain, and the foreign country, f, be UK. We set 1850 be in a steady state. That year everyone is informed about the evolution of productivity and iceberg costs going forward until year 2000, when they remain constant forever after.

The calibration consists of targeting a number of aggregate moments of the Spanish economy in year 1850 and year 2000. Finally, for all the years in between 1850 and 2000, we jointly target three sequences of macroeconomic aggregates: Spanish exports over GDP, Spanish GDP per working age population, and UK GDP per working age population. The three series of parameters that we use to target them are iceberg costs, $\{\tau_t\}_{t=1850}^{2000}$), Spanish productivities $\{Z_{h,t}\}_{t=1850}^{2000}$, and UK productivities $\{Z_{f,t}\}_{t=1850}^{2000}$.

We start by describing the parameters that are determined outside the model. We set $\beta = 0.885$ and $\delta = 0.129$, which imply an annual interest rate of 4% and an annual depreciation rate of 4.5%.[9] Follwoing Bas et al. (2017), we set $\rho_a = 0.5$ and $\rho_m = \rho_s = 0.85$, which imply an agricultural trade elasticity of 2, and a manufacturing and services trade elasticity of 6.67.[10] Last, we set the fixed cost of producing a variety in UK to $F_f = 1$, which is a normalization — any change in this figure only changes the measure of varieties in operation — and later on calibrate its Spanish counterpart to be consistent with observables in the data. Table 1 summarizes this part of the calibration.

Table 1: Parameters determined outside of the model

Parameter		**Description**	**Value**
β	Discount rate	Annual interest rate 4%	0.885
δ	Depreciation rate	Annual depreciation 4.5%	0.129
ρ_a	Agriculture CES	Trade elasticity = 2	0.500
ρ_m	Manufacturing CES	Trade elasticity = 6.67	0.850
ρ_s	Services CES	Trade elasticity = 6.67	0.850
F_f	UK fixed cost	Normalization	1.000

The other set of parameters is jointly determined in equilibrium. Many of those parameters target specific moments in year 1850 or year 2000. We solve the model so that in 1850 it is in a steady state. In that steady state, the minimum consumption requirement in agriculture, $\bar{c}_a$, is chosen to match Spain's percent of agriculture in GDP. Similarly, its

[9] Recall a period in the model is three years in the data.

[10] We are not aware of good estimates of services trade, and that is why we set it equal to manufacturing trade. Since aggregate trade elasticity for modern, rich economies tends to be similar to the manufacturing elasticity, we believe our choice of parameter is adequate.

services counterpart, $\bar{c}_s$, does the same for the percent of services in GDP. Agriculture home biases, $\nu_{h,a}$ and $\nu_{f,a}$, target the percentage of Spain's imports and exports accounted for by agriculture. All these parameters are reported in Table 2.

Table 2: Parameters determined jointly in equilibrium

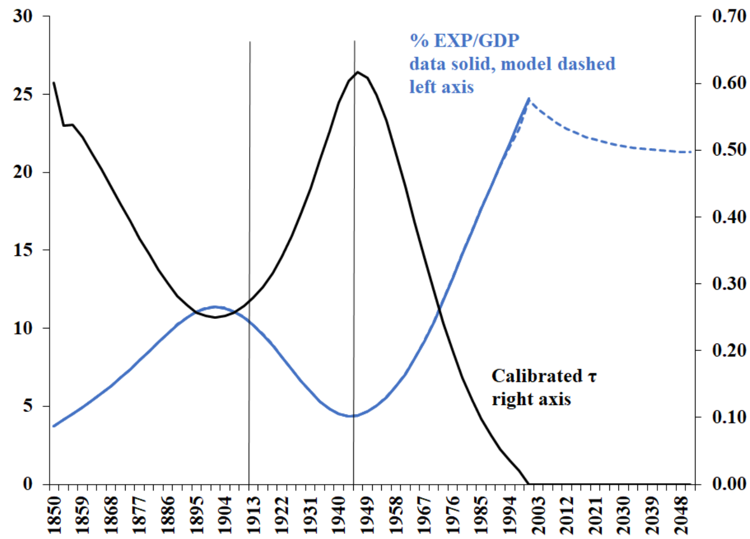
Parameter		Target	Value
Initial steady state		**year = 1850**	
$\bar{c}_a$	Ag cons floor	% Ag in GDP	0.723
$\bar{c}_s$	Serv cons ceiling	% Serv in GDP	0.035
$\nu_{h,a}$	Spain Ag home bias	Spain Ag Imp/GDP	0.896
$\nu_{f,a}$	UK Ag home bias	Spain Ag Exp/GDP	0.818
Along transition path		**year = 2000**	
μ_a	Ag utility share	% Ag in GDP	0.001
μ_m	Manu utility share	% Manu in GDP	0.036
μ_s	Serv utility share	$1 - \mu_a - \mu_m$	0.963
$\nu_{h,m}$	Spain manu home bias	Spain Exp/GDP	0.500
$\nu_{f,m}$	UK manu home bias	$\nu_{f,m} = \nu_{h,m}$	0.500
$\nu_{h,s}$	Spain services home bias	Spain serv exports	0.585
$\nu_{f,s}$	UK services home bias	$\nu_{f,s} = \nu_{h,s}$	0.585
α_a	Land share Ag	Ag employment share	0.339
α_m	Capital share Man	Total labor share	0.468
α_s	Capital share Serv	Serv employment share	0.306
f_h	Spain fixed cost	Spain varieties/UK varieties	0.792

There are a number of other parameters that target moments in year 2000. For instance, the utility shares μ_a, μ_m, and μ_s target the composition of GDP for that year, with the three parameters adding up to unity. The home bias parameters, $\nu_{h,m}$ and $\nu_{h,s}$ target exports over GDP and service exports respectively, and we impose their UK counterparts to have the same values, $\nu_{f,m} = \nu_{h,m}$ and $\nu_{f,s} = \nu_{h,s}$. We set the land share in agriculture, α_a, to match the agriculture employment share, the capital share in manufacturing, α_m, to match total labor share, and the capital share in services, α_s, to match the services employment share. Last, we use the Spanish fixed cost of producing a variety, f_h, to get the ratio of varieties between Spain and UK right in year 2000 — which implies that a variety in Spain is about 20% cheaper than in the UK.

The last part of our calibration consists of getting the series for the iceberg transportation cost and productivities of both countries, $\{\tau_t, Z_{h,t}, Z_{f,t}\}$, to match Spanish exports over GDP, and GDP per working age population of both Spain and the UK. Figure 1 shows, in the black line, the calibrated series for the iceberg cost, in the solid, blue line, data on exports over

GDP, and in the dashed, blue line, the model fit of exports over GDP. Note that we normalize the iceberg cost for the last year to zero, $\tau_{2000} = 0$. This assumes trade is completely free at the end of the transition, as we use home bias parameters to ensure that trade in year 2000 is consistent with the data.

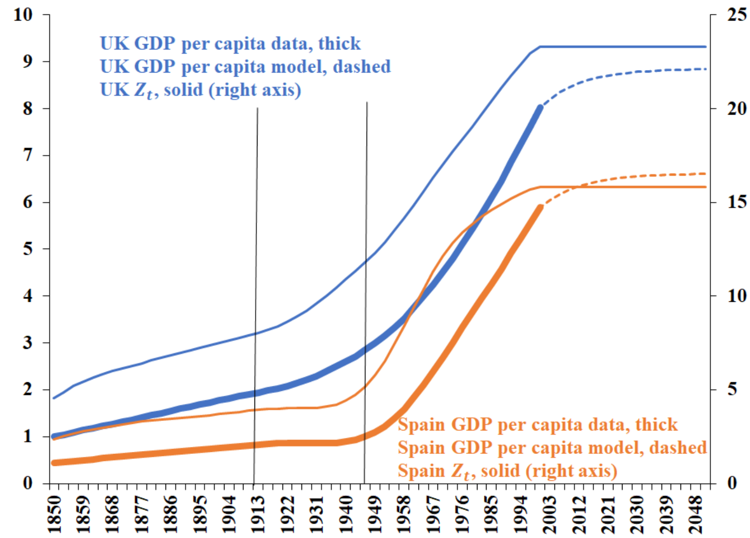
Figure 1: Calibration of iceberg cost



Usually, the inter-war period is dated between 1913 and 1946, the period between the First and the Second Golden Age of Globalization. We placed vertical black lines splitting the period at around those years. Notice that the first one is approximately coinciding with a local minimum in iceberg costs, whereas the second one does so with a local maximum. The coincidence between the calibrated series and those years is reassurance that the analysis we perform on Spain probably extrapolates to other western economies.

In Figure 2 we plot, as blue lines, variables for the UK, and as orange lines their Spanish counterparts. The solid, thin line is calibrated productivity; the solid, think line is the data; last, the dashed line is the model fit.

Figure 2: Calibration of productivity



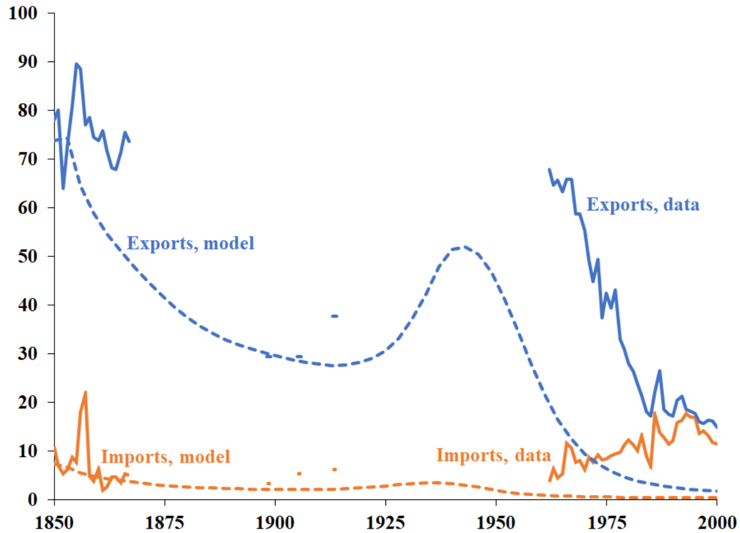
It is important to stress that in both figures, the data series and the model fit overlap, implying that we force our model to perfectly replicate the path of exports over GDP in Spain and GDP per working age population of both Spain and the UK. In the next section, we show that the model does a pretty good job at replicating paths in the data that are not targeted too.

5 Model performance

We now move on to report how the model does at producing patterns that are not targeted along the transition path. We first show two figures linking model output to the patterns uncovered in the historical Customs Data from Spain.

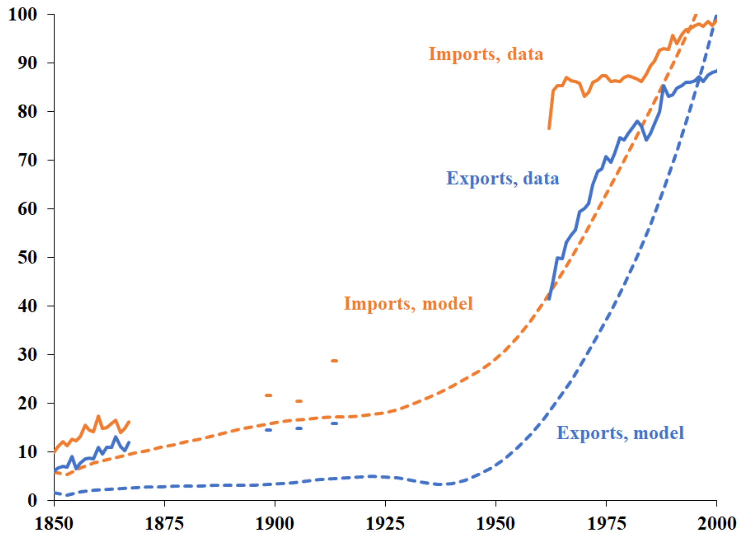
In the Figure 3 we show that the model does well getting the path of the fraction of trade accounted for by agriculture over manufacturing for both, exports and imports. Importantly, the only values that are targeted are those in 1850. For Spanish exports to the UK, the model implies a fall in the share of agriculture until the early 1900s that is consistent with the data. After that, the data does not start over again until we have the SITC data, in the 1960s, a time where the share of agriculture is very high and decreases sharply again. The model generates a similar pattern, with the hump peaking right before the 1950s, and having a pronounced decline right afterwards. While this result implies that the model generates the second fall in the share of agriculture a bit prematurely, the similarity between data and model is remarkable, especially taking into consideration that we did not calibrate any moment there. For Spanish imports from the UK, both the model and the data are consistent in that agriculture is never a big contributor to the series. The main difference between model and data is at the end of the period, when agriculture almost vanishes in the model while it is still around in the data.

Figure 3: Fraction of trade in agriculture



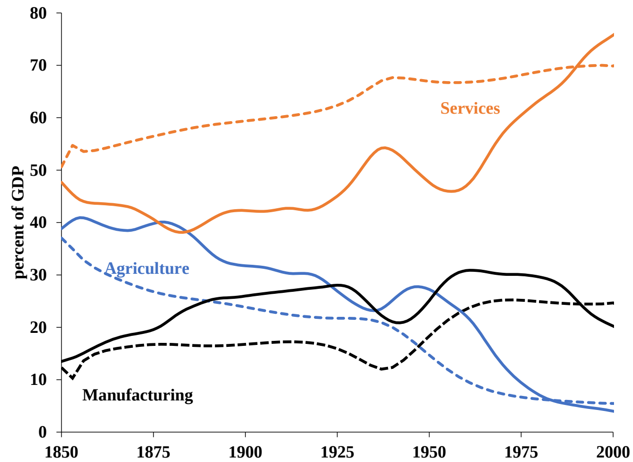
In Figure 4 we show that the model does a pretty good job at getting the path of the number of traded varieties for both, exports and imports. In particular, throughout, we get that there are more varieties imported than exported, and that both series grow over time. We normalize the number of varieties from the UK so that model and data get the same number in year 2000 and set the fixed cost of producing a variety in Spain to get the number of varieties from Spain right. The rest of the pattern is endogenously generated by the model.

Figure 4: Number of varieties



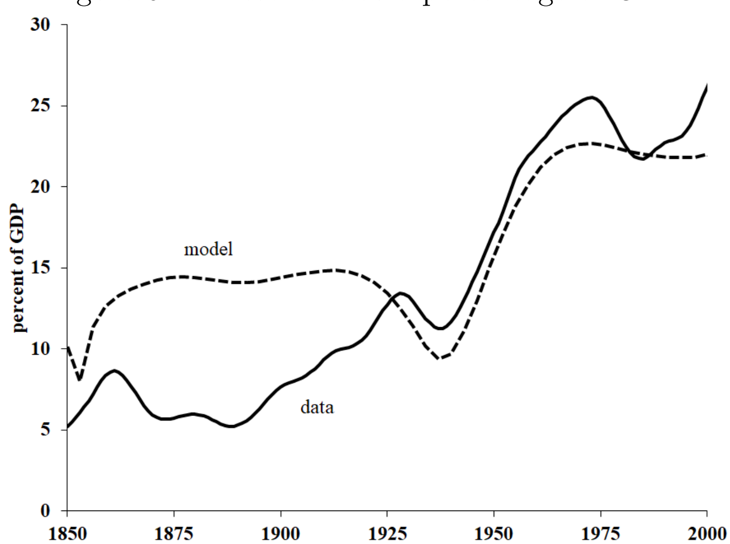
The model does pretty well getting the composition of Spanish GDP over time. In Figure 5 we plot the share of output accounted for by agriculture, manufacturing, and services both in the data (using the accounts from Prados de la Escosura, 2015) and in the model. Services grow in both, but more importantly, the hump that occurred right before the 1950s is also present in the model. Similarly, agriculture decreases, with the model implying a fall slightly earlier than in the data, but they resemble each other quite well. Last, manufacturing in both data and model exhibit a remarkably similar pattern as well. We believe this result is very important, especially because we do not use sector-specific productivities, which is a standard tool in the literature. Our simpler model is already able to capture the main patterns in the data.

Figure 5: GDP composition



Last, despite not using a single moment of investment data to perform the calibration, our model does a remarkable job getting its evolution. In Figure 6 we plot the fraction of GDP that is used for investment in the data (solid line) and predicted by the model (dashed).

Figure 6: Investment as a percentage of GDP



The model is able to reproduce the dip in investment that occurred after 1920 and until the early 1940s, with the following increase in investment that lasted until the early 1970s and its subsequent stabilization at over 20% of GDP until the end of the period. While the model overshoots total investment for the beginning of the period, we find the similarity between model and data eye-catching.

6 Trade and structural transformation

We now move on to scrutinize the role that structural transformation has on the patterns we observed, and then do the reverse exercise, what is the effect that trade has on structural transformation.

In the first one... TBD

In the second we want to understand what is the role of an expensive, changing trade cost, rather than having had cheap trade costs all along.

Structural transformation effects on trade

[TBD] *How does structural transformation affect trade? The benchmark model does well in accounting for fraction of trade in agriculture and number of varieties traded. We should look at the same graphs in a model without structural transformation (constant productivity) to show that structural transformation is important to account for the observed trade patterns.*

Trade effects on structural transformation

[TBD] *The benchmark model does well in accounting for GDP composition and investment as a percentage of GDP. We should look at the same graphs in a model with constant iceberg costs to show that trade matters for structural transformation. For this case, we might have to plot the ratios of the benchmark variable and the counterfactual variable (eg. investment in benchmark model / investment in counterfactual). That will also show how transitions matter. Towards the end of this section, we can talk about welfare by comparing welfare gains from the benchmark model, the counterfactual where iceberg costs are constant, and a counterfactual where iceberg costs fall immediately. This will show that the welfare gains from changing iceberg costs were small in 1850. But that leads us to the next section.*

Figure 7: Icebergs: cheap trade costs vs. benchmark

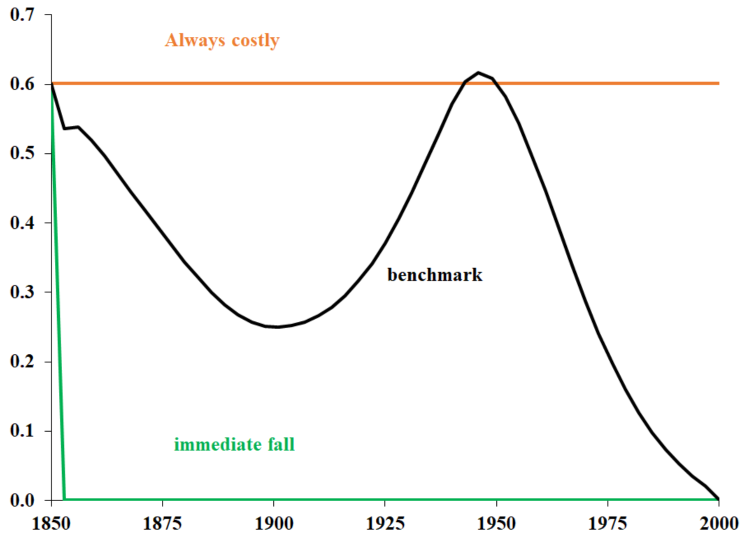
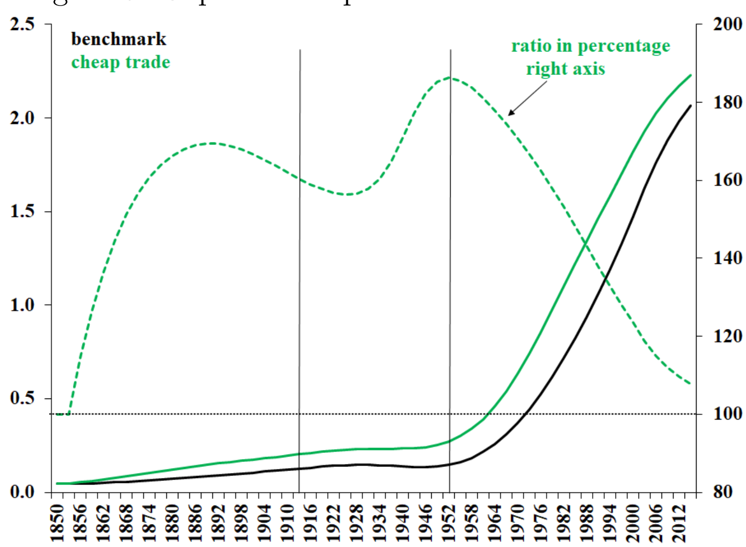


Figure 8: Capital: cheap trade costs vs. benchmark



7 Cost of trade disruptions

We now move on to measure the cost that trade disruptions have entailed. We do so for two different scenarios and compare them. The first one is a historical event, the Inter-war period. The second one is fiction: a trade disruption of the same nature as the Inter-war period, but happening nowadays.

Each exercise alone sheds light on the role that trade disruption causes on the economy at different stages of economic development. Comparing them illustrates why the more integrated economies become, the more costly it is to disrupt trade.

The inter-war period's cost

We next turn our attention to ask how costly is the spike in trade costs that occurred during the inter-war period. To this end, we compare the benchmark economy in 1900 (around the time that trade costs start to increase) with that same economy, shocked with an unexpected, linear fall in trade costs. In Figure 10 we plot them.

Figure 9: Icebergs: no inter-war period vs. benchmark

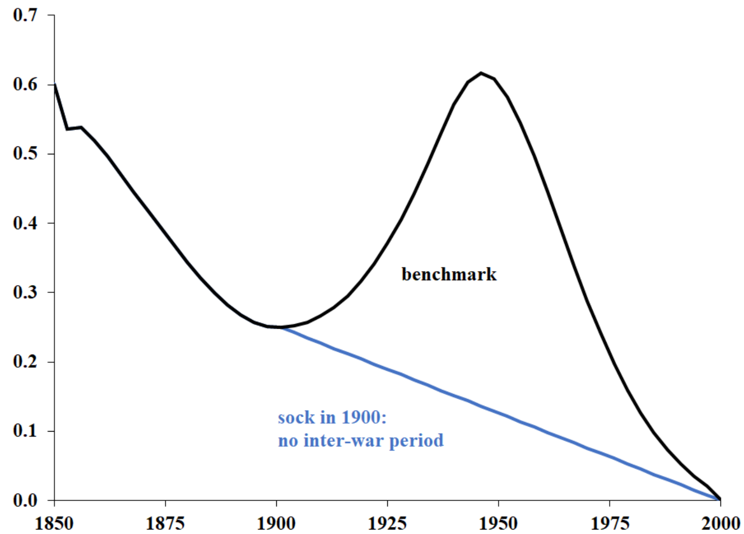


Figure 10: Icebergs: no inter-war period vs. benchmark

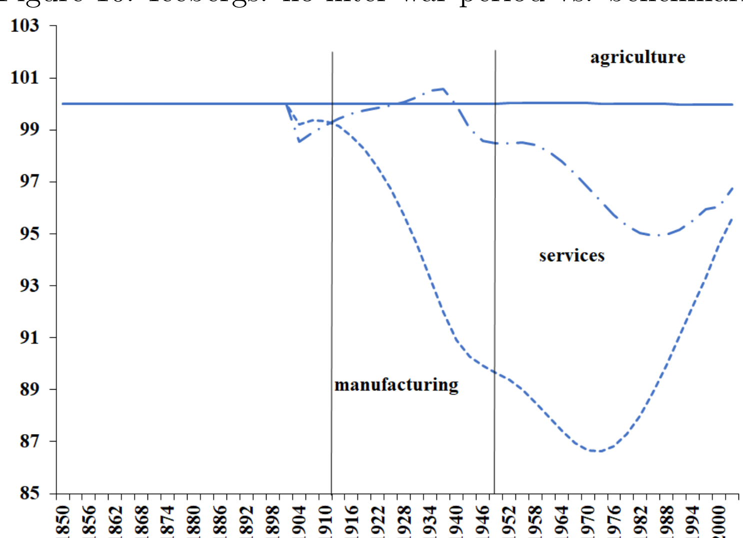
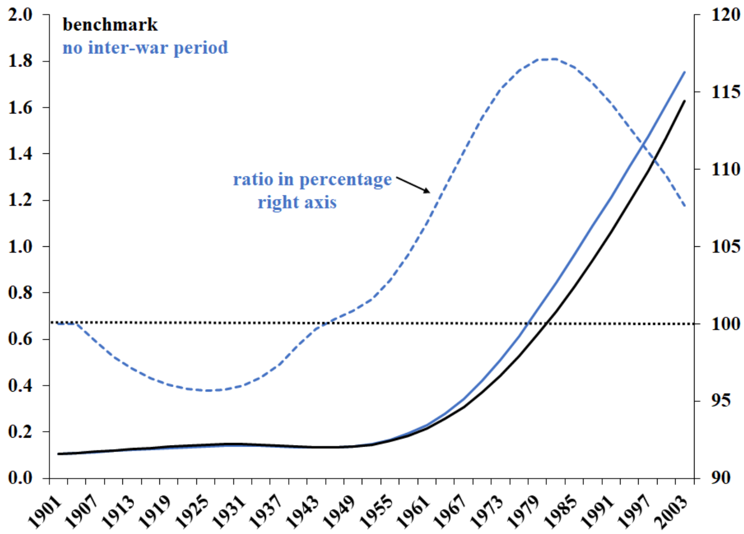


Figure 11: Capital: no inter-war period vs. benchmark



We find that the cost of this spike is equivalent to 0.89% of lifetime consumption. This cost is driven largely by the smaller increase in manufacturing consumption (less than 20% above benchmark at its peak) despite the huge disruption in trade (trade fell by 85% of what it could have been by 1946). The main reason for this small number is that the capital level is largely unaffected by the spike in trade costs.

A spike in trade costs in the early XXI Century

Last, we ask how costly would a spike in trade costs be if was to happen at the beginning of the XXI Century. To this end, we use the same unexpected increase in trade costs that we did in the previous exercise, but increase them in year 2000 (around the time that trade costs reach their lowest value). In Figure 12 we plot them.

Figure 12: Icebergs: trade costs spike vs. benchmark

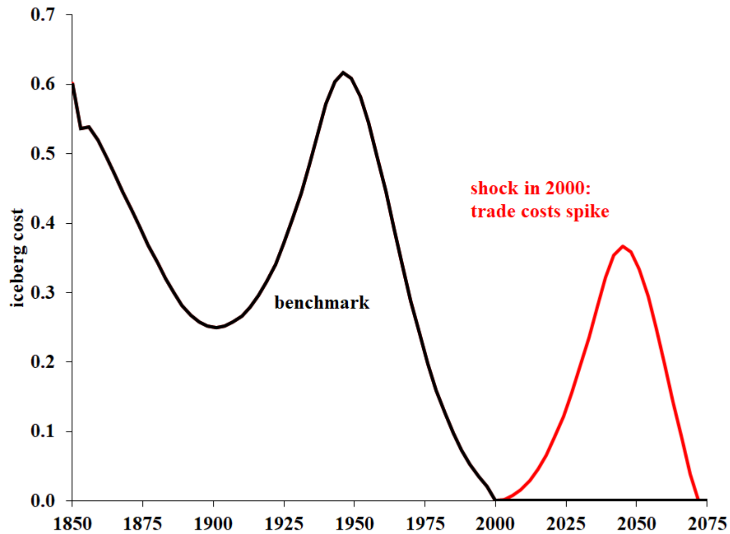


Figure 13: Consumption: trade costs spike as percentage of benchmark

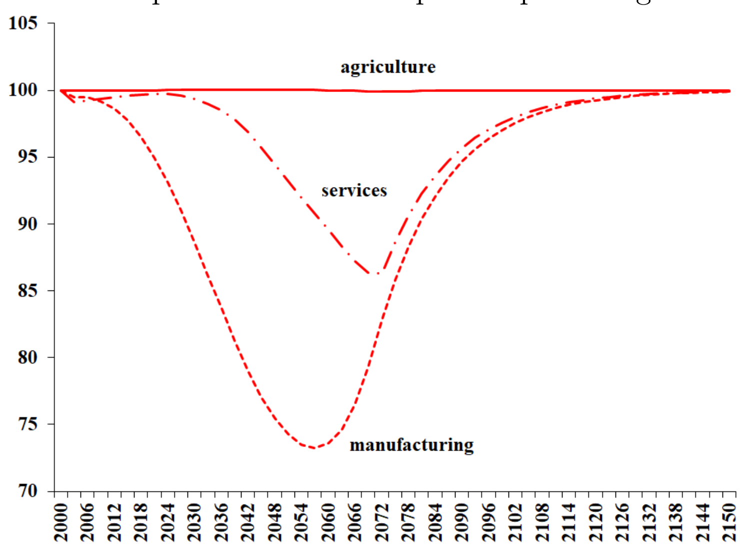
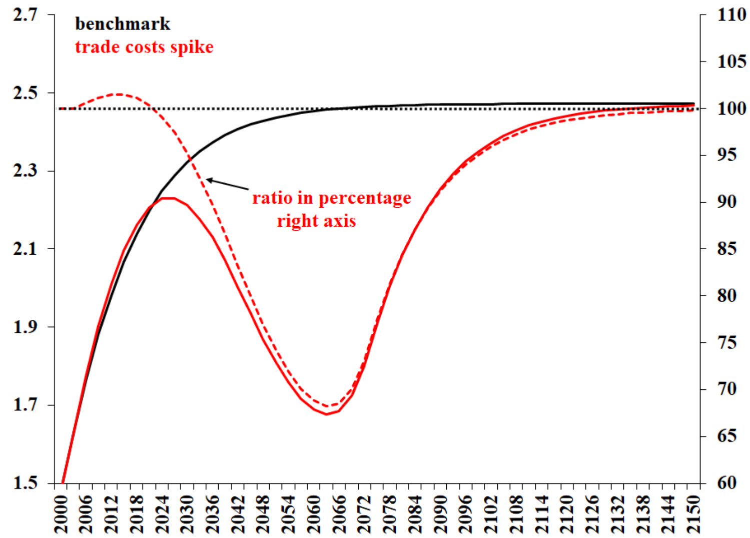


Figure 14: Capital: trade costs spike vs. benchmark



We find that the cost is actually larger than in the inter-war period, at 1.67%. This cost, roughly twice as large as the one of the inter-war period, comes from the large disruption in capital accumulation

8 Conclusions

In this paper, we have assessed the quantitative importance of trade integration for Spain's economic development over a period spanning two periods of globalization and the interwar trade collapse. We find that a model of structural transformation with trade and capital accumulation is able to account remarkably well for changes in the sectoral composition of Spain's trade with its largest trading partner, Great Britain, even in the absence of time-varying sector-specific TFP. Assessing the impact of past trade disruptions, we find that the interwar trade collapse imposed welfare costs on Spain equivalent 0.89% of lifetime consumption. Looking toward a possible future, we find that a trade friction shock of equal magnitude would today reduce welfare by twice as much. This is due to the greater progression of Spain's structural transformation and the resulting greater impact of trade disruption on capital accumulation.

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Appendix

Tables

Table 3: Aggregations of 4-digit SITC categories

Code	Name	4-digit included
1122A	Cider, beer & fermented beverages,nes	1122 and 1123
2422A	Sawlogs and veneer logs, conifer and non-conifer	2422 and 2423
042	Rice	all subordinate
072	Cocoa	all subordinate
251	Paper	all subordinate
273	Stone, sand and gravel	all subordinate
281	Iron ore & concentrates	all subordinate
332	Petroleum products	all subordinate
422	Other fixed vegetable oils	all subordinate
541	Medicinal & pharmaceutical products	all subordinate
561	Fertilizers manufactured	all subordinate
571	Explosives and pyrotechnic products	all subordinate
611	Leather	all subordinate
629	Articles of rubber, nes	all subordinate
631	Veneers, plywood boards & other wood, worked,nes	all subordinate
652	Cotton fabrics, woven ex. narrow or spec. fabrics	all subordinate
661	Lime, cement & fabr.bldg.mat. Ex glass/clay mat	all subordinate
664	Glass	all subordinate
666	Pottery	all subordinate
672	Ingots & other primary forms of iron or steel	all subordinate
673	Iron and steel bars,rods,angles,shapes,sections	all subordinate
674	Universals, plates and sheets of iron or steel	all subordinate
675	Hoop and strip of iron or steel	all subordinate
676	Rails & rlwy track constr mat. Of iron or steel	all subordinate
677	Iron and steel wire, excluding wire rod	all subordinate
678	Tubes,pipes and fittings of iron or steel	all subordinate
679	Iron steel castings forgings unworked, nes	all subordinate
694	Nails, screws, nuts, bolts, rivets and sim. articles	all subordinate
695	Tools for use in the hand or in machines	all subordinate
696	Cutlery	all subordinate
712	Agricultural machinery and implements	all subordinate