AN EMPIRICAL ASSESSMENT OF THE CHAIN OF COMPARATIVE ADVANTAGE:

or

HOW WELL DOES THE ECON 101 MODEL PREDICT THE PATTERN OF TRADE?

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Abstract

Single market (or partial equilibrium) textbook analysis predicts the pattern of goods trade by price comparisons between free trade and autarky. General equilibrium analysis suggests that simple price comparisons *can be* misleading; cross-market effects can violate the single market predictions. However, whether these price comparisons *will be* misleading depends on the magnitude of the cross-market effects resulting from trade liberalization. To what degree cross-market effects violate the single market predictions is an empirical question that has not been addressed in the literature. The natural experiment of Japan and the availability of market prices under autarky and free trade provide a unique opportunity to address this question.

We view Japan's opening up as a structural change problem, test for structural changes in real prices and construct counterfactual prices that would have prevailed if Japan had remained in isolation. For this purpose we have collected a high quality 30-year time series of real prices, covering Japan's last two decades of autarky and first decade of open international trade.

Our research strategy is as follows. If we find no statistical evidence for a structural break in a time series, then we are not in the position to construct the counterfactual price necessary to examine the prediction of the model. However, if we find evidence for a structural break in a series, then we can compare the post-break real price with the counterfactual real price from the pre-break regime and see how this compares to the observed trade pattern of the good. Our preliminary empirical results suggest that for products for which we can construct a counterfactual price, the single market model does remarkably well.

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1. Introduction

We provide an empirical assessment of the good-by-good trade prediction of neoclassical economics in the context of Japan's 19th century move from autarky to open trade. Previous research (Bernhofen and Brown (2004 and 2005)) has established the case of Japan's opening up as a "natural experiment" compatible with the assumptions of the small open economy neoclassical trade model. This paper employs a unique and high quality data set of national market prices for 22 traded commodities during the time period of 1838-1867, covering Japan's last two decades of autarky and its first decade of open international trade. For each traded good, we have constructed a 30-year time series of real prices, test for structural breaks in the data and investigate whether the trade-induced price changes are compatible with the single market textbook prediction of neoclassical economics.

Since trade economists consider the law of comparative advantage to be "…the very heart and soul of (their) field" (Ethier, 1984, p. 132), a key concern of the trade literature has been how to extend the standard two-good, two-factor undergraduate textbook version of the theory into an empirically relevant multi-good setting. The trade literature has developed two multi-commodity formulations of the principle of comparative advantage: the *correlation version* and the *chain version*.

The correlation version of the law of comparative advantage, developed by Deardorff (1980) and Dixit and Norman (1980), asserts that, on average, a country will import goods with high opportunity costs and export goods with low opportunity costs. Although the correlation version is the theoretically most robust formulation of comparative advantage, it is *weak* in the sense that it does not predict which particular good will be exported or imported. It is a statement about a country's trading vector as a whole, since it looks at all traded goods *simultaneously*. Empirically, one can just explore whether a country's entire trading vector is compatible with the prediction of the theory or not. In contrast, the chain versions of comparative advantage rank goods either in order of factor intensities or opportunity costs and uses this ranking to predict whether a particular good will be exported or imported.

Previously, we have provided historical evidence for the claim that Japan's economy before and after its dramatic opening up to world commerce in 1859 was compatible with the key assumptions of the neoclassical trade model. Having established the case of Japan as a natural experiment for investigating the law of comparative advantage, we found strong empirical support for the weak, or correlation, version of the law for each year of the sample period 1868-1875 (Bernhofen and Brown, 2004). This paper takes a step further and investigate whether Japan's trading pattern is compatible with the strong, or chain proposition of the law of comparative advantage.

We would like to emphasize that we are testing the prediction of what can be called an "empirical proposition", simply because the chain proposition is not as theoretically robust as the correlation proposition of comparative advantage. As the more detailed discussion in section 2 will show, the chain proposition has been formulated under more restrictive conditions than the correlation proposition.[2] However, since there is room for the prediction to fail, we are engaging in hypothesis testing.

Our empirical strategy in this paper is a time-series approach, which stands in contrast to the "cross-sectional approach" we undertook in testing the correlation version of comparative advantage (Bernhofen and Brown, 2004). The empirical test of the correlation version is formulated within an autarky-free trade framework. It tests the proposition in terms of a counterfactual. Were the Japan of the pre-1859 period (the "closed" period) open to trade, *on average* it would export goods for which the opportunity cost was low and it would import goods for which the opportunity cost was high. Opportunity cost is measured by the domestic price during the autarky (pre-1859) period. In the empirical application, this involves finding the sign of the Deardorff-Dixit-Norman (DDN) index of comparative advantage p^aT: the inner product of a counterfactual net trading T vector and the autarky price vector p^a. The theory of comparative advantage predicts that the sign is negative. For our evaluation, we used the net trading vector for each individual year during the years1868-1875. Finding the DDN index for various years introduced robustness into the test. In all years, the DDN index was negative. Against an alternative hypothesis that the index in these eight years was purely random, the result was an acceptance of the null hypothesis at a high level of significance. Note that since we did not use price data under free trade, the analysis did not involve any comparison between prices under autarky and free trade.[3]

[2] The Heckscher-Ohlin model is of course extendable to multiple dimensions, as has been shown by Vanek (1968) and Deardorff (1982). Davis and Weinstein (2003) provide a recent survey of the empirical Heckscher-Ohlin literature.

[3] A subtle feature of the price index p^aT is that is that it does not involve free trade prices. This is the case since the net trading vector T contains all relevant information about relative prices under free trade. This can be most easily seen in the familiar 2-good trade trade triangle where the slope of the terms of trade line, or the relative price under free trade, is equal to the ratio of the equilibrium trade volumes. This approach also contrasts sharply with the well-known paper by Huber(1971), which attempts to compare relative prices in Japan with world prices (a comparison in the spirit of examining absolute advantage) and then examines the movement of prices from the pre-opening up period through the 1870s.

For the purpose of the present analysis we constructed a time series of real goods prices for 22 Japanese tradable goods for the period of 1838-1867. We proceeded by testing each of the 22 time-series for structural breaks, assuming that the break date is exogenous. This assumption is justified by the wealth of historical evidence that concurs that the opening up was imposed upon Japan. Visual inspection of the data also confirms there is a potential break somewhere in the 1850s. For our purposes, we hypothesize the treaty year of 1859 as the break year. For two products, coal and ginseng, we chose 1853, the last autarky year, as a break date. This is justified by the historical evidence that these products were traded immediately after Japan was forced to open up.

We find evidence of structural breaks, or regime changes, for 14 of the 22 products in our sample. Since the model assumes the existence of price differences between autarky and free trade, we argue that products with no structural break do not fall into the domain of the theory. For the 14 products for which we find evidence of a structural break, we find strong support for the single market prediction of trade.

The paper is organized as follows. Section 2 gives the theoretical background. Section 3 reviews the natural experiment of Japan. Section 4 describes the data and section 5 contains the empirical analysis.. Concluding remarks are contained in section 6.

2. Theoretical framework

The principle of comparative advantage is central to our understanding of the pattern of and the gains from international trade. In the case of two goods, the principle is easily stated and verified: a country will export the good where it has a lower relative autarky price and this will result into gains from trade. In higher dimensions, the gains from trade argument carries through with few qualifications. However, a higher dimensional extension of the pattern of trade prediction has gone into several directions.[4]

Following his pioneering opportunity cost formulation of the doctrine of comparative advantage, Haberler (1936) suggested the first multi-commodity formulation of the doctrine: the chain of comparative advantage idea. This idea has two components. First, it assumes that goods can be ranked by comparative costs in a chain of increasing opportunity costs. Second, there exists a dividing line in the chain where all commodities to the left of this line—the low cost goods—will be exported and those to the right of this line—the high cost goods—will be imported.

[4] Ethier (1984) provides a thorough discussion of neoclassical trade theory in higher dimensions.

Assuming we have k different goods, p^a_i denotes the autarky price and p^f_i denotes the free trade price of good i (i=1,..,n), the goods can then be ranked in the order of increasing relative opportunity costs:

$$\frac{p_1^a}{p_1^f} < \frac{p_2^a}{p_2^f} < .. < \frac{p_k^a}{p_k^f} < .. < \frac{p_{n-1}^a}{p_{n-1}^f} < \frac{p_n^a}{p_n^f} . \qquad (1)$$

The chain proposition then identifies a border good k such that the low opportunity cost goods 1,..k-1, will be all exported and the high opportunity cost goods k+1,…,n will be all imported. In his seminal treatise on comparative advantage, Haberler (1936) has shown the validity of this chain prediction with an arbitrary number of goods if there is only a single factor of production, labor. This ranking provides the supply structure of Dornbusch, Fischer and Samuelson's (1977) seminal 'Ricardian continuum of goods model'. A special of the single factor model is that relative goods prices coincide then with the relative labor requirements, and these are exogenous. Drabicki and Takayama (1979) and Dixit and Norman (1980, p. 94-96) have provided counterexamples that price comparisons do not imply an unambiguous trading pattern in the case of multiple factors of production.[5] Although the theoretical trade literature has demonstrated that the chain comparison doesn't hold in general circumstances (see Ethier (1984)), there is no empirical study that has investigated how empirically relevant these violations are.

What hasn't been pointed out in the literature, at least to our knowledge, is that by assuming that the relative price of the border good is given by $p_k^a/p_k^f=1$, the partial equilibrium textbook prediction (see for instance Mankiw, 2004, p. 177) is a special case of the chain proposition. It involves a comparison between a good's free trade price p^f_i and its autarky price p^a_i and predicts that if the former is larger than the latter, the country will export the good and vice versa. Formally,

if $p^a_i < p^f_i$, the country has a comparative advantage in good i and $T_i>0$, (2a)
if $p^a_i > p^f_i$, the country has a comparative disadvantage in good i and $T_i<0$, (2b)

where T denotes the country's net export vector (i.e. if $T_i>0$, good *i* is exported and if $T_i<0$, good *i* is imported). The partial equilibrium textbook prediction is illustrated in Figure 1.

[5] If goods are ranked in terms of relative factor intensities, Deardorff (1979) has shown the validity of a chain comparison for two production factors and an arbitrary number of goods.

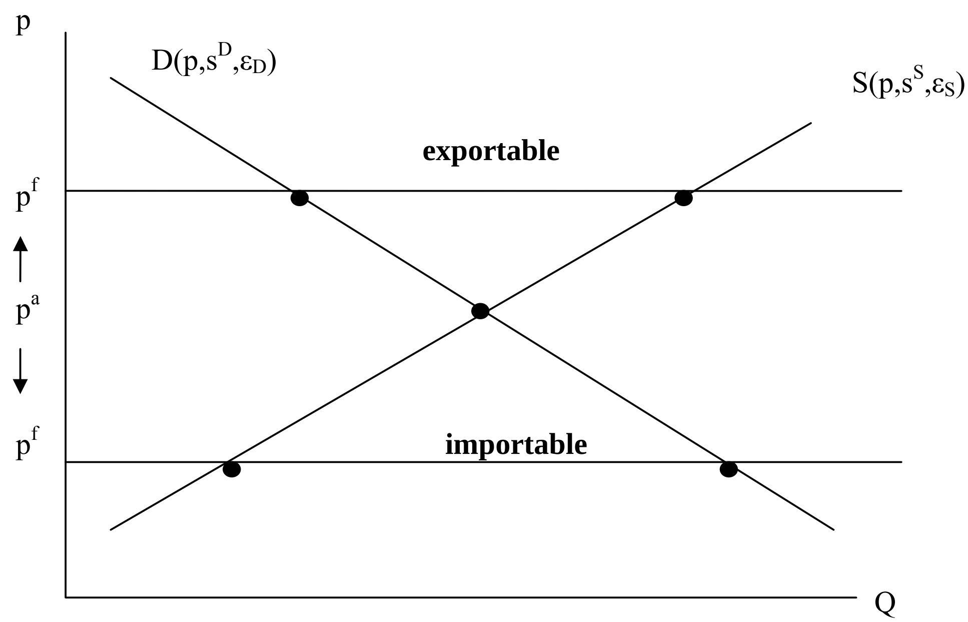


Figure 1: Trading equilibrium with no trade-induced shifts in demand or supply

The partial equilibrium prediction is based on the following rationale. Under autarky, domestic supply and demand leads to an equilibrium price p^a. Under free trade, the economy faces now an exogenous price p^f. If $p^f=p^a$, nothing can be said about the direction of trade. However, if $p^f>p^a$, domestic suppliers will have an incentive to expand their output, domestic consumers will cut their consumption, leading to an excess supply or exports. Alternatively, $p^f<p^a$ leads to an excess demand or imports. A key assumption of this logic is that there are no trade-induced shifts in the demand (e.g. income effects) or supply curves (i.e. substitution effects), which can be thought of as "violating cross-market effects". However, whether these cross-market effects will actually violate the single market prediction will depend on their relative magnitude.

Figure 2 illustrates the case of a violating cross-market effect: a rightward shift in demand ($s_o^D \rightarrow s_1^D$). The trade induced change in demand of the good causes the good to be imported although $p^f>p^a$.

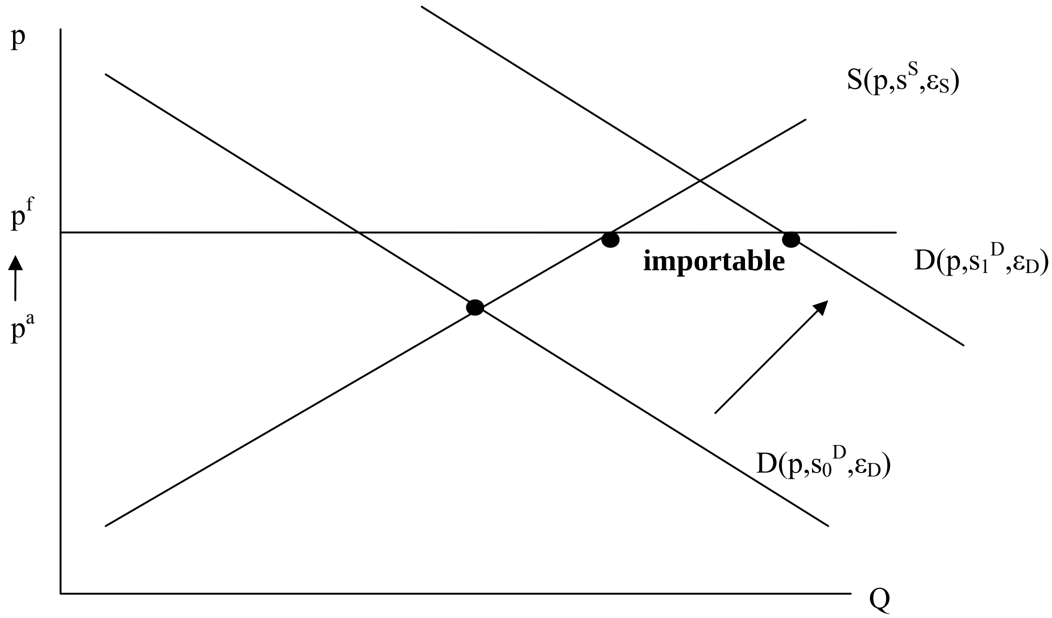


Figure 2: Trading equilibrium with a trade-induced shift in demand

It is an implicit assumption of Figures 1 and 2 that there is a detectable regime change in the price level, i.e. one can distinguish between a pre-trade price p^a and a free trade price p^f. However, if there are large 'intrinsic' disturbances in either supply or demand, it might be empirically impossible to identify a trade induced price change. Figure 3 illustrates a scenario that is particularly relevant to agricultural products, where the supply curve is fairly price inelastic relative to demand. In agricultural products, the intrinsic supply disturbance is weather. Fluctuations in weather, denoted by ε, leads to fairly large intrinsic price fluctuations. Although the free trade price might be larger than the average domestic price, trade liberalization might not lead to a regime change that can be detected in the data. Hence, the model can only be applied for products where there is a identifiable regime change in the real price data. We will discuss this issue in more detail in section 5.

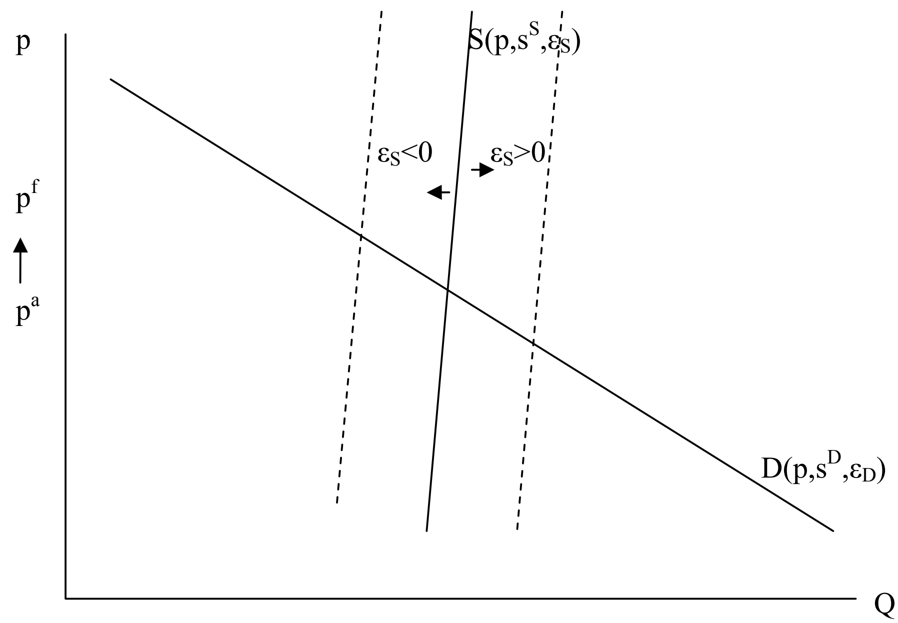


Figure 3: Lack of identifiable regime change

3. The natural experiment of Japan

The episode of Japan's opening up to full international trade in July of 1859 constitutes one of the most dramatic episodes in the history of international trade. Prior to the signing of two treaties in 1854 and 1859, Japan's economy had been in a period of nearly complete isolation from international markets for at least a century, if not two. The regime cannot be characterized as complete autarky, since a small amount of import-export trade was conducted through an artificial island of Deshima (or Dejima) with Chinese and Dutch traders negotiating with representatives of the Shogunate.[6]

The main export good was copper (with some camphor) and the main import good was sugar. Even this amount of legal trade was subject to severe limitations. Regulations imposed by the Shogunate restricted the amount of copper that could be legally exported and the number of ships (one Dutch ship and ten Chinese junks) that could be involved in any one year. The prices received by the Chinese and Dutch were also the result of bilateral negotiations between the treasury of the Shogunate and the traders. Meylan (1861) reports that the Shogunate took great pains to prevent the traders from learning the true domestic price of the export good copper and import goods such as sugar. The treasury then resold the

[6] A small amount of trade was also conducted through the Ryūkyū Islands and Satsuma (Kogoshima).

goods to Japanese merchants. Trading visits also became less frequent during the 19th century, with the Chinese making the trip only every other year and Dutch visits perhaps even less frequent. Under these circumstances, the average export value of about 0.014 cents per capita that can be calculated for 1833 may actually overstate the involvement of Japan in international trade if it were to be expressed in annual terms.[7]

The episode of opening up on July 4, 1859 dramatically changed this involvement in the international economy, particularly for some goods for which there was a strong export market. Bernhofen and Brown (2004 and 2005) provide additional details on the period that suggest that trade, while not entirely unimpeded, became relatively more open as the first decade continued. Tariff barriers were minimal. Currency incompatibilities created some barriers, as did the more open efforts of the Shogunate to restrict the export of silk. These efforts were countered by punitive western military actions. There is also some evidence of efforts to enforce sumptuary laws in some of the feudal domains, which would have tended to dampen the demand for imported woolens and cotton cloth.[8] These efforts were apparently not effective. In any event, openness is in the end a relative concept. By 1873, Japan's imports per capita were on the order of 73 cents, which is three times the level of China at the same time. No other Asian country experienced as large a relative price shock as did the Japanese economy during the 19th century.

4. Data

Our data consists of 22 traded commodities during the 30-year time period of 1838-1867. A summary of the products and their 1869 trade share is given in Table 1. We have 12 export goods, which constitute almost 67% of the total export volume in 1869 and 15 import goods, which constitute around 47% of the total import volume in 1869. The goods are recorded in the order of their relative trade shares. On the export side, the key missing item was silk worm eggs, for which there was only a limited market under autarky. On the import side, the key missing items were "new goods' (most importantly woolens) that the Japanese

[7] This calculation uses current market prices at Canton and Singapore and the actual quantities of exported goods, primarily copper. Since the trade was balanced by definition (except for goods that were unsold and remained in storage at Deshima), the export valuation offers the best approximation to the volume of trade conducted by the Dutch and the Chinese.

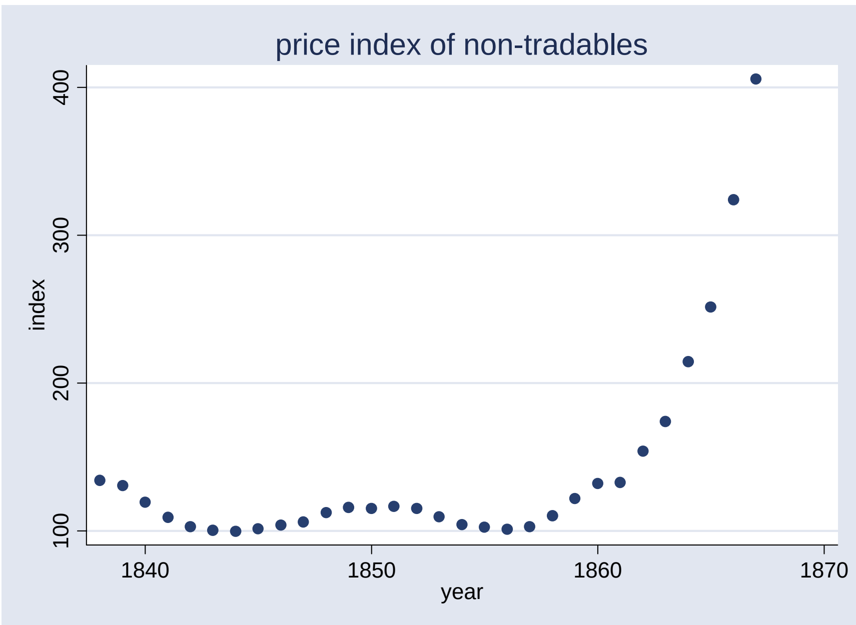
[8] Sugiyama(1988) and in subsequent research on trading networks suggests another potential source of friction between international and domestic prices. Western merchants were initially confined to a small geographic area around the four treaty ports, so that they found it difficult to ascertain market conditions for themselves directly. Instead, they relied upon networks of Japanese and Chinese traders. We expect that the magnitude of the relative price shock would have been sufficient in many markets to overcome the potential for this kind of strategic behavior to fully offset the impact of the opening up, but this question does need further examination.

economy did not produce under autarky. The two right-hand columns in Table 1 give each good's sample trade share (i.e. a good's trade share divided by 67% in the case of an exportable and a good's trade share divided by 47% in the case of an importable) and the cumulative trade share. On the export side, silk and tea dominated.

The raw data of the 22 commodities are given in nominal prices. Considerable effort went into making the nominal time series comparable with each other in terms of valuation in a common currency, the gold ryo. However, there remain some differences with regard to the points in time the prices pertain to. Many of the series are based on one observation in January, rather than an average. Some series are based upon an observation in the springtime. The remainder can be viewed as annual observations or annual averages of monthly data. However, consistency of data collection for an individual time series have hopefully mitigated the influences of seasonal fluctuations.

Since the Japanese economy experienced a rapid increase in inflation during the 1860s, the nominal ryo prices of all goods have risen considerably during that period. (see Figure 1 for a depiction of the Shinbo price index of non-tradables, indicating the rise of inflation through the 1860s). In order to be able to investigate the time-paths of real prices, we divided the nominal gold ryo price by a price-index of 13 non-tradables taken from Shinbo (1978, table 5-10) for each year. These 22 time series of real prices are the inputs on which the empirical analysis discussed in the next section is based.

FIGURE 1



Source: Shinbo (1978).

5. Empirical implemenation

5.1. Empirical specification

The theory pertains to two different regimes: autarky and free trade. It is a key assumption of equations (2a) and (2b) that the autarky price p^a_i of good *i* is distinct from its world price p^w_i. From an empirical point of view, it is not quite clear how to identify the world price for a specific good; mainly due to trade costs (i.e. transportation costs, lack of perfect arbitrage etc.). However, if the “forces of the opening up” are strong enough, we would expect to see a break in a good’s real price series, given that the sample period covers the economy’s last 20 years of autarky and the first 10 years of open international trade. Hence, we empirically investigate the good-by-good formulation of comparative advantage by testing the price series for each good for a structural break.

Our research strategy is as follows. If we find no statistical evidence for a structural break in a time series, then the underlying assumption of the theory does not apply to this good. However, if we find evidence for a structural break in a series, then the good lies within the domain of the theory and we can investigate whether the break is compatible with the prediction of the theory or not.

We consider the following model specification for each of the products in our sample:

$$rp_t = \beta_0+\beta_1 t+\beta_2 D_{breakyear}+ \beta_3\, D_{breakyear}*t+ \varepsilon_t, \qquad (3)$$

where rp denotes the real price of a good at time t, t denotes a time trend variable, $D_{Breakyear}$ denotes the break year dummy variable ($D_{breakyear}$=1 for t>*breakyear* and 0, otherwise) and $D_{breakyear}*t$ interacts the time trend with the break year dummy.

For 20 of 22 products we chose 1858, the treaty year, as the break year; for two products (coal and ginseng) historical evicence and visual inspection suggested to use 1853 as the break year.

We tested for a structural break by formulating the following null hypothesis:

$$H_0:\ \beta_2=\beta_3=0. \qquad (4)$$

If we are able to reject the null hypothesis (4), there is statistical evidence for a structural break in the data. If we cannot reject the null hypothesis, there is no evidence for a structural break.

Given that there is a structural break, we can investigate the pattern of trade is accord with the model's prediction? As we have discussed elsewhere (Bernhofen and Brown (2004 and 2005)), the autarky-free trade comparison must be interpreted in terms of a counterfactual. In our case, it involves a comparison between the estimated average real price $E(\mathrm{rp}_t)$ from the free trade, or post-break, regime and the predicted, or counterfactual, average real price, $PE(\mathrm{rp}_t)$ from the pre-break regime. The empirical counterparts of (2a) and (2b) are then given as follows:

if $PE(\mathrm{rp}_t) < E(\mathrm{rp}_t)$, then the good is expected to be exported, (5a)

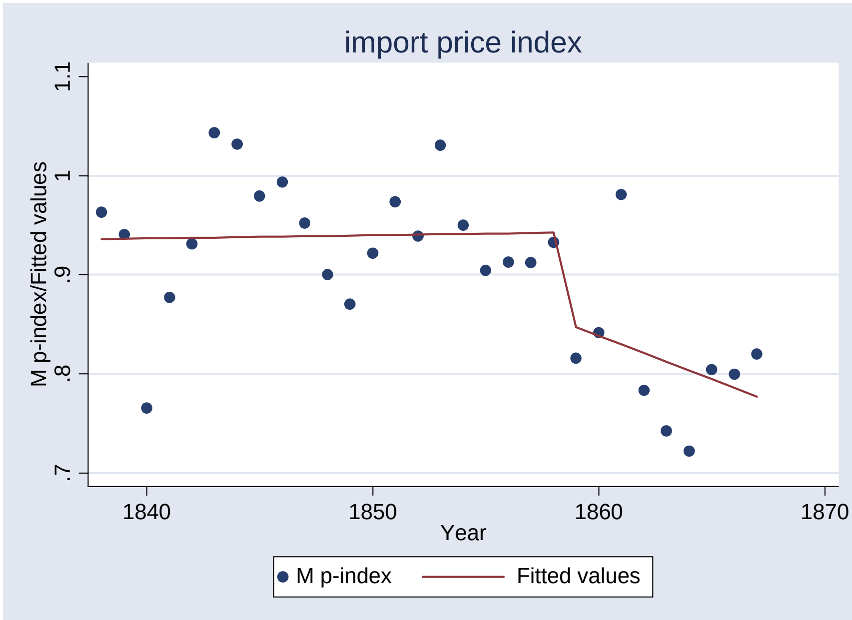
if $PE(\mathrm{rp}_t) > E(\mathrm{rp}_t)$, then the good is expected to be imported. (5b)

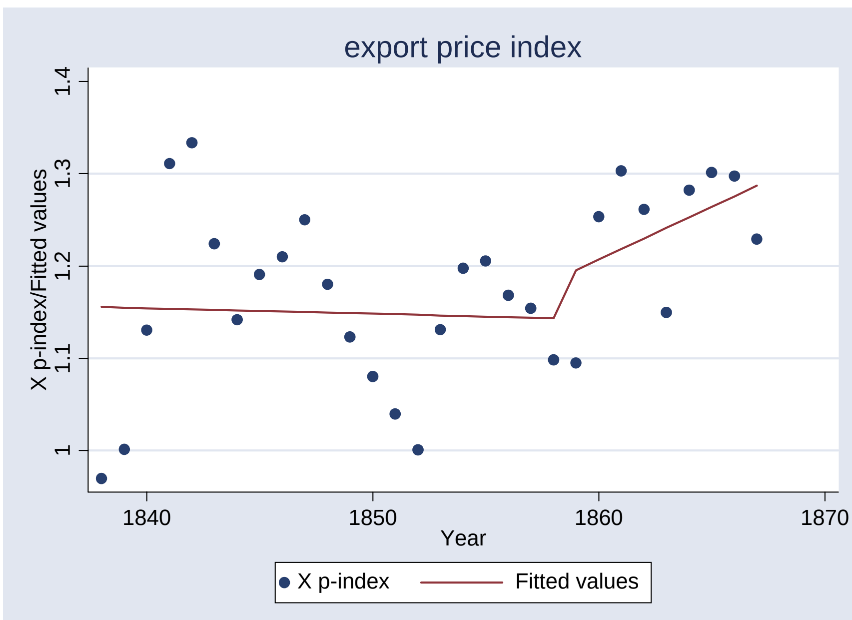
5.2 Results

We estimated equation (3) with OLS first for series of import and export price indices that we constructed and then separately for each individual price series. Since we are primarily interested in comparing the estimated post-break price lines with the predicted, or counterfactual, pre-break break price lines (equations (5a) and (5b)), we present all our results graphically. The import (export) price index has been calculated as a trade-weighted average of accumulated year-to-year price changes of all imports (exports) in the sample. For both indices we chose 1858 as the break year.

Figure 2 gives the pre-break and post-break prices lines for both indices. The predicted, or counterfactual pre-break price lines, which are simply the extensions of the pre-break line into the free trade period are not drawn. It can be seen that both price indices are compatible with what we would expect. We see a relatively sharp drop in the average import price index and a rise in the average export price index When testing for a structural breaks, we find that we can reject the null hypothesis (4) for the import price index at the 95% per cent confidence level. However, the structural break for the export price index is not statistically significant (i.e. we obtain a p-value of 20% for this series).

FIGURE 2





Next, we estimated equation (3) for each of the 22 products in our sample and tested for structural breaks. We tested the individual series with and without an intercept ("changing slope" versus "crash model") and chose, as discussed above, 1853 as the break year for coal and ginseng. The results are summarized in Table 2; the graphs for each of the 22 products are given in the Appendix.

Among the export goods, we found evidence of structural breaks for 7 of the 12 products in the sample. Among the 7 products, 5 products revealed a break consistent with the theory, one product (ginseng) showed ambiguous breaks (compatible with the theory when 1853 was chosen and incompatible when 1859 was chosen) and one product (charcoal) was inconsistent with the theory. In terms of trade volume, we found that 95% of the export volume revealed evidence of a structural break consistent with the theory.

On the import side, we found evidence of structural breaks for 7 of the 15 products in the sample. Among the 7 products with a statistically significant structural break, 6 were compatible with the theory and only one product (silk cloth) was incompatible. However, the product that was incompatible with the theory accounts for less than 0.5% of the total sample import share. In sum, we can conclude that we found, a bit surprisingly, evidence of price changes that are remarkably compatible with the single market prediction of comparative advantage.

6. Concluding Remarks

Virtually all undergraduate textbooks in economics discuss the pattern of trade using a single market analysis. A virtue of the single market analysis is that it provides an actual prediction for the direction of trade of a single good: a simple price comparison predicts that trade should in go in one direction and not the other. A shortcoming of the model is that it ignores the trade-induced interactions with other markets in the economy; general equilibrium trade theory incorporates these interactions in a systematic way. However, as a trade-off, general equilibrium analysis makes only a prediction about a country's entire trading vector (Deardorff, 1980), and makes a good-by-good prediction only under the one factor assumption.

The natural experiment of Japan provides an unusual opportunity to empirically investigate the single market predictions we teach our students in introductory economics. Maybe the most important contribution of this paper is the lesson we should take home to our students: the autarky-free trade price comparison is not just a figment of our imagination but can be linked to real world markets.

References

Bernhofen, Daniel M. and John C. Brown, 2004, "A direct test of the theory of comparative advantage: the case of Japan", *Journal of Political Economy*, 112 (1), 48-67.

Bernhofen, Daniel M. and John C. Brown, 2005,"An empirical assessment of the comparative advantage gains from trade: evidence from Japan", *American Economic Review*, 95(1), 208-225.

Bhagwati, Jagdish H., 1972. "The Heckscher-Ohlin theorem in the multi-commodity case", *Journal of Political Economy* 80, 1052-1055.

Davis Donald R. and David E. Weinstein, 2003, "The Factor Content of Trade". In Handbook of International Trade, edited by E. Kwan Choi and James Harrigan. Malden, MA: Blackwell Publishing.

Deardorff, Alan V, 1979, "Weak Links in the Chain of Comparative Advantage", *Journal of International Economics* 9(2), 197-209.

Deardorff, Alan V, 1980, "The General Validity of the Law of Comparative Advantage", *Journal of Political Economy* 88, 941-957.

Deardorff, Alan, V. 1982, "The General Validity of the Heckscher-Ohlin Theorem." *American Economic Review* 72, 683-694.

Dixit Avinash K. and Victor Norman, 1980, *Theory of International Trade*. Cambridge University Press, Cambridge.

Drabicki and Takayama, 1979, "An antimony in the theory of comparative advantage", *Journal of International Economics* 9: 211-223.

Ethier, Wilfred, 1984, "Higher dimensional issues in trade theory", in Handbook of International Economics, Volume 1, edited by Ronald W. Jones and Peter B. Kenen, North Holland:Amsterdam, pp. 131-184.

Haberler, Gottfried von, 1936, The Theory of International Trade with its Applications to Commercial Policy. William Hodge, London.

Huber, J. Richard J., 1971, "The Effect on Prices of Japan's Entry Into World Commerce after 1858." *Journal of Political Economy*, May/June 1971, 79(3), pp. 614-628.

Jones, Ronald W, 1956-57, "Factor Proportions and the Heckscher-Ohlin Theorem", *Review of Economic Studies* 24, 1-10.

Kinyū Kenkyūkai, 1937 *Waga kuni shōhin sōba tōkei hyō (Statistics of national commodity prices).* Tokyo: Kinyū Kenkyūkai.

Mankiw, Gregory, 2004, *Principles of Economics*, 3rd edition, Thomson Southwestern.

Miyamoto, Mataji, 1963, *Kensei Osaka no bukka to rishi (Prices and interest rates in Osaka during the pre-Meiji period)* Osaka Daigaku Kinsei Bukkashi Kenkyukai. Tokyo: Sōbunsha.

Nagazumi, Yōko, 1987, *Tōsen yushutsunyūhin sūryō ichiran, 1637-1833-nen (Summary of imports and exports for the years 1637-1833)*, Tokyo: Sōbunsha.

Nakai, Nobuhiko, ed. (Mitsui Bunko), 1989,. *Kinsei kōki ni okeru shuyō bukka no dōtai* (*Movement of the prices of staple commodities*), University of Tokyo Press.

Shinbo, Hiroshi, 1978, *Kinsei no bukka to keizai hatten: zen kōgoyō shakai e no sūryōteki sekkin (Prices and the development of the economy during the Edo era)*. Tokyo: Toyo Keizai Shinposha.

Sugiyama, Shinya, 1988, *Japan's industrialization in the world economy, 1859-1899: export trade and overseas competition*, London: Athlone Press.

Vanek, Jaroslav, 1968, "The Factor Proportions Theory: The N-Factor Case". *Kyklos* 21(4): 749-756.

Yamazaki, Ryūzō, 1983, *Kinsei bukkashi kenkyū (Price history of the Edo era)*, Tokyo: Hanawa Shobo.

TABLE 1A:
Products in the Sample: Exports

Product	Market	Category in Export Statistics	Trade share (share of 1869 exports)	Share of all exports in sample	Cumulative export share
Silk	Ōsaka	Raw silk	43.7	65.78	65.78
Green tea	Kyōtō	Tea (green)	16.3	24.54	90.32
Coal	Ōsaka	Coal	2.2	3.31	93.63
Dried mushroom (shiitake)	Ōsaka	Mushroom	1.4	2.11	95.74
Vegetable wax	Ōsaka	Wax, vegetable	1.0	1.51	97.25
Planks (cypress)	Ōsaka	Planks, hardwood	0.5	0.75	98.00
Ginseng, 1st quality	Kyōtō	Ginseng	0.5	0.75	98.75
Copper	Ōsaka	Copper	0.5	0.75	99.50
Fish manure (sardine)	Ōsaka	Fish manure	0.2	0.30	99.80
Charcoal	Ōsaka	Charcoal	0.1	0.15	99.95
Tea, bancha	Kyōtō	Tea, bancha	0.02	0.03	99.98
Fish, salted	Ōsaka	Fish, cod	0.01	0.02	100.00
Sum			66.43	100	

Sources: Data from Ōsaka are from Miyamoto (1963) with the exception of silk, which is from Yamazaki (1983). The data from Kyōtō are from Nakai (Mitsui Bunko) (1989).
Notes: To the best extent possible, export categories have been matched with the price series that is closest to the products.

TABLE 1B:
Products in the Sample: Imports

Product	Market	Category in Export Statistics	Trade share (share of 1869 imports)	Share of all imports in sample	Cumulative import share
Plain cotton cloth	Ōsaka	Cotton shirtings and other cloth	14.6	31.34	31.34
Cotton yarn	Ōsaka	Cotton yarn	7.3	15.67	47.02
Brown sugar	Ōsaka	Brown sugar	4.6	9.88	56.89
Rice (Higo, Kumamoto Prefecture)	Ōsaka	Rice	4.3	9.23	66.12
Ginned cotton (Settsu, near Ōsaka)	Ōsaka	Raw Cotton	4.1	8.80	74.92
White Sugar	Tokyo	White sugar	4	8.59	83.51
Heavier plain cotton cloth	Kyōtō	Cottons (tafachellas)	3.7	7.94	91.46
Sake	Kyōtō	Wines and Spirits	0.98	2.10	93.56
Nails (ca 15 cm or 5 sun)	Ōsaka	Iron manufactures	0.7	1.50	95.06
Soybean	Ōsaka	Beans, Peas, Pulse	0.6	1.29	96.35
Tobacco products	Kyōtō	Cigars	0.5	1.07	97.42
Sugar (candy)	Ōsaka	Sugar (candy)	0.4	0.86	98.28
Paper	Tokyo	Paper	0.3	0.64	98.93
Bar iron	Ōsaka	Iron in rods	0.3	0.64	99.57
Silk cloth (Chichibu, Saitama Prefecture)	Ōsaka	Silk cloth	0.2	0.43	100.00
Sum			46.6	100	

Sources: Data from Ōsaka are from Miyamoto (1963) with the exception of silk, which is from Yamazaki (1983). The data from Kyōtō are from Nakai (Mitsui Bunko) (1989). The data from Tokyo are from Kinyū Kenkyūkai (1937).
Notes: To the best extent possible, export categories have been matched with the price series that is closest to the products.

TABLE 2:
EMPIRICAL RESULTS

Exports		**Sample Export share**	**Cumulative export share**
a) with structural breaks	**Compatible with theory?**		
Silk	yes	65.78	65.78
Green tea	yes	24.54	90.32
Coal	yes	3.31	93.63
Vegetable wax	yes	1.51	95.14
Fish, salted	yes	0.02	95.16
Ginseng, 1st quality	ambiguous	0.75	
Charcoal	no	0.15	
b) with no structural breaks			
Dried mushroom (shiitake)		2.11	2.11
Planks (cypress)		0.75	2.86
Copper		0.75	3.61
Fish manure (sardine)		0.30	3.91
Tea, bancha		0.03	3.94

Imports		**Sample import share**	**Cumulative import share**
a) with structural breaks	**Compatible with theory?**		
Plain cotton cloth	yes	31.34	31.34
Cotton yarn	yes	15.67	47.02
Heavier cotton cloth	yes	7.94	54.96
Nails	yes	1.50	56.46
Tobacco products	yes	1.07	57.54
Paper	yes	0.64	58.18
Silk cloth	no	0.43	
b) with no structural breaks			
Sugar, brown		9.88	9.88
Rice		9.23	19.11
Ginned cotton		8.80	27.91
White sugar		8.59	36.50
Sake		2.10	38.60
Soybean		1.29	39.89
Sugar (candy)		0.86	40.75
Bar iron		0.64	41.39

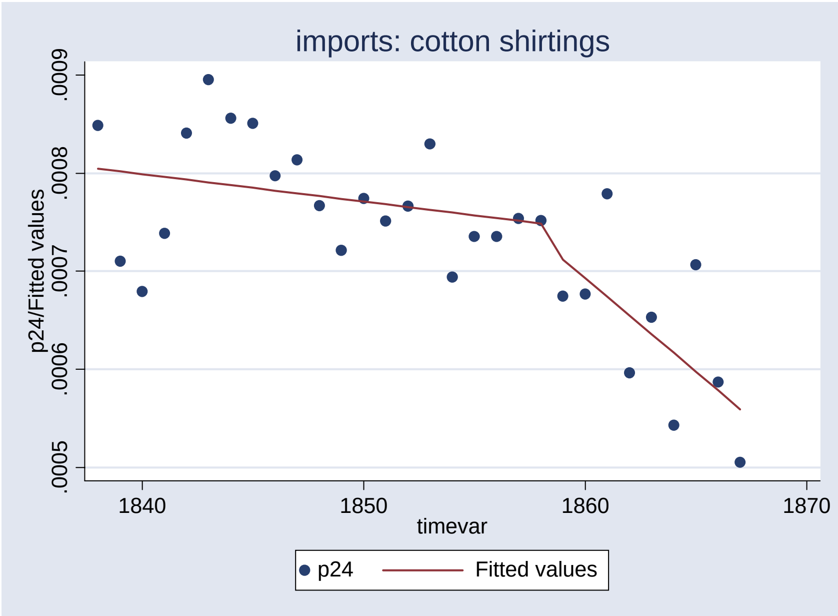
Source: Results of estimation of models of structural breaks. Detailed results of these tests are available from the authors.

APPENDIX

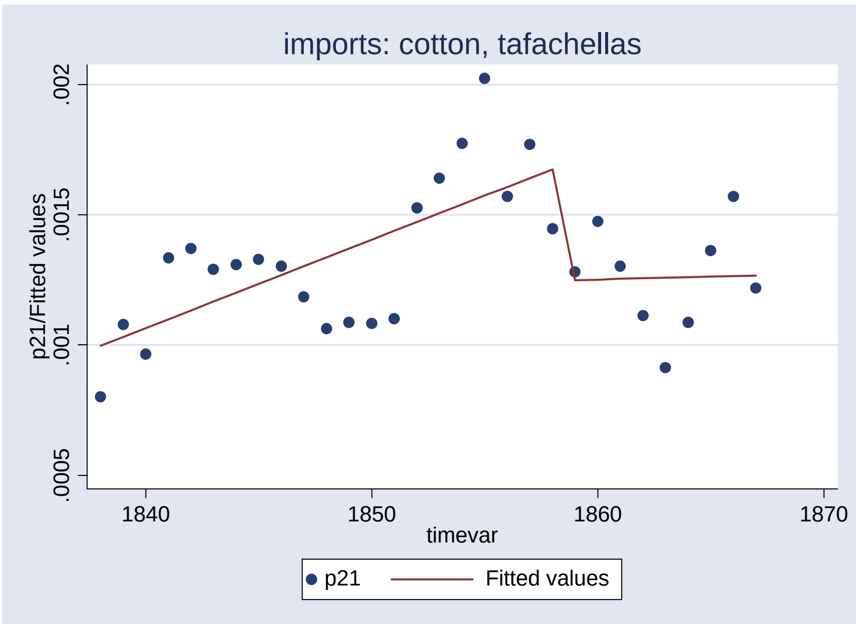
TEST RESULTS FOR INDIVIDUAL PRODUCTS:

I A. Imports with unambiguous structural breaks:

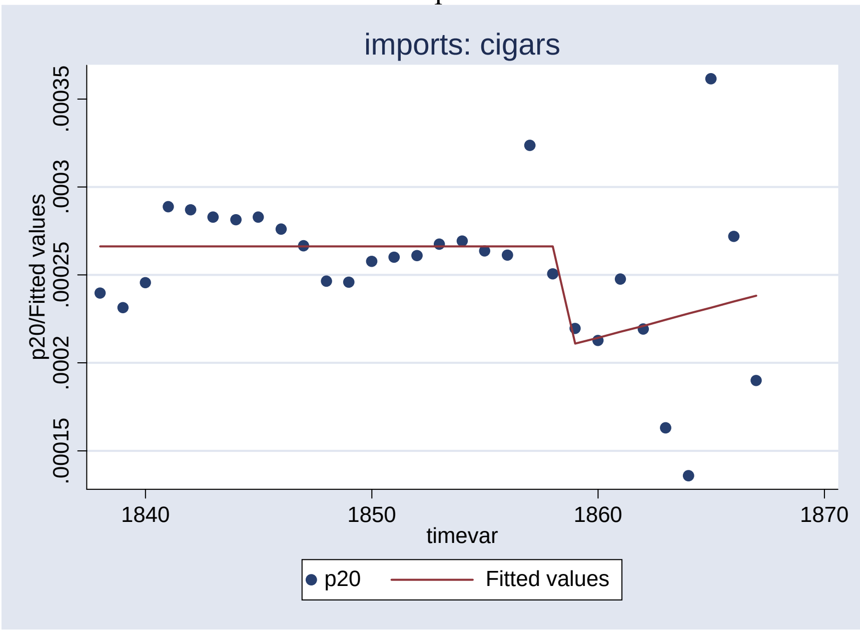
Plain cloth



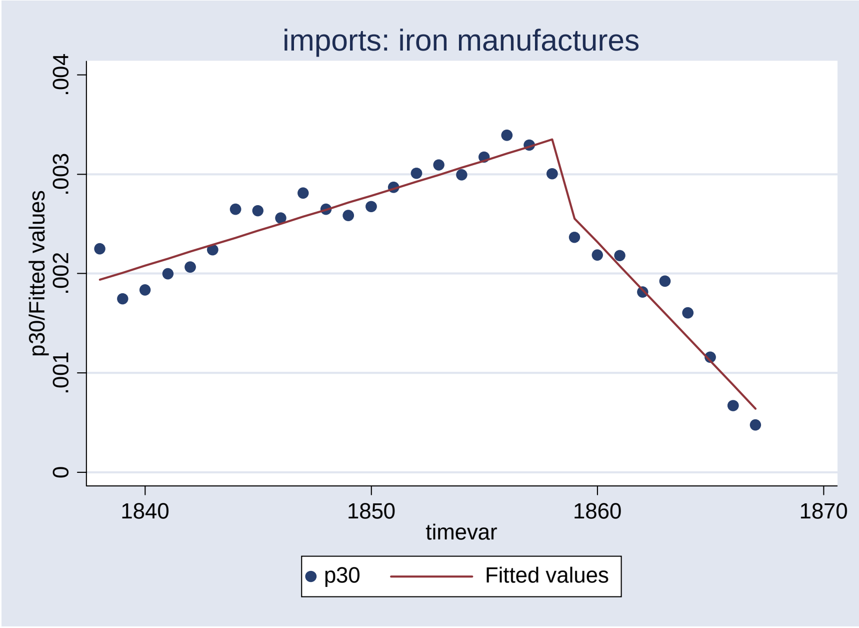
Heavier cloth



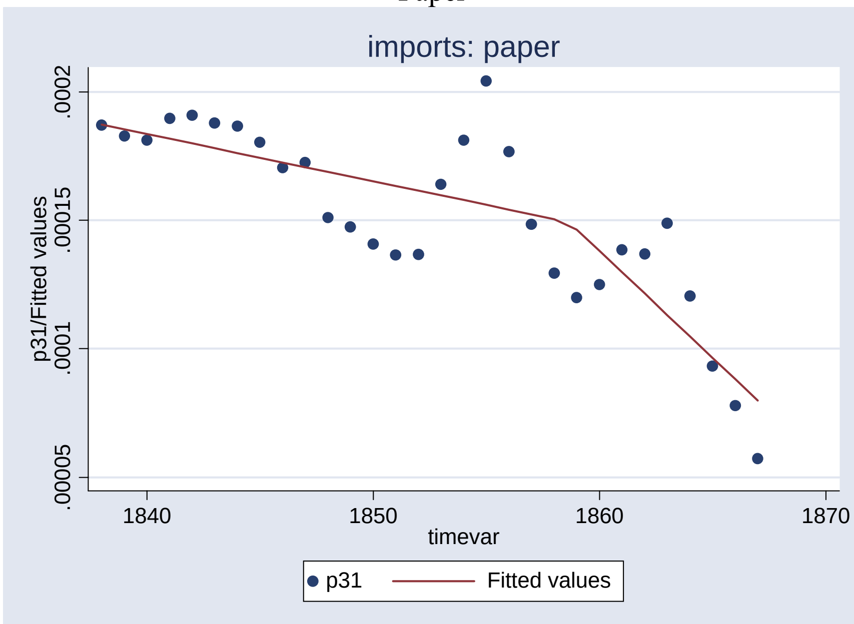
Tobacco products



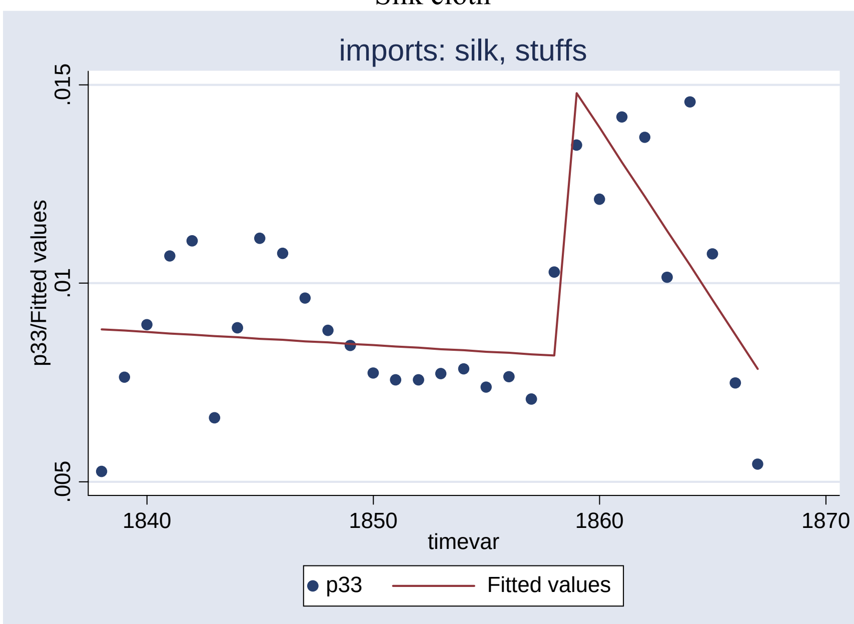
Nails



Paper



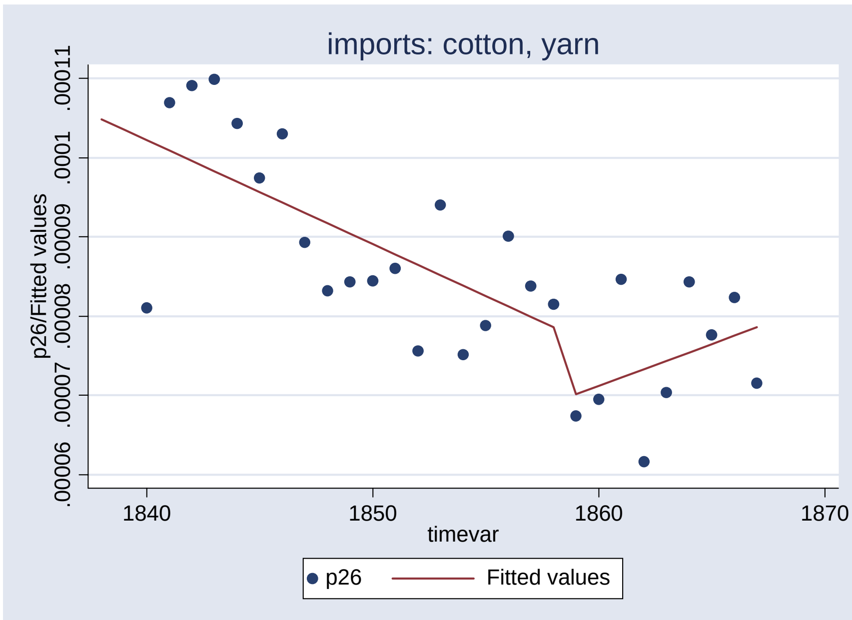
Silk cloth



IB. Imports with ambiguous structural breaks:

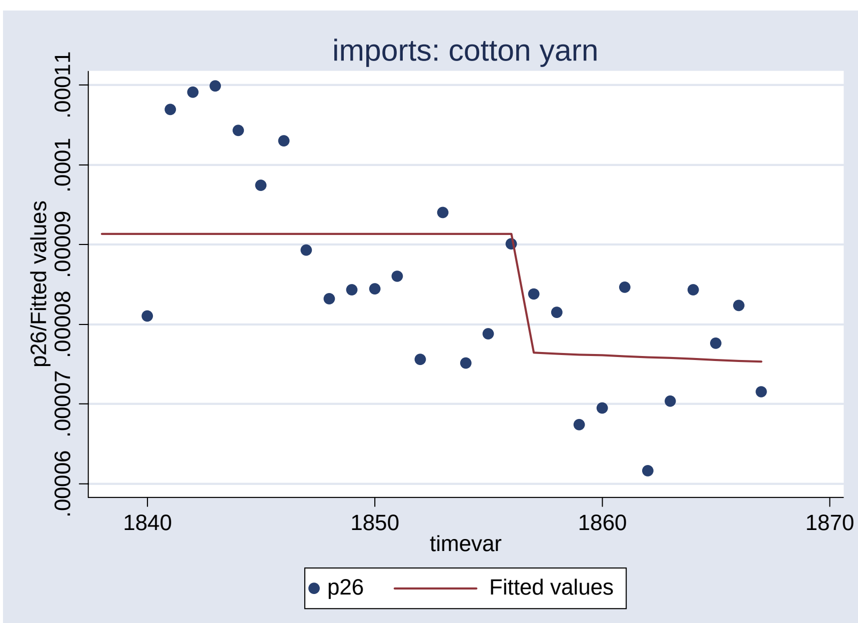
(i) Only a moderately significant structural break (p-value =0.15) under the regular specification (i.e. with a time trend); consistent with the theory.

First series of cotton yarn



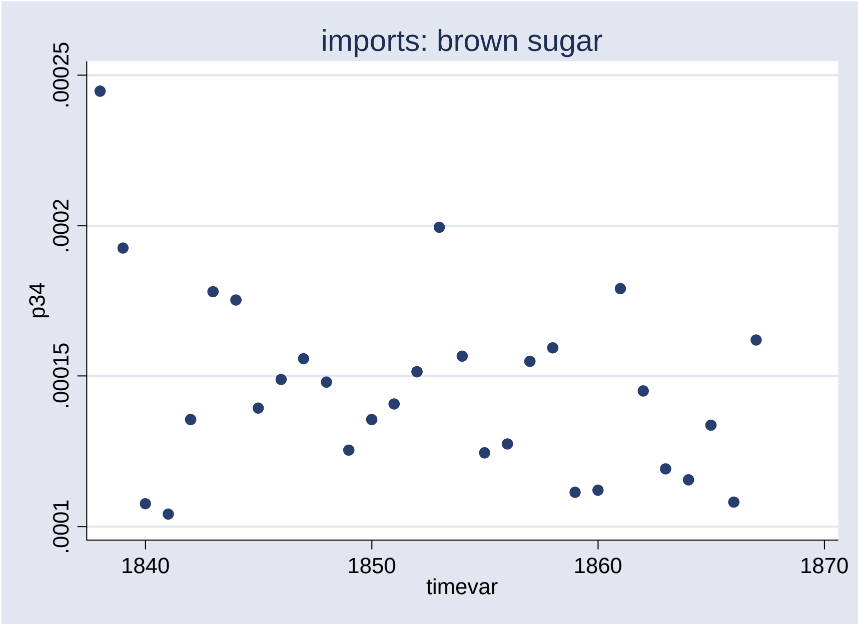
(ii) Highly significant structural break without a time trend, consistent with the theory.

Second series of cotton yarn

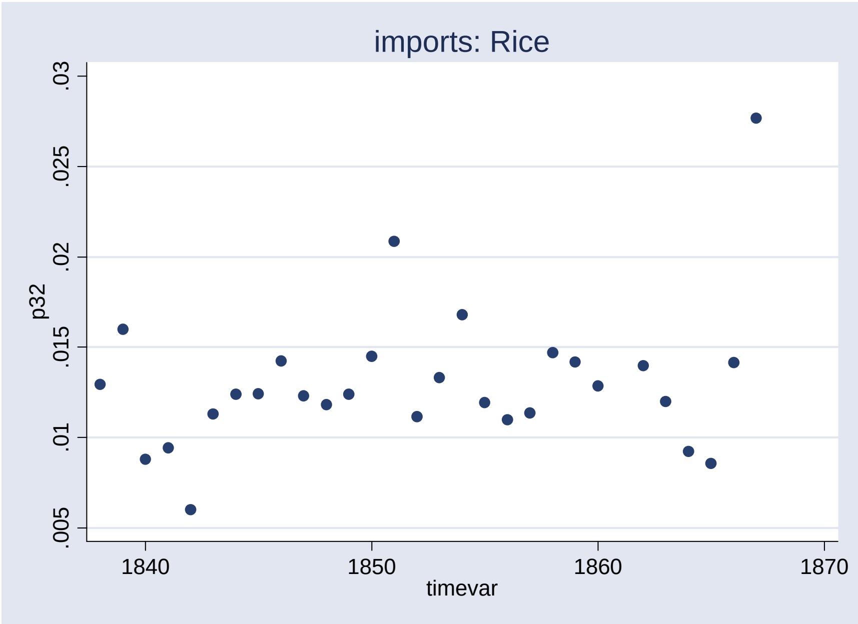


I C. Imports without structural breaks:

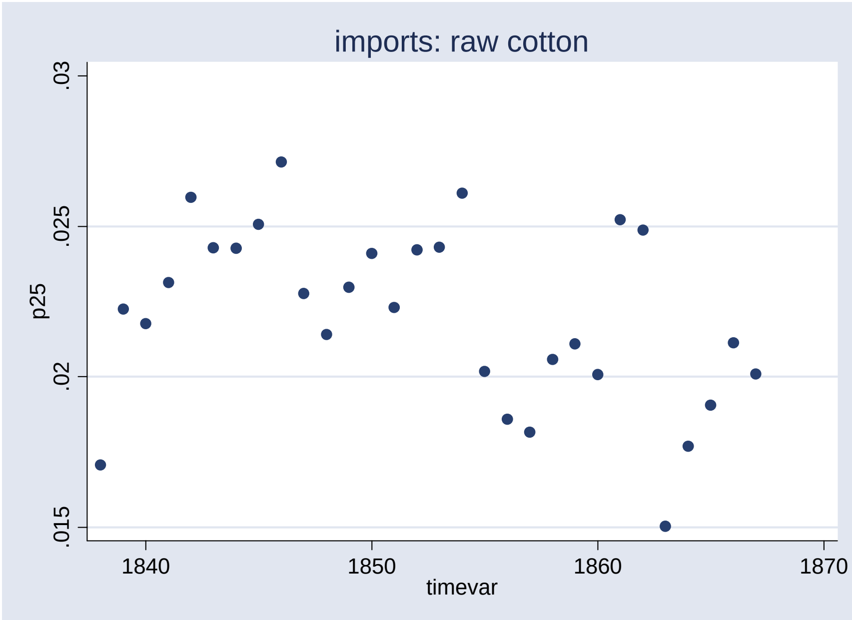
Brown sugar



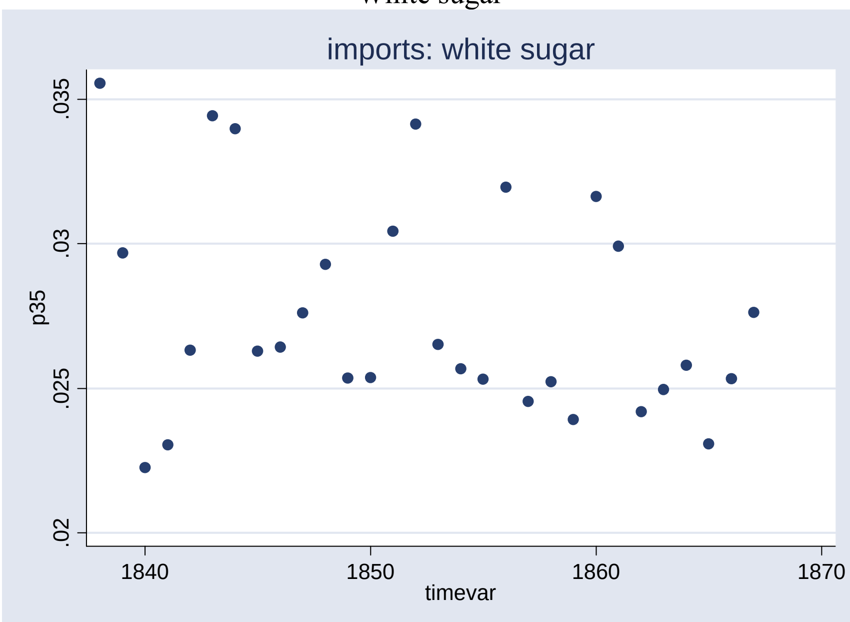
Rice



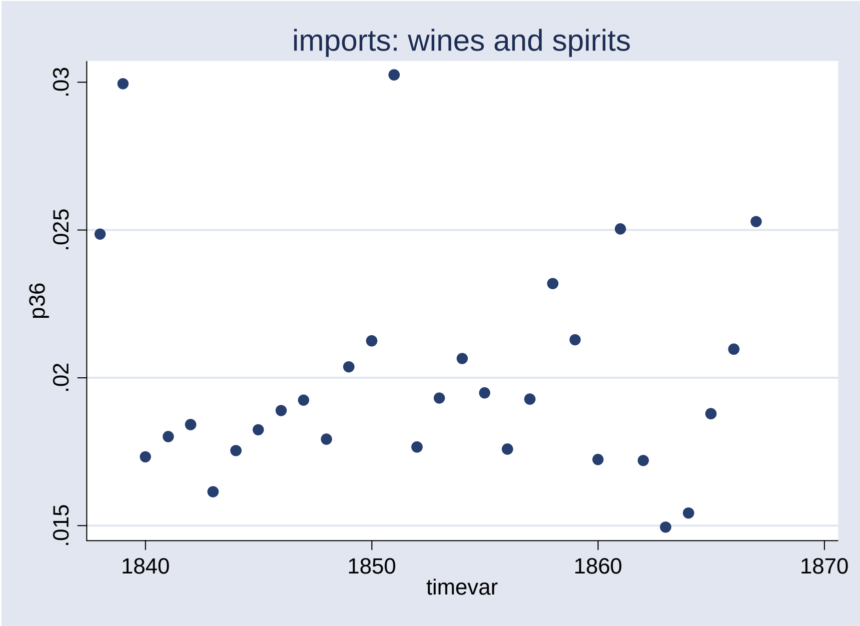
Ginned cotton



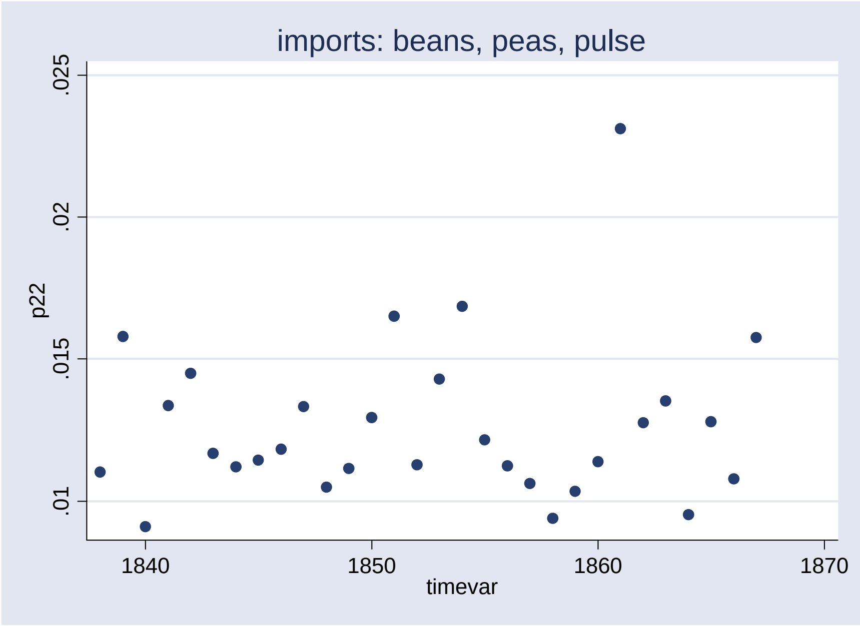
White sugar



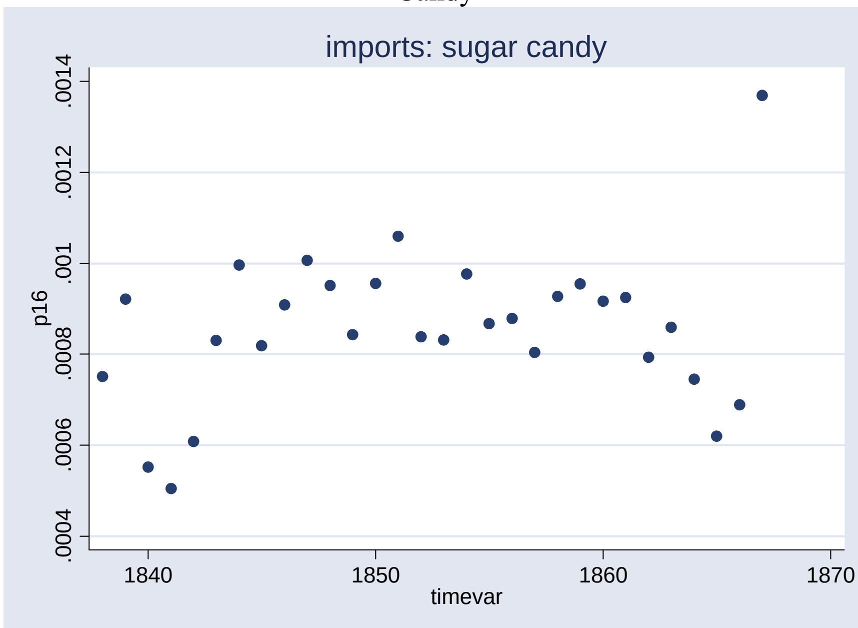
Sake



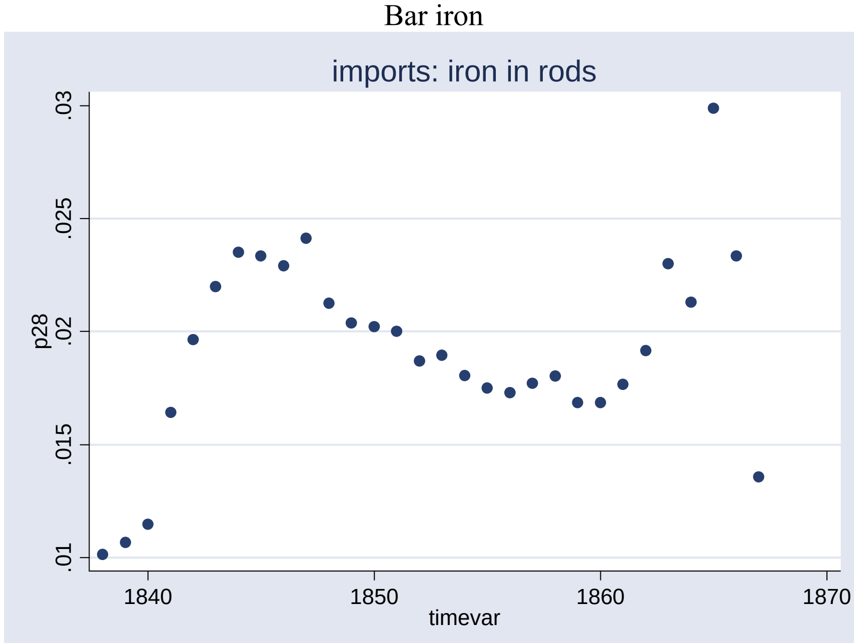
Soybean



Candy

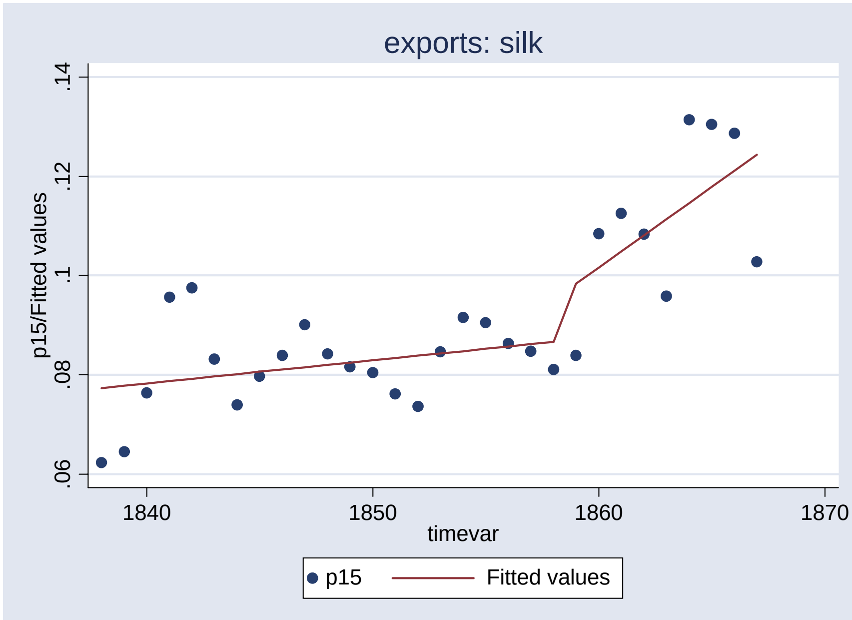


Bar iron

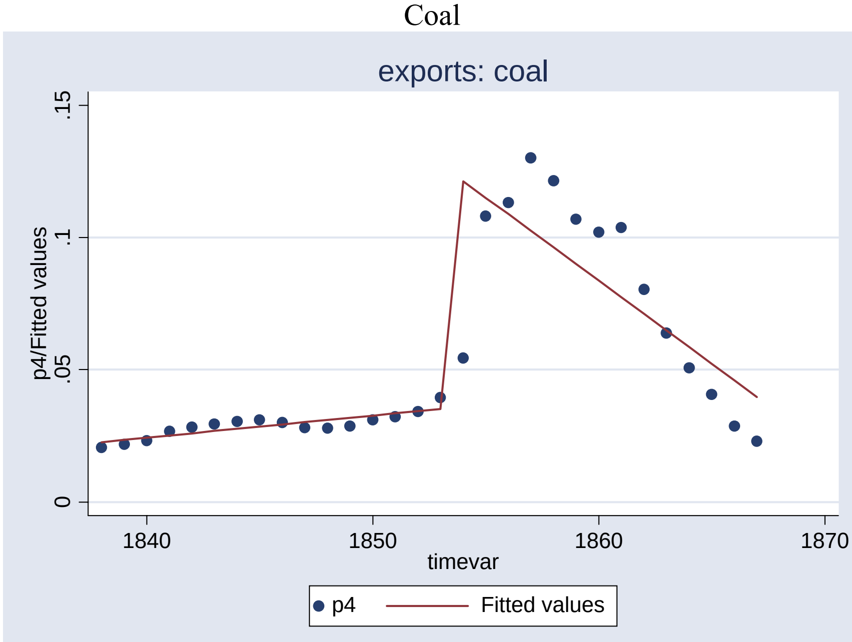


II A. Exports with unambiguous structural breaks:

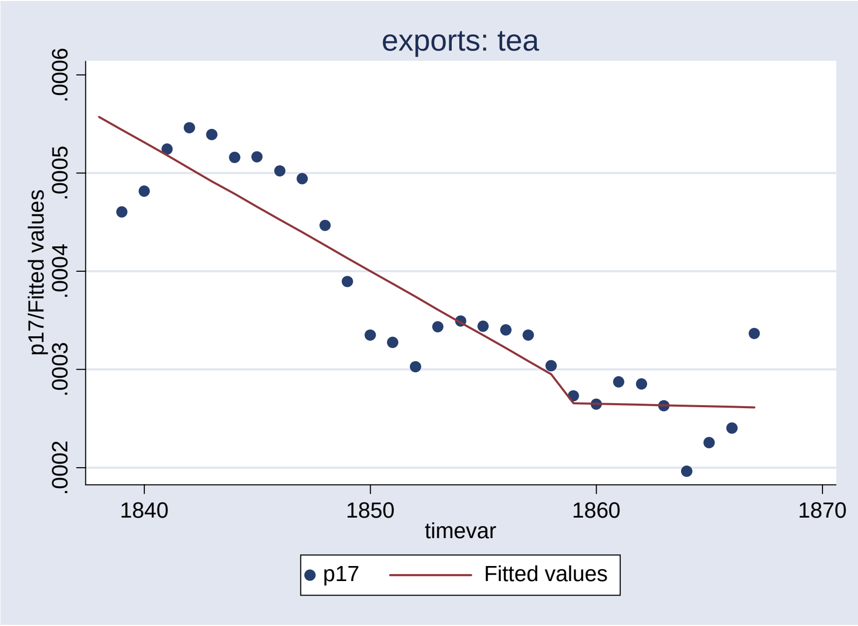
Silk



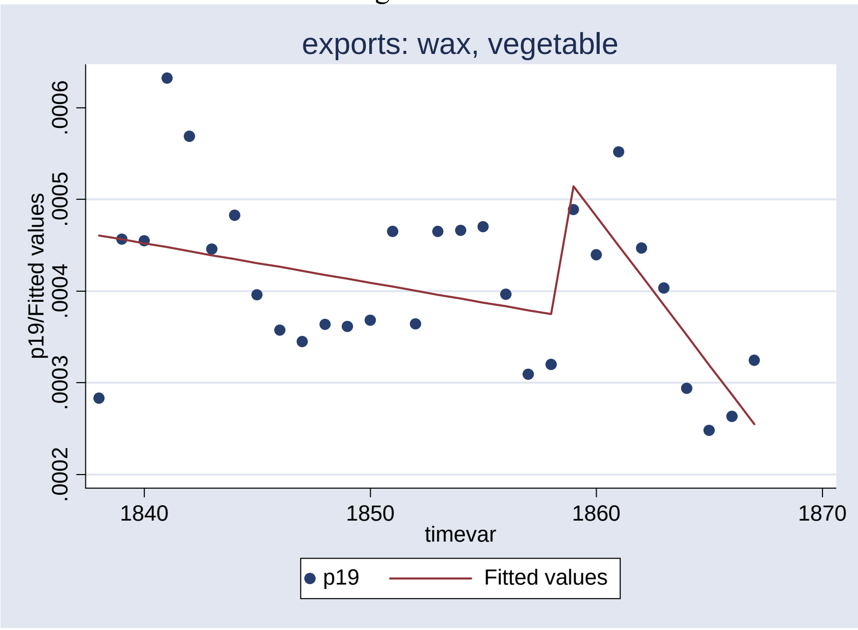
Coal



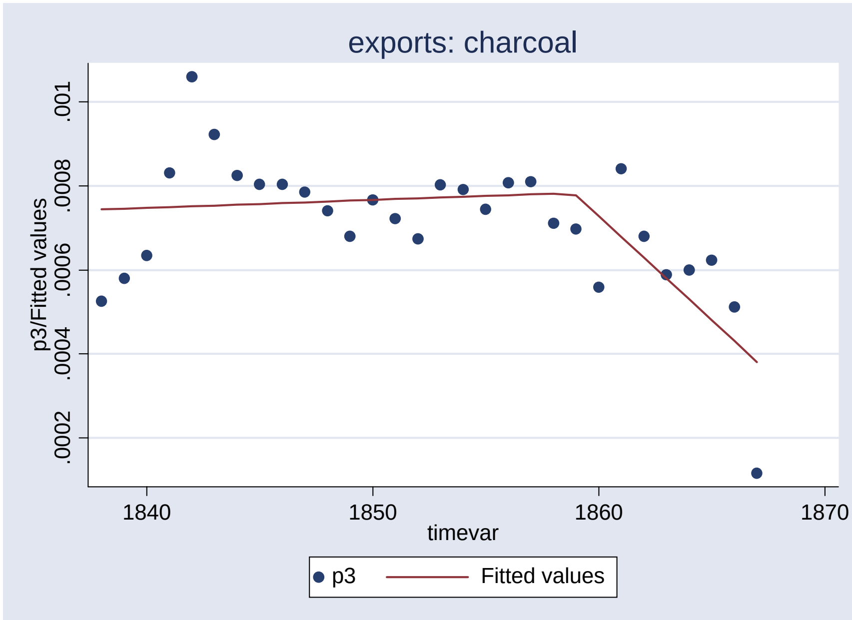
Green tea



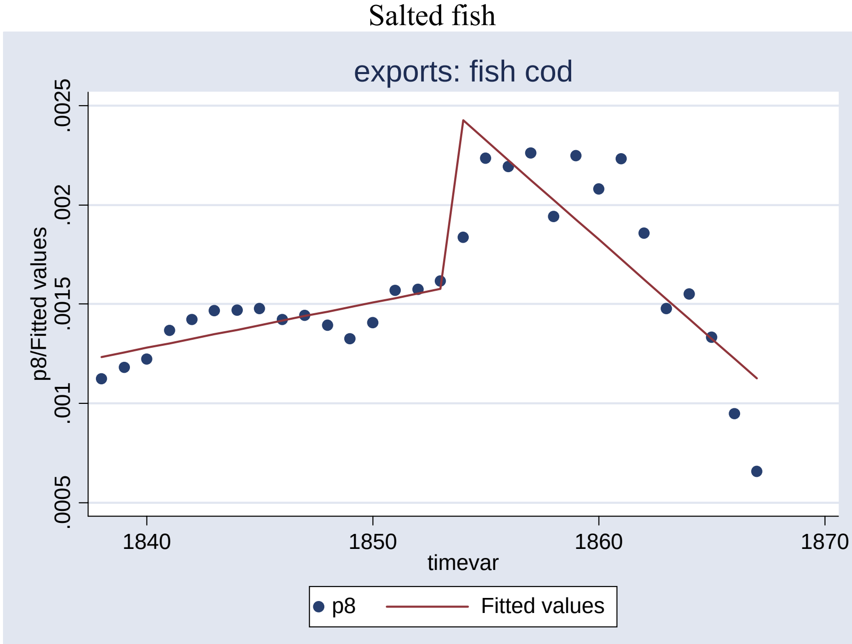
Vegetable wax



Charcoal



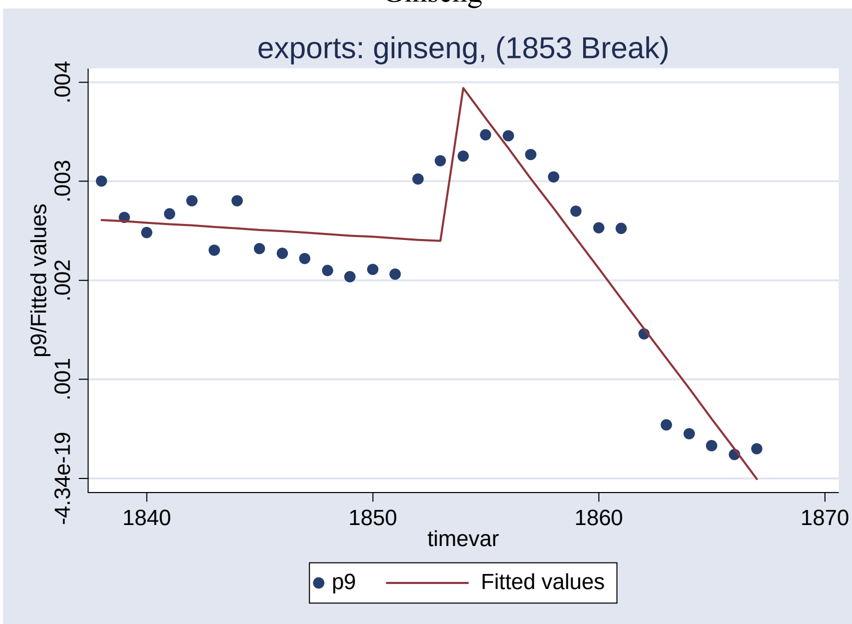
Salted fish



II. B. Exports with ambiguous structural breaks

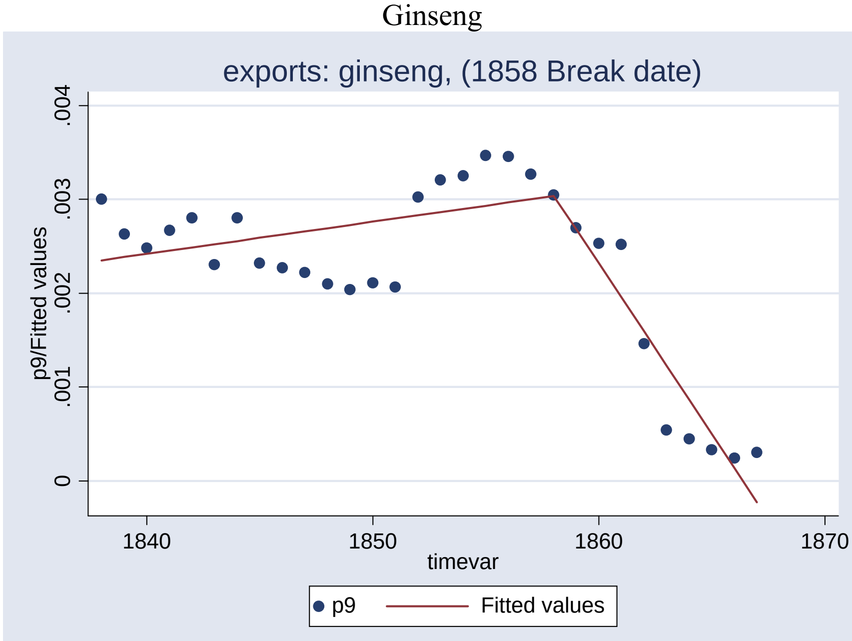
(i) Compatible with the theory

Ginseng



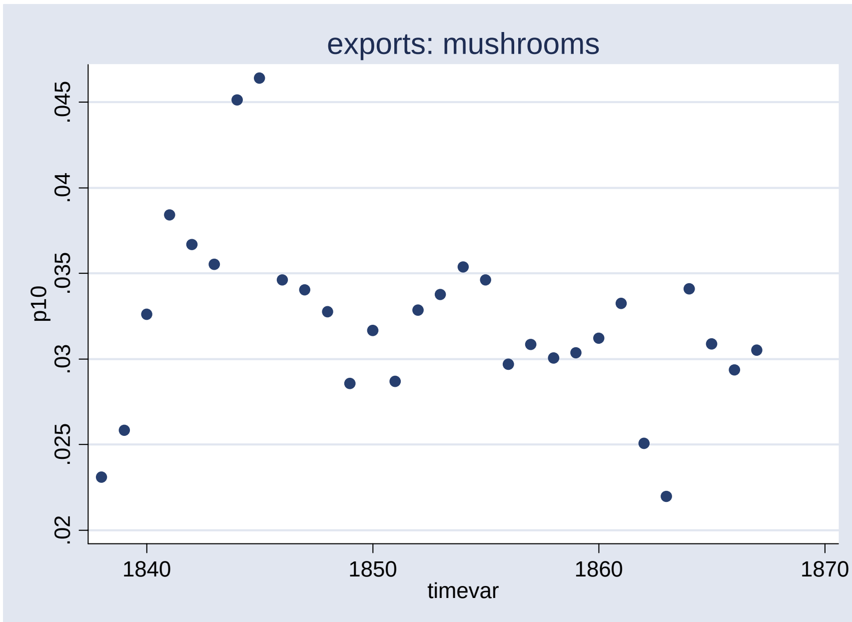
(ii) Incompatible with the theory

Ginseng

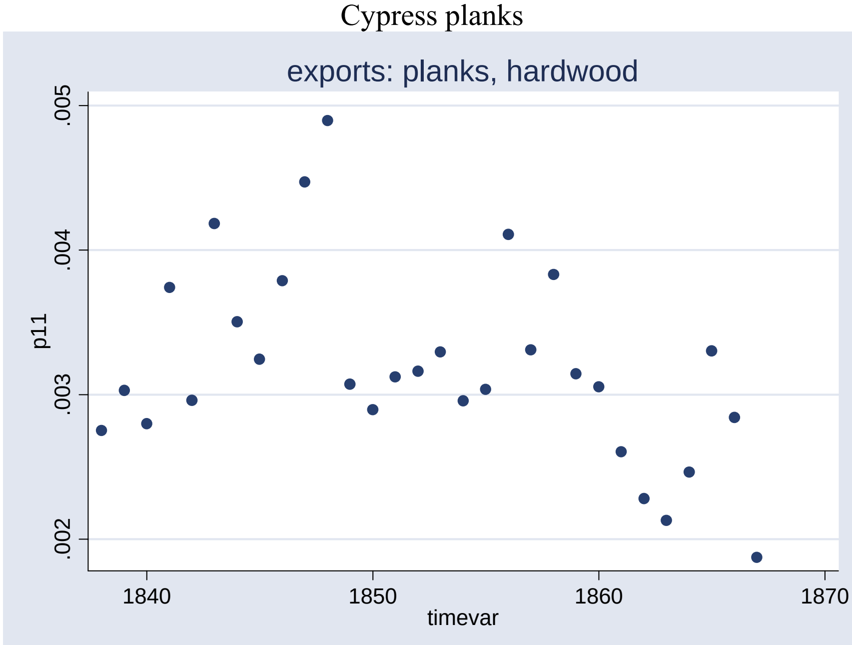


II. C. Exports without structural breaks

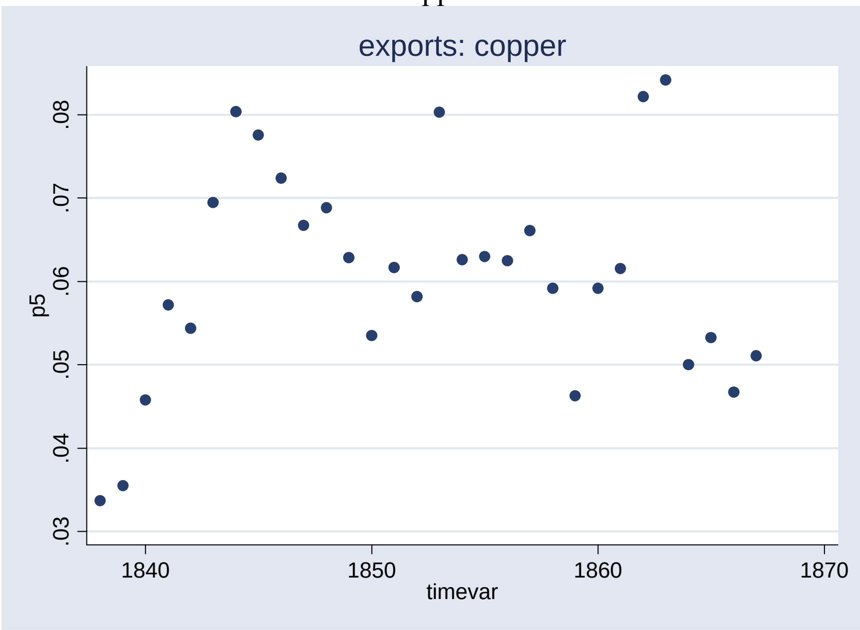
Shiitake mushrooms



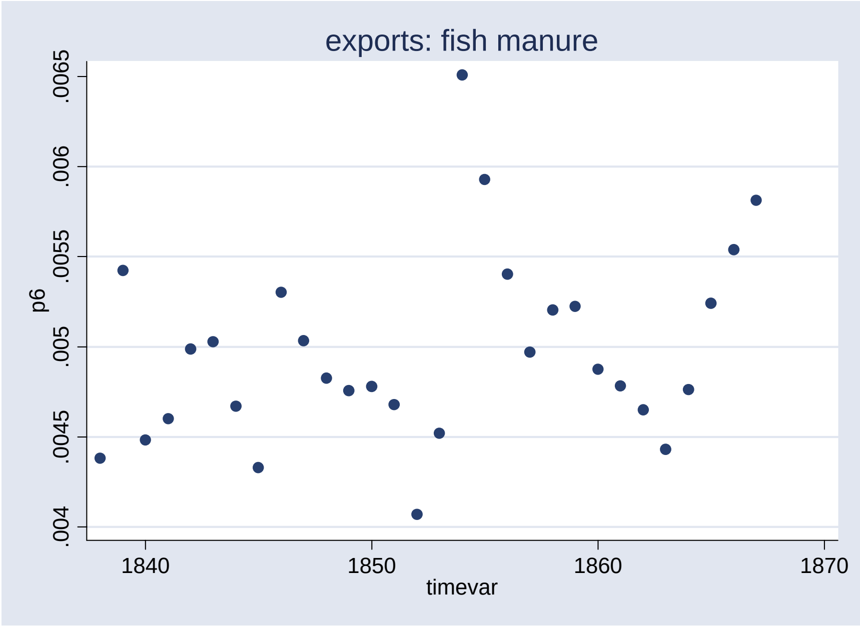
Cypress planks



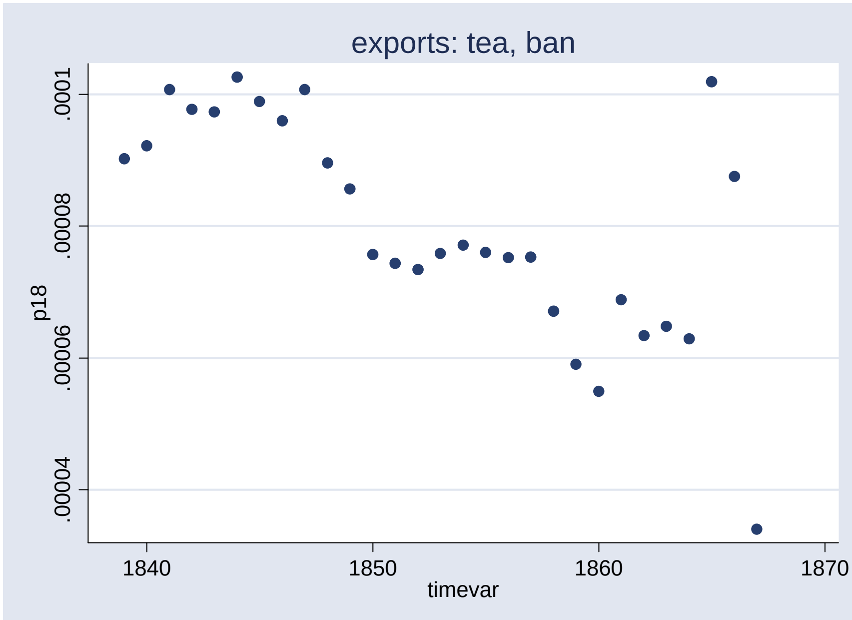
Copper



Fish manure



Bancha tea



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