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Co-movements in terms of trade volatility in land-abundant countries

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CO-MOVEMENTS IN TERMS OF TRADE VOLATILITY IN LAND-ABUNDANT COUNTRIES

ABSTRACT

We conjecture that extreme land abundant endowment constitutes a structural restriction driving sectoral specialization and terms of trade volatility. We estimate and compare several volatility indicators for Argentina, Australia and New Zealand in 1870-2009 finding co-movements, structural breaks in variability, significant cross correlations between TOT cycles, and in some cases heteroskedasticity. If "first nature" land-abundance is a long-term structural restriction, development policies for this type of economies must balance reductions in TOT volatility through export diversification (at rising costs) and a combination of efficiency improvements and internal flexibility to manage volatility effects.

Key words: Terms of trade. Volatility. Heteroskedasticity. Argentina. Australia. New Zealand

JEL: F10, F13, F14.

RESUMEN

Comparamos la volatilidad de los términos de intercambio (TOT) de Argentina, Australia y Nueva Zelanda, conjeturando que su abundancia extrema de tierra determina patrones de volatilidad de TOT comunes. Para 1870-2009 encontramos similar volatilidad y movimientos comunes, indicación indirecta de rigidez asociada a la dotación original relativa que se mantiene históricamente. La política de desarrollo para países con extrema abundancia de tierra debería balancear menor volatilidad de TOT por diversificación de exportaciones, a costos crecientes, con mejoras de eficiencia en sus sectores exportadores y flexibilidad interna para responder a la volatilidad de los precios.

JEL: F10, F13, F14.

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1. TERMS OF TRADE VOLATILITY IN FIRST NATURE LAND-ABUNDANT COUNTRIES

In this paper, we deal with the issue of the volatility of the terms of trade and the long-term export specialization of a particular type of economy: the extreme land-abundant, agricultural commodity-exporting countries, and the scope for efficient diversification. Policy lessons about how countries of this type shall manage volatility are suggested.

Barter terms of trade are a key relative price for an open economy. For some countries, this price has oscillated over time with large unexpected shocks and high volatility, which cause external vulnerability and hinder economic development. The amplitude and irregularity of the terms of trade volatility, with deleterious effects on development, is a latent menace to natural resources export-based countries[1].

To learn about the influence of structural features on trade, we focus on the historical terms-of-trade of a selective group of the so-called "New Settlement" countries, which are frequently studied together on account of a common past and resource abundance. Argentina, Australia and New Zealand belong to a peculiar group of small open economies, which experienced an export and growth boom after the mid-19th Century based on *extreme endowments differences* from their European trading partners, as shown in Table 1 and Table 2 (See also Table 9 in the annex at the end).

We proceed with a perspective, to our knowledge, hitherto unexplored: namely, the hypothesis that the pattern of the terms of trade (TOT) volatility over time is common to these countries. In many empirical studies, the contrast between developing and advanced economies has been noted, characterized by a relatively high and low TOT volatility, respectively. Hence, coincident paths of the TOT volatility in a particular cluster of countries defined by land abundance would be indeed a remarkable fact demanding explanation. Why should this happen?

If these countries had similar sectoral specialization determined by extreme land abundance (assuming similar preferences), the trade direction with land-scarce economies (exporting land-intensive commodities and importing manufactures) and the TOT volatility would exhibit a similar pattern. Our empirical task is to find out if the data are consistent with this conjecture.

[1] A different perspective regarding development problems of economies specializing in the production of commodities and natural resource-based exports is related to the association of economic growth with knowledge and technical change dynamics which is arguably faster in manufactures. The argument has been used in many developing countries to promote import-substitution activities.

Other explanations for the TOT volatility are found in the literature, such as the operation of non competitive markets or the industrial countries policies. We are interested in finding out if, and to what degree, the early 19th Century relative abundance remains to the present, to the extent that it would contribute to explain why until today manufactures are only a reduced fraction of their exports. Furthermore, this continued natural resource-based specialization is likely to determine the high volatility of the terms of trade in these economies: we look for co-movements in the terms of trade volatility and to determine volatility patterns over time.

In the following section, we emphasize that land-abundant countries, which experienced extraordinary growth rates during the transition between the 19th and 20th Centuries, remain indeed highly specialized in exports based on agricultural commodities. They benefit only partially from the impressive growth of worldwide trade, which is largely explained by the expansion of trade in manufactures and services through the process of vertical specialization, and are nowadays vulnerable to terms of trade shocks and volatility[2].

A research tradition has devoted attention to the comparison of the economic development of six land-abundant countries: Argentina (AR), Australia (AU), Canada (CA), New Zealand (NZ), Uruguay (UY) and the United States of America (USA), the "club" of the so-called "New Western Countries"[3] plus Argentina and Uruguay.

Dyster (1979) mentions AUS, NZ, South Africa, USA, CAN, UY and AR as the group of the so-called "regions of recent settlement", encompassing "large open grasslands"; and Meier (1969) describes AR, AUS, CAN and NZ as countries which proceeded at a rapid rate in the transition from underdevelopment to the status of "advanced" economies.

Several authors have been interested in comparisons between Argentina and Australia, namely Smithies (1965), Diéguez (1969), Dyster (1979), Di Tella (1986), Ferrer and Wheelwright (1966). Diéguez notes that Australian GDPpc was already higher at the beginning of the 20th Century. Its GDPpc growth was helped by early industrialization, the improvement in agricultural productivity (reached thanks to a research effort), imports substitution (more selective than in Argentina), and closer ties with the British Empire and European countries.

Mundlak, Cavallo and Domenech (1989) compare the growth performance of Argentina with other countries of the New World with similar resource bases. In an econometric simulation assuming policies had preserved the terms of trade free of distortions, growth in Argentina between 1929 and 1984 is higher than historical records, similar to Australia and slightly below that of Canada.

[2] Also, their share in world exports has fallen since the early 1950s.
[3] Maddison (1997).

Has the early gift of abundant land experienced a mutation into ballast for development? Schedvin (1990) selects AR, AUS, CAN and NZ as those countries which "have most characteristics in common and which are closest to the ideal-typical region of recent settlement". "Their economic success was achieved swiftly because of the favorable ratio of resources to population, and the four countries enjoyed some of the highest *per capita* incomes in the world". However, he warns that the structural characteristics of these countries may be inadequate for the modern conditions of the world economy: "Australia (with New Zealand and, to some extent Argentina) has been caught in a staple trap"; these economies have suffered adverse movements due to their "inability to move into high value-added production".

Since those TOT fluctuations are costly, the policy problem is which recommendations for external strategy are appropriate for this specific class of economies.

The presence of structural restrictions from endowments justifies Gottfried Haberler (1964) warning about the danger of concentrating efforts to control the highly cyclical fluctuations of prices of primary products at a high cost in terms of loss of trade, bureaucratic intervention and high administrative costs. He forcibly argued that a better approach is to learn to live with a certain degree of instability, building flexibilities in the economy and contriving methods to correct some of the consequences of fluctuations in international demand.

In synthesis, we ask about the existence and reasons for the similarities in the TOT volatility of land-abundant economies, and about policy lessons that can be learnt from this perspective.

The content of the rest of the paper is the following: Section 2 examines the theoretical link between land abundance and volatility; it provides a brief literature review focusing on how the TOT trends, shocks and volatility are determined by natural resource endowments and conceptual issues and on the effects of volatility and the assumptions and mechanisms that determine whether the TOT volatility is beneficial or costly; Section 3 addresses methodological issues concerning the question of what is *volatility* in contrast with measures of statistical *variability*. Time series analysis provides a framework for the empirical identification. We discuss technical issues and the definition and measurement of the barter TOT volatility and present empirical estimations of the long-term behavior of the TOT in Argentina, Australia and New Zealand, focusing on the comparison of the component of "volatility" between them over time; Section 4 concludes with a synthesis and a discussion of what can be learned to implement the corresponding policy.

2. Extreme land endowments and implications for long-term specialization

The importance of relative abundance related to the direction and the composition of international trade is illustrated by exports flows of Argentina in 1911, at the beginning of the 20th Century. Agricultural products amounted to almost 60% of total exports; the rest was mostly meat and, only marginally, other primary commodities. More than half of total exports went to four (land-scarce) European countries: Belgium, France, Germany and the UK. Moreover, there was no trade with New Zealand and only a negligible amount of imports from (and no exports to) Australia (Tornquist 1920). This pattern is in line with traditional endowment-based explanations of trade specialization.

Table 1 and Table 2 show that the geography of "first nature" extreme land abundance in which the growth of the New Settlement countries was based remains almost unchanged to our days. We argue that this is a long-term structural restriction on trade specialization. Furthermore, it may cause a limited response to trade policies, as seems to have happened in trade liberalization episodes.

Table 1.
Historical and current extreme differences in land endowments[4]
Population density (people per sq. km)

	Land-abundant countries						Scarce-land industrial countries						
	AR	**AU**	**NZ**	**UY**	**CAN**	**USA**	**FRA**	**BEL**	**ESP**	**SWI**	**UK**	**DEU**	**JPN**
1870	0.7	0.2	1.1	n.a.	0.4	4.4	70.2	168.3	32.4	66.6	121.2	66.1	94.5
2008	15	3	16	19	4	33	114	354	91	191	254	235	350

Sources: Population 1870 from Maddison (1997) adjusted to 1990 surface.
Land surface from WDI. Population 2008 from WDI

Table 2.
Continuing sectoral export specialization: participation of manufactures in imports and exports in 2008.
Share of manufactures in exports Xm and imports Mm

	Land-abundant countries						Scarce-land industrial countries						
	AR	**AU**	**NZ**	**UY**	**CAN**	**USA**	**FRA**	**BEL**	**ESP**	**SWI**	**UK**	**DEU**	**JPN**
Xm	31	15	25	26	47	75	78	77	73	89	71	86	89
Mm	83	71	68	59	76	65	70	70	65	80	68	71	45

Source of data: WTO Statistic Database, Trade Profiles.

[4] We use the following abbreviations: Argentina AR, Australia AUS, Belgium BEL, Canada CAN, France FRA, Germany DEU, Japan JPN, Spain ESP, United States USA, Switzerland SWI, New Zealand NZ.

Table 1 shows the extreme difference in population per square kilometer between the land- abundant and selected European countries and Japan. This relative abundance has remained so for almost one and a half century between 1870 and 2008.

Table 2 highlights the fact that for land-abundant countries the direction of trade largely remains of the "classical" type to our days. In particular, exports of manufactures in Argentina, Australia and New Zealand are on the range of 15% to 30%, while imports of manufactures are between 70% and 80%. This contrasts with the high participation of manufactures both in exports and imports of industrial countries, revealing the importance of intra-industry flows in North-North trade.

A factor proportions approach interpretation

The level of barter TOT, their long-run trends, shocks (of different size and duration), and the degree of volatility are expected to influence the economic activity. We shall now review briefly how volatility fits in the framework of trade models and how it is related to the peculiar resource endowment of land-abundant countries, as well as the reasons why volatility is beneficial or costly.

Models that explain trade flows of open economies are either real or possess financial assets. The tradition of real general equilibrium models (without assets), originated as early as the Ricardian model, and later with the Heckscher-Ohlin-Samuelson, is based on the theoretical presumption about the (atemporal) static structure of resource allocation, which is valid for whatever size and direction of changes in the TOT, assuming a world without frictions, with perfect information and costless resource reallocation.

The resource abundance approach to comparative advantages predicts that trade occurs between countries with different endowments. In the Heckscher-Ohlin-Vanek model, trade is a linear function of the endowments.

The direction of the trade of AR, AU and NZ with Europe was as expected by the Heckscher-Ohlin presumption. Furthermore, they started a rapid path of economic growth in the mid-19th Century, at the time of the first wave of globalization, blessed with an initial extensive supply of fertile land, which absorbed a continuous flow of European migration for decades. These international factor movements occurred with a combination of high productivity of labor and capital and rising terms of trade. Not only did physical capital in agricultural activities and transportation grow at a rapid pace, but also the agricultural frontier expanded, a process that may be described as $\hat{L} > \hat{K} > \hat{T}$ [5] with technical change contributing to raise land productivity.

5 L is labor services, K capital services and T land. Consistent with this description, an estimation of the rental/ wages ratio in Uruguay and New

The whole process was fueled by a growing global demand for agricultural commodities, and the effects of the TOT on resource allocation and growth were dominated by the dynamics of trade. Rising exports prices and improving the TOT trends helped to keep the expected positive differential factor payment rates with Europe, so that the volatility of the terms of trade was not a factor of concern. The economic process was accompanied by domestic policies and institutions which encouraged immigration and capital flows, keeping the stimuli for the flow of capital and labor alive for half a century.

A basic result of international trade theory is that differences in domestic prices open opportunities to trade, which, in turn, tends to equalize prices and factor rewards.

Theory predicts, however, that factor equalization may not be reached in a small open economy highly endowed with natural resources, which could drive the economy towards complete sectoral specialization before factor price equalization is reached.

Gandolfo (1994) notes that there is an admissible range of relative factor prices in which they would equalize; beyond these limits, a country will be completely specialized in the production of one good. The equalization of factor prices in a two-country model is possible if the ranges in both of them coincide. The presence or absence of equalization with countries producing all goods is related to the spreads between the relative factor endowments: the farther the relative factor endowments of the two countries are, the less probable is the presence of a segment of equalization; if this segment does not exist, there will be complete specialization in at least one country.

Terms of trade trends, shocks and volatility

Unexpected once-for-all TOT shocks determine shifts in sectoral specialization and factors returns. If the economy adapts instantly and without costs in continuous trade balance equilibrium, the TOT shifts affect allocations and welfare, but "volatility" has no implication whatsoever[6].

A long-run perspective provided by the Prebisch (1950) and Singer (1950) hypothesis concerning the effects of a declining TOT trend may be included within real models. Incorporating financial assets, intertemporal phenomena are allowed so that the TOT may have an effect on the current account. A wide literature has developed to our days in the framework of the Harberger- Laursen-Metzler effect. A discussion about the relevance of the duration and other characteristics

Zealand was raising steadily between 1875 and the end of the WWI; then declined until 1940. Scanniello *et al.* (2008), Figure 1.

6 In the popular 2x2x2 model, terms of trade are the ratio of prices of homogeneous aggregates assumed to fulfill the "composite good" condition. Weights and concentration are not an issue in the analysis.

of the temporal profile of the shock has been intensively discussed. Another type of these models is concerned with the dynamics of the TOT and the long-run effects on economic development, postulating that the TOT volatility has an influence on risk and on savings and investment decisions.

Since the early 1950s, following the seminal studies by Prebisch (1950) and Singer (1950), the issue of the characteristics, causes and effects of the TOT trends and shocks has been a field of intense debate. More recent references are, among others, Grilli and Young (1988), León and Soto (1995). Furthermore, the effect of the TOT shocks has been found to depend on their duration, profile, size, and sign. Less attention has been granted traditionally to the volatility of the TOT. However, modern experience is calling attention to its influence on incentives, in relation to uncertainty and the added difficulty to form accurate forward expectations. Over the last years, academic research has been increasing its efforts directed to understand the separate, specific, theoretical implications and the empirical characteristics of the TOT volatility.

Economies whose exports production and exports flows are concentrated on commodities with volatile prices have suffered from volatile terms of trade. We conjecture that, due to complete specialization, a group of small economies with common extreme endowment would have traditional North-South sectoral specialization and trade patterns. In the extreme case of identical specialization, they would face identical (exogenous) terms of trade fluctuations, a proposition that can undergo empirical testing.

The costs of TOT volatility

Two recent crises in Argentina are illustrative of the mechanisms through which the TOT volatility has costs for the economy. In the 1990s, the rising TOT (together with a favorable world trade environment) kept the exports to debt ratio at apparently safe levels; however, over-optimism regarding the future path of the TOT led to over- borrowing and contributed to precipitate the external crisis and default of 2001 (Díaz Cafferata and Fornero, 2006). Another recent case is the soybean crises of 2008: a rapid jump in prices triggered a battle between the state and the producers; when the episode finished, the government had lost majority in Parliament and the soybean price had returned to its previous level.

How costly are the impacts of terms of trade fluctuations on the economy? Joaquín Vial (2002)[7] mentions an IADB study reporting that for the whole of Latin American countries in 1970-1992, the effect of the TOT and real exchange rate volatilities, along with economic policy volatility related to growth, is negative and equal to -1.22%. Among those factors, the TOT volatility has the largest impact (-0.48%). In the

[7] Table 2

case of the Andean countries, the values found are even larger: a TOT effect of -1.24% out of a total of -2.22%.

Mendoza (1995), with data for 30 countries in the1965-1999 period, reports a standard deviation of the terms of trade of 5.37 for the countries of the Group of Seven (3.32 for Canada and 4.89 for the USA) and 12.44 for developing countries (8.91 for Argentina and 12.45 for Brazil). He concludes from simulations that terms of trade disturbances account for about one half of the observed variability of GDP.

Volatility becomes relevant when rigidities, imperfect information and time are introduced in the analysis. With limited information and imperfect mobility restrictions, the characteristics of the TOT movements may affect different types of decisions. Volatility determines the degree of uncertainty and is linked to savings-investment decisions and economic growth.

Properties of volatility related to the information set which must be identified in empirical studies are amplitude, frequency and irregularity (including the time span of cycles, outliers and asymmetries in the size of ups and downs).

Does volatility have a separate effect on welfare? Of what sign? In spite of the broad agreement that commodity-exporting LDCs are vulnerable to commodity price volatility, theory recognizes the possibility that under particular assumptions volatility may be good. Rodríguez (1980) compares welfare gains from trade of a small open economy with fixed or variable exogenous terms of trade that have the same mean. If taking risky decisions has a welfare cost, the gains may disappear. He assumes a firm which first decides the level of use of capital services based on expectations about the price, and then determines the level of production after the price is known, by changing the use of variable factors. A risk neutral firm maximizes expected benefits given a probability function of the prices. The possibility of gains from volatility is the consequence of gains from a high price larger than losses when the price is low. Also, Pomery (1984) points out that, in theory, the welfare effects of random terms of trade are ambiguous. They may be negative or beneficial depending on whether trading decisions can be postponed until after the realization of the terms of trade.

However, it is generally agreed that the welfare consequences of volatility are negative, usually associated with the possible inefficiency of choice under uncertainty. In the model proposed by Mendoza (1997), uncertainty of returns with risk aversion may or may not reduce investment impairing growth, but, in any case, the effect on welfare is negative.

Recommending diversification

If the TOT volatility is costly, and if it rises with concentration of exports in a reduced number of commodities, it seems natural to prescribe diversification as the remedy.

The effects of diversification on the exports pattern have apparently worked in the correct direction, reducing TOT fluctuations in diverse countries as in Australia, Mexico, and New Zealand. To mention a couple of studies, Blazquez and Santiso (2004) explain how Mexico gained stability in export income moving from a high specialization in oil (70% of exports in 1985) to a diversified manufactured production and exports. Jansen (2004) using the UNCTAD's exports concentration index, finds that concentration has a highly and significant effect on the TOT volatility, which is defined as the standard deviation of the log differences in terms of trade.

In view of this kind of evidence we shall discuss if the advice of diversification can be generalized, and which policy options exist. For example, Mansfield and Reinhardt (2008) suggest that participation in trade agreements is stimulated not only by improved access to the partners market, but also because it decreases the volatility of trade flows. In a nutshell, since the volatility of relative prices raises the costs of contracting arrangements of firms, trade agreements increase the volume of trade by reducing uncertainty. Supporting empirical evidence is reported.

With respect to the links with financial markets, Hilscher and Nosbusch (2010) find that the volatility of the terms of trade has a statistically and economically significant effect on emerging market sovereign credit spreads. It has been noted that financial markets, in practice, do not allow developing countries to smooth fluctuations[8].

When modeling the effects of volatility, theory does not provide a unique indication for the identification of volatility in the data. In consequence, diverse practical measures of volatility have been used in empirical research. In the following section, we discuss alternatives which range from the mere application of the variance or the standard deviation, to detrending or modeling time series.

[8] Caballero (2000).

3. VARIABILITY AND VOLATILITY. EMPIRICAL INDICATORS

In this section, firstly, we analyze variability properties of historical TOT time series for Argentina (AR), Australia (AU) and New Zealand (NZ). Secondly, we discuss the differences between variability and volatility. The latter is associated not only with the amplitude and frequency of the movements of the terms of trade, but also with uncertainty. In this framework, we estimate three alternative measures to approximate "TOT uncertainty" and compare the obtained results[9].

3.1. TOT variability

Some empirical commonly used measures of variability are variance, standard deviation, coefficient of variation (CV), either of raw data or else of the log differences, and the mean of the absolute value of the log differences. Descriptive statistics of raw data: mean, median, maximum and minimum, rank and standard deviation, depend on the year chosen as the base of the index. The CV, which is exempt from this problem, indicates that Australia is the most variable of the analyzed series (CV=0.20), followed by Argentina (CV=0.16) and New Zealand (CV=0.14). Note that these TOT coefficients of variation are higher than those usually reported for developed economies.

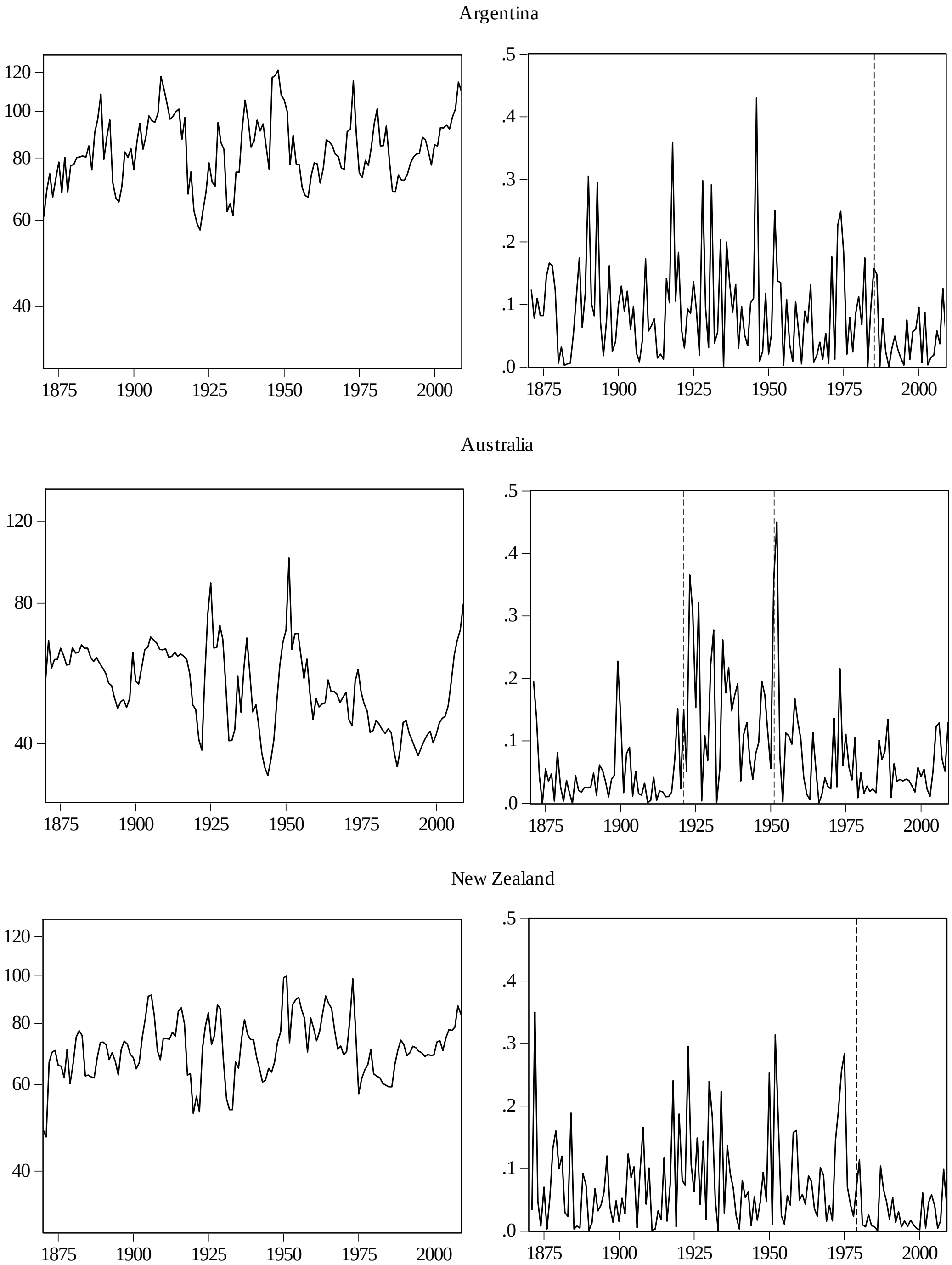
Terms of trade indexes for 140 years between 1870 and 2009 are depicted on the left column of Figure 1; the right column shows the absolute value of the log difference of annual TOT series for the three countries.

The mean of $|d\log(tot)|$ is another common variability measure**,** with the particular advantage of allowing to analyze the variability throughout time**.** Note, in the right column of Figure 1, that the mean of the absolute value of the differenced logarithm $|d\log(tot)|$ appears to change among sub-periods in the three economies. To formalize this perception, following Gillitzer and Kearns (2005) and Borkin (2006)[10], we test the presence of structural breaks in the mean using the Bai and Perron (1998, 2003) test and compare the mean among sub-periods.

[9] See data sources in Annex 1.
[10] Gillitzer and Kearns (2005) and Borkin (2006) calculate the mean of $|d\log(tot)|$ for Australia and New Zealand, respectively, and test the presence of structural breaks in the mean. We reproduced the test with their data and did the same for Argentina. Our results for Australia and New Zealand are the same as reported by these authors and can be compared with our estimations for Argentina.

FIGURE 1.
Argentina, Australia and New Zealand

Terms of trade index 1951=100 (log scale). Left TOT, right $|d \log(tot)|$



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The Bai and Perron (1998, 2003) test, evaluates the null hypothesis of "l" breaks against the alternative of "l+1" breaks, with arbitrary but fixed l. It is recognized for its virtues[11]. First, the breakpoints used to compute the value of the F are not required to be global minimizers. Second, the test is still useful when the trimming period on the two compared models differs. Third, it allows modeling from particular to general to determine the adequate number of breaks. The procedure follows two instances: dating the breaks and determining the optimal number of breaks. In general, adding breaks minimizes the sum of squares, but the optimal number of breaks is chosen in order to minimize Bayes information criteria (BIC).

TABLE 3.

Optimal number of structural breaks in the mean $|d\log(tot)|$

	Number of breaks	Dates and mean of sub-periods (mean of absolute log differences)		
Argentina	1	**1870-1985** 0.095	**1986-2009** 0.05	
Australia	2	**1870-1921** 0.05	**1922-1951** 0.15	**1952-2009** 0.07
New Zealand	1	**1870-1979** 0.08	**1980-2009** 0.03	

Table 3 shows remarkable differences in the variability of the TOT among sub-periods. According to the breakpoints obtained, two sub-periods are defined for Argentina and New Zealand, and three for Australia. For Argentina, we find that the mean of $|d\log(tot)|$ fell from 0.095 in 1870-1985 to 0.05 in 1986-2009. In New Zealand, $|d\log(tot)|$ went down from 0.08 in 1870-1979 to 0.03 in 1980-2009.

A somewhat different pattern is found in Australia, with three sub-periods. The first one in 1870-1921 exhibits a low variability of 0.05. The second in 1922-1951, are years of high variability with a value of 0.15. Finally, the third sub-period in 1952-2009 shows a reduction to 0.07. It is to be noted this falling variability of TOT, in all the three countries, in the last period.

Gillitzern and Kearns and Borkin explain the reduction of the terms of trade "volatility" as a consequence of the diversification of exports. However, this argument does not imply an advance towards the exports of goods which are not intensive in land but widen the range of goods within the traditional specialization.

[11] Garegnani (2001).

Although the CV of Australia is the highest, with the identification of sub-periods in the mean of absolute log differences, it is noticeable that Australia has only three decades of extremely high variability.

3.2. Volatility throughout time

Since we are interested in estimating a proxy for uncertainty, it is necessary, in the variability measures, to distinguish a predictable and an unpredictable component; the latter is the one called "volatility". From this perspective, the forward looking path of a more volatile variable is less predictable.

Furthermore, measures of mere variability, in spite of being commonly used, may lead to misleading interpretation. Given other properties, a variable is intuitively more volatile when its movements are irregular. For example, we would not interpret as "volatile" a price which evolves in regular temporal cycles, such as seasonal prices.

A procedure to calculate uncertainty is to compute deviations from an equilibrium value. In this case, a model to determine equilibrium prices of exports and imports in the international markets is required. Since this is a research effort in itself, a substitute for this procedure is to work with deviations from long-run trends. In this case, we follow this second approach.

Economic agents may recognize the TOT trend but would have more difficulties to predict each actual observation, because the former is more stable than the latter. Also, they might be aware of the fact that large shocks, such as the oil shock or the incorporation of China to the world economy, may be expected to affect trends. On the contrary, short term movements such as the unexpected upward movement in soy prices in 2008, are difficult to predict.

Dehn (2000) distinguished variability from volatility suggesting leaving aside the regular part to estimate volatility. Moreover, he observes that uncertainty may change over time. Uncertainty is a concept *ex ante* and different from "variability", which reflects components that are predictable by producers. Following Ramey and Ramey (1995), these components may be modeled as a function of explanatory variables, taking the variance of the residuals as the component of "uncertainty".

As a proxy for the unexpected component of the TOT variability, we will estimate two alternative measures: deviation from trend, using a Hodrick-Prescott filter and the conditional standard deviation from an ARCH type model, applying two detrending procedures. In the last part of the section, we compare the results decomposing the variance of each of them in the explained and unexplained components.

Mansfield and Reinhardt (2008) point out that some studies measure volatility on trade as the variance within a time series for a given country over a long period. They argue that a weakness of this technique is that unexpected shocks are not distinguished from predictable changes in terms of trade, and it does not allow for the possibility of varying volatility between sub-periods. One of the suggested measures of volatility is a dichotomic variable for changes equal or greater than 50% -or other appropriate cutoff [12].

It should be considered that a series might be variable because of its high frequency, even if it moves in a narrow band. On the contrary, large irregular shocks are more difficult to predict. Negative shocks are likely to be especially disturbing, and drops may be expected to be more costly than positive jumps. Since the TOT of the three economies are trend stationary, shocks are temporary. Along the stationary time series, large ups and downs alternate: in the three countries, the occurrence of large jumps are followed by a sharp change in the opposite direction rather than compensated smoothly.

3.2.1. Volatility measured by dispersion of the cycle generated from the Hodrick-Prescott filter (HP)

The upper panel of Figure 2 shows the local trend and the lower panel shows the cycle generated by decomposing a series into a trend and a cycle with the Hodrick and Prescott (1997) filter with lambda 100.

Let us consider the trends of the TOT in the upper panel of Figure 2.

The first period of growing TOT trends with a common local maximum around the beginning of the WW1, is particularly characterized by fast GDP growth. There is a "U" that ends with another local maximum about 1950, and again, after a valley in recent times, in 2009 a third local maximum seems to appear.

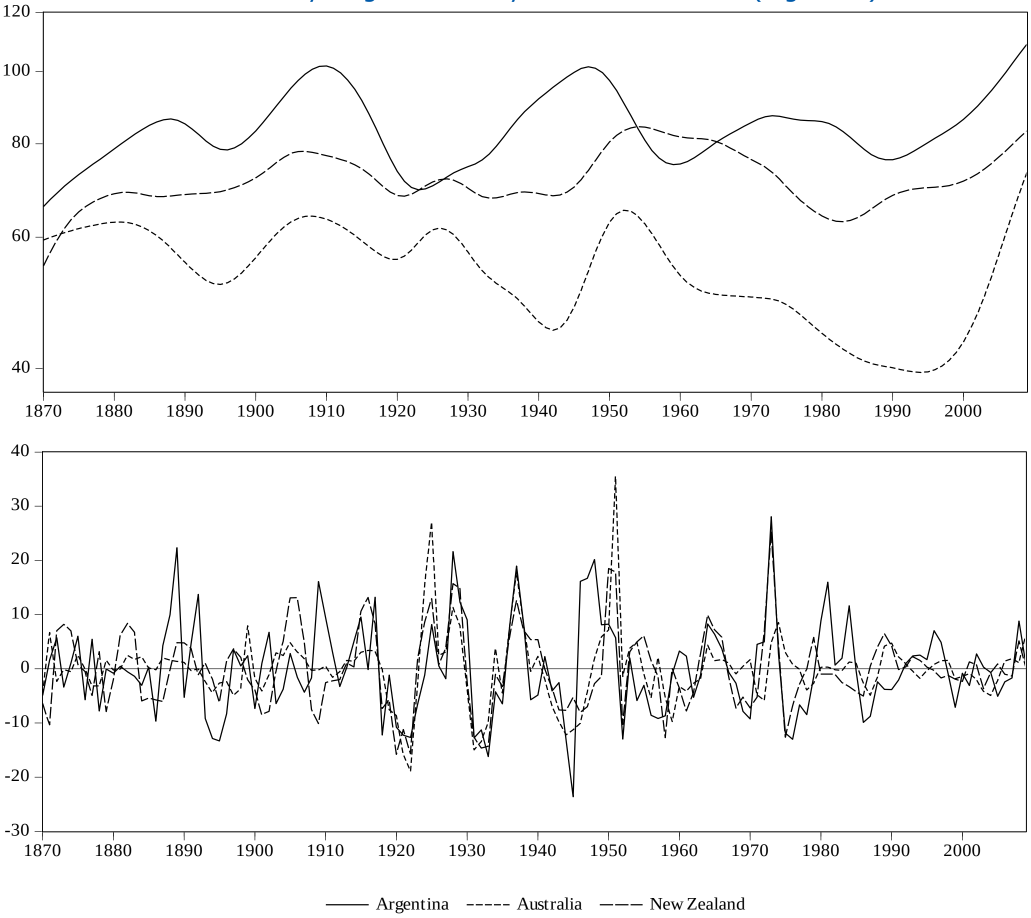
Regarding the cycles drawn in the lower panel of Figure 2, the generated HP cycle has a zero mean by construction. Australia presents the largest difference between the maximum and the minimum, as well as the largest standard deviation (0.11), while New Zealand and Argentina have the same difference and standard deviation (0.10).

It should be noted that this measure of volatility is not constant over time. For the three economies, the early period 1870-1913 of fast commodity-export-oriented growth is characterized by relatively low volatility, with standard deviations: AR 0.08; AU 0.05; NZ 0.09. The period 1914-1955 is the most volatile with standard deviations: AR 0.13; AU 0.19; NZ 0.13. After the mid fifties, there follow years of medium TOT volatility (in 1956-1975 standard deviations are: AR 0.10; AU 0.08; NZ 0.11). The last sub-period 1976-2009 exhibits the

[12] They estimate four measures, one is similar to our log difference, which we consider is not "volatility" but variability; the other two measures, which we are not going to use here, are the absolute value of the change in the supplier's export share in the importer's market; the other one is a GARCH estimate to assess the influence of trade agreements on exports volatility.

historically lowest volatilities: 0.07; 0.05; 0.04 for AR, AU and NZ, respectively. Note that, in contrast to the complete sample, when it is split into the mentioned sub-samples, normality holds for all of them.

FIGURE 2.
Argentina, Australia and New Zealand. 1870-2009.
Terms of trade index 1951=100
Trend and cycle generated by HP filter $\lambda = 100$ (log scale)



Ahumada and Garegnani (2000) recommend estimating the value of lambda simultaneously by maximum likelihood and propose a "less mechanical use" of the filter by testing the behavior of the generated components: the stationarity of the generated cycle and the existence of genuine cross correlation between the cycles. Although we use lambda=100, suggested by the Backus and Kehoe (1992) quadratic approximation for annual data, we follow their second advice and test stationarity of the cycle and cross correlations.

To test the presence of unit roots in the generated TOT cycle, we performed the Augmented Dickey-Fuller test for the generated cycles, using a model without constant or trend. The generated cycles are found to be stationary for the three countries.

Next, we proceed to evaluate the presence of genuine autocorrelation between the cycles generated by the Hodrick-Prescott filter (for the indexes 1951=100 in log scale). Following Ahumada and Garegnani, we construct the confidence interval considering the following asymptotic distribution:

$$r_{xy}(h) \sim AN\left(0, T^{-1}(1+2\sum_{j=1}^{\infty}\rho_x(j)\rho_y(j)\right)$$

where r_{xy} is the sample cross correlation at lag h between two series, T is the number of observations of the sample, and $\rho_x(j)$, $\rho_y(j)$ are the autocorrelation of stationary processes x_t and y_t at lag j.

In the first line of the Table 4, r_{xy}, the sample cross correlation between x_t and y_t is reported for country pairs for the whole period. The limit of the confidence interval is showed between brackets calculated as the autocorrelation adjusted asymptotic standard error times the limit (absolute value) of the 99% confidence interval for $\rho_{xy}(0)=0$, where ρ_{xy} is the population cross correlation coefficient between two independent stationary series, that is:

$$2.57\ T^{-1/2}\left(1+2\sum_{j=1}^{j=J}r_x(j)r_y(j)\right)^{1/2}$$

In none of the cases the confidence interval for $\rho_{xy}=0$ (spurious correlation) includes the sample cross correlations observed. We conclude that, in the whole period 1870-2009, sample cross correlations are statistically different from zero.

TABLE 4.
Cross correlation of TOT cycles (log scale series).
Limit of the confidence interval in parenthesis.

Period	Volatility	Cross correlations		
		AR-AU	AR-NZ	AU-NZ
1870-2009		**0.49*** (0.37)	**0.5*** (0.35)	**0.62*** (0.42)
1914-1955	High	0.66**	0.68***	0.85**
1956-1975	Medium	0.20	0.81***	0.32
1870-1913 1976-2009	Low	0.27* 0.24	0.03 0.09	0.1 0.12
*, ** and *** denotes that the observed cross correlation is statistically different from zero at the 10. 5 and 1 percent level of significance, respectively.				

Those correlations are not constant over time, and seem to be positively associated with volatility. Cross correlation between the TOT of the different economies, higher in more volatile periods, suggests predominance of "external forces" in the TOT formation during those periods. When world prices are overall more stable, the influence of specific to each economy prices are likely to prevail.

Compare the correlations for sub-periods with the values for the whole sample shown in Table 4: in the sub-period characterized by the highest observed volatility, between 1914 and 1955, the cross correlations of TOT deviations from the HP local trends are high: 0.66 for AR-AU, 0.68 for AR-NZ and 0.85 for AU-NZ. For the period 1956-1975, cross correlations are low for AR-AU and AU-NZ (0.20 and 0.32 respectively) and extremely high (0.81) for AR-NZ. Finally, the TOT cycles do not seem to be coordinated in the periods of lower volatility, 1870-1913 and 1976-2009, in which cross correlations are between 0.03 and 0.27.

3.2.3. A third volatility measure: residuals from ARMA/ARCH models

The second measure of volatility is the conditional standard deviation. Enders (1995) provides support for this approach. He argues that "rational expectation hypothesis asserts that agents do not waste information. In forecasting any time series, rational agents use the conditional distribution rather than the unconditional distribution."

The next paragraphs are devoted to the estimation of the ARCH type models. Following this aim, we start by characterizing the series, testing for stationarity and trends. Next, we detrend the series and estimate the ARCH.

Stationary[13] terms of trade are characterized by shocks with transitory effects. It implies that it is possible for economic policy to smooth its effects, for example through insurance or the use of stabilization funds on exports reward. A priori there is no reason why the terms of trade should be stationary, trend stationary (TS) or difference stationary (DS).

A range of tests have been developed to test the presence of unit roots. The tests can be classified into three categories. A first brand includes the Dickey-Fuller (1979) and Augmented Dickey-Fuller (1981), the Phillips (1987) and the Phillips-Perron (1988) ("first generation") tests. Using the same principle, reforms to improve the power of the test under particular situations have been introduced, among those the Augmented Dickey-Fuller generalized least Squares proposed by Elliott,

[13] Gillitzern and Kearns (2005) mention Lutz's (1999) argument that it is not appropriate to model the quotient of export and import prices, two nonstationary indexes, because it is implicitly assumed that the two prices are co-integrated with a long-run elasticity of one. Gillitzer *et al*. point out that due to the fact that the terms of trade are found to be stationary, it is a correct treatment.

Rothemberg and Stock (1996). A second brand introduces unit roots tests for panel data such as Maddala and Wu (1999), Im et al. (1997), Levin and Lin (1993). The third group includes authors such as Perron (1990) and Zivot and Andrews (1992), among others, who focus on the debate of the lack of power of the first generation tests when there are structural changes in time series.

The first generation tests have a low power to distinguish between a unit root process and a near unit root, biased towards the presence of a unit root. In addition, they have little power to distinguish between trend stationary and drifting processes, especially with finite samples and shocks that dissipate slowly. Elliott, Rothemberg and Stock (1996) propose a modified version of ADF to improve the power when an unknown mean or trend is present, the Dickey-Fuller Generalized Least Squares (DFGLS). Since this is the case of our TOT series, we perform this test in order to assess whether the series are stationary. Since the results vary depending on the criterion used to select the lags number, we use the Bayes information criterion (Min SC), and the modified AIC (MAIC) proposed by Ng and Perron (2001). With the Bayes information criterion, the unit root null hypothesis is rejected at 5% of significance in the Argentinean terms of trade and at 1% in the Australian and New Zealand's series. Nevertheless, since the more lags we add the more difficult it is to reject the null, if MAIC criterion is followed the null is rejected at 10% for Argentinean terms of trade and it is not rejected for New Zealand's and Australian series.

The decision of treating the series as having a deterministic trend is not trivial. Following Enders (1995) first differencing a trend stationary model implies introducing a non invertible unit root process into the moving average component of the model, while subtracting a deterministic trend from a difference stationary process results in a misspecification error and can generate a non stationary series. Comparing the two models, the author argues that the short-run forecast have nearly identical forecasting, while the long-run forecast will be quite different. In borderline cases, Monte Carlo simulations show that in many cases differencing the series brings about better one-step ahead forecast than detrending. For that reason, and because of the lack of data to perform a stationarity test, Dehn (2000) prefers to take first differences. However, Gillitzern and Kearns (2005) and Borkin (2006) treat the series as TS based on their finding that the shocks dissipate in a relatively short period. Because of this and due to the fact that more data was available to test for units roots, and hence the risk is lower than with a shorter sample, we will consider the series are formally trend stationary TS.

We test a deterministic trend[14] in a linear model: $tot_t = \alpha + \beta t$, including a constant term and a trend (Table 5.ii). Nevertheless, both the

[14] Other trends, such as polinomial trend, were tested but we did not find an improvement in the obtained results.

constant term and the trends are found statistically significant for the three countries, with a positive trend in the cases of Argentina and New Zealand and negative for Australia, the trend coefficients are close to zero in all the series. Even when we do not find evidence that formally rejects the Prebisch and Singer hypothesis, there is not a "strong" long-run trend but rather several changing local trends.

In addition, we tested the presence of structural changes in the linear model using the Bai and Perron test. Hence, we performed the detrending procedure following two alternatives:

(A) Linearly detrended series: the series are linearly detrended without considering the structural breaks.

(B) Detrended through linear trend with structural breaks series.

(A) Linearly detrended series

TABLE 5.
Stationarity test of the TOT series and detrending through linear model

(i) Unit root test: TOT			(ii) Linear trend		(iii) Unit root test: detrended series
DFGLS (Intercept and trend)			$tot_t = \alpha + \beta t$		ADF
	Min SC	Min MAIC	Constant	Trend	
Argentina	** (1 lag)	* (3 lags)	4.38 (0.000)	0.0006494 (0.0509)	***
Australia	*** (1 lag)	--- (8 lags)	4.13 (0.000)	-0.0022658 (0.000)	***
New Zealand	*** (1 lag)	--- (8 lags)	4.22 (0.000)	0.0006013 (0.037)	***
*, ** and *** denotes the rejection of the null hypothesis of unit root at the 10. 5 and 1 percent level of significance respectively. p-values in parenthesis.					

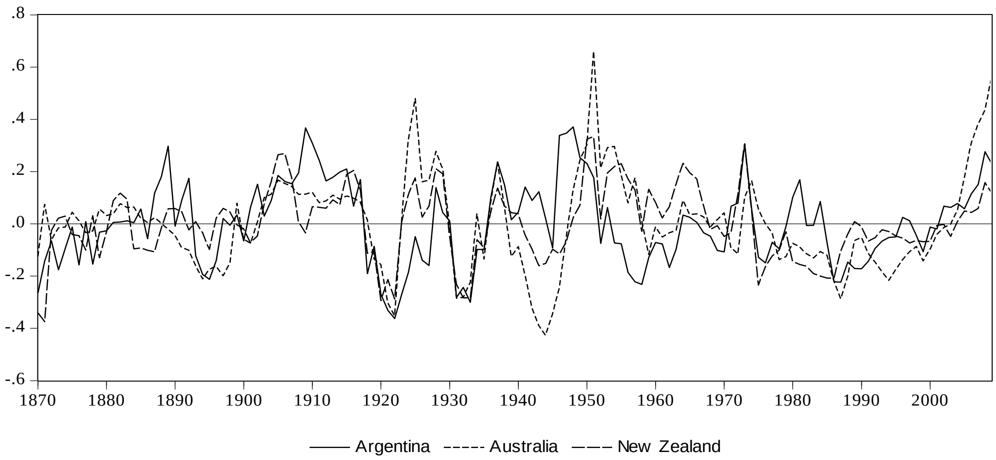
Table 5 (ii) and Figure 3 show the detrended TOT log series obtained as residuals of the linear model. The three TOT linearly detrended series are stationary: the ADF test (without constant or trend) rejects the null hypothesis of unit root at 1% of significance (Table 5 iii).

Reinforcing the visual image of co-movements, sample cross correlations are high, 0.40 for Argentina-Australia; 0.43 for Argentina-

New Zealand; and 0.65 for Australia-New Zealand (not shown in the table)[15].

Other features to note are, firstly, that the distributions are not normal except from Australia; secondly, the most variable detrended TOT series, according to the standard deviation and the difference between maximum and minimum is Australia, followed by Argentina and New Zealand.

FIGURE 3.
Linearly detrended terms of trade series. Index 1951=100, log scale



We have estimated the ARMA/ARCH models in two steps[16]. First, we look for the best fitting ARMA following the Box Jenkins procedure. Second, in case of finding a time-varying conditional standard deviation, we include a model for the conditional variance and estimate the equations jointly. Several specifications were compared looking forward to minimizing the Akaike (Ak) and Schwarz (Sch) information criteria. Table 6 summarizes the results showing the best fitting model for each series.

[15] Although it is noticeable that cross correlations differ widely from one period to another, the inclusion of this feature in the time series analysis would lead us to a much more complex multivariate framework, which would be left for subsequent studies.
[16] Our procedure differs from the one applied by Dehn (2000) who, when looking for volatility measures applies a homogeneous GARCH (1,1e) model for all the countries.

TABLE 6.
Modeling TOT time series
ARMA and ARCH estimations (p-values in parenthesis)

(A) Linearly detrended series										
	ARMA(p,q)		Variance Equation		Information Criteria		Q	ARCH Q	ARCH LM	JB
Country		Coef.		Coef.	Ak	Sch				
ARG	AR(1)	0.73 (0.000)	-	-	-220.3	-214.4	39.54 (0.491)	40.62 (0.44)	0.51 (0.98)	5.15 (0.076)
AUS	AR(1)	0.83 (0.000)	ARCH(1)	0.51 (0.005)	-269.7	-257.9	46.62 (0.219)	103.25 (0.000)	47.77 (0.000)	11.01 (0.004)
			GARCH(1)	0.49 (0.000)						
			C	0.001 (0.016)						
NZ	AR(1)	0.85 (0.000)	ARCH(1)	0.29 (0.027)	-272.6	-257.9	39.28 (0.502)	32.15 (0.81)	59.8 (0.000)	6.58 (0.037)
			ARCH(2)	0.34 (0.062)						
	AR(2)	0.19 (0.04)	C	0.004 (0.000)						

Since the detrended series are stationary in mean, we can proceed to estimate ARMA models. Then, we shall examine if the variance is constant. In case we found time varying variance, a Garch type model would be the appropriate one. Hence, we would have to distinguish two types of volatility, a short-term one (the time varying conditional standard deviation) and the long-term volatility (the long-run standard deviation, which is assumed constant). If the conditional standard deviation is not time-varying, an ARMA model will be the best representation for the data. In this last case, the conditional standard deviation does not add valuable information to the agent.

Tests for the behavior of the residuals and squared residuals are shown in Table 6. Residual autocorrelation is tested using Portmanteau Q test (Q); the null hypothesis is that the residuals are uncorrelated; hence, rejecting the null implies that there is residual autocorrelation remaining.

Normality of the residuals of the AR is tested with the Jarque Bera (JB) test, the null of normality is rejected in all the models.

We performed two tests for ARCH effects: the Pormanteau test (ARCH Q) for the square residuals and The Engle (1982) Lagrange Multipliers (ARCH LM) test. In the latter, the square of the fitted error is regressed on a constant and q lagged values of the squared residual; the statistic converges to a Chi square with q degrees of freedom. In both tests rejecting the null suggests the possibility of conditional heteroskedasticity.

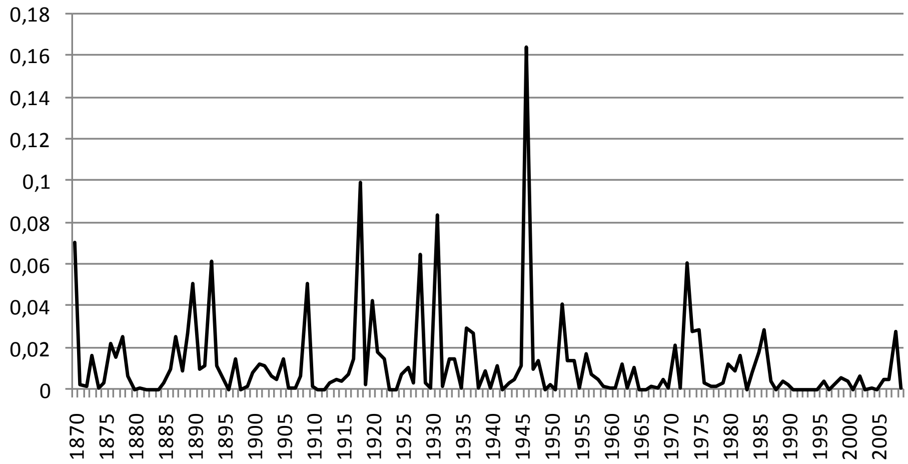
Both tests indicate that Argentina does not present heteroskedasticity. Australia shows a strong heteroskedasticity that remains even after modeling conditional variance[17]. The evidence is not conclusive in the case of New Zealand because the tests threw contradictory results.

In Figure 4, the Argentinean TOT volatility is represented by the squared residuals of the ARMA and can be compared with the conditional variances of the GARCH models fitted for Australia and New Zealand. The squared residuals of Argentina show frequent short-term peaks without a temporal pattern. In contrast, the conditional variances of Australia and New Zealand have noticeable time varying volatility, with periods of persistently high volatility followed by periods of tranquility.

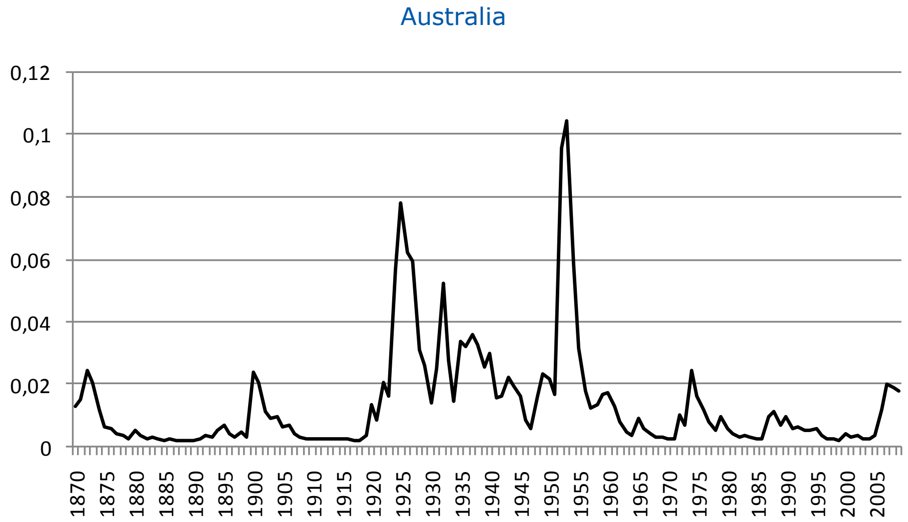
The estimated standard deviations of the white noise disturbance of the estimated models are 0.11 for Argentina and Australia and 0.09 for New Zealand.

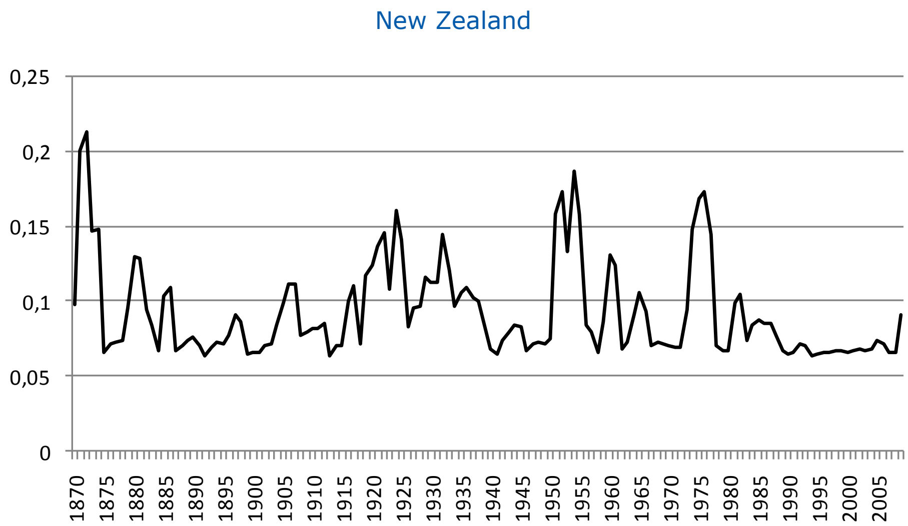
FIGURE 4.
Argentina squared residuals from ARMA. Australia and New Zealand conditional variance;

Argentina



[17] Several models were tested without a favorable result.





(B) Detrended through linear trend with structural breaks series

Next, we performed the analysis detrending the series through a linear model with structural breaks. We found that the detrended series are stationary.

Firstly, we determined the breaks making use of the Bai and Perron test following the procedure mentioned in the beginning of the section. The optimal number and dates of the breaks are presented in Table 7 (i) (the coefficients of the linear model of each of the sub-periods are not presented). Secondly, we applied the Box-Jenkins procedure to estimate the ARMA/ARCH models. Results are presented in Table 7 (ii).

The variance equation was only necessary for Australia. Argentina and New Zealand showed constant conditional variance.

TABLE 7.
Series detrended through a linear model with structural breaks and ARMA/ARCH model

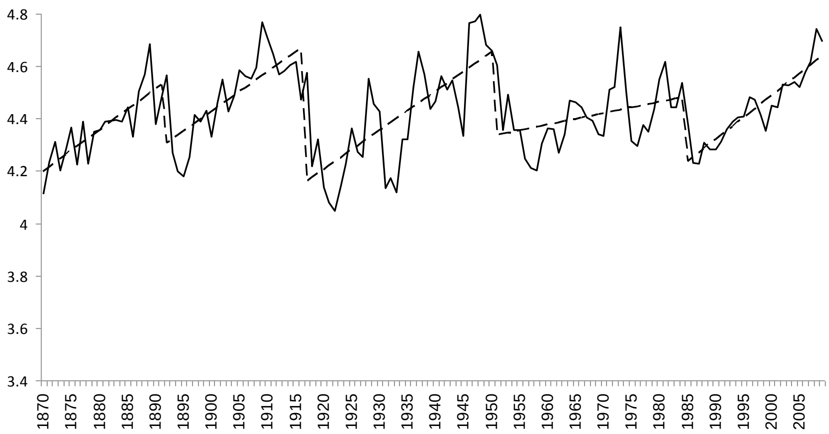
	(i) Detrending the series		(ii) ARMA/ARCH estimation			
	Structural breaks in the linear trend		ARMA(p,q)		Variance Equation	
	Nº	Date of breaks				
AR	4	1892-1917-1951-1985	AR(1)	0,257***	-	
			AR(3)	-0,244***		
			AR(6)	-0,203**		
AUS	4	1902-1923-1946-1986	AR(1)	0,484***	C	0,004
			MA(1)	0,438***	GARCH(1)	0,992
			MA(4)	0,203***		
NZ	3	1917-1949-1974	AR(1)	0,46***	-	
			AR(3)	-0,298***		
			AR(5)	-0,169**		
			AR(7)	-0,201***		
*, ** and *** denotes 10. 5 and 1 percent level of significance respectively.						

The estimated standard deviations of the models are: 0.1 for Argentina and Australia and 0.08 for New Zealand; all of them lower than the ones obtained through the linear detrending without breaks.

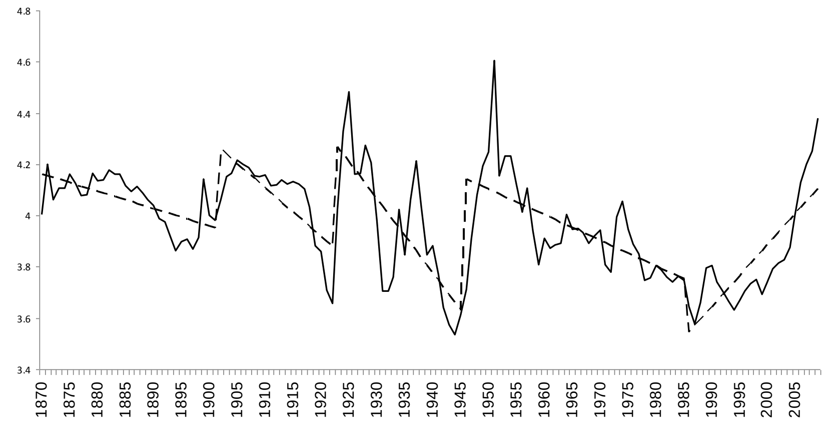
This method allows us to find the particular characteristics in the TOT trend of each country. Even though we observe the high volatility period between the world wars, the TOT trends in the defined sub-periods are remarkably different: growing for Argentina, deteriorating for Australia and almost constant for New Zealand. This suggests the convenience of deepening research about the specific export structure of each country.

FIGURE 5.
TOT detrended through a linear model with structural breaks

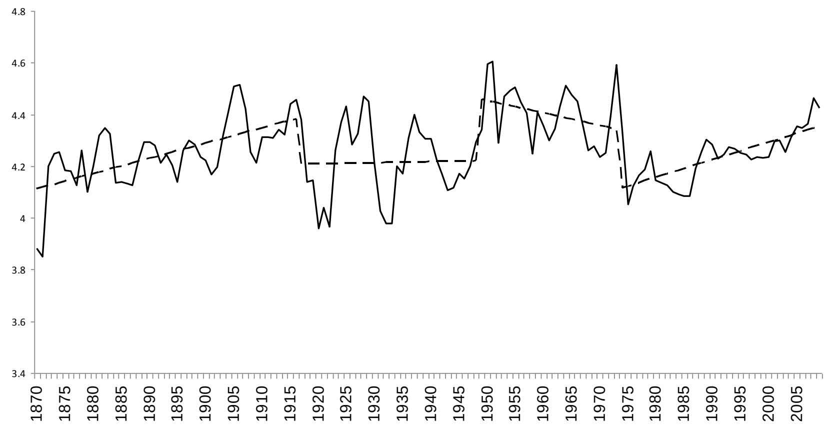
Argentina



Australia



New Zealand



3.2.4. Comparing the results

We argued above that the uncertainty created by the TOT variability is related to its unexpected component, which can be associated to the deviation from a perceived equilibrium value or, as a proxy for equilibrium levels, the long-term trends of the TOT. In Table 8, we decomposed the TOT variability into the explained and unexplained components of each of the models in order to compare them.

According to the property of the variance of a sum:

$$y = z + v \rightarrow \mathrm{var}(y) = \mathrm{var}(z) + \mathrm{var}(v) + 2 \times \mathrm{cov}(z, v)$$

In our case, the observed TOT value at each point in time is the sum of two terms: i) the component expected by agents (the part explained by a model: H-P trend, ARMA/GARCH model + linear- trend); ii) an error term or unpredicted component, which we call "volatility".

In our estimation of volatility as the standard deviation from H-P filter, *explained* component of the variance is given by the variance of H-P trend, the *unexplained* variance is the variance of the cycle generated by the H-P filter.

In the ARMA/GARCH models, the explained variance is the variance of the sum of the trend component (with or without breaks) and the ARMA/GARCH model. The *unexplained* variance is the variance of the error term.

TABLE 8.
Variance decomposition

Hodrick-Prescott filter			
	Argentina	Australia	New Zealand
Explained	0,01162 (46%)	0,02189 (54%)	0,00696 (36%)
Variance H-P cycle	0,00988 (39%)	0,01276 (31%)	0,00989 (52%)
2 x Cov(,)	0,00386 (15%)	0,00606 (15%)	0,00222 (12%)
Total Variance	0,02537 (100%)	0,04076 (100%)	0,01909 (100%)
ARMA/ARCH of the TOT linearly detrended			
Variance	Argentina	Australia	New Zealand
Explained	0.01 (52%)	0.01 (53%)	0.03 (69%)
Unexplained	0.012 (47%)	0.012 (46%)	0.009 (28%)
2 x Cov(,)	0.00 (1%)	0.00 (1%)	0.00 (3%)
Total	0.03	0.02	0.04
ARMA/ARCH of the TOT linearly detrended with breaks			
Variance	Argentina	Australia	New Zealand
Explained	0,01481 (60%)	0,03380 (82%)	0,01224 (70%)
Unexplained	0,01026 (41%)	0,01061 (26%)	0,00603 (34%)
2 x Cov(,)	-0,00020 (-1%)	-0,00318 (-8%)	-0,00078 (-4%)
Total	**0,02487 (100%)**	**0,04105 (100%)**	**0,01748 (100%)**

In most cases, the *unexplained* component is less than 50% of the total variability. From this comparison, it is noticeable that the order of the degree of volatility varies with the chosen model. The cycle generated by the Hodrick-Prescott filter includes a cycle and a residual or irregular component. The variance of the cycle of Australia is the highest one, followed by Argentina and New Zealand. In the ARMA/GARCH models, the uncertainty is higher for Argentina, followed by Australia and New Zealand. Finally, if we consider the models obtained with the linearly detrended series with structural breaks, the TOT of Australia are the most predictable ones. In this model, our proxy for "uncertainty of the TOT" amounts to 26% for Australia, 34% for New Zealand, and 41% for Argentina.

4. Synthesis and policy implications

Sharp fluctuations in commodity prices in recent years have renewed the academic interest in the pattern and effects of the TOT volatility. The accurate assessment of stylized facts, the interpretation of the observed movements in the TOT and the subsequent prediction capacity are becoming crucial for policy making.

A key decision for development is the way of integrating the economy in the world; the design of policy strategies must be based on the knowledge of how the economic system works on each specific economy rather than just following general receipts. In particular, when evaluating the advantages of insertion in the international economy, due concern must be kept about the possibility of adding instability on to economic activity.

Based on the perception that specialization rises (and diversification reduces) the terms of trade volatility, together with the empirical findings in the literature indicating that volatility is harmful, a usual policy recommendation for countries with high terms of trade volatility is to reduce it via export diversification. However, given the "first nature" of these countries' endowment, to move specialization away from their comparative advantages may be costly.

The sectoral specialization due to endowment abundance is associated to current controversial discussions: the role of natural resources in economic development, the distribution of benefits from trade, and the dynamic effects of exports diversification on manufactures.

We argue that the fact that Argentina, Australia and New Zealand show a similar pattern of volatility over time may be caused by their shared "extreme specialization". Our empirical estimations showed that there are substantial similitudes in the pattern of volatility of Argentina, Australia and New Zealand over 140 years. We tested whether the volatility of Argentinean, Australian and New Zealanders terms of trade shares similar historical long-run patterns since early in the 19th century between 1870-2009.

Firstly, results from the analysis of statistical measures of dispersion, and the finding of coincident structural breaks in terms of trade variability (around the beginning of WWI and in the early 1950s), are consistent with our presumption.

Secondly, under the hypothesis that rational agents form their expectations using available data on past observations, we use “variability” for statistical features, in contrast to “volatility” taken as a proxy for uncertainty in economic decisions or, in other words, the unexpected changes in terms of trade. We propose two empirical measures of volatility as the unexpected change in the TOT.

The first one is the cycle generated by a Hodrick-Prescott filter. The local trend has three peaks, two near the breaks and a third one in the current time for the three countries; and the terms of trade cycles of these land-abundant countries are genuinely cross-correlated.

The second volatility measure is obtained through time series modeling, following the intuition that rational agents form expectations based on the conditional distribution rather than on the unconditional distribution. We found there are common sub-periods of terms of trade volatility, with high conditional standard deviations in the years between the world wars for the three countries. “Volatility” has been lower during the last decades for the three of them.

Policy recommendations

The sectoral specialization and trade direction of the three countries are determined by land abundance and, as a consequence, their TOT are volatile. Since correcting via sectoral diversification is costly, the policy question is how to deal with volatility in the presence of structural resource rigidities.

In our view, the evidence suggests that land abundance, which is a peculiarity of resource endowment of these countries, creates a long-term restriction that remains in spite of diverging production structures, trade and institutions. Export diversification may have reduced TOT volatility in Australia and New Zealand within the group of land-abundant countries -compared with Argentina-, but this diversification did not reach the point of altering the differences between groups; namely, their relative endowments and larger TOT volatility relative to capital-abundant, land-scarce countries.

The discussion provides an interesting new ingredient concerning the idea that export diversification increases welfare by reducing the magnitude of aggregate TOT shocks (Kenen 1969). This single strategy may be associated in certain countries with rising costs of diversification in terms of the loss of benefits from trade when the economy moves away from comparative advantages. Policy schemes based on multiple instruments, rather than focusing on export diversification to reduce volatility that is likely to face increasing costs, look preferable. A combined strategy would work in various spheres. The first is to reduce volatility by diversification up to the point of optimal benefit-costs. The second one is to develop policies and institutions to manage what remains of volatility efficiently. The third is to implement instruments to smooth welfare effects of shocks, particularly of food prices with substantial weight in the consumption basket of workers.

Sectorial specialization may not have been worthwhile. From a revealed preferences perspective, persistent specialization may be the practical consequence of both private and public agents finding out that sticking to sectorial specialization is the best choice, given the set of information they have before the realization of prices. However, if dynamic externalities or intergenerational transfer problems create a gap between private and social optimal choices, the observed specialization cannot be interpreted as the best option for society.

Note that even with large exogenous terms of trade movements, if reducing terms of trade volatility by sectoral diversification is costly, it might be advisable to pursue a balance between alternative ways to manage the effects of fluctuations by export diversification and smoothing internal effects through a combination of efficiency gains, institutional development and internal flexibility.

The policy can be examined in two dimensions: the traditional "inter-sectoral" dichotomy (such as imports substitution) and, with a given sectoral specialization, the "intra-sectoral" opportunities with still ample room for raising efficiency. Improvements in productivity in the natural-resource abundant sector raises GDP: even if the terms of trade volatility remains unchanged, higher efficiency expands the possibilities frontier with resulting higher factor income and welfare. A related suggestion is that the diversification strategy may be intra-sectoral rather than inter-sectoral.

It has also been noted that the lack of efficient financial systems in developing economies weakens the capacity to smooth out the effects of the terms of trade shocks and volatility. Policy debates about optimal specialization and imports substitution alternatives for developing countries have not reached a consensus. Moreover, in countries like Argentina, government renewals still cause policy shifts, failing to provide stable signals for investment decisions related to trade.

The research agenda includes, among others, a revision of the theory about optimal trade and domestic policies under extreme land abundance, improving the empirical methods, distinguishing movements in prices of exports and imports and examining their time series properties together with the terms of trade behavior, broadening the sample by including other natural resource-abundant, "new settlement" countries (Uruguay, Canada and the United States) and non-land-abundant countries to identify properties of world trade prices volatility.

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Annex 1. Data sources

TOT	Annual data
Australia	1870-2004. Gillitzer and Kearns (2005), Reserve Bank of Australia 2005-2009. Australian Bureau of Statistics (number 50302.0)
New Zealand	1861-1998. New Zealand Institute of Economic Research NZIER 1999-2009. New Zealand's national statistical office: Statistics New Zealand.
Argentina	1810-1985. Ferreres (2005). 1986-2009. Indec.

Annex 2. Growth and exports

Table 9 illustrates the growth and trade framework. The three economies depict an extraordinary GDP growth record in the first period between 1870 and the First World War, especially faster in Argentina; but after the wars, their GDPpc performance diverged markedly. Even more remarkable differences are seen in their exports performance in the three last columns.

Table 9.
Growth performance of Argentina, Australia and New Zealand

	GDP			GDP Index 1993=100. (GDP per capita)			Export current dollars		
Year	AUS	ARG	NZ	AUS	ARG	NZ	AU	AR	NZ
1870	6157	2354	906	23 (3801)	8.1 (1311)	16 (3115)	98	29	12
1913	26540	29060	5810	100 (5505)	100 (3797)	100 (5178)	382	515	112
1994	308125	282408	52193	1161 (17107)	971 (8373)	898 (15085)	42542	12235	9824

Sources: Maddison (1997). (a)GDPpc, constant dollars of 1990. Table D.1a and D.1d.
(b) Index of GDP 1913=100 Table B.10a and B.10d. Author´s own tabulations.

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