European
Historical
Economics
Society

EHES WORKING PAPERS IN ECONOMIC HISTORY | NO. 118

Openness and growth in a historical perspective: a VECM approach

Giovanni Federico

University of Pisa, CEPR

Paul Sharp

University of Southern Denmark, CAGE, CEPR

Antonio Tena-Junguito

Universidad Carlos III Madrid

DECEMBER 2017

EHES Working Paper | No. 118 |December 2017

Openness and growth in a historical perspective: a VECM approach[1]

Giovanni Federico
University of Pisa, CEPR

Paul Sharp
University of Southern Denmark, CAGE, CEPR

Antonio Tena-Junguito
Universidad Carlos III Madrid

Abstract

Since Adam Smith, most economists have held the belief that trade fosters economic growth, although it has not been possible to establish a strong causal relationship. The results of growth regressions are, at best, mixed, and several historical studies have found a positive relationship between tariffs and economic growth in the nineteenth century. This paper adopts a different strategy. We look for cointegration between GDP per capita and openness for about thirty countries since 1830. About half return no cointegration – i.e. no relationship. The rest show mixed results, which change through time. An ordered probit model suggests that significantly positive relationships are more likely at low-to-middle income levels.

JEL classification: F1, N1, N7

Keywords: Openness, growth, VECM, cointegration, trade

[1] We would like to thank participants at the CEPR-NYU-CAGE Economic History Conference at NYU-Abu Dhabi in 2016 and at the Second Congress of Economic and Social History in Bonn, Germany for useful comments and suggestions. Also, many thanks are due to Maja Uhre Pedersen for extremely conscientious research assistance.

Notice
The material presented in the EHES Working Paper Series is property of the author(s) and should be quoted as such. The views expressed in this Paper are those of the author(s) and do not necessarily represent the views of the EHES or its members

1. Introduction

Since Adam Smith, most economists have strongly believed that trade fosters economic growth. This is the case for a number of good reasons, from the traditional argument about the benefits of specialization according to comparative advantages, to the ability to exploit economies of scale, increasing the variety of consumption goods and to foster the transfer of technologies (Krugman, Obstfeld and Melitz, 2014). This view is apparently confirmed by the acceleration of economic growth during the periods of globalization before 1913 and after the Second World War. Yet, despite very substantial efforts, scholars have not been able to demonstrate a causal relationship. The results of the growth regression first pioneered by Edwards (1998), are, at best, mixed (Singh 2010; Ackah, Leyaro and Morrissey, 2015). Economic historians have focused on the effect of nineteenth century tariffs, and at first a positive relationship was identified, the so-called 'tariff growth paradox' (O'Rourke 2000; Vamvakadis 2002; Clemens and Williamson 2004; Jacks 2006), although this has not been confirmed by the most recent contributions (Schularick and Solomou 2011). Others have suggested that the effects of protection on growth differed according to the structure of duties and on the level of development (Tena-Junguito 2010, Lehman and O'Rourke 2011).

The reason for this diversity of findings is most likely because the approach taken is plagued by three major problems (Donaldson 2015): the omission of potentially relevant explanatory variables (a common issue for growth regressions, see Sala-i-Martin et al 2004); endogeneity (since growth might for example also stimulate openness); and, last but not least, the assumption of a common effect of the treatment variable across countries and over time (although this might possibly be mitigated by interaction terms). Moreover, although a popular solution among economists is the use of microeconomic data at the firm level which solves the last problem, it does not address the others. Thus, endogeneity reappears as the dichotomy between learning by exporting vs. self-selection of exporting firms, and the analysis must omit key (unobservable) variables, such as managerial skills. On top of this, it is not clear how to draw inferences on the macroeconomic effects of trade and openness from microeconomic results. Besides, a microeconomic approach is ruled out for long run analyses by a lack of data.

This paper therefore adopts a different strategy. We run VECM models and look for cointegration between GDP per capita in constant prices and openness. By construction, VECMs do not assume

either variable to be exogenous, allow both positive and negative relationships and give some indication about the causality of the relationship (see Johansen 1996 and Juselius 2006). Our baseline measure of openness (*o*) is the ratio of merchandise exports to total GDP at current prices. We thus control for the size of the economy, which otherwise biases the results of the standard specification towards a positive relation between total GDP and total exports. We also compute openness as the ratio of exports to the value added of tradables (*ot*). This latter is arguably a more precise measure of the direct impact of trade as it focuses on the part of the economy which actually competed in the international markets and thus was more likely to have been impacted on by trade (Feenstra 1998). Unfortunately, however, we can only compute openness tradables for a significantly reduced number of countries and periods.

In the next section we briefly survey the previous VECM-based literature on export and growth. We sketch the basics of the VECM estimation in section 3 and we describe our data sources in section 4. The main trends in openness and growth for our sample of countries is presented in section 5 and we discuss our results in section 6, interpreting them with an ordered probit model. Section 7 concludes.

2. Literature survey

We are certainly not the first to use (different versions of) Granger causality in order to look for the relationship between trade and growth (cf. e.g. Kugler 1991, Marin 1992, Konya 2006, Awokuse 2008). Most of these works focus on the period after the Second World War, but there are also some historical studies. The results are mixed. Boltho (1996) finds no relation between exports and economic growth in Japan 1913-1950, while Oxley (1993) finds that GDP growth caused export growth in Portugal, from 1865 to 1985. Likewise, Henriques and Sadorsky (1996) find that GDP Granger-caused exports in Canada 1877-1946 and 1946-1991 (and exports Granger-caused terms of trade in the first period). GDP caused exports also in Italy from 1861 to 1913, while the opposite was true in 1954-2000 (Pistoresi and Rinaldi 2012). These results suggest a positive relation, running, contrary to the baseline hypothesis, from economic growth to exports. However, the sample of countries is small and possibly not representative and, as discussed above, the results might be biased. Indeed, Lampe and Sharp (2013), in the most systematic work in this literature, covering about 24 countries in 1870-1913 and 1950-2000, relate GDP per capita

to a different measure of openness, nominal protection (customs revenue/imports). They find a substantial number of cases of no–cointegration and, among the cointegrated series, a (small) majority of negative relations in both periods. Their results thus do not confirm the tariff-growth paradox before 1913 (which implies a positive relation between tariffs and growth), nor do they provide evidence of an adverse impact of protection on growth, as suggested by standard economic theory, after 1950. However, these results are not conclusive, for four reasons. First, protection is just one (albeit important) component of barriers to trade. Second, the revenue/import ratio may not be a good measure of protection if imports are price elastic. Indeed, substituting this with the arguably less biased Trade Restrictiveness Index (TRI) changes the results for the United States and Italy quite substantially (Federico and Vasta 2015). Third, since duties during the Great Depression were no longer the only (or even the main) tool of trade policy, nominal protection may underestimate their impact. Last but not least, Lampe and Sharp (2013) do not cover the period before 1870, which was arguably the most important period of the first globalization (Federico and Tena 2017).

3. The VECM methodology

We follow the methodology suggested by Juselius (2006), and used by Lampe and Sharp (2013)[2], and estimate the following cointegrated VAR model

$$\Delta X_t = \alpha\beta' X_{t-1} + \Gamma\Delta X_{t-1} + \mu + \alpha\beta_0' t + \varepsilon_t, \quad (1)$$

where $X_t = (y_t, o_t)'$ or $X_t = (y_t, ot_t)'$ and t is the trend.

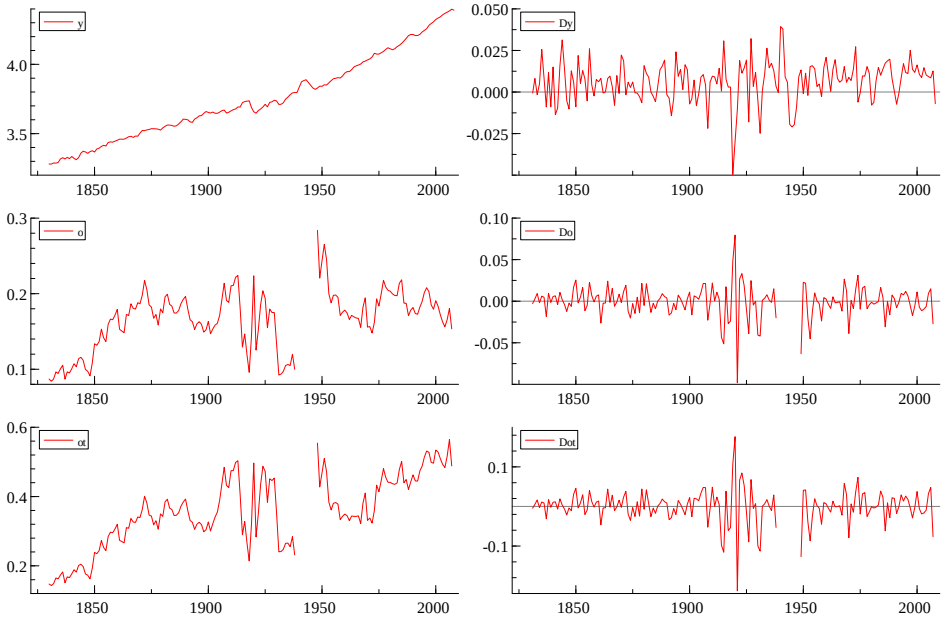
This model assumes that the p = 2 variables in X_t are related through r equilibrium relationships with deviation from equilibrium $u_t = \beta' Z_t$, and α characterizes the equilibrium correction. It holds that α and β are pxr matrices and the rank of $\Pi = \alpha\beta'$ is $r \leq p$. The autoregressive parameter, Γ, models the short-run dynamics, and throughout it is assumed that $\varepsilon_t \sim iidN_p(0, \Omega)$.

[2] The results were obtained using OxMetrics 4.02.

The model assumes that the residuals are iid and normally distributed (Juselius 2006). We thus report in Appendix 1 the PcGive tests for (no) autocorrelation up to second order and for normality. The most serious misspecification occurs in the case of autocorrelation which, however, is rarely a problem in the cases where we find significant results. The analysis also relies on the choice of a lag-length of 2 in the model in equation (1) being correct. Using information criteria, it is found that $k = 2$ lags are in fact sufficient to characterize the systematic variation in the model in both periods in all cases. Moreover, the model assumes constant parameters, motivating the split into various subsamples.

A crucial step in the analysis is to determine the number of equilibrium relationships, r. Since we only have two variables, we expect $r = 1$ if there is any causal relationship between the variables. Lampe and Sharp (2013) demonstrated that the growth of GDP per capita in almost all cases appears to be an I(0) stationary process, while we find that openness and openness tradables are in most cases I(1) non-stationary processes. This implies that there can never be a cointegrating relationship between GDP growth and levels of openness. We thus look for a cointegrating relationship between (log) levels of GDP per capita and levels of openness. For illustrative purposes, figure 1 gives the levels and differences of *y*, *o*, and *ot* for the United Kingdom. The first differences of *y* (growth rates) are clearly stationary I(0), whereas *o* and *ot* appear to be I(1).

Figure 1: Levels and differences of *y*, *o* and *ot* for the United Kingdom, 1830-2008



Source: See section 4.

The usual trace test is biased toward stationarity with limited samples, so we also make use of other methods for determining the number of cointegrating relationships. Thus, we look at graphs of the cointegrating relations, the roots of the companion matrix, and we plot recursive graphs of the trace test statistics (see Juselius 2006 for more on determining the cointegration rank). In most cases, an assumption of one unit root seems appropriate and is justified in as much as it allows for greater ease of interpreting the estimation results (Johansen 2006).

Our specification yields two pieces of information, i.e. whether there is a (negative or positive) causal relationship and, for cointegrated relationships, whether there is one-way causation (from growth to openness or vice-versa) or whether causality runs both ways. Most economists would assume the causal relation to be positive and to run from openness to economic growth, but a positive relationship with growth leading openness might be interpreted as evidence of technical progress in transportation or, in a political economy framework, as growth fostering the liberalization of trade.

Again, following Lampe and Sharp (2013), we emphasize that we are not suggesting that these are fully specified models and that we are presenting robust estimates of the openness–income relationship for the countries we look at. In fact, omitted relevant variables will make it less likely to identify cointegration and will bias the adjustment coefficients, meaning that any findings on causality are purely suggestive (Pashourtidou 2003). However, any cointegrating relationships found are robust to omitted variables, and we can thus look for differences between countries and for the same country over time when we do find cointegration.

4. The data

Our series for GDP per capita in constant 1990-dollars comes from the Maddison project (Bolt and van Zanden 2014), and we have linearly interpolated the (very few) instances of gaps in the data. Openness and openness tradables at current prices are taken from Federico and Tena-Junguito (2017). Before 1938, they compute openness as the ratio of exports from Federico and Tena (2016) to GDP and openness tradables as the ratio of exports to an estimate of value added in tradables, which they obtain by multiplying GDP by the share of agriculture, mining and

manufacturing on total Value Added. They extend the series to 2007 with data from the United Nations. These latter report data for almost all countries in the world, but in this paper we select only countries which have data before 1913, since we are mostly interested in comparing how the relationship between openness and GDP/capita has changed over time and in particular between the two globalizations. All these series are interrupted during the two world wars and end in 2007. We do not look beyond that date, as we suspect that the trade slowdown after the Global Financial Crisis[3] is likely to cause a break in the relationship of interest, and since our model assumes constant parameters it is therefore likely to be misspecified. Note that GDP and openness differ both in their construction (logs of absolute values per capita vs. nationwide ratios) and in their units of measurement (Geary-Khamis 1990 dollars vs current dollars, converted at market exchange rates), thus obviating the danger of finding spurious correlation due to similar underlying data.

We have computed openness for a total of twenty-nine polities - seventeen series starting from 1830, eight starting at different dates from 1836 to 1861 and four from 1870 onwards[4]. These countries are decidedly representative. They accounted for 67.2 percent of world GDP and 45 percent of its population in 1913, compared with 57.6 percent and 43.3 percent respectively in 2007. Moreover, they vary in size, level of development, and the timing of modern economic growth. In contrast, series of openness tradables are available for a total of seventeen countries[5].

5. Openness and economic growth: an overview

The average GDP per capita for all countries in the sample is illustrated in figure 2. It grew slowly in the first period (0.78 percent yearly from 1830-1870), accelerated before the First World War (1.2 percent from 1870-1913), resumed its growth after the troubled interwar years during the Golden

[3] See for example Hoeckman (2015).

[4] The countries are Argentina, Australia, Belgium, Brazil, Canada (since 1870), Chile, China (since 1840), Colombia, Cuba, Denmark, Finland (since 1861), France, Germany (since 1850), Greece (since 1850), India (since 1870), Italy (since 1861), Japan (since 1870), the Netherlands, New Zealand (since 1860), Norway, Peru, Portugal (since 1836), Spain (since 1850), Sweden, Switzerland (since 1851), the United Kingdom, the United States, Uruguay (since 1870), and Venezuela.

[5] The countries are Australia (since 1830), Belgium (since 1830), China (since 1840), Denmark(since 1830), Finland (since 1861), France(since 1830), Germany (since 1850), Italy (since 1861), India (since 1870) Japan (since 1870), the Netherlands(since 1830), Norway, Peru (since 1830), Spain, Sweden(since 1830), the United Kingdom(since 1830), and the United States (since 1870). The two additional countries are Canada and Brazil.

Age (at 5.6 percent), and continued to grow until the outbreak of the Great Recession (2.3 percent yearly from 1973-2006).

Figure 2: GDP per capita at constant prices, 29 polities, 1830-2008

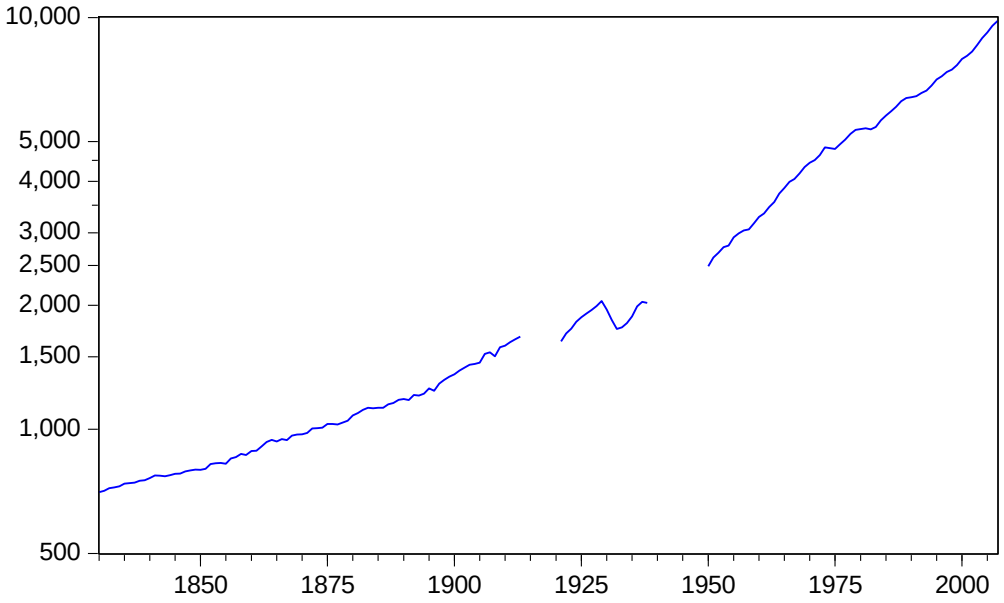


Figure 3: Export/GDP ratios 1830-2008

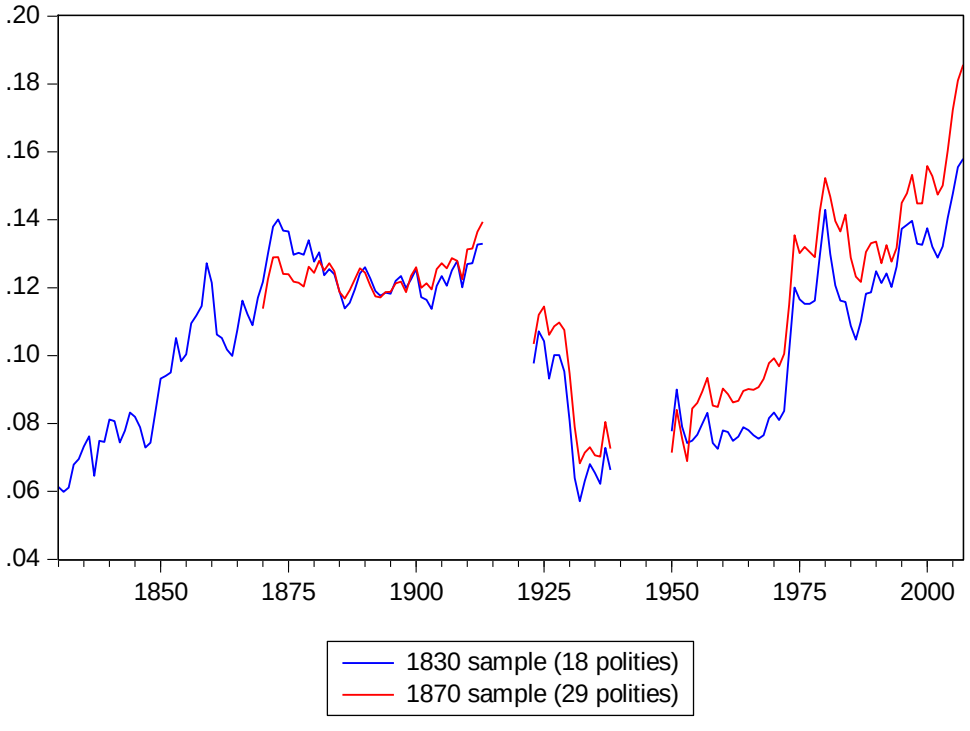


Figure 3 plots trends in aggregate openness for two different time-invariant samples, featuring 18 (since 1830) and 29 polities (since 1870) respectively. The figure highlights two waves of fast globalization, from the beginning of the series to 1870 and a century later, from the early 1970s onwards. The aggregate rate of openness for the 18 polity sample doubled from 6 percent in 1830 to a peak of 14 percent in 1873. Trends during the second globalization are to some extent blurred by the oil crises, which caused the relative prices of all tradables, not just of oil, to soar relative to non-tradables and thus also relative to GDP. Openness peaked in 1980 (at 15.2 percent for the larger sample), declined in the 1980s and then resumed its upward trend, up to a maximum in 2007-2008. The increase in openness tradables was even greater. The ratio between the two measures for a comparable sample of eighteen countries was about 1.5 in the 1870s, rose to 1.90 in 1913 and to 2.40, declined somewhat during the Great Depression, recovered to 2.5 in the early 1970s and then it jumped to 3.5 times in 2007.

The combination of movements in openness and in GDP per capita suggests a division into five periods, 1830-1870, 1870-1913, 1913-1950, 1950-1972 and 1973-2007, although it is unfortunately not possible to estimate the third and fourth of them since the sample size would be too small. As a partial substitute, we estimate 1950-2007, which also compares nicely to the period used by Lampe and Sharp (2013). As a first approximation, in these periods there seems to be no coincidence between growth in GDP per capita and in openness: periods of fast GDP growth seem to coincide with periods of sluggish or no increase in openness and vice-versa. This cannot however necessarily be generalized to imply a common pattern by country – one of the principle motivations behind the methodology employed in the present work. Indeed, there were quite wide differences among countries in both parameters of interest. The rate of growth of GDP per capita between 1830 and 1870 ranged from negative (Peru, Italy, Portugal) to 3.3 percent in Australia, with a coefficient of variation of over 1. After 1870 the dispersion halved but rates still ranged from negative (China) to 2.2 percent in Argentina. Then, there is clear convergence after the Second World War as all countries experienced much faster growth during the Golden Age (1950-1973), and, with the notable exception of China, a slowdown after the oil crisis.

Trends in openness show a remarkable pattern. All polities share an increase in openness from 1830 to 1870 and from 1970 onwards, with very few exceptions, most notably the United States in the first period and Cuba, New Zealand and the United Kingdom in the second. In most cases, openness increased very substantially. From 1830 to 1870, it doubled in the United Kingdom, from

8.5 percent to 19 percent, almost tripled in France, from 4.2 percent to 12 percent, and increased by five times in China, although from an abysmally low initial level (only 0.2 percent). From 1970 to 2006, openness increased on average in the remaining twenty six countries by 2.4 times and it jumped from 2.5 percent to 32 percent in China. In contrast, the periods of aggregate stagnation featured substantial differences between countries. From 1870 to 1913 openness grew in many poor countries, including India (from 7 percent to 11.7 percent) and China (but still only to 2.5 percent). In contrast, openness increased very little or declined in advanced countries, with the exception of the substantial rise in Germany. The ratio increased by one percentage point in the United States, but in the United Kingdom it remained below the level of the early 1870s until 1910[6]. Likewise, during the 1950s and 1960s, openness declined in most countries. It collapsed in Argentina (from 26 percent to 4.5 percent) and India (from an already low 3.1 percent to 0.9 percent), and decreased in France, the United Kingdom, Spain and so on. It remained roughly constant in the United States and Japan and increased substantially in Italy (from 12 percent to 21 percent) and Germany (from 20 percent to 34 percent).

6. The Results

We report the results of our VECM estimations in Table 1, following the compact notation used by Lampe and Sharp (2013). We highlight significant cointegrating relationships (at 5 percent) in bold and we signal results where there is misspecification of the residuals. One star indicates that there is autocorrelation, whereas two stars indicates that the residuals are non-normal (i.e., a high number of outliers). We could control for these using dummies or extra lags, but to keep the results as comparable as possible, we have chosen not to do so. The full cointegrating relationships we identify are reported in Appendix 1.

[6] Trends in openness differed among polities also in the interwar years, when on aggregate it collapsed. In 1950, aggregate openness was barely above a half of its 1913 level, but about a third of the polities, including Australia, Canada, Belgium, Denmark and the United Kingdom were more open.

Table 1: Openness and GDP per capita

a) 1830-1870

Sign	Negative			Positive		
Causality	o -> y	y -> o	o <-> y	o -> y	y -> o	o <-> y
Countries	**China**, Portugal**, United States	**Colombia****	**Cuba****	**Argentina*,****, **Denmark****, France, Netherlands**, Norway, Sweden**, **United Kingdom**	**Australia****, Belgium, Chile**, Peru	Venezuela**

b) 1871-1913

Sign	Negative			Positive		
Causality	o -> y	y -> o	o <-> y	o -> y	y -> o	o <-> y
Countries	**Belgium****, Canada, **Colombia****, India, **Spain****	**Australia****, Brazil**, China**, **New Zealand***,**, **Peru****, Portugal*,**, **Sweden**	**United Kingdom**	**Argentina**, **Denmark**, France, Germany, Japan (from 1875), **Norway**, Switzerland*,**	Chile, Cuba*,**, **Finland**, **Netherlands***, United States, Uruguay, **Venezuela****	**Greece****, **Italy****,

c) 1950-2008

Sign	Negative			Positive		
Causality	o -> y	y -> o	o <-> y	o -> y	y -> o	o <-> y
Countries		**Australia***, Belgium, Brazil**, Canada, Colombia**, **Denmark**, **Finland**, Greece*,**, **India**, New Zealand**, Portugal, Spain**, Sweden**	**United Kingdom**	**Chile****, Cuba**, Germany, Italy, Japan, **Uruguay****	Argentina*,**, France, **Norway****, United States, Venezuela	Netherlands**, **Peru****

Notes: Switzerland shows no error correction and is therefore not reported.

d) 1970-2008

Sign	Negative			Positive		
Causality	o -> y	y -> o	o <-> y	o -> y	y -> o	o <-> y
Countries	Belgium, Chile*, France*, Japan, Portugal, United States**, Uruguay	**Finland**, Greece, **Italy***, New Zealand, **Switzerland***, **United Kingdom**	Canada	Argentina**, **Brazil***, **China**, **Colombia****, Germany, Netherlands**, **Spain**, **Sweden**, **Venezuela**	Australia, Denmark, Norway, **India****	**Cuba****, **Peru***,**

A count of the number of cases, the simplest metric, highlights five stylized facts:

i) There is, unsurprisingly, a small majority of findings of no-cointegration in the whole sample (57 out of 102) and in all periods but the second (10 out of 17 in 1830-1870, 13 out of 29 1870-1913, 18 out of 27 1950-2008 and 16 out of 29 1973-2008). In these cases, one interpretation could of

course be that there was no relationship, but on the other hand the number of observations is small and, as a general rule, it is difficult to identify cointegration with few observations. Thus, one cannot rule out that, if we had more years of data (and of course if we added other relevant determinants of GDP per capita, as mentioned above) we would have been able to identify some additional significant relations.

ii) The 47 significant relations show a very similar number of positive and negative relationships (20 negative vs. 25 positive). This finding is similar for all periods (three negative and four positive for 1830-1870, eight to eight for 1870-1913, five to four for 1950-2008) except for the last (four negative to nine positive).

iii) The causal relations may not be very informative, but they do display some sort of regularity. Most positive and significant relations (19 out of 25) go from openness to growth or both ways, while in only six positive cases did economic growth lead to increased openness. By contrast, 16 out of the 20 negative relationships show the causality from growth to openness or both ways.

iv) There is no long run consistency: there is no single case of the same relationship for all four periods in our preferred three-ways classification (negative/positive/not cointegrated). Neither is there consistency between 1830-1870 and 1871-1913 (only four cases of cointegrated series with the same sign out of 19) or between 1870-1913 and 1950-2008 (four out of 28). Furthermore, only five out of 28 relations are cointegrated with the same sign between 1950-2008 and 1973-2008, despite the fact that these periods overlap.[7] This suggests a big impact of the start of the second globalization (Federico and Tena-Juinguito 2017). More in general, these results imply that worldwide conditions in each period (possibly interacting with period-specific, country-specific ones) seem to have prevailed over permanent country-specific features, such as institutions.

v) The results are not particularly consistent with Lampe and Sharp (2013), who admittedly use a slightly different period after the Second World War (1950-2000 vs. 1950-2008). We define consistent results as being if both works find no cointegration or if the cointegrating relationships have opposite signs (e.g. a negative relationship openness/growth is consistent with a positive relationship tariffs/growth and vice-versa). Out of 43 possible comparisons (21 for 1871-1913 and 23 for 1950-2008) only eleven – i.e. about a quarter – are consistent, and only five of them

[7] This suggests that some of the 1950-2008 estimations are misspecified, since the model assumes constant parameters.

(Denmark, Italy, Netherlands and Spain for 1871-1913, and India for 1950-2008) are consistent and significant.

These results are not easy to interpret and thus we explore the data in more depth by running an ordered probit model. In our baseline version, we classify relationships into three groups – negative and significant, positive and significant and not cointegrated. The explanatory variables are the level of relative development at the beginning of each period (i.e. the ratio of GDP per capita of each polity to the average GDP per capita for all countries in the sample), the geographical location (distinguishing between Europe, Asia, Latin America, and Western offshoots, including the United States), and the period. We use as the reference categories Europe during the first period, 1830-1870. By construction, a positive coefficient implies a higher likelihood of a positive relationship between openness and economic growth. The row gains in table 2 refer to the percentage increase in the number of correct predictions relative to the default – i.e. the assumption that no series is cointegrated. This latter is true in 56 cases and false in 46: in contrast, equation iii) correctly predicts nine cases of cointegrated relationships (two negative out of 20 actual ones and six positive out of 26), but it also falsely predicts six significant relationships. The net gain relative to the default is thus three predictions, or 6.5 percent of the incorrect ones.

Table 2: Ordered probit results

	i)	ii)	iii)	iv)	v)	vi)	vii)
GDP	-0.420 (2.12)**	-0.427 (2.16)**				-0.421 (1.50)	
POPULATION		-0.012 (0.56)					
GDP1830			0.817 (1.70)*	0.682 (1.41)	1.07 (2.29)**		1.026 (0.74)
GDP 1870			-0.463 (1.56)	-0.489 (1.59)	-0.260 (0.96)		-0.495 (1.25)
GDP1950			-0.338 (1.05)		-0.192 (0.63)		-0.660 (1.35)
GDP1970			-0.845 (2.90)***	-0.866 (2.87)***	-0.607 (2.36)**		-0.472 (1.24)
P1870-1913	0.054 (0.18)	-0.136 (0.39)	1.788 (2.02)**	1.615 (1.83)*	1.749 (2.09)**	-0.172 (0.31)	2.500 (0.97)
P1950-2008	0.177 (0.50)	-0.196 (0.55)	1.522 (1.66)*		1.695 (1.95)**	-1.11 (1.98)**	1.811 (2.55)
P1973-2008	0.496 (1.59)	0.307 (0.86)	3.017 (3.18)***	2.828 (2.99)***	2.895 (3.36)***	-0.265 (0.49)	2.375 (0.93)
Asia	-0.518 (1.08)	-0.237 (0.34)	-0.541 (1.10)	-0.432 (0.77)	-0.363 (0.78)	-0.579 (0.93)	-0.662 (1.05
Latin America	0.134 (0.44)	0.120 (0.39)	0.217 (0.70)	-0.037 (0.10)	0.329 (1.10)	-0.457 (0.86)	-0.527 (0.96)
Western Offshoots	0.02 (0.06)	0.04 (0.11)	0.087 (0.23)	0.109 (0.26)	-0.03 (0.09)	-0.257 (0.52)	-0.082 (0.16)
number	102	102	102	75	102	58	58
Gains	4.4%	4.4%	6.5%	8.1%	2.7%	13.9%	13.9%

t-values in parentheses; * significant at 10%, ** significant at 5%; *** significant at 1%

Column i) of table 2 reports a baseline specification, with GDP and period and location dummies. The negative and significant coefficient for GDP implies that a positive relation between openness and economic growth was more likely for a poor country[8]. The coefficients for location and period are not significant. Adding population, as a crude measure of size (column ii), does not change the main result, and the variable is not significant. On the other hand, the results improve substantially when GDP is interacted with periods (equation iii). The location dummies are still not significant, but all period dummies are positive and significant. In other worlds, given the relative GDP, the likelihood of a positive relation is greater after 1870 than for the period 1830-1870, which featured a massive growth in openness (Federico and Tena-Junguito 2017). The period-specific interacted GDP variables are positive and significant in the first period and negative in all other periods, but significant only in the last one. Thus, the rich countries had more chance of having a positive relationship in the first globalization and the poor thereafter. Our GDP variable is computed relative to an upward moving average: for instance, the GDP per capita of the richest country in 1830, the United Kingdom, was only about half of the average GDP for the whole sample in 1970. Thus, it might be argued that a positive relationship was more likely for middle-to-low levels of absolute GDP, around 1000 1990 $, which are above average in 1830, around average in 1870, slightly below in 1950 and much below average in 1970. Indeed, the coefficients of the GDP variable become positive (but not significant) if we restrict the sample to countries with GDP per capita below 2000 dollars.

The other columns of table 2 report some robustness tests. First, we drop the 1950-2008 period, because the inconsistencies with the results for 1973-2008 may imply that some of the relations for 1950-2008 are misspecified. The results (column iv) are almost identical but the predictive power increases somewhat. Second, we have experimented with three alternative classifications of outcomes, featuring two categories (positive/negative), four (positive cointegrated, positive not cointegrated, negative not cointegrated, and negative cointegrated) and seven (positive cointegrated with causality from openness to growth, positive cointegrated with two ways causality, positive cointegrated with causality from growth to openness, not cointegrated, negative cointegrated with causality from openness to growth, positive cointegrated with two ways causality, negative cointegrated with causality growth to openness). This latter yields the best results, (column vi), which however reproduce almost entirely those of column iii), with

[8] The coefficients in ordered probit regressions cannot be directly interpreted as marginal effects of explanatory variables on the dependent variable without additional specific computations (Greene 2003 p.738).

marginal differences in coefficients. On top of this, the predictive power of the regression is lower – so that the benefits from the additional detail in classification seems small at best.

The final robustness test involves openness tradables. We have been able to estimate 58 relationships, and we report the key results in table 3, with the same lay-out as table 2.

Table 3: Openness tradables and GDP per capita

a) 1830-70

Sign	Negative			Positive		
Causality	ot -> y	y -> ot	ot <-> y	ot -> y	y -> ot	ot <-> y
Countries	**Peru****			**Denmark****, France, **United Kingdom**	**Australia****, Belgium	

b) 1871-1913

Sign	Negative			Positive		
Causality	ot -> y	y -> ot	ot <-> y	ot -> y	y -> ot	ot <-> y
Countries	Belgium*	**Australia****, China**, Norway, **Sweden**	**Spain****, **United Kingdom**	**France****, Japan (from 1875)	**Denmark***,**, **Finland**, **Netherlands***, **Peru***,**, United States*	**Germany**, **Italy****

c) 1950-2007

Sign	Negative			Positive		
Causality	ot -> y	y -> ot	ot <-> y	ot -> y	y -> ot	ot <-> y
Countries	Japan**, **Peru****	**Australia**, Belgium**, Brazil**, **Canada****, Colombia**, **Denmark**, **Finland**, **Greece**, **Spain****, Sweden*,**United Kingdom**	**United States**	**Italy**,** Germany	**India**, **Norway**	

d) 1973-2007

Sign	Negative			Positive		
Causality	ot -> y	y -> ot	ot <-> y	ot -> y	y -> ot	ot <-> y
Countries	France*,**, **Japan**, United States**	Colombia, Denmark, **Finland**, Greece, **Italy***, Norway	**Canada****	Belgium*, **Brazil***, Germany, **India****, **Spain****, **Sweden**	**Australia**, United Kingdom	**Argentina****, **Peru**

The results of the VECM estimates are consistent with those using openness. Exactly half of the cases have significant relationships with the same sign, and a further seventeen are also consistent, since neither openness nor openness tradable are cointegrated with GDP per capita. In all the remaining fifteen cases, the two estimates are not consistent because only one of the two relationships (4 openness, 11 openness tradables) is significant. Last but not least there are no significant estimates with different signs. The ordered probit analysis confirms the basic insight – i.e. it was more likely to have a positive relation for (relatively) poor countries (Table 2 column vii). However, the results are clearly worse, possibly because the number of observations in some cells is too small. The dummies for continent and period are almost never significant (column vi) while

no coefficient in the most extended specification, with interacted GDP by period, is significant (column vii).

7. Conclusion

To sum up, even our highly simplified model gives significant relationships for half of our cases. At first glance, it might be difficult to sum them up in a general statement, but this is in fact our point, echoing that made by Lampe and Sharp (2013): the relationship between trade and growth is complex, and cannot be summarized within a single econometric framework. Country studies have, however, the potential to reveal the great heterogeneity of experiences, and to provide a greater understanding of this complex question. Our tentative conclusions suggest some evidence that a positive relationship seems more likely for poor countries, and that this does not vary much over time or space. Moreover, although we find no relationship between GDP per capita and openness for the majority of countries/cases we estimate, the true relationship might emerge with some additional (and hard to measure) variables, such as capital.

References

Ackah, C., V. Leyaro and O. Morrissey (2016). 'Trade, tariffs, growth and poverty'. In O. Morrissey, R. Lopez and K. Sharma (eds.) *Handbook on trade and development.* Cheltenham: Edward Elgar Cheltenham, pp.19-37.

Awokuse, T.O. (2008). 'Trade Openness and Economic Growth: Is Growth Export-led or Import-led?'. *Applied Economics* 40, pp. 161-173.

Bolt, J. and J.L. van Zanden (2014). 'The Maddison Project: collaborative research on historical national accounts'. *Economic History Review* 67, pp. 627–651.

Boltho, A. (1996). 'Was Japanese economic growth export-led?' *Oxford Economic Papers* 48, pp. 415-432.

Donaldson D. (2015). 'The gains from market integration'. *Annual Review of Economics* 7:6, pp. 19-647.

Clemens, M. and J.G. Williamson (2004) 'Why did the tariff-growth correlation change after 1950?' *Journal of Economic Growth* 9, pp. 5-46.

Edwards, S. (1998). 'Openness, productivity and growth: what do we really know?' *Economic Journal* 108, pp. 383-398.

Federico, G. and A. Tena-Junguito (2016). 'World trade, 1800-1938: a new data-set'. *EHES Working Paper* no .93.

Federico, G. and A. Tena-Junguito (2017). 'A tale of two globalizations: gains from trade and openness 1800-2010'. *Review of World Economics* 153:3, pp. 601-626.

Federico, G. and M. Vasta (2015). 'What do we really know about protection before the Great Depression: evidence from Italy'. *Journal of Economic History* 75, pp. 993-1029.

Feenstra, R. C. (1998). 'Integration of trade and disintegration of production in the global economy'. *Journal of Economic Perspectives* 12:4, pp. 31-50.

Greene, W.H. (2003). *Econometric Analysis.* London: Pearson.

Henriques, I. and P. Sadorsky (1996). 'Export-led growth or growth-driven exports? The Canadian case'. *Canadian Journal of Economics* 29, pp. 541-555.

Hoeckman, B. (2015). *The great trade slowdown: a new normal?* London: CEPR.

Konya, L. (2006). 'Exports and growth: Granger causality analysis on OECD countries with a panel data approach'. *Economic Modelling* 23, pp. 978-990.

Kugler P. (1991). 'Growth, exports and cointegration: an empirical investigation'. *Weltwirschaftlisches Archiv* 127, pp. 73-82.

Krugman, P., M. Obstfeld and M. Melitz (2014). *International Economics: Theory and Policy.* Boston: Pearson.

Jacks, D. 'New results on the tariff-growth paradox.' *European Review of Economic History* 10, pp. 205-30.

Johansen, S. (1996). *Likelihood-based inference in cointegrated vector autoregressive models. Advanced*

texts in econometrics. Oxford: Oxford University Press.

Juselius, K. (2006). *The Cointegrated VAR Model. Methodology and Applications*. Oxford: Oxford University Press.

Kónya, L. (2006). 'Exports and growth: Granger causality analysis on OECD countries with a panel data approach'. *Economic Modelling* 23:6, pp. 978-992.

Krugman, P., M. Obstfeld and M. Melitz (2014). *International Economics: Theory and Policy.* London: Pearson.

Lampe, M., and P. Sharp (2013). 'Tariffs and income: a time series analysis for 24 countries.' *Cliometrica* 7, pp. 207-35.

Lehmann, S. and K.H. O'Rourke (2011). 'The structure of protection and growth in the late 19th century'. *Review of Economics and Statistics* 93, pp. 606-616.

Marin D. (1992). 'Is the export-led growth valid for industrialized countries'. *Review of Economics and Statistics* 74, pp. 678-688.

O'Rourke, K.H. (2000). 'Tariffs and growth in the late 19th century.' *Economic Journal* 110, pp. 456-83.

Oxley L. (1993). 'Cointegration, causality and export-led growth in Portugal 1865-1885'. *Economic Letters* 43, pp. 163-166.

Pashourtidou N. (2003). 'Omitted variables in cointegration analysis'. Department of Economics, University

of Southampton, *Discussion Paper* No. 0304.

Pistoresi, B. and A. Rinaldi (2012). 'Exports, imports and growth. New evidence on Italy: 1863-2004'. *Explorations in Economic History* 49, pp. 241-254.

Sala-i-Martin, X., G. Doppelhofer and R. Miller (2004). 'Determinants of long-term growth: a Bayesian Averaging of Classical estimates (BACE) approach'. *American Economic Review* 94, pp. 813-836.

Schularick, M. and S. Solomou (2011). 'Tariffs and economic growth in the first era of globalization'. *Journal of Economic Growth* 16, pp. 33-70.

Singh, T. (2010). 'Does international trade cause economic growth? A survey'. *World Economy* 33, pp. 1517-1564.

Tena-Junguito A. (2010). 'Bairoch Revisited. Tariff Structure and Growth in Late 19th century'. *European Review of Economic History* 14, pp. 111-143.

Vamvakadis, A. (2002). 'How Robust is the Growth-Openness Connection? Historical Evidence.' *Journal of Economic Growth* 7, pp. 57-80.

Appendix 1

Europe

Belgium 1830-1870

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.31} \\ -0.04\end{bmatrix} [\{o - 0.67y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.54206[0.8197]$

N: $\chi^2(4) = 5.9089[0.2061]$

J: $[0.56]$

Belgium 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.19} \\ \mathbf{-0.52}\end{bmatrix} [\{y + \mathbf{0.98}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.6510[0.1296]$

N: $\chi^2(4) = 9.7728[0.0444]^*$

J: $[0.15]$

Belgium 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.18} \\ -0.00\end{bmatrix} [\{o + 0.73y - \mathbf{0.02}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.3293\ [0.2393]$

N: $\chi^2(4) = 4.1916\ [0.3807]$

J: $[0.85]$

Belgium 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.46} \\ -0.48\end{bmatrix} [\{y + 0.01o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.8138\ [0.1000]$

N: $\chi^2(4) = 6.4531\ [0.1678]$

J: $[0.52]$

Denmark 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.43} \\ 0.14\end{bmatrix} [\{y - \mathbf{0.39}o - \mathbf{0.00}\boldsymbol{t}\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.95913\ [0.4769]$

N: $\chi^2(4) = 11.737\ [0.0194]^*$

J: $[0.35]$

Denmark 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.28} \\ 0.12\end{bmatrix} [\{y - \mathbf{0.63}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.7898\ [0.0969]$

N: $\chi^2(4) = 4.9559\ [0.2918]$

J: $[0.18]$

Denmark 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.60} \\ -0.01\end{bmatrix} [\{o + \mathbf{0.93}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.59755\ [0.7776]$

N: $\chi^2(4) = 6.9937\ [0.1362]$

J: $[0.62]$

Denmark 1973-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.48} \\ 0.15\end{bmatrix} [\{o - 0.25y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.40290\ [0.9129]$

N: $\chi^2(4) = 0.23236\ [0.9938]$

J: $[0.13]$

Finland 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.25} \\ 0.14\end{bmatrix} [\{o - \mathbf{0.75}y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 2.0068\ [0.0608]$

N: $\chi^2(4) = 5.7318\ [0.2201]$

J: $[0.69]$

Finland 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.34} \\ 0.05\end{bmatrix} [\{o + \mathbf{0.51}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.4248$ [0.1970]
N: $\chi^2(4) = 6.0003$ [0.1991]
J: [0.66]

Finland 1973-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.03} \\ \mathbf{-0.02}\end{bmatrix} [\{o + \mathbf{15.45}y - \mathbf{0.16}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.93459$ [0.4982]
N: $\chi^2(4) = 8.5178$ [0.0744]
J: [0.59]

France 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.93} \\ 0.25\end{bmatrix} [\{y - 0.10o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.24614$ [0.9799]
N: $\chi^2(4) = 3.4722$ [0.4821]
J: [0.29]

France 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.60} \\ 0.08\end{bmatrix} [\{y - 0.56o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.6147$ [0.1397]
N: $\chi^2(4) = 9.0553$ [0.0597]
J: [0.36]

France 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.32} \\ -0.06\end{bmatrix} [\{o - 0.08y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.34205$ [0.9471]
N: $\chi^2(4) = 7.6759$ [0.1042]
J: [0.02]*

France 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.41} \\ -0.32\end{bmatrix} [\{y + 0.08o - 0.01t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 2.4573$ [0.0271]*
N: $\chi^2(4) = 8.6380$ [0.0708]
J: [0.51]

Germany 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.23} \\ 0.07\end{bmatrix} [\{y - 0.09o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.7804$ [0.0988]
N: $\chi^2(4) = 7.0546$ [0.1330]
J: [0.63]

Germany 1950-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.09} \\ -0.01\end{bmatrix} [\{y - 0.36o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.80692$ [0.5982]
N: $\chi^2(4) = 3.8522$ [0.4264]
J: [0.63]

Germany 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.44} \\ -0.26\end{bmatrix} [\{y - 0.07o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.88056$ [0.5403]
N: $\chi^2(4) = 3.6493$ [0.4555]
J: [0.49]

Greece 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.67} \\ \mathbf{0.34}\end{bmatrix} [\{y - \mathbf{1.11}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.38} \\ \mathbf{0.75}\end{bmatrix} [\{o - \mathbf{0.90}y + \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.1026$ [0.3744]
N: $\chi^2(4) = 11.048$ [0.0260]*
J: [0.30]

Greece 1950-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.33} \\ -0.12\end{bmatrix} [\{o + 0.02y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 7.4190\ [0.0000]^{**}$
N: $\chi^2(4) = 39.376\ [0.0000]^{**}$
J: [0.30]

Greece 1973-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.55} \\ -0.36\end{bmatrix} [\{o + 0.12y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 0.96278\ [0.4764]$
N: $\chi^2(4) = 0.79826\ [0.9387]$
J: [0.97]

Italy 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.17} \\ \mathbf{0.19}\end{bmatrix} [\{y - \mathbf{1.87}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.36} \\ \mathbf{0.32}\end{bmatrix} [\{o - \mathbf{0.54}y + \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.8867\ [0.0788]$
N: $\chi^2(4) = 11.925\ [0.0179]^{*}$
J: [0.45]

Italy 1950-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.01} \\ -0.00\end{bmatrix} [\{y - 0.13o + \mathbf{0.03}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.7779\ [0.0918]$
N: $\chi^2(4) = 8.9895\ [0.0614]$
J: [0.23]

Italy 1973-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.37} \\ 0.03\end{bmatrix} [\{o + \mathbf{1.04}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 2.4861\ [0.0255]^{*}$
N: $\chi^2(4) = 7.6084\ [0.1070]$
J: [0.59]

The Netherlands 1830-1870

$$\begin{bmatrix}\Delta y \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.45} \\ -0.64\end{bmatrix} [\{y - 0.06o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.63198\ [0.7475]$
N: $\chi^2(4) = 14.143\ [0.0069]^{**}$
J: [0.49]

The Netherlands 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.32} \\ \mathbf{0.05}\end{bmatrix} [\{o - \mathbf{4.76}y + \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 2.3698\ [0.0274]^{*}$
N: $\chi^2(4) = 3.3384\ [0.5029]$
J: [0.72]

The Netherlands 1950-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.04} \\ \mathbf{0.14}\end{bmatrix} [\{y - 0.59o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.08} \\ \mathbf{0.02}\end{bmatrix} [\{o - 1.70y + 0.01t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.56364\ [0.8050]$
N: $\chi^2(4) = 23.245\ [0.0001]^{**}$
J: [0.35]

The Netherlands 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.18} \\ 0.12\end{bmatrix} [\{y - 0.09o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.0407\ [0.4211]$
N: $\chi^2(4) = 21.188\ [0.0003]^{**}$
J: [0.40]

Norway 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.54} \\ 0.01\end{bmatrix} [\{y - 0.64o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.7716$ [0.1023]
N: $\chi^2(4) = 3.9608$ [0.4113]
J: [0.19]

Norway 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.01} \\ \mathbf{0.02}\end{bmatrix} [\{y - \mathbf{36.24}o + \mathbf{0.03}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.88050$ [0.5382]
N: $\chi^2(4) = 6.8029$ [0.1467]
J: [0.46]

Norway 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.48} \\ -0.00\end{bmatrix} [\{o - \mathbf{2.42}y + 0.02t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.78766$ [0.6147]
N: $\chi^2(4) = 17.788$ [0.0014]**
J: [0.88]

Norway 1973-2007

$$\begin{bmatrix}\Delta o \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.62} \\ -0.00\end{bmatrix} [\{o - 1.96y + 0.01t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.62673$ [0.7508]
N: $\chi^2(4) = 4.3357$ [0.3625]
J: [0.02]*

Portugal 1836-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.44} \\ -0.07\end{bmatrix} [\{y + \mathbf{2.08}o - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.1765$ [0.3347]
N: $\chi^2(4) = 15.817$ [0.0033]**
J: [0.17]

Portugal 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.44} \\ 0.04\end{bmatrix} [\{o + 0.05y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 2.3813$ [0.0267]*
N: $\chi^2(4) = 9.6337$ [0.0471]*
J: [0.82]

Portugal 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.30} \\ 0.04\end{bmatrix} [\{o + 0.19y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.98993$ [0.4493]
N: $\chi^2(4) = 9.0617$ [0.0596]
J: [0.81]

Portugal 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.37} \\ -0.25\end{bmatrix} [\{y + 0.03o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.2432$ [0.2975]
N: $\chi^2(4) = 3.8744$ [0.4233]
J: [0.12]

Spain 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.75} \\ -0.24\end{bmatrix} [\{y + \mathbf{0.78}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.57286$ [0.7960]
N: $\chi^2(4) = 18.495$ [0.0010]**
J: [0.57]

Spain 1950-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.23} \\ -0.02\end{bmatrix} [\{o + 0.00y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 0.39230$ [0.9222]
N: $\chi^2(4) = 15.085$ [0.0045]**
J: [0.52]

Spain 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.14} \\ 0.20\end{bmatrix} [\{y - \mathbf{0.56}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 0.54469\ [0.8166]$
N: $\chi^2(4) = 2.1159\ [0.7145]$
J: [0.83]

Sweden 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.63} \\ 0.06\end{bmatrix} [\{y - 0.24o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.1096\ [0.3710]$
N: $\chi^2(4) = 11.613\ [0.0205]^{*}$
J: [0.08]

Sweden 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.53} \\ 0.04\end{bmatrix} [\{o + \mathbf{1.26}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.8023\ [0.0944]$
N: $\chi^2(4) = 2.3369\ [0.6741]$
J: [0.30]

Sweden 1950-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.38} \\ 0.01\end{bmatrix} [\{o + 1.26y - \mathbf{0.04}t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 0.99351\ [0.4465]$
N: $\chi^2(4) = 16.866\ [0.0021]^{**}$
J: [0.76]

Sweden 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.10} \\ 1.01\end{bmatrix} [\{y - \mathbf{0.31}o + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 0.43996\ [0.8907]$
N: $\chi^2(4) = 2.0493\ [0.7267]$
J: [0.65]

Switzerland 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.31} \\ 0.07\end{bmatrix} [\{y - 0.16o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 2.9535\ [0.0075]^{**}$
N: $\chi^2(4) = 11.342\ [0.0230]^{*}$
J: [0.76]

Switzerland 1973-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.02} \\ \mathbf{-0.01}\end{bmatrix} [\{o + \mathbf{12.46}y - \mathbf{0.06}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 2.3190\ [0.0359]^{*}$
N: $\chi^2(4) = 2.0350\ [0.7293]$
J: [0.90]

United Kingdom 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.77} \\ -0.15\end{bmatrix} [\{y - \mathbf{0.37}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.1880\ [0.3228]$
N: $\chi^2(4) = 5.4320\ [0.2458]$
J: [0.15]

United Kingdom 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.38} \\ \mathbf{-0.50}\end{bmatrix} [\{y + \mathbf{0.34}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.37} \\ \mathbf{-0.10}\end{bmatrix} [\{o + \mathbf{1.27}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.4066\ [0.2124]$
N: $\chi^2(4) = 2.1738\ [0.7038]$
J: [0.72]

United Kingdom 1950-2007

$$\begin{bmatrix}\Delta y_t\\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.13}\\ \mathbf{-0.47}\end{bmatrix} [\{y + \mathbf{0.79}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t\\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.37}\\ \mathbf{-0.10}\end{bmatrix} [\{o + \mathbf{1.27}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.31127\ [0.9600]$

N: $\chi^2(4) = 3.3838\ [0.4958]$

J: $[0.43]$

United Kingdom 1973-2007

$$\begin{bmatrix}\Delta o_t\\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.64}\\ -0.05\end{bmatrix} [\{o + \mathbf{0.61}y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.1594\ [0.3448]$

N: $\chi^2(4) = 5.7140\ [0.2216]$

J: $[0.29]$

North America

Canada 1871-1913

$$\begin{bmatrix}\Delta y_t\\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.25}\\ -0.03\end{bmatrix} [\{y + 0.36o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.87059\ [0.5462]$

N: $\chi^2(4) = 0.99518\ [0.9105]$

J: $[0.62]$

Canada 1950-2008

$$\begin{bmatrix}\Delta o_t\\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.21}\\ 0.01\end{bmatrix} [\{o + 0.35y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 0.50119\ [0.8525]$

N: $\chi^2(4) = 5.2226\ [0.2652]$

J: $[0.83]$

Canada 1973-2008

$$\begin{bmatrix}\Delta y_t\\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.24}\\ \mathbf{-0.77}\end{bmatrix} [\{y + \mathbf{0.28}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t\\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.22}\\ \mathbf{-0.07}\end{bmatrix} [\{o + \mathbf{3.55}y - \mathbf{0.03}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 1.8089\ [0.0997]$

N: $\chi^2(4) = 6.2226\ [0.1831]$

J: $[0.26]$

USA 1830-1870

$$\begin{bmatrix}\Delta y_t\\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.33}\\ 0.06\end{bmatrix} [\{y + 0.11o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.0356\ [0.4209]$

N: $\chi^2(4) = 2.2249\ [0.6945]$

J: $[0.49]$

USA 1871-1913

$$\begin{bmatrix}\Delta y_t\\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.47}\\ \mathbf{0.97}\end{bmatrix} [\{o + 0.13y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.3480\ [0.2381]$

N: $\chi^2(4) = 4.9332\ [0.2942]$

J: $[0.04]^*$

USA 1950-2007

$$\begin{bmatrix}\Delta o_t\\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.25}\\ -0.15\end{bmatrix} [\{o - 0.07y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.96894\ [0.4654]$

N: $\chi^2(4) = 5.7475\ [0.2188]$

J: $[0.44]$

USA 1973-2007

$$\begin{bmatrix}\Delta y_t\\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.54}\\ -0.02\end{bmatrix} [\{y + 0.41o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.54326\ [0.8174]$

N: $\chi^2(4) = 9.6302\ [0.0471]^*$

J: $[0.24]$

Latin America

Argentina 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.02} \\ \mathbf{5.02}\end{bmatrix} [\{y - \mathbf{0.13}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 2.2505\ [0.0368]^{*}$

N: $\chi^2(4) = 20.268\ [0.0004]^{**}$

J: $[0.10]$

Argentina 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.30} \\ 0.17\end{bmatrix} [\{y - \mathbf{0.91}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.29213\ [0.9660]$

N: $\chi^2(4) = 4.3882\ [0.3560]$

J: $[0.47]$

Argentina 1950-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.21} \\ 0.02\end{bmatrix} [\{o - 0.03y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 3.9893\ [0.0004]^{**}$

N: $\chi^2(4) = 55.942\ [0.0000]^{**}$

J: $[0.70]$

Agentina 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.22} \\ 0.13\end{bmatrix} [\{y - 0.70o - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 0.34325\ [0.9441]$

N: $\chi^2(4) = 25.796\ [0.0000]^{**}$

J: $[0.36]$

Brazil 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.44} \\ -0.08\end{bmatrix} [\{o + 0.84y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.64342\ [0.7381]$

N: $\chi^2(4) = 54.865\ [0.0000]^{**}$

J: $[0.26]$

Brazil 1950-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.28} \\ 0.01\end{bmatrix} [\{o + 0.12y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 1.3574\ [0.2258]$

N: $\chi^2(4) = 22.622\ [0.0002]^{**}$

J: $[0.76]$

Brazil 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.31} \\ \mathbf{0.21}\end{bmatrix} [\{y - \mathbf{0.77}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 2.4884\ [0.0247]^{*}$

N: $\chi^2(4) = 5.3581\ [0.2525]$

J: $[0.80]$

Chile 1830-1870

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.45} \\ \mathbf{0.00}\end{bmatrix} [\{o + 0.07y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.5638\ [0.1567]$

N: $\chi^2(4) = 34.807\ [0.0000]^{**}$

J: $[0.33]$

Chile 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.47} \\ -0.09\end{bmatrix} [\{o - 0.06y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.84682\ [0.5658]$

N: $\chi^2(4) = 3.1765\ [0.5287]$

J: $[0.51]$

Chile 1950-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.06} \\ \mathbf{0.07}\end{bmatrix} [\{y - \mathbf{3.84}o + \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 00.37387\ [0.9319]$

N: $\chi^2(4) = 17.956\ [0.0013]^{**}$

J: [0.42]

Chile 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.25} \\ -0.04\end{bmatrix} [\{y + 0.13o - \mathbf{0.02}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 2.2555\ [0.0400]^{*}$

N: $\chi^2(4) = 5.7447\ [0.2190]$

J: [0.35]

Colombia 1830-1870

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.54} \\ 0.05\end{bmatrix} [\{o + \mathbf{0.18}y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.55565\ [0.8092]$

N: $\chi^2(4) = 308.29\ [0.0000]^{**}$

J: [0.59]

Colombia 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.07} \\ -0.05\end{bmatrix} [\{y + \mathbf{0.62}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.66951\ [0.7161]$

N: $\chi^2(4) = 36.646\ [0.0000]^{**}$

J: [0.25]

Colombia 1950-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.22} \\ 0.01\end{bmatrix} [\{o + 0.50y - 0.01t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 0.66248\ [0.7230]$

N: $\chi^2(4) = 10.897\ [0.0278]^{*}$

J: [0.60]

Colombia 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.16} \\ 0.07\end{bmatrix} [\{y - \mathbf{0.89}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 1.8014\ [0.1012]$

N: $\chi^2(4) = 10.420\ [0.0339]^{*}$

J: [0.33]

Cuba 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.04} \\ \mathbf{-0.79}\end{bmatrix} [\{y + \mathbf{0.93}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.74} \\ \mathbf{-0.03}\end{bmatrix} [\{o + \mathbf{1.07}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.99955\ [0.4468]$

N: $\chi^2(4) = 32.408\ [0.0000]^{**}$

J: [0.17]

Cuba 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.36} \\ 0.00\end{bmatrix} [\{o - 0.04y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 3.6859\ [0.0015]^{**}$

N: $\chi^2(4) = 125.60\ [0.0000]^{**}$

J: [0.26]

Cuba 1950-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.19} \\ -0.08\end{bmatrix} [\{y - 0.42o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 0.99136\ [0.4481]$

N: $\chi^2(4) = 28.074\ [0.0000]^{**}$

J: $[0.79]$

Cuba 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.14} \\ \mathbf{0.27}\end{bmatrix} [\{y - \mathbf{1.80}o - \mathbf{0.02}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.48} \\ \mathbf{0.26}\end{bmatrix} [\{o - \mathbf{0.56}y + \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 0.80355\ [0.6027]$

N: $\chi^2(4) = 23.413\ [0.0001]^{**}$

J: $[0.70]$

Peru 1830-1870

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.93} \\ -0.19\end{bmatrix} [\{o - 0.06y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.5530\ [0.1602]$

N: $\chi^2(4) = 5.4105\ [0.2477]$

J: $[0.65]$

Peru 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-1.09} \\ \mathbf{-0.80}\end{bmatrix} [\{o - \mathbf{0.18}y + \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.2210\ [0.3026]$

N: $\chi^2(4) = 28.114\ [0.0000]^{**}$

J: $[0.37]$

Peru 1950-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.10} \\ \mathbf{0.09}\end{bmatrix} [\{y - \mathbf{2.50}o - 0.00t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.23} \\ \mathbf{0.24}\end{bmatrix} [\{o - \mathbf{0.40}y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 1.7032\ [0.1080]$

N: $\chi^2(4) = 15.084\ [0.0045]^{**}$

J: $[0.94]$

Peru 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.23} \\ \mathbf{0.31}\end{bmatrix} [\{y - \mathbf{1.45}o + 0.00t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.44} \\ \mathbf{0.33}\end{bmatrix} [\{o - \mathbf{0.69}y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 2.5235\ [0.0230]^{*}$

N: $\chi^2(4) = 11.234\ [0.0241]^{*}$

J: $[0.80]$

Uruguay 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.32} \\ 0.17\end{bmatrix} [\{o - 0.08y + \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.85656\ [0.5577]$

N: $\chi^2(4) = 4.0230\ [0.4029]$

J: $[0.12]$

Uruguay 1950-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.16} \\ 0.12\end{bmatrix} [\{y - \mathbf{1.07}o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.25384\ [0.9786]$

N: $\chi^2(4) = 21.736\ [0.0002]^{**}$

J: [0.50]

Uruguay 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.45} \\ -0.00\end{bmatrix} [\{y + 0.20o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.4677\ [0.1966]$

N: $\chi^2(4) = 8.1252\ [0.0871]$

J: [0.47]

Venezuela 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.02} \\ \mathbf{0.22}\end{bmatrix} [\{y - \mathbf{1.45}o + 0.00t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.33} \\ \mathbf{0.03}\end{bmatrix} [\{o - \mathbf{0.69}y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.50641\ [0.8464]$

N: $\chi^2(4) = 34.676\ [0.0000]^{**}$

J: [0.34]

Venezuela 1871-1913

$$\begin{bmatrix}\Delta o \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.39} \\ 0.06\end{bmatrix} [\{o - \mathbf{0.83}y + \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.65745\ [0.7263]$

N: $\chi^2(4) = 12.796\ [0.0123]^{*}$

J: [0.93]

Venezuela 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.53} \\ \mathbf{0.15}\end{bmatrix} [\{o + 0.10y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.45944\ [0.8814]$

N: $\chi^2(4) = 6.2583\ [0.1807]$

J: [0.24]

Venezuela 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.16} \\ \mathbf{0.37}\end{bmatrix} [\{y - \mathbf{1.86}o + \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.74754\ [0.6496]$

N: $\chi^2(4) = 2.4366\ [0.6560]$

J: [0.43]

Oceania

Australia 1830-1870

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.91} \\ 0.29\end{bmatrix} [\{o - \mathbf{0.40}y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.2267\ [0.3008]$

N: $\chi^2(4) = 12.584\ [0.0135]^{*}$

J: [0.74]

Australia 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.60} \\ 0.06\end{bmatrix} [\{o + \mathbf{0.48}y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.8556\ [0.0842]$

N: $\chi^2(4) = 11.772\ [0.0191]^{*}$

J: [0.97]

Australia 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.38} \\ -0.05\end{bmatrix} [\{o + \mathbf{0.98}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 2.4046\ [0.0212]^{*}$
N: $\chi^2(4) = 4.6934\ [0.3202]$
J: $[0.54]$

Australia 1973-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.79} \\ 0.14\end{bmatrix} [\{o - 0.09y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.4978\ [0.1857]$
N: $\chi^2(4) = 8.3519\ [0.0795]$
J: $[0.37]$

New Zealand 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.40} \\ 0.16\end{bmatrix} [\{o + \mathbf{0.81}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 2.0988\ [0.0498]^{*}$
N: $\chi^2(4) = 9.8577\ [0.0429]^{*}$
J: $[0.62]$

New Zealand 1950-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.34} \\ 0.04\end{bmatrix} [\{o + 0.61y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.74551\ [0.6512]$
N: $\chi^2(4) = 18.230\ [0.0011]^{**}$
J: $[0.49]$

New Zealand 1973-2007

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.60} \\ \mathbf{0.31}\end{bmatrix} [\{o + 0.16y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.99778\ [0.4513]$
N: $\chi^2(4) = 5.1403\ [0.2732]$
J: $[0.44]$

Asia

China 1840-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.35} \\ -0.05\end{bmatrix} [\{y + \mathbf{3.88}o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,36) = 1.8225\ [0.1048]$
N: $\chi^2(4) = 3.8516\ [0.4265]$
J: $[0.47]$

China 1871-1913

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.97} \\ 0.02\end{bmatrix} [\{o + 0.03y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 0.46219\ [0.8777]$
N: $\chi^2(4) = 11.335\ [0.0230]^{*}$
J: $[0.47]$

China 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.40} \\ 0.27\end{bmatrix} [\{y - \mathbf{0.80}o - \mathbf{0.02}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 1.2771\ [0.2788]$
N: $\chi^2(4) = 2.0542\ [0.7258]$
J: $[0.42]$

India 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-1.02} \\ 0.10\end{bmatrix} [\{y + 0.08o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 1.3896\ [0.2196]$
N: $\chi^2(4) = 6.6972\ [0.1528]$
J: $[0.58]$

India 1950-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.10} \\ \mathbf{-0.10}\end{bmatrix} [\{o - \mathbf{0.51}y + 0.00t\}_{t-1}] + \cdots$$

N: $\chi^2(4) = 8.9045\ [0.0635]$

J: $[0.01]^*$

India 1973-2008

$$\begin{bmatrix}\Delta o_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.29} \\ -0.16\end{bmatrix} [\{o - \mathbf{0.51}y + \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 0.79659\ [0.6085]$

N: $\chi^2(4) = 13.198\ [0.0103]^*$

J: $[0.43]$

Japan 1875-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.95} \\ 0.18\end{bmatrix} [\{y - 0.27o - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,52) = 0.48973\ [0.8580]$

N: $\chi^2(4) = 6.7965\ [0.1470]$

J: $[0.03]^*$

Japan 1950-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.00} \\ 0.00\end{bmatrix} [\{y - 0.54o + \mathbf{0.06}t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 0.48721\ [0.8625]$

N: $\chi^2(4) = 8.7909\ [0.0665]$

J: $[0.75]$

Japan 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta o_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.06} \\ 0.04\end{bmatrix} [\{y + 1.04o - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 0.63196\ [0.7467]$

N: $\chi^2(4) = 1.1295\ [0.8896]$

J: $[0.16]$

Appendix 2

Europe

Belgium 1830-1870

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.35} \\ -0.04\end{bmatrix} [\{ot - 0.49y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.52262\ [0.8345]$

N: $\chi^2(4) = 7.0412\ [0.1337]$

J: [0.57]

Belgium 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.41} \\ \mathbf{-1.21}\end{bmatrix} [\{y + 0.12ot - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 3.1831\ [0.0042]^{**}$

N: $\chi^2(4) = 3.0198\ [0.5545]$

J: [0.13]

Belgium 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.02} \\ 0.00\end{bmatrix} [\{ot + 10.92y - 0.30t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.1896\ [0.3142]$

N: $\chi^2(4) = 59.7242\ [0.0453]^{*}$

J: [0.86]

Belgium 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.35} \\ 4.23\end{bmatrix} [\{y - 0.00ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 2.1882\ [0.0469]^{*}$

N: $\chi^2(4) = 5.4359\ [0.2454]$

J: [0.61]

Denmark 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.79} \\ -0.32\end{bmatrix} [\{y - \mathbf{0.13}ot - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.0297\ [0.4251]$

N: $\chi^2(4) = 36.864\ [0.0000]^{**}$

J: [0.57]

Denmark 1871-1913

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.41} \\ 0.02\end{bmatrix} [\{ot - \mathbf{1.40}y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 2.7992\ [0.0101]^{*}$

N: $\chi^2(4) = 11.561\ [0.0209]^{*}$

J: [0.18]

Denmark 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.61} \\ -0.01\end{bmatrix} [\{ot + \mathbf{1.36}y - \mathbf{0.02}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.46653\ [0.8766]$

N: $\chi^2(4) = 6.4788\ [0.1661]$

J: [0.63]

Denmark 1973-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.50} \\ 0.05\end{bmatrix} [\{ot + 0.28y - 0.01t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.53477\ [0.8239]$

N: $\chi^2(4) = 0.97026\ [0.9143]$

J: [0.12]

Finland 1871-1913

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.17} \\ \mathbf{0.08}\end{bmatrix} [\{ot - \mathbf{1.82}y + \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 1.5310\ [0.1642]$
N: $\chi^2(4) = 2.7173\ [0.6062]$
J: [0.77]

Finland 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.28} \\ \mathbf{0.07}\end{bmatrix} [\{ot + \mathbf{0.90}y - \mathbf{0.02}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.6667\ [0.1175]$
N: $\chi^2(4) = 6.2783\ [0.1793]$
J: [0.33]

Finland 1973-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.01} \\ \mathbf{-0.00}\end{bmatrix} [\{ot + \mathbf{151.67}y - \mathbf{1.55}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.97365\ [0.4689]$
N: $\chi^2(4) = 8.1889\ [0.0849]$
J: [0.58]

France 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.94} \\ 0.36\end{bmatrix} [\{y - 0.08ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 0.27237\ [0.9724]$
N: $\chi^2(4) = 3.3792\ [0.4965]$
J: [0.25]

France 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.18} \\ \mathbf{0.21}\end{bmatrix} [\{y - \mathbf{1.97}ot - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 1.5762\ [0.1497]$
N: $\chi^2(4) = 10.635\ [0.0310]^{*}$
J: [0.17]

France 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.41} \\ -1.07\end{bmatrix} [\{y + 0.05ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 2.9790\ [0.0093]^{**}$
N: $\chi^2(4) = 11.041\ [0.0261]^{*}$
J: [0.49]

Germany 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.19} \\ \mathbf{0.25}\end{bmatrix} [\{y - 0.03ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.01} \\ \mathbf{0.01}\end{bmatrix} [\{ot - \mathbf{37.61}y + \mathbf{0.23}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 0.87841\ [0.5395]$
N: $\chi^2(4) = 3.5319\ [0.4730]$
J: [0.73]

Germany 1950-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.08} \\ 0.01\end{bmatrix} [\{y - 0.18ot - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.89078\ [0.5277]$
N: $\chi^2(4) = 6.8791\ [0.1424]$
J: [0.64]

Germany 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.43} \\ -0.40\end{bmatrix} [\{y - 0.02ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.79333\ [0.6113]$
N: $\chi^2(4) = 5.4508\ [0.2441]$
J: $[0.48]$

Greece 1955-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.59} \\ -0.10\end{bmatrix} [\{ot + \mathbf{0.14}y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,80) = 0.55621\ [0.8104]$
N: $\chi^2(4) = 3.8113\ [0.4321]$
J: $[0.53]$

Greece 1973-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.90} \\ -0.04\end{bmatrix} [\{ot + 0.20y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.4122\ [0.2183]$
N: $\chi^2(4) = 0.72694\ [0.9480]$
J: $[0.99]$

Italy 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.21} \\ \mathbf{0.43}\end{bmatrix} [\{y - \mathbf{1.09}ot - \mathbf{0.00}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.47} \\ \mathbf{0.23}\end{bmatrix} [\{ot - \mathbf{0.92}y + \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 1.2864\ [0.2665]$
N: $\chi^2(4) = 11.674\ [0.0199]^{*}$
J: $[0.63]$

Italy 1950-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.01} \\ 0.00\end{bmatrix} [\{y - \mathbf{11.22}ot + \mathbf{0.07}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.91097\ [0.5112]$
N: $\chi^2(4) = 116.13\ [0.0000]^{**}$
J: $[0.43]$

Italy 1973-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.37} \\ 0.03\end{bmatrix} [\{ot + \mathbf{1.05}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 2.4858\ [0.0255]^{*}$
N: $\chi^2(4) = 7.6205\ [0.1065]$
J: $[0.59]$

The Netherlands 1871-1913

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.24} \\ 0.02\end{bmatrix} [\{ot - \mathbf{13.74}y + \mathbf{0.04}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 3.4005\ [0.0026]^{**}$
N: $\chi^2(4) = 4.7385\ [0.3152]$
J: $[0.69]$

Norway 1871-1913

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.74} \\ 0.10\end{bmatrix} [\{ot + 0.15y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 0.82819\ [0.5810]$
N: $\chi^2(4) = 6.7368\ [0.1505]$
J: $[0.88]$

Norway 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.43} \\ 0.00\end{bmatrix} [\{ot - \mathbf{7.52}y + 0.06t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.3544\ [0.2276]$

N: $\chi^2(4) = 4.8394\ [0.3042]$

J: $[0.91]$

Norway 1973-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.66} \\ -0.01\end{bmatrix} [\{ot + 0.90y - 0.03t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.6337\ [0.1428]$

N: $\chi^2(4) = 3.0717\ [0.5459]$

J: $[0.02]^{*}$

Spain 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.49} \\ \mathbf{-0.41}\end{bmatrix} [\{y + \mathbf{0.38}ot - \mathbf{0.00}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.16} \\ \mathbf{-0.19}\end{bmatrix} [\{ot + \mathbf{2.64}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 0.57567\ [0.7941]$

N: $\chi^2(4) = 12.457\ [0.0143]^{*}$

J: $[0.44]$

Spain 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.20} \\ -0.01\end{bmatrix} [\{ot + \mathbf{0.80}y - \mathbf{0.03}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.47493\ [0.8709]$

N: $\chi^2(4) = 59.348\ [0.0000]^{**}$

J: $[0.38]$

Spain 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.26} \\ 0.06\end{bmatrix} [\{y - \mathbf{0.36}ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 1.3983\ [0.2227]$

N: $\chi^2(4) = 11.774\ [0.0191]^{*}$

J: $[0.95]$

Sweden 1871-1913

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.47} \\ -0.01\end{bmatrix} [\{ot + \mathbf{1.24}y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 1.5333\ [0.1635]$

N: $\chi^2(4) = 1.7371\ [0.7840]$

J: $[0.81]$

Sweden 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.20} \\ 0.01\end{bmatrix} [\{ot + 1.02y - \mathbf{0.03}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 2.1002\ [0.0437]^{*}$

N: $\chi^2(4) = 6.9054\ [0.1410]$

J: $[0.87]$

Sweden 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.14} \\ -0.21\end{bmatrix} [\{y - \mathbf{0.41}ot + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.83193\ [0.5795]$

N: $\chi^2(4) = 3.5018\ [0.4776]$

J: $[0.57]$

United Kingdom 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.76} \\ -0.27\end{bmatrix} [\{y - \mathbf{0.20}ot - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.1663\ [0.3356]$

N: $\chi^2(4) = 5.5092\ [0.2389]$

J: $[0.13]$

United Kingdom 1871-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.48} \\ \mathbf{-0.90}\end{bmatrix} [\{y + \mathbf{0.13}ot - \mathbf{0.00}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.12} \\ \mathbf{-0.07}\end{bmatrix} [\{ot + \mathbf{7.44}y - \mathbf{0.03}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 0.80427\ [0.6011]$

N: $\chi^2(4) = 1.7798\ [0.7762]$

J: $[0.89]$

United Kingdom 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.38} \\ -0.03\end{bmatrix} [\{ot + \mathbf{1.67}y - \mathbf{0.02}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.69089\ [0.6986]$

N: $\chi^2(4) = 4.1832\ [0.3818]$

J: $[0.29]$

United Kingdom 1973-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.72} \\ 0.10\end{bmatrix} [\{ot - 0.18y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.88829\ [0.5341]$

N: $\chi^2(4) = 5.5583\ [0.2347]$

J: $[0.21]$

North America

Canada 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.19} \\ 0.00\end{bmatrix} [\{ot + \mathbf{1.63}y - \mathbf{0.03}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.0195\ [0.4273]$

N: $\chi^2(4) = 10.480\ [0.0331]^*$

J: $[0.83]$

Canada 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.32} \\ \mathbf{-1.92}\end{bmatrix} [\{y + \mathbf{0.09}ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.18} \\ \mathbf{-0.03}\end{bmatrix} [\{ot + \mathbf{10.65}y - \mathbf{0.09}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.0333\ [0.4262]$

N: $\chi^2(4) = 10.836\ [0.0285]^*$

J: $[0.42]$

United States 1871-1913

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.38} \\ \mathbf{0.50}\end{bmatrix} [\{ot - 0.02y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,62) = 2.1036\ [0.0487]^*$

N: $\chi^2(4) = 5.4812\ [0.2414]$

J: $[0.03]^*$

United States 1950-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.19} \\ \mathbf{-0.22}\end{bmatrix} [\{y + \mathbf{0.54}ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.12} \\ \mathbf{-0.10}\end{bmatrix} [\{ot + \mathbf{1.85}y - \mathbf{0.02}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.54901\ [0.8165]$

N: $\chi^2(4) = 2.1645\ [0.7055]$

J: $[0.51]$

United States 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.55} \\ 0.17\end{bmatrix} [\{y + 0.04ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.37703\ [0.9272]$

N: $\chi^2(4) = 10.691\ [0.0303]^{*}$

J: $[0.34]$

Latin America

Argentina 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.29} \\ \mathbf{0.63}\end{bmatrix} [\{y - \mathbf{0.36}ot + 0.00t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.23} \\ \mathbf{0.10}\end{bmatrix} [\{ot - \mathbf{2.81}y - 0.01t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 0.45211\ [0.8825]$

N: $\chi^2(4) = 20.482\ [0.0004]^{**}$

J: $[0.33]$

Brazil 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.28} \\ -0.00\end{bmatrix} [\{ot + 0.22y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.3198\ [0.2439]$

N: $\chi^2(4) = 21.505\ [0.0003]^{**}$

J: $[0.75]$

Brazil 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.36} \\ 0.28\end{bmatrix} [\{y - \mathbf{0.47}ot - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 2.3671\ [0.0326]^{*}$

N: $\chi^2(4) = 4.2024\ [0.3793]$

J: $[0.70]$

Colombia 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.23} \\ -0.01\end{bmatrix} [\{ot + 1.18y - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 0.82160\ [0.5856]$

N: $\chi^2(4) = 12.786\ [0.0124]^{*}$

J: $[0.64]$

Colombia 1973-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.42} \\ -0.01\end{bmatrix} [\{ot + 1.56y - \mathbf{0.02}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.7395\ [0.1160]$

N: $\chi^2(4) = 8.4573\ [0.0762]$

J: $[0.30]$

Peru 1830-1870

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.57} \\ -0.53\end{bmatrix} [\{y + \mathbf{0.13}ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.6051\ [0.1442]$

N: $\chi^2(4) = 32.388\ [0.0000]^{**}$

J: $[0.89]$

Peru 1871-1913

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.50} \\ \mathbf{-0.24}\end{bmatrix} [\{ot - \mathbf{0.28}y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,60) = 3.3391\ [0.0032]^{**}$
N: $\chi^2(4) = 26.663\ [0.0000]^{**}$
J: $[0.74]$

Peru 1950-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.09} \\ 0.11\end{bmatrix} [\{y - \mathbf{1.43}ot - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 1.7691\ [0.0933]$
N: $\chi^2(4) = 11.474\ [0.0217]^{*}$
J: $[0.92]$

Peru 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.27} \\ \mathbf{0.52}\end{bmatrix} [\{y - \mathbf{0.85}ot + \mathbf{0.00}t\}_{t-1}] + \cdots$$

or

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.44} \\ \mathbf{0.23}\end{bmatrix} [\{ot - \mathbf{1.18}y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 2.1220\ [0.0527]$
N: $\chi^2(4) = 7.1937\ [0.1260]$
J: $[0.76]$

Oceania

Australia 1830-1870

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.57} \\ 0.17\end{bmatrix} [\{ot - \mathbf{0.75}y + 0.01t\}_{t-1}] + \cdots$$

AR: $F(8,56) = 1.5001\ [0.1781]$
N: $\chi^2(4) = 10.763\ [0.0294]^{*}$
J: $[0.71]$

Australia 1871-1913

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.58} \\ -0.07\end{bmatrix} [\{ot + \mathbf{1.26}y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,64) = 1.5772\ [0.1494]$
N: $\chi^2(4) = 14.311\ [0.0064]^{**}$
J: $[0.91]$

Australia 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.31} \\ -0.02\end{bmatrix} [\{ot + \mathbf{3.06}y - \mathbf{0.03}t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.5990\ [0.1362]$
N: $\chi^2(4) = 3.7962\ [0.4343]$
J: $[0.69]$

Australia 1973-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.48} \\ 0.05\end{bmatrix} [\{ot - 0.47y - 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.4845\ [0.1904]$
N: $\chi^2(4) = 5.5819\ [0.2326]$
J: $[0.32]$

Asia

China 1869-1912

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-1.21} \\ -0.07\end{bmatrix} [\{ot + 0.02y - \mathbf{0.00}t\}_{t-1}] + \cdots$$

AR: $F(8,62) = 0.62720\ [0.7518]$

N: $\chi^2(4) = 11.641\ [0.0202]^*$

J: $[0.57]$

India 1950-2007

$$\begin{bmatrix}\Delta ot_t \\ \Delta y_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.07} \\ \mathbf{-0.04}\end{bmatrix} [\{ot - \mathbf{1.05}y + 0.00t\}_{t-1}] + \cdots$$

AR: $F(8,90) = 1.9560\ [0.0612]$

N: $\chi^2(4) = 7.4631\ [0.1133]$

J: $[0.01]^*$

India 1973-2007

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.45} \\ 0.27\end{bmatrix} [\{y - \mathbf{0.95}ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,44) = 1.5123\ [0.1806]$

N: $\chi^2(4) = 12.205\ [0.0159]^*$

J: $[0.47]$

Japan 1875-1913

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.95} \\ 0.42\end{bmatrix} [\{y - 0.08ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,52) = 0.40718\ [0.9114]$

N: $\chi^2(4) = 6.0521\ [0.1953]$

J: $[0.05]^*$

Japan 1950-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.01} \\ 0.01\end{bmatrix} [\{y + 1.88ot + 0.04t\}_{t-1}] + \cdots$$

AR: $F(8,92) = 0.37129\ [0.9332]$

N: $\chi^2(4) = 10.026\ [0.0400]^*$

J: $[0.77]$

Japan 1973-2008

$$\begin{bmatrix}\Delta y_t \\ \Delta ot_t\end{bmatrix} = \begin{bmatrix}\mathbf{-0.07} \\ 0.08\end{bmatrix} [\{y + 0.43ot - \mathbf{0.01}t\}_{t-1}] + \cdots$$

AR: $F(8,46) = 0.61233\ [0.7628]$

N: $\chi^2(4) = 1.2118\ [0.8761]$

J: $[0.17]$

European Historical Economics Society

EHES Working Paper Series

Recent EHES Working Papers

2017

EHES 117 The Bank of England as Lender of Last Resort: New historical evidence from daily transactional data
Mike Anson, David Bholat, Miao Kang, Ryland Thomas

EHES 116 Harbingers of Modernity: Monetary Injections and European Economic Growth, 1492-1790
Nuno Palma

EHES 115 'Rational' Farmers and the Emergence of Modern Accounting in Danish Dairying
Markus Lampe, Paul Sharp

EHES 114 Missed opportunities? The development of human welfare in Western Europe, 1913-1950
Daniel Gallardo Albarrán

EHES.113 Portugal's wine globalization waves, 1750-2015
Pedro Lains

EHES.112 Effects of reforms and supervisory organizations: Evidence from the Ottoman Empire and the İstanbul bourse
Elmas Yaldız Hanedar, Avni Önder Hanedar and Ferdi Çelikay

EHES.111 Resource endowments and agricultural commercialization in colonial Africa: Did labour seasonality and food security drive Uganda's cotton revolution?
Michiel de Haas and Kostadis J. Papaioannou

EHES.110 Currency Valuations, Retaliation and Trade Conflicts: Evidence from Interwar France
Thilo Albers

All papers may be downloaded free of charge from: www.ehes.org
The European Historical Economics Society is concerned with advancing education in European economic history through study of European economies and economic history. The society is registered with the Charity Commissioners of England and Wales number: 1052680