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# American Growth and Napoleonic Wars

**Summary:** Four years after the French Revolution, in 1793 a series of wars among France and other major powers of Europe began and they lasted until 1815. There is disagreement among economic historians about the effects of these wars on the trend of US economic growth. This paper aims to answer the following question. Did America as a neutral nation take advantage of economic possibilities caused by Europe at war through trade? To put it differently, this paper questions whether there was an export-led growth due to the war. To answer this question, we re-examined the export-led growth hypothesis for the period 1790-1860 using the ARDL methodology. Based on this methodology, a cointegrated relationship is found among the variables of real GDP, labor, exports and exchange rates. The results suggest that the economic growth of the US was not export-driven. In addition, parallel to the results of unit root tests with structural breaks, the coefficient of the dummy variable was statistically significant in the long run, implying that the war did have a significant effect on the economic growth trend of the US.

**Key words:** Napoleonic wars, United States trade growth, ARDL methodology.

**JEL:** N11, N41, N71.

Four years after the French Revolution, in 1793 a wave of wars which included major European countries and their colonies broke out. The warfare ended in 1815 with the final defeat of Napoleon Bonaparte. The first part of this period of consecutive wars, i.e. the period between 1793 and 1799 is called the French Revolutionary Wars and the period between 1799, which started with Napoleon's seizure of power in France, and 1815 is called the Napoleonic Wars. This long period of warfare deeply influenced political and economic life in Europe and it left permanent marks on world history. This study questions the effects of the Napoleonic Wars on the growth of the United States economy. To be more precise, we aim to find answers to the following two questions. First, did the US economy enjoy an impressive growth rate during the Napoleonic Wars thanks to increasing exports? Second, did the US economy enjoy a high growth rate during the Napoleonic Wars at all? Before answering these two questions, we will briefly present viewpoints for and against the argument of export-led growth of the US during the Napoleonic Wars.

## 1. Arguments For and Against the Export-Led Growth Hypothesis in a Nutshell

Most American economic history books and a great deal of articles published on this issue depict the Napoleonic War era as a period of prosperity and growth for the

American economy. They emphasize the growing ocean trade of the US with Europe and its colonies as a result of American neutrality and British and French drafts of their cargo ships for military purposes. According to Charles A. Keene (1978) after the start of the Anglo-French wars in 1793, the Americans reaped the benefits of neutrality and quickly extended their involvement in trans-Atlantic trade. For Robert E. Gallman (2000) the years of hostilities between France and England (1793-1807) were the years of prosperity for American merchants, shippers and shipbuilders, and therefore correspond to a high growth rate period for the American economy. According to Gilbert C. Fite and Jim E. Reese (1973) the European wars created an overall betterment of American business and industry over the 25 years concluding in 1815, resulting in a high demand for American surplus. On the whole, they state, "the Napoleonic Wars were a stimulus rather than a deterrent to American economic growth". Similarly, Gary M. Walton and Hugh Rockoff (1990) state those were "extraordinary years", a period of unique prosperity and heightened economic activity, most especially in the eastern port cities of America, a time characterized by full employment and markedly rising urbanization. However, Walton and Rockoff (1990) add that the economic upsurge of the period from 1793 to 1807 is less exceptional in comparison with the subsequent decades of the 19th century than it is unique in its marked economic reversal and advancement when compared to the two decades following 1772. Stanley L. Engerman and Kenneth L. Sokoloff (2000) state that, coinciding with independence, the government of the United States employed various British economic policies and introduced mercantilistic provisions intended to encourage the expansion of manufacturing and general economic growth. Alexander Hamilton, the Secretary of the Treasury, issued a formal Report on Manufactures in 1791, and in it he outlined the great benefits to be gained from growth and development. He proposed policies such as tariffs on specific imports in order to raise their relative prices in favor of domestic producers. According to Matthew H. Wahlert (2011), the Napoleonic Wars fostered protectionism in America. Hamilton also proposed open immigration to enable an increase in the labor force; a greater utilization of women and children, whom had been previously underemployed, in the labor force; and he proposed the introduction of a patent system to stimulate innovation and invention. The aforementioned suggestions were in direct encouragement of industry, yet the concerns of manufacturers were also taken into consideration in relation to other government policies, such as those policies affecting human capital (such as education and immigration), land policies, money and banking controls, laws regulating property rights, and direct governmental support of technological development and innovation. Policies such as these, Engerman and Sokoloff (2000) summarize, influenced general economic growth, and had substantial impacts on the relative development of the manufacturing sector.

Dwight W. Morrow (1954) asserts that the years from 1792 to 1807 were extraordinarily prosperous not solely for the merchant marine, but for America as a whole, regardless of the intermittent problems caused by British warships, pirates from Tripoli, or French privateers men. He explains that the rapid increase in exports was comprised mainly of provisions, for which the war had created a market. Europeans at the time were preoccupied with fighting and could not provide sufficient

foodstuff for themselves, and relied increasingly on America for supplies of grain, meat, and raw materials such as cotton, leather, and wool.

Certainly Douglass North is the most prominent scholar who defends the view that “between 1793 and 1807 the United States prospered mightily as a neutral trader and carrier” (Douglass C. North and Robert P. Thomas 1968). For North (1966) “the years 1793-1808 were years of unparalleled prosperity”. North (1958) asserts that during the French and Napoleonic Wars, the English fleet reduced the availability of world shipping so extensively that the American merchant marine was almost the sole source of supply, and that as a result, freight rates more than doubled, with the exception of a brief interval during the Peace of Amiens. North adds that the earnings of American shipping played a strategic part in the development of the American economy during those years of warfare in Europe.

Along the same line with North, George R. Taylor (1964) also argued that “for more than a decade, the Napoleonic Wars greatly stimulated the American economy”. Taylor (1964) estimates that the average standard of living in America during the eight years from 1799 to 1806 could not be matched again until the early 1830’s, and though there was some improvement during that decade, the average standard of living for 1836-1840 was at best only slightly better than it was during those prosperous years at the beginning of the century. North (1966) ascribes the prosperity of the 1793-1808 period to: “1) the importance of the export sector in the total economy; 2) the five-fold (or more) expansion of this sector during the period; 3) the equally large increase in imports for consumption at favorable import prices; 4) the expansion in the domestic economy induced by the increase in income from the export sector”.

There is no doubt that during this period foreign trade was an important sector in the US economy. Robert E. Lipsey (2000) informs us that at the beginning of the 19th century, the United States was twice as trade-oriented as Europe, and greater than five times as export-oriented as the world overall, in terms of its own products per capita, exclusively re-exports of products made by others. When we add re-exports, the volume of the US foreign trade increases substantially, for, as Lipsey (2000) notes further, the fact that re-exports made up an exceptionally large portion of the total exports of the United States was one of the distinctive features of US trade during the turn of the century. Lipsey further elaborates that during almost every year from 1796-1808, over half of the total exports consisted of re-exports, rather than exports of US domestic merchandise, up until the time of the Embargo.

Trade revenue dropped significantly with America’s enactment of the Embargo Act. Kevin H. O’Rourke (2005) explains that the young US government, in December of 1807, closed its ports to “belligerent shipping” and also forbade American ships to leave the ports. O’Rourke describes the events leading up to the Embargo, such that in November 1807 the British declared that neutral ships could be seized if they were discovered to be carrying goods from enemy colonies to their mother countries, even if they first passed through neutral ports. At the same time, England declared that neutral ships could still transport goods from enemy colonies to their own home ports or to British ports, or, finally, from British ports to enemy ports. The overall effect of these declarations was that neutral ships would have to first dock in

British ports if they, for example, wanted to transport goods to France, from either the French colonies or their own country. Napoleon declared, in retaliation, that any neutral ship putting into a British port was fair game and could be seized. Thus, the United States was faced with circumstances in which neutral ships carrying goods to the Continent could be seized from either side, and therefore the government closed its ports that December and prohibited its own ships from leaving.

Although the shipping earnings of the US declined sharply with the Embargo, the cutting off of relations with Europe promoted manufacturing within the country (Douglas A. Irwin 2004). Before the Embargo it was difficult for American manufacturers to compete with British goods, however the interruption of trade as a result of the Embargo improved American manufacturing. O'Rourke (2005) states that the take-off of the American cotton textiles industry went along with the elimination of British imports. In 1790 the United States and Britain had 2.000 and more than 2 million cotton spindles, respectively. This number reached 8000 in the US in 1809 and 93.000 in 1812. As a matter of fact, the importance given to the manufacturing industry can be seen a lot earlier, in the Report on Manufactures presented to Congress on December 5, 1791, which was discussed earlier.

Some researchers present counter arguments to these views of the unusually prosperous times. Donald R. Adams (1980) argues that some scholars have overstated the benefits of American neutrality and neglected some of the costs, that they have examined the ensuing prosperity without a complete reckoning of the distribution of benefits, and that they "have failed to differentiate carefully between changes that occurred because of neutrality and those that most likely would have occurred in the absence of the Continental Wars". Claudia D. Goldin and Frank D. Lewis (1980) also maintain that the rise in the volume of trade between 1793 and 1807 had a modest effect on the rate of economic growth in the US. Meanwhile, they underscore the growth of port cities, the rise in shipping tonnage, and the spread of commercialization and banking services. Adams (1980) asserts that the ship owners whose quasi-rents increased substantially, and shipbuilders, whose profits increased as prices rose faster than wages, were the chief beneficiaries of the increased demand for American ships. Therefore, gains collected by the American shipping sector were highly concentrated among a small number of individuals. According to Adams (1980) it is not accurate to argue that America's status as a neutral trader between 1793 and 1807 was unremunerative. On the contrary, since the British and French merchant marines were occupied in the war effort and/or were in constant threat of search and seizure, US ships and ship owners served a valuable and gainful function in the Atlantic trade network. Yet, Adams (1980) suggests that the economic changes presented as evidence of prosperity during the wars had their roots in the pre-war period; that the benefits from neutrality were concentrated in the northeastern seaports; that the Continental Wars were burdensome not only to the belligerents, but also to those who expected gains from this conflict; and that "the term unparalleled prosperity to describe the years from 1793 to 1807 is perhaps too strong a statement if applied to the United States as a whole".

As outlined above, the literature does not have a strong agreement regarding the effects of the Napoleonic Wars on the US economy. The next section will empir-

ically investigate the topic of whether the US economy was positively or negatively affected by the Napoleonic Wars.

## 2. The Model

Since a strong correlation exists between exports and the real GDP, a great number of studies have concentrated on the relationship between exports and economic growth with an emphasis on specific (developing and industrialized) countries, using different econometric methods. If there was an export-driven growth during the Napoleonic Wars, it should have brought about a significant economic performance in the US economy during the times of the Napoleonic Wars. We believe that this paper contributes to the literature regarding the Napoleonic Wars and American growth since, to the best of our knowledge, this paper is the first one which uses econometric methods to investigate the relationship between the Napoleonic Wars and American growth at the beginning of the 19<sup>th</sup> century, with the aim of testing the export-led economic growth hypothesis. Both historical US data and recent time series econometric techniques are utilized in this paper.

The estimation method is the autoregressive distributed lag (ARDL) model proposed by M. Hashem Pesaran, Yongcheol Shin, and Richard J. Smith (2001). This model has some advantages over other methods in analyzing long-run relationships. First, the application of the model is simple. Once the order of the ARDL model is identified, the cointegration relationship can be estimated by ordinary least squares (OLS). Second, it allows a mixture of I(0) or I(1) variables. Thus, variables do not need to be of the same order of integration. Third, the procedure is efficient with small and finite sample data.

In export-driven growth models, the real export variable is used as one of the determinants of real output growth, and a significantly positive coefficient of the real export variable characterizes the fact that export promotion induces economic growth (Bela Balassa 1978; Augustin K. Fosu 1990; Antoine Brunet 2009).

Following Dierk Herzer, Felicitas Nowak-Lehmann, and Boriss Silverstovs (2006), and Marta C. N. Simoes (2011) we start with a simple neoclassical production function in the Cobb-Douglas form:

$$Y_t = A_t K_t^\alpha L_t^\beta, \quad (1)$$

where  $Y_t$  represents real aggregate output at time  $t$ ,  $K$  and  $L$  are capital and labor inputs and  $A$  is the level of total factor productivity.

The export-led growth hypothesis postulates that export expansion can play a significant role in enhancing output growth directly as a component of aggregate output. As export demand increases, income and employment increase in the exportable sectors and resources in an economy are used in the most efficient sectors. In addition, export promotion leads to greater capacity utilization, and exploitation of economies of scale. Foreign competition forces firms to work with a lower capital-output ratio and use better technology. Thus, labor productivity also increases. The export-led growth hypothesis implies that an expansion in exports can cause an increase in economy-wide efficiency and growth in productivity. These arguments are

discussed and tested in the literature (for example, among others, Balassa 1978; Dalia Marin 1992; Jang C. Jin 2002; and Titus O. Awokouse 2006).

In addition to exports, this paper includes the exchange rate variable in affecting total factor productivity following the arguments by Darryl McLeod and Elitza Mileva (2011), who found in their simulations that weaker real exchange rates with a combination of “learning by doing” lead to workers moving into traded goods production sectors, which in turn leads to a surge in total factor productivity. Therefore, we assume that total factor productivity can be rewritten as a function of exports ( $X_t$ ), exchange rates ( $ER_t$ ) and other exogenous factors ( $C_t$ ):

$$A_t = f(X_t, ER_t, C_t) = X_t^\delta ER_t^\lambda C_t. \quad (2)$$

Combining (1) and (2) and taking the natural logarithms of both sides:

$$\ln Y_t = c + \alpha \ln K_t + \beta \ln L_t + \delta \ln X_t + \lambda ER_t + u_t, \quad (3)$$

where  $c$  is a constant parameter and  $u_t$  is a white noise error term. To this equation, we add a dummy variable  $D$  representing the Napoleonic Wars ( $D = 1$  for the war period, 1799-1815, and  $D = 0$  for the rest of the period). Then, the equation becomes:

$$\ln Y_t = c + \alpha \ln K_t + \beta \ln L_t + \delta \ln X_t + \lambda ER_t + \rho D + u_t, \quad (4)$$

where  $\alpha$ ,  $\beta$ ,  $\delta$  and  $\lambda$  are constant elasticity coefficients of output with respect to capital, labor, export and exchange rate and  $\rho$  is the coefficient of the dummy variable,  $D$ .

### 3. Data Analysis

All data are annual and were obtained from the website of Historical Statistics of the United States.<sup>1</sup> Even though the period could be extended to the later periods, the period 1794-1860 was chosen to focus on the effects of the Napoleonic War era with a reasonable data period before and after the Napoleonic Wars, and in accordance with the availability of data. The real GDP variable, which is a proxy for aggregate output, is readily available on the website in 1996 million dollars. Until World War I, the dollar-sterling, meaning dollar-(British) pound, exchange rate was of overwhelming importance in the American foreign-exchange market. There were three main exchange-market instruments: (1) the sixty-day bill of exchange, (2) the sight (or demand) bill of exchange, and (3) the cable (or telegraphic) transfer. Among them, the sixty-day bill of exchange rates were used in the equations since this was the dominant exchange-market instrument until the Civil War. The David-Solar Based price deflator (1860=100), which was converted to the base of 1996=100, was used to deflate exports and exchange rates. The population of the US during the sample period was used as a proxy for labor input. Furthermore, all series were transformed into natural logarithm form.

<sup>1</sup> **Historical Statistics of the United States Millennial Edition Online.** 2012. <http://hsus.cambridge.org/HSUSWeb/toc/hsusHome.do> (accessed January 05, 2012).

The capital stock variable was eliminated from the model since US capital stock data and prospective proxy variables for capital stock, such as the investment to output ratio or cumulative gross investment, are not available for the period 1790-1860. Thus, the model we used is now:

$$\ln Y_t = c + \beta \ln L_t + \delta \ln X_t + \lambda ER_t + \rho D + u_t. \quad (5)$$

It is expected that the white noise error term captures the influence of capital stock and all other exogenous factors. The sign of the coefficients  $\beta$ ,  $\delta$  and  $\lambda$ , are expected to be positive, while the sign of  $\rho$  is uncertain and is the subject of the investigation.

#### 4. Unit Root Tests

Before testing the existence of the cointegration relationship, the integration orders of the variables should be determined. The augmented Dickey-Fuller Tests (ADF) (David A. Dickey and Wayne A. Fuller 1979), Dickey-Fuller Generalized Least Squares Test (DF-GLS) (Graham Elliott, Thomas J. Rothenberg, and James H. Stock 1996) and Zivot-Andrews Tests (Eric Zivot and Donald Andrews 1992) are employed to test for the existence of a unit root.

The unit root testing procedure in the ADF test starts with the most general model:

$$\Delta y_t = \beta_0 + \lambda t + \phi y_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + u_t \quad (6)$$

in which the extra lagged terms of the dependent variable eliminate autocorrelation in the error term. Since the actual data generating process is hardly known by a researcher, a test down procedure suggested by Juan Doldado, Tim Jenkinson, and Simon Sosvilla-Rivero (1990) is followed to determine deterministic regressors in Equation (5). Based on this methodology, the second column of Table 1 reports the results from the ADF tests in which the null hypothesis of  $\phi = 0$  cannot be rejected for the  $\ln Y$  and  $\ln ER$  series and rejected for  $\ln X$  and  $\ln L$  series in their levels. However, the null hypothesis of  $\phi = 0$  is rejected for all series in their first differences. Thus, the ADF tests conclude that while the  $\ln Y$  and  $\ln ER$  series are integrated of order 1, the  $\ln X$  and  $\ln L$  series are integrated of order zero.

**Table 1** Unit Root Tests

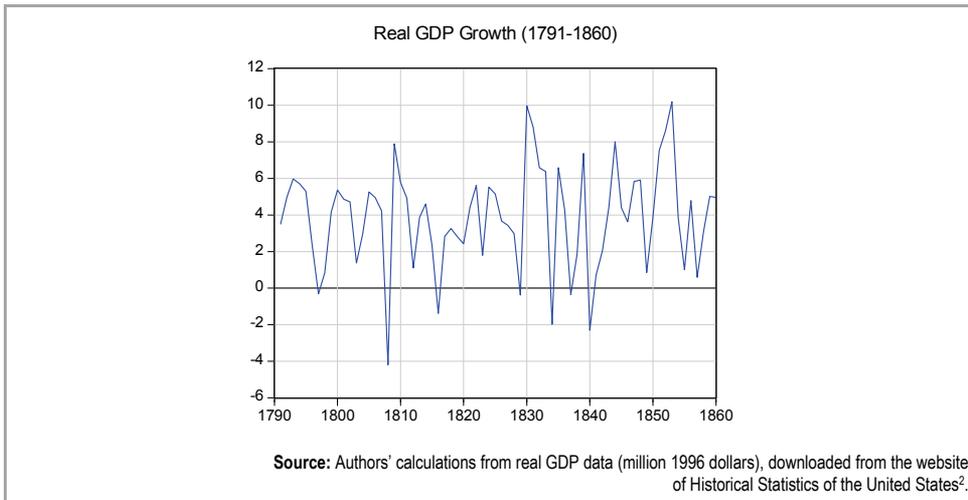
Variable	ADF	DF-GLS	Zivot-Andrews	Break year
$\ln Y$	-1.82	-1.91	-3.40	1816
$\ln X$	-4.12*	-4.16*	-6.71*	1808
$\ln L$	-6.13*	-5.73*	-6.68*	1820
$\ln ER$	-2.70	-1.69	-3.99	1820
$\Delta \ln Y$	-7.36*	-7.47*	-7.55*	1844
$\Delta \ln X$	-10.03*	-10.10*	-8.77*	1815
$\Delta \ln L$	-4.56*	-4.58*	-4.00	1847
$\Delta \ln ER$	-6.71*	-6.74*	-7.90*	1814

**Notes:** \* indicates that the null hypothesis is rejected at the 1% level. The choice of lags is based on the Schwarz Criterion.

**Source:** Authors' calculations.

Due to limitations in the size and power of the ADF test, a group of new tests have been proposed with higher power than the ADF test. One of these tests, the so-called DF-GLS test, was developed by Elliott, Rotherbeng, and Stock (1996). This test is computed in two steps. In the first step, the intercept and trend in the series are estimated by generalized least squares. In the second step, the Dickey-Fuller test is used to test for a unit autoregressive root in de-trended series. Studies show that the DF-GLS test, a textbook representation of which can be found in Stock and Mark W. Watson (2003), has better performance in terms of small-sample size and power, thus predominating the ordinary Dickey-Fuller Test. The third column of Table 1, which reports the DF-GLS test results, demonstrates the same results as in the ADF test. While the null hypothesis that series have a unit root cannot be rejected for the  $\ln Y$  and  $\ln ER$  series in their levels, it is rejected for its first differenced forms. However, the null hypothesis is rejected for the  $\ln X$  and  $\ln L$  series in their levels.

During the period under investigation, the US economy experienced several business cycles of varying durations. Figure 1 shows the real GDP growth of the US for the period 1791-1860. The number of business cycles is 14. Thus, the business cycles in this period averaged about five years, whether measured from trough to trough or peak to peak. However, the durations of business cycles are different from one another, which may reflect structural changes in the economy.



**Figure 1** US GDP Growth (1791-1860)

Pierre Perron (1989) asserted that the standard unit root tests, such as the ADF and DF-GLS tests, may not be reliable in the presence of structural breaks, since they do not account for the possibility of a structural break. The tests without a structural break are biased toward finding a unit root. Thus, a unit root catching the structural breaks in a time series should be conducted to confirm the results of the previous

<sup>2</sup> **Historical Statistics of the United States Millennial Edition Online.** 2012. <https://hsus.cambridge.org/HSUSWeb/index.do> (accessed January 05, 2012).

tests. One of the commonly applied structural break unit root tests was developed by Zivot and Andrews (1992). This test allows for an endogenous determination of the date of the structural break. The break can be in the level of the series (Model A), in the slope of the trend function (Model B), or both (Model C).

Zivot and Andrews propose the following three models to test for unit root:

$$\begin{aligned} \Delta y_t &= c + \alpha y_{t-1} + \beta t + \gamma DU_t + \sum_{j=1}^k d_j \Delta y_{t-j} + \varepsilon_t && \text{Model A} \\ \Delta y_t &= c + \alpha y_{t-1} + \beta t + \theta DT_t + \sum_{j=1}^k d_j \Delta y_{t-j} + \varepsilon_t && \text{Model B} \\ \Delta y_t &= c + \alpha y_{t-1} + \beta t + \gamma DU_t + \theta DT_t + \sum_{j=1}^k d_j \Delta y_{t-j} + \varepsilon_t && \text{Model C} \end{aligned} \quad (7)$$

where  $DU_t$  and  $DT_t$  are two differently unknown-date break dummies;  $DU_t = 1$  if  $t > TB$ , and 0 otherwise,  $DT_t = t - TB$  if  $t > TB$ , and 0 otherwise, in both of these  $TB$  is a possible break date. Here the null hypothesis is that the series  $y_t$  is integrated of order one without an exogenous structural break against the alternative that the series  $y_t$  is a trend-stationary  $I(0)$  process with a breakpoint occurring at some unknown time. The possible breakpoints are selected as the date which minimizes the one-sided  $t$  statistic. In addition, the end points of the sample are trimmed as  $(0.15T, 0.85T)$  to avoid asymptotic distribution of the statistic diverging towards infinity. Model C is estimated with two differently unknown break dates.

The results for the Zivot-Andrews test are presented in the fourth and fifth columns of Table 1. These results suggest that while we can reject the null of the unit root for the  $\ln X$ ,  $\ln L$  series at a 1% significance level at their levels, we fail to reject the unit root hypothesis for the level of the  $\ln Y$  and  $\ln ER$  series. We can reject the null of the unit root at a 1% significance level for all of the series in their first differences except the first differenced form of  $\ln L$ , which is stationary at its level. These results confirm the results obtained from the ADF and DF-GLS tests. While  $\ln X$  and  $\ln L$  are  $I(0)$ ,  $\ln Y$  and  $\ln ER$  are  $I(1)$ . In addition, the Zivot-Andrews test results show that a structural break occurs for the series of real exports during the Napoleonic War period, in 1808, reflecting the effects of the Embargo. However, the break point in the real GDP series is detected just after the war, in 1816. These preliminary results suggest that although the war affected the volume of foreign trade, it did not affect the economic growth progress of the US.

## 5. ARDL Modeling and Testing Procedure

Having determined the order of the variables, we can test for cointegration. Econometric theory states that a set of variables are cointegrated if the linear combination of the series cancels out the stochastic trends in the series. Using the cointegration relationship among the series in the system requires that all variables in the cointegration regression should have the same order of integration. However, the unit root tests above indicate that the series are not in the same order of integration. Thus,

standard approaches, such as the Engle-Granger and Johansen approaches, cannot be used to detect a cointegration relationship. The ARDL modeling approach developed by Pesaran, Shin, and Smith (2001) does not have this defect and can be applied irrespective of whether the variables are  $I(0)$  or  $I(1)$ . In addition to this main advantage, the ARDL approach also has other advantages such as being more efficient with small or finite data sizes and allowing estimation by OLS once the sufficient numbers of lags are determined.

The ARDL framework for Equation (5) is as follows:

$$\Delta \ln Y_t = \beta_0 + \beta_1 \ln Y_{t-1} + \beta_2 \ln L_{t-1} + \beta_3 \ln X_{t-1} + \beta_4 \ln ER_{t-1} + \rho D_t + \sum_{i=1}^p \delta_i \Delta \ln Y_{t-i} + \sum_{i=0}^q \lambda_i \Delta \ln L_{t-i} + \sum_{i=0}^r \phi_i \Delta \ln X_{t-i} + \sum_{i=0}^s \eta_i \Delta \ln ER_{t-i} + u_t \quad (8)$$

where  $\beta_0$  is the drift,  $\beta_1$ ,  $\beta_2$ ,  $\beta_3$  and  $\beta_4$  are long-run multipliers, a dummy variable  $D$  represents the Napoleonic War, and  $u_t$  is a white noise error term. The short-run effects are captured by coefficients of the first differenced variables.

As a first step, in order to test for the existence of a cointegration relationship, Equation (8) is estimated by OLS and the  $F$ -test is conducted for the joint significance of the long-run multipliers:  $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$  against the alternative  $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ .

The distribution of the  $F$ -statistic is not standard and depends on the number of variables in the model, the order of integration of the variables, and whether the model contains an intercept and/or a trend. The critical values are tabulated in Pesaran, Shin, and Smith (2001). If the statistic is greater than the upper critical value, then the null hypothesis of no cointegration among the variables is rejected. Conversely, if the statistic falls below the lower critical value, the null hypothesis cannot be rejected. On the other hand, if the statistic falls between these upper and lower bound values, the result is inconclusive.

In the second step, if cointegration is found among the variables, the conditional ARDL( $p, q, r, s$ ) long-run model for  $\ln Y_t$  can be estimated:

$$\ln Y_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \ln Y_{t-i} + \sum_{i=0}^q \beta_{2i} \ln L_{t-i} + \sum_{i=0}^r \beta_{3i} \ln X_{t-i} + \sum_{i=0}^s \beta_{4i} \ln ER_{t-i} + \delta D_t + u_t \quad (9)$$

where all of the variables have been previously defined. The orders of the ARDL( $p, q, r, s$ ) model are selected using the Akaike information criterion (AIC).

In the final step, the short-run dynamic parameters can be obtained by estimating an error correction model of the associated model:

$$\Delta \ln Y_t = \beta_0 + \sum_{i=1}^p \delta_i \Delta \ln Y_{t-i} + \sum_{i=0}^q \lambda_i \Delta \ln L_{t-i} + \sum_{i=0}^r \phi_i \Delta \ln X_{t-i} + \sum_{i=0}^s \eta_i \Delta \ln ER_{t-i} + \alpha \text{ecm}_{t-1} + u_t \quad (10)$$

where  $\delta$ ,  $\lambda$ ,  $\phi$  and  $\eta$  are short-run parameters and  $\alpha$  is an error correction coefficient showing how quickly the equilibrium is restored in each period.

## 6. Cointegration Test Results

Equation (8) is estimated to see whether there is a long-run relationship. Since the first difference regression is of no direct interest to the bounds cointegration test, Table 2 shows only the *F-statistics* and other diagnostic statistics of this estimation. The calculated *F-statistics* is higher than the upper bound critical value at the 1% level. Thus, the null hypothesis of no cointegration is rejected at the 1% level, implying along-run cointegration relationship among the variables.

**Table 2** Statistical Values for the Bounds Test

k	F-statistics	Critical values		
		Significance level	Lower bound	Upper bound
3	5.91	1%	4.29	5.61
		5%	3.23	4.35
		10%	2.72	3.77

**Diagnostic Statistics:**  $R^2=0.39$   $Adj.R^2=0.25$   
 $JB=0.43$  (0.80)  $LM(1)=0.00$  (0.95)  
 $LM(2)=0.65$  (0.52)  $White=1.50$  (0.15)

**Notes:** Critical values are from Pesaran, Shin, and Smith (2001), Table CI(iii) Case III: unrestricted intercept and no trend. *JB*, *LM* and *White* denote statistics of Jarque-Bera normality, serial correlation and White heteroscedasticity tests, respectively. The numbers in parentheses behind the values of the diagnostic test statistics are the corresponding *p*-values. *k* is the number of independent variables in Equation (8). ARDL(1, 0, 1, 2, 0) is selected based on AIC.

**Source:** Authors' calculations.

Once we established that a long-run cointegration relationship existed, Equation (9) is estimated using the ARDL(2, 0, 1, 2) specification based on AIC. The results are obtained by normalizing on real GDP assuming that there are no dynamics in the long run. The estimated coefficients of the long-run relationship between economic growth, labor, exports and exchange rates are shown in Table 3.

**Table 3** Results for the Long-Run Model

Equation (8): ARDL(1, 0, 1, 2, 0) selected based on AIC. Dependent variable: $\ln Y_t$			
Variable	Coefficient	t-statistic	Probability
$\beta_0$	-2.752	-8.44	0.00*
$\ln L_t$	1.282	34.06	0.00*
$\ln X_t$	0.028	0.94	0.34
$\ln ER_t$	0.090	0.87	0.38
$D_t$	0.076	2.12	0.03**

**Note:** \*(\*\*) indicate that a coefficient is significant at the 1% (5%) level, respectively.

**Source:** Authors' calculations.

The results indicate that all variables have correct signs, both the real exports and exchange rate variables are not statistically significant, suggesting that the export-led growth hypothesis is not supported for the US economy for the period 1796-1860. The labor variable proxied by the population of the US has a very high significant effect on real GDP. A 1% increase in labor leads to a 1.27% increase in the real GDP, all things being equal. The dummy variable for the Napoleonic Wars (*D*) is positive and significant at the 3% level. From this evidence we can infer that the economic growth of the US was positively affected by the Napoleonic Wars.

In order to get short-run dynamic coefficients, Equation (10) is estimated with the dummy variable, as presented in Table 4. Diagnostic statistics indicate that the overall goodness of fits of the estimated equations is low, with the result of an adjusted  $R^2$  of 0.25. However, we can see that the model passes three tests: the Jarque-Bera (JB) normality test, suggesting that the errors are normally distributed; the Breusch-Godfrey tests ( $LM(1)$  and  $LM(2)$ ), showing that there is no evidence of autocorrelation in the disturbance of the error term; and the White tests for heteroscedasticity (*White*) showing that the error terms are homoscedastic.

**Table 4** Error Correction Representation for the Selected ARDL Model

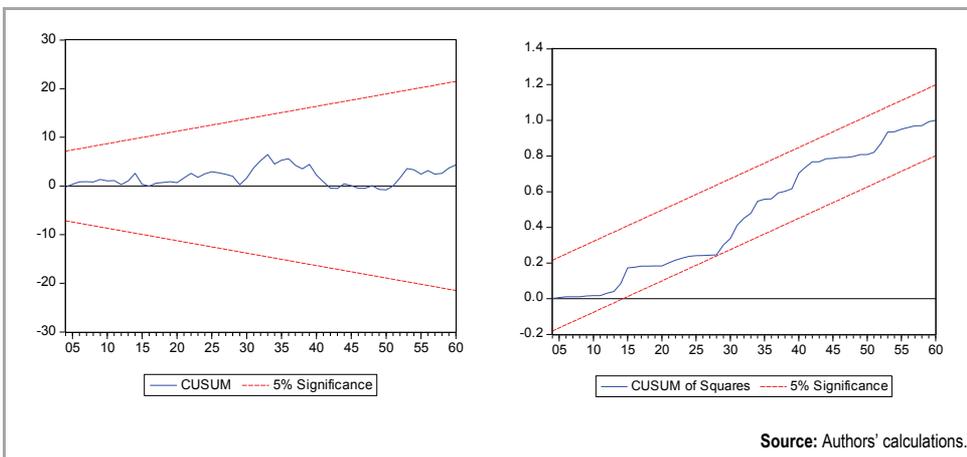
ARDL(1, 0, 1, 2, 0) selected based on AIC. Dependent variable is $\Delta \ln Y_t$ .			
Variable	Coefficient	t-statistic	Probability
$\beta_0$	-1.329	-4.54	0.00*
$\Delta \ln Y_{t-1}$	0.114	1.00	0.31
$\Delta \ln L_{t-1}$	0.743	0.57	0.56
$\Delta \ln X_t$	0.023	3.06	0.00*
$\Delta \ln ER_t$	-0.058	-1.16	0.24
$\Delta \ln ER_{t-1}$	-0.119	-2.42	0.01*
$D$	0.001	0.19	0.84
$ecm_{t-1}$	-0.312	-4.53	0.00*

**Diagnostic Statistics**  
 $ecm = \ln Y_t + 2.752 * \beta_0 - 1.282 * \ln L_t - 0.028 * \ln X_t - 0.09 * \ln ER_t - 0.076 * D_t$   
 $R^2 = 0.33$  Adj  $R^2 = 0.25$  JB = 0.71 (0.69) White = 1.24(0.27) LM(1) = 0.70 (0.40) LM(2) = 1.12 (0.33)

**Notes:** \* indicates that the variable is significant at the 1% level. The numbers in parentheses behind the values of the diagnostic test statistics are the corresponding  $p$ -values.

Source: Authors' calculations.

In addition, to confirm the stability of the estimated model, the tests of CUSUM and CUSUMSQ are employed. Figure 2 provides the graphs of the CUSUM and CUSUM of Squares tests, both of which indicate that the estimated model is stable.



**Figure 2** Stability Tests (1799-1815 Period)

In Table 4, it is clear that the error correction term ( $ECM_{t-1}$ ) has the right sign (negative) and is statistically significant at the 1% level. This result provides evidence of cointegration among the variables in the model. Specifically, the estimated value of  $ecm_{t-1}$  is  $-0.31$  which implies that 31% of the disequilibrium, caused by previous period shocks, converges back to the long-run equilibrium. The sign of the real exports is positive, as in the long-run model. However, now the coefficient of the real export variable is statistically significant, suggesting that a 1% increase in real exports leads to a 0.02% increase in economic growth in the short run. The coefficient of the dummy variable is now insignificant, implying that the Napoleonic Wars did not affect the path of the economic growth of the US in the short run.

## 7. 1799-1807 Period

In the previous analyses, acknowledging that the Napoleonic Wars occurred during the period 1799-1815, the period 1790-1860 was chosen as a sample period to focus on the effects of the war, with a reasonable period of time for data before and after the Napoleonic Wars. Since the Embargo Act of 1807 is an important date for the period under investigation, we study the period 1799-1807 using the same model, and the same tools and approaches to further examine the topic. As a first step, in order to test for the existence of a cointegration relationship, Equation (8) is estimated by OLS and an F-test is conducted for the joint significance of the long-run multipliers.

The test statistics, shown in Table 5, suggest that the model is not well specified, that is, R-squared and the adjusted R-squared are low. However, the assumption of normally distributed residuals cannot be rejected ( $JB$ ), and the Lagrange multiplier ( $LM$ ) tests for autocorrelation based on 1 and 2 lags do not indicate any problems concerning auto-correlated residuals. Furthermore, the null hypothesis of there is no heteroscedasticity cannot be rejected with the *White* heteroscedasticity test. Therefore, the results are serially uncorrelated, homoscedastic and normally distributed, and thus give overall support for a reliable interpretation.

**Table 5** Statistical Values for the Bounds Test

k	F-statistics	Critical values		
		Significance level	Lower bound	Upper bound
3	6.85	1%	4.29	5.61
		5%	3.23	4.35
		10%	2.72	3.77

**Diagnostic statistics:**  $R^2 = 0.41$   $Adj.R^2 = 0.29$   
 $JB = 0.70$  (0.70)  $LM(1) = 0.03$  (0.84)  
 $LM(2) = 0.74$  (0.48)  $White = 1.27$  (0.26)

**Notes:** Critical values are from Pesaran, Shin, and Smith (2001), Table CI(iii) Case III: unrestricted intercept and no trend.  $JB$ ,  $LM$  and *White* denote statistics of Jarque-Bera normality, serial correlation and White heteroscedasticity tests, respectively. The numbers in parentheses behind the values of the diagnostic test statistics are the corresponding  $p$ -values.  $k$  is the number of independent variables in Equation (7). The ARDL(1, 1, 0, 1, 0) model is selected based on AIC.

**Source:** Authors' calculations.

Table 5 shows the results of the bounds cointegration test with the null hypothesis that  $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$  against the alternative  $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ . The

calculated F-statistic 6.85 is higher than the upper bound value at the 1% level, implying that the null hypothesis of no cointegration among the variables can be rejected.

Once we established that a long-run cointegration relationship existed, Equation (9) was estimated using the ARDL(2, 2, 1, 2, 0) specification based on AIC. The results were obtained by normalizing on real GDP assuming that there were no dynamics in the long run. The estimated coefficients of the long-run relationship between the variables in the model are shown in Table 6.

**Table 6** Results for the Long-Run Model

Equation (8): ARDL(2, 2, 1, 2, 0) selected based on AIC. Dependent variable: $\ln Y_t$			
Variable	Coefficient	t-statistic	Probability
$\beta_0$	-2.716	-8.60	0.00*
$\ln L_t$	1.322	29.63	0.00*
$\ln X_t$	-0.006	-0.20	0.84
$\ln ER_t$	0.028	0.34	0.72
$D_t$	0.087	2.12	0.03**

Note: \* indicates that a coefficient is significant at the 1% level.

Source: Authors' calculations.

The results indicate that the labor variable has the biggest effect on economic growth, the coefficient of the real exports variable (exchange rate) has a negative (positive) sign but is statistically insignificant, suggesting that the export-led growth hypothesis is not supported for the US economy for the period 1790-1860. However the dummy variable for the Napoleonic Wars ( $D$ ) is positive and statistically significant. From this evidence we can infer that the economic growth of the US was affected by the Napoleonic Wars.

In order to get short-run dynamic coefficients and to confirm the cointegration relationship, Equation (10) was estimated and is shown in Table 7.

**Table 7** Error Correction Representation for the Selected ARDL Model

ARDL(2, 2, 1, 2, 0) selected based on AIC. Dependent variable is $\Delta \ln Y_t$			
Variable	Coefficient	t-statistic	Probability
$\beta_0$	-1.356	-4.70	0.00*
$\Delta \ln Y_{t-1}$	0.110	1.00	0.31
$\Delta \ln L_{t-1}$	1.361	1.03	0.30
$\Delta \ln X_t$	0.023	3.06	0.00*
$\Delta \ln ER_t$	-0.056	-1.15	0.25
$\Delta \ln ER_{t-1}$	-0.117	-2.43	0.01*
$D$	0.006	0.70	0.48
$ecm_{t-1}$	-0.313	-4.65	0.00*

**Diagnostic statistics**

$$ecm_t = \ln Y_t + 2.716 * \beta_0 - 1.322 * \ln L_t + 0.006 * \ln X_t - 0.028 * \ln ER_t - 0.087 * D_t$$

$$R^2=0.35 \quad Adj.R^2=0.27 \quad JB=0.68 (0.70) \quad White=1.01(0.48) \quad LM(1)=0.67 (0.41) \quad LM(2)=1.38 (0.25)$$

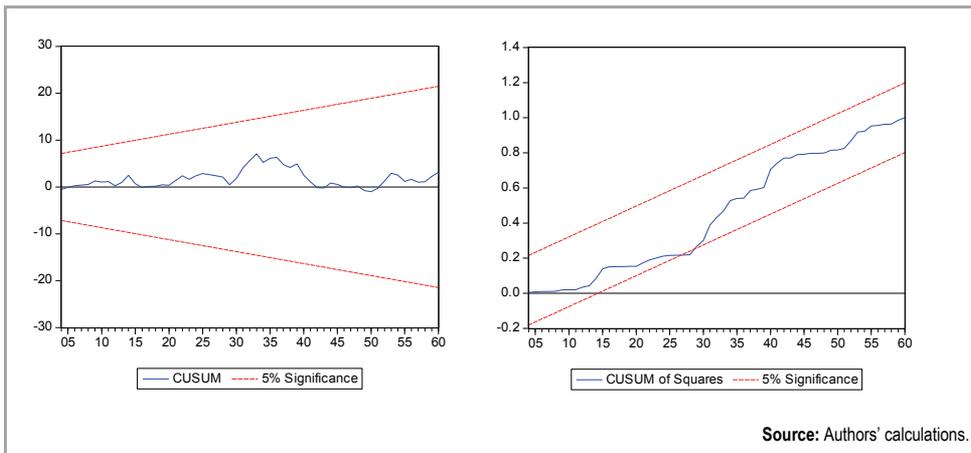
Notes: \* indicates that the variable is significant at the 1% level. The numbers in parentheses behind the values of the diagnostic test statistics are the corresponding p-values.

Source: Authors' calculations.

The diagnostic statistics and the results are almost the same as the previous estimation. The diagnostic statistics indicate that the overall goodness of fits of the es-

timated equations is too low, with the result of adjusted  $R^2$  equal to 0.27, the errors are normally distributed and there is no evidence of autocorrelation in the disturbance of the error terms ( $LM(1)$  and  $LM(2)$ ), and the error terms are homoscedastic (*White*).

Additionally, to confirm the stability of the estimated model, the tests of CUSUM and CUSUMSQ were employed. Figure 3 provides the graphs of the CUSUM and CUSUM of Squares tests. The plot of the CUSUM test is completely within criteria bands. While the CUSUM test deviates in some parts of the sample, the deviation seems to be transitory, as there is a sign that the plot of CUSUM is returning back towards the criteria bands. Therefore, both tests indicate that the coefficients of the model are stable over the sample period.



**Figure 3** Stability Tests (1799-1807 Period)

From Table 7, it is clear that the error correction term ( $ecm_{t-1}$ ) has the right sign (negative) and is statistically significant at the 1% level. This result provides evidence of cointegration among the variables in the model. The coefficient of the real exports variable is statistically significant at the 1% level, indicating that the export-led growth hypothesis is valid in the short run. As in the previous analysis, the coefficient of the dummy variable is insignificant, implying that the Napoleonic Wars did not affect the path of the economic growth of the US in the short run.

## 8. Conclusion

There is disagreement among economic historians about the effects of the Napoleonic Wars on the trend of US economic growth. On one side there is a group of economic historians claiming that there was an export-led growth during the war period thanks to the economic possibilities brought about by the increased ocean trade. On the other side there are historians arguing that the supporters of the export-led growth theory are overstating the benefits of American neutrality. The results reached through this analysis point out that although the US economy experienced a significantly high growth rate during the Napoleonic War era, it was not due to increased

exports, supporting the latter argument. To put it differently, the arguments against the American export-led growth hypothesis during the Napoleonic Wars are sustained. However, it is important to bear in mind that, due to the limitation of the availability of data, the results found in this paper should be considered as preliminary and should be interpreted with caution. More analysis could be conducted if more data were available. Nevertheless, we believe that this paper will shed some light on and provide an empirical basis for further study of this topic.

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