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Balance-of-payments constrained growth in the case of the Bulgarian economy: an empirical study

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# Abstract

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**Abstract:**

**Introduction:** Post-Keynesian economists state that there is a direct relationship between balance-of-payments and economic growth. Anthony Thirlwall, in particular, has formulated a model which defines the balance-of-payments equilibrium growth rate that would allow the economy to grow in the long-run sustainably without deteriorating their external balance or entering major debts.

**Problem:** The purpose of this study is to investigate to what extent Thirlwall's law applies to historical data from the Bulgarian economy.

**Method:** I will perform traditional OLS regression analysis on the variables involved in the theoretical model. Further tests like Johansen cointegration and Granger causality will verify for long-run relationship trends.

**Results:** The regression analysis does not give a significant evidence or measure of the relationship stated by Thirlwall's law. The cointegration method, however, shows that there is a certain long-run equilibrium relationship between the analysed variables, but of insignificant measure. The Granger test shows reverse unilateral causality, thus rejecting any evidence for balance-of-payments constraint and export-led growth.
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1. Statement of the problem

1.1 Introduction

Economists have long agreed on the issue of international trade and the role it plays in economic growth theory. The neoclassical theory postulates how consumer and producer surpluses can be utilized for mutually beneficial trade, and how specialisation and economies of scale boosts the global economy. However, the question that still remains is why some countries grow faster than others, when they all participate in international trade. Does the benefit of trade linearly relate to economic growth, or is there an optimal rate of growth that will maximize the benefits from trade?

This topic has been addressed by Keynesian and post-Keynesian economists, the most profound of which are Sir Roy Harrod(1933), Thirlwall(1979), Hussain & Thirlwall(1982). They have all taken the Keynesian approach to growth, with the basic idea that demand drives the economic system to equilibrium, while supply follows it. Along this line of thought comes the theory of export-led growth, which states that exports are the main determinant factor for economic growth. It not only maximises the efficiency of domestic labour and capital, but it also exposes the economy to the positive externalities of trading on world markets and builds-up foreign currency reserves.

Anthony Thirlwall has developed a model of balance-of-payments constraint on economic growth. It states that there is an optimum growth rate at which the economy can expand without entering ever-increasing debt. There has been a number of empirical studies of Thirlwall's law and its validity in developing economies like Mexico(Moreno-Bird, 2003), Brazil (Ferreira & Canuto, 2003), Bolivia (Vasquez & Charquero, 2007) and others.
1.2 Aim of the study

Based on the theoretical framework of Thirlwall's law (Thirlwall, 1979), I will test empirically to what extent the model is valid in the case of the Bulgarian economy for the period from 1995 to 2007, using quarterly data.

1.3 Method

The theoretical part of this study consists of Thirlwall's law and several other concepts that will help the reader understand the derivation of the model of balance-of-payments constrained growth. This includes a short version of the predecessor of Thirlwall's law – the Harrod trade multiplier, the model of balance-of-payments constrained growth and its application in the Bulgarian case. There is also a short history of the economic development in Bulgaria over the past 2 decades.

In the empirical part of this study I will perform statistical tests on historical data from the Bulgarian economy. Firstly I will use linear regression analysis with Ordinary Least-Square estimators to determine whether the datasets for Bulgaria fit the relationship stated by Thirlwall.

A test for co-integration will also be applied to investigate whether the datasets are suitable for that. The co-integration method has an advantage over regression analysis when it comes to detecting a long-term relationship between non-stationary variables from a data set of limited length. In order to test for co-integrating vector, we have to ensure that the time-series are non-stationary, by applying the Augmented Dickey-Fuller test for the presence of unit-root. At last the Granger Causality test will be used to determine the direction of causality, or in other words, whether exports cause GDP, or GDP causes exports.

A detailed description of the empirical methods and information about the data can be found in section 4.1

Finally a conclusion will be drawn about the validity of Thirlwall's law in the case of Bulgaria. It will be based on the results from the empirical tests.
1.4 Delimitation

The results from this study are only experimental and should not be used to make general conclusions about the validity of Thirlwall's law since there are many simplifications and assumptions. The assumption that the change in terms of trade is statistically close to zero has been made, despite the fact that this might not be always true in a fixed exchange rate regime. However, I assume that it is true in order to make empirical tests possible, and any deviation between actual data and predictions by the model will be attributed to the instability of terms of trade.

For the empirical tests I have used unadjusted numbers. That includes nominal GDP and exports and imports measured at current prices. The presence of inflation in these variables may lead to exhibiting a relationship with trend, which does not actually exist.

Due to the number of shocks on the economy during the investigated period the results may prove time specific or inconclusive. Since the number of observations is not large, I use quarterly observations. Usually quarterly statistics are preliminary and not as accurate as the annual statistics, and are often revised.
2. Theoretical framework

2.1 What drives economic growth

In neoclassical economic theory growth is treated mainly in the context of endogenous growth models like Solow (1956), Romer (1986), and others. They view economic growth as dependent on the growth of factors on the supply side of the economy (the supply of labour, capital and their overall productivity). This concept is very logical and generally holds in the scope of the national economy in the long-run. Technological progress has always been accompanied by an increase of output and therefore growth. However, it cannot be applied to compare economic growth across countries because neoclassical models do not explicitly point out the reason for growth on the supply side of the economy and do not justify why demand should follow and adjust to supply. In Keynesian theory, on the other hand, it is demand that drives the economic system and supply adjusts to it. The same critique applies to that theory because it does not justify that when demand exists the supply will always follow.

According to this approach, a country's growth rate is determined by the level of demand, and in open economies the balance of payments is the main constraint on demand. Thirlwall (1979) describes the mechanism of a balance-of-payments crisis. When an economy gets balance-of-payments deficit while expanding demand towards the short-term full-capacity growth rate, then demand has to be cut back. In this way supply peaks over demand which slows down technological progress and investments. The economy will have difficulties exporting its goods and this brings it into even deeper trade deficit. That is why it is important for developing economies to maintain a stable balance-of-payments close to the equilibrium rate from Thirlwall's law.

In this study we will look at the problem from a Keynesian point of view without arguing about which approach is better.
2.2 The Harrod trade multiplier

The Harrod model presented in Harrod(1933) states the so called “trade multiplier” as the ratio which always brings balance of payments back to equilibrium by adjusting income. The model assumes that there is no leaking or unaccounted expenditure of income. All income(Y) is either generated through producing goods for exports(X), or can be spent on consuming goods(C) and paying import bills(M). There is no saving or taxes.

\[ Y = C - M + X. \]  

(1)

The basic assumption Harrod made about international trade is that it is balanced. This implies that the domestic economy consumes exactly as much as it produces, there are constant terms of trade, and income adjusts to consumption to preserve the balance, i.e. \( Y = C \). Therefore, from equation (1) for the national income we have exports and imports balancing each other, i.e. \( X = M \).

We define the import function as: \( M = \bar{M} + mY \), where \( \bar{M} \) is the level of autonomous imports, and \( m \) is the marginal propensity to import. Y is again domestic income. Since we assumed that trade is balanced and exports equal imports, we have:

\[ X = \bar{M} + mY. \]  

(2)

The partial derivative of equation (2) will give us the trade multiplier.

\[ \frac{\Delta X}{\Delta Y} = m \Rightarrow \frac{\Delta Y}{\Delta X} = \frac{1}{m} \]

\[ \frac{\Delta Y}{\Delta X} = \frac{1}{m} \]  

(3)

Please observe that this form of the Harrod trade multiplier is quite unrealistic because of the assumptions it makes. The absence of savings, taxes and capital flows
in the economy makes this model practically inapplicable to modern economic theory. However, there have been further developments of this model incorporating income leakages and government expenditures, but we are interested at the core concept used by Harrod(1933), and later by Thirlwall(1979).

2.3 The Thirlwall law of balance-of-payments-constrained economic growth

Thirlwall's law (1979), based on the Harrod trade multiplier, states that the balance-of-payments constraint on economic growth can be best expressed as the equilibrium growth rate at which the country can utilize its full production capacity and simultaneously keep expanding its economy without entering ever-increasing debts. If a country manages to keep its balance-of-payments close to this equilibrium, this will allow for a steady growth of output based on expanding the production capacity without a constant capital inflow.

It is important to emphasise that this model seems to be asymmetrical when it comes to the direction of disequilibrium. Empirical studies on some debt-burdened developing economies such as Bolivia, Mexico and Brazil have shown the presence of a balance-of-payments constraint on economic growth, implying that countries with deficit on the current account really do face a constraint on growth. If we look at the other end of the spectrum, there are developing economies like China and India which are running significant current-account surpluses alongside with extremely high growth rates for many years in a row. This points at the lack of constraint on growth for these cases. We can state with uncertainty that Thirlwall's law only may hold for countries with current-account deficit, and not for countries with surplus on current account. See Thirlwall(1980), pp. 254:

“... While a country cannot grow faster than its balance-of-payments equilibrium growth rate for very long, unless it can finance an ever-growing deficit, there is little to stop a country growing slower and accumulating large surpluses. In particular this may occur where the balance-of-payments equilibrium growth rate is so high that a country simply does not have the physical to grow at that rate. ...”
In order to utilise Thirlwall’s law, we need to understand the concept of balance-of-payments. A country’s national account consists of the current account and the capital account. For a balance-of-payments the following identity should hold:

\[ \text{Current Account} + \text{Capital Account} + \text{Financial Account} = 0 \]

The current account consists of the difference between exports and imports of goods and services, while the capital account represents the financial flows and traded capital goods. A balance-of-payments means that any current account deficit is financed by the capital or financial account with foreign-currency reserves or capital inflows like borrowing and investments.

First we are going to look at the case of balance-of-payments equilibrium on current account. The original Thirlwall model from 1979 makes the major assumption that an open economy has no capital market and that continuous deviation from the balance-of-payments equilibrium on current account will deteriorate the trade balance and income growth further. This assumption is more true than false for most developed countries since they have already accumulated considerable production capacity and their growth rates have converged close to the long-term rate modelled by Thirlwall's law. The balance-of-payments equilibrium without capital account is derived from the current account balance equation:

\[ P_d X = P_f M E \]

Here \( P_d \) is the average domestic price of exports and \( X \) is the quantity of exports. Therefore, the left-hand side \( P_d X \) is the value of exports in domestic currency. \( P_f \) is the average price of imports in foreign currency and \( M \) is the quantity of imports. Please observe, that in the definition of Thirlwall's law \( M \) is the volume of imports, while in the Harrod model \( M \) is the total value of imports. \( E \) is the exchange rate or the home price of foreign currency. When the economy grows, the condition for the balance-of-payments to remain in equilibrium is that the rate of growth of export earnings has to be equal to the rate of growth of import
expenditures. We will use the continuous rate of change of the variables by taking natural logarithms of both sides of the current account balance equation:

$$\ln P_d + \ln X = \ln P_f + \ln M + \ln E$$

(4)

The next step in our analysis is to express the rates of change of imports and exports alternatively. Thirlwall's model employs the elasticities approach which stresses the importance of trade elasticities as the main factor affecting the current account. This approach is based on the assumption that the exchange rate is fixed and the demand elasticities for imports and exports are constant. Exports usually depend on the home price of exports \((P_d)\), the price of similar goods abroad expressed in home currency \((P_f)\) and the level of “world” income \((Z)\). Here \(\varepsilon\) is the income elasticity of demand for exports and \(\eta\) is the price elasticity of demand for exports.

$$X = \left(\frac{P_d}{P_f E}\right)^\eta Z^\varepsilon$$

Analogically, the import function with constant elasticity is:

$$M = \left(\frac{P_f E}{P_d}\right)^\psi Y^{\pi}$$

\(Y\) is the domestic income, \(\pi\) and \(\psi\) are respectively the income and price elasticities of demand for imports.

We express these equations in terms of continuous growth rates by taking natural logarithms of both sides in order to obtain the rate of change of exports and imports respectively:

$$\ln X = \eta |\ln P_d - \ln P_f - \ln E| + \varepsilon |\ln Z|$$

(5)

$$\ln M = \psi |\ln P_f + \ln E - \ln P_d| + \pi |\ln Y|$$

(6)
The equations above represent the rates of export growth and import growth. It is easy to see that export growth depends on “world” income \( Z \), the world's income elasticity of demand for exports \( \varepsilon \), the change of real terms of trade, or how fast domestic prices change relative to foreign prices \( \ln P_f + \ln E - \ln P_d \) multiplied by the price elasticity of demand for exports \( \eta \). Import growth, on the other hand, depends on the domestic income \( y \), the income elasticity of demand for imports \( \pi \), the inverse change in real terms of trade \( -\ln P_f + \ln E - \ln P_d \) multiplied by the price elasticity of demand for imports \( \psi \).

If we substitute equations (5) and (6) into (4) we obtain the balance-of-payments equilibrium for income growth:

\[
\ln Y = \frac{(1 + \eta + \psi)(\ln P_d - \ln P_f - \ln E) + \epsilon(\ln Z)}{\pi}
\]

The income elasticity of demand for imports can be estimated from historical data as the ratio between import growth and income growth. Therefore:

\[
\ln Y = \frac{(1 + \eta + \psi)(\ln P_d - \ln P_f - \ln E)}{\pi} + \frac{\epsilon(\ln Z)}{\pi}
\]

(7)

The first term on the right-hand side represents the elastic effect of terms-of-trade on growth, while the second term is the effect of income changes for the rest of the world.

In his paper from 1979 Thirlwall employs the purchasing power parity (PPP) and assumes that a flexible exchange rate perfectly adjusts for the change in domestic and foreign price levels. This implies that the terms-of-trade \( \left( \frac{E P_f}{P_d} \right) \) should be constant, or in other words their rate of change is zero, i.e.

\[
(\ln E + \ln P_f - \ln P_d) = 0.
\]
This leads to a very convenient simplification of the Thirlwall law by cancelling the terms-of-trade effect on the balance-of-payments equilibrium growth rate:

\[ \ln Y = \frac{\epsilon (\ln Z)}{\pi} \]

According to McCombie(1997) this assumption does not completely neglect the terms-of-trade effect on trade flows, but only that in the long-run changes in relative prices have relatively small impact on trade. We should bear in mind that this might eventually lead to deviations in the empirical estimates, especially because of the drastic movements in relative prices in the case of Bulgaria (see Figure 1).

Because we do not have information about the world income and income elasticity of demand for exports, we assume that \( \ln X = \epsilon (\ln Z) \). According to Thirlwall(2006) the world's income elasticity of demand for a country's exports \( \epsilon \) depends also on various non-price factors such as consumer's taste, characteristics of goods and others.

Eventually we arrive at the simplified formulation of Thirlwall's law, also known as the dynamic Harrod trade multiplier.

\[ \ln Y = \frac{1}{\pi} \ln X \]  

(8)

However, the assumption of constant terms-of-trade is not necessarily true in the case of the Bulgarian economy because from 1997 to present times the Bulgarian Lev is hard-pegged to the Euro with a Currency Board Agreement(CBA). This implies that the central bank does not have the necessary tools to balance the terms-of-trade, and the change in nominal exchange rate is 0.

The fact that \( e = 0 \) and nominal exchange rate is constant does not imply that the relative price level will remain constant. When the Currency Board Agreement was signed, exchange rate was fixed at the level for equilibrium of relative prices in 1997.
Since then, however, domestic inflation has been considerably higher than the rest of the world, which artificially appreciated real exchange rate (see Figure 1).

Since it is very unreliable to test empirically equation (7) with estimated price and income elasticities of demand for exports, we neglect the effect of terms-of-trade on the balance-of-payments constraint on economic growth. We will test our datasets with equation (8).

\[ \frac{EP_f}{P_d} \]

\textit{Figure 1: Real Effective Exchange Rate under Bulgaria's Currency Board Agreement, 1997Q2=100%}

\textit{Source: Bulgarian National Bank}
3. The Bulgarian Economy

Bulgaria has had a very turbulent economic history in the past several decades. During the period 1945-1989 the country was an autocracy with a centrally planned economy. Bulgaria was a quasi-closed economy, which means that there are no market mechanisms in place and the only exchange of goods and commodities was carried out within the CMEA-member countries. CMEA (Council of Mutual Economic Assistance, also known as COMECON) interconnects communist-ruled economies in the Soviet Union and in Eastern Europe in order to provide economic and political cooperation.

For several decades of planned economy Bulgaria developed considerable production capacities and was exporting large volumes of industrial goods to other CMEA members. Because of the planned nature of the economy, and the lack of market incentives productivity remained very low and Bulgaria became increasingly dependent on trade with the Soviet Union. In the late 1980s the Soviet Union's share of Bulgaria's trade turnover was more than 50%. Simultaneously the production efficiency was decreasing and the Bulgaria's terms-of-trade continued to deteriorate.

With the collapse of the Soviet Union Bulgaria took the biggest impact among all CMEA members, as the country lost more than 50% of its trade markets. Bulgaria started a transition from planned- to market-economy including liberalisation of prices and foreign-trade, allowing private actors on the market, and opening the economy by removing state regulation.

The result was that prices sky-rocketed and started a spiral of inflation which caused serious political and economic instability. At the same time the production factors in Bulgaria were exposed to international competition. Due to decades of operating in a planned economy domestic production turned out extremely inefficient and unable to adapt to the new market conditions. This combined with the high levels of inflation caused liquidation of most of the industries (which were still state-owned at the time) and the production capacities shrunk to a fraction of their previous levels. In the following years economic reforms were fairly inconsistent and slow because of

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1 Based on Dobrinsky(2000), Vasileva(2002)
political turmoil. The transitional recession continued for several years until in 1994-1995 the first positive growth of the economy was registered. However, just one year later, the situation worsened dramatically. Because of politicizing economic decisions and applying a very unreasonable fiscal and monetary policy the economy spun out of control. Weak banking supervision allowed for commercial banks to give an excessive amount of loans which turned out non-collectable. The government continued to subsidise bankrupt state-owned enterprises, while the central bank funded the increasing deficit by printing more and more domestic currency. As a result GDP dropped by more than 10% in 1996, and the first quarter of 1997 marked a 23% fall in real terms compared to the same period of the previous year. Inflation exploded and reached the record levels of 250% per month in the beginning of 1997. In desperate attempts to prevent a liquidity crisis the central bank increased interest rates substantially. Despite that there were mass withdrawals and the bank system was on the verge of collapsing. The increased interest rates worsened the situation even further causing bankruptcy of many companies and default loans.

This critical economic situation caused violent public protests and the government was overthrown. In March 1997 a new government stepped in office and initiated extensive economic reforms in partnership with the IMF. This included a Currency Board Agreement (CBA) as a tool for enforcing stability. CBA is a fixed exchange rate regime which hard-locks the domestic currency to a stable “reserve currency”. This provides full coverage of the domestic money supply with the equal value of reserve currency. The Bulgarian Lev was pegged to the German Mark at exchange rate 1 DM/BGL, and after January 1999 to the Euro at an exchange rate equal to 1.95583 BGL/EUR rate. The currency board maintains full foreign-exchange coverage for all cash and deposit liabilities of the central bank, prevents it from financing the government and takes away its functions of a lender of last resort (LOLR).

In this way the central bank has no tools for manipulating the interest rate and the money supply. The purpose of the currency board was to impose fiscal and monetary discipline in order to restore the credibility in the bank system and the results started to appear shortly after it was introduced. In the period before 1997 direct investments
in the economy decreased by an average of 9% per year, while after 1997 they grew with 20% per year on average. The GDP growth rates also improved dramatically: during the period 1990-1997 average rate was -4.6%, while from 1998-2002 growth was 4.1%. With the inflow of foreign investments and the shift towards trade with OECD countries has helped Bulgaria recover after the collapse of the Soviet markets. The Bulgarian economy has developed considerably since the crisis in 1997. Exports have increased dramatically, almost 4 times over the last decade(Figure 1). According to export statistic by the Bulgarian NSI just above 60% of the exports in 2006 were to the EU-25 zone, which shows that the economy is shifting to trade with new markets.

Figure 2: EU-25 exports as a share of total exports (current prices, mil. €)

Source: Bulgarian National Bank

GDP has also grown steadily ever since as it can be seen on Figure 2. The periodical fluctuations in the level of GDP can be explained by the structure of the Bulgarian economy. The sectors generating most of the national income are tourism

Figure 3: Nominal Gross Domestic Product (current prices, mil. €)

Source: Bulgarian National Bank
and agriculture which are highly dependent on seasons and weather. Thereby income increases in 2nd and 3rd quarter of the year, and decreases during the rest of the year.

Despite those positive trends in the economy, there have been some recent negative developments. Since 2004 the trade balance on current account started to deteriorate dramatically, as imports peaked over exports. Analysts have warned that deficit on current account of 15% of GDP is critical. Capital inflows, on the other hand, are increasing accordingly and finance the deficit, but this poses the risk of a serious currency board crisis in the long run, if the capital flow decreases or stops suddenly. There is also a risk that the trade deficits will deteriorate the GDP growth rate.

A quick look at Figures 3 and 4 reveals a strong negative relationship between the deficit on current account and GDP growth. This suggest that we can expect the empirical tests to reject the existence of Thirlwall's law in the Bulgarian economy. This means that there might be no constraint on economic growth for Bulgaria.

Figure 4: Balance on Current Account as a share of GDP

Source: WorldBank
4. Empirical results

4.1 The method

In the previous sections I have presented the model of balance-of-payments constrained growth. The original formulation of the model claims the following in the absence of capital flows to the economy, given by equation (8):

\[ \ln Y = \frac{1}{\pi} \ln X \]

Where \( \ln Y \) is the balance-of-payments equilibrium growth rate, \( \ln X \) is the change in exports and \( \pi \) is the income elasticity of demand for imports, calculated periodically as the ratio between the change in imports and change in income:

\[ \pi_t = \frac{\Delta M_t}{\Delta Y_t} \]

We should bear in mind that despite the fixed exchange rate and relatively high inflation rates, I assume that the effect of terms-of-trade is insignificant. This is the only viable way of testing the model in this case, because of lack of data for the trade elasticities.

In order to analyse the validity of Thirlwall's law in the case of Bulgaria, I will assume that despite the fixed exchange rate and relatively high inflation rates, the effects of terms-of-trade is irrelevant. This is the only viable way of testing the model in this case, because of lack of data for the trade elasticities.

In order to verify whether the law holds in the Bulgarian case I will use 2 approaches:

1. Non-linear regression using the Ordinary Least Squares(OLS) method
   \[ \ln Y_t = \beta \ln X_t + \epsilon_t \quad \text{and} \quad \ln Y_t = \alpha + \beta \ln X_t + \epsilon_t \]
2. Check the $\ln Y$ and $\ln X$ time-series for non-stationarity and their order of integration by testing for unit-roots with the Augmented Dickey-Fuller (ADF) test. If the data proves to be non-stationary of I(1) order, we can perform a Johansen cointegration test.

3. Use the Johansen cointegration test to determine whether there is a long term equilibrium relationship between exports and the level of income.

4. Perform a Granger Causality test on X and Y to determine the direction of causality.

### 4.2 The data

The datasets used for empirical testing consist of quarterly and annual data for the levels of Nominal Gross Domestic Product, exports and imports at current prices, nominal GDP growth, current account balance and trade balance for the period 1995 to 2007. The quarterly information has been collected from Bulgarian National Bank ([www.bnb.bg](http://www.bnb.bg)) and National Statistical Institute ([www.nsi.bg](http://www.nsi.bg) and [www.stat.bg](http://www.stat.bg)), while some annual series used in figures but not in data tests have been obtained from the WorldBank website ([devdata.worldbank.org/data-query/](http://devdata.worldbank.org/data-query/)) The time-series for balance-of-payments constrained growth was obtained by own calculations and illustrated for visual comparison. All data up to 2006 is final, data for 2007 and 2008 is preliminary.
4.3 Ordinary Least Square Regression

4.3.1 Linear regression without intercept

The first step is to regress $\ln Y$ on $\ln X$ with no intercept. The linearised model is:

$$\ln Y_t = \beta \ln X_t + \epsilon_t$$

After performing least square regression on the quarterly data from 1995 to 2007 I obtain the following output from EViews:

The estimated value of the $\beta$ coefficient is 1.1238 with a negligible standard error of 0.0041 which rejects the hypothesis that $\beta=0$ and shows that the obtained $\beta$ coefficient is significant at the 5% level. The R-squared statistic shows that more than 73% of the variance in $\ln Y$ can be explained by movements in $\ln X$.

Figure 5: Natural logarithms of exports and GDP
In order to verify if there is a linear relationship between $\ln Y$ and $\ln X$ we will test the hypothesis that the regression coefficient ($\beta$) for $\ln X$ is equal to 0. That is $H_0: \beta = 0$ versus $H_1: \beta > 0$. The test-statistic ($272.7724$) is larger than the critical $t$-value even at 1% level of significance ($t_{(0.01, 50)} = 2.403272$), therefore we reject the null hypothesis $\beta = 0$ at the 99% confidence level.

Despite the fact that we proved the statistical significance of the regression coefficients, we should be careful about stating the existence of a relationship between the regressor (LNX) and regressand (LNY). Since the $R^2$ value is greater than the Durbin-Watson statistic ($0.737348 > 0.535561$), we have reasons to suspect a spurious regression. According to Gujarati (2001) there are two ways to check if the regression is spurious: 1) investigating the autocorrelation coefficients of the residuals, and 2) testing for non-stationarity with Augmented Dickey-Fuller test.

First, let us take a look at the correlogram of the residuals. As a rule of thumb we choose to include a number of lags close to one-quarter of the length of the time-series. In my case of 52 observations I chose to examine the autocorrelation coefficients for up to 15 lags.

---

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNX</td>
<td>1.123816</td>
<td>0.004120</td>
<td>272.7724</td>
</tr>
</tbody>
</table>

**Figure 6: Regression results for** $\ln Y_t = \beta \ln X_t + \epsilon_t$
We can see that the behaviour of autocorrelation coefficients is similar to that of a non-stationary series. They start with very high autocorrelation at one lag, and converge to zero as we increase the number of lags. In order to be sure about the non-stationarity of the residuals, we will use the Augmented Dickey-Fuller (ADF) test for unit-root. We take the widest-used form of the test, with an intercept and no trend:

$$\Delta \epsilon_t = \alpha + \beta \epsilon_{t-1} + \gamma_1 \Delta \epsilon_{t-1} + \ldots + \gamma_p \Delta \epsilon_{t-p} + u_t$$  \hspace{1cm} (9)$$

ADF tests the null hypothesis $H_0: \beta = 0 (\epsilon$ is non-stationary) versus the alternative $H_1: \beta < 0 (\epsilon$ is stationary).

<table>
<thead>
<tr>
<th>Autocorrelation</th>
<th>Partial Correlation</th>
<th>AC</th>
<th>PAC</th>
<th>Q-Stat</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.721</td>
<td>0.721</td>
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<tr>
<td>2</td>
<td>0.437</td>
<td>-0.173</td>
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</tr>
<tr>
<td>3</td>
<td>0.390</td>
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<tr>
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<tr>
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<td>-0.269</td>
<td>56.074</td>
<td>0.000</td>
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</tr>
<tr>
<td>6</td>
<td>-0.047</td>
<td>-0.034</td>
<td>56.208</td>
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<tr>
<td>7</td>
<td>-0.001</td>
<td>0.167</td>
<td>56.208</td>
<td>0.000</td>
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<tr>
<td>8</td>
<td>0.057</td>
<td>0.015</td>
<td>56.417</td>
<td>0.000</td>
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<tr>
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<td>-0.130</td>
<td>56.588</td>
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<tr>
<td>10</td>
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<td>57.445</td>
<td>0.000</td>
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<tr>
<td>13</td>
<td>0.071</td>
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<td>58.963</td>
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<td>-0.118</td>
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<td>0.000</td>
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<tr>
<td>15</td>
<td>0.027</td>
<td>0.074</td>
<td>59.110</td>
<td>0.000</td>
<td></td>
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</tbody>
</table>


Figure 7: Correlogram for the residuals: $\ln Y_t = \beta \ln X_t + \epsilon_t$

Figure 8: ADF unit-root test on the residuals from $\ln Y_t = \beta \ln X_t + \epsilon_t$
Here the ADF test-statistic is -1.368426 and its absolute value is even below the 10% critical t-value. Therefore the residuals are non-stationary, which means that the regression of LNY on LNX is spurious. We conclude that there is no proof for or against the hypothesis that LNY and LNX are related.

**4.3.2 Linear regression with intercept**

In order to achieve even better fitting regression we will regress \( \ln Y \) on \( \ln X \) with a constant intercept. That is: 

\[
\ln Y_t = \alpha + \beta \ln X_t + \epsilon_t
\]

After applying the Ordinary Least Squares method for regression on 52 quarterly observations between 1995 and 2007 the results are given in Figure 7. The \( \alpha \) coefficient is vertical offset between actual and fitted data and in this test is estimated to \( \alpha = 1.933103 \). The slope of the regression is estimated to \( \beta = 0.860252 \) with a standard error \( se(\beta) = 0.058147 \).
The R-squared statistic here is even higher, showing that 81% of the variance in income level can be explained by changes in exports. The positive relationship between the dependent and independent variables will be analysed once again by hypothesis testing of $H_0 : \beta = 0$ and $H_1 : \beta > 0$ at the 99% confidence level. The test-statistic (14.79435) is larger than the critical t-value even at 1% level of significance $t_{0.01, 50} = 2.403272$, therefore we reject the null hypothesis $\beta = 0$ at the 99% confidence level. This means that $\beta$ is positive and significantly different from zero. Despite the fact that we proved the statistical significance of the regression coefficients, we should be careful about stating the existence of a relationship between the regressor (LNX) and the regressand (LNY). Again the $R^2$ value is greater than Durbin-Watson (0.814038 > 0.789053), we have reasons to suspect a spurious regression.

We see analogical results from the correlogram of the residuals. Here they start considerably high and decline as we increase the number of lags. This gives us a reason to suspect non-stationarity of the residuals. In order to confirm that we use again the ADF unit-root test with an intercept and no trend:

$$\Delta \epsilon_t = \alpha + \beta \epsilon_{t-1} + y_1 \Delta \epsilon_{t-1} + \ldots + y_p \Delta \epsilon_{t-p} + u_t$$

(10)

ADF tests the null hypothesis $H_0 : \beta = 0 (\epsilon$ is non-stationary) versus the alternative $H_1 : \beta < 0 (\epsilon$ is stationary).
As we can see from the test results above the ADF test statistic is by absolute value lower than the 5% critical value. Therefore we cannot reject the hypothesis of unit-root at the 5% significance level, and consequently the residuals of regressing LNY on LNX with intercept are non-stationary. Therefore even this regression is spurious and there is no evidence for the hypothesis that there is a relationship between LNY and LNX.

<table>
<thead>
<tr>
<th>Test</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-2.787667</td>
<td>0.0679</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.581152</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-2.926622</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-2.601424</td>
<td></td>
</tr>
</tbody>
</table>


Figure 11: ADF unit-root test on the residuals from \( \ln Y_t = \alpha + \beta \ln X_t + \epsilon_t \)
4.4 The co-integration method

I will perform co-integration tests on the time series for exports and income in order to trace any long-term equilibrium relationship between the two variables. The co-integration approach is considered superior to least-square regression and has been widely used for analysing the relationship between non-stationary variables. Very often the linear combination of two non-stationary time series of order I(1) is spurious, which makes the results from the OLS regression irrelevant. Co-integration theory, on the other hand, test whether the difference between two non-stationary series produces a stationary sequence. If two variables are cointegrated they must follow an equilibrium relationship in the long-run, even if they diverge considerably from short-run equilibrium.

The first step to co-integrating is to check if the variables to be analysed are non-stationary and of order of integration I(1), which are the necessary conditions for cointegration analysis.

4.4.1 Augmented Dickey-Fuller unit-root test

The Augmented Dickey-Fuller (ADF) unit-root test will be used to determine whether the series of logarithms of exports and income are non-stationary. The econometric software package EViews6 will run the test and will automatically calculate the t-statistics and critical values for hypothesis testing. The definition of an I(1) series is that it is non-stationary, and its first-difference is stationary. That is why we can determine if the variables are I(1) series by testing its first difference for unit-root.

The ADF test with an intercept and no trend estimates the following equation:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \ldots + \gamma_p \Delta Y_{t-p} + \epsilon_t$$  \hspace{1cm} (11)
Here $\alpha$ is the intercept constant, $\beta$ is the first lag of $Y_t$, and $\gamma_1 \ldots \gamma_p$ are the coefficients of $p$ lags of $\Delta Y_t$. The econometric software uses the Schwartz Info Criterion to determine a sufficient number of lags such that there is no autocorrelation in the error terms $\epsilon_t$. The test for unit-root is based on the coefficient $\beta$ of the lagged dependent variable $Y_{t-1}$.

We have to test the null hypothesis $H_0: \beta = 0$ ($Y$ is non-stationary) against the alternative $H_1: \beta < 0$ ($Y$ is stationary). First let the test statistic be

$$ t_{ADF} = -\frac{\hat{\beta}}{SE(\hat{\beta})} $$

which has the t-distribution with $(n-2)$ degrees of freedom.

Here $n$ is the number of observations, $\hat{\beta}$ is the estimated first-lag coefficient from equation (11), and SE is its standard error. For the LNX variable, we have the following results:

<table>
<thead>
<tr>
<th>Augmented Dickey-Fuller test statistic</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.510489</td>
<td>0.0856</td>
<td></td>
</tr>
</tbody>
</table>

Test critical values:

- 1% level: $-3.565430$
- 5% level: $-2.919352$
- 10% level: $-2.597305$


*Figure 12: ADF unit-root test on LNX (intercept, no trend)*

From the figure above it can be concluded that $t_{ADF} = 0.510489$ is outside the rejection region $t_{ADF} > t_{n-2}(0.01)$, therefore we cannot reject $H_0$ and the series LNX is non-stationary at the 1% significance level.

In order to check the order of integration of LNX, we apply the ADF on its first difference:
In this case the test statistic is within the rejection region, therefore we reject $H_0$ and conclude that $D(\text{LNX})$ is stationary.

As a result from the two unit-root tests above we can say that LNX is non-stationary of integration order I(1) and is suitable for co-integration.

For the logarithm of income LNY we have the following results from the ADF unit-root test:

<table>
<thead>
<tr>
<th>Augmented Dickey-Fuller test statistic</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.094467</td>
<td>0.9618</td>
</tr>
</tbody>
</table>


Figure 13: ADF unit-root test for the first difference of LNX(intercept, no trend)

It is easy to see that $t_{ADF} = 0.094467$ is outside the rejection region and the hypothesis $H_0$ of existence of unit-root cannot be rejected at the 1% significance level. Therefore the LNY variable is non-stationary.

Testing the first difference of the logarithm of income $D(\text{LNY})$ gives us:
Here $t_{ADF} = -6.561416$ is within the rejection region and we reject $H_0$ of the existence of unit-root. Therefore the first difference of LNY is stationary and LNY is of integration order I(1).

From the tests performed in this section we can conclude that the series for LNX and LNY are non-stationary of order I(1) and are suitable for co-integration tests.
4.4.2 Johansen co-integration test

From the analysis in section 4.4.1 we saw that the LNY and LNX series are non-stationary of order I(1), and in section 4.3.2 we found that their linear combination is stationary I(0) series. According to the Engle-Granger test (Gujarati, 2001) two I(1) variables are cointegrated if the residuals of their regression are also of order I(1). However, we will employ a more complex test, namely Johansen's test. It is based on a Variance Autoregressive Regression (VAR) model and was developed by Johansen (1991).

The figure above shows the results of hypothesis testing for the existence of cointegration. The first row in the table sets the null hypothesis that there are zero cointegrating equations. The trace-statistic is in the rejection region, therefore we reject the hypothesis of no cointegration. The second row sets a null hypothesis of at most one cointegrating equation. We cannot reject $H_0$ in this case, therefore LNY and LNX are cointegrated.

The next step will be to determine the vector of cointegration, which is automatically calculated by EViews and reported on Figure 17. The coefficient for LNX is statistically not different from zero, therefore we cannot do hypothesis testing for comparing it with the coefficient expected by Thirlwall $\frac{1}{\pi}$.
4.5 Granger causality test

According to the original formulation of the law stated by Thirlwall (1979) GDP growth is a function of the independent variable for growth of exports. In other words, it is exports(X) that cause GDP(Y), and not the other way around. This view is typical for Keynesian economists and can be expressed as $X \rightarrow Y$. It is also possible that in our case the causality runs in the opposite direction, namely $Y \rightarrow X$ as neoclassical economists claim.

In order to determine the direction of causality in the relationship I will use the Granger causality test. This method looks at the matter to what extent current $Y$ values can be explained by its previous values, and whether adding lagged values of $X$ can improve this prediction. It is important to bear in mind that the statement “$X$ Granger-causes $Y$” does not mean that $Y$ is the result of $X$. It just indicates that past values of $X$ bear some information about future values of $Y$.

According to Gujarati (2001) the Granger causality test assumes that the analysed time-series are stationary. However, $X$ and $Y$ proved to be nonstationary, and can not be tested directly. Gujarati (2001, pp. 698) suggests that in such cases we can analyse the first difference of the time-series if it is stationary.

Here we have a two-variable causality test on $DY$ and $DX$. This is favourable since Granger causality test on more than two variables can return misleading results if
there is auxiliary cointegration through a third variable. The Granger test is also sensitive to the number of lags. Lags are the number of past time periods that could help predict the target variable, and generally it is better to use more rather than few lags. Here I chose 4 lags because I use quarterly data observations, and I believe that 1 year is the optimal time span within which some Granger causality can be observed.

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>DY does not Granger Cause DX</td>
<td>47</td>
<td>4.39472</td>
<td>0.0051</td>
</tr>
<tr>
<td>DX does not Granger Cause DY</td>
<td>148237</td>
<td>0.2267</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 18: Granger causality test on DX and DY, using 4 lags*

The null-hypotheses for both directions are that there is no Granger-causality. The p-values in the last column indicate that we reject the null hypothesis that *DY* does not Granger cause *DX* at less than 1% significance level. Therefore we can state that *DY* Granger-causes *DX*, thus past values of *DY* can help predicting *DX*. In the second test the null hypothesis of DX not causing DY cannot be rejected, which implies *DX* does not Granger cause *DY*.

From the results above we can conclude that there is a unidirectional causality

*DY → DX*, which contradicts Thirlwall's Keynesian model.
5. Analysis

In this section I will summarise the findings from the empirical tests in the previous section. It is very important to emphasise that the empirical tests in this study employed Thirlwall's law in its generalised form. The assumption that the purchasing-power-parity holds even in fixed exchange rate regime has been made in order to make empirical tests possible.

The Ordinary Least-Squares regression analysis in sections 4.3.1-2 with and without intercepts showed statistically significant regression coefficients. However, the $R^2$ and Durbin-Watson statistics raised suspicions about serial correlation of the error terms and spurious regression. After investigating autocorrelations and performing Augmented Dickey-Fuller tests on the error terms, those suspicions were confirmed. There is spurious regression between the continuous rates of change in exports and income($lnX$ and $lnY$ respectively). Therefore the regression method can not conclude whether there exists a relationship between these two variables, as Thirlwall suggests. This is a common problem when analysing the linear combination of nonstationary I(1) variables, and experience has shown that many time-series in macroeconomics behave exactly in this way. The failure to determine regression coefficients does not allow us to perform hypothesis tests if it relates to the theoretical value of $\frac{1}{\pi}$ suggested by Thirlwall's law. That is why we had to resort to a more sophisticated method.

The cointegration method was developed especially for detecting long-run equilibrium relationships between nonstationary variables. It is based on the idea that the errors from the linear combination of the related variables tend to disappear and return to zero. The method can determine a long term equilibrium relationship even if we have a small sample of data and the relationship does not hold in the short-run. A prerequisite for employing this method is that the involved time-series should have a unit-root (i.e. should be nonstationary). The Augmented Dickey-Fuller unit-root was used for this purpose. After applying the test on the $lnY$ and $lnX$ variables they proved to be nonstationary and therefore suitable for cointegration.
The Johansen (1991) cointegration test was performed in section 4.4.2. It proved that the continuous rates of change in \( X \) and \( Y \) are cointegrated. The null hypothesis of no cointegrating equations was rejected at less than 1% significance level, while the hypothesis of (at most) 1 equations was not rejected. The test also produced cointegration coefficient which unfortunately can not be analysed because it is statistically not different from 0.

The third econometric test employed in this study is the Granger causality test. Because it requires stationarity of the analysed variables, we used the first difference of the I(1) variables \( X \) and \( Y \) and denoted it by \( DX \) and \( DY \) respectively. The results was that \( DY \) Granger-causes \( DX \) at less than 1% significance level \( (DY \rightarrow DX) \). The nature of the test does not imply true causality, but states that movements in \( DY \) precede and can to certain extent predict related movements in \( DX \). The obtained results contradict the specifications of the Thirlwall theoretic model, which postulates demand-led growth. Instead, in our empirical findings we see GDP causing exports, which can be interpreted as supply-led growth.

Since exports follow GDP we cannot support the theoretical model of balance-of-payments constrained growth. We can also state that the Keynesian framework does not match the empirical findings, and the classical approach of supply-led growth might be more suitable for analysing this case.
6. Conclusions

The purpose of this study was to test empirically the validity of Thirlwall's law in the case of Bulgaria. The incentive for this investigation was the increasing current-account deficit and steady economic growth of the Bulgarian economy. There have been no other studies on this topic using Bulgarian data.

Thirlwall (1979) suggests that there is an optimal equilibrium rate of growth that allows the economy to grow in a sustainable way. If the economy grows at this rate and maintains a healthy balance-of-payments, it will be able to expand its production capacity and will decrease its dependence on imports. It would also allow for a higher equilibrium growth rates in the long-run.

The empirical investigation on the Bulgarian economy failed to provide exact measure of the relationship between the analysed variables, and therefore Thirlwall's model can not be proved one-to-one in the Bulgarian economic history. Alternative econometric techniques like cointegration and Granger causality proved the existence of a long-term relationship between export growth and economic growth. However, the latter test showed that the causality runs from income to exports (ΔY causes ΔX), which is the opposite to what the theoretical model suggests.

This leads us to the conclusion that there is a long-run relationship between exports and domestic income, but it is exports that follow GDP. This allows us to reject the Keynesian theory of export-led growth in the case of Bulgaria. This result may be due to misspecifying the regression models in section 4 by using false assumptions. For instance, the assumption of insignificance of the terms-of-trade effect on the model. We assumed this for the Bulgarian case for the sake of making empirical tests possible, despite the fact that the Bulgarian economy operates under a Currency Board Agreement with a hard-pegged exchange rate. Such a exchange rate regime is said to have negative effects on relative price levels, and therefore it might be the reason for Thirlwall's model inconsistency in the case of the Bulgarian economy.
Another possible explanation for the discouraging results may be the turbulent economic conditions in the Bulgarian economy during the analysed time period. The period (1995-2007) follows the transition from planned to marketing economy, and some market mechanisms may still not be in place.
7. References


### Appendix

<table>
<thead>
<tr>
<th>Year</th>
<th>Quarter</th>
<th>GDP (mil. €)</th>
<th>Current Account (mil. €)</th>
<th>Exports (mil. €)</th>
<th>Imports (mil. €)</th>
<th>Exports to EU-25 (mil. €)</th>
<th>Real Effective Exchange Rate (CPI deflated) 1997Q2=100%</th>
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<tr>
<td>1995</td>
<td>Q1</td>
<td>1805.3</td>
<td>-72.6</td>
<td>861.6</td>
<td>882.1</td>
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<tr>
<td></td>
<td>Q2</td>
<td>2135</td>
<td>29.9</td>
<td>926.7</td>
<td>946.4</td>
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<td></td>
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<td>18.9</td>
<td>962.4</td>
<td>993</td>
<td>422.77</td>
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<td>1143.2</td>
<td>239.1</td>
<td>983.7</td>
<td>799.6</td>
<td>494.44</td>
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<td>2106.4</td>
<td>242.3</td>
<td>1071.4</td>
<td>1090.8</td>
<td>511.46</td>
<td>100.00%</td>
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<tr>
<td></td>
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<td>3015</td>
<td>381.9</td>
<td>1130.9</td>
<td>1181.3</td>
<td>528.06</td>
<td>107.00%</td>
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<tr>
<td></td>
<td>Q4</td>
<td>2848.3</td>
<td>70</td>
<td>1070.3</td>
<td>1234.9</td>
<td>547.2</td>
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<tr>
<td>1998</td>
<td>Q1</td>
<td>2422.8</td>
<td>-34.7</td>
<td>1006.3</td>
<td>1085</td>
<td>573.32</td>
<td>111.41%</td>
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<td></td>
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<td>2599.3</td>
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<td>-225.3</td>
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<td>604.13</td>
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<tr>
<td>Year</td>
<td>Quarter</td>
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<td>Current Account (mil. €)</td>
<td>Exports (mil. €)</td>
<td>Imports (mil. €)</td>
<td>Exports to EU-25 (mil. €)</td>
<td>Real Effective Exchange Rate (CPI deflated) 1997Q2=100%</td>
</tr>
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<td>Q1</td>
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<td>-300.3</td>
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Sources: Bulgarian National Bank, National Statistical Institute