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Econometric Forecasting of Bulgaria's Export and Import Flows

Grigor Stoevsky

BULGARIAN NATIONAL BANK


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SUMMARY. The study comprises an empirical analysis of Bulgaria's foreign trade, aimed at projecting the export and import dynamics of the country. The forecasting objective of the study restricts econometric specifications to include primarily explanatory factors for which external assumptions on their likely future development are available. The relatively long transition period and the associated structural changes shorten the available time series and raise specific econometric issues.

An important conclusion of the study is that the modeling approach developed produces forecasts that are only reliable over a short horizon and may serve but an auxiliary function to a full-fledged macroeconomic projections model.

Keywords: foreign trade forecasting, econometric modeling.

JEL: F17.

This paper is based on the results from a research project at the Bulgarian National Bank completed together with Andrey Vassilev and Svilen Pachedjiev. I am particularly indebted to Andrey Vassilev for providing ideas and comments throughout the process.

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Introduction

Traditionally in empirical analysis of economic relations, one of two broad approaches is followed. According to the first, a theoretical model is built, based on certain assumptions about the underlying processes, which is reduced to an estimable representation and then tested with the available data for a particular country. The objectives of this approach usually are to assess the applicability of the given model for the specific country, to give recommendations about future model modifications, as well as to evaluate the existence of certain relations. According to the second approach, the objective is not to test a specific model, but rather to evaluate as accurately as possible existing empirical relations between the processes of interest. The starting point of the analysis is theoretically postulated or empirically derived in different circumstances relations, based on which reduced-form estimable equations are built and tested with the country-specific dataset of interest. The focus is on the empirical estimation of these relations and the usual procedure to follow is the so-called "general-to-specific" strategy. The main task in this second approach is to extract maximum amount of information from the available data about the relations between the processes, following a number of econometric rules and procedures guaranteeing the reliability of the obtained results. It is this latter approach which we follow in the research paper.

The main objective of the study is to perform an empirical analysis of Bulgaria's foreign trade, aimed at projecting the export and import dynamics of Bulgaria. It is motivated by the need of producing a reliable assessment of the foreign trade development of the country and allowing better forecasting of the other balance of payments components as well. Logically the forecasting is preceded by an analysis of the relations between the macroeconomic processes. The forecasting objective of the study restricts econometric specifications to include primarily explanatory factors for which external assumptions on their likely future development are available. The relatively long period of transition in Bulgaria and the associated structural changes shorten the available time series and raise specific econometric issues. These characteristics limit the applicability and reliability of standard stationarity tests, on the one hand, and on the other land, hinder the estimation of long-term relationships, thus naturally restricting the forecasting horizon to up to one year ahead.

The fulfillment of the so-defined objective requires the realization of the following specific tasks:

- Choosing the appropriate methodological framework, defining the theoretical relations between the macroeconomic processes, which are the basis for the empirical analysis;

• Collecting and transforming the data for the key variables in a form appropriate for econometric testing. Assessment of the time-series properties of the data, in particular their stationarity and autocorrelation structure;

• Econometric estimation of the relations between the variables following the "general-to-specific" approach and finding parsimonious specifications;

• Applying a series of tests for significance, stability and reliability of the reduced-form models and the estimated coefficients;

• Performing in-sample and out-of-sample forecasts and analysis of the forecasting power of the models.

The initial hypotheses of the author are the following:

• The physical volume of Bulgarian exports should exhibit a positive relation with the external demand dynamics and the real depreciation of the Bulgarian lev;

• The price dynamics of the exported and imported goods is characterized by inertia and depends on the dynamics of the international prices and the exchange rates;

• The physical volume of the imports should depend on the economic activity in the country and the dynamics of the real effective exchange rate.

The development of satellite instruments for forecasting the export and import flows of the country is motivated by the importance of the trade balance both in the external transactions and in the national accounts. The balance of goods is one of the main components of the current account of the balance of payments, and given the currency board arrangement in Bulgaria, is a direct determinant of the foreign reserves of the central bank. The private agents decisions to consume (use in production) imported goods, as well as to export their products to the international markets depend on their financial potential and their competitiveness.

The foreign trade is also an important component of the final use approach to the GDP developments. The existence of trade deficits for a relatively long period of time might under some circumstances be a risk factor for the future growth prospects. On the other hand, the deficits might represent the process of capital accumulation and through the intensified investments increase the growth potential of the country. In all cases, developing an alternative instrument for short run export and import forecasting is justified by the need of providing better analysis and forming more accurate expectations about the economic development of the country.

The paper is organized in the following way: Section 1 presents the theoretical approaches and relations, forming the basis for the empirical estimation. A sample of research studies testing similar relations for other economies is also presented. Section 2 describes the variables used in the analysis and

their time-series properties. The reduced-form specifications are given in Section 3, whereas the forecasting performance of the equations is discussed in Section 4. The paper concludes with some options for improvement of this empirical work in the future.

1. Theoretical Grounds and Recent Empirical Studies

The contemporary foreign trade theory encompasses a wide variety of research problems, analyzes the relations and causality between a number of economic processes and provides an ample field for empirical work. A large part of the traditional theory is focused on the causes of the foreign trade development and its consequences. The increasingly integrated world and the trend towards higher openness and interdependence between the countries led towards the incorporation of open economy features in almost all models for macroeconomic analysis and forecasting. In empirical work, however, there is always a trade-off between theoretical consistency and practical relevance. As the approach followed in the current research effort is one of econometric estimation of the existing economic relations, the balance between theory and empirical relevance is in favour of the latter.

The classical international trade theory includes the Ricardian, technology-based model and the Heckscher-Ohlin factor endowments model. More recently, the foreign trade factors and driving forces were expanded to include increasing returns to scale, monopolistic competition, preference for variety, market failures, while the predicted specialization is one of intra-industry trade. Gravity and endogenous growth models also contributed to the theoretical advances along with the theory of competitive advantage.[1]

Examples of empirical foreign trade studies, relevant to the presented work, include Amano and Wirjanto (1994), Senhadji and Montenegro (1999), Mehta and Mathur (2003), Bussiere, Fidrmuc and Schnatz (2005), Anderton, Baltagi, Skudelni and Sousa (2005) among others. The authors of the first study model the Canadian foreign trade flows as a function of the agents' decisions in solving a dynamic optimization problem. The desired level of imports in their setup is a linear function of domestic demand and relative prices, and the solution of the problem leads to an Euler equation for imports. The coefficients of this equation are estimated in two steps, with co-integration techniques at the first and generalized method of moments (GMM) at the second. The estimated import elasticities with respect to (w.r.t.) domestic

[1]Grossman and Helpman (1991), Porter (1990). Textbooks such as Obstfeld and Rogoff (1996) and Feenstra (2003) present the theory in a systematic and consistent manner.

demand and relative prices are respectively 1.5 and -0.5. Although the method provides micro foundations for the empirical estimation of macroeconomic relations, the co-integration and GMM methods are practically inapplicable to small samples.

Senhadji and Montenegro (1999) analyze the exports of 75 countries using the fully modified estimator of Phillips and Hansen (1990) in estimating the relations. The results about the export elasticity w.r.t. relative prices show an insignificant relation in the short run and a coefficient close to 1 in the long run. The export elasticities w.r.t. the income of the trade partners are generally below 0.5 in the short run and around 1.5 in the long run. One of the conclusions of the study is that the export elasticities are lower in the industrial countries as compared to the developing countries.

Mehta and Mathur (2003) review the existing models for short run forecasting of Indian exports. The exports are generally modeled as a function of the demand of the trade partners of India and the development in relevant price indexes and exchange rates along with its autoregressive structure. Bussiere, Fidrmuc and Schnatz (2005) analyze the trade integration of the Central and Eastern European (CEE) countries with the euro area using an augmented gravity model. In the panel data estimation, they find a significantly positive trade dependence on the economy size (GDP), neighbourhood, language similarity, trade union membership, price effect (captured by the real exchange rate dynamics), while the distance influences negatively the trade flows. An example of an alternative econometric approach is provided by Anderton, Baltagi, Skudelni and Sousa (2005) who use the three-stage least squares (3SLS) system estimator for analyzing the import demand of nine Eurosystem countries.

Based on the fundamental theoretical relations, describing the export and import dynamics of a country, as well as on the variety of empirical methods for studying the foreign trade determinants and forecasting its developments, we analyzed the following relations for the Bulgarian economy:

• The export modeling has the following general form:

$$X_t = f(X_{t-i}, ED_{t-i+1}, ER_{t-i+1}, \mathbf{P_{t-i+1}}), i = \{1,2,3,...\} \quad (1),$$

where *X* is the export of goods (expressed in nominal or real terms), *ED* is a composite measure of external demand, *ER* is the exchange rate (nominal or real, effective or not), and **P** is a vector of prices, giving the price dynamics for groups of commodities on the international markets.

• The general form for the import modeling is:

$$M_t = f(M_{t-i}, DD_{t-i+1}, Y_{t-i+1}, ER_{t-i+1}, \mathbf{P_{t-i+1}}), i = \{1,2,3,...\} \quad (2),$$

where *M* is the imports of goods (expressed in nominal or real terms), *DD* is domestic demand, *Y* is the gross domestic product (GDP), *ER* is the exchange rate, and **P** is the price vector.

• The export and import deflator modeling is based on the understanding that Bulgaria is a small open economy, which is a price-taker on the international markets, hence the prices of the foreign traded goods should follow the dynamics on the international markets:[2]

$$P_t^{X,M} = f(P_{t-i}^{X,M}, ER_{t-i+1}, \mathbf{P_{t-i+1}}), i = \{1,2,3,...\} \quad (3),$$

where $P_t^{X,M}$ is the corresponding export or import deflator, while the other variables are as described above. The following section presents the macroeconomic processes included in the analysis and the statistical properties of the available time-series.

2. Data Properties

The empirical analysis of the foreign trade of Bulgaria aimed at projecting the future development of the export and import flows is based on econometric estimation of relations between macroeconomic processes selected on theoretical and logical grounds. The choice of explanatory variables in the export and import modeling is restricted by the forecasting objective of the analysis. Namely, the set of explanatory factors is restricted to those, for which external forecasts or assumptions on their likely development in the future are available. Those variables include domestic demand and GDP growth rates (based on the core macroeconomic projections model), GDP and price dynamics of Bulgaria's main trading partners, international prices of basic commodities and exchange rates.

The time horizon of the forecast is restricted to one year ahead due to the specifics of the Bulgarian transition period. The relatively long period of transformation of the economic system, the ongoing structural changes and the crisis of 1996–1997 led to an abrupt change in the monetary regime with the introduction of a Currency Board Arrangement in July 1997. For this reason,

[2]The hypothesis is that the exporters are "price-takers" on the international markets whereas the importers are "price-makers" on the domestic market.

the time series span the period 1998–2007 and the additionally required data transformation shortens the available observations for some of the variables to the period 1999–2007. These characteristics of the data limit the applicability and reliability of standard stationarity tests, on the one hand, and on the other hand, hinder the estimation of long-term relationships, thus naturally restricting the forecasting horizon to up to one year ahead.

In econometric estimation with a sample of eight to nine years, the most suitable data frequency in our opinion is quarterly. At this periodicity, the short run noise present in the monthly data is eliminated and also it is the highest frequency for the national accounts data. Furthermore, the relatively short time span makes the annual data inappropriate for econometric estimation. Finally, the requirement of producing quarterly forecasts also guided the data choice.

One property of the quarterly reporting for most of the series is their seasonality. In order to cope with it in a straightforward way, we decided to work with annual growth rates (or annual differences) of the series. With such transformation the seasonality is removed while the short run relation is retained. If however the first difference of the series is used in some estimation, we account for seasonality through the inclusion of seasonal dummies. As most of the variables we analyze are flow processes (as opposed to stocks), the economic interpretation of their annual or chain difference is acceleration/deceleration or intensification/diminishing of their dynamics.

From statistical point of view, the transformation of the data into annual changes makes most of the series stationary. The stationarity of the series is important for the validity of the econometric estimation, the proper statistical significance of the coefficients and for the stability of the relations in different time horizons. It is the assumption of coefficient stability which allows out-of-sample forecasting of the dependent variable.

The main variables for the analysis are:

- Exports and imports of goods, quarterly data, defined as nominal and real annual growth rates as reported in the national accounts statistics;
- GDP and domestic demand (DD) growth rates, the latter comprises the final consumption of households and the government and the gross capital formation;
- External demand, defined as a GDP growth rate or import dynamics of Bulgaria's main partners weighted by their respective shares in Bulgaria's exports;
- International price indexes of basic commodities – crude oil and metals;
- Exchange rate USD/EUR (given the fixed BGN/EUR rate).

The unit root hypothesis is tested by two alternative methods, having a different null, namely the Augmented Dickey Fuller (ADF) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The results of the two methods are conclusive (qualitatively similar) for all key variables of the analysis and they are presented in Appendix 1. In interpreting the results, we had in mind that these tests are asymptotic and thus formally inapplicable to small samples. Nevertheless, we decided to have formal tests supporting the qualitative judgment about the stationarity of the series (the latter based on the stylized facts in this regard).

3. Reduced-form Specifications

The econometric procedure followed to find the best specification for each variable is the general-to-specific approach. The main idea of this approach is to start with a general specification of the model, which should pass a number of diagnostic tests. Then the specification is sequentially reduced by an exclusion of the least significant regressor (one at a step). At each step, the validity of the model is verified through a series of diagnostic tests. The procedure stops with a parsimonious model specification which cannot be further reduced without violating the validity of the model.

The choice of regressors for the initial general specification is guided by theory and logical considerations. The starting lag structure for the explanatory factors is based on the author's judgment about the relevant time span of the relation. Dummy variables are included to cope with seasonality (in one of the specifications), as well as to account for one-off factors, influencing the relation between the macroeconomic processes.

The set of diagnostic tests for each specification and at each step of the procedure includes analysis of the residuals and of the estimated coefficients. The former are tested for normality, serial correlation and heteroskedasticity, while the latter are tested for stability by recursive least squares. The residuals are also graphically examined for outliers. In applying these tests, the author followed the standard for empirical work significance levels (5%). Nevertheless, the small sample size and the specifics of the structural changes in the economy throughout the period postulate the use of a more flexible approach in deciding whether a particular specification passes or not a diagnostic test. In applying the procedure, one might reach a reduced-form specification, which does not pass the diagnostic tests. In such cases, the author repeated the procedure, following a different route and trying to find an alternative reduced-form specification. In some cases, a dummy variable is added for an outlier correction. It is in cases when the author takes the specification for adequate (in economic and statistical terms) but some data anomaly is

present. The final parsimonious model specifications should maximize the adjusted coefficient of determination and minimize the information criteria of Akaike and Schwarz.

The analysis of the export and import flows comprises the three interrelated data dimensions. Independently of each other are estimated and forecasted the nominal and real growth rates, as well as the respective deflators, in spite of the fact, that each of these variables might be implicitly computed for the other two. This approach allows the calculation of two independent forecasts for the variable of primary interest. For example, for the balance of payments projections the primary interest is on the nominal variables, whereas for the real sector projections the real growth rates are of a first order of importance.

Based on the application of the general-to-specific approach, the derived reduced-form equations for each dependent variable have the following form.

• The exports of goods are modeled as real, nominal and price dynamics. The external (import) demand measure is also modeled as an auxiliary equation. The regression equations are:

$$\frac{\Delta_4 X_t}{X_{t-4}} = \alpha_1 + \beta_1^1 \frac{\Delta_4 X_{t-1}}{X_{t-5}} + \beta_1^2 \frac{\Delta_4 ED_t^M}{ED_{t-4}^M} + \varepsilon_1 \quad (4)$$

$$\frac{\Delta_4 (P^X X)_t}{(P^X X)_{t-4}} = \alpha_2 + \beta_2^1 \frac{\Delta_4 (P^X X)_{t-1}}{(P^X X)_{t-5}} + \beta_2^2 \frac{\Delta_4 ED_t^M}{ED_{t-4}^M} + \beta_2^3 \frac{\Delta_4 ER_{t-1}^{\varepsilon/\$}}{ER_{t-5}^{\varepsilon/\$}} + \varepsilon_2 \quad (5)$$

$$\frac{\Delta_4 P_t^X}{P_{t-4}^X} = \alpha_3 + \beta_3^1 \frac{\Delta_4 P_{t-1}^X}{P_{t-5}^X} + \beta_3^2 \frac{\Delta_4 P_{t-4}^X}{P_{t-8}^X} + \beta_3^3 \frac{\Delta_4 P_t^{Oil}}{P_{t-4}^{Oil}} + \beta_3^4 \frac{\Delta_4 P_t^{Metals}}{P_{t-4}^{Metals}} + \beta_3^5 \frac{\Delta_4 ER_t^{\varepsilon/\$}}{ER_{t-4}^{\varepsilon/\$}} + \varepsilon_3 \quad (6)$$

$$\frac{\Delta_4 ED_t^M}{ED_{t-4}^M} = \alpha_4 + \beta_4^1 \frac{\Delta_4 ED_{t-1}^M}{ED_{t-5}^M} + \beta_4^2 \frac{\Delta_4 ED_{t-4}^M}{ED_{t-8}^M} + \beta_4^3 \frac{\Delta_4 ED_t^{GDP}}{ED_{t-4}^{GDP}} + \varepsilon_4 \quad (7),$$

where the superscripts *X* or *M* relate the variable to the exports or imports, *Oil* and *Metals* represent the respective price indexes of crude oil and metals, and the exchange rate is defined as euro per 1 USD.

• The modeling of the imports of goods also comprises real, nominal and price dynamics. Furthermore, an alternative specification is formulated in terms of chain differences of the variables in constant prices. The reduced-form specifications are:

$$\frac{\Delta_4 M_t}{M_{t-4}} = \alpha_5 + \beta_5^1 \frac{\Delta_4 M_{t-1}}{M_{t-5}} + \beta_5^2 \frac{\Delta_4 DD_t}{DD_{t-4}} + \beta_5^3 \frac{\Delta_4 DD_{t-1}}{DD_{t-5}} + \varepsilon_5 \qquad (8)$$

$$\frac{\Delta_4 (P^M M)_t}{(P^M M)_{t-4}} = \alpha_6 + \beta_6^1 \frac{\Delta_4 (P^M M)_{t-1}}{(P^M M)_{t-5}} + \beta_6^2 \frac{\Delta_4 (P^M M)_{t-4}}{(P^M M)_{t-8}} + \beta_6^3 \frac{\Delta_4 (P^{DD} DD)_t}{(P^{DD} DD)_{t-4}} + \beta_6^4 \frac{\Delta_4 ER_t^{\varepsilon/\$}}{ER_{t-4}^{\varepsilon/\$}} + \varepsilon_6 \quad (9)$$

$$\frac{\Delta_4 P_t^M}{P_{t-4}^M} = \alpha_7 + \beta_7^1 \frac{\Delta_4 P_{t-1}^M}{P_{t-5}^M} + \beta_7^2 \frac{\Delta_4 P_{t-2}^M}{P_{t-6}^M} + \beta_7^3 \frac{\Delta_4 P_t^{Oil}}{P_{t-4}^{Oil}} + \beta_7^4 \frac{\Delta_4 P_{t-1}^{Oil}}{P_{t-5}^{Oil}} + \beta_7^5 \frac{\Delta_4 ER_t^{\varepsilon/\$}}{ER_{t-4}^{\varepsilon/\$}} + \beta_7^6 \frac{\Delta_4 ER_{t-1}^{\varepsilon/\$}}{ER_{t-5}^{\varepsilon/\$}} + \beta_7^7 \frac{\Delta_4 P_t^{Metals}}{P_{t-4}^{Metals}} + \varepsilon_7 \qquad (10)$$

$$\Delta M_t = \alpha_8 + \beta_8^1 \Delta M_{t-1} + \beta_8^2 \Delta Y_t + \beta_8^3 \Delta Y_{t-1} + seas + \varepsilon_8 \qquad (11),$$

where the variable descriptions are as explained above, while *seas* represents the included seasonal dummies. The sub-indices of the variables represent the time period (at a quarterly frequency), while the coefficients are numbered following a convention according to which the subscript denotes the equation and the superscript denotes the consecutive order of the explanatory variable within the equation. The econometric results from the export and import analysis are presented in **Appendixes 2 and 3** and are discussed together with the forecasting performance below.

4. Forecasting Performance of the Equations

We present in this part only the direct forecasting properties of the equations presented above (4)–(11), while the interrelations between the dependent variables are disregarded. In our view, the direct link between the equations might be used at a later stage for producing a direct and an indirect forecast for the variable of primary interest. For example, if we are primarily interested in the nominal foreign trade development, we could forecast it directly (via equations (5) and (9)) or forecast the real and price developments and then calculate from these the nominal forecast, i.e. forecast it indirectly.

In the forecasting exercise, we use and compare the two main methods, one-period ahead (static) and multi-period (dynamic) projections. The forecasting properties of the equations are tested with in-sample and out-of-sample projections over the one year horizon. For the latter, the equations are

initially re-estimated over a sub-sample and then the forecasts are produced one year forward from the restricted sample. Finally, dynamic and static forecasts are produced over the period 2000q1:2008q2. It should be kept in mind that the dynamic multi-period method uses the projected value of the dependent variable for the previous period, calculated at the preceding iteration, for forecasting the value of the current period. In this way, forecasts for a period longer than several quarters ahead might diverge significantly from the actual values of the variable and increase the forecasting error. On the other hand, the static (one-period ahead) forecast might be more accurate over longer time horizons (in-sample), but in real-life the method produces only one-period ahead, out-of-sample forecast. For a comparison of the two approaches, we present three measures of the deviation between the forecasts and the actual values, namely the root mean squared error (RMSE), the mean absolute error (MAE) and the mean absolute percent error (MAPE).

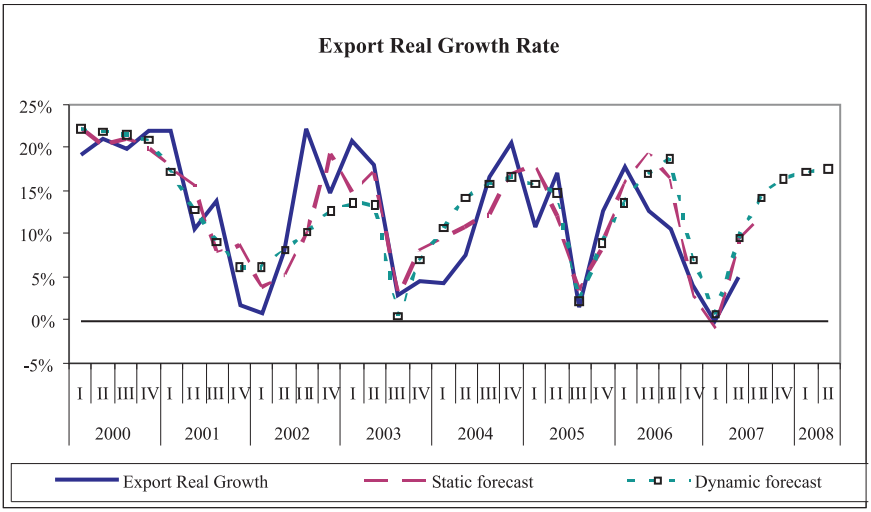
4.1. Export Flows Estimation and Forecasting

Real Growth Rate of Exports

Following the procedure described above, we arrive at a reduced-form of the model (equation 4 and Appendix 2) explaining the real growth rate of the exports of goods. The export real growth rate exhibits an auto-regressive structure of order one (there is some inertia in the process) and it depends positively on the weighted demand of the trading partners (measured by their real growth of imports). A dummy variable corrects for three episodes with actual export growth much lower than the predicted one, which in our view is due to large and uncaptured by the model one-off factors. These episodes are primarily identified on statistical grounds, i.e. the residuals of the equation have extreme values in these sample points implying that the observations in these episodes might be regarded as outliers from an econometric point of view. However, one may relate the export underperformance in two of these episodes to particular events that took place at that time, namely there were floods in the summer of 2005 that destroyed much of the harvest in that year (hence the agricultural exports were low in that period), while the joining of the EU in 2007 was associated with a methodological change in the data collection scheme (introduction of the Intrastat system) which might have led to initial underreporting of exports.

Chart 1 below presents the actual real export growth rates and the dynamic and static forecasts over the period 2000–2008. The forecasts are produced with coefficients, estimated over the whole sample. **Table 1** presents the comparison between the two forecasting methods over different time horizons for this specification.

Chart 1



As expected, the static forecast performs better over the longer horizon, although marginally. On the other hand, the dynamic forecast has lower MAPE in the one-year ahead projection both in- and out-of-sample, at least for the last four quarters of the sample.

Table 1

Variable	Forecasting Method	Sample	Forecasting Horizon	RMSE	MAE	MAPE
Export_r_g	Dynamic	in-sample	2006q3:2007q2	0.036	0.029	53.0%
		out-of-sample	2006q3:2007q2	0.039	0.032	186.8%
		whole period	2000q3:2008q2	0.045	0.038	85.6%
	Static	in-sample	2006q3:2007q2	0.035	0.030	202.6%
		out-of-sample	2006q3:2007q2	0.041	0.036	328.0%
		whole period	2000q3:2008q2	0.046	0.039	83.3%

Nominal Growth Rate of Exports

The specification for the nominal export growth rate is similar to the one for the physical volumes. The nominal growth has a positive autocorrelation of first order and it depends on the external demand and the exchange rate euro/US dollar from the previous period. The absence of a significant constant in the growth equation is interpreted as a lack of statistically significant linear trend in the corresponding export data in levels.

The direct forecasts of the nominal export growth are presented in **Chart 2** and **Table 2** below. Contrary to the real growth rates forecast, the static projections for the nominal growth outperform the dynamic ones in all horizons.

Chart 2

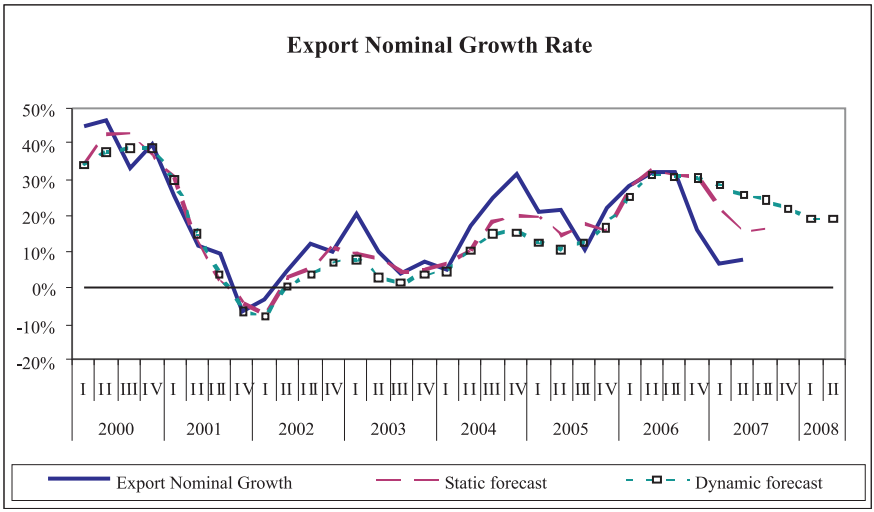


Table 2

Variable	Forecasting Method	Sample	Forecasting Horizon	RMSE	MAE	MAPE
Export_r_g	Dynamic	in-sample	2006q3:2007q2	0.158	0.138	158.9%
		out-of-sample	2006q3:2007q2	0.209	0.184	210.6%
		whole period	2000q3:2008q2	0.087	0.068	56.1%
	Static	in-sample	2006q3:2007q2	0.113	0.097	103.5%
		out-of-sample	2006q3:2007q2	0.145	0.127	136.2%
		whole period	2000q3:2008q2	0.068	0.053	42.5%

Export Deflator

The export deflator depends on a set of international prices, and from the initial more general specification only the crude oil and metals prices are retained based on statistical significance. The export deflator depends also on the nominal exchange rate behavior and exhibits inertia (AR1) and base effects (significant fourth lag). The autoregressive structure is consistent with the behavior of the nominal and real growth rates of export.

The one- and multi-period ahead forecasts, presented at **Chart 3** and **Table 3**, are fairly close to each other due to the relatively high explanatory power of the model. Nevertheless, the formal tests reveal slightly better static method for the out-of-sample projection, while the opposite is true for the in-sample exercise.

Chart 3

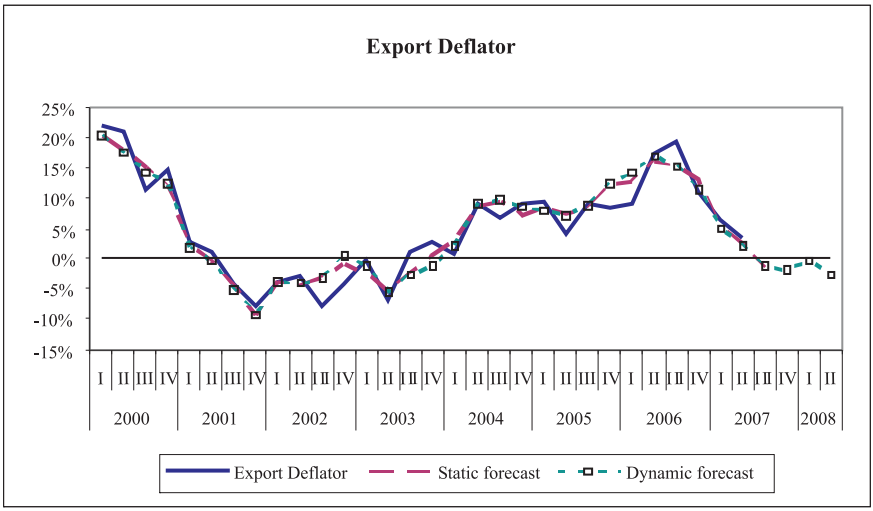


Table 3

Variable	Forecasting Method	Sample	Forecasting Horizon	RMSE	MAE	MAPE
Export_r_g	Dynamic	in-sample	2006q3:2007q2	0.021	0.016	18.2%
		out-of-sample	2006q3:2007q2	0.036	0.033	43.2%
		whole period	2000q3:2008q2	0.025	0.020	88.2%
	Static	in-sample	2006q3:2007q2	0.022	0.019	20.0%
		out-of-sample	2006q3:2007q2	0.033	0.026	33.3%
		whole period	2000q3:2008q2	0.025	0.021	123.2%

External Import Demand

The forecasting of the weighted import growth of the trade partners of Bulgaria is necessary as an auxiliary regression due to the unavailability of such forecasts from external sources, whereas GDP forecasts are normally available as an external assumption. The final reduced-form specification includes autocorrelation and base effects in the import dynamics of the partners as well as positive dependence on the trade-weighted GDP growth rates. The produced with the estimated relation forecasts (static and dynamic) are presented in **Chart 4** and **Table 4** below.

Chart 4

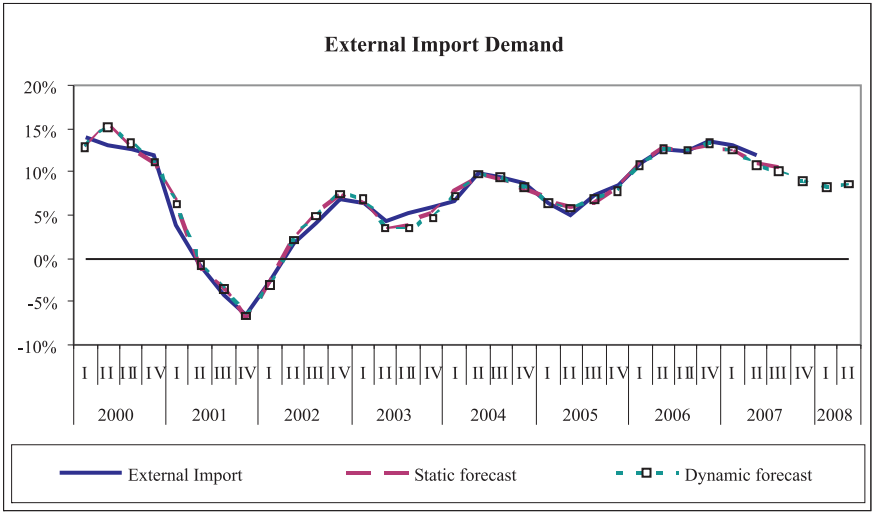


Table 4

Variable	Forecasting Method	Sample	Forecasting Horizon	RMSE	MAE	MAPE
Export_r_g	Dynamic	in-sample	2006q3:2007q2	0.007	0.005	4.2%
		out-of-sample	2006q3:2007q2	0.009	0.008	6.5%
		whole period	2000q3:2008q2	0.009	0.007	11.6%
	Static	in-sample	2006q3:2007q2	0.005	0.004	3.5%
		out-of-sample	2006q3:2007q2	0.007	0.007	5.3%
		whole period	2000q3:2008q2	0.009	0.007	11.7%

4.2. Import Flows Estimation and Forecasting

Imports of Goods in Real Terms

For the forecasting of the real import developments several alternative approaches were tested, including the two presented in this paper, which are forecasting the import flow at constant prices with a subsequent calculation of the growth rates and forecasting directly the real import growth rates.

The results from the first of these approaches (equation 11), i.e. modeling the first differences of the real variables, are presented in **Appendix 3**. The differencing of the variables was required due to the non-stationarity of the processes. The presence of a significant seasonality is accounted for by the inclusion of a full set of seasonal dummies (irrespective of their significance). In addition to the autoregressive structure of imports it depends also on GDP dynamics. The forecasts of the model are presented in **Chart 5** and **Table 5**

below. The high explanatory power of the model results in small forecast errors, expressed as a per cent of the dependent variable, and more accurate static method in all horizons and samples.

Chart 5

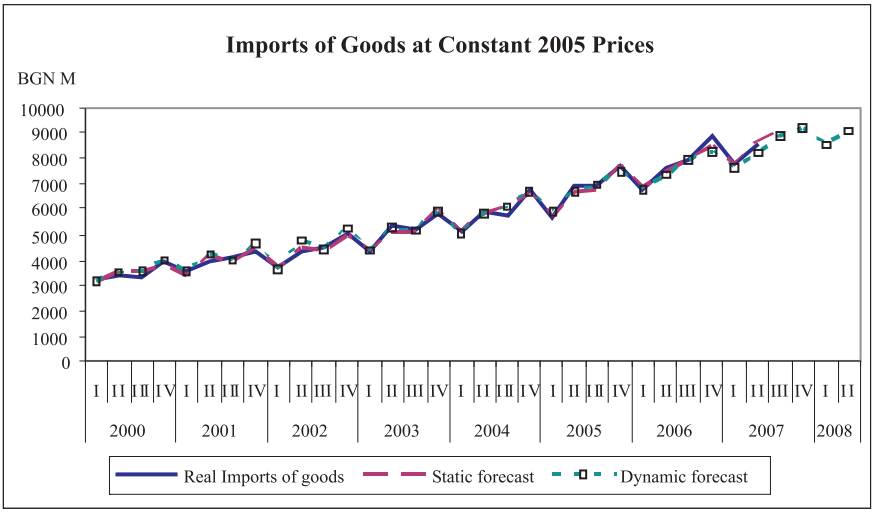


Table 5

Variable	Forecasting Method	Sample	Forecasting Horizon	RMSE	MAE	MAPE
Export_r_g	Dynamic	in-sample	2006q3:2007q2	229.3	185.4	2.2%
		out-of-sample	2006q3:2007q2	277.8	217.7	2.5%
		whole period	2000q3:2008q2	212.0	161.7	3.1%
	Static	in-sample	2006q3:2007q2	213.2	151.1	1.7%
		out-of-sample	2006q3:2007q2	263.5	188.3	2.2%
		whole period	2000q3:2008q2	174.7	141.5	2.8%

The second approach, based on the direct forecasting of the real import growth rate, produced a significant dependence on the domestic demand developments, as well as first-order autocorrelation. Two periods are identified, where the dependent variable exhibits unsystematic and significant deviation from its predicted value, which are corrected by the inclusion of impact dummy variables (having the value of '1' for one or two quarters and zero otherwise). The forecasting performance of the model is illustrated in **Chart 6** and **Table 6**. For this specification the static projection performs better in the one-year ahead horizon while the dynamic forecast is marginally better over the whole sample.

Chart 6

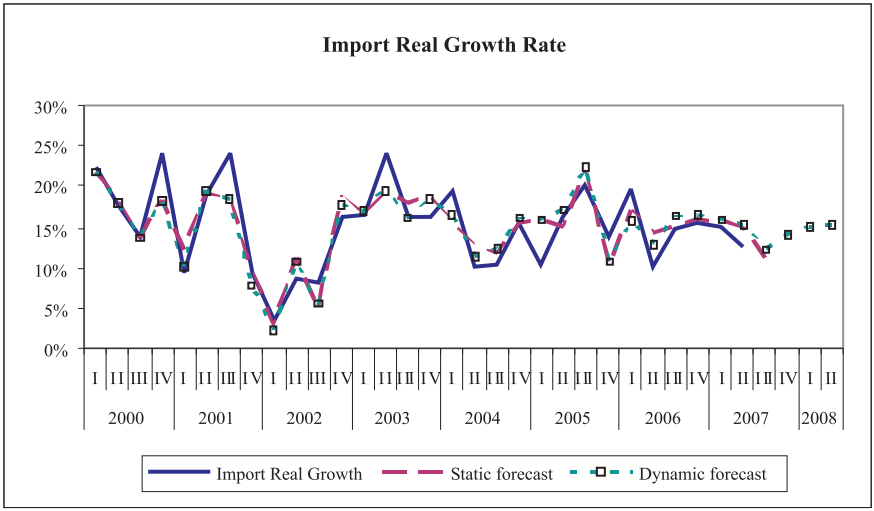


Table 6

Variable	Forecasting Method	Sample	Forecasting Horizon	RMSE	MAE	MAPE
Export_r_g	Dynamic	in-sample	2006q3:2007q2	0.014	0.011	8.2%
		out-of-sample	2006q3:2007q2	0.019	0.017	12.1%
		whole period	2000q3:2008q2	0.027	0.020	14.9%
	Static	in-sample	2006q3:2007q2	0.012	0.009	7.0%
		out-of-sample	2006q3:2007q2	0.016	0.013	9.9%
		whole period	2000q3:2008q2	0.028	0.022	16.0%

Nominal Growth of Imports

The reduced-form specification for the nominal development of imports includes the first and the fourth lag of the dependent variable, the nominal growth rate of domestic demand, as well as the exchange rate EUR/USD. The experiments with different specifications revealed a worse explanatory power for the nominal GDP growth as compared to domestic demand. The significant effect of exchange rate developments, which was revealed for exports is also related to the share of foreign trade invoiced in USD (mostly commodities and energy resources). The interpretation of the coefficient is the following: nominal depreciation of the BGN (EUR) against the USD (an increase of the exchange rate index) is associated with larger nominal value of imports due to the low price elasticity of the USD-invoiced imported goods (energy resources). Hence, even when the quantity of imported goods declines due to

the higher imported prices (in domestic currency), the price effect dominates in the nominal amount and the overall effect is positive.

Chart 7 and **Table 7** below present the forecasts for the nominal import growth. For this specification the dynamic forecast performs relatively well in the one-year ahead horizon.

Chart 7

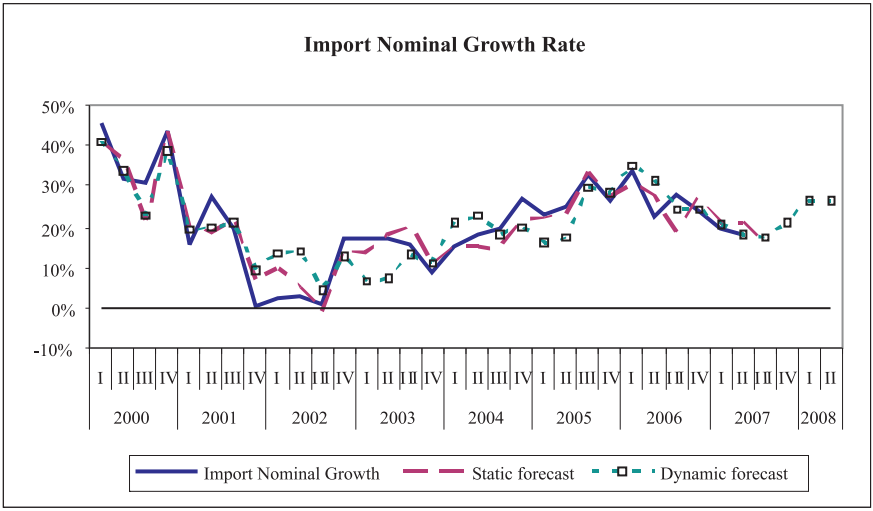


Table 7

Variable	Forecasting Method	Sample	Forecasting Horizon	RMSE	MAE	MAPE
Export_r_g	Dynamic	in-sample	2006q3:2007q2	0.052	0.039	16.0%
		out-of-sample	2006q3:2007q2	0.053	0.038	15.9%
		whole period	2000q3:2008q2	0.060	0.050	200.0%
	Static	in-sample	2006q3:2007q2	0.054	0.044	18.4%
		out-of-sample	2006q3:2007q2	0.055	0.044	18.4%
		whole period	2000q3:2008q2	0.044	0.036	128.6%

Import Deflator

Following the same general-to-specific approach described above the derived specification for the import deflator includes an autoregressive structure, international prices of crude oil and metals and the EUR/USD nominal exchange rate. The effect of the exchange rate in the price equation is in line with the interpretation given above for the nominal import development, namely, that the price component dominates the real effect. The autoregressive structure of the import deflator reveals higher inertia than the corresponding export deflator behaviour.

The forecasts, presented in **Chart 8** and **Table 8** below, reveal relatively good properties of the dynamic projection, although in the out-of-sample exercise the static forecast clearly dominates.

Chart 8

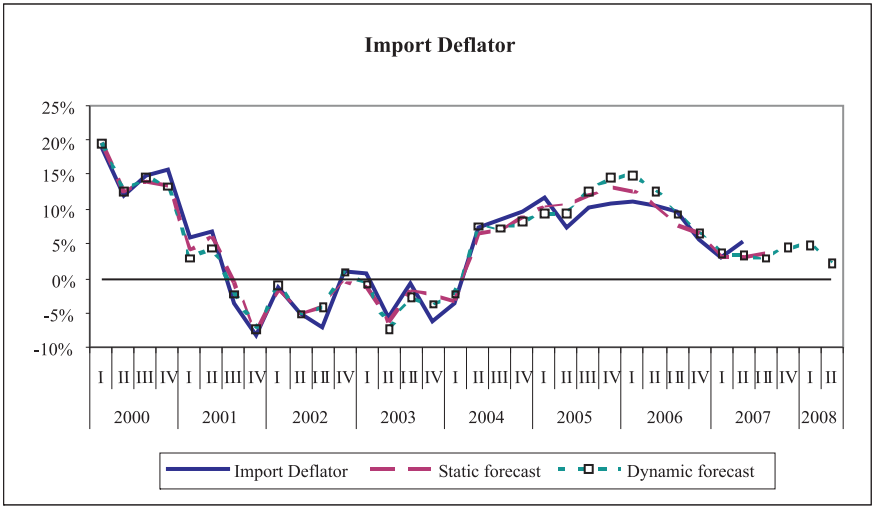


Table 8

Variable	Forecasting Method	Sample	Forecasting Horizon	RMSE	MAE	MAPE
Export_r_g	Dynamic	in-sample	2006q3:2007q2	0.015	0.010	16.8%
		out-of-sample	2006q3:2007q2	0.028	0.027	49.5%
		whole period	2000q3:2008q2	0.018	0.015	36.6%
	Static	in-sample	2006q3:2007q2	0.016	0.013	20.8%
		out-of-sample	2006q3:2007q2	0.021	0.017	28.0%
		whole period	2000q3:2008q2	0.017	0.013	36.5%

4.3. Insignificance of the Real Effective Exchange Rate

In spite of its theoretical importance, the different series for the real effective exchange rate (REER) of the BGN do not appear to be significant in the estimations we performed, neither for the export, nor for the import flows. We could not find a significant explanatory power not only for the CPI-deflated REER, but also for the ULC-based index.

Explanations for this result probably relate to the specifics of the transition and restructuring period in Bulgaria, as well as to the current converging path of the economy. On the one hand, productivity catching up naturally causes a trend of appreciation of the REER. On the other hand, deepening integration within the EU market influences foreign trade developments. Such structural but unaccounted factors probably break the statistical relation between REER developments and export and import flows of the country.

Conclusion

One of the main conclusions of the author is that with the available data for the Bulgarian economy and the chosen modeling approach only short run export and import forecasts could be produced. Although accurate (particularly for some of the specifications), the forecasts are reliable for only several quarters ahead. Therefore, we regard the developed model as an auxiliary instrument to a full-fledged macroeconomic projections model, which might be used for comparing and checking the results from the main tool.

In our view, there are a number of ways for extending and improving the forecasting methods and results, presented in this paper. First, the relations should be re-estimated as the sample size increases with time, and therefore additionally checked for robustness. The short sample size of the available data for Bulgaria reduces the applicability of a number of econometric techniques, which are based on asymptotic results and thus appropriate for large samples. Second, the obvious alternative to the classical statistical methods is the Bayesian approach to parameter estimation, which might result in better forecasting performance of the equations. The Bayesian method also allows the incorporation of additional information in the form of expert judgment on prior probabilities.

Finally, there are a number of alternative approaches for developing forecasting instruments in the field of foreign trade. One way to go is to give up the econometric estimation approach completely and to develop a macro model with calibrated relations. Such a model could follow the neo-classical or new keynesian tradition and could produce model-based forecasts, although not being informed by actual data.

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Appendix 1

UNIT ROOTS TESTS FOR THE KEY VARIABLES

Variables	Description	Period	ADF					KPSS					
			Levels		1 difference		Order of	levels	1 difference	critical values			Order of
			t-statistic	p-value'	t-statistic	p-value'	integration	t-statistic	t-statistic	1%	5%	10%	integration
DD_4d	Annual nominal growth rate of domestic demand	1998:Q1-2007:Q2	-114.028	0.000			I(0)	0.324360		0.739	0.463	0.347	I(0)
DD_rg	Annual real growth rate of domestic demand	1998:Q1-2007:Q2	-6.521	0.000			I(0)	0.249816		0.739	0.463	0.347	I(0)
Exp_defl	Goods export deflator	1999:Q1-2007:Q2	-1.978	0.047			I(0)	0.170212		0.739	0.463	0.347	I(0)
Exp_ng	Annual nominal growth rate of exports	1998:Q1-2007:Q2	-3.277	0.024			I(0)	0.182604		0.739	0.463	0.347	I(0)
Exp_r_g	Annual real growth rate of exports	1999:Q1-2007:Q2	-3.898	0.005			I(0)	0.146246		0.739	0.463	0.347	I(0)
Export	Exports of goods, mln euro	1998:Q1-2007:Q2	-2.061	0.550	-3.627*	0.0437	I(1) or I(2)	0.696541	0.402025	0.739	0.463	0.347	I(1) or I(2)
Ext_gdp	Composite measure of external demand in terms of real GDP growth of our trade partners	1999:Q1-2007:Q2	-2.689	0.087			I(0)	0.215423		0.739	0.463	0.347	I(0)
Ext_imp	Composite measure of external demand in terms of the real import growth of our trade partners	1999:Q1-2007:Q2	-2.636	0.097			I(0)	0.196137		0.739	0.463	0.347	I(0)
Imp_defl	Goods import deflator	1999:Q1-2007:Q2	-1.992	0.046			I(0)	0.126200		0.739	0.463	0.347	I(0)
Imp_n_g	Annual nominal growth rate of imports	1998:Q1-2007:Q2	-3.854	0.005			I(0)	0.128274		0.739	0.463	0.347	I(0)
Imp_r_g	Annual real growth rate of imports	1999:Q1-2007:Q2	-4.800	0.001			I(0)	0.055558		0.739	0.463	0.347	I(0)
Import	Imports of goods, mln euro	1998:Q1-2007:Q2	0.818	1.000	-2.6564*	0.2598	I(2)	0.703179	0.384153	0.739	0.463	0.347	I(1) or I(2)
Metals	Metal Prices Annual Change	1998:Q1-2007:Q2	-3.215*	0.098			I(0)	0.096741*		0.216	0.146	0.119	I(0)
Oil	Petroleum spot price, annual change	1998:Q1-2007:Q2	-4.756	0.001			I(0)	0.073895		0.739	0.463	0.347	I(0)
REER_ULC	Real Effective Exchange Rate, ULC-deflated	1998:Q1-2007:Q2	-3.242	0.002			I(0)	0.305834		0.739	0.463	0.347	I(0)
RGDP	GDP at constant prices	1998:Q1-2007:Q2	-0.762	0.959	-5.7911*	0.0003	I(1) or I(2)	0.818478	0.198245	0.739	0.463	0.347	I(1)
RimpG	Imports at constant prices	1998:Q1-2007:Q2	-0.218	0.990	-2.875546	0.0594	I(1) or I(2)	0.713898	0.148658	0.739	0.463	0.347	I(1)
USD	Annual change of the BGN/USD rate	1998:Q1-2007:Q2	-1.883	0.058			I(0)	0.344615		0.739	0.463	0.347	I(0)

Notes: IMF or ECB forecasts are used for the variables Ext_gdp, Ext_imp, USD, Oil, Metals. ADF stands for Augmented Dickey Fuller and KPSS for Kwiatkowski-Phillips-Schmidt-Shin tests. The tests are performed with a constant and without a trend term in the test regression (with the exception of the variables Exp_defl, Imp_defl, REER_ULC, USD for which both are excluded).

* includes trend and a constant in the test regression

' MacKinnon (1996) one-sided p-values

EXPORT EQUATIONS

Dependent Variable: EXP_R_G
Method: Least Squares
Date: 11/01/07 Time: 10:38
Sample (adjusted): 1999Q2 2007Q2
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.040877	0.019213	2.127633	0.0420
EXP_R_G(-1)	0.541677	0.094915	5.706966	0.0000
EXT_IMP	0.437828	0.190650	2.296501	0.0291
D033_053_064_071	-0.130086	0.030304	-4.292649	0.0002

R-squared	0.636535	Mean dependent var	0.113668
Adjusted R-squared	0.598935	S.D. dependent var	0.088038
S.E. of regression	0.055754	Akaike info criterion	-2.822510
Sum squared resid	0.090148	Schwarz criterion	-2.641115
Log likelihood	50.57142	F-statistic	16.92922
Durbin-Watson stat	2.226063	Prob (F-statistic)	0.000002

Dependent Variable: EXP_N_G
Method: Least Squares
Date: 11/01/07 Time: 10:38
Sample (adjusted): 1999Q2 2007Q2
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXP_N_G(-1)	0.463544	0.088064	5.263744	0.0000
EXT_IMP	1.310235	0.220426	5.944092	0.0000
USD(-1)	0.351344	0.131744	2.666857	0.0122

R-squared	0.753924	Mean dependent var	0.174315
Adjusted R-squared	0.737519	S.D. dependent var	0.140625
S.E. of regression	0.072046	Akaike info criterion	-2.336509
Sum squared resid	0.155720	Schwarz criterion	-2.200463
Log likelihood	41.55240	Durbin-Watson stat	1.568140

Dependent Variable: EXP_DEFL
Method: Least Squares
Date: 11/01/07 Time: 10:38
Sample (adjusted): 2000Q1 2007Q2
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXP_DEFL(-1)	0.265920	0.093261	2.851343	0.0086
EXP_DEFL(-4)	-0.140846	0.072577	-1.940636	0.0637
OIL 0.070373	0.017758	3.962765	0.0005	
METALS0.186749	0.030810	6.061408	0.0000	
USD 0.365795	0.063860	5.728078	0.0000	

R-squared	0.910898	Mean dependent var	0.053622
Adjusted R-squared	0.896642	S.D. dependent var	0.083732
S.E. of regression	0.026919	Akaike info criterion	-4.240933
Sum squared resid	0.018116	Schwarz criterion	-4.007400
Log likelihood	68.61399	Durbin-Watson stat	2.229111

Dependent Variable: EXT_IMP
Method: Least Squares
Date: 11/01/07 Time: 10:38
Sample (adjusted): 2000Q1 2007Q2
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C -0.034454	0.006111	-5.638466	0.0000	
EXT_IMP(-1)	0.338866	0.065665	5.160522	0.0000
EXT_IMP(-4)	-0.158596	0.038847	-4.082624	0.0004
EXT_GDP3.300480	0.296698	11.12403	0.0000	

R-squared	0.972685	Mean dependent var	0.069848
Adjusted R-squared	0.969534	S.D. dependent var	0.054885
S.E. of regression	0.009580	Akaike info criterion	-6.334728
Sum squared resid	0.002386	Schwarz criterion	-6.147901
Log likelihood	99.02091	F-statistic	308.6235
Durbin-Watson stat	2.275812	Prob (F-statistic)	0.000000

IMPORT EQUATIONS

Dependent Variable: IMP_R_G
Method: Least Squares
Date: 11/01/07 Time: 10:38
Sample (adjusted): 1999Q2 2007Q2
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C 0.102384	0.021070	4.859129	0.0000	
IMP_R_G(-1)	0.367427	0.090362	4.066187	0.0004
DD_RG0.970643	0.190455	5.096451	0.0000	
DD_RG(-1)-1.039880	0.189352	-5.491781	0.0000	
D994 0.174015	0.032397	5.371313	0.0000	
D014_021-0.083656	0.022209	-3.766737	0.0008	

R-squared	0.746971	Mean dependent var	0.150893
Adjusted R-squared	0.700114	S.D. dependent var	0.055094
S.E. of regression	0.030170	Akaike info criterion	-4.000940
Sum squared resid	0.024577	Schwarz criterion	-3.728848
Log likelihood	72.01551	F-statistic	15.94141
Durbin-Watson stat	2.563843	Prob (F-statistic)	0.000000

Dependent Variable: IMP_N_G
Method: Least Squares
Date: 11/01/07 Time: 10:38
Sample (adjusted): 1999Q1 2007Q2
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IMP_N_G(-1)	0.559248	0.070349	7.949621	0.0000
IMP_N_G(-4)	-0.424518	0.062823	-6.757386	0.0000
DD_4D1.295746	0.134101	9.662447	0.0000	
USD 0.159297	0.088617	1.797600	0.0827	
D004 0.193140	0.050907	3.793962	0.0007	

R-squared	0.855247	Mean dependent var	0.204172
Adjusted R-squared	0.835281	S.D. dependent var	0.114279
S.E. of regression	0.046381	Akaike info criterion	-3.168808
Sum squared resid	0.062384	Schwarz criterion	-2.944344
Log likelihood	58.86974	Durbin-Watson stat	2.197973

Dependent Variable: IMP_DEFL
Method: Least Squares
Date: 11/01/07 Time: 10:38
Sample (adjusted): 2000Q1 2007Q2
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IMP_DEFL(-1)	0.481221	0.105831	4.547068	0.0001
IMP_DEFL(-2)	0.129433	0.067596	1.914807	0.0680
OIL 0.159182	0.023005	6.919383	0.0000	
OIL(-1)-0.085098	0.025487	-3.338830	0.0029	
USD 0.486693	0.071882	6.770756	0.0000	
USD(-1)-0.301364	0.078001	-3.863594	0.0008	
METALS0.058532	0.021028	2.783490	0.0106	

R-squared	0.948627	Mean dependent var	0.048447
Adjusted R-squared	0.935226	S.D. dependent var	0.074470
S.E. of regression	0.018953	Akaike info criterion	-4.892716
Sum squared resid	0.008262	Schwarz criterion	-4.565770
Log likelihood	80.39073	Durbin-Watson stat	1.561010

Dependent Variable: D(RIMPG)
Method: Least Squares
Date: 11/01/07 Time: 10:38
Sample (adjusted): 1998Q3 2007Q2
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RIMPG(-1))	-0.762540	0.118807	-6.418281	0.0000
D(RGDP)0.551893	0.119640	4.612951	0.0001	
D(RGDP(-1))	0.736279	0.142466	5.168090	0.0000
@SEAS(1)1006.093	236.3708	4.256419	0.0002	
@SEAS(2)1118.387	226.9118	4.928731	0.0000	
@SEAS(3)-918.3313	255.0416	-3.600711	0.0012	
@SEAS(4)-579.6580	248.7004	-2.330748	0.0272	
D021 -571.2839	214.3365	-2.665359	0.0126	

R-squared	0.919376	Mean dependent var	164.1231
Adjusted R-squared	0.899221	S.D. dependent var	611.4562
S.E. of regression	194.1115	Akaike info criterion	13.56787
Sum squared resid	1055019.	Schwarz criterion	13.91977
Log likelihood	-236.2217	Durbin-Watson stat	2.306140

DISCUSSION PAPERS

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