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Income and Price Elasticities of Croatian Trade – A Panel Data Approach

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Income and Price Elasticities of Croatian Trade – A Panel Data Approach

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Abstract

This paper deals with the estimation of price and income elasticities of Croatian trade flows using disaggregated data by industries for the period after Croatia joined the WTO in 2000 and until 2007. Export and import demand functions are estimated for total merchandise trade as well as for several partner country subsamples, with controls for other potential trade flow determinants, such as the exchange rate, tariffs, FDI inflows and credit supply to particular industries. Given the dynamic nature of the studied flows and potential endogeneity issues, the models were estimated using the Arellano-Bond method (1991). The results indicate that the sensitivity of both exports and imports to prices is relatively low, while income effects are stronger. These results are confirmed in all the country subsamples. The influence of other factors, however, does not appear to be as stable or uniform across country subsamples.

JEL:
F12, F14

Keywords:
trade modelling, income and price elasticities, panel data

Contents

1 Introduction

The Croatian economy has been faced with significant problems of external imbalance, as seen through the growing current account deficit, which in turn primarily reflects a large deficit in merchandise trade. In fact, the high dependence on imports and lackluster export performance are frequently stressed among the key issues facing the Croatian economy. The purpose of this paper is to determine the most important factors that affect movements in Croatian merchandise trade, with particular interest in determining income and price elasticities of both imports and exports. Stable elasticity coefficients estimated from historical data can be of use in gauging the impact of changes in the economy as well as of fiscal and monetary policy on the trade balance and the current account. These elasticities can also be used in macroeconomic forecasting, as they describe the interdependencies between variables of interest and determine the intensity of the effect of various policy measures. Determinants other than prices and income are also analyzed. Perhaps the most interesting of these, given its much debated influence on the trade and competitiveness of Croatian goods, is the kuna/euro exchange rate.

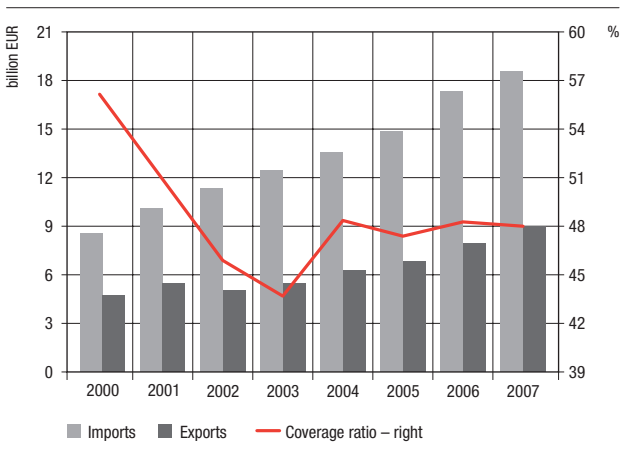
Issues regarding merchandise trade in Croatia have been the subject of numerous debates and analyses. However, the latter have for the most part been descriptive, while the number of papers treating the subject by applying econometric methods is relatively small. The aim of this paper is, therefore, to make a contribution by quantifying the effect of the potential determinants of imports and exports using sectoral data for the period 2000 to 2007. Using panel data makes it possible to investigate changes in the series over time while taking into account the heterogeneity of the different sectors in the dataset. In this it avoids both problems associated with cross-section data and those that arise from using aggregate data in time-series analysis, which may lead to aggregation bias. Furthermore, it also means that the estimation will be based on a much larger set of observations, something of particular importance in the case of transition countries such as Croatia, where the length of available time series is limited.

The rest of the paper is organized as follows: the second section gives an overview of Croatian trade and its characteristics during the analyzed period, while the third presents the theoretical background and econometric method applied in the estimation, as well as a summary of relevant empirical research. Variables included in the specification and data characteristics are listed in the fourth section, estimation results are presented in the fifth section, while the sixth concludes the paper.

2 Characteristics of Croatian trade, 2000 – 2007

The many and substantive changes that occurred during the 1990s in the political and economic system of Croatia and many of its neighbouring countries, which accounted for a large share of the Croatian export market, as well as the liberalization of trade in the same period, resulted in significant structural breaks in the data. These breaks make it difficult to conduct econometric analysis and obtain meaningful results, which is why this estimation has been based on data for the period between 2000 and 2007. Croatia became a member of the World Trade Organization (WTO) in 2000, after which the only significant institutional change came with the entry into the Central European Free Trade Agreement (CEFTA) in early 2003. Although this is a relatively short period, given that panel data methods will be applied, it nevertheless contains enough information and a sufficient number of observations to serve as the basis for econometric analysis. Data for the period prior to 2000, apart from having several structural breaks, are either unavailable in many instances, or significantly less reliable.

Figure 1 Trade performance, 2000 – 2007



Source: Central Bureau of Statistics.

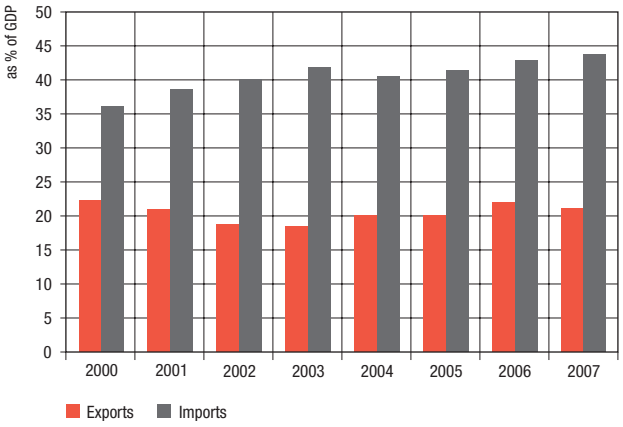
During the period in question, Croatian merchandise trade was characterized by the constant growth of both imports and exports. However, the much stronger growth of the former resulted in a very low coverage ratio, with exports accounting for, on average, just under half of total imports (48.6%). The main reasons for such dismal trade results are the deep structural problems and low competitiveness of the economy after the collapse of the centrally-planned economic system, further exacerbated by the war, which coincided with the first few crucial years of transition. Coupled with the practical disappearance of the internal Yugoslavian market, significant negative consequences of the mismanaged process of privatization and low investment, this resulted in a severe drop in exports compared to the pre-transition period. While export growth did pick up during the period analyzed in this paper, the initial drop and the structural changes left lasting consequences. However, although most transition countries in Central and Eastern Europe faced some similar problems, none, with the

possible exception of Latvia, has consistently recorded such a pronounced imbalance in international trade.

The Croatian trade deficit recorded high positive growth rates in all but one of the years during the period in question. Exports increased from EUR 4.8 billion in 2000 to EUR 9.0 billion in 2007, with an average annual growth rate of 10.7%. Export growth was slower during the first half of this period, picking up considerably in the later years. Imports more than doubled in the same period, increasing from EUR 8.6 billion in 2000 to EUR 18.8 billion in 2007, with an average annual growth rate of 12.6%. Growth was slowest in 2004, with imports increasing by only 6.5%. The fact that Croatian imports grew at a much higher rate than nominal GDP, which averaged 8.9% in the same period, should indicate a relatively high income elasticity of imports.

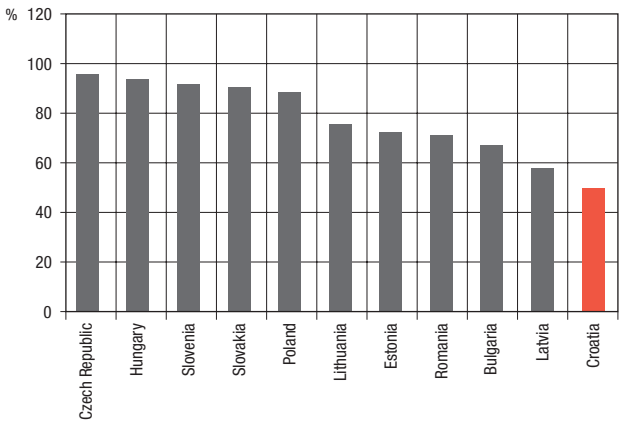
Given that the analysis is based on sectoral imports and exports according to the National Classification of Economic Activities (NCEA), it is important to look at structural dynamics in order to be aware of certain issues that might affect the outcome as well as the validity of the analysis. Particularly worth noting are developments in those sectors that, due to their share in total exports or higher volatility, have significant impacts on changes in aggregate exports. The most important of these are exports of other transport equipment (NCEA 35), mostly ships, which had the highest, albeit slightly decreasing, share in total exports during the analyzed period. This sector is characterized by significant differences in dynamics within each year, both of imports and exports, due to the very high value of individual ships, as well as to the method of gross accounting applied when recording their imports and exports. Significant seasonal volatility is also present in many other sectors, particularly in the export of textiles (NCEA 17) and wood (NCEA 20). In general, using disaggregated trade data for shorter time periods is problematic in the case of Croatia, because the values of imports and exports often vary widely from period to period, and even more so when sectors are very narrowly defined. Available quarterly data would have to be seasonally adjusted, which still does not entirely eliminate the

Figure 2 Merchandise trade as % of GDP, 2000 – 2007



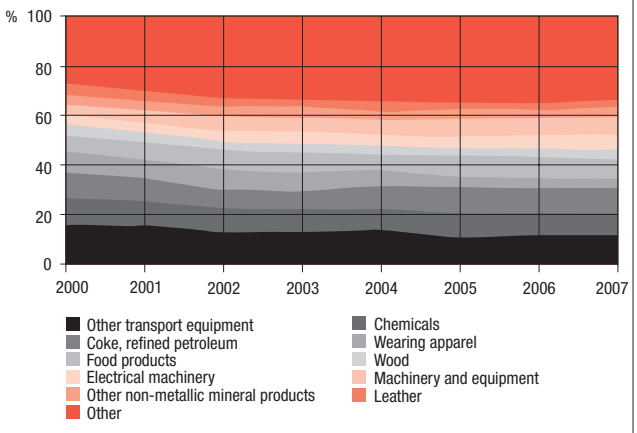
Source: Central Bureau of Statistics.

Figure 3 Average 2000 – 2007 merchandise trade coverage ratio (exports as % of imports)



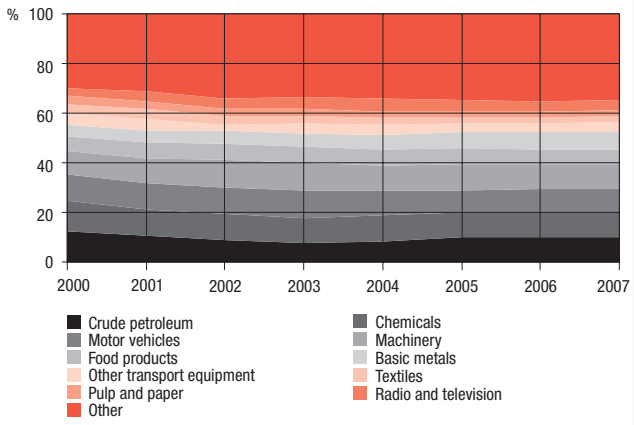
Source: Eurostat.

Figure 4 Structure of exports according to NCEA, 2000 – 2007



Source: Central Bureau of Statistics.

Figure 5 Structure of imports according to NCEA, 2000 – 2007



Source: Central Bureau of Statistics.

problem (Mervar, 2003). These issues prompted the use of annual data in this analysis.

Another point which has to be taken into account is the fact that changes in the value of exports of certain sectors were highly dependent on administrative decisions, such as in the case of the exports of fish (NCEA 5), which heavily depend on quotas for fishing and exports of certain kinds of fish; of tobacco products (NCEA 16), where the price of final products is regulated by the state; of certain food products (NCEA 15), etc.

As with exports, no significant changes were recorded in the structure of imports, in which ten sectors with the largest share in the total made up more than 65%. In fact, four sectors accounted for more than 10% each: crude petroleum, chemicals, motor vehicles and machinery and equipment.

3 Theoretical basis and issues in trade modelling

The framework and methods of trade modelling are numerous and the choice is influenced by several factors: whether the purpose of the model is hypothesis-testing or forecasting future movements in the trade balance; data availability and the level of their disaggregation; the type of traded goods; and, ultimately, the final purpose of the model (Algieri, 2004).

Models of trade can be divided into two basic groups – perfect and imperfect substitution models. Given that empirical evidence shows that prices of goods in different countries do not converge to a single price, the law of one price does not appear to hold. The causes of international arbitrage inefficiency in the setting of one world price are many, but their discussion is outside the scope of this paper; however, it does indicate that the latter model is more suitable in this context.

3.1 Imperfect substitutes model

The basic assumption of this model is that neither imports nor exports serve as perfect substitutes for domestic goods. This assumption has been confirmed empirically, both in the short and in the long run. If domestic and foreign goods were perfect substitutes, then countries would specialize, either only importing or only exporting each particular good. In practice, however, both domestic and imported goods can be found coexisting on markets, indicating that countries do not in fact specialize to such a high degree. If we were to analyze only trade of certain goods, the perfect substitutes model could be applied, as in the case of some undiversified goods (e.g. wheat or other agricultural products). However, given that we analyze total merchandise trade divided into sectors within which there is still a relatively large number of very different goods, the application of the prefect substitutes model would not be appropriate.

Models of import and export demand assume that households first choose the level and structure of consumption that maximizes their utility and then allocate the chosen level between domestic and imported goods. The same is true of intermediary and investment goods, the demand for which is the result of the minimization of a cost function with a given level of production and input prices (Cubadda, Fachin and Nucci, 1999). The result is therefore the same for all markets and all types of goods, and that is that sectoral imports depend on domestic demand in the importing country and relative prices. In line with that, import and export demand is specified as a function of the level of income in the importing country and of the price ratio of domestically produced goods and their imported substitutes.

$$I_i = f(Y_i, PIm_i / P_i)$$
$$X_i = f(Y^*_i, PEx_i / P^*_i)$$

where:

I_i ... imports;
X_i ... exports;
Y_i ... domestic income;
Y_{i^*} ... world income;
PIm_i ... import prices;
PEx_i ... export prices;
P_i ... price of domestic goods;
P_{i^*} ... price of foreign goods on the world market;
i ... groups of goods 1, ... 30, according to NCEA classification.

The model is specified as an exponential function, which means that applying a logarithmic transformation also modifies the hypothesis; given that what is being estimated are coefficients on logs, they can be interpreted as elasticities. This type of specification is more appropriate for the description of nonlinear factors determining growth, with an additional advantage in the fact that it reduces the impact of the size of each sector on estimation results, which could otherwise cause bias toward sectors with a larger share in the total. The coefficients on income (Y_i, Y^*) are expected to be positive, as are the coefficients on the prices of domestic substitutes in the importing country (P_i, P^*). On the other hand, elasticity coefficients on the prices of exports and imports (PIm_i, PEx_i) are expected to be negative. The income variable Y_i should reflect domestic demand for products of sector *i* in the import equation, just as Y^* captures foreign demand in the export equation. Both of these variables will in fact measure aggregate demand for goods of all sectors, using real GDP as a proxy. While the expected sign of the coefficients is clear, making predictions on their absolute size is more difficult. The choice of price variables and the limitations which influenced it are discussed in more detail in Section 4. Also worth noting is the fact that the logarithmic transformation means that coefficients on the variables forming the relative price ratio can be estimated separately.

In addition to these variables, other factors that potentially determine imports and exports are also included in the estimation: the nominal exchange rate of the kuna against the euro (*ER*), foreign direct investment (FDI_i), tariffs on imports ($Tariff_i$) and credit supply to firms in the export equation ($Credit_i$). Tariffs are introduced into the model because they represent one of the most common barriers to uninterrupted trade flows between countries. The exchange rate, on the other hand, affects the competitiveness of the economy as a whole,

determining the price of a foreign product in domestic currency and vice-versa, thus separating the price effect contained in the price variable from the effect of changes in the exchange rate. Foreign direct investment influences supply-side determinants of exports and imports, reflecting to some extent the quality of physical capital as well as worker skills and market penetration potential (Benaček, Prokop, Višek, 2003). Similarly, access to credit supply should be related to higher productivity as well as production and export prospects. The functions estimated here are therefore specified as:

$$I_i = f_I(GDP, P\,Im_i, P_i, ER, Tariffs_i)$$
$$X_i = f_I(GDP^*, P_i^*, PEx_i, ER, FDI_i, Credit_i)$$

3.2 Econometric methods and issues

The estimation of a dynamic model was prompted by the nature of the relationships being investigated and the dynamic aspect of data adjustment. A previous version of this model was static OLS with fixed cross-section effects used to control for existing differences between NCEA sectors (estimation results obtained with this method are reported in the Appendix). If a static model is estimated and the underlying dynamics ignored, significant information might be lost, resulting in poor estimation results. When a dynamic model is estimated, although the coefficient on the lagged dependent variable is not of interest, dynamics are allowed for in the underlying processes, which might be essential for the recovery of consistent estimates of other parameters (Bond, 2002). The inclusion of lagged quantities, in addition to accounting for rigidities in adjustment, also lessens the problem of omitted variables. The dynamic model is then specified as:

$$y_{it} = \alpha_{yi,t-1} + \beta x_{it} + (\eta_i + \varepsilon_{it}) \qquad \text{Eq. (1)}$$

where y_{it} is the value of the dependent variable of sector i in period t; $y_{i,t-1}$ is the value of the dependent variable for the same sector lagged one period; x_{it} is the vector of explanatory variables for sector i in period t; η_i are the individual effects and ε_i is the disturbance term. The sectoral effects are being treated as stochastic, while a further assumption critical for the consistency of the model is that the disturbances ε_i are serially uncorrelated. The fixed effects model, which would control for sectoral differences when estimating a static model, is not applicable in this case, with the individual sectoral effects removed by first-differencing in the dynamic estimation. The most appropriate framework for obtaining estimates in this context is the generalized method of moments (GMM) (Arellano and Bond, 1991); the transformed model is then given by:

$$\Delta y_{it} = \alpha \Delta_{yi,t-1} + \beta \Delta x_{it} + \Delta \varepsilon_{it} \qquad \text{Eq. (2)}$$

where $\Delta y_{it} = y_{it} - y_{i,t-1}$. Estimation by GMM uses a different number of instruments for the lagged dependent and other endogenous variables for each period, depending on how many are available. In addition, the estimation may include other variables which are exogenous and therefore need not be instrumented. Since differencing the data, necessary to remove sectoral effects, also introduces correlation between the lagged differences of the dependent variable and the differenced error term, Arellano and Bond (1991) propose the use of lagged levels of the endogenous variables as instruments, resulting in a more efficient estimator that takes into account all available moment restrictions. In the case of the lagged dependent variable, valid instruments will be those which are correlated with $\Delta y_{i,t-1}$ and uncorrelated with $\Delta \varepsilon_{it}$. An instrument that satisfies this condition is the lagged level of the dependent variable, since it is correlated with its first-difference, but orthogonal to the differenced disturbance term. In other words, in $t = 3$ the instrument for $\Delta y_{i,2}$ in Equation (2) is $y_{i,1}$; if $t > 3$ more lags may be used as instruments, so in $t = 4$ potential instruments for $\Delta y_{i,3}$ are both $y_{i,1}$ and $y_{i,2}$. The explanatory variable x, if assumed to be endogenous, is treated symmetrically with the lagged dependent variable y_{t-1} (Bond, 2002). Important to note is the fact that lagged levels will convey meaningful information on subsequent changes in the variable only if the variable is not close to a random walk, which was pointed out by Blundell and Bond (1998). However, values of the autoregressive coefficient in the least squares equation do not indicate that this would be a problem in our case. The method uses the White period weighting matrix and corrected standard errors.

The validity of the assumptions can be tested in two ways: first, by testing for the absence of second-order serial correlation in the residuals of the first-differenced equation, a condition essential for obtaining consistent estimates, the initial hypothesis of no serial correlation in the original disturbance term can be confirmed (Arellano and Bond, 1991); secondly, if $t > 3$ the model is overidentified and the Sargan test can be used to test for overidentifying restrictions. The first condition of no second-order serial correlation, crucial for the validity of the instruments, is in this case defined for $t \geq 5$ and requires $E[\Delta u_{it} \Delta u_{it-2}] = 0$. Testing for validity of the instruments by using the test of overidentifying restrictions in effect tests for correlation of the residuals with all exogenous variables. The Sargan test will be constructed using the fact that $t > 3$ and the reported J-statistic.

3.3 Overview of existing literature

Within the large body of research on this topic of particular interest are papers that have dealt with the estimation of import and export elasticities for countries in the region and are comparable to Croatia, such as the Czech Republic, Slovakia and Poland. The estimates obtained in these papers often differ to a significant degree, not only among different countries, but also for the same country in different estimations. This is the result of differences in model specification, the choice of variables and the econometric methods applied in each case. On the other hand, a common characteristic of most of these papers is that their theoretical foundation is in the imperfect substitutes model.

The papers by Houthakker and Magee (1969), and Goldstein and Khan (1985) presented a comprehensive theoretical overview of the issues and techniques in the modelling of trade elasticities as well as empirical results for a number of countries, serving as a basis for many researchers in the field. Benaček, Prokop and Višek (2003) applied panel data methods on sectoral data for Czech trade flows, estimating static random and fixed effects models, while an updated version of the paper (Benaček, Podpiera and Prokop, 2005) estimated both a static and a dynamic model, the latter using

the two-step Arellano-Bond method; Tomšik (2000) also estimated Czech import and export elasticities using OLS on aggregate trade series and those of particular sectors. The latter approach was used in Vagač et al. (2001) on Slovakian trade data, while Algieri (2004), analyzing Russian data, and Catão and Falcetti (2002), for Argentinean trade data, estimated elasticities using an error-correction model. While the estimates in some papers confirmed the theoretical expectations about the sign, as well as size of the elasticity coefficients, others obtained results that to a certain extent differ from what was expected (Table 1).

Income and price elasticities of Croatian trade have previously been the topic of analysis in Mervar (2003), with the export and import functions estimated using OLS as well as other methods; this was done both for aggregate imports and exports, but also for particular sectors according to the Standard International Trade Classification (SITC). A study of the impact of FDI on Croatian exports is presented in Vukšić (2005), which also analyzes the effects on exports of productivity and real exchange rate changes using panel data and a fixed effects model on data in logs.

The values of income elasticity coefficients estimated in the above papers lie in the range from 0.17 to 5.3, while price elasticities vary from positive to negative values. Such significant variation in the obtained coefficients, as well as their divergence from theoretical expectations, can be explained by both the various methods used in the estimations and the different data series used for certain variables. In the case of the price variable, for example, the data series used included unit value indices, producer and consumer price indices, etc.; similarly, for the income variable both nominal and real GDP were used, as well as real GDP reduced by exports, consumption and industrial production. Aggregation bias might also account for some of the differences. Table 1 gives an overview of elasticity coefficients obtained in the aforementioned papers; in cases where multiple coefficients were estimated, the number included is that obtained in the way most similar to the methods applied in this paper.

Table 1 Estimated income and price elasticities for comparable countries

	Exports		Imports	
	Income elasticity	Price elasticity	Income elasticity	Price elasticity
Tomšik (2000) – Czech Republic	5.29	not significant	1.10	not significant
Benaček, Podpiera, Prokop (2005) – Czech Republic	1.55	0.14	3.08	0.23
Vagač et al. (2001) – Slovakia	–	–	1.99	–1.39
Wdowinski, Milo (2002) – Poland	2.10	–0.85	1.87	–1.05
Mervar (2003) – Croatia	0.86	not significant	2.04	–1.74

4 Selection of variables in the model

While the previous section dealt with the theoretical background and described what should, according to theory, explain movements in the dependent variables, this section lists variables and explains particularities of the data series which were actually included in the empirical analysis. The differences between theory and practice in this case arise primarily as a result of data availability.

4.1 Exports and imports

The estimations are based on real imports and exports data,[1] i.e. volumes of exports and imports in tonnes as comparable units across all sectors. The panels consist of 30 sectors according to the National Classification of Economic Activities (NCEA) for the period 2000 to 2007. A similar approach, namely the estimation of elasticities based on trade volumes, is used in most empirical research, although there are exceptions such as the estimation in Benaček, Prokop and Višek, (2003), where nominal values are used. However, using values of imports and exports means the dependent variable already contains price effects, thus possibly biasing the estimation.

4.2 Income

The income variable in the export equation is proxied by world total real gross domestic product, as well as the real GDP of country groups (EU 15, main trading partners), whereas in the import equation real GDP for Croatia was used to proxy for domestic income. The choice of income variable in the literature has varied widely: for instance, in estimating export and import elasticities, Goldstein and Khan (1978) use real income of the importing economy, more specifically the weighted average real income of all trade partners in the export equation; Senhadji and Montenegro (1998) use trade partners' weighted average GDP minus their exports, while Tomšik (2000) uses the volume of industrial production in estimating import elasticities.

[1] According to trade data of the Central Bureau of Statistics.

4.3 Prices

Exports and imports do not depend on their respective prices as such; rather, trade flows are affected by their price relative to that of the same or similar products in the importing country. An increase in prices of foreign goods in comparison with those in the importing country leads on the one hand to relatively more expensive imports, which will have the effect of lowering imported quantities. On the other hand, exports will now be relatively cheaper, thereby increasing in volume. The ideal price index in the import function would have to reflect changes in the prices of all imported goods relative to those of domestically produced substitutes in the importing economy; in the export function, it would have to compare the prices of all exports as opposed to those of competing goods produced abroad. Such indicators are for practical purposes impossible to obtain on a disaggregated level, particularly in the case of world prices of export substitutes. As a result, various alternative indicators are used and their choice depends on data availability and characteristics considered more important in each particular case depending on the purpose and objectives of the analysis (Goldstein and Khan, 1985). For instance, Tomšik (2000) uses a producer price index (PPI), consumer price index (CPI) and the harmonized index of consumer prices (HICP) in the importing country and in the rest of the world; Benaček, Prokop and Višek (2003) use unit value indices[2], while Vagač (2001) uses a combination of import price indices and the PPI. If aggregate trade flows are analyzed the real exchange rate serves as a relative price indicator (such as in Algieri, 2004), combining price and exchange rate effects.

One of the possibilities is to compare price levels in the country with the price level in its trade partners; however, such data do not fit the purposes of this analysis nor do they have the necessary scope and level of disaggregation. Domestic CPI reflects the price level of all goods on the domestic market, both domestically produced and imported, while PPI does not include all the sectors that are part of the analysis. Furthermore, the price of a particular domestically produced good on the domestic market and its export price can diverge to some degree for longer periods of time as a consequence of various market imperfections (Goldstein and Khan, 1985).

Due to these limitations and lack of availability, the price indicators used as proxies for domestic and foreign prices used in this analysis are unit value indices of exports and imports calculated from disaggregated data for the period in question. Important to note is the influence the changes in import and export structure might have on the value indices: goods with high price variability may often have very low elasticity to those price changes, which would negatively bias the estimated price elasticity if the analysis was based on data with some level of aggregation. Furthermore, although goods in each particular group of the NCEA sectorisation are similar, these sectors are nevertheless not perfectly homogenous. Moreover, a decrease in the imported quantity of a particular good will lower its weight in the price index, meaning that a potential increase in the price of that good need not necessarily be reflected in an increase of the price index itself. In this sense, a unit price index would probably be a better indicator than a unit value index but since it and other more precise data are unavailable, the latter index is the best available alternative. Hence value per tonne, as a comparable unit for all sectors, is used as an approximation of unit value. Most of the relevant literature and research dealing with this topic, for the same practical reasons, uses similar alternatives (Goldstein and Khan, 1985).

Using a value index also makes it difficult to separate the effects on competitiveness of price and quality. It is to a certain extent possible to discern between the two, if the variable is statistically significant, by the sign on the coefficient (Benaček, Prokop, Višek, 2003), i.e. a negative coefficient means that a decrease in export prices results in an increase in exports; the fall in prices could, in turn, either be a result of lower production costs or of lower quality. Since an increase in exports cannot logically be a result of lower quality, it can be inferred that the prevailing effect is that of price competitiveness. Conversely, if the coefficient is positive and significant, the opposite is true – an increase in exports is probably the result of higher quality, rather than of higher costs. Obviously, separating these effects is not usually so straightforward given that both may simultaneously be at play, particularly if they are working in opposite directions, making it impossible to determine the underlying factors.

It should also be noted that the unit value index expressed in euros, as calculated from euro value and volumes data, to some extent also contains the effects the exchange rate has on prices. The intensity of this effect is determined by the way in which producers/exporters set prices of the particular goods being exported, that is, whether they set prices in kuna or in euros. If exporters initially determine prices in kuna, independently of what they will be when converted into euros and only taking into account production costs, an increase in prices will not necessarily result in a decrease in exports, because the final effect will depend on exchange rate movements. A depreciation of the kuna against the euro will dampen the impact of a price increase, resulting in a lower absolute value of the estimated coefficient. On the other hand, if exporters take the exchange rate into account when setting prices, the previously described effect will not occur, with the elasticity coefficient reflecting only the real price effect. On the imports side, prices are assumed to be set in foreign currency and are taken as given, which means that exchange rate movements will have no impact on price setting, as opposed to exports.

4.4 Exchange rate, FDI, tariffs and credit supply

The exchange rate effect on trade is analyzed by the inclusion of the nominal kuna/euro exchange rate in the model, which is justified by the fact that the euro accounts for around 70% in the merchandise trade currency structure. An appreciation of the kuna against the euro (i.e. decrease in the HRK/EUR exchange rate) observed in the analyzed period led to relatively cheaper imports and more expensive exports, so that the coefficient on the exchange rate variable is expected to be positive in the export and negative in the import function.

Other possible exchange rate indicators include the real or nominal effective exchange rates. However, a problem arises

[2] Unit value indices are calculated by dividing the total value of a product group by its quantity. Unit value indices are not strictly *price indices*, given that their changes may be due to developments in both prices and quantity. However, they are frequently used in economic analysis as a substitute for price indices.

with both indices due to the much higher volatility of the kuna/dollar exchange rate than that of the kuna/euro exchange rate and the high negative correlation of their rates of change. This means that the effective exchange rate indices reflect mostly the kuna/dollar rate movements, despite the euro's much higher share in total trade. Some authors analyzing aggregate trade flows have used the real exchange rate as an indicator of relative prices; however, this applies if aggregate trade flows are analyzed, given that the real exchange rate does not differ across sectors.

Foreign direct investment is included only in the export equation, in which it should have a much stronger impact than would be the case with the import equation, as well as a much clearer interpretation. An increase of FDI in a particular sector can be expected to increase its competitiveness and productivity – higher levels of investment should indicate that a given sector has some comparative advantages and the potential for growth, because it wouldn't have been able to attract investment otherwise (Benaček, Prokop, Višek, 2003). Higher competitiveness should then be reflected in higher exports, while lower levels of investment, on the other hand, could mean that growth potential has not been recognized in a particular sector, which in turn means that it should export less. The sign of the coefficient on FDI in the export equation is therefore expected to be positive. It should however be noted that in the case of Croatia the most significant share of incoming FDI went into services, more specifically financial services and telecommunications. Therefore the impact of investment through improvements in these and other sectors might also have an indirect effect on the exports of other sectors, which would not be reflected in the value of the FDI elasticity coefficient which measures only the direct effect. Similarly, access to and availability of credit to exporters is another factor affecting the production side, positively influencing exported quantities. A variable of credit supply to firms (disaggregated by sector)[3] is included in the model, and is expected to have a positive sign.

The model, as described in the previous section, would be a realistic description of real-world developments if there were no impediments to international trade. These barriers, however, are numerous, the most important form being tariffs (export tariffs are ignored as they are usually much rarer). Also not included in the export function are tariffs levied on Croatian exports in importing countries. The very large number of countries to which goods are exported and the resulting equally large number of different tariffs being applied to those exports makes the construction of a single tariff indicator very difficult. Even if necessary data were available, the calculation of an "average" tariff would be very complex and prone to errors, resulting in a series that might only be a very rough approximation of the real tariff rates being applied. Indeed, trying to determine average rates when the differences between the tariff rates are so many and occasionally so large, could lead to wrong conclusions about the factors affecting trade flows and bias the whole analysis. Therefore, the impact of tariffs was included only in the import equation.

Tariff rates used in the estimation were calculated from data on values, tariff rates and tariff – exempt quotas according to the detailed tariff nomenclature.[4] Using these figures, tariff revenues were calculated for each product category, which were then sorted into the appropriate NCEA categories. Finally, these revenues were divided by the total value of imports in order to obtain the implied tariff rate for each sector. Due to unavailability of the data, tariffs were included only in the model of trade with all countries.

5 Estimation results

While the fact that prices determine, to different degrees, imported and exported quantities is certainly true, it is also possible that the causal relationship works the other way around as well; in other words, the quantities of exported or imported goods may influence the price asked for those same goods. On the other hand, in the case of a small country such as Croatia, which cannot significantly affect prices, it may be argued that prices should be taken as given, i.e. exogenous. However, imposing strict exogeneity assumptions in this case, meaning that prices would have to be treated as entirely independent of past or present exported/imported volumes, is too restrictive. Import and export prices are therefore treated symmetrically with the lagged dependent variable, i.e. they are instrumented with their lagged values. The other explanatory variables are assumed to be exogenous and not correlated with the individual sectoral effects. Two lags, $t-2$ and $t-3$, were used as instruments for the endogenous variables, which is prompted both by the relatively small sample size and the fact that additional lags brought little increased efficiency to the estimation. Alternative lag structures were also tested, but although the validity of these additional instruments was not rejected by the Sargan test, in most cases its value did not improve and the additional lags were therefore dropped.

Since trade patterns, as well as tariff regimes regulating it, might not be the same for imports from and exports to different country groups, the sample is also divided into subsamples such as old EU member countries (EU15 as of 1995) and most important trading partners,[5] which make up for 70-75% of total trade in the analyzed period. This is also a way of checking the robustness of the results for the initial model, since the obtained coefficients for various groups should not differ drastically from those in the model capturing total trade volume.

5.1 Export function

Results of the export model estimation are summarized in Table 2. Three models were estimated (All countries, EU 15,

[3] Based on Financial Agency data.
[4] The calculation is based on trade and tariff data provided by the World Trade Organization, according to the standardized Harmonized System 6-digit subheading level.
[5] This group includes: Austria, Bosnia and Herzegovina, China, Czech Republic, France, Germany, Hungary, Italy, Malta, The Netherlands, Poland, Russia, Serbia and Montenegro, Slovenia, Switzerland, the UK and USA.

Main trading partners). Due to high correlation between the import and export price variables and the fact that their coefficients can be estimated separately, the former was dropped from the model owing to its lower statistical significance.

Both real GDP and export prices are significant and have the expected signs on the coefficients – world GDP growth will have a positive effect on Croatian exports, while an increase in prices will be reflected negatively in exported quantities. Negative price elasticity, apart from indicating that lower prices result in higher exports, also means that the competitiveness of Croatian exports manifests itself primarily through prices. In other words, these results seem to indicate that total exports are dominated by sectors that produce goods that are not high-quality and high value-added, meaning that an increase in exports with the current structure in place will mostly be a result of lower prices, rather than increases in quality. It has to be noted that the possible presence of the exchange rate effect, described in Section 4.3 might mean that the elasticity coefficient is in fact higher, in absolute terms, than the one obtained here, which could account for lower than expected price elasticities, particularly for main trading partners. The results generally appear to be robust to the changing of the country sample. The obtained income elasticity coefficients are broadly similar, significant across all country groups and within expectations, with the coefficient on EU 15 income somewhat lower than for the overall sample. Price coefficients vary somewhat less markedly, in this case with EU 15 showing higher sensitivity to export price changes.

The nominal kuna/euro exchange rate appears to have a statistically significant effect only on Croatian exports to EU15 countries, with no impact on flows to other country groups, which is not in line with expectations. However, given that changes in the kuna/euro rate were very small with a slight tendency towards appreciation during most of the eight-year period in question (strengthening against the euro by 5%), the absence of a statistically significant positive coefficient in most specifications is not in fact a surprising result. A lag of the exchange rate was also tested to verify the possible presence of J-curve effects; however, results were inconclusive, with the lag significant only in the model in which the exchange rate in time *t* was also significant (EU15), and not in the other specifications. This would seem to indicate that lack of statistical significance of the exchange rate variable in the model is not due to the fact that the effect is only seen with a time lag. The impact of FDI on export performance, although with an unexpected negative sign and significant, is for practical purposes zero (–0.009), which is contrary to the results obtained by Vukšić (2005), who finds a positive, albeit not very strong relationship between FDI and exports. Supply of credit to firms, on the other hand, for the most part does have a statistically significant effect on exports, although the impact is very limited.

Neither instrument test rejects the validity of the instruments in all three models, as reported in the table. The Sargan test does not reject the hypothesis of no correlation between the instruments and residuals, while tests of second-order serial correlation fail to reject the existence of serially uncorrelated errors, although in the main trading partners specification there is marginal evidence of the latter. Robustness and stability of the results were also tested by changing the estimation period, i.e. the sample was cut, which in most cases had little effect on the obtained coefficient values or their statistical significance.

5.2 Import function

Table 3 presents the import model estimation results. The coefficient on prices is, similarly to exports, negative and lower than one in absolute value. Relatively low price elasticity, i.e. lower than 1, is in fact to be expected in the case of imports, as a result of the very high import dependence of the Croatian economy. However, it is surprising that the coefficients are slightly larger, in absolute terms, than those for exports, since Croatian exports could be expected to be much more sensitive

Table 2 Export model estimation results

Dependent variable: Export volumes

Method: Panel generalized method of moments

	All countries	EU 15	Main trading partners
GDP	2.4504*** (0.1027)	1.6538*** (0.1458)	2.0874*** (0.0946)
Export price	–0.7002*** (0.0606)	–0.8047*** (0.0669)	–0.3081*** (0.0222)
Exchange rate (HRK/EUR)	0.3519 (0.2993)	0.9738** (0.4027)	-0.2574 (0.3111)
FDI	–0.0097** (0.0042)		
Credit supply	0.0065*** (0.0114)	0.0453*** (0.0050)	0.0290** (0.0126)
J-statistic	22.3876	22.6163	21.8355
Sargan test p value	0.1905	0.3080	0.3495
Second order correlation p value	–0.0604 0.6143	–0.0992 0.3501	0.1048 0.2609
No. of observations	134	158	154

Note: Sample period from 2000 to 2007. The model was estimated using EViews 7.0. Standard errors are in parentheses.
*** Statistically significant at 1%.
** Statistically significant at 5%.
* Statistically significant at 10%.

to price changes, given the competition on the world market. Imports should, on the other hand, be relatively less sensitive to price changes, while our result indicates the opposite. However, this might be related to the exchange rate effect on the determination of export prices as explained in Section 4.3.

The obtained income elasticity coefficients are all within expectations, while also implying that there is some difference between imports from EU15 countries (most of the main trading partners are from this group) and those from the rest of the world. The relatively low income coefficient for the former is expected, given the high dependence on imports and the large share of imports from this country group. The difference in coefficients on income in other specifications reflects higher growth of imports from non-EU countries, which is well illustrated by the case of China – adding it into the sample for most important trading partners noticeably alters the income elasticity coefficient.

The negative coefficient on tariffs, although statistically significant, is almost negligible (–0.04), indicating that tariffs had little effect on trade flows. Unlike exports, overall imports are affected by exchange rate changes, as evidenced by the statistically significant coefficient close to –1. Since the kuna recorded a steady appreciation against the euro during most of the eight years in question, this coefficient indicates that it has had a slight stimulating effect on imports. However, it should be viewed with caution since kuna appreciation does not have a similar positive and significant impact on imports flows when subsamples are analyzed. Again, testing the lag of the exchange rate does not yield results that would point conclusively to J-curve effects.

As in the case of exports, the Sargan test and a lack of second-order correlation do not reject the validity of the instruments and estimator consistency and do not indicate any dynamic misspecification. As in the case of exports, as an additional check of robustness, the sample was shortened and the model reestimated with different time periods. The obtained results, while varying somewhat, remain stable and statistically significant.

Table 3 Import model estimation results

Dependent variable: Import volumes

Method: Panel generalized method of moments

	All countries	EU 15	Main trading partners
GDP	2.0129*** (0.1150)	1.2919*** (0.1552)	2.0574*** (0.1695)
Import price	–0.8802*** (0.0661)	–0.8432*** (0.0705)	–0.5549*** (0.1391)
Exchange rate (HRK/EUR)	–1.0290** (0.4034)	1.0178 (0.7103)	–0.6182 (0.4967)
Tariffs	–0.0394*** (0.0100)	– –	– –
J-statistic	16.5245	20.9051	20.4816
Sargan test p value	0.3199	0.1399	0.3349
Second order correlation p value	–0.0152 0.8750	–0.0402 0.6288	–0.0323 0.7220
No. of observations	137	167	170

Note: Sample period from 2000 to 2007. The model was estimated using EViews 7.0. Standard errors are in parentheses.
*** Statistically significant at 1%.
** Statistically significant at 5%.
* Statistically significant at 10%.

6 Conclusion

The aim of this paper was to estimate income and price elasticities of imports and exports, as well as to quantify the effect of some other potential trade determinants. The estimated model is based on the imperfect substitutes model, which is in line with most empirical work on this topic. The basic hypothesis tested was the dependence of export and import volumes on changes in income of the importing country as well as on changes in the prices of exported goods and their imported substitutes. In addition, the impact on trade of changes in other variables, such as the exchange rate and tariffs, was also tested within the model. Issues with data availability, its consistency and the length of the data series have significantly influenced the variables included in the model as well as the estimation technique.

In the estimation, dynamic panel data methods were applied to disaggregate data which allowed for sectoral differences in the data as well as for dynamic adjustment of data through time. The Arellano-Bond method was used to estimate the model in first differences, where the lagged dependent and potentially endogenous explanatory variables were instrumented with their lagged levels.

The income and price elasticity coefficients, both in the import and in the export model, have the expected signs – increases in income positively affect exports and imports, while increases in prices lower them. Judging by the size of the coefficients, income effects appear to be much more substantial than price effects for both exports and imports, which confirms the results for Croatia obtained in Mervar (2003) and

is similar to results for most other comparable countries. The slightly lower income elasticity of imports than of exports can to some extent be explained by the high import dependence of the Croatian economy. When analyzing subsamples, income effects tend to be less pronounced for the EU 15 than for other trade partners, both for imports and for exports.

Furthermore, the signs on the price coefficients also seem to indicate that, in the case of Croatian exports, competitiveness works primarily through prices, rather than through quality of the goods, while import price elasticities lower than unity confirm high import dependence. Results concerning the exchange rate are mixed and imply that, although it is frequently pointed out as one of the main "culprits" contributing to Croatian trade imbalances, the exchange rate did not in fact have such a strong role in determining trade flows. In this sense, the use of currency depreciation as an export promotion tool is not validated by the results of this estimation, although it has to be stressed that the very low variability of the exchange rate makes it difficult to obtain significant results.

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Appendix

1 Results of the OLS panel fixed effects estimation

Exports (volumes), OLS cross-section fixed effects

	Coefficient	Std. error	t-Statistic	Probability
C	–0.015226	0.042314	–0.359827	0.7195
GDP_WORLD	2.614040	1.136518	2.300042	0.0229
EX_PRICE	–0.628015	0.096338	–6.518851	0.0000
HRK_EUR	–1.006002	0.527598	–1.906757	0.0586
Cross-section fixed (dummy variables)				
Adjusted R-squared	0.444070			
S.E. of regression	0.116679			
F-statistic	6.029405			
Prob(F-statistic)	0.000000			
Durbin-Watson stat	2.047735			

Imports (volumes), OLS cross-section fixed effects

	Coefficient	Std. error	t-Statistic	Probability
C	–0.091789	0.051722	–1.774649	0.0795
GDP_Croatia	3.881960	1.089402	3.563386	0.0006
IM_PRICE	–0.920175	0.024596	–37.41152	0.0000
Tariffs	–0.031149	0.010692	–2.913395	0.0046
HRK_EUR	–0.617684	0.323299	–1.910565	0.0594
Cross-section fixed (dummy variables)				
Adjusted R-squared	0.786766			
S.E. of regression	0.052013			
F-statistic	16.75210			
Prob(F-statistic)	0.000000			
Durbin-Watson stat	2.060308			

2 List of NCEA sectors included in the analysis

- 01 Agriculture, hunting and related service activities
- 02 Forestry, logging and related service activities
- 05 Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing
- 10 Mining of coal and lignite; extraction of peat
- 11 Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction
- 13 Mining of metal ores
- 14 Other mining and quarrying
- 15 Manufacture of food products and beverages
- 16 Manufacture of tobacco products
- 17 Manufacture of textiles
- 18 Manufacture of wearing apparel; dressing and dyeing of fur
- 19 Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
- 20 Manufacture of wood and products of wood and cork; manufacture of articles of straw and plaiting materials
- 21 Manufacture of pulp, paper and paper products
- 22 Publishing, printing and reproduction of recorded media
- 23 Manufacture of coke, refined petroleum products and nuclear fuel
- 24 Manufacture of chemicals and chemical products
- 25 Manufacture of rubber and plastic products
- 26 Manufacture of other non-metallic mineral products
- 27 Manufacture of basic metals
- 28 Manufacture of fabricated metal products, except machinery and equipment
- 29 Manufacture of machinery and equipment n. e. c.
- 30 Manufacture of office machinery and computers
- 31 Manufacture of electrical machinery and apparatus n. e. c.
- 32 Manufacture of radio, television and communication equipment and apparatus
- 33 Manufacture of medical, precision and optical instruments, watches and clocks
- 34 Manufacture of motor vehicles, trailers and semi-trailers
- 35 Manufacture of other transport equipment
- 36 Manufacture of furniture, manufacturing n. e. c.
- 40 Electricity, gas, steam and hot water supply

3 Descriptive statistics

	Exports		Imports		Trade balance	
	billion EUR	as % of GDP	billion EUR	as % of GDP	billion EUR	as % of GDP
2000	4.8	21.5	8.6	36.6	–3.8	–15.1
2001	5.2	20.8	10.2	38.8	–5.0	–18.0
2002	5.2	18.8	11.3	40.0	–6.1	–21.2
2003	5.5	18.6	12.5	41.8	–7.0	–23.2
2004	6.4	20.2	13.3	40.7	–6.9	–20.5
2005	7.1	20.2	14.9	41.2	–7.8	–21.0
2006	8.2	21.6	17.1	43.0	–8.8	–21.3
2007	9.0	21.5	18.8	43.5	–9.8	–22.0

Structure of exports by sector, share in total

	2000	2001	2002	2003	2004	2005	2006	2007
Other transport equipment	14.5	15.7	12.7	12.7	13.8	10.8	11.8	11.8
Chemicals	12.0	10.1	9.8	9.2	8.9	9.5	8.8	9.1
Coke, refined petroleum	10.3	8.5	7.7	7.9	9.2	10.2	9.9	10.0
Wearing apparel	8.8	8.5	8.1	7.2	5.8	4.8	3.8	3.3
Food products	6.0	6.5	7.5	8.2	6.3	8.0	8.7	7.6
Wood	4.6	3.9	4.0	4.1	3.7	3.6	3.6	4.0
Electrical machinery	4.5	4.2	4.0	4.7	4.3	4.5	4.9	5.4
Machinery and equipment	4.2	4.4	5.5	5.5	6.2	7.0	6.9	7.8
Other non-metallic mineral products	3.9	4.0	4.1	4.0	3.5	3.8	3.6	3.7
Leather	3.9	4.1	3.9	3.3	3.8	3.0	3.0	2.7
Other	27.3	30.1	32.7	33.3	34.5	34.7	35.0	34.4

Structure of imports by sector, share in total

	2000	2001	2002	2003	2004	2005	2006	2007
Crude petroleum	12.4	10.3	8.5	7.4	8.1	9.7	10.1	9.8
Chemicals	12.2	10.8	10.7	10.4	10.5	10.3	10.0	10.1
Motor vehicles	10.9	10.4	10.5	10.9	9.9	9.0	9.1	9.2
Machinery	9.1	10.0	11.3	11.5	10.4	10.6	10.0	10.1
Food products	6.0	6.5	6.5	6.2	6.3	6.2	6.3	6.0
Basic metals	4.9	5.2	5.1	5.2	6.2	6.3	6.9	7.3
Other transport equipment	4.6	4.2	2.4	4.1	3.9	3.5	3.5	3.9
Textiles	3.8	4.6	3.7	3.3	3.0	2.7	2.5	2.6
Pulp and paper	3.1	3.0	2.9	2.7	2.5	2.4	2.2	2.3
Radio and television	3.1	4.1	4.4	4.6	5.0	4.6	4.2	4.1
Other	29.9	30.9	33.8	33.7	34.3	34.7	35.2	34.6

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The second page should contain the abstract and the key words. The abstract is required to be explicit, descriptive, written in third person, consisting of not more than 250 words (maximum 1500 characters). The abstract should be followed by maximum 5 key words.

A single line spacing and A4 paper size should be used. The text must not be formatted, apart from applying bold and italic script to certain parts of the text. Titles must be numerated and separated from the text by double-line spacing, without formatting.

Tables, figures and charts that are a constituent part of the paper must be well laid out, containing: number, title, units of measurement, legend, data source, and footnotes. The footnotes referring to tables, figures and charts should be indicated by lower-case letters (a,b,c…) placed right below. When the tables, figures and charts are subsequently submitted, it is necessary to mark the places in the text where they should be inserted. They should be numbered in the same sequence as in the text and should be referred to in accordance with that numeration. If the tables and charts were previously inserted in the text from other programs, these databases in the Excel format should also be submitted (charts must contain the corresponding data series).

The preferred formats for illustrations are EPS or TIFF with explanations in 8 point Helvetica (Ariel, Swiss). The scanned illustration must have 300 dpi resolution for grey scale and full colour illustration, and 600 dpi for lineart (line drawings, diagrams, charts).

Formulae must be legible. Indices and superscript must be explicable. The symbols' meaning must be given following the equation where they are used for the first time. The equations in the text referred to by the author should be marked by a serial number in brackets closer to the right margin.

Notes at the foot of the page (footnotes) should by indicated by Arabic numerals in superscript. They should be brief and written in a smaller font than the rest of the text.

References cited in the text are listed at the last page of the manuscript in the alphabetical order, according to the authors' last names. References should also include data on the publisher, city and year of publishing.

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