Impact of openness to GDP per capita: empirical research

Rezime: Predmet ovog rada jeste testiranje uticaja otvorenosti nacionalnih privreda na per capita BDP. Iako je mišljenje naučne javnosti o ovom pitanju prilično podeljeno, smatramo da prevladava stav o pozitivnom uticaju. Primenom ekonometrijskih tehnika, oslanjajući se na model Frenkla i Romera (1996), ocenili smo traženu zavisnost i to na uzorku podataka preseka koji obuhvata 51 zemlju i odnosi se na 2007. godinu. Ocenjena jednačina, uprkos izvesnim statističkim manjkavostima, pokazuje da rast otvorenosti za jedan procentni poen dovodi do porasta per capita BDP za 0,58%. Naši rezultati se u izvesnoj meri podudaraju sa nalazima Frenkla i Romera, s tim što je ocenjeni efekat u našem modelu dosta slabiji.

Ključne reči: otvorenost, per capita dohodak, instrumentalne varijable, endogenost objašnjavajuće promenljive.

Summary: Subject of this paper is testing of impact of foreign trade to GDP per capita. Although economists’ opinion about this particular issue is pretty divided, we deem that there is a prevailing attitude about positive impact. Through application of econometric techniques, relying to Jeffrey A. Frankel and David Romer’s model (1996), we have estimated required dependence in cross section data which covers 51 countries and which pertains to 2007. Estimated equation, despite certain statistical weaknesses, has shown that growth of openness by one percentage point leads to growth in GDP per capita by 0.58%. Our results are somewhat equivalent to Frankel and Romer’s (1996) findings, but estimated effect in our model is pretty weaker.

Keywords: openness, income per capita, instrumental variables, endogeneity of explanatory variable.

1. INTRODUCTION

During the development of this paper, we have tried to get into the nature of the impact of countries’ openness to income per capita. Since the Adam Smith’s time, economists have been interested in this causality. There is a well-known dilemma of import substitution versus export specialization, which is only one of many reasons because economists...
are making efforts to discover the aforementioned causality. Yet, no matter how much this issue seems simple even to laymen, we still cannot say that there are firm and unique proofs about positive impact of external trade to the income.

Lack of firm and assuring findings makes a rigid line between those who deem that the observed impact is positive and high and those whose standpoint is that such impact does not exist at all. On the basis of researches which were used in the development of this paper, the impression was that smaller and poorer countries tend to be more oriented to export strategies due to scarcity of resources, technological falling behind and limited potential of domestic market growth. The author’s opinion is that attitude about positive impact is still dominating one. Nevertheless, in order to avoid relying too much to the author’s perception, let us look into results obtained in well-known researches.

One of them is surely the research about the impact of international trade to life standard (see /8/). During the analysis, starting point was the fact that degree of countries’ openness is not exogenously determined, and that problem of endogeneity should be solved through careful selection of instrumental variables. This has been done on the basis of gravitational model, estimating components of openness which is consequence of geographic factors influence. In other words, trade determined by geographic characteristics most probably has exogenous character, i.e., it does not depend on other income determiners, and therefore it cannot be correlated with random disturbance in income equation. The results of this research are consistent, taking into account the whole sample and all used specifications, and they show that increase in ratio of import and export to GDP by one percentage point increases income per capita by at least 1.5% in two ways: encouraging factor accumulation and increasing outputs for given level of factor accumulation.

Performed tests on impact of openness to growth of Easter Asia countries have generated similar results (see /9/). The problem of endogeneity was solved in similar manner as in the previous paper, by using variables of gravitational model as instrumental variables. Respecting Grossman and Helpman’s standpoints that transmission of technological development from developed to developing countries is performed equally through export and import, and both external trade aggregates had been taken into account. Depending on availability of data, the research covered 100 to 123 countries between 1960 and 1985. Estimations obtained through instrumental variables method are higher than estimation obtained through ordinary least squares method (OLS). Growth in openness by 1% affects change in income per capita by 0.34%. Besides, it has been estimated that transition from totally closed economy to the economy whose trade share in GDP is 200% implies GDP growth of about 68%. According to the results obtained in individual research, openness has strong impact in many countries, in Hong Kong and Singapore in particular.

Another research carried out by using ordinary least squares method (OLS) in the sample of 74 countries between 1960 and 1990 has shown that high external orientation affected increase in growth (see /6/). Impact of projected openness is to some extent reflected through the investment channel. Since
omission of countries with high openness and rapid growth (Hong Kong and Singapore) and low openness and slow growth (Uruguay and Argentina) does not affect much the calculated estimation and its statistical significance, constancy of obtained results cannot be easily questioned.

Empirical research of the impact of openness to economic growth of Chile between 1960 and 1998 has shown that liberalization of external trade affected growth of real GDP through investment channel (accumulation of capital). Besides, external trade liberalization significantly affected growth of factor productivity, whereas factor productivity is not cointegrated with the growth of real GDP.

Certain findings, relying to Krugman’s technological gap model, imply that impact of openness to sectoral productivity depends on the growth potential in the observed sector (see /4/). In fact, if it is about a sector with low growth potential, increase of international trade has small or no impact to productivity growth. At the same time, growth in import competition in sectors with medium productivity growth has significant positive impact, while expansion of export in sectors with high productivity growth leads to its acceleration. These effects have been estimated in the sample of 44 countries in the period between 1970 and 1993.

Similar conclusions were made in studies of trade between the North and the South (see /7/). It is based on theories of endogenous growth according to which the importing countries, mainly developing ones, gain significant benefits from the import of capital goods, intermediary goods and technologies from the developed countries. The research was started in the manner that firstly a model was structured which used factor abundance of importers and various gravitation variables as import determiners. Afterwards, measures of openness were formulated, which were based on deviation of actual from model estimated import. Obtained results showed that openness has significant positive impact to the economic growth in the South, whereas the revealed relation is robust one, because calculated regression coefficients were positive and statistically significant, regardless the used measure of openness and model specification.

Trade is significant determinant of growth in developing countries as well (see /5/). Analyzing the countries with characteristically strong reduction of tariffs and dynamic growth of international trade, results were obtained which imply strong positive impact of external trade to economic growth. Acceleration of economic growth is, on average, proportionally transmitted to the increase in poor ones’ income. Taking into account that China and India have been covered by the research sample, the obtained results pertain to more than a half of population in all developing countries.

Also, cancellation of external trade barriers by developed countries would greatly encourage growth of developing countries (see /13/). If the United States of America (USA) only eliminated the remaining external trade barriers in import from developing countries, income in some poorest regions in the world would increase up to 14% within 15 year time.
Yet, despite numerous econometric studies and significant theoretical knowledge about the nature of interaction between economic policy and growth, we are still burdened with huge dilemmas. Accordingly, there are opinions that impact of trade on economic growth depends on the regulation level of national economies (see /3/). In long term, this impact does not exist or is negative in strongly regulated economies.

According to some authors, reduction of poverty mainly depends on growth of income per capita. Trade liberalization is a significant determinant of economic growth, but it does not have outstanding impact to the life standard in poorest countries (see /10/). In other words, income of the poorest ones grows proportionally with average income growth. Proofs about positive impact of openness to economic growth and poverty are subject to critics due to the fact that openness is not isolated from other measures of economic policy which are applied together with trade liberalization. Therefore, significance of trade should not be overestimated, because it is only one among determiners of economic growth.

Positive relation between openness and economic growth may originate from mistaken model specifications, but also from usage of openness measures which are correlated with other growth determiners. (see /12/). Those who advocate such standpoint do not claim that external trade protectionism is desirable, but they challenge positive impact of external trade liberalization.

Also, certain authors deem that economic development strategies which rely on export orientation are not too desirable (see /11/). Accordingly, appropriate recommendation for economic policy creators would be to not insist on open economy and growth of export at any cost, but to shape the development in accordance with coherent policy, no matter of relative balance between export sectors and those which are not. Also, taking into account that there is no a general indicator which would quantify degree of economic policy towards export, results about positive relation should be taken with caution. This thesis is also supported with the fact that use of alternative indicators of openness produces completely different ranks of countries.

Finally, key reasons for disagreement among economists are maybe hidden in different notion of the openness concept (see /1/, /2/). In some cases, accent is put not only on external trade barriers, but also on the exchange rate, monetary and fiscal policy, which makes additional confusion. If economy is balanced, openness may act as stimulation to the economic growth, while in the case of unbalance, it can be appropriate in certain time and under certain conditions. Therefore, positive impact to economic growth has reduction of external trade barriers only, combined with stable and non-discriminatory exchange rate system, prudent monetary and fiscal policy and uncorrupted administration.

Through this empirical research we are making efforts to provide at least a modest contribution to explanation of impact of openness to economic growth, thereby helping in formation of a clearer picture about this very intriguing phenomenon. In the first part of the paper we have explained econometric model, which served as methodological framework. The second part is
dedicated to sources of data which we used during the analysis. In the pre-final part we presented most important results of the empirical research. Final considerations are provided in the end of the paper.

2. ECONOMETRIC MODEL

It may be noticed from the above presented papers that certain difficulties faced in estimation of the impact of external trade to income originate from the existence of endogeneity problem, i.e., disturbance of assumption that explanatory variables are exogenously determined. Endogenous regressors are manifested in their correlation with random disturbance. If such problem really exists, application of ordinary least squares method (OLS) does not present adequate methodological framework.

Related to this, there is a serious doubt that external trade is not exogenous variable, but it affects the income, and it depends on it at the same time. Therefore, application of OLS method could generate biased and inconsistent estimations and may lead the researcher to wrong conclusion (see /8/ p. 1). In other words, countries which have high income, independently from external trade, may trade more. In such case, dependant variable is trade, while explanatory one is income, which implies endogeneity of trade.

This problem is solved through introduction of instrumental variables (IV), calculated through two stage least squares method (2SLS). In short, this method means that endogenous explanatory variable is regressed in the first phase on the so-called instrumental variables which are exogenous with respect to the original dependant variable, i.e., which are not influenced by its remaining determiners. Afterwards, the fitted value from the first-stage regression is used as exogenous explanatory variable in the second-stage regression of income. Both regressions are estimated through OLS method and they imply fulfillment of all usual assumptions of classical linear regression model.

Use of external trade policy indicators instead of indicators of openness cannot solve the problem of endogeneity (Ibidem, p. 2). Is a country applies stable monetary and fiscal policy in parallel with external trade liberalization, there is high probability that indicators of external trade policy in the income equation are correlated with random disturbance. This would be direct consequence of the impact of fiscal and monetary policy to the income and their omission from the regression.

According to gravitation model, geographic characteristics in various countries are significant determiners of bilateral trade. For example, data about distance between two countries may provide us with important information about their trade size (Ibidem). External trade which originates from geographic variables most probably is not correlated with other income determiners. It is difficult to imagine that geographic distance of a country may otherwise affect its income, except through interaction with other countries. That is why we will try to
estimate impact of openness to income *per capita*, using geographic features of different countries as instrumental variables - *pure geography approach* (Ibidem, p. 3).

The first step is to estimate first-stage regression of bilateral openness, starting from the model with the following specification (Ibidem, p. 6):

\[
\ln\left(\frac{T_{ij}}{GDP_i}\right) = b_0 + b_1 \ln(D_{ij}) + b_2 \ln(S_i) + b_3 \ln(S_j) + \varepsilon_{ij},
\]

where variables \(T_{ij}\), \(GDP_i\), \(D_{ij}\), \(S_i\) and \(S_j\), respectively represent size of external trade between countries \(i\) and \(j\), gross domestic product of country \(i\), distance between capitals of \(i\) and \(j\) countries, size of country \(i\) and size of country \(j\). The size of those countries is quantified in two ways, through total population and area that they cover.

Taking into account that this model disregards important information about geographic components of external trade, we have also used extended model in our research (Ibidem, p. 7):

\[
\ln\left(\frac{T_{ij}}{GDP_i}\right) = b_0 + b_1 \ln(D_{ij}) + b_2 \ln(P_i) + b_3 \ln(A_i) + b_4 \ln(P_j) + b_5 \ln(A_j) + b_6 (L_i + L_j) + b_7 (B_{ij}) + b_8 \ln(D_{ij}) + b_9 \ln(P_i) + b_{10} \ln(A_i) + b_{11} \ln(P_j) + b_{12} \ln(A_j) + b_{13} (L_i + L_j) + \varepsilon_{ij},
\]

where \(P\) and \(A\) denote population and area of the observed country \((i\ or\ j)\), while the effect of joint border and landlock are respectively modeled with dummy variables \(B_{ij}\), \(L_i\) and \(L_j\). This model also contains limitation, i.e., coefficients on dummy variables \(L_i\) and \(L_j\) are equal, which does not significantly affect the results of this research (Ibidem). Therefore, variable \(B_{ij}\) takes unit value when countries \(i\) and \(j\) have joint land border, i.e., zero value when countries do not share the same border. Also, variables \(L_i\) and \(L_j\) take unit values if countries \(i\) and \(j\) are landlocked, i.e., zero values if countries have sea or ocean line. Model (1.2) is a modification of model (1.1), into several directions. Firstly, this model contains two simultaneously introduced variables of size – population and area. Secondly, very important influence of joint border and landlock has been covered. Finally, variables of interaction with joint border have been introduced due to the fact that influence of certain explanatory variables may differ if countries share the same borderline. Methodologically, statistic significance of interaction with variable \(B_{ij}\) means that value of regression coefficient on the observed variable is changed if joint borderline exists.

The presented models are estimated on the basis of cross section data for 2007, which pertain to 27 EU member states and Serbia. Removal of pairs of countries whose trade equals zero, we have formed sample of 736 observations.

Since we have estimated the shown regressions, we calculated the constructed openness, which we will use as replacement for real openness in second-stage regression of income *per capita*. This procedure firstly implies application of estimated models to data from extended sample which incorporates 51 countries, i.e. which apart from 27 EU member states and Serbia includes: BaH, Montenegro, Macedonia, Russian Federation, USA, Canada, Japan, China, Mexico, Turkey, Norway, India, United Arab Emirates, Republic of Korea,
Australia, Ukraine, Hong Kong, Switzerland, Brazil, Singapore, Algeria, South African Republic and Libya. Afterwards, we applied antilogarithm operation to the obtained values and their sum-up for each country per all external trade partners which was covered in the sample. Hence, application of estimated regression resulted in:

\[ \ln(T_{ij}/GDP_i) = B X, \]  

(1.3)

where B presents vector of regression coefficients \((b_0, b_1, b_2, \ldots)\), and \(X\) vector of explanatory variables in models (1.1) and (1.2). Calculated values are natural logarithms of bilateral indicators of openness, due to which they must be exposed to antilogarithm operation, so that:

\[ ocT_{ij}/GDP_i = \exp(B X). \]  

(1.4)

Estimation of openness influence to income per capita requires summing up of results (1.4) per all countries marked with \(j\), i.e.:

\[ T_i = \sum_{j \neq i} ocT_{ij} / GDP_i. \]  

(1.5)

Value obtained in this way presents constructed openness of country \(i\) which will be used as explanatory variable in the income equation, initial form of which is the following:

\[ \ln(Y_i) = c_0 + c_1 T_i + c_2 \ln(P_i) + c_3 \ln(A_i) + \varepsilon_i. \]  

(1.6)

Variables \(Y_i\), \(P_i\) and \(A_i\) respectively denote GDP per capita, population and area which is covered by country \(i\). The population and area were included in the model so that we could control impact of size to the openness (Ibidem, pp. 18-19). If we could rank countries according to their size, following the ascending line, we would probably notice reduction of their openness level. Component of openness which is correlated with size of countries most probably does not reflect variations in total trade, but their composition, i.e. domination of the internal with respect to the external trade. In other words, movement towards the ascending size of countries may coincide with reduction of openness, although proportion of total trade and GDP remains unchanged. This reduction would be compensated through increase in internal trade, and since it affects income, it may happen that income grows or stagnates simultaneously with reduction of openness. It would be correct that effect of openness is estimated on the basis of sample composed of the countries of very similar size, but unfortunately this is not possible. Accordingly, it is necessary to control size of the countries.

### 3. DATA

Data about bilateral trade flows were taken from Eurostat and Statistical Office of RS:
(http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/; http://webrzs.stat.gov.rs/axd/index.php). Distance between capitals was found at the following web page:

http://www.geobytes.com/citydistancetool.htm. Finally, source for all other pieces of information was the World Bank web site:

(http://web.worldbank.org/WEBSITE/EXTERNAL/DATASTATISTICS/0,,menuPK:232599~pagePK:64133170~piPK:64133498~theSitePK:239419,00.html). As for measurement units, it is necessary to emphasize the following: GDP is originally expressed in US$ billions, whereas such values were recalculated for our needs into € billions using average annual exchange rate for US$ and €, bilateral trade flows are originally expressed in € millions, but by dividing them with 1000 we recalculated them in € billions, distance is expressed in kilometers, population in millions, while area is expressed in thousands square meters. All data pertain to 2007, except for data about GDP in the United Arabic Emirates, which pertain to 2006.

4. RESULTS OF EMPIRICAL RESEARCH

Econometric modeling has been carried out through application of program package EViews 3.1. Test statistics and statistic indicators have been marked in the following way: $R^2$ and $R^2_{kor}$. – simple and adjusted coefficient of determination, $DW$ – Durbin-Watson’s test statistics of first-order autocorrelation, $F$ - test statistics of F test, $JB$ – Jarque-Bera’s test statistics of normally distributed disturbance, $Q$ – Ljung-Box’s test statistics of autocorrelation, $BG$ - Godfrey-Breusch’s test statistics of autocorrelation, $WH$ – White’s test statistics of heteroskedasticity, which is calculated on the basis of test regression which used products of explanatory variables of the estimated model as explanatory variables.

Evaluation of models (1.1) and (1.2) resulted in calculation of coefficients presented in Table 1. Basic weakness of both equations is acceptance of null hypothesis on normally distributed disturbance only at the significance level of 1%. The first column contains estimation of model (1.1), on the basis of which we can see that only constant and land area of $j$ country remained as statistically significant explanatory variables. Change in land area of $j$ by one per cent would affect increase in bilateral openness by 0.58%.

The other model provides more information (see table 1, column 2). After the elimination of statistically insignificant regressors, we extracted influence of distance, land area in country $i$ and population of country $j$. In fact, effect of distance is negative, as expected, and is very similar to the estimation calculated by Frankel and Romer (Ibidem, p. 37). Elasticity with respect to distance is reduced to -0.49 (-0.94+0.45) if countries share the same border line. Coefficient on the land area of country $i$ is negative and is very similar to the estimation calculated by Frankel and Romer (Ibidem). At the same time, growth in
population of country $j$ by one per cent in *ceteris paribus* conditions affects increase of bilateral openness by 0.97%. This is also according to Frankel and Romer’s findings the only variable which has positive effect to bilateral openness, whereas our estimation is higher by half and a bit more. The effect is almost the same if observed countries share the same border line. In such case, the effect of the observed variable, according to our results, amounts to 0.56% (0.97-0.41), while according to Frankel and Romer’s estimation is negligibly lower and amounts to 0.47% (Ibidem). Finally, population of country $i$ and landlock of countries have certain effect only if countries share the same border line.

Application of estimated equations in data of the sample which covered 51 countries give estimated values of logarithm of bilateral openness for all possible pairs of countries. It should be taken into account that data about geographic features of countries are necessary for this calculation, including dummy variables, but not data about bilateral trade flows. After that, we applied equation (1.4), i.e., we applied antilogarithm operation to the obtained estimation. Summing up all such calculated values for each country per all external trade partners covered in the sample, we obtained constructed measure of openness (1.5) which we used as exogenous explanatory variable in the equation of income *per capita* (1.6).

<table>
<thead>
<tr>
<th>Estimation of the bilateral openness equation</th>
<th>(1)</th>
<th>(2)</th>
</tr>
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<tbody>
<tr>
<td>C</td>
<td>-7.71</td>
<td>-</td>
</tr>
<tr>
<td>ln(Aj)</td>
<td>0.58</td>
<td>-</td>
</tr>
<tr>
<td>ln(Dij)</td>
<td>-0.94</td>
<td>-</td>
</tr>
<tr>
<td>ln(Ai)</td>
<td>-0.13</td>
<td>-</td>
</tr>
<tr>
<td>ln(Pj)</td>
<td>0.97</td>
<td>-</td>
</tr>
<tr>
<td>Bijln(Dij)</td>
<td>0.45</td>
<td>-</td>
</tr>
<tr>
<td>Bijln(Pi)</td>
<td>-0.26</td>
<td>-</td>
</tr>
<tr>
<td>Bijln(Pj)</td>
<td>-0.41</td>
<td>-</td>
</tr>
<tr>
<td>Bij(Li+Lj)</td>
<td>-0.41</td>
<td>-</td>
</tr>
</tbody>
</table>

Included observations: 736

- $R^2$: 0.31, 0.77
- $R^2$ adjusted: 0.31, 0.77
- DW: 2.08, 2.02
- $F$: 333.96
- $JB$: 7.63 (*), 7.17 (*)
- $Q$: (3) 3.74 (**), (3) 6.55 (**)
- $BG$: (3) 3.75 (**), (3) 6.64 (**)
- $WH$: 1.11 (**), 29.10382 (***)

**Note:** Presented findings are results of the author’s calculation. Dependant variable is ln(Tij/GDPi). Marks (*), (**), and (***), point out to the acceptance of null statistic hypothesis at the significance level of 1%, 5%, and 10%, respectively. Standard errors are in brackets.
Table 2. Equation of GDP per capita

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>8.95</td>
</tr>
<tr>
<td></td>
<td>(0.290)</td>
</tr>
<tr>
<td>Ti</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>(0.287)</td>
</tr>
</tbody>
</table>

Included observations 51

\[ R^2 = 0.08 \]
\[ R^2 \text{ adjusted} = 0.06 \]
\[ DW = 1.99 \]
\[ F = 4.02 \]
\[ JB = 2.75 (*** \) \]
\[ Q (24) = 12.20 (*** \) \]
\[ BG (24) = 16.88 (*** \) \]
\[ WH = 3.98 (*** \) \]

Note: Presented findings are results of the author's calculation. Dependant variable is \( \ln(Y_i) \). Marks (*), (**) and (***) point out to the acceptance of null statistic hypothesis at the significance level of 1%, 5% and 10%, respectively. Standard errors are in brackets.

Results from estimation of GDP per capita equation (see table 2) show that openness is the only statistically significant determinant, because variables of countries' size are excluded from the model as statistically insignificant. This equation is estimated on the basis of instrumental variables presented in column 2 of Table 1 and it has pretty statistic characteristics. The only weakness of the model is that calculated regression coefficient, at the significance level of 5%, stands at the edge of statistic acceptability. Also, low coefficient of determination may be understood as weakness; however, it is characteristic for the Frankel and Romer's model as well (Ibidem, p. 39).

Calculated coefficient shows that growth of openness by one percentage point implies growth of GDP per capita by 0.58%, whereas this effect is pretty weaker that the one estimated by Frankel and Romer.

5. CONCLUSION

In this paper we have shown results obtained in the research of impact of countries' openness to life standard. Using Frankel and Romer's methodology, and taking into account that openness is not exogenously determined explanatory variable, we have organized the analysis into two basic parts. The first part pertains to the selection of appropriate instrumental variables which we used to solve problem of endogeneity, while the second part is dedicated to estimation of GDP per capita dependence on constructed openness. Using geographic features of countries as instrumental variables, applying two stage least squares method to data of the sample which covers 51 countries, we have estimated that growth of openness by one percentage point leads to increase in
income *per capita* by 0.58%. Weakness of these results is reflected in insufficiently reliable statistic significance of the openness as regressor. Still, despite that, the conclusion that foreign trade positively affects life standard to great extent matches the results obtained in other researches.

**REFERENCES**