# ESTIMATING TRADE ELASTICITIES FOR EX-SOCIALIST COUNTRIES: THE CASE OF MACEDONIA


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**ABSTRACT**

Estimating trade elasticities for the ex-socialist countries is a challenging task, due to the short time series and the low variability in the data. This paper argues that this problem can be addressed by using bilateral-trade data, instead of aggregate, which greatly increases the number of available observations. Dynamic heterogenous panels techniques are employed on Macedonian data, to illustrate the approach. Results show that relying on aggregate data can lead to wrong conclusions about the trade elasticities.



**Keywords:** trade elasticities, dynamic panel, heterogenous panel, Macedonia

**JEL classification:** F10, F14, F4


## I. Introduction

Trade elasticities show how exports and imports respond to changes in economic activity (income) and the real exchange rate (relative prices). Consequently, they are very important for the policy makers because they basically show if depreciation of the exchange rate can have positive effects on the trade balance and how the economy would respond to various demand shocks. They further have implications for the choice of the optimal exchange-rate regime.

Trade elasticities have been in the focus of the economic discipline in the 70s and 80s (Houthakker and Magee, 1969, Goldstein and Khan, 1985), but were then forgotten for the next 2-3 decades. Recently, with the global crisis, the great trade collapse and the global saving glut hypothesis, trade elasticities again came to the fore (see Bussiere et al. 2011, Cheung et al. 2012).

Traditionally, trade elasticities have been estimated using aggregate data: total exports are regressed on a foreign-demand variable (i.e. trade-weighted foreign GDP) and relative-prices variable (i.e. real effective exchange rate), while total imports are regressed on domestic GDP and the real effective exchange rate. However, estimating trade elasticities in this way for countries with short time series can be a challenging task, due to the low variability in the aggregate data. The aim of this paper is to illustrate how to reliably estimate trade elasticities for such countries, like the Eastern European countries.The country on which this exercise will be done is the home country of the author of this paper, Macedonia[1]. The paper will first illustrate the problems associated with using aggregate data, and will then show how these problem can be overcome - by using billateral-trade data.

Several existing studies estimate some form of trade elasticities for Macedonia – Jovanovic (2007), Jovanovic and Petreski (2008), Kadievska-Vojnovic and Unevska (2008). Strangely or not, their results point to different conclusion about the relative magnitude of the Macedonian elasticities and can therefore confuse the reader. These differences can be partly attributed to the different data sources and the different variable definitions used, but are mainly arising from the fact that all these studies use aggregate data, which are unlikely to yield a robust econometric analysis, as we will illustrate. By using bilateral trade data, the number of observations increases substantially (by the number of trading partners which are included in the analysis, in our case roughly by 25 times), which increases variability in the data. In addition to this, working with disagregated data has two more advantages. First, it decreases the simultaneity bias, arising from the fact that exports and imports also affect the explanatory variables (exports are likely to affect the nominal exchange rate, while imports affect both the exchange rate and the domestic GDP).

1. This paper is a part of a bigger research project, which aims to investigate determinants of trade elasticities in Eastern European countries, and, potentially, their implications for the optimal exchange rate regime. The first part of that analysis is to estimate the trade elasticities. The aim of the present paper is to illustrate how to reliably do this.

Second, the demand approach to modelling trade is more likely to be appropriate for bilateral trade data than for aggregate; on the aggregate level ommited supply factors can substantially bias the results, whereas on disagregated level these supply factors will be something like regression outliers. All this, as will be illustrated, results in more precise estimates.

The paper is structured as follows. Section II briefly surveys the existing literature on estimating trade elasticities and on Macedonian trade elasticities. Section III estimates trade elasticities for Macedonia using aggregate data, once again, to illustrate the problems associated with this exercise. Section IV estimates the trade elasticities using bilateral trade data. It first discusses the main advantages of using disaggregated data, then it explains the econometric methodology and finally, it presents the results, investigates their robustness and discusses their implications. The final section concludes and points to areas for future investigation.

## II. Literature review

Rich literature exists on econometric modelling of exports and imports. Some of the studies include Houthakker and Magee (1969), Goldstein and Khan (1978, 1982 and 1985), Krugman (1989), Holly and Wade (1991), Riedel (1984 and 1988), Muscatelli et al. (1990a and 1990b). The traditional approach is to model them as a *demand function* (see Houthakker and Magee, 1969, Goldstein and Khan, 1985), assuming that supply can meet whatever quantity is demanded. Econometrically, this approach to modelling implies regressing total exports/imports on an income variable (usually GDP) and price variable (relative prices, i.e. real exchange rate). Goldstein and Khan (1978), however, argue that supply conditions can be as much important for the exports as the demand conditions, especially for small countries: there is always demand for the exports of the small countries, because of their small size, so their exports depend on their supply. Recently, Bussiere et al. (2011) revisited the question of how properly to estimate trade elasticities in the light of the trade collapse during the global crisis, arguing that the demand variable should be a weighted average of the various GDP components, due to the fact that different components have different import intensity. Imbs and Mejean (2010) estimate price elasticities of exports and imports for 33 countries using a novel approach - using elasticities of substitution between different goods, obtained from ComTrade data. Cheung et al. (2012), in the context of the global saving glut discussion, estimate trade elasticities for China, in order to assess whether appreciation of the

Chinese currency would lead to adjustment in international trade flows.

Several studies so far have estimated trade elasticities for Macedonia - Jovanovic (2007), Kadievska-Vojnovic and Unevska (2007) and Jovanovic and Petreski (2008). Surprisingly, their findings differ substantially, as can be seen from Table 1.

Table 1: Macedonian trade elasticities from existing studies

| Study | | Income | Price |
|---|---|---|---|
| Jovanovic (2007) | Imports | 2.1 and 2.5 | 1.2 and 1.3 |
| | Exports | 1.5 and 1.6 | -2.2 and -2.8 |
| Kadievska-Vojnovic and | Imports | 3.5 | 1.6* |
| Unevska (2007) | Exports | 1.5 | -0.7 |
| Jovanovic and Petreski (2008) | Imports | 1.4 | 0 |
| | Exports | 4.7 | -1.5 |

*This coefficient in the original study is -1.6, but the definition of the price variable is opposite of the other two studies, so it is multiplied by -1 here, to enable comparison.

Regarding imports, the income elasticity is estimated in the range 1.4-3.5, while the price elasticity ranges from 0 to 1.6. Income elasticity of exports ranges from 1.5 to 4.7, while exports price elasticity is in between -0.7 and -2.8. Needless to say, such differences in the results can confuse even the most informed readers.

These differences are to some extent a consequence of the different ways the variables have been constructed in the studies: different studies include different countries with different weights in the construction of the foreign demand and the relative prices variables. Also, they might be due to the different period which they refer to. But these things help explain the different estimates only partially. As will be seen in the next section, estimates obtained from aggregate data are unlikely to be robust, as we argue - due to the low number of observations and the insufficient variability in the aggregate data.

## III. Elasticities from aggregate-trade data

In this section we estimate exports and imports equations on aggregate Macedonian data, once again, to illustrate the problems associated with this exercise. Three estimation techniques will be used – Ordinary Least Squares (OLS), Autoregressive Distributed Lag (ARDL) and the Johansen technique. The analysis features seven variables: five basic (real exports, real imports, foreign demand, Macedonian GDP, real effective exchange rate) and two additional variables for the exports (metals prices and industrial production). All the data are in real terms and have been seasonally adjusted. The foreign demand and the real effective exchange rate (REER) are those used by the central bank in its decision-making process, regularly reported in the central bank reports[2]. The series are shown on Figure I in the Appendix. They are all integrated of order one (formal stationarity tests are available upon request), hence - suitable for cointegration analysis.

The results of the exports equation are discussed first. They are presented in Table 2. As applied econometricians, we begin the analysis with the OLS technique. In the first OLS specification (column 1), exports are regressed only on foreign demand and REER. The residuals from this regression seem stationary, and the diagnostic tests do not suggest misspecification. The results would suggest that the demand elasticity of exports is two, which is high, but not implausible, bearing in mind that Macedonia is a developing country which is in a process of catching-up its major trading partners from the EU. The price elasticity of the exports is implausible, though, since it is positive, implying that exports increase by 1.1% when the real exchange rate appreciates by 1%. The positive price elasticity could be due to the ommission of some important variables which are positively correlated with both the exports and the real exchange rate. Two such variables come to mind – metals prices and the industrial production. Metals constitute big part of Macedonian exports (roughly speaking, 30%), so an increase in their prices should lead to increase in exports. Industrial production could be another important determinant of exports which is ommited. As noted in the literature review section, supply is important determinant of exports in small countries, and this is particularly evident in Macedonia, where restarting some big production capacities in the 2002-2006 period lead to an increase in both the industrial production and the exports. Since these two variables are positively correlated with the the REER, their ommission could bias its coefficient upwards. The OLS regression with the metals prices is shown in column

2. The foreign demand is constructed as a weighted average of the real GDP of the following 9 countries: Germany, Greece, Italy, Netherlands, Belgium, Spain, Serbia, Croatia, Bulgaria. Weights are the normalized shares in the exports in 2005-2010.
The REER is based on the Producer Price Index, and increase stands out for real appreciation (i.e. loss of competitiveness). It is constructed as a weighted average of the real exchange rates against the following 12 countries: Austria, Bulgaria, Croatia, Germany, Greece, Italy, Netherlands, Russia, Slovenia, Turkey, USA and Serbia. The weights are the shares in the total trade in 2006.

2. Metals prices are highly significant and positive, with a coefficient of one third, suggesting that they are important determinant of exports. It can be also observed that the demand coefficient falls substantially and becomes insignificant, suggesting that metals prices take some of its effect. However, the coefficient of the REER stays positive, decreasing only marginally, implying that its wrong coefficient is not due to an ommission of metals prices. Column 3 includes the industrial prodution. The positive and significant coefficient in front of the industrial production gives some evidence in favour of the thesis that supply factors explain aggregate Macedonian exports. Our main problem is still present, though - the coefficient on the REER does not change a lot and remains with the unexpected positive sign. Including both the metals prices and the industrial production does not help either (column 4).

The unsatisfactory results might be due to the use of a wrong estimation technique. For that reason, we next move to the ARDL technique. This technique is based on an OLS estimation of a regression similar to the one from above, enriched by lags from both the dependent and explanatory variables. Though popular in the old days, it was considered obsolete up to one decade ago, when Pesaran and Shin (1997) and Pesaran, Shin and Smith (2001) showed how it can be used for cointegration analysis. Due to the focus of our research, and to preserve space, we only present the long-run and short-run results of the model, without too many details of the estimation. The results of the basic ARDL specification are shown in column 5 of Table 2. The only notable difference with respect to the previous results is that the long-run income and price elasticities obtained from the ARDL are a bit higher. The main problem remains - the price elasticity is still positively signed, both in the long-run and in the short run. Adding the metals prices and the industrial production does not help here either, as shown in columns 6 and 7.

Table 2: Results from the aggregate-data exports regressions

| | -1- OLS | -2- OLS | -3- OLS | -4- OLS | -5- ARDL[1] | -6- ARDL[2] | -7- ARDL[3] | -8- Johansen[4] |
|---|---|---|---|---|---|---|---|---|
| | | | | **Long-run relationship** | | | | |
| constant | -4 | 4.6 * | -5.2 ** | 2.5 | -14.9 | -1.5 | -11.4 | 37.9 |
| log(foreign_demand) | 2 *** | 0.14 | 1.7 *** | 0.4 | 3.2 *** | 0.6 | 2.5 *** | 4.9 *** |
| log(REER) | 1.1 *** | 0.78 *** | 0.8 *** | 0.7 *** | 2.2 * | 1.5 * | 1.5 | 5.4 *** |
| log(metals) | | 0.34 *** | | 0.3 *** | | 0.4 *** | | |
| log(industrial) | | | 0.8 *** | 0.4 *** | | | 0.7 * | |
| | | | | **Short-run relationship** | | | | |
| ECM | | | | | -0.22 *** | -0.47 *** | -0.28 *** | -0.16 *** |
| dlog(foreign_demand) | | | | | 3.1 *** | 2.1 *** | 2.9 *** | -1 |
| dlog(REER) | | | | | 0.5 *** | -0.1 *** | 0.4 | 0.4 |
| dlog(metals) | | | | | | 0.2 *** | | |
| dlog(industrial) | | | | | | | 0.2 | |
| No serial corr. test p val. | 0 | 0 | 0 | 0 | 0.69 | 0.07 | 0.4 | |
| Homoscedasticity test p val. | 0.22 | 0.69 | 0.04 | 0.82 | 0.57 | 0.6 | 0.64 | |
| Normality test p val. | 0.44 | 0.24 | 0.79 | 0.11 | 0.59 | 0.67 | 0.47 | |
| Test for unit root in resid. p val. | 0.07 | 0 | 0.04 | 0.04 | | | | |

***, **, * denotes significance at 1%, 5% and 10%, respectvely. Sample: 1998Q1-2011Q2 (54 observations).

[1] The ARDL includes ona lag from exports and from foreign demand

[2] The ARDL includes ona lag from exports, foreign demand and exchange rate

[3] The ARDL includes ona lag from exports and from foreign demand

[4] VAR of order 2 chosen. Option 3 (intercept in both short-run and long-run relationship) chosen.

Both the trace and the maximum eigenvalue tests indicated 1 cointegrating vector.

The Johansen technique (Johansen, 1988, 1991) is applied last. This technique is based on a VAR analysis, which means that it is "endogeneity-proof". It has many other advantages which make it a standard approach to analysing time series today - it can include many variables and several cointegrating vectors etc. Still, to get good results with this technique, one needs to specify medium-scale VAR, with at least several variables (4-5) and several lags (see Juselius, 2006). Such VARs are almost impossible to estimate precisely when working with short samples, which limits its usefulness for our purpose. Therefore, its results should be taken with a grain of salt. These results are shown in column 8. It seems that the Johansen technique is too costly for our data - the coefficients seem implausibly high. Most importantly, the REER elasticity is positive, again. Adding the metals prices halved the above elasticities, while adding the industrial production increased them further, but the REER always stayed positive. Treating the foreign demand and the metals prices as exogenous did not help (these results are not shown, to conserve space).

To sum up, the three techniques that were applied gave demand elasticities of exports ranging from 0.1 to 4.9 and price elasticity between 0.7 to 5.4. Despite these huge differences, they were all unanimous regarding one thing - the price elasticity was always with the opposite, positive sign, implying that real appreciation improves exports. Hence, although we did not really manage to replicate the results from the existing studies[3], we believe that we showed that it is very difficult to get robust estimates of the exports trade elasticities from the aggregate data.

The imports equation is examined next (Table 3). The three estimation techniques seem to give similar results in the imports regession. They suggest that the income elasticity of the imports is around 1.4-1.6 while the price elasticity is probably zero (it is estimated between 0.1 and 0.4, but is always insignificant). The finding that the imports are price inelastic is in accordance with Jovanovic and Petreski (2008) and does not seem surprising at first sight – Macedonia is a small economy, poor in resources and dependent on imports. The income elasticity of roughly 1.5 is, we believe, a sensible for a developing country like Macedonia. Demand elasticity of exports above 1 are considered problematic in the literature, because they imply that the ratio of imports to GDP should be above 100% in the long run. The fact that empirical studies very often estimate this coefficient to be above 1 has been termed the Houthakker-Magee puzzle. We do not believe that our income elasticity is a problem, because our sample covers a period during which the Macedonian economy is not in equilibrium, but is rather approaching it, and it is plausible that the income elasticity of imports is above 1 during the early stage of the catching-up process, but falls to one or below one in the later stages.

3. This could be done if we used some dummy variables which other studies used, or restrict our sample to the periods from those studies.

Table 3: Results from the aggregate-data imports regressions

| | -1- OLS | -2- ARDL[1] | -3- Johansen[2] |
|---|---|---|---|
| **Long-run relationship** | | | |
| constant | -6 ** | -9.2 | -4.2 |
| log(GDP) | 1.4 *** | 1.6 *** | 4.9 *** |
| log(REER) | 0.15 | 0.4 | 5.4 *** |
| **Short-run relationship** | | | |
| ECM | | -0.46 *** | -0.16 *** |
| dlog(GDP) | | 1.6 *** | -1 |
| dlog(REER) | | 0.18 | 0.4 |
| No serial corr. test p val. | 0 | 0.1 | |
| Homoscedasticity test p val. | 0.19 | 0.59 | |
| Normality test p val. | 0.74 | 0.27 | |
| Test for unit root in resid. p val. | 0.01 | | |

***, **, * denotes significance at 1%, 5% and 10%, respectvely. Sample: 1998Q1-2011Q3 (55

[1] The ARDL includes ona lag from imports and from GDP.

[2] VAR of order 4 chosen, option 3 (intercept in both short-run and long-run relationship). Both the trace and the maximum eigenvalue tests indicated 2 cointegrating vectors (hence, 2 identifying restrictions on each vector). The first vector (the one we are interested in) is identified by setting the imports as the dependent variable and that the second ECM is zero. Various identifying schemes were tried for the second vector. They neve affected the results of the first vector. Therefore, as we are interested only in the import regression, we do not report the results of the second vector, for clarity. Only some of the coefficients from the short-run regressions are shown, for clarity. Those that are shown are sums of the coefficients on all the lags of a certain variable (e.g. the coefficient on dlog(GDP) is the sum of the coefficients on dlog(GDP(-1)), dlog(GDP(-2) and dlog(GDP(-3)). Results from the third short-run regression are not shown, for clarity, but are available on request.

But, why do we get wrong results for the exports equations? Two explanations are possible. First, it is possible that there is simultaneity between the exports and the REER – higher exports can lead to exchange rate appreciation (mostly through the prices, since the nominal exchange rate is fixed). This positive effect of the exports on the REER is likely to bias the REER coefficient in the exports equation upwards. If the bias is so strong, it can make the REER coefficient in the exports equation positive. The second potential explanation is that there is not enough variability in the data for a precise estimation. This can be seen from the descriptive statistics (Table 9 in the Appendix). The coefficient of variation is relatively low for all the variables, but especially for the REER, where it is only 8%. After 2001, i.e. for majority of our sample, it is only 5%. Such a small variation in the data can be problematic. Both these problems are avoided if one works with bilateral trade data, as is discussed next.

# IV. Elasticities from bilateral-trade data

## *IV.A. Advantages of using bilateral data*

Using bilateral trade data has several advantages. First, the number of observations increases greatly. If one uses aggregate data, the number of observations will be around 50 (quarterly data for Macedonian exports and imports are available only from 1998). If one uses bilateral trade data, the number of observations increases by a factor which is equal to the number of countries that are included (in our case, roughly by 25 times). More observations further translate into more variability. For instance, while the coefficient of variation of the real effective exchange rate used in the aggregate analysis was only 8%, the coefficient of variation of the corresponding variable from the bilateral-trade analysis (the bilateral real exchange rate) is 20% (see Table 10 in the Appendix). This then implies more precise estimates. Second, the demand approach to modelling exports and imports is more appropriate when the analysis is done on a country-by-country level, than on an aggregate level. On aggregate level supply factors can also be very important. For example, when some big production capacity is opened or restarted, that immediately increases exports. Failure to control for this, i.e. omission of the supply factors, can lead to an upward bias in the estimated trade elasticities. This is less likely to hold when the analysis is done on a country level, since these supply factors will apply only to few countries, and are therefore unlikely to bias the coefficients up, but will rather be something like outliers. Finally, working with disaggregated data has an advantage that the results are less likely to be biased by the endogeneity between the dependent variable and the regressors. If we take the exports equation, for example, it is very likely to be biased by endogeneity when estimated on aggregate data, since exports can affect the REER too: higher exports imply higher domestic prices, which translates into higher REER[4]. This is likely to bias the REER coefficient in the exports regression upwards. Similar simultaneity bias

4. Exports can affect the REER through the nominal exchange rate, too – higher exports imply higher demand for domestic currency, i.e. higher nominal exchange rate. This channel will not be present in Macedonia, since its currency is pegged to the euro.

is possible in the imports equation as well, due to the simultaneity between the imports and the GDP – imports are part of the GDP, hence higher imports imply lower GDP, ceteris paribus, as a result of what the income elasticity in the imports equation will tend to be biased downwards. These biases will be much smaller in the disaggregated analysis, since trade with one country is much less likely to affect domestic GDP and the price level than aggregate trade.

On the other hand, the main problem with working with bilateral-trade data is that these data can often be noisy, because of factors which are not taken into account in the analysis (certain administrative and political factors, one-time shocks etc.). Therefore, one must carefully examine the data prior to the analysis, to make sure that there are no huge outliers or structural breaks.

## *IV.B. Data*

Quarterly data will be employed in the analysis. The structure of the regressions remains as previously explained. The main sources of data are the International Financial Statistics (IFS) and the Directions od Trade Statistics (DOTS) of the International Monetary Fund. Data on exports/imports by countries are from DOTS. Data on GDP, PPI (producer price index) and the nominal exchange rate are from IFS.

Data on exports/imports from DOTS are nominal, so they were deflationed by dividing with the Macedonian PPI index. This is only an approximation, but, arguably, it is as good as one could get. The real exchange rate is based on PPI and is constructed so that increase stands for real appreciation (i.e. RER=domestic PPI * nominal exchange rate/foreign PPI).

The countries were selected on the grounds of their share in Macedonian exports/imports for the period 1997-2010. First, 30 countries with highest shares were selected. Then, countries which did not have quarterly data were discarded (China and Kosovo). Finally, some countries which had high shares for only some periods and negligible shares for the majority of the perids were left out (India in the exports, Poland, Romania, Hungary, UK and Kazakhstan in the imports). This, as already discussed, is very important, because such high jumps can potentially bias the results. The finally-chosen countries are reported in Table 4.

Table 4: Exports and imports by countries

| Exports | | Imports | |
|---|---|---|---|
| Country | Share (%) | Country | Share (%) |
| Germany | 18.13 | Germany | 11.3 |
| Serbia* | 14.92 | Russia | 10.4 |
| Greece | 11.4 | Greece | 8.83 |
| Italy | 8.05 | Serbia* | 6.66 |
| Bulgaria | 5.75 | Italy | 5.97 |
| Croatia | 4.81 | Bulgaria | 5.66 |
| US | 3.87 | Slovenia | 4.55 |
| Netherlands | 2.61 | Ukraine | 3.36 |
| Bosnia | 2.37 | Croatia | 2.44 |
| Belgium | 2.26 | US | 2.26 |
| UK | 2.07 | Switzerland | 2.17 |
| Slovenia | 2.03 | Austria | 2.12 |
| Albania | 1.97 | France | 1.9 |
| Spain | 1.94 | Netherlands | 1.73 |
| Switzerland | 1.35 | Brazil | 1.2 |
| France | 1.16 | Japan | 0.89 |
| Russia | 1.06 | Spain | 0.88 |
| Austria | 0.71 | Czech | 0.86 |
| Romania | 0.59 | Sweden | 0.85 |
| Montenegro | 0.43 | Korea | 0.81 |
| Portugal | 0.4 | Belgium | 0.7 |
| Sweden | 0.37 | Slovakia | 0.47 |
| Czech | 0.36 | India | 0.41 |
| Poland | 0.32 | | |
| Slovakia | 0.23 | | |
| Hungary | 0.21 | | |
| Ukraine | 0.2 | | |
| Total | 89.58 | Total | 76.42 |

*Serbian data until 2009 include trade with Kosovo.

The plots of the variables are given in the Appendix (Figures II-VII). All the variables are non-stationary (results of the formal unit root tests are available on request).

## *IV.C. Econometric methodology*

Two features of our dataset determine the appropriate estimation technique. The first is that our panels consist of, roughly, 25 cross sections and 50 periods, i.e. are “moderate N, moderate T”, which suggests that the coefficients might differ across groups. The second one is that our variables are non-stationary. Dynamic heterogenous panels techniques are appropriate in such cases (see Pesaran and Smith, 1995, Pesaran, Shin, Smith, 1999 and Blackburne and Frank, 2007). These techniques are based on the ARDL approach that was mentioned before, i.e. they begin with a regression where the dependent variable is regressed on its own lags and current and lagged values of the explanatory variable:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{h=0}^{q} \delta_{ih} x_{i,t-h} + \mu_i + \epsilon_{it} \tag{1}$$

where $y$ is the dependent variable, $x$ is a vector of explanatory variables, $i$ is an index denoting the different cross-sectional units, $t$ is the time index, $\mu$ represents the fixed effects, $\epsilon$ are the residuals, $\lambda$ are the coefficients of the lags of the dependent variable and $\delta$ are the coefficients of the explanatory variables. The above ARDL is said to be of order $(p, q, q, ...)$, since there are $p$ lags of the dependent variable in the regression and $q$ lags of the explanatory variables (it is not required that all explanatory variables are included with same number of lags).

The above equation can be rewritten as:

$$\Delta y_{it} = \phi_i y_{i,t-1} + \gamma_i x_{it} + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta y_{i,t-j} + \sum_{h=0}^{q-1} \delta^*_{ih} \Delta x_{i,t-h} + \mu_i + \epsilon_{it} \tag{2}$$

For example, let us rewrite the ARDL(2,2) model:

$$y_{it} = \alpha_{i,o} + \alpha_{i,1} y_{i,t-1} + \alpha_{i,2} y_{i,t-2} + \beta_{i,1} x_{i,t} + \beta_{i,2} x_{i,t-1} + \beta_{i,3} x_{i,t-2} + \mu_i + \epsilon_{it}$$

Substract $y_{i,t-1}$ from both sides:

$$\begin{aligned} y_{it} - y_{i,t-1} &= \alpha_{i,o} + \alpha_{i,1} y_{i,t-1} - y_{i,t-1} + \alpha_{i,2} y_{i,t-2} \\ &\quad + \beta_{i,1} x_{i,t} + \beta_{i,2} x_{i,t-1} + \beta_{i,3} x_{i,t-2} + \mu_i + \epsilon_{it} \end{aligned}$$

Rewrite $y_{i,t-2}$ as $y_{i,t-1} - \Delta y_{t-1}$ ,$x_{i,t}$ as $x_{i,t-1} + \Delta x_t$ and $x_{i,t-2}$ as $x_{i,t-1} - \Delta x_{t-1}$ :

$$\begin{aligned} y_{it} - y_{i,t-1} &= \alpha_{i,o} + \alpha_{i,1} y_{i,t-1} - y_{i,t-1} + \alpha_{i,2}(y_{i,t-1} - \Delta y_{t-1}) \\ &\quad + \beta_{i,1}(x_{i,t-1} + \Delta x_t) + \beta_{i,2} x_{i,t-1} + \beta_{i,3}(x_{i,t-1} - \Delta x_{t-1}) + \mu_i + \epsilon_{it} \end{aligned}$$

Collect terms, to get the representation from equation (2):

$$\begin{aligned} \Delta y_{it} &= \alpha_{i,o} + (\alpha_{i,1} + \alpha_{i,2} - 1) y_{i,t-1} + (\beta_{i,1} + \beta_{i,2} + \beta_{i,3}) x_{i,t-1} \\ &\quad - \alpha_{i,2} \Delta y_{t-1} + \beta_{i,1} \Delta x_t - \beta_{i,3} \Delta x_{t-1} + \mu_i + \epsilon_{it} \end{aligned}$$

In this representtion, the terms in first differences give the short-run dynamics, while the terms in levels give the long-run relationship.

Three different dynamic heterogenous methods exist: dynamic fixed effects (DFE), the mean group (MG) estimator of Pesaran and Smith (1995) and the pooled mean group (PMG) estimator of Pesaran, Shin and Smith (1999). The DFE assumes homogenous coefficients across all the cross sections, i.e. $\phi_i, \gamma_i, \lambda^*_{ij}$ and $\delta^*_{ih}$ from equation 2 are same for all $i$. The MG assumes different coefficients for every cross section (i.e. $\phi_i, \gamma_i, \lambda^*_{ij}$ and $\delta^*_{ih}$ are different for all $i$) and the PMG assumes that the short-run coefficients differ between the units, while the long-run coefficients are same for all units (i.e. $\phi_i$ and $\gamma_i$ are same, $\lambda^*_{ij}$ and $\delta^*_{ih}$ are different for different $i$). We discard the DFE on theoretical grounds because we do not believe that trade elasticities are common for different trading partners – the composition of trade differs between countries, so should the trade elasticities[5]. Hence, we are left with the PMG and the MG. Since we cannot decide on theoretical

5. This argument does not discard the PMG estimator, however, since PMG allows for short-run heterogeneity,

grounds which of the two is more appropriate, we will decide on statistical grounds. Namely, the PMG estimates are efficient and consistent if the long-run coefficients are same across cross sections, while the MG are only consistent in such a case. On the other hand, if the long-run coefficients are different between cross sections, the PMG is inconsistent, while MG is still consistent. This is a natural environment for an application of the well-known Hausman test, which tests the difference between two estimators, one efficient, one consistent, under a given null hypothesis (the hupothesis in our case is that coefficients are homogenous). If the difference between the two estimators is statistically significant, this means that the consistent estimator is prefered (MG in our case).

## ***IV.D. Results***

The first step in the application of the dynamic heterogenous panels, as in all ARDL analyses, is to determine the appropriate lag structure. This is usually done on the grounds of the standard information criteria (IC). However, one must not forget that the heterogenous panel estimators are based on the assumption that the residuals from the above regression are serially uncorrelated and uncorrelated between different cross sections (see Pesaran et al. 1999, assumption 3.1). Therefore, the chosen lag order should be high enough to make sure that this assumption is satisfied. However, we could not achieve this even when we included 5 lags from all the regressors. Hence, we continued our analysis with the lag order suggested by the information criteria, although this assumption was not met (we will return to this issue with the residuals later).

Three criteria were consulted when the number of lags was decided - the Schwarz IC, the Akaike IC and the $\overline{R}^2$. We estimated regression for each individual country allowing for up to 4 lags of each explanatory variable. Then, we chose the optimal number of lags for each country - we determined which lag structure is suggested by most of the criteria (if all criteria gave different suggestions, we chose the lag structure suggested by the Schwarz IC). Finally, we saw which option is most common (i.e. which option is optimal for most of the countries). Results are in the Appendix (Tables 11 ans 12), and the choice was (1,0,0) for both the exports and the imports, i.e. 1 lag of the trade variable and no lags of the price and income variable. The residuals from these regressions are shown in the Appendix (Figures VIII and IX), just to gain some insight about the seriousness of the serial correlation and the cross-equations correlation. Our subjective judgement is that the

which guarantees differences in trade between countries.

residuals are not as terrible as they could be. Serial correlation seems to be present only in some cases, and even then – it is not that strong. We also tested if the residuals were stationary, the null of unit root was strongly rejected.

The next step is to test for cointegration. We applied the test developed by Westerlund (2007), which is based on testing the significance of the error correction mechanism from the error correction transformation of the ARDL model. The results are shown in Table 5 and indicate that the null of no cointegration can be rejected[6].

Table 5: Westerlund test for cointegration.

$H_0$: No cointegration.

| Exports | | Imports | |
|---|---|---|---|
| Test | P value | Test | P value |
| Gt | 0.00 | Gt | 0.00 |
| Ga | 0.00 | Ga | 0.00 |
| Pt | 0.00 | Pt | 0.00 |
| Pa | 0.00 | Pa | 0.00 |

The results of the PMG estimator for the exports are shown below. Here we show only the aggregate short-run results, the results for each country are not reported, to conserve space, but are available upon request.

$$\begin{aligned}
\text{Long-run relationship} &: \\
log(exports) &= 1.9^{***} \cdot log(GDP) - 0.4^{*} \cdot log(RER) \\
\text{Short-run relationship} &: \\
dlog(exports) &= -0.26^{***} \cdot ECM + 2.9^{**} \cdot dlog(GDP) \\
&\quad +0.64 \cdot dlog(RER)
\end{aligned}$$

***, **, * denotes significance at 1%, 5% and 10%, respectvely. Period of estimation: 1995Q1-2011Q2, 1301 observations. Number of cross sections: 27. Observations per cross section: min 16, max 66, average

6. We allowed for a constant in the long-run regression and limited the number of lags to 1, as this was suggested by the information criteria from above.

48. Log likelihood: -260.6; after 8 iterations. The short-run coefficients are the averages. The regression includes a dummy which takes value of 1 for Serbia, for 2007 and 2008 (not shown, for clarity).

The aggregate MG results are shown below. Usually, the MG estimates are the unweighted averages of the coefficients from each cross section regression. Here we present the weighted averages, since this is more appropriate given our interpretation of the long-run coefficients as an aggregate trade elasticities. The weights that are used are the shares of each corresponding country in total exports/imports, shown previously. The estimates of the individual regressions are not shown, due to space limitation, but are available upon request.

$$\begin{aligned}
\text{Long-run relationship} &: \\
log(exports) &= 2.8^{***} \cdot log(GDP) - 0.6^{*} \cdot log(RER) \\
\text{Short-run relationship} &: \\
dlog(exports) &= -0.45^{***} \cdot ECM + 2.9^{**} \cdot dlog(GDP) \\
&\quad +0.07 \cdot dlog(RER)
\end{aligned}$$

***, **, * denotes significance at 1%, 5% and 10%, respectvely. Period of estimation: 1995Q1-2011Q2, 1301 observations. Number of cross sections: 27. Observations per cross section: min 16, max 66, average 48. The regression for Serbia includes a dummy which takes value of 1 in 2007 and 2008, to control for some high values of exports (not shown, for clarity).

From eyeballing, the PMG and MG coefficients seem fairly similar: 1.9 vs 2.8 for the income elasticity of exports and -0.4 vs. -0.6 for the price elasticity. As already said, we distinguish between the two on the grounds of the Hausman test. The MG estimates are consistent always, the PMG are consistent and efficient if the long-run coefficients are really identical, but it is inconsistent if the true coefficients are heterogenous. Therefore, if the two estimates are statistically equal, this means that we should take the PMG, since it is efficient, but if they are different, we should take the MG, since it is always consistent. The p value of the Hausman test was 0.43, which means that we cannot reject the null hypothesis that the estimates are same, so we choose the PMG.

Therefore, we could say that exports are highly income-elastic, increasing by 1.9% in the long run when foreign demand increases by 1%. The high income elasticity, which points out to high sensitivity to external shocks, becomes more apparent when the short-run income elasticity is observed (it is around 3). This is in accordance with the behaviour of the exports during the crisis of 2008-9, when exports fell substantially, particularly in the begining of the crisis. On the other hand, the price-elasticity is low, implying that exports increase by 0.4 in the long-run when the price competiteveness improves by 1%. This points out that improving price competitiveness, through exchange rate depreciation for example, will lead only to minor improvements in the exports. This is in accordance with the devaluation episode from 1997, when the 17%-devaluation of the currency did not result in any significant improvements in the trade balance. It is also interesting to note that the short-run price elasticity is positive (though insignificant). This "J curve" is, however, different from the conventional "J curve" effect in the literature on exchange rate devaluations, which points out that devaluations initially result in worsening of the trade deficit, due to higher import prices.

It ishould also be noted that these results are pretty different from those obtained from aggregate data, especially when the price elasticity is concerned - the aggregate-data estimates, oddly, always gave positive price elasticity. These results are also in stark contrast with the existing studies discussed above.

The imports results are shown next. We first present the PMG results.

$$\begin{aligned}
\text{Long-run relationship} &: \\
log(imports) &= 1.5^{***} \cdot log(GDP) - 0.6^{**} \cdot log(RER) \\
\text{Short-run relationship} &: \\
dlog(imports) &= -0.37^{***} \cdot ECM + 1.1^{***} \cdot dlog(GDP) \\
&\quad -0.38 \cdot dlog(RER)
\end{aligned}$$

***, **, * denotes significance at 1%, 5% and 10%, respectvely. Period of estimation: 1997Q1-2011Q2, 1245 observations. Number of cross sections: 23. Observations per cross section: min 17, max 57, average 54. Log likelihood: -14.8; after 10 iterations.

The weighted MG results are:

$$
\begin{aligned}
\text{Long-run relationship} &: \\
log(imports) &= 1.9^{***} \cdot log(GDP) + 0.5 \cdot log(RER) \\
\text{Short-run relationship} &: \\
dlog(imports) &= -0.49^{***} \cdot ECM + 0.8^{***} \cdot dlog(GDP) \\
&\quad -0.57 \cdot dlog(RER)
\end{aligned}
$$

***, **, * denotes significance at 1%, 5% and 10%, respectvely. Period of estimation: 1997Q1-2011Q2, 1245 observations. Number of cross sections: 23. Observations per cross section: min 17, max 57, average 54.

We descriminate between the two using the Hausman test. Its p-value was 0.02, which means that the null hypothesis of equality between the PMG and the MG imports coefficients can be rejected with small probability of making an error. In other words, the MG estimates are prefered. This is not strange, since long-run-coefficient homogenity in the imports equation implies similar shares of imports from all countries, in the long run (since the demand variable for all countries is the same – Macedonian GDP).

So, similarly to the exports, imports appear to have high income elasticity (1.9), but low price elasticity (0.6). In addition, the short-run demand elasticity is rather low (0.8), suggesting that episodes of a fall in domestic GDP initially result in small contraction of the imports, which eventually becomes higher. This is exactly how imports behaved during the crisis in 2008/9. The short-run price elasticity is unexpectedly negative, but insignificant. The long-run price elasticity of the imports is positive, low and insignificant, implying that depreciations will lead to a small fall in the imports, which is not strange, given the high import dependance of the economy (this coefficient becomes significant in the second half of the sample, as we will see later). From the existing studies, Jovanovic and Petreski (2008) obtain import elasticities similar to ours. It is also interesting to note that the aggregate imports elasticity estimates are only slightly different from those obtained from the billateral trade data. The income elasticity from the aggregate analysis was a bit lower than the one from the bilateral trade, which, as argued above, is due to the downward bias of this coefficient in the aggregate analysis, due to the simultaneity between the imports and the GDP.

### *IV.E. Further analysis*

As already pointed out, heterogenous panel techniques are based on the assumption that the residuals are serially uncorrelated and uncorrelated between cross sections. We already saw that the assumption of no serial correlation is not met, but we did not consider this to be a serious problem, because we could not get rid of the serrial correlation and because it did not seem to be widespread, judging by the visual inspection of the residuals. Now we test for cross-sectional correlation between the residuals, using the CD test proposed by Pesaran (2004). The results are shown in Table 6.

Table 6: CD test for cross-error correlation.
$H_0$: No correlation.

| | Exports | Imports |
|---|---|---|
| Number of groups: | 27 | 23 |
| Average number of obs. per group: | 41.5 | 53.9 |
| Correlation | 0.042 | 0.068 |
| Abs. Correlation | 0.335 | 0.272 |
| CD test | 5.92 | 7.04 |
| P value | 0.00 | 0.00 |

As can be seen, the residuals seem to be cross-sectionally correlated. This is most likely due to an omitted common factor affecting all cross sections (gradual development of the financial sector, gradual technological advance, global economic environment...). Econometric techniques for modelling common factors are fairly recent, and currently there are two such techniques – the common correlated effects (CCE) model of Pesaran (2006) and the augmented mean group (AMG) estimator of Bond and Eberhardt (2009). Bond and Eberhardt (2009) argue that the two estimators are rather similar. Loosely speaking, the CCE controls for the common factors by including means of the explanatory variables across the cross-sections, while the AMG includes time dummies. The latter approach seems to be more appropriate in our case. So, we next apply the AMG estimator, to see if those results are different from the baseline results that were presented in the previous section. The main reason why the AMG was not chosen as the baseline estimator is that it is pretty new and has yet to pass the test of the empirics.

The basic regressions are the same as in PMG and MG – one lag of the dependent variable is included on the right hand side. In addition, trends are included in the individual country reggressions, to avoid spurious identification of the common factor. We also control for outliers, by using the option "robust" in Stata. The results are shown below. Only the transformed long-run coefficients are reported, for brevity.

$$log(exports) = 1.9 \cdot log(GDP) - 0.4 \cdot log(RER) + 0.78^{***} \cdot common$$

***, **, * denotes significance at 1%, 5% and 10%, respectvely. Period of estimation: 1995Q1-2011Q2, 1301 observations. The trends are significant in 6 countries.

$$log(imports) = 1.4^{***} \cdot log(GDP) + 0.2 \cdot log(RER) + 0.29^{***} \cdot common$$

***, **, * denotes significance at 1%, 5% and 10%, respectvely. Period of estimation: 1997Q1-2011Q2, 1245 observations. The trends are significant in 5 countries.

It can be seen that these results are very similar to those presented in the previous sub-section. The difference between them is insignificant statistically. Furthermore, the residuals from these regressions are free from correlation, both serial and cross-sectional. The only notable difference between these AMG results and the baseline is that the AMG coefficients are less significant. But, since we use the AMG only as a cross-check for the baseline results, we do not consider this to be a serious problem.

### *IV.F. Robustness and structural stability*

In this section we first check how stable the results are, by carrying out the above estimations for the exports and the imports on drastically reduced samples. First, some initial observations are cut, then some observations from the beginning and the end of the sample are excluded, and finally the regressions are estimated for two subgroups of countries. The results are in Table 7 and Table 8.

Table 7: Robustness of the exports results.

| | **-1-** | **-2-** | **-3-** | **-4-** | **-5-** |
|---|---|---|---|---|---|
| | **baseline** | **no first 32 periods** | **no first 15 and last 18 periods** | **first 14 countr.** | **last 13 countr.** |
| | | | **long-run** | | |
| log(gdp) | 1.9 | 3.7 | 2.1 | 1.9 | 2.4 |
| | *** | *** | *** | *** | *** |
| log(rer) | -0.4 | -0.6 | -0.6 | -0.4 | -0.7 |
| | * | ** | * | | ** |
| | | | **short-run** | | |
| ECM | -0.26 | -0.38 | -0.3 | -0.27 | -0.3 |
| | *** | *** | *** | *** | *** |
| dlog(gdp) | 2.9 | 1 | 3 | 3.2 | 4 |
| | ** | | | ** | |
| dlog(rer) | 0.64 | 1.4 | 0.9 | -0.2 | 1.7 |
| No. Obs. | 1301 | 857 | 940 | 663 | 638 |
| No. Cross s. | 27 | 27 | 27 | 14 | 13 |

Table 8: Robustness of the imports results.

| | -1- baseline | -2- no first 18 periods | -3- no first 10 and last 14 periods | -4- first 11 countr. | -5- last 12 countr. |
|---|---|---|---|---|---|
| | | | **long-run** | | |
| log(gdp) | 1.9 | 1.9 | 1.6 | 1.5 | 2.3 |
| | *** | *** | *** | *** | *** |
| log(rer) | 0.5 | 1.4 | 0 | 0.5 | 0.5 |
| | | *** | | | |
| | | | **short-run** | | |
| ECM | -0.49 | -0.46 | -0.65 | -0.67 | -0.33 |
| | *** | *** | *** | *** | *** |
| dlog(gdp) | 0.8 | 0.5 | 0.3 | 0 | 1.6 |
| | *** | | | | *** |
| dlog(rer) | -0.6 | -1 | -0.7 | -0.4 | -0.7 |
| | | ** | | | *** |
| No. Obs. | 1245 | 897 | 748 | 619 | 626 |
| No. Cross s. | 23 | 23 | 23 | 11 | 12 |

The results from the estimations over reduced samples seem very similar to the baseline results. Only two differences appear to be bigger - the income elasticity in the exports equation, in the latter part of the sample (column 2, Table 7), and the price elasticity of the imports in the latter part of the sample (column 2, Table 8). These potential structural breaks can be easily tested using the Chow test. The results of these regressions are shown below (only the long-run elasticities are reported).

$$log(exports) = 1.8^{***} \cdot log(GDP) - 0.6^{*} \cdot log(RER)^{**} + 1.5^{***} \cdot post\_2001 \cdot log(GDP)$$

$$log(imports) = 2^{***} \cdot log(GDP)^{***} + 0.5 \cdot log(RER) + 0.4 \cdot post\_2001 \cdot log(RER)$$

The structural stability test points out that the change in the export demand elasticity after 2001 is statistically significant, while the change in the import price elasticity is not. The change in the income elasticity of exports can be attributed in the change in the structure of the exports that happened after 2001. As already mentioned, after this period several big production capacities from the metals industry were restarted, which increased the share of commodities in the exports. Since commodities are well known to be high-income elastic, this change is not surprising.

### *IV.G. Summary of the bilateral-trade analysis*

To sum up, the bilateral-trade analysis suggests that Macedonian *exports* have high income elasticity (1.8 in the period before 2001 and 3.3 in the period afterwards) and low price elasticity (-0.6). The short-run income elasticity of exports is higher than the long-run. This all suggests that adverse shocks in foreign demand will affect Macedonian economy severely, especially in the short-run, and that real exchange rate depreciation will have only minor positive effects on Macedonian exports. Macedonian *imports*, similarly, are more elastic to changes in income than to changes in prices (1.9 vs. 0.5), but the short-run income elasticity is lower than the long-run. This implies that negative shocks to the domestic demand will result in more than proportional fall in the imports, but only after some time, and that real exchange rate depreciation will decrease imports only marginally. The sum of the price elasticity of the imports and the exports is slighly above 1, which implies that Macedonian economy would satisfy the Marshall-Lerner condition, the necessary condition for exchange rate depreciation to have positive effects on the trade, if the exchange rate pass-through to domestic inflation was low (i.e. zero). However, as the pass-through from the nominal exchange rate to domestic inflation in Macedonia is estimated to be around 0.4 (see Besimi et al., 2006 and Vrboska, 2006), depreciation of the nominal exchange rate is likely to worsen the trade balance in Macedonia, rather than improve it.

## V. Conclusion

Trade elasticities are very important for the policy makers - the demand elasticities show how exports and imports react to changes in foreign/domestic demand, the price elasticities show how exports and imports react to changes in the exchange rate. In this paper we argue that efforts to estimate trade elasticities for countries with short time series (like the ex-socialist countries) in the conventional manner - on aggregate trade data, may end in vain. For these countries, we argue, it is more appropriate to use bilateral trade data: the number of observations increases greatly when one works with bilateral trade data, which in turn implies much more precise estimates.

This is illustrated on the case of Macedonia. The aggregate trade elasticities indeed seem imprecise, especially in the *exports* case - the income elasticity is estimated between 0.1 and 4.9, while the price elasticity between 0.7 and 5.4 (the price elasticity is even wrongly signed). Using bilateral-trade data, the income elasticity of exports is estimated to be 3.3 (1.8 before 2001), while the price is estimated at -0.6. The *import* elasticities obtained from aggregate data, on the other hand, seem to be less biased - only the income elasticity is slightly lower than the one obtained from bilateral trade data (1.4, instead of 1.9).

The apprach which was set-up in this paper should now be extended to other countries. This is worthwile, not only due to the recent revival in the interest in trade elasticities in the economic literature (see Bussiere et al. 2011 and Imbs and Mejean, 2010, Cheung et al. 2012), but also because no study so far has offered a thorough analysis of trade elasticities in the ex-socialist countries.

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# VI. APPENDIX

TABLE 9: DESCRIPTIVE STATISTICS OF THE VARIABLES USED IN THE AGGREGATE-TRADE ANALYSIS

| | exports | foreign demand | metals | industrial | imports | GDP | REER |
|---|---|---|---|---|---|---|---|
| Mean | 31838.4 | 112.3 | 110.9 | 102.1 | 45670.6 | 73555.6 | 98.7 |
| Max | 44889.5 | 128.8 | 248.6 | 118.6 | 67082.4 | 90329.3 | 118.6 |
| Min | 23559.2 | 93.9 | 49.6 | 86.9 | 29527.3 | 59446.5 | 88.6 |
| Std.Dev. | 5461.3 | 11.0 | 60.8 | 7.5 | 9165.4 | 9841.2 | 8.5 |
| Coef.Var. | 0.172 | 0.098 | 0.549 | 0.073 | 0.201 | 0.134 | 0.080 |
| No.Obs. | 54 | 54 | 54 | 54 | 54 | 54 | 54 |

TABLE 10: DESCRIPTIVE STATISTICS OF THE VARIABLES USED IN THE BILATERAL-TRADE ANALYSIS

| | export | GDP_for | RER_expo | imports | GDP_mk | RER_impo |
|---|---|---|---|---|---|---|
| Mean | 1017.67 | 0.91 | 1.02 | 1570.33 | 0.84 | 1.05 |
| Max | 13208.33 | 1.41 | 2.16 | 10372.81 | 1.04 | 2.53 |
| Min | 0.00 | 0.56 | 0.68 | 0.00 | 0.65 | 0.64 |
| Std.Dev. | 1579.04 | 0.12 | 0.20 | 1802.97 | 0.12 | 0.20 |
| Coef.Var. | 1.55 | 0.13 | 0.20 | 1.15 | 0.14 | 0.20 |
| No.Obs. | 1321 | 1321 | 1321 | 1268 | 1268 | 1268 |

Table 11: Lag order in the imports equation

Number of lags of GDP, RER and imports, respectively

| | AIC | SBC | Rbar2 | Final choice |
|---|---|---|---|---|
| Austria | 1,3,3 | 0,0,1 | 1,3,3 | 1,3,3 |
| Belgium | 0,0,0 | 0,0,0 | 0,0,0 | 0,0,0 |
| Brazil | 0,3,0 | 0,3,0 | 1,3,0 | 0,3,0 |
| Bulgaria | 1,0,3 | 0,0,1 | 3,0,3 | 0,0,1 |
| Croatia | 0,3,0 | 0,2,0 | 0,2,3 | 0,2,0 |
| Czech | 0,0,2 | 0,0,2 | 0,2,3 | 0,0,2 |
| France | 2,1,1 | 1,1,1 | 3,0,3 | 1,1,1 |
| Germany | 2,1,3 | 1,0,3 | 2,2,3 | 1,0,3 |
| Greece | 2,0,2 | 2,0,2 | 2,2,2 | 2,0,2 |
| India | 0,0,1 | 0,0,1 | 1,2,1 | 0,0,1 |
| Italy | 0,0,1 | 0,0,0 | 2,0,1 | 0,0,0 |
| Japan | 0,2,1 | 0,2,1 | 0,3,1 | 0,2,1 |
| Korea | 1,0,3 | 0,0,1 | 1,0,3 | 0,0,1 |
| Netherlands | 0,0,2 | 0,0,1 | 2,0,2 | 0,0,1 |
| Russia | 1,1,1 | 1,0,1 | 1,1,1 | 1,1,1 |
| Serbia | 1,1,1 | 1,1,0 | 1,1,1 | 1,1,1 |
| Slovakia | 1,0,1 | 1,0,1 | 1,0,3 | 1,0,1 |
| Slovenia | 0,0,1 | 0,0,1 | 1,0,2 | 0,0,1 |
| Spain | 0,0,2 | 0,0,2 | 3,0,2 | 0,0,2 |
| Sweden | 2,0,2 | 1,0,1 | 2,3,2 | 1,0,1 |
| Switzerland | 1,3,1 | 1,3,1 | 1,3,1 | 1,3,1 |
| Ukraine | 1,0,1 | 1,0,1 | 2,2,1 | 1,0,1 |
| US | 1,0,3 | 0,0,1 | 1,2,3 | 0,0,1 |

For most of the countries (6) order 0,0,1 is chosen

(i.e. no lags of GDP and RER and 1 lag of imports)

Table 12: Lag order in the exports equation

Number of lags of GDP, RER and exports, respectively

| | AIC | SBC | Rbar2 | Final choice |
|---|---|---|---|---|
| Albania | 0,0,1 | 0,0,1 | 0,0,1 | 0,0,1 |
| Austria | 0,0,1 | 0,0,1 | 0,1,1 | 0,0,1 |
| Belgium | 1,0,1 | 1,0,1 | 3,0,1 | 1,0,1 |
| Bosnia | 2,3,1 | 2,3,1 | 2,3,1 | 2,3,1 |
| Bulgaria | 0,0,1 | 0,0,0 | 0,0,1 | 0,0,1 |
| Croatia | 0,3,0 | 0,3,0 | 0,3,1 | 0,3,0 |
| Czech | 3,1,3 | 2,0,3 | 3,1,3 | 3,1,3 |
| France | 0,1,1 | 0,0,1 | 0,3,1 | 0,0,1 |
| Germany | 0,3,3 | 0,3,1 | 0,3,3 | 0,3,3 |
| Greece | 2,2,1 | 2,0,1 | 2,2,1 | 2,2,1 |
| Hungary | 3,3,2 | 0,0,2 | 3,3,2 | 3,3,2 |
| Italy | 0,3,2 | 0,3,2 | 2,3,2 | 0,3,2 |
| Montenegro | 2,3,0 | 2,3,0 | 2,3,0 | 2,3,0 |
| Netherlands | 1,2,1 | 0,0,1 | 2,3,2 | 0,0,1 |
| Poland | 0,0,1 | 0,0,1 | 1,0,3 | 0,0,1 |
| Portugal | 0,0,1 | 0,0,1 | 3,0,1 | 0,0,1 |
| Romania | 0,0,3 | 0,0,1 | 0,2,3 | 0,0,1 |
| Russia | 3,0,1 | 0,0,0 | 3,0,1 | 3,0,1 |
| Serbia | 3,3,3 | 3,3,3 | 3,3,3 | 3,3,3 |
| Slovakia | 3,3,1 | 0,0,1 | 3,3,3 | 0,0,1 |
| Slovenia | 3,0,1 | 1,0,1 | 3,0,3 | 1,0,1 |
| Spain | 0,0,1 | 0,0,1 | 1,0,1 | 0,0,1 |
| Sweden | 0,3,1 | 0,0,1 | 3,3,1 | 0,0,1 |
| Switzerland | 0,0,3 | 0,0,1 | 3,0,3 | 0,0,1 |
| Ukraine | 0,3,1 | 0,1,1 | 0,3,1 | 0,3,1 |
| UK | 3,3,1 | 0,3,1 | 3,3,1 | 3,3,1 |
| US | 1,0,3 | 1,0,3 | 2,2,3 | 1,0,3 |

For most of the countries (12) order 0,0,1 is chosen

(i.e. no lags of GDP and RER and 1 lag of exports)

Figure I: plots of variables used in the aggregate trade analysis

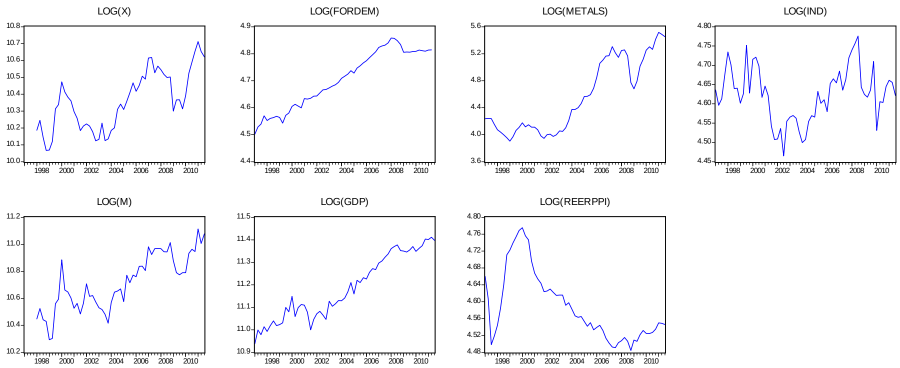

FIGURE II: LOGARITHM OF EXPORTS BY COUNTRIES

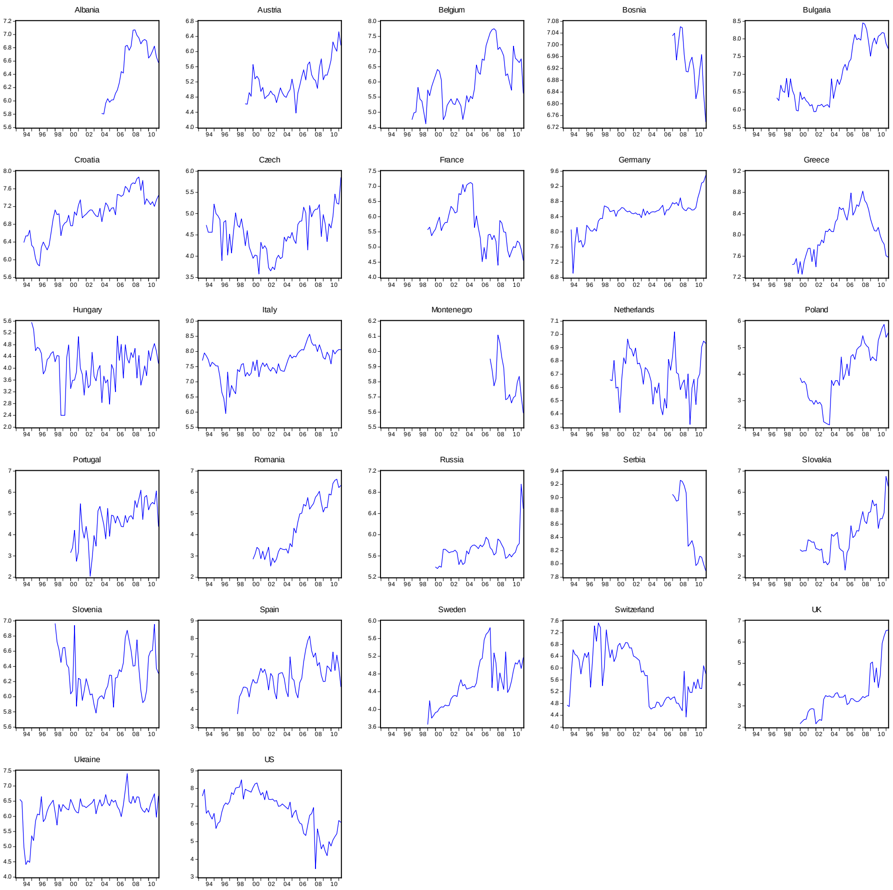

FIGURE III: LOGARITHM OF FOREIGN GDP

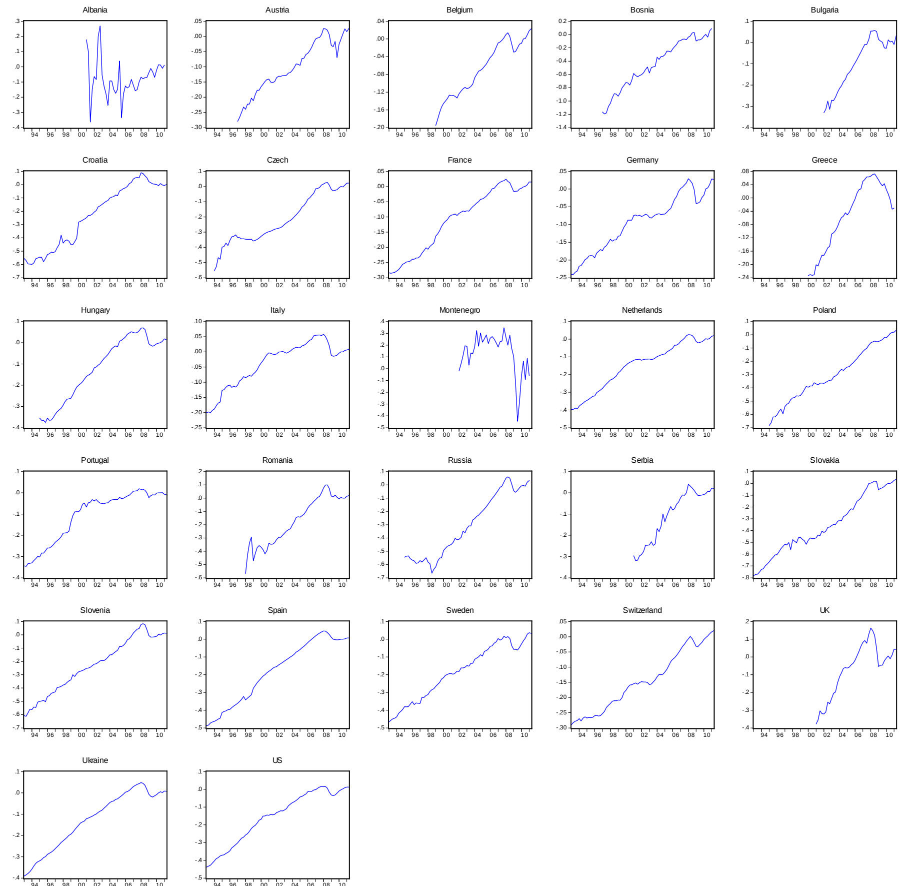

Figure IV: logarithm of bilateral real exchange rate (exports regression)

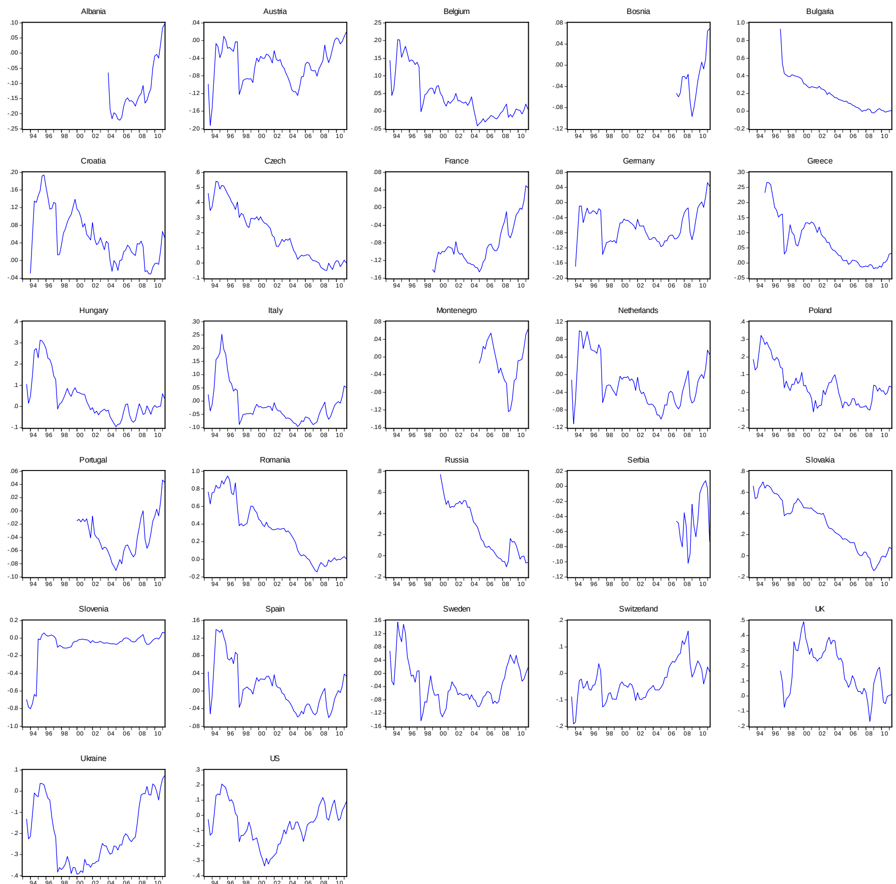

FIGURE V: LOGARITHM OF IMPORTS BY COUNTRIES

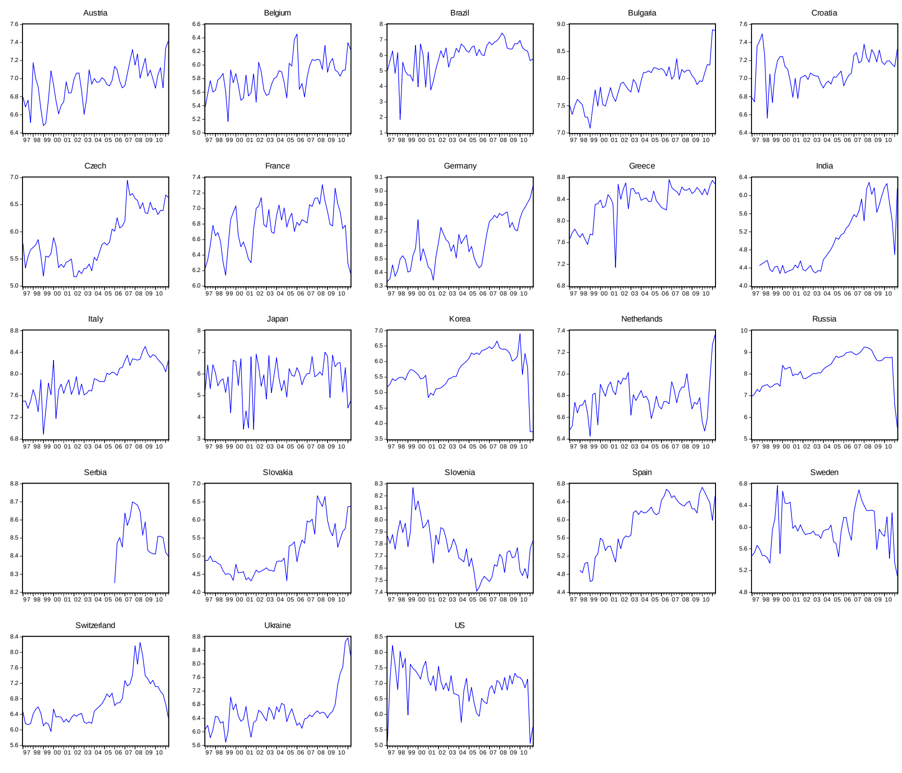

Figure VI: logarithm of macedonian gdp

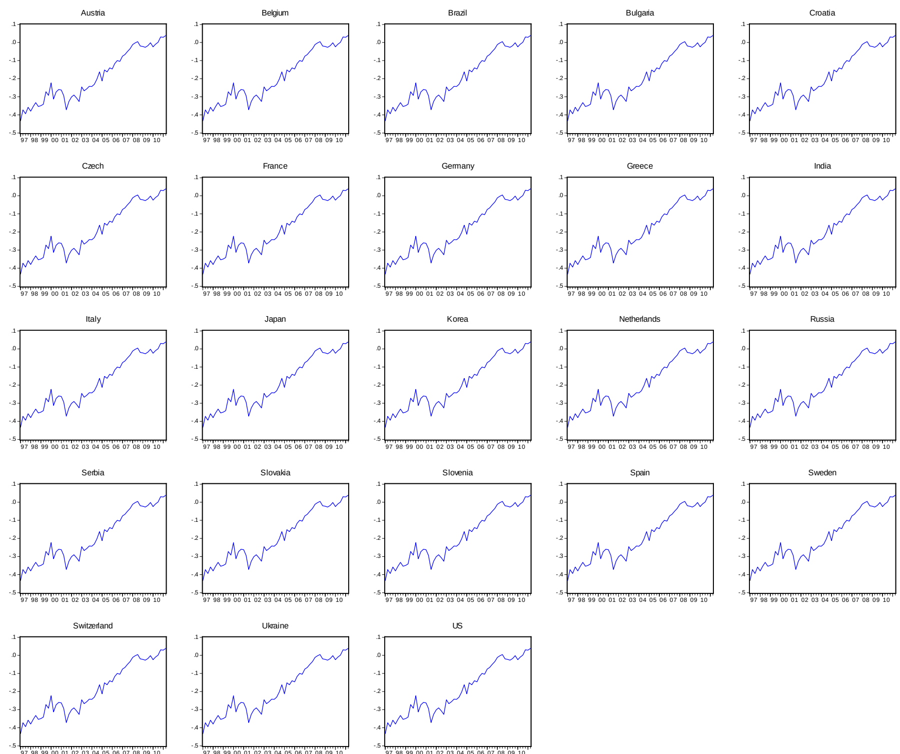

Figure VII: logarithm of bilateral real exchange rate (imports regression)

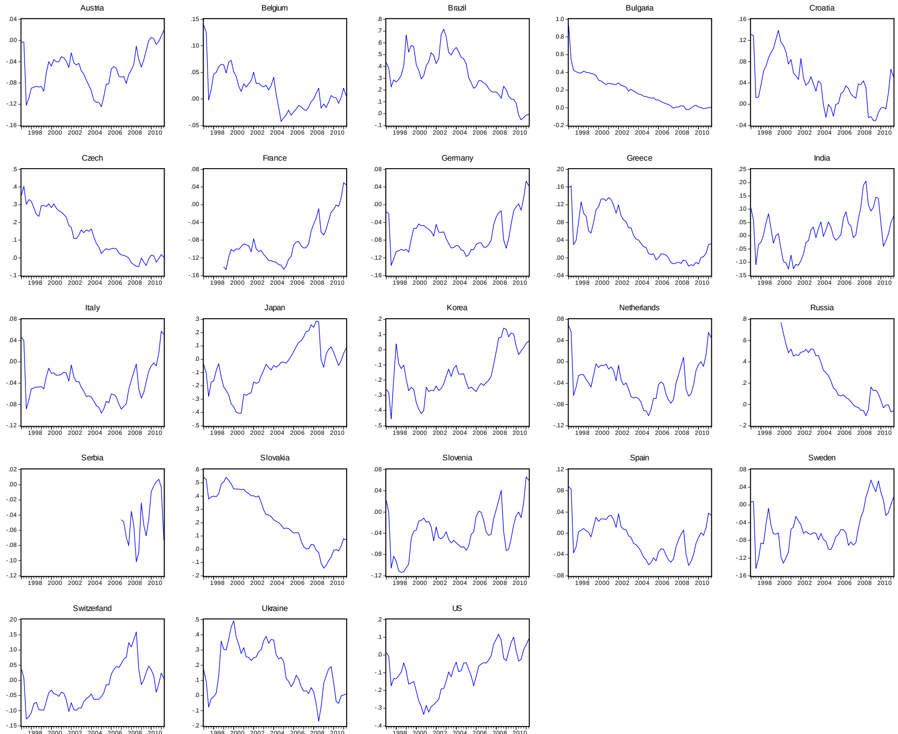

Figure VIII: Plot of the residuals from the exports ARDL

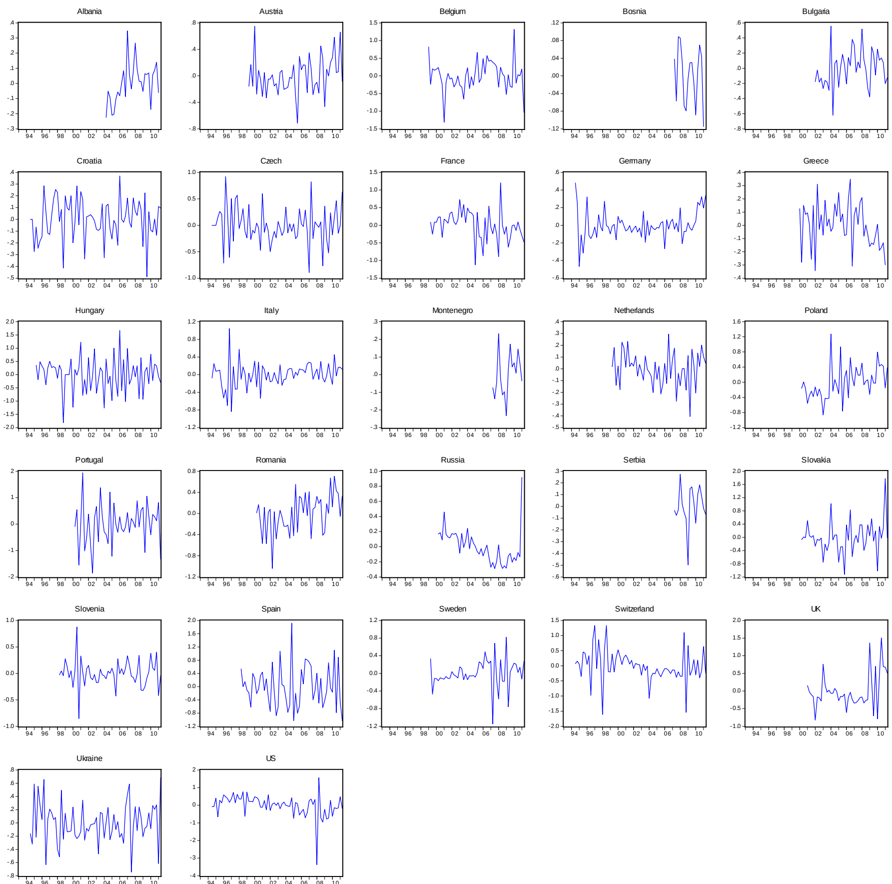

Figure IX: plot of residuals from the imports ardl