The Long-run Relationship between Production and External Trade of Basic Metals Division in Serbia

Rezime: Being the major foreign exchange earner basic metals division is without a doubt an important manufactury division for Serbia. Given the importance of the industry cointegration and error correction techniques were used to estimate the long-run relationship between monthly external trade and production of basic metals. Both the long-run and short-run results indicate that external trade is positively related with production. Contrary to expectations, import was found to have a positive relationship with production. Furthermore, production and export of this division are increasingly import dependent, especially upon raw materials.

Ključne reči: manufacture of basic metals, cointegration, error correction model

Summary: Kao najveći izvoznik oblast proizvodnje osnovnih metala je bez sumnje veoma važna oblast srpske prerađivačke industrije. S tim u vezi smo tehnikom kointegracije i modelom korekcije ka ravnoteži ocenili međuzavisnost proizvodnje i spoljnotrgovinske razmene ove oblasti. Rezultati i u dugom i u kratkom roku ukazuju da je spoljnotrgovinska razmena pozitivno vezana sa proizvodnjom. Suprotno očekivanjima, pokazalo se da između uvoza i proizvodnje postoji takođe pozitivna veza. Štaviše, proizvodnja i izvoz ove oblasti su visoko uvozno zavisni, posebno u pogledu sirovina.

Keywords: proizvodnja osnovnih metala, kointegracija, model korekcije ka ravnoteži

1. INTRODUCTION

The share of division 27 - Manufacture of basic metals - in Serbian gross domestic product (GDP) was 0.6% in 2004; in total Serbian exports 22.4% (2005) and in imports 7.6% (2005). It is clear that manufacture of basic
metals has significant foreign trade results in spite of very small share in forming GDP of Serbia. Serbia does not have ore reserves of appropriate quality for iron production, so that iron ore is imported.

**Box 1. - Sartid refresher**

The biggest company - SARTID a.d. Smederevo had over 90% of production in the division of ferrous metallurgy before bankruptcy, with the capacity of 2.2 million tons and 9,000 employees. In September 2003 the U.S. Steel (United States Steel Corporation) purchased big Serbian company SARTID a.d., an integrated steel manufacturer with facilities in Smederevo and Šabac. The new company - U.S. Steel Serbia was designed to have an annual raw steel production capability of 2.4 million net tons. It was expected to have increased production above to its designed capacity in 2006.

U.S. Steel Serbia primarily produces sheet products, including tin mill and galvanized products. U.S. Steel Serbia was reborn as a giant with competitive production and high level of export (one of the biggest exporters) and employs over 8,500 people.

Manufacture of basic metals is division with solid upward trend in last five years. In 2005 production was around 90% larger than in 2001 and recovery of this division was one of the most successful in manufacturing industry. Trend is accelerating, since average growth rate in 2004 and in 2005 was 32% compared to 5% in 2002 and 2003. Manufacture of basic metals participated in total industry with 4.6% and with 6.2% in manufacturing industry.

All five industry groups within division 27 have larger production in 2005 than in 2001. Most intensive growth has been recorded in Manufacture of basic iron and steel and of ferro-alloys (industry group 271, production almost tripled in period 2001-2005).

Due to favourable world prices of metal products and promising investment in companies within division 27, stable production increase should continue in the following period. In the period January - May 2006 relative to the same period 2005, production in division 27 increased on average by 16.8%, while the most impressive growth was registered in industry groups 272 - Manufacture of basic precious and non-ferrous metals, and 273 - Casting of metals (in the first quarter of 2006, 48% and 61%, respectively), i.e. industry groups with slowest progress in previous period – these groups are catching-up with the leaders.

Total number of employees in this division last years shows the tendency of sharp fall. Average number of employees in year 2005 was 23,4 thousand what is for 13 thousand or 36% lower in comparison with the year 2001. The fall of
employment is not consequence to the contraction of industrial production which increased from year 2000 for 71%.

![Graph showing employment and manufacturing production from 2001 to 2005.](image)

**Figure 1: Production and employment dynamics in Manufacture of basic metals**

Nevertheless, this is particular division where the fall of employees from year 2000 is not followed by the decrease of labor productivity. On the contrary, the whole division during the period under review period recorded the increase in productivity of even 165% and it is the consequence of reanimation of production, what is the qualitative difference compared to other Serbian manufacturing divisions.

In the last year, 2005, division 27 recorded trade surplus for the first time in the period 2001 – 2005. Total trade is constantly growing. Annual average growth rates of export and import are 30% and 21% respectively. Cumulative growth in the period under review is 269% for export and 161% for import. It is noteworthy to mention that great change in export happened in 2004 when its value has been more than doubled.

**Table 1. - Trade in division 27: Serbia – World, 2001 -2005, 000 EUR**

<table>
<thead>
<tr>
<th>Year</th>
<th>Export</th>
<th>Import</th>
<th>Index of export</th>
<th>Index of import</th>
<th>Trade Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>222,884</td>
<td>248,252</td>
<td>100.0</td>
<td>100.0</td>
<td>-25,368</td>
</tr>
<tr>
<td>2002</td>
<td>238,339</td>
<td>299,406</td>
<td>106.9</td>
<td>120.6</td>
<td>-61,067</td>
</tr>
<tr>
<td>2003</td>
<td>274,792</td>
<td>365,770</td>
<td>115.3</td>
<td>122.2</td>
<td>-90,978</td>
</tr>
<tr>
<td>2004</td>
<td>562,283</td>
<td>605,372</td>
<td>204.6</td>
<td>165.5</td>
<td>-43,089</td>
</tr>
<tr>
<td>2005</td>
<td>822,018</td>
<td>647,602</td>
<td>146.2</td>
<td>107.0</td>
<td>174,416</td>
</tr>
</tbody>
</table>
The share of division 27 in total Serbian export from 2001 till 2005 was doubled and in 2005 it was 22.4%. Such big share makes this industry group extremely important for Serbian economy. On the other side, share in total import of this division increased from 5.2% to 7.6%.

RCA (Revealed Comparative Advantage) indicator \( RCA_i = \frac{X_i - M_i}{X_i + M_i} \), where \( X_i \) and \( M_i \) are the values of export, i.e. imports of division \( i \). At the level of total trade RCA shows the relation between the foreign trade balance and total amount of trade with the world; the positive value of RCA for a certain division means that the country has comparative advantages in trading with that product. in 2005 is positive (0.12) which is good result considering negative competitiveness value at the beginning of period (-0.14 in 2003). This result is very important considering imports growth was very high (more than 2,5 higher imports in 2005 than in 2001), which means that exports grew even faster (3.7 times greater).

2. MODEL

To analysis the impact of external trade i.e. export and import on production of this division and vice versa from Januar 2001 to May 2006 we have been hypothesized a simple linear functions as follows:

\[
\log IND_{27} = f(\log X_{27}, \log M_{27}) \quad (1)
\]

\[
\log IND_{27} = f(\log X_{27}) \quad (2)
\]

\[
\log IND_{27} = f(\log M_{27}) \quad (3)
\]

To capture both the long run and the short run dynamics of those variable behaviour we estimate an error correction model (ECM) using the Engle-Granger methodology. Source: [3].

A brief discussion of the methodology follows.

If two time series \( y_t \) and \( x_t \) are both integrated of order d (i.e. I(d)), then, in general, any linear combination of the two series will also be I(d); that is, the residuals obtained on regressing \( y_t \) on \( x_t \) are I(d). If, however, there exists a vector \( b \), such that the disturbance term from the regression \( \epsilon_t = y_t - \beta x_t \) is of a lower order of integration I(d-b), where \( b > 0 \), then Engle and Granger define \( y_t \) and as \( x_t \) cointegrated of order (d,b).

The economic interpretation of cointegration is that if two or more series are linked to form an equilibrium relationship spanning the long run, then even though the series themselves may be non-stationary, they will move closely together over time and their difference will be stationary. Their long run
relationship is the equilibrium to which the system converges over time, and the
disturbance term $\varepsilon_t$ can be interpreted as the disequilibrium error or the
distance that the system is away from equilibrium at time $t$.

In order to estimate the long run relationship between $y_t$ and $x_t$ it is necessary
to estimate the static model:

$$y_t = \beta x_t + \varepsilon_t$$  \hspace{1cm} (5)

Although the equilibrium long run relationship can be estimated directly using
(5), it is also important to consider the short run dynamics of the variables under
consideration, since the system may not always be in equilibrium. A simple
dynamic model of short run adjustment can be written as:

$$y_t = a_0 + \gamma_0 x_t + \ldots + \gamma_1 x_{t-1} + \alpha_1 y_{t-1} + u_t$$  \hspace{1cm} (6)

Reparameterising and rearranging (6) gives the error correction formulation
(ECM):

$$\Delta y_t = \gamma_1 \Delta x_t - (1 - \alpha_1) \left[ y_{t-1} - \beta_0 - \beta_1 x_{t-1} \right] + u_t$$  \hspace{1cm} (7)

where $\beta_0$ and $\beta_1$ are coefficients estimated from equation (5).

The ECM incorporates both short run and long run effects. When equilibrium
holds, $\left[ y_{t-1} - \beta_0 - \beta_1 x_{t-1} \right] = 0$. But in the short run, when disequilibrium exists,
this term is non-zero and measures the distance that the system is away from
equilibrium during time $t$. Thus $(1 - \alpha_1)$ provides an estimate of the speed of
adjustment of the variable $y_t$. For instance, if $\left[ y_{t-1} - \beta_0 - \beta_1 x_{t-1} \right] < 0$, that is,$y_{t-1}$ has moved below its equilibrium level, since $- (1 - \alpha_1)$ is negative, it will
boost $\Delta y_t$, thereby forcing it back to its long run path.

Engle and Granger show that two or more variables are cointegrated of order
$I(1,1)$ if and only if an ECM exists.

The first stage in the Engle-Granger framework is to test whether the variables
are cointegrated. This is accomplished by testing the residuals of equation (5)
for stationarity. That is, the null hypothesis of $\varepsilon_t$ being I(1) is tested against the
alternate of it being I(0). Although any unit root test can be used, Engle and
Granger advocated the use of Augmented Dickey Fuller tests on the residuals.

The second stage of the EG procedure comprises of estimating the short run
ECM itself from the residuals of the regression of the first stage. That is, having
obtained $\varepsilon_{t-1} = y_{t-1} - \beta x_{t-1}$, we estimate equation (7) to determine the dynamic
structure of the system.

We expect that there is a long-run relationship between industrial production and
external trade. We therefore test for the existence of a cointegrating relationship.
This is done using the above ECM methodology. In the first step we estimate the coefficients by OLS and test for the existence of a unit root in the residuals. The analysis is also supplemented by testing for the number of cointegrating relationships using the Johansen procedure.

The deviations from the long run path are captured at the second stage. When the coefficients of the lagged residual term from the first stage is negative, it suggests that the system comes back to the long-run path or adjusts. Therefore, there exists an error correction mechanism.

3. RESULTS AND DISCUSSION

Drawing on the time-series and cointegration literature, we proceed in a sequential fashion. First, we carry out unit root and cointegration tests to evaluate the statistical properties of the variables in our dataset and test for the existence of cointegrating relationships. As we are unable to reject that the series are integrated of order 1 and that they are jointly cointegrated, we then estimate an ECM model that captures both the short-term dynamics of the variable set and the long-term cointegrating relations.

The initial step in our analysis require that we establish the presence of a unit root in the series of interest. Augmented Dickey Fuller (ADF) and Phillips-Perron test statistic, for Manufacture of basic metals (logIND$_{27}$) and external trade (export log$X_{27}$ and import log$M_{27}$) variables, are presented in Table 2 below. These tests were carried out using the E-Views 5 software.

Utilising the ADF test statistic, the H$_0$ was not rejected thus indicating that both Manufacture and External trade series exhibit unit roots. This means that these time series follows a random walk pattern, which possesses a purely nonpredictable component, and all the variables in our dataset satisfy the statistical properties necessary for the existence of cointegrating relations.

### Table 2. - Unit Root Tests

<table>
<thead>
<tr>
<th>Variables</th>
<th>Augmented Dickey-Fuller (ADF) Test</th>
<th>Phillips-Perron Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>First Difference</td>
</tr>
<tr>
<td>logIND$_{27}$</td>
<td>-0.76</td>
<td>-11.46*</td>
</tr>
<tr>
<td>logX$_{27}$</td>
<td>-0.62</td>
<td>-9.53*</td>
</tr>
<tr>
<td>logM$_{27}$</td>
<td>-1.07</td>
<td>9.54*</td>
</tr>
</tbody>
</table>

Critical value for 1% level significant is -3.57 (constant is exogenous) and -4.1(constant and trend are exogenous. The * indicates rejection of the null hypothesis of a unit root at the 1 percent significance level.

Dependence between Manufacture of basic metals (logIND$_{27}$), and export (log$X_{27}$) and import (log$M_{27}$) of these products estimated by OLS method gives next results:
Table 3. – Results of regression analyses

Dependent Variable: logIND_{27}
Method: Least Squares
Included observations: 65

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>logX_{27}</td>
<td>0.417774</td>
<td>0.039587</td>
<td>10.55324</td>
<td>0.0000</td>
</tr>
<tr>
<td>logM_{27}</td>
<td>0.098950</td>
<td>0.054206</td>
<td>1.825431</td>
<td>0.0728</td>
</tr>
<tr>
<td>C</td>
<td>2.229157</td>
<td>0.123416</td>
<td>18.06213</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared     0.898537     Mean dependent var 4.249082
Adjusted R-squared 0.895264     S.D. dependent var 0.313447
S.E. of regression 0.101441     Akaike info criterion -1.693629
Sum squared resid 0.637994     Schwarz criterion -1.593273
Log likelihood 58.04295     F-statistic 274.5297
Durbin-Watson stat 1.895614     Prob(F-statistic) 0.000000

Because the value of ADF test (-7.74) is smaller than the critical value on the level of significance of 1%, it can be concluded that cointegrating relation exists. Econometric characteristics of estimated model are solid: parameters are significant (logM_{27} is significant at 10%), no autocorrelation. Box-Ljung test of autocorrelation is of twelfth level Q(12) = 10.1 (0.61), and this model has explained 90% of variations of Manufacture of basic metals. Coefficients represent long-term elasticities of Manufacture of basic metals related to export and import, and have positive sign, what means that doubling of export or import increases the production for 42% and 10%, respectively.

Short-term dynamic of production in this division could be explained by ECM which outcomes are given in the next table, while on figure real and model estimated values are compared.

Table 4. – Results of ECM analyses

Dependent Variable: ΔlogIND_{27}
Method: Least Squares
Included observations: 64 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ(logIND_{27}-0.42logX_{27}-0.10logM_{27})</td>
<td>-0.986422</td>
<td>0.133649</td>
<td>-7.380718</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔlogM_{27}</td>
<td>0.110076</td>
<td>0.044916</td>
<td>2.450723</td>
<td>0.0171</td>
</tr>
<tr>
<td>ΔlogX_{27}</td>
<td>0.454899</td>
<td>0.073118</td>
<td>6.221413</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared     0.592930     Mean dependent var 0.012948
Adjusted R-squared 0.579583     S.D. dependent var 0.154432
S.E. of regression 0.110013     Akaike info criterion -1.718895
Sum squared resid 0.611623     Schwarz criterion -1.617697
Log likelihood 58.00464     Durbin-Watson stat 2.048544
Econometric characteristics of estimated model are satisfactory. Statistical significance of long-term coefficient (-0.99) confirms endogenity of production in relation to export and import. Its amount shows that production adjust almost completely to its long-term relation to export and import: 99% monthly. Manufacture of basic metals and their export form the next long-term relation:

$$\log{IND_{27}} = 2.40 + 0.47 \log{X_{27}}$$

$$R^2 = 0.90$$

(29,4) (22,9)

$ADF = -7.95$ (critical value for the 1% level of significant is -3.55),

As it can be seen in the Jan. 2001-May 2006 period the increase of export of basic metals for 1% meant the increase in production of 47%. Econometric characteristics of estimated model are very good; model explains 90% variations of industrial production. Distant from equilibrium decreases for about 100% per month, what means that production adjust to export for 100% monthly.

Used of Johansen procedure shows that cointegration, i.e. long-term relation exist between Manufacture of basic metals and import, too. On the next figure we can see that the dependence between variables is stationary and the variables are cointegrated, what value of ADF test, -xx, proves.
From the cointegrating relation follows balancing dependence for Manufactur of basic metals which looks like:

$$\log\text{IND}_{27} = 1,81 + 0,59 \log\text{M}_{27}$$

$$R^2=0,72$$

$$\text{ADF} = -5,39$$ (critical value for the 1% level of significant is -3.55).

Estimated dependence shows that the import rise of 1% leads to production rise of 59%.

Foregoing cointegrating relation represent the base for estimation of short-term dynamics of Manufacture of basic metals in the form of ECM. Next table gives the results of estimated model, while on the next figure actual and by model obtained growth rate of Manufacture of basic metals are compared.

**Table 5. – Results of ECM analyses**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\log\text{IND}<em>{27}-1,81+0.59\log\text{M}</em>{27})_1</td>
<td>-0.449179</td>
<td>0.103547</td>
<td>-4.337905</td>
<td>0.0001</td>
</tr>
<tr>
<td>(\Delta\log\text{M}_{27})</td>
<td>0.278518</td>
<td>0.058991</td>
<td>4.721384</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared 0.327328 Mean dependent var 0.012948

Adjusted R-squared 0.316478 S.D. dependent var 0.154432

S.E. of regression 0.127677 Akaike info criterion -1.247873

Sum squared resid 1.010690 Schwarz criterion -1.180408

Log likelihood 41.93193 Durbin-Watson stat 2.191128
4. CONCLUSION

This paper attempted to estimate a production function of division 27 – Manufacture of basic metals for Serbia in an error correction framework, to investigate the factors that determine production and for the purpose of forecasting production in the medium term.

Division 27 – Manufacture of basic metals has improved its competitiveness in the last five years due to the very successful privatization of U.S. Steel. As the findings of this study shows, manufacture of basic metals went through the process of restructuring and privatization very successfully (lesser part is still in the pipeline). Also, this industry records very high level of investments (tendency to be the highest).

The findings reveal the existence of a long-run relationship between production, export and import, suggesting that production is significantly determined by export and import. Production elasticities obtained for export and import are reasonable and imply that 42 percent of production of basic metals in Serbia are sensitive to changes in current export, in the long-run. Import was found to have a positive relationship with production.

Furthermore, the study also finds that production adjusts to equilibrium levels quite fast. Finally, the results of the forecast evaluation suggest that the short-run model constructed in this study has relatively good forecasting abilities and
can produce a reliable forecast for Serbian basic metals production in the medium term.

REFERENCES