Exports, Foreign Direct Investments and Economic Growth for five European countries: Granger Causality Tests in Panel Data

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Exports, Foreign Direct Investment and Economic Growth for Five European Countries: Granger Causality Tests in Panel Data

Abstract

This study investigates the relationship between exports, foreign direct investments (FDI), and economic growth in five Eurozone countries (Greece, Portugal, Ireland, Spain, Italy) using panel data for the period 1970 to 2011. The panel data causality results revealed that there is bidirectional causality between exports and economic development, while there is no causality between economic growth and FDI nor between FDI and exports.

Keywords: Economic development, Foreign direct investments, Exports, Causality, Panel analysis.

JEL Classification: C22, E31, E50
1. Introduction

The relationship between foreign direct investments (FDI), exports, and economic growth has been the focus of a considerable number of academic studies. Recent literature has highlighted the role of both exports and FDI in the context of economic growth. As proposed and supported by Hsiao and Hsiao (2006) there exists a triangular relationship among FDI, exports, and economic growth. This means that FDI has both direct and indirect effects on economic growth through exports.

FDI inflows can play a vital role in host countries due to the fact that it increases the supply of funds for domestic investments. Furthermore, FDI inflows not only can increase the export capacity of the host country but also encourage the creation of new jobs.

The world FDI inflows increased significantly from 207 billion US dollars in 1990 to 1,975 billion US dollars in 2007 (UNCTAD 2013). This led to a number of surveys which studied the impact of FDI on the host country’s economy. Most studies found positive effects between FDI and economic growth.

However, we cannot say that the relationships linking FDI, exports, and economic growth are clear. Studies focusing on the long-term relationships among these three variables have produced contradictory results. The purpose of this paper is to examine the links between FDI, exports, and economic growth in five Eurozone countries (Greece, Portugal, Spain, Ireland, Italy) over the period 1970-2011.

The contribution of this paper is shown in the following paragraphs:

It is used a Keynesian demand model in an open economy to examine the relations among foreign direct investments, exports, and economic growth in a VAR model.

The data for our analysis are grouped into five Eurozone countries which are under recession, with large public debt, high unemployment and political instability.

To our knowledge very few studies have taken into consideration these three variables together and have used the causality analysis of panel data. In terms of econometric methods, this study investigates the causality relations among foreign direct investments,
exports, and GDP (a proxy for economic growth) for the five weakest economies of the Eurozone.

The structure of the paper is as follows: Section 2 briefly reviews the theoretical literature. Section 3 presents the recent empirical literature. Section 4 presents the analytical framework, the econometric methodology and the empirical results. Concluding remarks are given in the final section.

2. Review of Theoretical Literature

According to economic theory, the long-term economic development of a country is determined by the availability of productive factors: workforce and capital and their productivity which in turn reflects the technological progress and the efficient allocation of factors. In most models of endogenous growth, foreign direct investments are shown to be determinants in the development of these three variables as they increase the capital adequacy and the available workforce and enhance technological progress in the host country.

In the neoclassical growth model, technological progress and labor are exogenous factors of foreign direct investments that simply increase the rate of investments and afterwards lead to an increase to per capita income, without having any effect on long-term growth. The new model in the theory of growth that was developed in the 1980s considers technological progress as an endogenous factor and foreign direct investments to have a permanent effect on the development through technology transfer.

Since FDI has increased worldwide the last few decades, there are ongoing discussions related to the impact of foreign direct investments in a host country economy. Most of the studies found positive effects of foreign direct investments in transitional and long term economic growth through capital accumulation and transfer of knowledge (Basu, et al. 2003). In an open economy, technology and knowledge can also be transferred through exports and imports and consequently the economic growth can be promoted (Grossman and Helpman 1997).
Furthermore, some studies have shown that these positive results may be insignificant or even negative due to the concentration of domestic capital (Carkovic and Levine 2005).

It is also pointed out that multinational companies try to find out the most productive countries, with fast growth, so as to invest in these developing economies. In other words we would say that the causality of foreign direct investments and economic growth can run in both directions.

The issue of exports and economic growth has been discussed thoroughly since 1960, in many studies. The results have showed that there is no obvious agreement on whether economic growth has led exports or exports have led economic growth. However, the relationship among foreign direct investments, exports, and economic growth has received less attention in academic community. The relationship between trade and foreign direct investments are positively related (complementary) between asymmetric countries and negative (substitutes) between symmetric countries (Markusen and Venables 1998). Thus, the relationship can be positive or negative. On the other hand, when exports increase foreign direct investments will pave the way for new investments, reducing the transaction cost of investors with the knowledge of the structure of the market in the host country.

3. Review of Recent Empirical Literature

In current literature, most of the published studies examine the bivariate relationships, either theoretically or empirically, between the pairs of economic growth and exports, economic growth and foreign direct investments or exports and foreign direct investments. Despite the relationships between them, there are very few studies that have examined empirically the causality relations among these three variables in a group of countries. Also, there are even fewer studies that carried out their analysis in the panel framework.

There are several studies that examine the Granger causality with these three variables in a country. Liu, et al. (2002) found bidirectional causality between each pair of real GDP, real exports, and real FDI for China using seasonally adjusted quarterly data during the period 1981–1997.
Dritsaki, et al. (2004) investigated the relationship between exports, FDI, and GDP of Greece over the period of 1960-2002. This study found that there is a long run relation and a causality relation between the examined variables.


Eryigit (2012) examined the relationship between FDI, exports, and GDP for Turkey through cointegration tests for the period of 2000-2010. The results of the study showed that there is a long-term relationship between FDI and export volume, FDI and GDP, and export volume and GDP.

Meerza (2012) investigated the casual relationship between FDI, trade, and economic growth for Bangladesh over the period 1973-2008. This study found that there is a long run relationship between the examined variables. In addition, there is a unidirectional a causality relation between FDI and exports with direction from exports to FDI.

There are also studies that examine the Granger causality with these three variables in a group of countries. Wang, et al. (2004) used a large panel data set encompassing 79 countries over the period 1970-1998. Their study revealed that FDI are more beneficial for high-income countries, while the international trade is more important for low-income countries. The stationarity of the variables was not examined and the panel causality analysis was not implemented in this study.

Cho (2005) applied the panel data causality analysis for nine economies (China, Korea, Taiwan, Hong Kong, Singapore, Malaysia, Philippines, Thailand, and Indonesia). He found only a strong unidirectional causality from FDI to exports among the three variables (FDI, exports, and GDP) using annual data for the period 1970-2001. In Cho’s model GDP is taken as the Malmquist productivity index.

Hsiao and Hsiao (2006) examined the relationship among FDI, exports, and GDP for eight East and Southeast Asian economies through Granger causality test and panel data analysis for the period of 1986-2004. Their study revealed that FDI influences GDP both
directly and indirectly through exports. Also, they found that there is bidirectional causality between exports and GDP for the group.

A similar study (Yao 2006) investigated the effect of exports and FDI on economic performance, using a large panel data set encompassing 28 Chinese provinces over the period 1978-2000. The results of the study showed that both exports and FDI have a strong and positive effect on economic growth.

Won, Hsiao, and Yang (2008) examined the causality relations among GDP, exports, and FDI in first generation Asian industrializing economies (Korea, Taiwan, Singapore) and in second generation industrializing economies (Malaysia, Philippines, Thailand, China) using panel data over the period 1981-2005. The results of the study showed that there are bidirectional causality relations among all variables for the first generation countries. Also, there is a bidirectional causality relation between exports and GDP for the second generation countries.

Nishiyama and Yamaguchi (2010) investigated FDI inflows from developed countries to developing countries. They found that FDI leads to an increase in GDP of developing countries.

Ahmadi and Ghanbarzadeh (2011) examined the Granger causality relations among GDP, exports, and FDI in Middle East and North Africa countries (MENA countries) using panel data for the period of 1970-2008. They found that there are bidirectional causality relations among all three variables for this group.

A similar study (Acaravci and Ozturk 2012) investigated the causal relationship among economic growth, exports, and FDI for ten European countries over the period 1994-2008. Their study revealed that there is causality relation among FDI, exports, and economic growth in four out of ten countries.

Abdullahi, Aliero, and Yusuf (2012) examined the role of FDI on economic growth making a comparison between selected countries of Asia and Africa for the period of 1990-2009. Result of combined dataset for Africa and Asia indicated a unidirectional causality running from FDI to GDP. However, when data were split into Africa and Asia the same
conclusion was maintained in Africa. Also, they found that there is no causality relation between the examined variables in the case of Asia.

In general, the empirical literature suggests that the causality relations depend on econometrics methods and the period the studies were carried out. The results can be unidirectional causality, bidirectional causality or no causality relation. In any case, the results seem to indicate a positive relation among exports, economic growth, and FDI.

Table 1

Causality relations among EXP, FDI and GDP for a group of countries using panel data

<table>
<thead>
<tr>
<th>Authors</th>
<th>Period</th>
<th>Country</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cho (2005)</td>
<td>1970-2001</td>
<td>China, Korea, Taiwan, Hong Kong, Singapore, Malaysia, Philippines, Thailand, and Indonesia</td>
<td>FDI→EXP</td>
</tr>
<tr>
<td>Hsiao and Hsiao</td>
<td>1986-2004</td>
<td>China, Korea, Taiwan, Hong Kong, Singapore, Malaysia, Philippines, Thailand</td>
<td>EXP↔GDP FDI→GDP FDI→EXP</td>
</tr>
<tr>
<td>Won, Hsiao, and Yang</td>
<td>1981-2005</td>
<td>Seven ANIEs (Asian Newly Industrializing Economies)</td>
<td>EXP↔GDP EXP↔FDI FDI→GDP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First generation ANIEs (Korea, Taiwan, Singapore)</td>
<td>EXP↔ GDP GDP↔ FDI FDI↔ EXP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second generation ANIEs (Malaysia, Philippines, Thailand, China)</td>
<td>EXP↔ GDP</td>
</tr>
</tbody>
</table>
4. Analytical Framework

In order to test the causality relations among the examined variables, we specify a vector autoregressive model (VAR), as implemented by Sims (1980). The VAR model is expressed in equation (1).

\[ U = (GDP, FDI, EXP) \]  

where: GDP is the economic development, FDI are the foreign direct investments, and EXP are the exports. The main advantage of the VAR model is that it treats each variable of the system as endogenous and relates each variable to its own past values and to past values of all other variables included in the model.

The following equation shows the form of VAR model in panel data.

\[ y_{it} = \alpha_i + x_{it} \beta + u_{it} \]  

where \( y_{it} \) is one of the three endogenous examined variables, \( i \) is the number of sections (countries) and \( t \) are the observations. The constant \( \alpha_i \) takes into consideration the heterogeneity of each variable, which may differ between sections (countries). \( x_{it} \) is a vector that contains the lags of the endogenous variables. \( \beta \) is a column vector of slope coefficients for the group of countries. The error term \( u_{it} \) follows asymptotically the normal distribution \( u_{it} \sim N(0, \sigma^2_{u_{it}}) \).

Panel data analysis has the advantage of using information about cross-section units and time series. Also, panel data analysis can examine the heterogeneity of individual cross-section units, which give more variability, less collinearity among the variables, more degrees
of freedom and more efficiency (Baltagi 2001). In addition, the repeated cross-section units of observations are better adapted for studying the dynamics of changes of variables such as foreign direct investments, exports, and development.

The five Eurozone economies under consideration have similar problems the last few years. Considering the interdependence of these economies, we proposed to integrate their data over the 42 years (1970-2011) in a panel data set and then use a table of regressions to examine Granger causality relations. Data are gathered from economic databases Annual macro-economic database (AMECO) and United Nations Conference on Trade and Development (UNCTAD). The current prices of exports, GDP and foreign direct investments are expressed in euro, deflated by the GDP deflator of each country (2000=1) in order to be converted in constant prices.

4.1 Panel Data Unit Root Tests

During the last decade considerable work has been carried on unit root testing in panel data models. Most panel unit root tests are designed to test the null hypothesis of a unit root for each individual series in a panel. The formulation of the alternative hypothesis is instead a controversial issue that critically depends on which assumptions one makes about the nature of the homogeneity/heterogeneity of the panel. A number of panel unit root tests proposed in the literature use the following articulation of the alternative hypothesis: (Pesaran 2012).

\[ H_1^A = \text{Each of the series is stationary as a panel}, \]

while other tests use:

\[ H_1^B = \text{At least one of the series in the panel is generated by a stationary process}. \]

The above two formulations of the alternative hypothesis are not satisfactory for carrying inference on the non-stationarity properties of panel data models (Pesaran 2012). The following equation follows a dynamic heterogeneous panel on N cross sections observed over T time periods:
$$\Delta y_{it} = \alpha_i + \beta_i \Delta y_{i,t-1} + e_{it} \quad \text{where: } i = 1, \ldots N \text{ and } t = 1, \ldots T$$

(3)

The null hypothesis of unit roots can then be written as:

$$H_0 : \beta_i = 0 \quad \text{for all } i.$$  

(4)

Under a homogeneous alternative that we have $\beta_i = \beta \neq 0$ for all $i$ so the alternative would be:

$$H_i^A : \beta_i < 0$$

(5)

Tests for unit roots in homogeneous series in a panel are the tests of Harris and Tzavalis (1999) and Levin, Lin, and Chu (2002).

One drawback of tests based on such alternative hypothesis is that they usually have power also if not all units are stationary. Westerlund and Breitung (2009) show that the local power of the Levin, Lin, and Chu (2002) test is greater than that of the Im, Pesaran, and Shin (2003) test, based on a less restrictive alternative, also when not all individual series are stationary (Pesaran 2012).

The alternative hypothesis $H_1^B$ is completely opposite and indicates that

$$H_1^B : \beta_i < 0 \quad \text{for one or more } i.$$  

(6)

The alternative hypothesis $H_i^B$:

$$H_i^B : \beta_i < 0 \quad \text{for one or more } i.$$  

(7)

Such alternative hypothesis is at the basis of panel unit root tests proposed by Chang (2002, 2004).

We observe that $H_1^B$ is only appropriate when $N$ is finite, namely within the multivariate model with a fixed number of variables analyzed in the time series literature. On the contrary, in the case of large $N$ and $T$, panel unit root tests will lack power if the alternative, $H_1^B$, is adopted (Pesaran 2012).

We begin by testing the stationarity of three variables (real FDI, real EXP, and real GDP). The recent literature proposes several methods for unit root tests in panel data. Since
these methods may give different results, we selected Breitung (2000), Levin, Lin and Chu (2002) (LLC), Im, Perasan and Shin (2003) W-test (IPS), ADF-Fisher Chi-square test (ADF-Fisher), PP Fisher Chi-Square test (PP-Fisher), Maddala and Wu (1999), and Hadri (2000) to perform panel data unit root tests. In all these tests except Hadri, the null hypothesis is that the variable contains a unit root (i.e., it is not stationary) (All details from the description of the above methods are given in Appendix).

The results of level and first difference unit root tests for the three variables are provided in Table 2.

**Table 2**

**Panel Data Unit Root Tests**

<table>
<thead>
<tr>
<th>Panel Level Series</th>
<th>GDP</th>
<th>FDI</th>
<th>EXP</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual intercept</td>
<td>-0.64343</td>
<td>-0.13051</td>
<td>5.01584</td>
</tr>
<tr>
<td>(0.2600)</td>
<td>(0.4481)</td>
<td>(1.0000)</td>
<td></td>
</tr>
<tr>
<td>Individual intercept and trend</td>
<td>-1.85992**</td>
<td>0.49143</td>
<td>-1.91583**</td>
</tr>
<tr>
<td>(0.0314)</td>
<td>(0.6884)</td>
<td>(0.0277)</td>
<td></td>
</tr>
<tr>
<td>Breitung</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual intercept</td>
<td>3.51568</td>
<td>1.70438</td>
<td>5.73350</td>
</tr>
<tr>
<td>(0.9998)</td>
<td>(0.9558)</td>
<td>(1.0000)</td>
<td></td>
</tr>
<tr>
<td>Individual intercept and trend</td>
<td>-1.7679**</td>
<td>-5.0758***</td>
<td>-0.31915</td>
</tr>
<tr>
<td>(0.0385)</td>
<td>(0.0000)</td>
<td>(0.3748)</td>
<td></td>
</tr>
<tr>
<td>IPS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual intercept</td>
<td>2.79602</td>
<td>-3.3470***</td>
<td>6.12158</td>
</tr>
<tr>
<td>(0.9974)</td>
<td>(0.0004)</td>
<td>(1.0000)</td>
<td></td>
</tr>
<tr>
<td>Individual intercept and trend</td>
<td>-1.7679**</td>
<td>-5.0758***</td>
<td>-0.31915</td>
</tr>
<tr>
<td>(0.0385)</td>
<td>(0.0000)</td>
<td>(0.3748)</td>
<td></td>
</tr>
<tr>
<td>ADF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual intercept</td>
<td>9.73209</td>
<td>43.2279***</td>
<td>5.28004</td>
</tr>
<tr>
<td>(0.4643)</td>
<td>(0.0000)</td>
<td>(0.8717)</td>
<td></td>
</tr>
<tr>
<td>Individual intercept and trend</td>
<td>16.2923*</td>
<td>44.8807***</td>
<td>15.3194</td>
</tr>
<tr>
<td>(0.0916)</td>
<td>(0.5306)</td>
<td>(0.1208)</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual intercept</td>
<td>0.11587</td>
<td>52.3633***</td>
<td>0.00567</td>
</tr>
<tr>
<td>(1.0000)</td>
<td>(0.0000)</td>
<td>(1.0000)</td>
<td></td>
</tr>
<tr>
<td>Individual intercept and trend</td>
<td>9.01543</td>
<td>56.2391***</td>
<td>3.13515</td>
</tr>
<tr>
<td>(0.5306)</td>
<td>(0.0000)</td>
<td>(0.9781)</td>
<td></td>
</tr>
<tr>
<td>Hadri</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual intercept</td>
<td>9.26438***</td>
<td>2.13076**</td>
<td>8.99528***</td>
</tr>
<tr>
<td>(0.0000)</td>
<td>(0.0166)</td>
<td>(0.0000)</td>
<td></td>
</tr>
<tr>
<td>Individual intercept and trend</td>
<td>6.24177***</td>
<td>-0.58559</td>
<td>7.12022***</td>
</tr>
<tr>
<td>(0.0000)</td>
<td>(0.7209)</td>
<td>(0.0000)</td>
<td></td>
</tr>
</tbody>
</table>
### First Difference Unit Root Test Results

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>FDI</th>
<th>EXP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel First Difference Series</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLC</td>
<td>Individual intercept</td>
<td>-1.83262** (0.0334)</td>
<td>-5.7895*** (0.0000)</td>
</tr>
<tr>
<td></td>
<td>Individual intercept and trend</td>
<td>1.19804 (0.8845)</td>
<td>-3.9342*** (0.0000)</td>
</tr>
<tr>
<td>Breitung</td>
<td>Individual intercept</td>
<td>3.71610 (0.9999)</td>
<td>1.54987 (0.9394)</td>
</tr>
<tr>
<td></td>
<td>Individual intercept and trend</td>
<td>-2.8167*** (0.0024)</td>
<td>-9.6945*** (0.0000)</td>
</tr>
<tr>
<td>IPS</td>
<td>Individual intercept</td>
<td>0.15093 (0.5600)</td>
<td>-8.5074*** (0.0000)</td>
</tr>
<tr>
<td></td>
<td>Individual intercept and trend</td>
<td>25.9695*** (0.0038)</td>
<td>108.168*** (0.0000)</td>
</tr>
<tr>
<td></td>
<td>Individual intercept and trend</td>
<td>15.7193 (0.1080)</td>
<td>106.114*** (0.0000)</td>
</tr>
<tr>
<td>ADF</td>
<td>Individual intercept</td>
<td>20.0265** (0.0290)</td>
<td>176.235*** (0.0000)</td>
</tr>
<tr>
<td></td>
<td>Individual intercept and trend</td>
<td>10.8190 (0.3718)</td>
<td>711.087*** (0.0000)</td>
</tr>
<tr>
<td>PP</td>
<td>Individual intercept</td>
<td>2.88758*** (0.0019)</td>
<td>-1.68354 (0.9539)</td>
</tr>
<tr>
<td></td>
<td>Individual intercept and trend</td>
<td>5.51334*** (0.0000)</td>
<td>-0.69343 (0.7560)</td>
</tr>
</tbody>
</table>

**Notes:**
1. Panel data include all countries.
2. The numbers in parentheses denote p-values.
3. ***, **, * denotes rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively.
4. The null hypothesis of these tests is that the panel series has a unit root (nonstationary series) except with the Hadri test which has no unit root in panel series.
5. Lag length selection automatic based on Schwarz criterion.

As can be seen from Table 2, most of the test results showed that FDI is stationary in levels, while the other two variables contain a unit root. Most of the test results indicated that all variables are stationary in their first differences. Therefore, we use first differences to analyze the causality in VAR model.
4.2 Panel Data VAR and Granger Causality Test

When we estimate panel data regression models, we consider various assumptions about the intercept, the slope coefficients, and the error term. This procedure requires selecting either the fixed effects model or the random effects model.

Because the random effects model requires a number of sections (units) greater than the number of coefficients, having five sections (units-countries) in our study, we can estimate a model VAR(p) with lags $p = 1$ or $2$. In case we have two lags, we lose some certain information when the data are related to a period of 42 years. The optimal lag length selected by the minimum value of Akaike criterion.

The following three models are estimated:

$$
\Delta GDP_{it} = \beta_{1i} + \sum_{k=1}^{p} \beta_{1ik} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \beta_{12k} \Delta FDI_{i,t-k} + \sum_{k=1}^{p} \beta_{13k} \Delta EXP_{i,t-k} + u_{1i,t} \quad (8)
$$

$$
\Delta FDI_{it} = \beta_{2i} + \sum_{k=1}^{p} \beta_{21k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \beta_{22k} \Delta FDI_{i,t-k} + \sum_{k=1}^{p} \beta_{23k} \Delta EXP_{i,t-k} + u_{2i,t} \quad (9)
$$

$$
\Delta EXP_{it} = \beta_{3i} + \sum_{k=1}^{p} \beta_{31k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \beta_{32k} \Delta FDI_{i,t-k} + \sum_{k=1}^{p} \beta_{33k} \Delta EXP_{i,t-k} + u_{3i,t} \quad (10)
$$

In this article, we rely on the concept of Granger causality to test empirically the causal relationship between exports, GDP, and foreign direct investments without assuming the exogeneity or endogeneity of the underlying variables a priori. Although Granger causality test for time series data has been well developed, a better way of testing causality is to combine both the cross sectional and time series data, and perform the so-called panel Granger non-causality test (Hurlin and Venet 2001, Hurlin 2004, 2005). Consequently, the panel Granger non-causality test is more efficient than when only the time series data are used (Lin and Ali 2009).

Hausman (1978) proposed a test based on the difference between the random effects (RE) and fixed effects (FE) estimates. Since fixed effects (FE) estimator is consistent when unit effects are correlated with x-variables, but random effects (RE) is inconsistent, a
statistically significant difference is interpreted as evidence against the random effects assumption of strict exogeneity.

The null hypothesis for the Hausman’s test statistic is that there is no difference between the estimated coefficients of a fixed effects and a random effects estimator (Ho: difference in coefficients not systematic). However, if the null hypothesis is true, the fixed effects estimator $\hat{\beta}_{FE}$ is not efficient under the random effects specification, because it relies only on the within variation in the data.

On the other hand, the random effects estimator $\hat{\beta}_{RE}$ is efficient under the null hypothesis but is biased and inconsistent when the effects are correlated with the x-variables. The difference between these estimators is $\hat{q} = \hat{\beta}_{FE} - \hat{\beta}_{RE}$ and tends to zero in probability limits under the null hypothesis and is non-zero under the alternative. The variance of this difference is equal to the difference in variances, $\text{Var}(\hat{q}) = \text{Var}(\hat{\beta}_{FE}) - \text{Var}(\hat{\beta}_{RE})$ and the covariance is $\text{Cov}(\hat{q}, \hat{\beta}_{RE}) = 0$ under the null hypothesis. Hausman’s test statistic is based asymptotically in $X^2$ distribution with k degrees of freedom under the null hypothesis

$$X^2(k) = (\hat{\beta}_{FE} - \hat{\beta}_{RE})' \left[ \text{Var}(\hat{\beta}_{FE}) - \text{Var}(\hat{\beta}_{RE}) \right]^{-1} (\hat{\beta}_{FE} - \hat{\beta}_{RE})$$ (11)

This test was generalized by Arellano (1993) to make it robust to heteroskedasticity and autocorrelation of arbitrary forms. In fact, if either heteroskedasticity or serial correlation is present, the variances of the FE and RE estimators are not valid and the corresponding Hausman test statistic is inappropriate (Baltagi 1988).

We also apply the Hausman test (1978) to help in choosing between FEM and REM estimations before implementing the Wald test of coefficients to determine the Granger causality directions.
The Hausman test results indicate that we should use the FEM to estimate the first equation \( DGDP \) and the third equation \( DEXP \) and use the REM to estimate the second equation \( DFDI \).

### 4.2.1. Granger Causality Test

Table 4 presents the estimated panel data VAR(2) for the five countries under investigation, in two FEM and in one REM. The Wald test of coefficients indicates the Granger causality directions.

### Table 4

**Panel Data Granger Causality Tests**

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Model</th>
<th>Coefficient Estimates</th>
<th>Wald test of Coefficients Causality Direction (1)</th>
<th>Wald test of Coefficients Causality Direction (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ho F-statistic</td>
<td>Ho F-statistic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B F(2,187)=0.305 (0.737)</td>
<td>C F(2,187)=13.83 (0.000) *** EXP→GDP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A F(2,183)=0.815 (0.444)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A F(2,187)=9.770 (0.000) *** GDP→EXP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B F(2,187)=0.591 (0.554)</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- a) The numbers in parentheses denote p-values.
- b) *** (**, *, +) denotes rejection of null hypothesis at the 1% (5%, 10%, 15%) level of significance, respectively.
- c) Ho=null hypothesis, \( F \)-stat=\( F \)-statistic.
- d) In Wald test of coefficients, the null hypothesis A is \( c2=c3=0 \), B is \( c4=c5=0 \), C is \( c6=c7=0 \), respectively.

### Table 3

**Hausman Tests**

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>FDI</th>
<th>EXP</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X^2(2) )</td>
<td>16.504</td>
<td>0.782</td>
<td>14.576</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.676)</td>
<td>(0.000)</td>
</tr>
</tbody>
</table>
e) Hausman test is used in the selection of fixed effects or random effects model.

From the results of table 4 for the five countries viewed as a group, we see that:

The coefficients of dummy variables are negative in the first and third function. This means that the economic crisis had significant negative impacts on these five Eurozone countries, as group.

From the first equation (DGDP) of Table 4 we see that there is a strong unidirectional causality relation between exports and economic development with direction from exports to economic development, while there is no causality relation between foreign direct investments and economic development. This result indicates that exports are a vital force for increasing economic development.

The second equation (DFDI) indicated that there is no causality relation between economic development and foreign direct investments nor between exports and foreign direct investments. Obviously, it seems that the increase in exports for the group of five Eurozone countries is not the only factor in attracting foreign direct investments. Factors, such as low wages, tax breaks, human capital, bureaucracy, proper administration etc, are the ones that can attract foreign direct investments.

From the third equation (DEXP) of Table 4 we find that there is a strong unidirectional causality relation between exports and economic development with direction from economic development to exports. This relation shows the increase in domestic products of the five examined countries as group, which is a dynamic in the promotion of exports. On the contrary, there is no causality relation between foreign direct investments and exports. This means that investors are reluctant to invest in this group of countries where there is an economic recession. Summarizing the results for the three equations we can say that there is only a strong bidirectional causality relation between exports and economic development (see Figure 1).
In this paper we employed a Keynesian demand model in an open economy to examine the relations among foreign direct investments, exports, and economic development in a VAR model. For the empirical analysis in this study we used panel data causality analysis for five Eurozone countries that are in recession during the last few years. There are many theoretical and empirical studies on the bivariate causality between exports and economic development, exports and imports, trade and foreign direct investments. However, there are few studies that deal with the causality relations among exports, economic development, and foreign direct investments. The selection of these five Eurozone countries was motivated by the fact that there are few studies using panel data VAR to examine the heterogeneous economic characteristics in the stages of recession.

In this paper, the most significant econometric finding is that foreign direct investments influence neither exports nor development. On the contrary, there is a strong bidirectional causality relation between exports and economic development. This causal relation indicates that an increase in domestic products of the five countries will cause a dynamic impulse both in exports and development. The results of this study differ from those in Hsiao and Hsiao (2006) where it is argued that exports and foreign direct investments together are the most important indicator of economic development, in a group of developed
countries. The difference between the results is due to two main reasons. The first is that the authors examine countries with newly developed economies such as Korea, Taiwan, Singapore, Hong Kong and rapidly developing economies such as China, Malaysia, Philippines and Thailand. The second reason is that the authors have chosen the period 1986 to 2004, the most dynamic phase of development compared with other regions of the world. On the contrary, in this study the examined countries are under recession, with large public debt, high unemployment and political instability.

The main objective of all the governments is the connection of growth with foreign direct investments and exports. The incentives provided by the governments in order to attract foreign investments, which can affect both exports and growth, depends on the desire, the need and the situation of the host country. Usually, the more developed infrastructures and the institutional framework of a country, the less the need for incentives. The most common incentives are tax reliefs, export subsidies, the financing of a part of an investment through the development laws of each country, the interest rate subsidy, as well as the preferential use of certain infrastructures. On institutional changes belong a series of measures relating to the conditions of competition, the proprietary rights, the transparency of corporate governance, the labor market, the protection of the environment etc.

Therefore, the governments of the countries that we are studying should immediately implement policies to attract foreign direct investments and foreign capitals. The attraction of foreign direct investment in these countries is closely linked to their public debt. The reduction of debt will be the trigger for new capital inflows which will increase foreign direct investments, will boost exports and economic growth and will help in reducing unemployment.
Appendix


Levin-Lin-Chu Test (2002) suggest the following hypotheses

\( H_0 \): each time series contains a unit root or \( H_0 : \rho = 1 \)

\( H_1 \): each time series is stationary or \( H_0 : \rho < 1 \)

The procedure works as follows:

First, we run augmented Dickey-Fuller (ADF) for each cross-section on the equation:

\[
\Delta y_{it} = \rho_i y_{it-1} + \sum_{L=1}^{L_0} \beta_{iL} \Delta y_{it-L} + \alpha_m d_m + \epsilon_i
\]

In the second step, we run two auxiliary regressions:

\( \Delta y_{it} \) on \( \Delta y_{it-L} \) and \( d_m \) to obtain the residuals \( \hat{\epsilon}_{it} \) and

\( y_{it-1} \) on \( \Delta y_{it-L} \) and \( d_m \) to get residuals \( \hat{v}_{it-1} \)

The third step involves standardization of the residuals by performing

\[
\hat{\epsilon}_{it} = \frac{\hat{\epsilon}_{it}}{\hat{\sigma}_{\epsilon_i}} \quad \text{and} \quad \hat{v}_{it-1} = \frac{\hat{v}_{it-1}}{\hat{\sigma}_{v_i}}
\]

Finally, we run the pooled OLS regression

\[
\hat{\epsilon}_{it} = \rho \hat{\epsilon}_{i,t-1} + \hat{\epsilon}_{it}
\]

The null hypothesis is \( H_0 : \rho = 0 \) (see Levin et al. 2002).

Im-Pesaran-Shin (2003)

The Im-Pesaran-Shin test is not as restrictive as the Levin-Lin-Chu test, since it allows for heterogeneous coefficients. The null hypothesis is that all individuals follow a unit root process:

\( H_0 : \rho = 0 \quad \forall i \)

The alternative hypothesis allows some (but not all) of the individuals to have unit roots:
\[ H_1: \begin{cases} 
\rho_i < 0 & \text{for } i = 1, \ldots, N_i \\
\rho_i = 0 & \text{for } i = N_i + 1, \ldots, N 
\end{cases} \]

When \( t_{i\tau} \) is the individual t-statistic for testing the null hypothesis \( \rho_i = 0 \) for all \( i \), then the test is based on averaging individual unit root tests \( \bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{i\tau} \).

If this statistic is properly standardized, it is asymptotically N(0, 1) distributed. Monte Carlo simulations reveal that the small sample performance of the Im-Pesaran-Shin test is better than Levin-Lin-Chu test. If either \( N \) is small or if \( N \) is large relative to \( T \), then both Im-Pesaran-Shin and Levin-Lin-Chu show size distortions. Additionally, the tests have little power if deterministic terms are included in the analysis (Kunst 2009).


The procedure of the Breitung’s test can be described as follows.

First, we run augmented Dickey-Fuller (ADF) for each cross-section on the equation:

\[
\Delta y_{it} = \rho_i y_{it-1} + \sum_{l=1}^{d} \beta_{il} \Delta y_{it-l} + \alpha_{it} d_{it} + \epsilon_{it} \quad \text{(except that we do not include deterministic terms)}.
\]

In the second step, we run two auxiliary regressions:

\[
\Delta y_{it} \quad \text{on} \quad \Delta y_{i,t-L} \quad \text{and} \quad d_{it} \quad \text{to obtain the residuals} \quad \hat{\epsilon}_{it} \quad \text{and} \quad \\
y_{it-1} \quad \text{on} \quad \Delta y_{i,t-L} \quad \text{and} \quad d_{it} \quad \text{to get residuals} \quad \hat{v}_{i,t-1}.
\]

The third step orthogonalization transformation is applied to the residuals \( \hat{\epsilon}_{it} \) such that we obtain \( \hat{\epsilon}_{it} \).

Finally, we run the pooled OLS regression

\[
\hat{\epsilon}_{it} = \rho \hat{v}_{i,t-1} + \hat{\epsilon}_{it} \quad \text{which is asymptotically N(0, 1) distributed.}
\]

The null hypothesis is \( H_0 : \rho = 0 \)
**Fisher-type Test**

The Fisher-type test uses p-values from unit root tests for each cross-section \( i \). The formula of the test looks as follows:

\[
P = -2 \sum_{i=1}^{N} \ln p_i
\]

The test is asymptotically chi-square distributed with \( 2N \) degrees of freedom (\( T_i \to \infty \) for finite \( N \)). A big benefit is that the test can handle unbalanced panels. Furthermore, the lag lengths of the individual augmented Dickey-Fuller tests are allowed to differ. A drawback of the test is that the p-values have to be obtained by Monte Carlo simulations (Kunst 2009).

**Maddala and Wu (1999)**

Maddala and Wu (1999) proposed the use of the Fisher \( p \lambda \) test which is based on combining the p-values of the test-statistic for a unit root in each cross-sectional unit. Let \( \pi_i \) be the p-value from the \( i \)-th test such that \( \pi_i \) are \( U[0, 1] \) and independent, and \( -2 \log_e \pi_i \) has a \( \chi^2 \) distribution with 2 degrees of freedom. So \( p \lambda = -2 \sum_{i=1}^{N} \log_e \pi_i \) has a \( \chi^2 \) distribution with \( 2N \) degrees of freedom. The null and alternative hypotheses are the same as in the IPS test. Applying the ADF estimation equation in each cross-section, we can compute the ADF t-statistic for each individual series, find the corresponding p-value from the empirical distribution of ADF t-statistic (obtained by Monte-Carlo simulation), and compute the Fisher-test statistics and compare it with the appropriate \( \chi^2 \) critical value (Hoang and McNown 2006).

**Hadri (2000)** residual based Lagrange multiplier (LM) test for the null that the time series for each \( i \) are stationary around a deterministic trend against the alternative of a unit root in panel data.
\[ y_{it} = r_{it} + \beta_{it} t + \epsilon_{it} \]

where \( \beta_{it} \) is the deterministic component \( r_{it} \) is a random walk, \( r_{it} = r_{i,t-1} + u_{it} \), \( \epsilon_{it} \) is a stationary process, and \( u_{it} \rightarrow \text{IID}(0, \sigma_u^2) \), \( t = 1, \ldots, T \), and \( i = 1, \ldots, N \) are the observed series for which we wish to test stationarity for all \( i \).

So: \( y_{it} = \beta_{it} t + \epsilon_{it} \), \( \epsilon_{it} = \sum_{j=1}^{i} u_{ij} + \epsilon_{it} \) and \( E[\epsilon_{it}] = 0 \)

Let \( \hat{\epsilon}_{it} \) be the residuals and \( \hat{\sigma}_e^2 \) is a consistent estimator of \( \sigma_e^2 \) under \( H_0 \).

More specifically, the test takes the following form:

\[ H_0 : \lambda = 0 \text{ against } H_1 : \lambda > 0 \text{ where } \lambda = \frac{\sigma_u^2}{\sigma_e^2} \]

The LM statistic is:

\[ LM = \frac{\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T^2} \sum_{j=1}^{T} S_{it}^2}{\hat{\sigma}_e^2} \]

where \( S_{it} = \sum_{j=1}^{i} \hat{\epsilon}_{ij} \) and \( \hat{\sigma}_e^2 = \frac{1}{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\epsilon}_{it}^2 \).
References


http://homepage.univie.ac.at/robert.kunst/panels2e.pdf


