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FDI and trade: A Granger causality analysis in a heterogeneous panel

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Abstract

This paper will investigate the Granger causality between outward Foreign Direct Investment (FDI) and the exports of goods and services in 11 European countries from 1996 to 2008. Using a new method to evaluate causality in a heterogeneous panel, we find that the causal relationship from FDI to exports is homogeneous among the panel. However, we find strong evidence of a heterogeneity of the causal relationship from exports to FDI in our sample.

1. Introduction

Over the past decade, international trade and capital flows have experienced an unprecedented growth due to the emergence of new powers such as China or India on the world market. Indeed, globalization has allowed internationalisation of production and fragmentation of the value added chain thanks to the removal of tariff barriers and the reduction in transport and communication costs. Thus, firms are multinationals and organize their production in a global value added chain which can be split up in several countries (Sturgeon *et al.*, 2008). In this way, domestic firms can locate the production of high skilled labour-intensive commodities inland and outsource the production of low skilled labour-intensive commodities in a foreign country where labor costs are weaker. Multinational firms, therefore, benefit from a better cost-competitiveness.

As a result, between 1990 and 2008, the world stock of Foreign Direct Investment (FDI) has been multiplied by 7 with an average annual growth of around 13 %. Over the same period, the export of goods and services have been less significant with an average annual rate of around 7 %. Similar facts can be noticed for the Euro zone which represents 30 % of the world stock of outward FDI in 2008. Results concerning Euro zone members are mixed. If Germany remains the largest country investing abroad in 2008, with a share of 23 % of the Euro zone stock of outward FDI and 8 % of the world stock, its share has been strongly reduced since 1990. On the contrary, the share of France in the world stock of outward FDI has experienced a strong increase between 1990 and 2008 increasing from 5 % to 8 %. Concerning trade, on the other hand, Germany has maintained its position on the global market whereas France has lost export market share.

The effect of FDI on exports, that is, whether outward FDI and exports are substitutes or complements has been a subject of a lot of both theoretical and empirical studies since the 1970s. The theoretical literature distinguishes between horizontal and vertical FDI to assess the nature of the relationship between those two variables. Horizontal FDI is a simple replication of the firm in a foreign country. Therefore, each foreign affiliate produces same goods as its parent company and serves the local market. This type of FDI aims at facilitating investor's access to foreign markets with favorable prospects for growth. The main motivation for horizontal FDI is to avoid trade costs like tariffs or to get access to a foreign market which can only be served locally. On the contrary, vertical FDI implies the international fragmentation of production (Arndt and Kierzkowski, 2001), i.e. the splitting-up of the production process into separate components so they can be produced in different locations. The production is divided into different stages which can be located in some different plants inside or outside the home country. The fragmentation occurs in order to exploit differences in relative factor costs.

Theoretical literature focusing on horizontal FDI shows that the substitution between FDI and trade prevails over complementarity especially when countries are similar in size, technologies and factor endowments (see in particular Markusen, 1984 and Brainard, 1997). On the other hand, when focusing on vertical FDI, theoretical literature, such as Helpman (1984) and Helpman and Krugman (1985), predicts that FDI is a complement to export flows of final products. Indeed, there is evidence of trade in intermediary inputs between the parent company and its foreign affiliates. All these studies only focus on the two-country framework. However, more recent works have emphasized the importance of third countries in the relationship between FDI and trade. In particular, Yeaple (2003) and Ekholm *et al.* (2007) have developed models of export-platform FDI where multina-

tional firm invests in a host country with the intention to serve third nations *via* exports of final goods from its affiliates located in the host country. The rise of trade blocks with low internal trade barriers and high external barriers has promoted this trend. Therefore, in a context of increasing regional integration and free trade areas, it is more profitable for multinational firms to increase their FDI rather than exporting in order to benefit from a large market allowed by such integrations. For example, Blonigen *et al.* (2007) find evidence suggestive of export-platform FDI for most industries within the developed European countries.

Results of the empirical literature are more convergent. Indeed, a major strand of the empirical literature indicates a complementary relationship between FDI and trade (see for instance Lipsey and Weiss, 1984; Pfaffermayr, 1994; Fontagné and Pajot, 1997; Clausing, 2000; Oberhofer and Pfaffermayr, 2008). However, some empirical works find little evidence of a substitution effect between trade and FDI. For instance, Blonigen (2000) shows in his analysis on the Japanese automobile parts to the US market that there is only a complementary effect for vertical production, otherwise there is a predominant substitution effect between FDI and trade. More recently, Türkcan (2007) indicates a slight substitution effect between FDI and trade for finished goods.

The aim of this paper is to evaluate the causal relationship between export of goods and services and outward FDI for a panel of 11 Euro zone countries¹ using a new framework for Granger causality analysis in heterogeneous panel. Indeed, the common method used with time-series variables proposed by Granger (1969) cannot be implemented for a panel data analysis. To overcome this issue, the empirical literature (see Holtz-Eakin *et al.*, 1988 and Arellano and Bond, 1991) has introduced a new Granger analysis framework for panel data relying on a Vector Autoregressive (VAR) model and a simple Wald test. However, this procedure supposes that the causal relationship between two variables is homogeneous, i.e. the same for all the individuals of the panel. Now, the use of the cross sectional information implies taking into account the heterogeneity across individuals in the definition of the causal relationships. Therefore, to assess the causal relationship between outward FDI and trade in a heterogeneous panel, we use the empirical framework proposed by Hurlin and Venet (2001).

2. Data and empirical strategy

2.1. Method

To address the causal relationship between FDI and trade for 11 European countries, we rely on the three steps bi-variate framework proposed by Hurlin and Venet (2001). This methodology has also been used in the analysis of Hoffmann *et al.* (2005) and Hood *et al.* (2008). Their method is just an extension of the basic Granger framework. Note, that the testing process implies that the variables are time-stationary.

Let us consider a time-stationary VAR representation, adapted to a panel data context. For each individual i we have, $\forall t \in [1, T]$:

$$Y_{i,t} = \alpha_i + \sum_{k=1}^p \zeta_k Y_{i,t-k} + \sum_{k=1}^p \theta_{i,k} X_{i,t-k} + \epsilon_{i,t} \quad (1)$$

¹Austria, Belgium-Luxembourg Economic Union (BLEU), Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Spain and Portugal.

with $p \in \mathbb{N}$, $\epsilon_{i,t}$ are *i.i.d.*($0, \sigma_\epsilon^2$) and α_i represents the fixed effects. In their framework, Hurlin and Venet (2001) assume that the autoregressive coefficients ζ_k and the regression coefficients slopes $\theta_{i,k}$ are constant $\forall k \in [1, p]$. They also suppose that parameters ζ_k are identical for all individuals of the panel, whereas the regression coefficients slopes $\theta_{i,k}$ could be heterogeneous among the panel. Then, the procedure to identify causal relations in a heterogeneous panel follow three steps.

The first step tests the homogeneous non-causality hypothesis. Then, the null hypothesis of the first scenario is that there is no evidence that X causes Y in any of the cross-sections. It means that the regression slope coefficients associated to $X_{i,t-k}$ are null for all cross-sections i and all lags k . The corresponding test proposed by Hurlin and Venet (2001) is then:

$$H_0 : \theta_{i,k} = 0 \quad \forall i \in [1, N], \forall k \in [1, p]$$

$$H_1 : \exists(i, k) / \theta_{i,k} \neq 0$$

This first hypothesis is assessed by constructing a Wald test statistic (F_1):

$$F_1 = \frac{(RSS_2 - RSS_1)/NP}{RSS_1/[NT - N(1 + p) - p]} \quad (2)$$

Where N denotes the number of individuals, p denotes the number of lags, T denotes the number of time periods, RSS_2 denotes the restricted sum of squared residual obtained under the null hypothesis and RSS_1 corresponds to the residual sum of squares computed from equation (1). Interpretation of the statistic relies on the Fisher distribution with Np , $NT - N(1+p) - p$ degrees of freedom. If the F_1 statistic is not significant, i.e. if the null hypothesis is accepted, it indicates that X does not cause Y in any cross-section of the sample. In this case, the testing process ends at this step. On the contrary, if the F_1 statistic is significant, i.e. if the null hypothesis is rejected, it indicates that X causes Y in at least one of the individuals of the sample. However, this result could hide heterogeneous causal relationships among the entire panel. It is then necessary to test whether the causal relationship is homogenous for all individuals of the sample.

Thus, the second step tests the null hypothesis that a causal process is manifest for all individuals of the sample, i.e. the regression slope coefficients associated to $X_{i,t-k}$ are identical. The test is then the following one:

$$H_0 : \forall k \in [1, p] / \theta_{i,k} = \theta_k \quad \forall i \in [1, N]$$

$$H_1 : \exists k \in [1, p], \exists(i, j) \in [1, N] / \theta_{i,k} \neq \theta_{j,k}$$

Under the null hypothesis, coefficients of the lagged explanatory variables, $\theta_{i,k}$, are supposed to be equal and different from 0 for each individual of the sample. Again, Hurlin and Venet (2001) propose the use of a simple Wald statistic to test the homogeneity of the causal relationship (F_2):

$$F_2 = \frac{(RSS_3 - RSS_1)/[p(N-1)]}{RSS_1/[NT - N(1+p) - p]} \quad (3)$$

Where RSS_3 is the residual sum of squares obtained in a model (1) when one imposes that the slope terms are constrained to be equal for each cross-section in the sample. Under the null hypothesis, the statistic follows a Fisher distribution with $p(N-1)$, $NT-N(1+p)-1$ degrees of freedom. If the F_2 statistic is not significant, the null hypothesis is accepted and the causal relationship is homogeneous for every individual of the sample. Then, the testing process ends. On the other hand, if the null hypothesis is rejected, it means that, for at least one individual of the sample, X does not cause Y. Thus, it is necessary to determine for which individual i , the causal relationship is rejected.

The last step of the testing process consists in testing the null hypothesis that X does not cause Y for each individual of the sample. Following Hurlin and Venet (2001), we consider the following heterogeneous non-causality test:

$$H_0 : \exists i \in [1, N] / \forall k \in [1, p] \theta_{i,k} = 0$$

$$H_1 : \forall i \in [1, N], \exists k \in [1, p] / \theta_{i,k} \neq 0$$

The test is run for each individual of the sample and the Wald statistic (F_3) is the following one:

$$F_3 = \frac{(RSS_{2,i} - RSS_1)/p}{RSS_1/[NT - N(1+2p) + p]} \quad (4)$$

with $RSS_{2,i}$ is the residual sum of squares from model (1) in which the slope coefficient for only the individual i is constrained to 0. Under the null hypothesis, the F_3 statistic follows a Fisher distribution with p , $NT-N(1+2p)-1$ degrees of freedom. For individual i , if the null hypothesis is rejected, then X causes Y.

2.2. Data

We test the causal relationship between outward FDI (FDI) and exports of goods and services (X) for a panel of 11 European countries over the period 1996-2008. Data for outward FDI stocks in current dollars were collected from the United Nations Conference on Trade and Development (UNCTAD). Outward FDI stock is chosen rather than outward FDI flows since the stock data is more complete and less volatile than the flows data. We use the export price index to convert the outward FDI stock data in constant 2000 dollars. Data on the exports of goods and services expressed in constant 2000 dollars are taken from the OECD database. The two variables of our study (FDI and exports) are expressed in a logarithmic form.

3. Results

3.1. Panel unit root tests

Before using the testing process described below, we have to test whether outward FDI stock and exports of goods and services are time-stationary. If those tests are common

in time-series data, they are recent concerning panel data thanks to the contributions of Levin and Lin (1992). Following this work, several unit root tests have been developed in the empirical literature. The most famous ones are those proposed by Levin *et al.* (2002), Im *et al.* (2003) and Maddala and Wu (1999). Indeed, the main limit to the test developed by Levin, Li and Chu (LLC) is that it supposes that the autoregressive root is homogeneous for all the individuals of the panel. Phillips and Sul (2003) have shown using specification tests that this hypothesis is wrong and can lead one to reject the null hypothesis of the presence of a unit root in too many cases. This could lead to biased results. Thus, Im, Pesaran and Shin (IPS) have proposed a new framework for panel unit root tests which allows for heterogeneity on the lagged level term. Finally, Maddala and Wu (1999) have proposed two different unit root tests directly comparable with the IPS test, one relying on the Augmented Dickey-Fuller framework (MW-ADF) and the other one based on the Phillips-Perron method (MW-PP). Therefore, we implement four different panel unit root tests summarized in table 1. All tests contain a constant but no trend.

Table 1: Panel unit root tests results

	LLC (t^*)	IPS (W_{tbar})	MW-ADF	MW-PP
$Ln(X)$	-8.25***	-3.31***	48,03***	71.28***
$Ln(FDI)$	-6.20***	-2.14**	39.39**	48.51***

*, **, ***: significant a 10%, 5 %, 1%

Results of panel unit root tests are convergent. We reject the null hypothesis of a unit root for all of our variables and conclude that they follow stationary process. We can, therefore, apply the three steps method proposed by Hurlin and Venet (2001) to evaluate the causality relations between FDI and exports.

3.2. Causality tests

We carry out Granger causality tests for our sample of 11 European countries over the period 1996-2008. We estimate three models based on the equation (1), including one, two and three lags.

We first test the homogeneous non-causality hypothesis between FDI and exports. Note that we also consider the reverse relationship. Results concerning the F_1 statistic are summarized in table 2.

Table 2: Homogeneous non-causality tests (F_1)

	p=1	p=2	p=3
$Ln(FDI) \rightarrow Ln(X)$	2.74***	1.94***	1.34
$Ln(X) \rightarrow Ln(FDI)$	1.77**	1.51*	1.60**

*, **, ***: significant a 10%, 5 %, 1%

The F_1 statistic confirms the existence of a causal relationship from FDI to exports for at least one country of our sample. Indeed, we reject the null hypothesis that FDI

does not cause exports at lag 1 and 2. On the other hand, F_1 is not significant concerning the model including three lags. Therefore, there is no causal relationship from FDI to exports after two years for all the countries of our sample. Our results concerning the F_1 statistic also allow us to reject the null hypothesis of non-causality from exports to FDI at one, two and three lag. So, for at least one country of our sample (and possibly all), there is evidence that exports cause FDI. Then, we continue the testing process for the two causal relationships and implement the F_2 statistic. Table 3 summarizes the homogeneous causality tests results.

Table 3: Homogeneous causality tests (F_2)

	p=1	p=2	p=3
$Ln(FDI) \rightarrow Ln(X)$	1.48	1.36	1.15
$Ln(X) \rightarrow Ln(FDI)$	1.77**	1.45*	1.46*

*, **, ***: significant a 10%, 5 %, 1%

The homogeneity test of the causal relationship from FDI to exports leads us to accept the null hypothesis for the three lags studied, especially at first and second lag. Thus, the causal relationship from FDI to exports is homogeneous for all the countries of our sample. Therefore, there is clear evidence that for all countries of our sample FDI causes exports after one and two years. However, our findings show that the reverse causal relationship is heterogeneous among the panel. Indeed, we reject the null hypothesis that the causal relationship from exports to FDI is homogeneous for all of the selected countries and for all lags studied. Thus, we have to continue the testing process for this causal relationship but the procedure stops at this step for the causal relationship from FDI to exports.

Results summarized in table 4 confirm the strong heterogeneity of the causal relationship from exports to FDI among our sample.

Table 4: Heterogeneous non-causality tests (F_3)

	p=1	p=2	p=3
Austria	7.94***	6.21***	6.81***
BLEU	3.62*	2.87*	3.49**
Finland	3.74*	3.75**	4.41***
France	0.27	0.63	1.42
Germany	9.57***	7.72***	8.25***
Greece	1.75	2.41*	3.38**
Ireland	1.28	1.15	2.46*
Italy	0.88	1.67	2.21
Netherlands	5.93**	4.75**	5.27***
Portugal	4.07**	3.52**	4.90***
Spain	1.96	2.31	3.30***

*, **, ***: significant a 10%, 5 %, 1%

First, we can notice that the null hypothesis that exports does not Granger cause FDI is rejected for Austria, Germany and Netherlands at 5 % level for all the lags selected. In those countries, there is clear evidence of a bi-directional causal relationship between FDI and exports. This is especially the case in Germany where the F_3 statistic is significant at 1% level for all the three lags. Results concerning BLEU and Finland are less robust since the causal relationship from exports to FDI is only significant at 10% after one year. However, it becomes more significant after two and three years. For those countries too, there is clear evidence of a bi-directional causal relationship between FDI and exports, especially after two years. Results concerning Spain show that the causal relationship from exports to FDI appears only after 3 years. Indeed, we only accept the null hypothesis of a causal relationship for the model including three lags. To a lesser extent, results are similar for Ireland. Finally, our findings indicate that there is no causal relationship from exports to FDI for France and Italy. Indeed, F_3 is never significant for those countries. Thus, for those two countries, there is only a one-way causal relationship from FDI to exports which disappears after two years.

Our results concerning Germany are line with the “bazaar theory” developed by Sinn (2006). Indeed, over the recent period, German firms have strongly increased their investment in emerging countries, especially in Eastern Europe, in order to use intensively the new division of labour and benefit from lower production costs. Therefore, German firms have split the value added-chain in different stages over different countries. They, then, import semi-finished products from their foreign affiliates, finish the production of the final good inside the home company and re-export the product from Germany. It swells German exports and increases the import content of exports. So, there is a complementarity relationship between trade and capital flows: new investments entail new exports which entail new investment flows. Thus, there is a combination of trade in inputs and capital flows between the parent company based in Germany and its affiliates located abroad.

Our findings also show a bi-directional relationship between FDI and trade for smaller countries like Netherlands or BLEU, but interpretations are not the same as for Germany. Indeed, these countries are known to have attractive tax systems. As a result, a lot of firms from industrialized countries have created specific financial holding companies called *Special Purpose Entities* (SPE) in these countries. These financial affiliates are in charge of financial activities for their parent company including cash pooling or zero balancing activities. Moreover, if a foreign firm owns more than 10 % of one financial holding company, it is reflected in FDI statistics. Furthermore, all financial flows from this financial affiliate to its parent company are recorded as outward FDI flows. Thus, for Netherlands and BLEU, there is a combination of financial flows and exports of financial services.

Finally, results for France and Italy indicate only a one-way causal relationship. There are two possible explanations for this conclusion. First, Italian firms are just at the beginning of their internationalization process (Breda *et al.*, 2008). So, Italian firms are less vertically integrated than German companies. Second, French and Italian firms seems to have another strategy for their internationalization of production. Indeed, they use more intensively the total relocation of production which only involves a causal relationship from FDI to exports.

4. Concluding remarks

This paper analyses the causal relationship between exports of goods and services and outward FDI for a panel of 11 European countries over the period 1996-2008. Using both homogeneous and heterogeneous non-causality tests based on the testing process developed by Hurlin and Venet (2001), we reach two main conclusions:

- First, we find that there is a causal relationship from outward FDI to exports of goods and services for all countries of our sample. However, after three years the causal relationship is rejected at 10 % level.
- Secondly, there is a strong heterogeneity for the causal relationship from export of goods and services to outward FDI among our panel. If some countries like Germany or Netherlands benefit from a bi-directional causal relationship between FDI and trade, there is no evidence of a causal relationship from exports to FDI for France and Italy over the recent period. Therefore, Germany could have benefited from a virtuous circle in which exports lead to FDI and then FDI entails new exports. This could explain part of the over performance of Germany on the world market.

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