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Production under foreign ownership and domestic volatility: An empirical investigation at the sector level

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Abstract

The main goal of this paper is to assess empirically to which extent the volatility of production is due to activities of firms under foreign ownership. Following Bergin et al. (2009) and Levasseur (2010), we postulate that multinational firms can use their contractors and their sites of production located abroad to "export" some of their domestic fluctuations, thus exacerbating further the business cycles of the hosting economy. Using a sample of twelve manufacturing sectors in eight EU countries and a data panel estimation, we find that the higher the share of firms under foreign ownership in a given sector of a country, the higher the volatility of production in that sector of that country, thus confirming the aforementioned assumption. Moreover, our estimates show how important to deal with sector-specific volatility, a result we attribute to idiosyncratic shocks arising at the sector level from both demand and supply sides. Our findings are robust to various ways of extracting cycles and to different time spans for measuring volatility.

Keywords: Offshoring, European integration, sector analysis, business cycles volatility, data panel estimation.

JEL codes: F21, F23, F4, L60, C30.

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1. Introduction

Volatility – and, in particular, reducing volatility – is a key concern for most policymakers and academics, as economic agents are assumed adverse to large fluctuations in their incomes, prices and so on. Fluctuations would produce uncertainties faced by agents, thus making complex their economic calculus and increasing the potential for errors or bad decisions[1]. Some even argue that volatility would hurt growth in the long run (Aghion and Banerjee, 2005; Ramey and Ramey, 1995; Hnatkovska and Loayza, 2004). In the economic literature, only the canonical model of real business cycles (RBC) concludes that any policy intervention aiming at smoothing fluctuations is sub-optimal as cyclical fluctuations are simply optimal responses of private agents to technological shocks arising in the economy (Kydland and Prescott, 1982)[2]. To this notable exception, however, the bulk of works in economic literature is assuming that fighting fluctuations – or, at least, smoothing them – is a key goal for policymakers, alongside the redistributive one.

The goal of this paper is twofold. First, we aim at documenting the volatility of economic activity using sectoral data at a two-digit level for a sample of fourteen European Union (EU) countries, including both "old" and "new" EU members. To our knowledge, documenting volatility to such a sector level has not been done yet for European countries, all previous studies on the subject concentrating on data of GDP or industrial production as a whole[3]. Second, we want to assess to which extent the volatility of sector production is due to offshoring or foreign ownership[4]. Following Bergin et al. (2009) and Levasseur (2010), we postulate that multinational firms can use their contractors and their sites of production located abroad to "export" some of their domestic fluctuations, thus exacerbating further the business cycles of the hosting economy. Put differently, according to this assumption, the higher the share of firms under foreign control in a given economy through either contracting or FDI, the higher the volatility of production in that economy. Using monthly data of activity in maquiladoras (*i.e.* assembly plants of American multinationals in Mexico), Bergin et al.

1. For instance, according to Bertola and Caballero (1994), in a context of risk aversion and irreversibility of investment process, uncertainty is likely to lead firms to under-invest or invest in "wrong" projects.
2. Relaxing the assumption of complete financial markets and/or considering nominal rigidities are sufficient conditions for the conclusion against any policy intervention falls in RBC models. See Chari and Kehoe (1999) for a review of the literature on optimal fiscal and monetary policy in RBC models.
3. For the United States, there is a (small) literature documenting volatility at a sector level. See for instance Christiano and Fitzgerald (1998).
4. Bergin et al. (2009) define offshoring (or international outsourcing) as "the arrangement whereby firms contract with independent counterparts in another country to carry out particular stages of production". It is worth noting that such a fragmentation in production process can be also realized through foreign direct investment (FDI) in which case 'counterparts in another country' are no longer 'independent' as soon as its capital structure is concerned. For the issue at stake, however, both kinds of relationship between domestic firms and their counterparts abroad would have similar consequences.

(2009) found that volatility in the Mexican outsourced industries is twice as high as in the corresponding American industries. This result would confirm that American multinationals are exporting to Mexico some of their fluctuations over the business cycle. In a similar vein, Levasseur (2010) documented that the higher volatility of sector production in Slovakia than in the Czech Republic – or Germany – may be caused by a larger level of international outsourcing made by multinationals in Slovakia, especially over the recent years. Our econometrical work aims at assessing the link between volatility and foreign ownership for a sub-sample of twelve sectors in eight EU countries, after controlling for the country size and other specific effects. By this way, our paper also contributes to a growing empirical literature on the determinants of volatility[5].

2. Volatility of sectoral production

Table 1 presents a synthetic view on the volatility of production for 12 sectors and 14 EU countries. In the upper part of table 1, figures for each individual sector are obtained by averaging across countries while, in the lower part of table 1, figures for each individual country are obtained by averaging across its sectors. The volatility of production in sector *i* of country *j* is measured as the standard deviation of its growth rate, with the growth rate computed as the twelve-difference of (seasonally-adjusted) monthly data taken in a log form. The time span for production data is 2000:01-2010:06.

Data of production by sector are coming from Eurostat for all countries of our sample, except Slovakia and Ireland. In these two latter cases, data are provided by their respective national statistical offices. For some sectors, data of Slovakia and Ireland cannot be perfectly fitted with those of other EU countries. Yet, for Finland, Portugal and Sweden, some data are missing. The pooled sample is then unbalanced, as also evident from the numbers of observations reported in table 1. The appendix provides more information on availability and treatment of data.

5. See Alouini and Hubert (2010) for an interesting and updated review of the literature on the subject and for their own estimates.

Table 1: Volatility of production, by sector and country

Individual sectors	Volatility	N.observations
A_Food, beverages and tobacco	0.054	13
B_Textiles, wearing apparel, leather, footwear	0.100	11
C_Wood and paper products	0.073	14
D_Chemicals and chemical products	0.116	13
E_Rubber and plastic products	0.105	13
F_Non-metallic mineral products	0.118	13
*G_H_ Basic and fabricated metal products**	0.179	2
G_Basic metals	0.162	12
H_Fabricated metal products	0.120	14
I_Medical, precision, optical instruments	0.160	12
J_Electric machinery and electronic equipment	0.149	13
K_Non-electrical machinery and equipment	0.145	14
L_Transport equipment	0.186	14
Average	**0.126**	**Total: 156**

Individual countries	Volatility	N.observations
AUT_Austria	0.111	10
CZ_Czech rep.	0.143	12
FI_Finland	0.145	8
FR_France	0.090	12
GER_Germany	0.102	12
HU_Hungary	0.160	12
*IR_Ireland**	0.167	11
IT_Italy	0.107	12
PL_Poland	0.116	12
POR_Portugal	0.107	11
*SK_Slovakia**	0.196	9
SP_Spain	0.119	12
SW_Sweden	0.125	11
UK_United Kingdom	0.081	12
Average	**0.126**	**Total: 156**

* Sectors G_ and H_ compiled in a unique sector for Ireland and Slovakia.
Sources: Eurostat and OECD; computations of the author.

As shown in the upper part of table 1, sectors are presenting very different degrees of volatility, from roughly 0.05 to more than 0.18 or, put differently, in a factor of one for three. The lowest volatility is found in sectors of Food, beverages & tobacco (A_) and Wood & paper products (C_) while the largest volatility is found in the sector of Transport equipment (L_). Yet, the sector of Basic metals (G_), which is largely backward-linked to the one of Transport equipment, is also presenting a high volatility (0.162), together with the one of Medical, precision & optical instruments (I_, 0.160). To some extent, the difference in sectoral volatility reflects differences in shocks arising at the sectoral level. Thus, the sector of Food & beverages is potentially less subject to large and abrupt changes in demand for its products than the sector of cars (included in Transport equipment). Yet, technological changes – and then supply shocks – are presumably more important in the sector of Transport equipment and in some sub-sectors of Medical, electric & electronic machinery (included in I_, J_, K_). The difference in sectoral volatility – in a factor of one for three – is an important

finding to consider as differences in volatility across countries at a more aggregated level (*e.g.* GDP or industrial production as a whole) may reflect differences across countries in the specialization of their productive structure. In particular, countries specialized in sectors with small and infrequent shocks – both from the demand and supply sides – would reveal a comparatively lower aggregate volatility than countries specialized in sectors with large and frequent shocks. In our econometrical work (see next section), we will assess for a sector-specific volatility.

Turning to individual countries, it is clear that the dispersion of volatility is lower than for individual sectors, as ranging from 0.08 (the United Kingdom) to roughly 0.2 (Slovakia) or, put differently, with a factor of one for two. Moreover, as summarised in table 2, the large countries (proxy here by population size) are presenting a lower volatility than the small ones (0.102 against 0.150 respectively). Such a finding has been previously documented using more aggregate data (GDP or industrial production as a whole) and, investigated empirically by Furceri and Karras (2007, 2008), Alouini and Hubert (2010). Reasons behind a negative relation between volatility and country size are viewed as a consequence of diversified productive structure for a large economy which dilutes the impact of sector-specific shocks (Imbs, 2007). Comparatively, as small economies are more specialized, sector-specific shocks tend to become country-specific shocks (Carré et al., 2000). Moreover, as small economies are very open, shocks on their terms of trade have a larger effect than in large economies (Crucini, 1997). Finally, poor countries – which largely overlap with Central and Eastern European countries (CEECs) in our sample – are presenting a higher volatility than rich countries or non-CEECs (table 2). Various factors, from the lack of financial depth to the lagging behind institutional development, may explain why poor countries (mostly CEECs in our case) experience larger fluctuations of sectoral production than rich countries (or non-CEECs)[6].

In our econometrical work, we will control for the country size and other country-specific factors in explaining volatility. Importantly, we will assess the extent to which activities of firms under foreign ownership may account for such differences of volatility across sectors and countries. To date, to our knowledge, that explanatory variable has not been investigated econometrically while both intuition and theory suggest it could be a relevant factor for explaining volatility.

6. See Hnatkovska and Loayza (2004) for further evidence on the link between level of economic development and macroeconomic volatility.

The next section provides some (additional) insights on why considering activities of firms under foreign ownership is relevant for explaining volatility in a world (and, particularly in Europe) characterized by large trade flows across countries as well as large capital flows including those through FDI.

Table 2: Volatility of production and foreign activity, by group*

(Unweighted average)

Groups	Volatility	Foreign (in %)	Countries included in the group
Large countries	0.102	31.4	FR, GER, IT, PL, SP, UK
Small countries	0.150	44.8	AUT, CZ, FI, HU, IR, POR, SK, SW
Rich countries	0.119	35.5	AUT, CZ, FI, FR, GER, IR, IT, SP, SW, UK
Poor countries	0.146	47.9	HU, PL, POR, SK
CEECs	0.155	53.2	CZ, HU, PL, SK
Non-CEECs	0.115	33.4	AUT, FI, FR, GER, IR, IT, POR, SP, SW, UK
Net exporting-FDI countries	0.108	29.0	FI, FR, GER, IT, SW, UK
Net importing-FDI countries	0.139	46.3	AUT, CZ, HU, IR, PL, POR, SK, SP

* 'Large' countries are defined as countries whose population accounts for more than 48 % of the one of Germany (the more populated country in our sample). 'Small' countries are countries with a population below 48 % of the German one. Data source: the Penn World Table 6.3.
'Rich' (resp. 'poor') countries are countries whose GDP per capita is higher (resp. lower) than 80 % of the EU-27 average since 2007. Data source: Eurostat.
'CEECs' is for Central and Eastern European Countries.
'Net importing (resp. net exporting) FDI countries' consist of countries with a net stock of inward (resp. outward) FDI over the 2000's. Data source: CNUCED.
For mnemonics of countries included in the groups, see table 1.
Sources: Eurostat and OECD; computations of the author.

3. Production of firms under foreign ownership

For measuring international outsourcing, we use data of domestic production made by firms under foreign ownership, which are provided by OECD[7]. Such data are available for almost countries of our sample at a two-digit level. Figures reported in table 3, as well as those used for our econometrical work, are for 2004 year and are expressed as a share of total production on the domestic territory (in percentage). The appendix provides more details on data and their treatment.

Considering the figures for individual sectors (the upper part of table 3), it appears that the degree of foreign ownership is very different across sectors, ranging from around 20 % in Textiles, wearing apparel & leather (B_) and Fabricated metal products (H_) to some 55-60 % in Electric machinery & electronic equipment (J_) and Transport Equipment (L_). However it

7. That means that we consider only production made by firms in which a foreign entity holds at least 50 % of capital shares, in conformity with the statistical definition of FDI by OECD.

is worth mentioning two points. First, for the sector of Textiles, wearing apparel & leather, the low figure in average (*i.e.* 20 %) is masking large differences across countries with a share of foreign ownership from less than 10 % (in Italy, Spain, Portugal and Finland) to more than 50 % (in Hungary and Ireland). It would be thus wrong to conclude that the sector of Textiles, wearing apparel & leather is no longer a sector under foreign ownership in Europe: all depends on countries and, in particular, if their domestic producers have been able to maintain and develop their own brands in the context of globalization. Second, in the sector of Textiles, & wearing apparel, the level of international outsourcing as defined by Bergin et al.(2009)[8] is presumably high, with (a lot of small) firms in some countries acting as contractors of (large) multinational firms[9]. Such data of international outsourcing are unfortunately unavailable at a two-digit level for the twelve sectors considered in this study[10].

Turning now to the figures by individual country (the lower part of table 3) as well as by group (table 2), it is clear that foreign ownership is, first, positively related to whether countries are CEECs or non-CEECs (53.2 % against 33.4 % in average), then whether countries are poor or rich (47.9 % against 35.5 %) and finally whether countries are small or large (44.8 against 31.4 %). Surely, some countries are complying with both criteria. Thus Slovakia is both a CEEC, a poor and a small country with a large share of its enterprises under foreign ownership (around 57 %). Conversely, Germany is both a non-CEEC, a rich and a large country with a small share of its enterprises under foreign ownership (23.5 %). At the same time, Finland is not complying with all criteria together: it is a non-CEEC, a rich country but a small one with a low share of enterprises under foreign ownership (23.6 % or, put differently, as low as in Germany). Similarly, Poland is a CEEC, a poor country but a large one with a non-negligible share of enterprises under foreign ownership (47.7 %). Those examples point out that foreign ownership cannot considered as a pure mirror of country size: introducing simultaneously country size and foreign ownership as regressors to assess their impact on volatility can provide interesting insights (see next section).

8. See footnote 4.
9. For instance H&M – a Sweden multinational fashion clothing retailer – is well-known for contracting with enterprises in Eastern Europe to produce clothes.
10. More precisely, such data have to be constructed on the basis of assumptions which may be controversial. See Feenstra et al.(2010) on that point.

Table 3: Share of production under foreign ownership, by sector and country

Individual sectors	Foreign (in %)	N.observations
A_Food, beverages and tobacco	31.7	13
B_Textiles, wearing apparel, leather, footwear	20.5	11
C_Wood and paper products	33.0	14
D_Chemicals and chemicalproducts	52.5	13
E_Rubber and plastic products	38.1	13
F_Non-metallic mineral products	32.3	13
*G_H_ Basic and fabricated metal products**	46.6	2
G_Basic metals	36.9	12
H_Fabricated metal products	18.1	14
I_Medical, precision, optical instruments	40.7	12
J_Electric machinery and electronic equipment	55.1	13
K_Non-electrical machinery and equipment	43.0	14
L_Transport equipment	59.8	14
Average	**39.1**	**Total: 156**

Individual countries	Foreign (in %)	N.observations
AUT_Austria	33.7	10
CZ_Czech rep.	51.7	12
FI_Finlande	23.6	8
FR_France	36.5	12
GER_Germany	23.5	12
HU_Hungary	56.8	12
*IR_Ireland**	66.2	11
IT_Italy	16.2	12
PL_Poland	47.7	12
POR_Portugal	31.2	11
*SK_Slovakia**	56.7	9
SP_Spain	26.4	12
SW_Sweden	39.4	11
UK_United Kingdom	35.0	12
Average	**39.1**	**Total: 156**

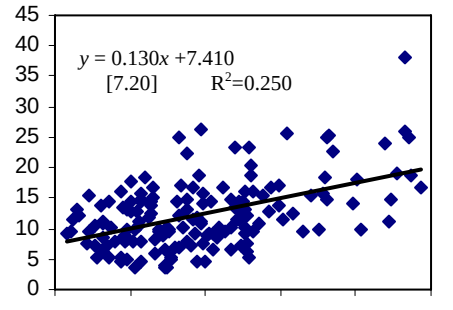
* Sectors G_ and H_ compiled in a unique sector for Ireland and Slovakia.
Sources: Eurostat and OECD; computations of the author.

Before turning to our econometrical work, graph 1 plots the share of production under foreign ownership in sector *i* of country *j* and the volatility of domestic production in sector *i* of country *j* (measured as in the previous section)[11]. As evident from graph 1, there is a positive (and significant) relationship between 'foreign ownership' of production and volatility of production in that sector on the domestic territory. Interestingly, considering only net importing-FDI countries gives a slightly higher slope (graph 2) while the relationship does vanish and becomes insignificant when we consider only net exporting-FDI countries (graph 3)[12]. Those univariate regressions provide a first confirmation of the issue at stake: *net FDI-importing countries* are also *net importers of volatility*. By contrast, the relationship does not hold – and does not have to hold – for *net FDI-exporting countries* which are also presumably

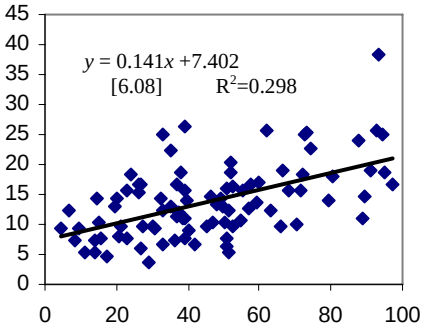
11. For both the graphs and the econometrical work, figures of volatility have been multiplied by 100.
12. Net FDI-importing countries are countries with a net stock of inward FDI while net FDI-exporting countries are those with a net stock of outward FDI. See appendix for further details.

net exporters of volatility. In the next section, our econometrical work will be based on the sample of net FDI-importing countries, which constitutes the relevant sample to consider.

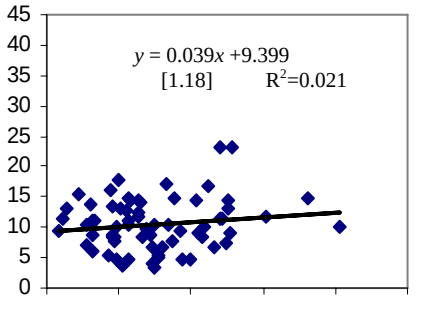
Graph 1: Share of production under foreign ownership (X-axis) and volatility of domestic production (Y-axis)
Full countries sample



Graph 2: Share of production under foreign ownership (X-axis) and volatility of domestic production (Y-axis)
Net importing-FDI countries



Graph 3: Share of production under foreign ownership (X-axis) and volatility of domestic production (Y-axis)
Net exporting-FDI countries



Notes: t-statistics in brackets.
See table 2 for countries included in the groups of net FDI-importing and -exporting countries.

4. Econometrical work

4.1. The general econometrical framework

Econometrically speaking, we estimate various pooled models whose general form can be expressed as follows:

$$\sigma y_{ij} = \alpha_0 + \alpha_1 \text{foreign}_{ij} + \alpha_2 \text{DumSector}_i + \alpha_3 \text{DumCountry}_j + \alpha_4 \text{Size}_j + \alpha_5 \text{DumGroupCountries}_j + \varepsilon_{ij}$$

where • σy_{ij} denotes the volatility of production in sector *i* of country *j* (measured by the standard deviation of its growth rate, see section 2, and multiplied by 100);

• foreign_{ij} stands for the degree of production made by firms under foreign ownership in sector *i* of country *j* (see section 3);

• DumSector_i is a dummy for sector *i* (common to all countries) taken a value of 1 for sector *i* and 0 otherwise, aiming at controlling for volatility specific to sector *i* (see section 2);

• DumCountry_j is a dummy for country *j* (common to all sectors of country *j*) taken a value of 1 for country *j* and 0 otherwise, aiming at controlling for volatility specific to country *j* (see section 2).

As the volatility specific to country *j* may be related to its size, some of our variants will consider (the log of) population (denoted Size_j) to assess for this effect (see section 2)[13]. Yet, as some countries are presenting common characteristics (for instance, CEECs), other variants will control for characteristics of countries group with the help of dummies (denoted $\text{DumGroupCountries}_j$) taken the value of 1 if country *j* belongs to the group and 0 otherwise (see sections 2 and 3).

• α are coefficients to be estimated and ε_{ij} are residuals of the pooled estimation.

It is worth noting that it makes no difference to estimate a fixed-effects model or a pooled model with dummies. In the former case, the "fixed-effects" (or *within*) estimator could only explain the variation between individual countries or between individual sectors, not both. That means we would have to resort to dummies for assessing either country specificities or sector specificities. We have chosen to estimate pooled models with dummies to gain some flexibility in dropping some particular countries and/or sectors dummies. See Verbeek (2008, p.360) for a comprehensive view on panel data modeling.

13. Considering the relative population (with respect to Germany for instance) rather than the (log of) population does not change the qualitative results of our estimates.

4.2. The benchmark estimates

In this section, we present and comment the results obtained from variants of our pooled models. In all cases, our sample consists only of net FDI-importing countries and volatility of production is computed over 2000:01-2010:06. Results of our benchmark estimates are reported in table 4.

The striking result is that, whatever the exact specification of the model, 'foreign ownership' is always a very significant variable in explaining the volatility of production. More precisely, the coefficient associated to 'foreign ownership' is found significantly positive (at a 1 % level), meaning that the higher the production of firms under foreign ownership, the higher the volatility of production in the sector of that country. This result suggests that affiliates belonging to that sector would import some fluctuations from abroad through their parents companies, thus confirming the point developed by Bergin et al.(2009) and Levasseur (2010).

The 'country size' and, more generally, the 'country dummies' do not help a lot in the global fitting of the model. Yet, in models (1) and (5), the 'country size' is no longer a significant variable at conventional levels. By contrast, the introduction of 'sector dummies' provides a better global fitting of the model. For instance, the adjusted R^2 is 0.575 in model (3) with 'sector dummies' (against less than 0.30 in model (1) without 'sector dummies'). This finding points out how important to deal with characteristics specific to sector when assessing determinants of volatility. We return to this issue below.

A dummy for countries belonging to the CEECs' group (as in model 4) is barely significant at reasonable levels and provides no real improvement compared to model (3). By contrast, a dummy for Slovakia (as in model 5) is very significant (at a 1 % level) and improves the global fitting of the model compared to all previous models[14]. Yet, a comparison of models (5) and (3) shows that Slovakia alone is largely accounting for the (significance of the) coefficient associated to the 'country size' in model (3). Finally, the point of estimate for 'foreign ownership' is similar in models (3) and (5): a 10 % increase in the share of production under foreign ownership would increase the volatility of domestic production by 1 %. Model (6), which mirrors model (5) except that 'size' is excluded, gives a slightly higher point of estimate: a 10 % increase in the share of production under foreign ownership would increase the volatility by 1.14 %.

14. In this paper, for saving space, we do not report all variants of our estimations related to country dummies. They are available upon request to the author.

Table 4: Volatility and foreign ownership
(sample of net FDI-importing countries)

	(1)	(2)	(3)	(4)	(5)	(6)
Foreign ownership	0.130*** [5.31]	0.125*** [4.55]	0.100*** [4.08]	0.081*** [3.06]	0.101*** [4.52]	0.114*** [5.47]
Size	-1.043 [-1.42]	No	-1.448** [-2.40]	-1.722*** [-2.72]	-0.818 [-1.41]	No
DumSector	No	No	Yes	Yes	Yes	Yes
DumCountry	No	Yes	No	No	Only for Slovakia: 5.350*** [3.75]	Only for Slovakia: 5.930*** [4.32]
DumGroupCEECs	No	No	No	1.602* [1.72]	No	No
Constant	17.72** [2.40]	No	No	No	No	No
R^2 (adjusted)	0.298	0.327	0.575	0.586	0.639	0.634
Observations	89	89	89	89	89	89

Note: t-statistics in brackets; (***), (**) and (*) for significant at respectively 1, 5 and 10 %.

To illustrate further the importance of dealing with sector specificities when assessing the determinants of volatility, table 5 provides coefficients associated to sector dummies for models (3), (5) and (6)[15]. Most coefficients are very significant at a 1 % level, with sectors like Food, beverages & tobacco (A_) or Wood & paper products (C_) reporting the lowest coefficients (albeit sometimes insignificant ones). At the other extreme, sectors like Medical, precision, optical instruments (I_) or those related to cars (Basic metals (G_) and Transport equipment (L_)) have the highest coefficients. Moreover, except in very few cases, the Wald tests do not allow us to conclude in favour of coefficients' equality for some sector dummies[16]. That suggests that sectors are characterized by their own (driven factors) volatility, a feature we already discussed in section 2. All in all, those estimates underline the relevance of considering the sector specialization of a country when assessing the determinants of volatility and that, even when macroeconomic volatility is concerned. Indeed, according to our estimates, other things being equal, a country specialized in Food, beverages and tobacco (A_) will have necessarily a lower volatility than a country specialized in, say, Transport equipment (L_).

15. The coefficients associated to sector dummies in model (4) are not reported. They are available upon request to the author. Note these coefficients do not differ substantially from those reported for model (3).
16. A Wald test of coefficients' equality for sectors K and G_H in model (5) gives a probability of 99.6 %. For sectors F and G_H in model (6), a Wald test gives also a high probability of coefficients' equality, that is 98.6 %. For other sectors, the probability falls dramatically as a quick glance on coefficients reported in table 4 would indicate.

Table 5: Coefficients associated with sector dummies
(sample of net FDI-importing countries)

DumSector	Model (3)	Model (5)	Model (6)
A_Food, beverages and tobacco	16.47 [2.63]**	9.71 [1.61]	1.49 [0.93]
B_Textiles, wearing apparel, leather, footwear	21.15 [3.37]***	15.09 [2.51]**	6.93 [4.25]***
C_Wood and paper products	17.40 [2.77]***	10.76 [1.78]*	2.53 [1.61]
D_Chemicals and chemical products	21.76 [3.39]***	15.09 [2.44]**	6.71 [3.92]***
E_Rubber and plastic products	20.41 [3.23]***	13.76 [2.26]**	5.48 [3.41]***
F_Non-metallic mineral products	23.72 [3.79]***	17.70 [2.96]***	9.55 [6.10]***
G_H_Basic and fabricated metal products	25.47 [4.03]***	17.38 [2.80]***	9.60 [3.35]***
G_Basic metals	27.46 [4.24]***	21.30 [3.44]***	12.92 [7.49]***
H_Fabricated metal products	24.66 [3.95]***	18.64 [3.12]***	10.51 [6.77]***
I_Medical, precision, optical instruments	28.84 [4.54]***	22.09 [3.61]***	13.79 [8.16]***
J_Electric machinery and electronic equipment	23.01 [3.46]***	16.31 [2.55]***	7.73 [3.97]***
K_Non-electrical machinery and equipment	24.05 [3.79]***	17.40 [2.84]***	9.08 [5.53]***
L_Transport equipment	26.81 [3.89]***	19.91 [3.01]***	11.07 [5.14]***
N. observations	**89**	**89**	**89**

Note: t-statistics in brackets; (***), (**) and (*) for significant to respectively 1, 5 and 10 %.

4.3. Robustness tests

This section is devoted to evaluate how our results are robust to (*i*) another time span for measuring volatility, (*ii*) a different measure of volatility for production and (*iii*) the exclusion of Slovakia from the country sample.

4.3.1. A shorter time span for measuring volatility

Our first robustness test considers a shorter time period for computing volatility of production. In particular, we drop the last years of our time span which correspond to the financial crisis and its aftermath. From a statistical viewpoint, the variability of time series has increased substantially with the episode of crisis, due to dramatic falls of production in most sectors. In turn, that may affect our points of estimates. Yet, from an economical viewpoint, the crisis may have altered the degree of international outsourcing (Levasseur, 2010). Thus, estimating models (1)-(6) with a sample excluding the last years can provide interesting insights from both a statistical and economical viewpoints. The "shorter time span" runs from 2000:01 to 2007:12. Results are reported in table 6.

Our main findings are robust to the use of a shorter time span for computing volatility. Namely, 'foreign ownership' is a significant variable in explaining volatility of production. The point of estimates is even slightly higher than with the full time sample (see table 4). Yet,

the 'country size' is hardly a significant variable at reasonable levels, contrasting with the significance of both 'sector dummies' and the 'country dummy' for Slovakia[17].

Table 6: Volatility and foreign ownership
(sample of net FDI-importing countries: **shorter time period for volatility**)

	(1)	(2)	(3)	(4)	(5)	(6)
Foreign ownership	0.132*** [6.01]	0.132*** [5.20]	0.115*** [4.73]	0.103*** [3.86]	0.117*** [4.96]	0.125*** [5.78]
Size	-0.769 [-1.16]	No	-0.987 [-1.63]	-1.170* [-1.87]	-0.537 [-0.88]	No
DumSector	No	No	Yes	Yes	Yes	Yes
DumCountry	No	Yes	No	No	Only for Slovakia: 3.826** [2.56]	Only for Slovakia: 4.207*** [2.95]
DumGroupCEECs	No	No	No	1.068 [1.13]	No	No
Constant	11.49* [1.73]	No	No	No	No	No
R^2 (adjusted)	0.339	0.329	0.507	0.509	0.541	0.543
Observations	89	89	89	89	89	89

Note: t-statistics in brackets; (***), (**) and (*) for significant at respectively 1, 5 and 10 %.

4.3.2. Another measure of volatility for production

Our second robustness test is based on an alternative measure of volatility for production: we compute the standard deviation of production's cycles, with cycles extracted using the Hodrik-Prescott (HP) filter. The use of another measure of volatility is motivated by the absence of consensus on the best way of disentangling cycles from trend. Alongside the growth rate in time series, the HP filter constitutes another very popular method to assess cycles. Results for models (1)-(6) are reported in table 7. The time span is 2000:01-2010:06, such as results are comparable with those reported in table 4.

Our qualitative findings are by no way affected by this alternative measure of volatility. Only the point of estimates for 'foreign volatility' is found substantially lower, due to a scale effect directly related to the measure used.

17. For models (1)-(6) in tables 6 and 7, the coefficients associated to sector dummies in model (4) are not reported. They are available upon request to the author.

Table 7: Volatility and foreign ownership
(sample of net FDI-importing countries: **HP filter for volatility**)

	(1)	(2)	(3)	(4)	(5)	(6)
Foreign ownership	0.064*** [4.97]	0.066*** [4.62]	0.044*** [3.16]	0.032** [2.14]	0.045*** [3.66]	0.051*** [4.47]
Size	-0.527 [-1.34]	No	-0.798** [-2.32]	-0.972*** [-2.78]	-0.381 [-1.19]	No
DumSector	No	No	Yes	Yes	Yes	Yes
DumCountry	No	Yes	No	No	Only for Slovakia: 3.541*** [4.51]	Only for Slovakia 3.812*** [5.06]
DumGroupCEECs	No	No	No	1.019* [1.93]	No	No
Constant	9.39** [2.39]	No	No	No	No	No
R^2 (adjusted)	0.271	0.331	0.496	0.514	0.600	0.598
Observations	89	89	89	89	89	89

Note: t-statistics in brackets; (***), (**) and (*) for significant at respectively 1, 5 and 10 %.

4.3.3. The exclusion of Slovakia from the country sample

Our third robustness test is related to the exclusion of Slovakia from the sample, as the dummy for this country has a notable impact on the significance of 'country size' as well as on the size of coefficient associated to 'foreign ownership'. We consider our two measures of volatility over the full time sample. The results reported in the upper part of table 8 are based on the standard deviation of growth rates while the lower part is for the standard deviation of cycles extracted using the HP filter. The estimates are then directly comparable with, respectively, table 4 and table 7.

The point made clear is that the 'country size' and/or the CEECs' dummy are no longer significant variables when Slovakia is excluded from the country sample. That means that Slovakia was previously weighting for the significance of the 'country size' and/or the CEECs' dummy. Other findings are robust to the exclusion of Slovakia. First, 'foreign ownership' is a very significant variable is explaining volatility of production, with all coefficients estimated at a 1 % confidence level and mainly unchanged. Yet, for each measure of volatility, the point of estimate for 'foreign ownership' is mainly unchanged. Second, the fitting of the model is substantially improved when 'sector dummies' are included, underlining again the necessity to deal with sector specificities. The coefficients of 'sector

dummies' for models (4 bis) based on our two measures of volatility are reported in table 8. Sectors like Medical, precision & optical equipment (I_) and Basic metals (G_) are unambiguously presenting the highest coefficients while Food, beverages & tobacco (A) and Wood & paper products (C_) are presenting the lowest.

Table 8: Volatility and foreign ownership
(sample of net FDI-importing countries: **Slovakia excluded**)

S.d of growth rates	**(1)**	**(2)**	**(3)**	**(4)**	**(4bis)**
Foreign ownership	0.121***	0.116***	0.113***	0.112***	0.122***
	[5.59]	[4.62]	[5.94]	[5.17]	[7.07]
Size	-0.511	No	-0.575	-0.602	No
	[-0.77]		[-1.19]	[-1.13]	
DumSector	No	No	Yes	Yes	Yes
DumCountry	No	Yes	No	No	No
DumGroupCEECs	No	No	No	0.102	No
				[1.12]	
Constant	17.72**	No	No	No	No
	[2.40]				
R^2 (adjusted)	0.314	0.310	0.677	0.672	0.675
Observations	80	80	80	80	80

S.d of cycles with HP filter	**(1)**	**(2)**	**(3)**	**(4)**	**(4bis)**
Foreign ownership	0.059***	0.061***	0.050***	0.050***	0.055***
	[5.74]	[5.10]	[5.22]	[4.54]	[6.25]
Size	-0.158	No	-0.268	-0.280	No
	[-0.50]		[-1.08]	[-1.04]	
DumSector	No	No	Yes	Yes	Yes
DumCountry	No	Yes	No	No	No
DumGroupCEECs	No	No	No	0.048	No
				[0.11]	
Constant	5.85*	No	No	No	No
	[1.84]				
R^2 (adjusted)	0.317	0.308	0.635	0.629	0.634
Observations	80	80	80	80	80

Note: t-statistics in brackets; (***), (**) and (*) for significant at respectively 1, 5 and 10 %.

Table 9: Coefficients associated with sector dummies
(sample of net FDI-importing countries: **Slovakia excluded**)

DumSector	**Model (4 bis)** ***Growth rate***	**Model (4 bis)** ***HP filter***
A_Food, beverages and tobacco	1.72 [1.25]	1.78 [2.55]**
B_Textiles, wearing apparel, leather, footwear	6.69 [5.03]***	4.37 [6.46]***
C_Wood and paper products	2.75 [2.05]**	1.94 [2.84]***
D_Chemicals and chemical products	4.91 [3.31]***	3.63 [4.80]***
E_Rubber and plastic products	5.83 [4.25]***	3.63 [5.20]***
F_Non-metallic mineral products	9.26 [7.25]***	4.84 [7.44]***
G_H_Basic and fabricated metal products	13.34 [4.36]***	6.64 [4.26]***
G_Basic metals	12.58 [8.92]***	7.10 [9.90]***
H_Fabricated metal products	10.24 [8.07]***	5.41 [8.38]***
I_Medical, precision, optical instruments	13.15 [8.89]***	6.59 [8.76]***
J_Electric machinery and electronic equipment	8.37 [5.11]***	5.08 [6.10]***
K_Non-electrical machinery and equipment	8.19 [5.90]***	4.58 [6.49]***
L_Transport equipment	8.65 [4.78]***	5.46 [5.93]***
N. observations	**80**	**80**

Note: t-statistics in brackets; (***), (**) and (*) for significant to respectively 1, 5 and 10 %.

5. Conclusion

In this paper, we have pointed out two important findings. First, we have demonstrated empirically the importance of foreign ownership on volatility at the sector level, thus contributing to the literature on the determinants of volatility. To date, this factor had not been yet investigated for explaining volatility while theory (see the model developed by Bergin et al., 2010) and intuition (see Levasseur, 2010) suggest that adjustment of production by firms under foreign ownership to smooth changes in demand faced multinational firms or parent companies would contribute to import some fluctuations from abroad.

Our finding with respect the higher volatility induced by foreign ownership puts forward one negative side related to FDI – or offshoring – which has not been yet largely documented by contrast to its positive effect on growth and catching up[18]. Put differently, hosting FDI or offshoring activities could be viewed as a trade-off between higher growth but to the cost of higher volatility.

The second finding of the paper is related to the importance of dealing with characteristics specific to sector when assessing the determinants of volatility, as sectors are definitely presenting different degrees of intrinsic volatility at a two-digit level. Consequently, the specialization of the productive structure is by no way neutral: a country specialized in

18. For instance, according to the estimates of Levasseur (2004), a 1 % point increase of FDI inflows in GDP accounted for an increase of 0.42 % point of per capita GDP growth in CEECs and Cohesion countries over 1995-2004. Other studies found a similar positive impact of FDI on growth of hosting economies (see references in Levasseur, 2004).

some particular sectors (in first instance, medical, precision & optical instruments or basic metals and transport equipment) will present *ceteris paribus* a higher volatility than a country specialized in sectors related to primary inputs (food, beverages & tobacco or wood & paper products). We attribute this finding to the fact that the former sectors are presumably more subject to large and frequent (demand and technological) shocks than the latter ones.

Availability, source and treatment of data

Data of foreign activity

Data of activities made by multinational firms on domestic territory are coming from OECD. For almost 12 manufacturing sectors at a two-digit level, data of production (eventually turnover) are available for 14 EU countries: Austria, the Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Portugal, Slovakia, Spain, Sweden and the United Kingdom. In most cases, activity is measured by production except for France, Germany and the United Kingdom for which we used instead turnover. A comparison of figures for countries for which both production and turnover are available shows that such figures are very close. In the case of Austria, data of production or turnover are missing for the sector of "Food, beverage & tobacco" (A_, in table 1, main text) and the one of "Textiles, wearing apparel, leather & footwear" (C_).

Data reported in table 3 (main text) and data used in the econometrical work are expressed as a percentage of total production (or turnover) on the domestic territory. Yet, those data are for 2004 year (with eventually some missing data completed by data for 2005 or 2003 years). We choose the 2004 year, as that corresponds to the middle of our time span which goes from 2000:01 to 2010:06 for sectoral production (see below). Note that, in most countries, the share of foreign activity in a given sector does not change dramatically from one year to another over 2001-2007 (with 2007 the last year of available data).

The choice of EU countries included in our sample has been constrained by the availability of data on foreign production.

Data of production by sector

Data of production by sector are coming from Eurostat (Industry, NACE Rev.2, Production index, Monthly data, 2005 = 100) for almost countries of our sample. Exceptions are Ireland and Slovakia for which data are coming from their respective national statistical offices. Note that for some sectors, data of Ireland and Slovakia cannot be perfectly fitted with those of other EU countries. In particular, data for the sectors of "Basic metals" (G_ in table 1, main text) and "Fabricated metal products" (H_) are compiled in a unique sector entitled "Basic and fabricated metal products" in the case of Ireland and Slovakia. Yet, some data of production by sector are missing for Finland (D_, E_, I_ and J_), Sweden (B_) and Portugal (I_ available only from 2000:01 to 2008:08). Data have been seasonally adjusted using the standard X11 multiplicative method available in Eviews7.

Data on net FDI-importing (or exporting) countries

A net FDI-importing country is defined as a country with a net stock of inward FDI (inward FDI minus outward FDI > 0). Symmetrically, a net FDI-exporting country is a country with a net stock of outward FDI (inward FDI minus outward FDI < 0). For establishing the two groups of countries, we use data of inward and outward FDI stocks provided by UNCTAD. For each country of our sample, data of net stocks (in % of GDP) are reported in table A for 2004 and in average over 2000-2009. Some countries are clearly net importers of FDI (the Czech Republic, Hungary, Ireland, Poland, Portugal and Slovakia) while others are clearly net exporters of FDI (Finland, France, Germany and United Kingdom). Evidence is more mixed for Austria and Italy, and to some extent for Spain and Sweden, where figures are near 0. We have checked robustness of our results to the inclusion or exclusion of Austria, Italy, Sweden and Spain to one or another group: points of estimates are unaltered. Austria and Spain are classified as FDI-importers and Italy and Sweden as FDI-exporters.

Table A: Net stock of inward FDI (in % of GDP)

	2004	Average 2000/2009	Classified as:
AUT_Austria	0.3	1.9	Net FDI-importer
CZ_Czech rep.	48.8	48.1	Net FDI-importer
FI_Finlande	-14.6	-16.2	Net FDI-exporter
FR_France	-13.9	-20.9	Net FDI-exporter
GER_Germany	-15.0	-17.5	Net FDI-exporter
HU_Hungary (HU)	55.4	50.7	Net FDI-importer
IR_Ireland (IR)	54.6	50.8	Net FDI-importer
IT_Italy (IT)	-3.5	-5.6	Net FDI-exporter
PL_Poland (PL)	33.0	28.3	Net FDI-importer
POR_Portugal (POR)	12.9	15.6	Net FDI-importer
SK_Slovakia (SK)	49.8	43.4	Net FDI-importer
SP_Spain (SP)	12.0	6.2	Net FDI-importer
SW_Sweden (SW)	-5.2	-10.3	Net FDI-exporter
UK_United Kingdom (UK)	-24.8	-23.6	Net FDI-exporter

Source: UNCTAD; computations of the author.

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