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International outsourcing over the business cycle: some intuition for Germany, the Czech Republic and Slovakia

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Abstract

In this paper, we assess the extent to which multinational firms – in the first instance, the German ones – may adjust their international outsourcing over the business cycle in the Czech Republic and Slovakia. For that purpose, we have used monthly data of production for the manufacturing sector as a whole and some of its sub-sectors, since 2000 onwards. Our econometrical estimates suggest that there would be an asymmetry in the international outsourcing across the states of the economy, meaning that multinationals firms would be engaged differently in outsourcing activities, depending on whether bad or good economic times occur. Yet, such an asymmetry is found increasing over the time for German and French multinationals operating in the transport equipment sector of Slovakia. Another conclusion is that international outsourcing made by multinational firms in Slovakia may account for a portion of its large business cycles volatility.

Keywords: International outsourcing, foreign direct investment, business cycles, Central and Eastern European countries, European integration

JEL codes: F21, F23, F4, L60.

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1. Introduction

The countries of the European Union (EU) have been unevenly affected by the economic crisis which began in September 2008 with the bankrupt of Lehman Brothers. Some EU countries have shown a sharp and persistent decline in their economic activities while others have recorded more moderate falls with a quite fast recovery. Numerous and intricate factors may help to explain this differentiated impact of the actual economic crisis on the EU countries. To quote some: differences in fiscal policy across countries, differences in their monetary policy including the exchange one as some EU countries have not adopted the euro yet, differences in their wage developments, shifts in relative demand (*e.g.* consumption *versus* intermediate goods) and, related to the latter point, the specialisation *versus* diversification of productive structures. Yet, multinational firms may have adjusted their international outsourcing in a context of very bad – and uncertain – economic times.

The way multinational firms may adjust their international outsourcing in a context of (very) bad economic times is not clear-cut, though. On the one hand, multinational firms emanating from high-wage countries may have an incentive to further produce abroad to save even more on labour costs and shut down home plants. That induces then a higher level of international outsourcing which further exacerbates the loss of home production. On the other hand, multinational firms may reduce production abroad as a result of cuts in trade credit, fears of boycott on their products or of other negative home feedbacks. That induces a lower level of international outsourcing which mitigates the loss of home production[1]. All in all, whether the actual crisis has resulted in changes in the level of outsourcing is an empirical

[1] Fears of boycott and/or political pressures may be particularly acute in a context of very bad economic times as demonstrated in January 2010 when Renault – a French car brand – wanted to produce its new car model in Turkey rather than in France. Nicolas Sarkozy, the French president, was very angry about this project, as car producers were at that time indirectly government-subsidized *via* the system of "prime à la casse" aiming at supporting the purchase of cars by French households. Finally, due to media and political pressures, Renault had to renounce its project of higher outsourcing in Turkey.

matter on which we have no evidence due to the lack of data on the activities of multinational firms abroad and domestically. Moreover, as far as adjustment over the cycle is concerned, such data would have to be available at a high frequency, let us say on a monthly or quarterly basis, to be relevant[2]. To our knowledge, only the study of Bergin et al.(2009) deals with the issue of volatility in economic activity due to international outsourcing. Using monthly data of maquiladoras plants (*i.e.* assembly plants of American multinationals in Mexico), they find that the United States would export to Mexico a portion of its employment fluctuations over the business cycle, as "in all outsourcing industries, the volatility of economic activity in Mexico is significantly higher than in the US" (Bergin et al., 2009, p.1664).

The goal of this paper is to provide some intuition on the adjustment in the level of international outsourcing to cyclical developments, with a particular focus on the actual crisis. As data on the activities of multinational firms are lacking, we use instead data of manufacturing production which are readily available and that, for Germany, the Czech Republic and Slovakia. The three countries under scrutiny have large and long lasting economic relationships, with Germany acting as a major foreign investor in the Czech and Slovak manufacturing sectors for a decade and half. Yet, German firms have developed important trade links with Czech and Slovak firms, importing some inputs from them rather than outsourcing domestically. These three countries are then natural candidates to investigate the issue of international outsourcing, in particular the way German multinational firms may adjust differently their international outsourcing to good and bad times.

The remaining of the paper is as follows. First, we present some basic data related to the manufacturing sector in the three countries. What are the key sectors in each country in terms of value added (VA)? How important is the foreign ownership in manufacturing sectors for the Czech Republic and Slovakia? How synchronized are the manufacturing productions of

[2] See Feenstra et al.(2010) for a state of available data to study international trade and investment. In the case of multinational firms, confidentiality in data may be a huge problem and anonymity turns to be a lure when the sector in which they operate is heavily concentrated.

the three countries, especially since the onset of the financial crisis? Second, we report the results of some regressions aiming at evaluating if the manufacturing production of Slovakia (respectively, of the Czech Republic) responds asymmetrically to good and bad economic times in Germany. Finally, the paper presents some concluding remarks.

2. Data on the manufacturing sector in the Czech Republic, Slovakia and Germany

2.1. Some structural data

In the three countries under scrutiny, as long as we are concerned with the NACE industry classification at the two-digit level, four sectors account for the bulk of manufacturing activity, namely (*i*) transport equipment, (*ii*) machinery & equipment, (*iii*) metal products, and (*iv*) chemical & plastics products (table 1). In terms of VA, the four afore-mentioned sectors represent together 65 % of the manufacturing sector in Slovakia, 68 % in the Czech Republic and up to 78 % in Germany. A similar picture would be drawn from employment data while those of trade would show that they constitute a large share of trade flows, in particular between the three countries (Gay, 2009).

The manufacturing sector is largely under foreign control in Slovakia and the Czech Republic (table 1). Notably, in transport equipment, some 90 % of the Czech and Slovak VA are realized by multinational firms. Figures are even higher for the sub-sector of motor vehicles and (semi-)trailers, for which 93-94 % of VA is under foreign ownership in the Czech Republic and Slovakia. Chemicals (in the Czech Republic), electrical & optical equipment (in Slovakia), and basic metals (in the two countries) are also predominantly foreign-owned sectors, with at least 70 % of the VA realized by multinational firms.

Table 1: Basic data on manufacturing

In 2007	Share of sectors in manufacturing VA			Share of VA made by multinational firms	
	Czech republic	Slovakia	Germany	Czech republic	Slovakia*
MANUFACTURING	100%	100%	100%	59%	69%
Food products, beverages and tobacco	9%	9%	7%	52%	46%
Textiles, textile products, leather and footwear	3%	5%	2%	52%	..
Wood and products of wood and cork	4%	5%	1%	52%	39%
Pulp, paper, paper products, printing and publishing	5%	6%	6%	30%	48%
Chemical, rubber, plastics and fuel products (4)	12%	12%	15%	68%	82%
Coke, refined petroleum products and nuclear fuel	0%	3%	1%	..	..
Chemicals and chemical products	5%	4%	10%	76%	54%
Rubber and plastics products	7%	4%	4%	61%	73%
Other non-metallic mineral products	7%	6%	3%	72%	65%
Basic metals and fabricated metal products (2)	17%	24%	14%	50%	74%
Basic metals	6%	11%	5%	74%	87%
Fabricated metal products, except machinery and equipment	11%	13%	9%	35%	36%
Machinery and equipment (1)	23%	19%	31%	51%	66%
Other Machinery and equipment	11%	7%	16%	43%	54%
Electrical and optical equipment	12%	12%	15%	57%	70%
Transport equipment (3)	15%	11%	17%	89%	91%
Motor vehicles, trailers and semi-trailers	14%	11%	15%	93%	94%
Other transport equipment	2%	1%	2%	56%	4%
Manufacturing n.e.c. and recycling	4%	3%	3%	35%	49%
Aggregate of sectors (1),(2),(3)	56%	53%	62%	77%	75%
Aggregate of sectors (1),(2),(3), (4)	68%	65%	78%	78%	76%
Mémorandum: Share of manufacturing in total VA of the country	27%	24%	24%		

*Some data are for 2006.
Source: OECD.

Germany is a major foreign direct investor in the Czech Republic and Slovakia, accounting for around 30 % of primary and secondary foreign direct investment (FDI) in the two countries[3]. The German manufacturing FDI are heavily sector-concentrated: as for 2008, 76.5 % are realized in the sole sector of motor vehicles and (semi-)trailers in Slovakia (table 2). The corresponding figure is somewhat lower in the Czech Republic (57 %) where the sector of electrical machinery and apparatus also accounts for 13.2 % of German manufacturing FDI.

Table 2: FDI of Germany in Slovakia and the Czech republic (by economic activity, 2008)*

	Slovakia	Czech republic
Manufacturing, All	100.0%	100.0%
Of which : Chemicals and chemical products	3.9%	3.0%
Machinery and equipment	3.7%	3.9%
Electrical machinery and apparatus	2.7%	13.2%
Motor vehicles, trailers, and semi-trailers	76.5%	57.0%

* In % of German manufacturing FDI position in the hosting country. FDI include primary and secondary FDI.
Source: Deutsche Bundesbank.

Strong relationships between Germany and the countries of the former "Czechoslovakia" are explained by geography as well as proximity in their productive structures. In particular, the industry of metals and all related activities – from machinery to transport equipment – have played an important role in linking the economies of Germany, the Czech Republic and Slovakia. Those links have been created and developed through either FDI or trade, or both[4].

[3] Due to a tax-friendly system, a lot of multinationals are located in the Netherlands through holdings companies. Consequently, the weight of the Netherlands in FDI position is oversized as soon as only primary FDI are concerned. Here, we use data of FDI position provided by the Deutsche Bundesbank which present the advantage of coping with primary as well as secondary FDI, then offering a better picture of the "true" nationality of investors. See Deutsche Bundesbank (2006) for a general overview of German foreign direct investment. Austria and France are known as being (after Germany) the two other major investors in Slovakia and the Czech Republic. The lack of data covering both primary and secondary FDI does not allow an exact ranking of France and Austria in terms of foreign ownership in the Czech Republic and Slovakia, though.

[4] See Fidrmuc and Horvath (1999) for a comparison of industrial structures in the two entities of Czechoslovakia in 1993. See Gay (2009) for a presentation of their trade structures with Germany in 2008.

2.2. Some data on multinationals operating in the Czech Republic and Slovakia

The sector of transport equipment deserves a special attention, as accounting for huge German investments in the Czech Republic and Slovakia. Yet, the presence of German manufacturers in both assembly and auto-parts has attracted other foreign manufacturers while also allowing the flourishing of local producers which supply simple or more complex components to multinationals[5]. All in all, once indirect employment is included, the sector of transport equipment is accounting for around 40 % of the manufacturing workforce in the two countries (8 % when only direct employment is concerned)[6].

With regard to the Czech Republic, three auto-makers are currently operating in the country (table 3): Volskwagen (a German multinational producing almost exclusively the Skoda brand), Toyota-PSA (a Japanese-French joint venture producing for 70 % of French brands and 30 % of the Japanese brand) and Hyundai-Kia (a South Korean multinational). The presence of Volskwagen in the Czech Republic is the longest, as far back as 1991 when the German multinational formed a joint venture with the manufacturer Skoda. So far, Volskwagen remains an important auto-maker in the Czech Republic, with a share of around 60 % in the total production over 2007-2009 (table 3). Compared to Volskwagen, the presence of Toyota-PSA is more recent: the Japanese-French joint venture began really to produce on a large scale in 2006, accounting currently for around 1/3 of the cars production. Finally, Hyundai-Kia is a newcomer in the Czech automobile sector, starting production in November 2008 in the worst economic times. Consequently, the South Korean multinational still accounts for a small share in the cars production of the Czech Republic. The huge amount of investment made by Hyundai-Kia indicates however that the Czech Republic may become

[5]See Pavlínek and Janák (2007) for an interesting analysis of the supplier network of Skoda in the Czech Republic, according to a tiered structure. More generally, the reader interested in the operations of German multinationals in Central and Eastern Europe will refer to Marin (2004) or Temouri and Driffield (2009). No competing study on the operations of French multinationals can be found. For a deep analysis of Austrian FDI by main countries and industries, see Hunya (2008).

[6] A lot of data on the sector of transport equipment can be found on the websites of agencies promoting investment in the Czech republic (www.afi.cz) and Slovakia (www.sario.sk) as well as on the website of the European Automobile Manufacturers' Association (www.acea.be).

an important site of production for the South Korean multinational in the near future. Note that the three auto-makers are exporting almost all of their production (table 3), meaning that the Czech Republic is used as a platform production to export mainly towards the European markets.

Turning to Slovakia, the presence of foreign auto-makers in the country goes back in the early 1990s, with the arrival of Volskwagen to produce its own brands. The presence of PSA Peugeot Citroën and that of Kia Motors Corporation is much more recent, as both started production in 2006. Currently, Volskwagen still remains an important auto-maker in Slovakia with a share in the total production of 33 % over 2007-2009 (table 4). However, PSA Peugeot Citroën and Kia Motors Corporation have gained substantial shares in few years of operations, accounting respectively for 36 % and 31 % of the cars production over 2007-2009. Yet, PSA Peugeot Citroën could produce 450 000 cars a year once reaching the full capacity of its plant while another 300 000 finished cars could leave the plant of Kia Motors annually. Such developments would place (a) PSA Peugeot Citroën as a predominant auto-maker in Slovakia and (b) Slovakia as the first platform of production in Central Europe, coming ahead of the Czech Republic and Poland. Indeed, near 100 % of the cars produced by the three multinationals operating in Slovakia are exported.

Featuring most significant foreign investors in other sectors of the Czech Republic and Slovakia is not a straightforward task, due to the complexity of links in equity ownership, combined with numerous small and medium size enterprises. Among those easily identifiable, Siemens (a German multinational specialized in electrical and electronic products) has to be mentioned, as accounting for a workforce of respectively 10,700 and 3,700 people in the Czech Republic and Slovakia. US Steel has been a major American investor in the metal industry of Slovakia since 2000. With 13,000 employees (including the subsidiary companies), it is the most important private employer in the country and it had invested 700

million dollars over a ten-year period. In both the Czech Republic and Slovakia, Panasonic and Sony (two Japanese multinationals) as well as Samsung (a South Korean multinational) are present in the sector of electronics. Despite these predominant investors in those sectors, Germany remains the largest provider of foreign capital: some 3,500 German companies are currently active in the Czech Republic while 35 % of larger investments in Slovakia were coming from Germany over the 2002-2007 period. That suggests close economic links between Germany, the Czech Republic and Slovakia.

Table 3: Auto-makers in the Czech republic

	Amount of investment (million EUR)	Nationality of foreign investor
Toyota-PSA (TPCA)	over 650	Japan/France
Hyundai-Kia	990	South Korea
Volskwagen (Skoda)	over 500	Germany

	Production of cars (average 2007-2009)*	Share in total production (in %)	Share of exports in production (2008)**
Toyota-PSA (TPCA)	321,752	34%	99.2%
Hyundai-Kia	43,350	5%	98.3%
Volskwagen (Skoda)	585,126	62%	93.2%
Total	950,228	100%	95.2%

Source: www.acea.be; www.state.gov; Ernst & Young (2009).
*Hyundai-Kia started production in the Czech republic in November 2008. Its cars production for 2009 was 118,000 units.
**2009 pour Hyundai-Kia.

Table 4: Auto-makers in Slovakia

	Amount of investment (millions EUR)	Nationality of foreign investor
PSA Peugeot Citroën	1089	France
Kia Motors Corporation	1250	South Korea
Volskwagen	over 1300	Germany

	Production of cars (average 2007-2009)	Share in total production (in %)	Share of exports in production (2008)
PSA Peugeot Citroën	190,000	36%	99.7%
Kia Motors Corporation	165,333	31%	97.9%
Volskwagen	177,957	33%	100.0%
Total	533,291	100%	99.2%

Source: www.sario.sk

2.3. Data on business cycles

The business cycles of the three countries under scrutiny are found in the empirical literature quite correlated or, to put it differently, synchronized[7]. When measured by the growth rates of production since 2000 onwards, the business cycles of the Czech Republic and Germany have coefficients of correlation in the range of 0.30-0.95, depending on the sectors and/or time periods (table 5)[8]. The corresponding figures for Slovakia and Germany are somewhat lower, in the range of 0.20-0.85, meaning than the Slovak and German business cycles are a little less synchronized than the Czech and German ones.

Importantly, the volatility of time series (measured by the standard deviation of growth rates) is found higher in Slovakia than in the Czech Republic or Germany (Table 5). This stands out particularly for the sector of transport equipment, as illustrated by Graph 1. For that sector, the standard deviation of the Slovak production is more than two times higher than the Czech or German ones. Moreover, following the beginning of the global crisis – we set it in September 2008 with the bankrupt of Lehman Brothers –, the fall of production in transport equipment was both larger and more abrupt in Slovakia than in Germany and the Czech Republic. Yet, in the transport equipment, while the recovery was to some extent delayed in Slovakia, the actual rebound in the production is larger in Slovakia than in the Czech Republic or Germany[9]. The sector of other machinery and equipment also tends to present higher volatility in Slovakia than in the Czech Republic or Germany (Table 5). Moreover, after the turmoil of the financial crisis, the recovery was by far stronger in Slovakia than in its two counterparts. Consequently, while Slovakia resumed with its pre-crisis level of production in the first quarter of 2010, productions in Germany and the Czech Republic were still 25 % below at that time.

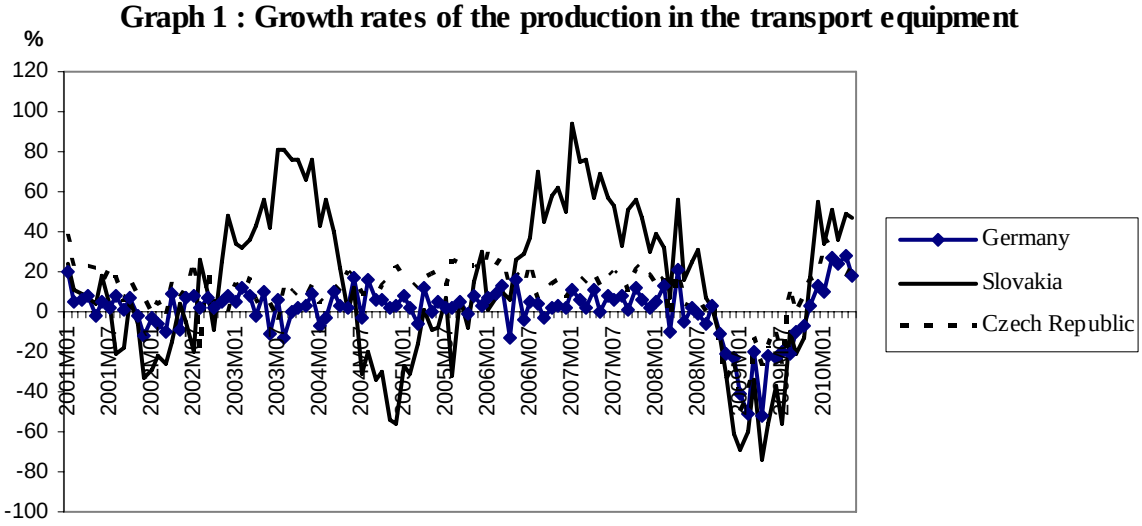
[7] See Levasseur (2008a) for references and evidence on the business cycle synchronization between countries of Eastern and Western Europe.
[8] See section 3.2. for a description and the source of data we use.
[9] Adding France in the picture would place this country with Germany and the Czech Republic, not with Slovakia.

Table 5: Correlations and (relative) standard deviations of growth rates*

	Germany	Czech republic	Slovakia
Manufacturing production			
Correlation full sample	1.00	0.87	0.75
Correlation 2005:01-2010:05	1.00	0.94	0.85
Standard deviation full sample	0.09	0.10	0.14
Standard deviation 2005:01-2010:05	0.11	0.12	0.17
Ratio of standard deviation full sample	1.00	1.14	1.56
Ratio of standard deviation 2005:01-2010:05	1.00	1.08	1.52
Of which:			
Transport Equipment			
Correlation full sample	1.00	0.77	0.54
Correlation 2005:01-2010:05	1.00	0.85	0.73
Standard deviation full sample	0.13	0.15	0.38
Standard deviation 2005:01-2010:05	0.16	0.18	0.40
Ratio of standard deviation full sample	1.00	1.15	2.98
Ratio of standard deviation 2005:01-2010:05	1.00	1.12	2.54
Electrical and Optical Equipment			
Correlation full sample	1.00	0.30	0.20
Correlation 2005:01-2010:05	1.00	0.84	0.41
Standard deviation full sample	0.14	0.20	0.25
Standard deviation 2005:01-2010:05	0.16	0.17	0.26
Ratio of standard deviation full sample	1.00	1.42	1.74
Ratio of standard deviation 2005:01-2010:05	1.00	1.05	1.60
Other Machinery and Equipment			
Correlation full sample	1.00	0.88	0.44
Correlation 2005:01-2010:05	1.00	0.93	0.56
Standard deviation full sample	0.13	0.17	0.26
Standard deviation 2005:01-2010:05	0.16	0.20	0.28
Ratio of standard deviation full sample	1.00	1.34	2.05
Ratio of standard deviation 2005:01-2010:05	1.00	1.25	1.78
Basic metals and fabricated metal products			
Correlation full sample	1.00	0.90	0.64
Correlation 2005:01-2010:05	1.00	0.95	0.83
Standard deviation full sample	0.12	0.14	0.19
Standard deviation 2005:01-2010:05	0.15	0.17	0.19
Ratio of standard deviation full sample	1.00	1.19	1.59
Ratio of standard deviation 2005:01-2010:05	1.00	1.14	1.26

* Correlations and relative standard deviations are with respect Germany.
Growth rates are computed as the twelfth-difference of monthly data taken in log form.
The full sample corresponds to the 2001:01-2010:05 period.

Graph 1 : Growth rates of the production in the transport equipment



All in all, the previous findings suggest that multinational firms operating in some sectors of Slovakia may adjust very fast and very strongly their level of international outsourcing, thus amplifying the economic fluctuations of the country. Yet, the adjustment in international outsourcing may be asymmetric across the states of the economy (good *versus* bad times), as illustrated by the recent crisis. The next section presents a simple econometrical framework aiming at evaluating asymmetry in the level of international outsourcing across the states of the economy. This econometrical model is estimated to assess the extent to which multinational firms – in the first instance, the German ones – are adjusting their international outsourcing in the Czech Republic and Slovakia, depending on whether good or bad economic times occur.

3. The econometrical framework

3.1. The model to be estimated

Econometrically speaking, the model we estimate is as follows:

$$\Delta IP_{ij,t} = \alpha \Delta IP_{ij,t-1} + \beta^{POS} \Delta IP_{iGER,t\_Pos} + \beta^{NEG} \Delta IP_{iGER,t\_Neg} + \varepsilon_{ij,t} \qquad (1)$$

where $\Delta IP_{ij,t}$ denotes the growth rate of the production in manufacturing sector *i* of country *j* at time *t*. Country *j* is either the Czech republic or Slovakia in our case.

$\Delta IP_{iGER,t\_Pos}$ (respectively $\Delta IP_{iGER,t\_Neg}$) is the growth rate of the production in manufacturing sector *i* of Germany at time *t* when positive (resp. when negative).

β^{POS} and β^{NEG} are coefficients to be estimated and associated respectively to the positive and negative growth rate of production in sector *i* in Germany.

α is a coefficient to be estimated, aiming at capturing for inertia in production in sector *i* of country *j*.

$\varepsilon_{ij,t}$ is a white noise.

We justify our econometrical specification in the following manner: during good economic times (proxied here by $\Delta IP_{iGER,t\_Pos}$), German multinational firms facing to a larger demand for their goods would produce more both domestically and abroad, meaning econometrically that $\beta^{POS} > 0$ is expected. From a theoretical viewpoint, we can even expect $\beta^{POS} > 1$, as German firms may have an incentive to take advantage of good times to implement even more international outsourcing. Anyway, in good times (and even more in the very good ones), full production capacities may be reached in Germany such as any additional demand could be only satisfied by more production abroad. To sum up, a one percent production growth in sector *i* in Germany may induce more than a one percent of production growth in sector *i* in country *j*[10].

During bad economic times (proxied here by $\Delta IP_{iGER,t\_Neg}$), the coefficient β^{NEG} may be either negative or positive. If the estimate of β^{NEG} is found negative ($\beta^{NEG} < 0$), that would

[10] Another mechanism for $\beta^{POS} > 1$ is related to the differences in the labour-market institutions across countries. If hiring (and firing) workers is easier in the host country than at home, that may induce a larger response of production in the former than in the latter. The empirical evidence on the link between job market regulations and volatility of employment is not clear-cut, though. See Bergin et al.(2009), Botero et al. (2004), Cuñat and Melitz (2006) on that point.

suggest a higher level of international outsourcing by German multinationals in bad economic times, as a decrease of production in sector *i* in Germany would result in an increase (not a decrease) of production in sector *i* in country *j*. Yet, if the estimate of β^{NEG} is found positive ($\beta^{NEG}>0$), that does not mean that German firms do not engage in adjustment of their level of international outsourcing. Two cases have to be distinguished. First, if $0 < \beta^{NEG} < 1$, that means that a one percent of production decrease in sector *i* in Germany will induce a less than one percent decrease in sector *i* in country *j*. In that first case, bad economic times are also resulting in more international outsourcing by German multinationals, albeit to a lesser extent than if β^{NEG} would be negative. By contrast, in the second case where $\beta^{NEG}>1$, bad economic times are resulting in less international outsourcing by German multinationals, as a one percent of production decrease in sector *i* in Germany will induce a more than one percent decrease in sector *i* in country *j*. In that second case, by reallocating production domestically, German multinationals exacerbates further the fall in activity in country *j* while smoothing the German one. Table 6 presents a synthesis of the expected signs and their interpretation with respect to adjustments in the level of international outsourcing.

Table 6 : Theoretical signs and their interpretation

	Good economic times	Bad economic times
$\beta^{POS} > 0$	+	No
$\beta^{POS} > 1$	++	No
$\beta^{NEG} < 0$	No	++
$0 < \beta^{NEG} < 1$	No	+
$\beta^{NEG} > 1$	No	–
"+" means "more international outsourcing by multinational firms" or "more production abroad" "–" means "less international outsourcing by multinational firms" or "less production abroad" "no" means "no theoretical relevance"		

Concretely, the asymmetries in the international outsourcing are estimated by interacting the growth rate of production in manufacturing sector *i* of Germany with appropriate

dummies: 1 when the growth rate is positive and 0 otherwise, to proxy "good times"; 1 when the growth rate is negative and 0 otherwise, to proxy "bad times". The growth rate of production in the manufacturing sector *i* of Germany is thus splitting into two time series which enter in equation (1) under notations $\Delta IP_{iGER,t\_Pos}$ and $\Delta IP_{iGER,t\_Neg}$. This way of estimating asymmetry by interacting a variable with dummies has been largely used in the case of the exchange rate pass-through, according to whether it appreciates or depreciates[11].

Note that some robustness tests are based on the use of French, South Korean or EU-15 growth rates instead of the German ones. The same method to compute "interacting terms" is then applied to the time series.

3.2. Data and empirical results

Equation (1) is estimated using monthly data from 2000:01 to 2010:05 provided by Eurostat for the Czech Republic and Germany and, by the national statistical office for Slovakia[12]. We consider the manufacturing sector as a whole, and some of its sectors depending on the data availability. In particular, for Slovakia, the industry classification is not fully in line with the standard NACE classification, forcing us to restrict our empirical work. Thus, among the four largest sectors of the economy we have reported in table 1, we have not been able to match the data of Slovakia with those of Germany and the Czech Republic for chemicals and related products. Finally, the sectors we consider for our econometrical work are those reported in tables 5 and 7, namely (*i*) transport equipment, (*ii*) basic metals and fabricated metal products with machinery & equipment split into two sub-sectors, (*iii*) electrical and optical equipment and (*iv*) other machinery and equipment.

[11] See Levasseur (2008b) for instance.
[12] Data used for the robustness tests are provided by Eurostat for France and the EU-15 and, by the national statistical office for the South Korea.

All the series are seasonally adjusted. Growth rates are computed as the twelfth-difference of the log form. When necessary, the serial correlation in the residuals of equation (1) has been corrected with an AR process of appropriate order. In general, the appropriate order is 12 which is consistent with monthly data.

Note that a preliminary analysis of cross-correlograms indicates that no lag constitutes the best way for specifying international relationship of production between the Czech Republic and Germany (and, Slovakia and Germany). Moreover, while some Granger causality tests show that causality may run from the Czech Republic (or from Slovakia) to Germany at some lags, most of them indicate that indeed causality runs from Germany to the Czech Republic (or to Slovakia), thus substantiating the idea that Germany would lead their business cycles.

Equation (1) has been estimated over the full period as well as over shorter time samples. In particular, recursive regressions were running to assess stability in the estimated coefficients and to detect turning points in the asymmetry of international outsourcing. In table 7, we have reported the results of our estimates for the full period (*i.e.* 2000:01-2010:5)[13]. Note that when the full time sample is considered, German data are presenting some 63-71 % of positive growth rates (or, correspondingly, 29-37 % of negative growth rates), depending on the sector under study[14].

Based on our various econometrical experiments, the following findings have to be pointed out.

First at all, our estimates suggest there is an asymmetry in the international outsourcing across the states of the economy. In all specifications, β^{POS} is found significantly different from β^{NEG}, with both coefficients always positive and $\beta^{POS} > \beta^{NEG}$ whatever the country (*i.e.*

[13] For saving space, we do not report results of the recursive analysis which are available upon request to the author.

[14] In a purpose of comparison, estimates have been also realized without distinguishing good from bad economic times in Germany. In that case, the production of sector *i* in the Czech Republic (or Slovakia) have been simply regressed on the one of Germany, with AR terms when necessary. As evident when comparing table 7 (in the main text) and table A (in the appendix), distinguishing good from bad economic times in Germany provides additional information while generating in general a better global fitting of the model.

Slovakia or the Czech Republic) and the time period. Put differently, in both Slovakia and the Czech Republic, good German economic times would induce a higher increase in the manufacturing production than bad economic times would decrease it[15].

Second, the whole manufacturing sector of the Czech Republic appears more sensitive to bad and good economic times in Germany, as the estimates of both β^{POS} and β^{NEG} are found higher for the Czech Republic than for Slovakia. Thus, when the manufacturing production improves by 1 % point in Germany, the one of the Czech Republic increases by 0.92 % point (against 0.86 % point in Slovakia). Conversely, when the manufacturing production deteriorates by 1 % point in Germany, the one of the Czech Republic decreases by 0.67 % point (against 0.62 % point in Slovakia). As a result of this highest sensitivity to cyclical developments in Germany, the Czech manufacturing sector as a whole is more correlated with the German one than the Slovak one with the German one (see table 3).

Third, estimates with less aggregated data over the recent period show that some sectors of Slovakia are however presenting a higher sensitivity than the Czech ones to German cyclical developments, namely the sector of transport equipment and the one of other machinery & equipment. In particular, from 2005 onwards, dropping months progressively – as in a recursive analysis – shows that β^{POS} tends to become significantly higher than 1 for the sector of transport equipment in Slovakia, but not in the Czech Republic. Yet, restricting the time sample since 2008 onwards shows that estimates of β^{NEG} also turns to be higher than 1 for the sector of transport equipment in Slovakia. For instance, based on a model estimated over 2008:02 to 2010:05, a 1 % point increase of transport equipment production in Germany induces a 1.69 % point increase in Slovakia while a 1 % point decrease of transport equipment production in Germany induces a 1.12 % point decrease in Slovakia (table 8). It thus becomes

[15] To some extent, this finding may rely on the catching up process of Slovakia and the Czech Republic towards richer countries (*e.g.* Germany) rather than on a pure phenomenon of international outsourcing. Our econometrical methodology does not allow distinguishing between the two (and probably complementary) explanations, though.

clear that such an adjustment in the level of international outsourcing over the business cycles further exacerbated the fluctuations in Slovakia, with a large boom in the transport equipment production in the pre-crisis period followed by a sharp decline in the aftermath of the financial crisis. Note that, in Slovakia, the French multinational may have adjusted more strongly than the German one, as a similar exercise realized with data of French transport equipment production gives higher estimates for both β^{POS} and β^{NEG} (respectively, 1.86 % point and 1.18 % point) over 2008:02 to 2010:05[16]. Interestingly, the estimates of β are no longer above 1 when the data of the South Korean transport equipment are used instead. In that case, whatever the time span, the estimates of β^{POS} and β^{NEG} are small and/or hardly significant, suggesting that Kia motors Corporation is not interested in the fluctuations of demand in its own country but rather in those on the European market – its main export market from Slovakia – when it has to decide on how many cars to produce in Slovakia. Finally, the results obtained with data of transport equipment for the whole EU-15 – which is probably a good indicator of demand faced by multinationals hosted in Slovakia – indicates how dramatic the effect of the last downturn in the automobile sector was for the economy of Slovakia: for a 1 % point decrease of production in the EU-15, the production has decreased by more than 2 % point in Slovakia. By contrast, no similar estimate is found for the Czech Republic. In fact, the country was immune from a fall of production for purposes of adjustment in international outsourcing by Volskwagen, as Skoda has no in-house competitor in producing its cars. Consequently, as the Skoda cars can only be produced in the Czech Republic, their volume of production are only responding to the state of demand for the Skoda cars[17].

[16] It should be noted that the differences in the points of estimates have to be considered with due caution as our methodology does not enable us to discriminate *accurately* among the foreign investors. For instance, when using the data of French transport equipment, we are capturing the business cycles of both PSA Citroën and Renault, the other important French cars producer. Even if their cycles are not diametrically opposed, that introduces a bias in the estimates. For the German data, the same difficulty arises with Volskwagen and, say, Opel.

[17] The author thanks an anonymous referee for making clear this point.

Table 7: Estimates over 2001:01-2010:05

	Czech republic	Slovakia
Manufacturing production		
α	0.33 ***	0.47 ***
β^{POS}	0.92 ***	0.86 ***
β^{NEG}	0.67 ***	0.62 ***
Adjusted R^2	0.85	0.83
Of which:		
Transport Equipment		
α	0.58 ***	0.84 ***
β^{POS}	0.86 ***	0.85 ***
β^{NEG}	0.37 ***	0.37 **
Adjusted R^2	0.59	0.83
Electrical and Optical Equipment		
α	0.44 ***	0.88 ***
β^{POS}	0.77 ***	0.40 ***
β^{NEG}	0.49 **	0.05
Adjusted R^2	0.79	0.61
Other Machinery and Equipment		
α	0.46 ***	0.36 ***
β^{POS}	1.06 ***	1.06 ***
β^{NEG}	0.62 ***	0.49 *
Adjusted R^2	0.87	0.36
Basic metals and fabricated metal products		
α	0.41 ***	0.76 ***
β^{POS}	0.76 ***	0.41 ***
β^{NEG}	0.71 ***	0.24 *
Adjusted R^2	0.89	0.73

(***),(**), (*) means that coefficients are significant at respectively 1%, 2% and 5%.
For saving space, coefficients associated to AR processes are not reported. They are available upon request to the author.

Table 8: Estimates over 2008:02-2010:05 for the sector of transport equipment in Slovakia

	Germany	France	South Korea	EU-15
α	0.30 ***	0.38 ***	0.84 ***	0.22
β^{POS}	1.69 ***	1.86 ***	0.31	1.21 ***
β^{NEG}	1.12 ***	1.18 ***	0.44 ***	2.29 ***
Adjusted R^2	0.87	0.86	0.87	0.80

(***),(**), (*) means that coefficients are significant at respectively 1%, 2% and 5%.
For saving space, coefficients associated to AR processes are not reported. They are available upon request to the author.

Finally, a recursive analysis shows that the sector of other machinery & equipment in Slovakia also presents some evidence of growing β^{POS} over the time. By contrast, the estimate of β^{NEG} is roughly unchanged when the time sample is restricted to the recent period. That suggests that over the recent period, multinational firms operating in Slovakia may have been engaged increasingly in international outsourcing during good economic times (not during the bad times). However, this conclusion has to be taken with due caution as "only" half of the production of other machinery & equipment is under foreign control in Slovakia (table 1). Put differently, producers under domestic control in Slovakia may still account for that finding rather than multinational firms adjusting their international outsourcing during good economic times. By contrast, our conclusion with respect to the sector of transport equipment in Slovakia is by far less controversial, as most of its production is under foreign control.

3.3. Further robustness tests

This section is devoted to further robustness tests using the growth rates of the EU-15. It should be stressed that albeit indicators of good and bad times for the EU-15 are computed in a similar way as for Germany, their timing does not necessarily overlap those of Germany. Yet, a similar remark holds for the number of good *versus* bad times and their amplitude. Thus, over the full sample, we found a slightly higher number of negative growth rates for the EU-15 than for Germany and that, for the manufacturing production as a whole and each sector under scrutiny. Moreover, the negative interacting terms of the EU-15 and Germany are presenting a coefficient of correlation in the range of 0.22-0.93, depending on the sector (table 9). For the positive interacting terms, the corresponding range for correlations is 0.32-0.69. That clearly means that good and bad economic times in Germany are no longer coincidental

with those of the EU-15, as long as sector data (yet, at a high frequency) are used. This point stands out particularly for the sector of transport equipment, the one of basic metals and fabricated metal products as well as for the one of other machinery and equipment: these sectors are all presenting the lowest correlations of interacting terms between the EU-15 and Germany. By contrast, the manufacturing sector as a whole is presenting the highest correlations. With these preliminary remarks in mind, the results of our robustness tests (reported in table 10 for the full sample period) will be better understood.

The following findings have to be underlined.

First, as far as the manufacturing sector as a whole is concerned, the growth rates of the Czech Republic and Slovakia are more sensitive to EU-15 developments than to the German ones in good economic times. The difference of responsiveness is particularly pronounced for Slovakia where a 1 % point increase in the EU-15 induces a 1.26 % point increase in its manufacturing production (against "only" 0.86 % for a 1 % point increase in Germany). By contrast, in bad economic times, the manufacturing production of the Czech Republic and Slovakia are more sensitive to German developments than to the EU-15 ones. For a 1 % point decrease in the EU-15, the respective declines in the Czech Republic and Slovakia are "only" 0.44 % and 0.30 % point. These are lower estimates than when we assume a 1 % point decrease in Germany (0.67 % and 0.62 % point respectively). Yet, note that the global fitting of the model is better when good and bad economic times are extracted from developments in Germany rather than in the EU-15. In particular, the adjusted R^2 are higher in table 7 than in table 10.

Second, the previous finding does not apply when less aggregated data are considered. For all sectors under scrutiny, the Czech Republic and Slovakia are much more sensitive to bad times occurring in the EU-15 than in Germany. Notably, five estimates of β^{NEG} (out of eight) are found higher than 1. That may suggest that, faced to a deteriorated economic situation in

Europe, some multinationals are adjusting sharply their level of outsourcing in the Czech Republic and Slovakia, in a way similar to what we document for the automobile sector in Slovakia. By contrast, in good times, the Czech Republic and Slovakia are more sensitive to German developments than to the EU-15 ones[18]. That would confirm that German multinationals are adjusting their level of outsourcing and, more generally, that for the Czech Republic and Slovakia, Germany is conducive to growth.

Finally, and interestingly, in the case of Slovakia, the estimates of β^{POS} and β^{NEG} for the sector of basic metals and fabricated metal products are higher (and more significant) when data of the EU-15 rather than of Germany are used for extracting bad and good times. That finding would reflect simply the presence of US Steel in Slovakia which, like the South Korean multinational Kia Motors Corporation, would be mainly interested in developments occurring on the European market when it has to decide how much to produce in the country. Yet, the global fitting of the model is better in that case, reinforcing our interpretation.

Table 9: Correlation of good (respectively, bad) times between Germany and the EU-15*

	Good times	Bad times
Manufacturing production	0.69	0.93
Transport Equipment	0.32	0.29
Electrical and Optical Equipment	0.64	0.51
Other Machinery and Equipment	0.36	0.40
Basic metals and Fabricated metal products	0.32	0.22

*Sample: 2000:01-2010:05.

[18] The sector of basic metals and fabricated metal products in Slovakia is an exception. See below for explanation.

Table 10: Robustness tests with the EU-15 (estimates over 2001:01-2010:05)

	Czech republic	Slovakia
Manufacturing production		
α	0.60 ***	0.70 ***
β^{POS}	1.05 ***	1.26 ***
β^{NEG}	0.44 ***	0,30 °
Adjusted R^2	0.74	0,77
Of which:		
Transport Equipment		
α	0.66 ***	0,70 ***
β^{POS}	0.22 °	0,60 *
β^{NEG}	0.78 **	1,49 ***
Adjusted R^2	0.50	0,84
Electrical and Optical Equipment		
α	0.53 ***	0,85 ***
β^{POS}	0.62 ***	-0,02
β^{NEG}	1.14 **	1,00 ***
Adjusted R^2	0.80	0,63
Other Machinery and Equipment		
α	0.31 ***	0,29 ***
β^{POS}	0.78 ***	0,58 ***
β^{NEG}	1.48 ***	1,54 *
Adjusted R^2	0.84	0,35
Basic metals and fabricated metal products		
α	0.42 ***	0,46 ***
β^{POS}	0.58 ***	0,51 ***
β^{NEG}	0.74 ***	0,62 ***
Adjusted R^2	0.84	0,78

(***),(**), (*), (°) means that coefficients are significant at respectively 1%, 2%, 5% and 10%. For saving space, coefficients associated to AR processes are not reported. They are available upon request to the author.

4. Concluding remarks

In this paper, we have provided some intuition on the way multinational firms – in the first instance, the German ones – may adjust their level of international outsourcing over the cycle in the Czech Republic and Slovakia. One conclusion is that asymmetry in the international outsourcing seems to be at work across several dimensions: across the states of the economy, across the sectors and across the countries. Asymmetry may even exist according to the nationality of foreign investors (*e.g.* the German *versus* French

multinationals in the sector of transport equipment in Slovakia). By contrast, we suspect that the non-European multinationals (*e.g.* the American, Korean or Japanese ones) would take into account mainly the state of demand on the European market when deciding on how much to produce in the Czech Republic and Slovakia. Hosting a European or a non-European multinational would be thus non neutral from this point of view. Our methodology, which is driven by the lack of data on the activities of multinationals abroad and domestically at a high frequency, does not enable us to discriminate accurately across the different foreign investors, though.

Another conclusion is that such adjustments in the level of international outsourcing may account for a portion of volatility in the economic activity of Slovakia. In particular, large fluctuations in the transport equipment production of Slovakia have become a rule since multinationals arrived en masse (graph 1). This contrasts sharply with the Czech Republic or Germany (or France) where the fluctuations are by far smoother. While the country size may be a good factor to explain the difference in business cycle volatility across countries, it cannot account for the whole difference. In fact, with no in-house competitor to date, Skoda was immune to ups-and-downs for purposes of adjustment in international outsourcing by Volskwagen. The fact that Skoda is the first cars brand produced in the Czech Republic contributes to stabilize the whole cars production of the country. Things turn out to be very different in Slovakia where there is in-house competition, from Germany and France in the first place. Adjustments in the level of outsourcing over the automobile business cycle, while benefiting Slovakia at the peaks, also have huge negative consequences at the downturns, as illustrated by the one of 2008/2009. That is the reverse of the medal for Slovakia: a high volatility in its economic activity.

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Appendix

Table A: Estimates without distinction between "good" and "bad" economic times

	Czech republic	Slovakia
Manufacturing production		
α	0.28 ***	0.38 ***
β	0.78 ***	0.75 ***
Adjusted R^2	0.84	0.83
Of which:		
Transport Equipment		
α	0.67 ***	0.84 ***
β	0.42 ***	0.46 ***
Adjusted R^2	0.54	0.82
Electrical and Optical Equipment		
α	0.86 ***	0.93 ***
β	0.16 °	0.20 ***
Adjusted R^2	0.77	0.60
Other Machinery and Equipment		
α	0.46 ***	0.34 ***
β	0.80 ***	0.67 ***
Adjusted R^2	0.85	0.36
Basic metals and fabricated metal products		
α	0.40 ***	0.76 ***
β	0.73 ***	0.28 ***
Adjusted R^2	0.88	0.73

(***),(**), (*), (°) means that coefficients are significant at respectively 1%, 2%, 5% and 10%.

Estimates are running over 2001:01-2010:05.

The model is $\Delta IP_{ij,t} = \alpha \Delta IP_{ij,t-1} + \beta \Delta IP_{iGER,t} + \varepsilon_{ij,t}$

where $\Delta IP_{ij,t}$ (resp. $\Delta IP_{iGER,t}$) denotes the growth rate of the production in manufacturing sector *i* of country *j* (resp. of Germany) at time *t*. Country *j* is either the Czech republic or Slovakia in our case.

For saving space, coefficients associated to AR processes are not reported. They are available upon request to the author.