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Firm heterogeneity, rules of origin and rules of cumulation

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Abstract

We analyse the impact of relaxing rules of origin (ROOs) in a simple setting with heterogeneous firms that buy intermediate inputs from domestic and foreign sources. In particular, we consider the impact of switching from bilateral to diagonal cumulation when using preferences (instead of paying the MFN tariff) involving the respect of rules of origin. We find that relaxing the restrictiveness of the ROOs leads the least productive exporters to stop exporting. The empirical part confirms these results. We use the most recent techniques developed by Helpman, Melitz and Rubinstein (2007) on highly disaggregated data (HS6 digit) to analyse the effects of the introduction of the Pan-European Cumulation System (PECS). We find that PECS reverses the negative impact of strict ROOs on intermediate trade which turns positive as a consequence of introducing diagonal rules of cumulation (ROCs).

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Firm Heterogeneity, Rules of Origin and Rules of Cumulation*

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Abstract

We analyse the impact of relaxing rules of origin (ROOs) in a simple setting with heterogeneous firms that buy intermediate inputs from domestic and foreign sources. In particular, we consider the impact of switching from bilateral to diagonal cumulation when using preferences (instead of paying the MFN tariff) involving the respect of rules of origin. We find that relaxing the restrictiveness of the ROOs leads the least productive exporters to stop exporting. The empirical part confirms these results. We use the most recent techniques developed by Helpman, Melitz and Rubinstein (2007) on highly disaggregated data (HS6 digit) to analyse the effects of the introduction of the Pan-European Cumulation System (PECS). We find that PECS reverses the negative impact of strict ROOs on intermediate trade which turns positive as a consequence of introducing diagonal ROCs.

JEL classification: F12, F13, F14, F15

Keywords:Intermediate goods, Rules of origin, Rules of cumulation, Firm heterogeneity, Gravity.

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1 Introduction

Rules of origin and rules of cumulation are unavoidable parts of preferential regimes. They characterize unilateral trade preferences and free trade areas, FTAs. Rules of origin (henceforth ROOs), by determining the origin of a product, define whether a good qualifies or not for preferential access. Rules of cumulation (henceforth ROCs) define whether a firm can use imported intermediate products, so that the final product of the importing firm does not loose the originating status. A preferential regime can allow either for bilateral, diagonal or full cumulation. To qualify its final product for preferential access with bilateral cumulation[1], a firm can either use the domestic intermediates or the intermediates produced in a preference receiving country. Whereas, with diagonal cumulation, a firm can use the intermediate goods coming from any of the preferential regime partners produced under the same ROOs and ROCs. Alternatively, a preferential regime can allow for full cumulation. In this case all the intermediates coming from free trade area partners can be used, regardless of the fact that the imported products qualify or not for preferential access.

Despite that rules of origin are formulated in a context of preferential trade liberalization, their effects on trade flows are rather ambiguous. More precisely, they can either prevent exporters from taking advantage of the preferential tariff or they can constitute a trade diverting factor. Indeed, as argued by Krishna (2005), much of what we have learnt from the literature is that ROOs can provide hidden protection for intermediate inputs and that the effect of rules of origin in the short run may be primarily in terms of trade flows while in the long run it may take the form of investment flows. On the other hand, as highlighted by Baldwin, Evenett and Low (2007) "permissive ROCs can mitigate the protectionist content of ROOs by expanding firms' choice when it comes to their international supply networks".

The aim of this paper is to focus on the issue of bilateral versus diagonal or full cumulation. Our paper contributes to the literature by analyzing the combined effect of ROOs and ROCs. To show that bilateral cumulation, as opposed to diagonal or full cumulation, can distort the purchase pattern of intermediate inputs, we model ROOs and ROCs by incorporating the Puga and Venables (1995) model into the Melitz framework using a three country setting. Puga and Venables (1995) show that in a model with a preferential trading arrangement between hub and spoke countries the hub-spoke arrangement lead to the relocation of industry into the hub country. However, as shown by Demidova, Krisna and Loo Kee (2006), a homogeneous firm setting cannot take into account important results

[1] We also refer to this set up as restrictive ROOs.

due to different trade policies. Indeed, Demidova,Krisna and Loo Kee (2006) build a heterogeneous firm setting which shows that firms sort according to the export markets and to the different types of trade policy. They model the response of Bangladesh firms in two sectors, the woven and no woven sectors, with respect to the decision of exporting to the EU market, under the "Everything But Arms" (EBA) initiative and to the US market, under the quota regime. In both cases firms can take advantage of these trade policies only if they comply with ROOs. Modelling ROOs as an additional marginal and fixed cost they show that firms that take advantage of the less restrictive EU's ROOs are less productive than those firms that export to the US, where tariffs are higher.

In our model we close the gap between these two models. On the one hand, we allow for different firms responses. Firms can decide to invoke preferential tariffs and thus, comply with rules of origin. A sufficient condition ensures the existence of different types of responses. On the other hand, differently from Demidova, Krisna and Loo Kee (2006), we model the implications of ROOs by introducing an intermediate good sector in a three countries model. This enables us to we investigate the effects of ROOs on the intermediate sector and on the trade between the two spokes countries. Finally, we look at the implications of diagonal ROCs on intermediate and final sectors.

To confirm our theoretical predictions, we bring the model to the data. The natural experiment is to consider the Pan European system of cumulation. The system introduced in 1997 has allowed the major part of the European Union's free trade partners to cumulate stages of production in order to qualify for preferential access in the European market. Since the literature that examines the combined effects of rules of origin and rules of cumulation on supply choice is rather scarce, our empirical purpose is to shed light on the restrictive nature of ROOs and on the role of ROCs in mitigating the protectionist content of ROOs. To do so, we use an index of restrictiveness of Product Specific Rules of Origin constructed by Cadot, Carrère, de Melo and Tumurchudur (2005). Their latter paper shows that rules of origin tend to be more restrictive for activities with greater processing (i.e. lower value added), and that non-least developing countries face restrictive ROOs in sectors in which they have a revealed comparative advantage (in the sense of high export shares).

To examine the impact of the relaxation of ROOs in the European context, Augier, Lai-Tong and Gasiorek (2007) consider the European Union Mediterranean Partneship and the Pan European system of cumulation. First they establish whether there is any evidence on the impact of cumulation from the trade data following the introduction of the Pan European system in 1997, which extended diagonal cumulation to the Central and Eastern Europe and the Baltic states. They show that both

at the aggregate and sectoral level the relaxation of rules of origin via the introduction of diagonal cumulation arrangements between the EU and its' trading partners generates positive effects.

In line with this research is the paper by Anson, Cadot, Estevadeordal, de Melo, Suwa-Eisenmann and Tumurchudur (2004), which studies the impact of ROOs on trade flows in the case of NAFTA. They argue that these may be representative of a North-South FTA. They find that the restrictiveness nature of ROOs impacts negatively on trade flows. They predict that in absence of tariff change, the application of rules of origin lead final good producers to shift their purchases of intermediates to intra-FTA intermediates. Additionally if final goods are imperfect substitutes by origin, consumers will shift towards intra-FTA from rest of the world (ROW) trade if the benefits of complying with rules of origin are greater than zero.

The contribution of our paper is as follows. Absent ROCs, our model generates a hub spoke situation. This result is less strong than the situation predicted by the Puga-Venables (1995) framework due to the presence of the heterogeneous firms setting. Moreover, absent ROCs, firms in the spoke sort according to the ability of respecting rules of origin. This is line with the predictions of Krishna, Demidova and Loo Kee (2006). Differently from them we explicitly model the constraints imposed by rules of origin introducing an intermediate production sector. An important aspect of our paper is that we consider the situation in which diagonal ROCs are allowed between the spoke countries. Our model shows that ROCs do mitigate the effect of ROOs by leading countries to a situation that is closer to a free trade situation.

In the empirical part we analyze how the extensive and intensive margins of trade are affected by ROOs and ROCs. More specifically, we follow the Helpman, Melitz and Rubinstein (2008) gravity equation which brings the heterogeneous firm model to the data and allows to analyze the effect on the extensive margin and intensive margin of trade correcting for the presence of zero trade flows. We disentangle trade flows by looking separately at the trade among the EU 15 and the EFTA, BAFTA, CEFTA and MED countries and by distinguishing the effects of ROOs and ROCs on the trade of both the intermediate and final goods[2]. We show that diagonal cumulation relaxes ROOs particularly for the Spoke countries. Whilst ROOs under bilateral cumulation decrease intermediate export from Spoke to Spoke countries, diagonal cumulation reverts this negative effect leading to trade creation inside the Pan European cumulation zone. Spoke countries seem to have gained the most by the possibility to cumulate. For the EU 15, ROOs under bilateral cumulation lead to a decrease both

[2]See Appendix A.5. for details on Countries.

at the extensive and intensive margin in the export of intermediate goods and to an increase in the export of the final good. The introduction of cumulation accentuates these effects. The only exception concerns the effect of diagonal cumulation on the export of the intermediate good from the EU 15. Specifically, for the EU 15, the probability of exporting the intermediate good decreases while the volume of trade increases. This effect is confirmed by the robustness check. These results suggest that the FTAs have been used to reorganized production inside the European Union spaghetti bowl. Cumulation has increased the incentive to split the value chain of production among all the EU FTA partners, with the EU 15 shifting the intermediate stages of production to the peripheral countries and with a consequent increase in intra-firm trade. As far as we know there are no other papers that apply the Helpman, Melitz and Rubinstein (henceforth HMR) gravity equation using the Harmonised System (HS) 1992, which categorizes trade flow along 5019 tariff lines.

The remainder of the paper is as follows. The next section presents a brief overview of the evidence on trade and ROOs. Section three sets up the model and derives partial equilibrium results. Section four characterizes the equilibrium and investigates some comparative statics. In section five are discussed the main features of the Pan European system of cumulation, the empirical strategy and the results. The last section concludes.

2 Theoretical Framework

We study the effect of a FTA with rules of origin and bilateral cumulation between a hub and two spoke countries. The preferential access to the FTA partner's market requires that firms comply with ROOs and bilateral ROCs. Compliance with these rules restricts the possibility of using intermediate goods from the other spoke country. Rather than adopting a partial restriction in the use of inputs, we make the strong assumption that only intermediates from the origin and destination markets can be used when exporting under preferential tariff. This assumption captures the essence of ROOs with bilateral cumulation, whose effects are essentially on the inputs' choices made by final good producers. As such, our assumption does not affect the main message behind the model and it allows to keep the analysis as simple as possible[3]. For instance, EU rules of origin for cotton clothing stipulate that the manufacturing process must 'manufacture from yarn', implying that imported cotton fabric cannot be used and that the yarn must be sourced locally[4].

[3] This assumption does not affect the general results.

[4] For many small developing countries this rule is very difficult to satisfy and often precludes the use of preferential access to the EU market under the GSP.

The main value of our theory and key to our empirics lies in the consideration of changes in rules of cumulations. Specifically, to explore the role of cumulation in reducing the distortionary impact of preferential ROOs, we investigate the changes induced by the possibility of diagonal cumulation between the spoke countries.

2.1 Preferences

Consumers in each country share the same preferences over two final goods: a homogeneous good, z, and a differentiated good, x. We assume a two-tier preference with Cobb-Douglas in the upper tier and CES in the lower tier. A fraction of income, μ, is spent on the differentiated good, x, and a fraction $(1-\mu)$ is spent on the homogeneous good, z. The utility function is:

$$U = z^{(1-\mu)} \left[\int_{v \in V} c(v)^{(\sigma-1)/\sigma} dv \right]^{\frac{\sigma\mu}{\sigma-1}} \tag{1}$$

where $\sigma > 1$ represents the elasticity of substitution between any two products within the group and V is the set of available varieties. Given that preferences across varieties have the standard CES form, the demand function for a final good variety is:

$$x_c(v) = \frac{\mu E}{P_{f,c}^{1-\sigma}} p_{f,c}(v)^{-\sigma}$$

where $c = o, d$, o stands for origin and d for destination; $p_{f,c}(v)$ is the final price of a variety v, $P_{f,c}^{1-\sigma}$ is the CES price index for the final good and μE is the aggregate level of spending on the differentiated good.

2.2 Technology and market structure

We focus on the effects of ROOs with bilateral cumulation on supply networks. For this reason, the set-up of the model is based on three identical countries: a hub country and two spoke countries. Each country is endowed with labor, L, which is supplied inelastically. There are three sectors, one homogeneous, one manufacturing sector and one differentiated intermediate good sector. The homogeneous sector produces a good, z, with constant returns to scale and perfect competition. In this sector the technology is simple. We choose units of z such that one unit of labor is required per unit of output. Thus, the unit cost function is w, where w is the wage rate for labor. This unit cost function

represents marginal and average costs. In the homogeneous sector, competition implies price equal marginal costs, $p_z = w$. It is convenient to choose good z as the numeraire, so that $p_z = 1$; hence, the pricing condition will become: $1 = w$. As long as the homogeneous good z is produced in every country and is freely traded on international markets, the cost of producing this homogenous good is the same in every country, and hence, so are the wages.

The manufacturing sector produces a continuum of horizontally differentiated varieties, $x(v)$, *à la* Melitz. These varieties are produced using labour, L, and a CES composite of intermediate inputs. These two factors are combined in a Cobb-Douglas production function, which gives the following unit variable cost $a(v)P_M^{\eta}$, where $a(v)$ is the unit input requirement, P_M is the price index of the composite intermediate goods, M, and η is the Cobb-Douglas cost share of the intermediate bundle. We assume that each spoke country signs a FTA with the hub country. The existence of the FTA allows the firms to choose between two tariffs. One is the non-discriminatory tariff, called 'most favoured nation' tariff, which provides the handy abbreviation, MFN. This tariff equals to $\tau_{MFN} - 1$, where $\tau_{MFN} \geq 1$ represents the cost of selling one unit in the export market. Since between the two spoke countries there is no FTA the only tariff which applies is the MFN tariff. On the contrary, FTA partners make use of the preferential tariff, $\tau_{FTA} < \tau_{MFN}$, subject to the respect of rules of origin which affects the choice of the intermediate good sector.

The differentiated intermediate good sector produces a continuum of horizontally differentiated varieties, $m(i)$, $i \in [0, ..., 1]$, in a Dixit-Stiglitz monopolistic competition setting, using only labour[5]. It follows that the pricing rule of each intermediate good producer is

$$p_m = \beta\sigma/(\sigma - 1) \tag{2}$$

where p_m is the price of the m good, β is the unit input requirement. For simplicity, we assume that the intermediate good firms are homogeneous and their trade frictionless[6]. This strong assumption allows us to keep the analysis as simple as possible without affecting the main results. Given that final good preferences are Cobb Douglas and nations are symmetric, each nation will devote the same amount of labour to intermediate good production. Hence, the mass of intermediate good varieties is the same across nations and equal to n_M. The standard CES price index for the intermediate good

[5] Following Puga and Venables (1995), we assume the same elasticty of substitution across varieties, σ, for both the intermediate and the final good sectors.

[6] It does not make any difference whether we consider or not heterogeneous firms even in the intermediate sector.

sector, which includes all the existing varieties, is:

$$P_M^{1-\sigma} = 3n_M p_m^{1-\sigma} \tag{3}$$

where $n = \eta E/\sigma f$ is the equilibrium number of intermediate good varieties produced in each country and f is the Dixit-Stiglitz fixed cost of production.

The introduction of these restrictive rules of origin make firms face a fundamental trade-off between optimizing intermediate good source and having access to the preferential tariff. To capture this key trade-off, while maintaining analytical tractability, we make the bold assumption that the restrictive ROOs take the form of an absolute prohibition on using intermediate varieties from non partner nations. Thus, if the restrictive ROOs are respected, the CES price index for intermediate is:

$$P_{M,Roo}^{1-\sigma} = 2n_M p_m^{1-\sigma} \tag{4}$$

rather than (3). Given our assumptions, we can find closed form solutions for (4) and (3). This shows that firms face a trade-off between the efficiency in production and preferential tariff for final good.

The homogeneous sector is not subject to trade costs as well as the intermediate good sector. More specifically, we assume a frictionless world for these sectors which allows us to keep the analysis as simple as possible without affecting the main results. Given this set-up, it follows that a certain number of final good producers will sell only domestically (D-type firms) and a sub-sample of them, the more productive ones, will also export to the other markets (X-type firms).

Concerning the intermediate good producers, their supply will depend on the demand of final good producers. As we describe in the next subsection, this, in turn, depends on the final good producers' decision to comply or not with ROOs and bilateral ROCs.

Introducing FTA with ROOs

The main value added of our theory is to deal with ROOs and bilateral cumulation (also called restrictive ROOs). We assume that each spoke country signs a FTA with the hub country. The existence of the FTA allows the firms to choose between two export strategies. A firm that wants the preferential tariff, $\tau_{FTA} < \tau_{MFN}$, has to respect the restriction imposed by the ROOs and bilateral cumulation. This implies that the firm that invokes preference for exporting in the hub (spoke) market can only use the intermediate input-varieties produced in its own domestic market and in the spoke

(hub) country involved in the specific FTA. Moreover, ROO imposes a fixed cost, f_R. This fixed cost is the sum of the market entry cost, f_X, plus the administrative costs linked to the proof of originating status. When a firm decides to respect these restrictions, it will face a larger fixed costs and a restricted choice of inputs but a lower tariff, $\tau_{FTA} < \tau_{MFN}$. On the contrary, refusing the preferential access implies that the firm can exploit a greater range of intermediate inputs, a lower fixed cost but a higher tariff. The trade off between asking or not for preferential access is due to the fixed and intermediate input costs versus the preferential tariff.

The introduction of a FTA with ROO and bilateral cumulation will generate two types of exporting firms. A certain number of exporting firms will not fulfil the restrictive ROOs. Hence, they will not receive the preferential access. We call these firms X-type firms. On the other hand, there will be another fraction of exporting firms, which fulfil the restrictive ROOs. We call these firms R-type firms.

2.3 Intermediate Results

2.3.1 Market entry decision of final good firms

Following Melitz (2003) and Helpman, Melitz and Yeaple (2004), entering the final good sector involves a fixed variety-development cost f_I[7]. Subsequently, each entrant draws a labor per-unit-output coefficient (called a) from a cumulative density function $G[a]$, that is common to every country. The support of the continuous random variable a is $0 \leq a \leq a_0$. Upon drawing its own parameter a, each firm decides to exit and not to produce (this happens if it has a low productivity draw), or to produce. If it chooses to produce for its own domestic market, it pays the additional fixed market entry cost, f_D. If the firm chooses to export, without invoking preferential tariff, it bears the additional market entry costs f_X. If the firm decides to respect the restrictive ROO, it faces a fixed cost, f_R. This fixed cost is the sum of the market entry cost, f_X, plus the administrative costs linked to the proof of originating status[8]. It follows that the fixed cost f_R, which provides preferential market access, will be more attractive to larger firms.

When a firm decides to respect the restrictive ROOs, it will face a larger fixed costs, a restricted choice of inputs but a lower tariff, $\tau_{FTA} < \tau_{MFN}$. On the contrary, refusing the preferential access implies that the firm can exploit a greater range of intermediate inputs, a lower fixed cost but a higher tariff. The trade off between asking or not for preferential access is due to the fixed and intermediate

[7] Where the subscript I stands for innovation.
[8] All the fixed cost are in terms of labor.

input costs versus the preferential tariff. Hence, the introduction of a FTA with restrictive ROOs will generate two types of exporting firms.

Solving for the cost minimization problem, the profit function for D-type firms, for which ROOs are irrelevant, is equal to $p_D(v)\,x(v) - x(v)a(v)P_M^{\eta} - f_D$. The pricing rule that follows from the profit maximization is $p_D = a(v)P_M^{\eta}\sigma/(\sigma-1)$. Using the intermediate results from consumer and firms' optimization problems, we calculate the operating profit for the domestic firm:

$$\Pi_D^o(a) = \left[\left(\frac{\sigma}{1-\sigma}\right)\frac{aP_{M,Roo}^{\eta}}{P_{f,o}^{1-\sigma}}\right]^{1-\sigma}\frac{\mu E}{\sigma} - f_D$$

The modes of export vary according to the considered foreign market. In the case of a FTA partner, a firm, in the origin country, can choose between two possible export strategies, which are related to the fulfilment of restrictive rules of origin. If a firm decides to respect ROO and bilateral cumulation, the equilibrium profits are:

$$\Pi_R^d(a) = \left[\left(\frac{\sigma}{1-\sigma}\right)\frac{a\tau_{FTA}P_{M,Roo}^{\eta}}{P_{f,d}^{1-\sigma}}\right]^{1-\sigma}\frac{\mu E}{\sigma} - f_R \tag{5}$$

whereas, if a firm decides not to take advantage from preferential access, the equilibrium profits are:

$$\Pi_X^d(a) = \left[\left(\frac{\sigma}{1-\sigma}\right)\frac{a\tau_{MFN}P_{M,Roo}^{\eta}}{P_{f,d}^{1-\sigma}}\right]^{1-\sigma}\frac{\mu E}{\sigma} - f_X \tag{6}$$

The introduction of FTA with ROO induces a sorting of exporting firms into two groups. The first group decides to fulfil ROOs in order to enjoy the preferential access (5). The second group, instead, is characterized by the firms that decide to not accept the ROO and therefore the preferential access (6). Comparing equation (5) with (6), firms that fulfil ROO and bilateral cumulation face a higher intermediate good Price Index, $P_{M,Roo}^{\eta}$, a higher fixed cost, f_R, but a lower tariff, $\tau_{FTA}-1$. For what concern the trade between the two spoke countries, since there is no agreement, the equilibrium profit for exporting will be always represented by (6).

Rearranging terms and defining $\Gamma = P_M^{\eta(1-\sigma)}$ and $\Omega = P_{M,Roo}^{\eta(1-\sigma)}$, we can rewrite the equilibrium profits from domestic sales as[9]:

$$\Pi_D^o(a) = \Gamma B^o a^{1-\sigma} - f_D \tag{7}$$

where $B^o = A/P_{f,o}^{1-\sigma}$ and $A = (\mu E/\sigma)(\sigma/1-\sigma)^{1-\sigma}$.

[9] Note: $B^o = A/B$

If a firm chooses to export, without fulfilling ROOs, then its equilibrium net operating profit in that market is:

$$\Pi_X^d(a) = \Gamma a^{1-\sigma} B^d \phi_{MFN} - f_X \tag{8}$$

where $\phi_{MFN} = \tau_{MFN}^{1-\sigma}$ and $B^d = A/P_{f,d}^{1-\sigma}$.

If a firm chooses to export fulfilling ROOs, the equilibrium net operating profit is:

$$\Pi_R^d(a) = \Omega a^{1-\sigma} B^d \phi_{FTA} - f_R \tag{9}$$

where $\phi_{FTA} = \tau_{FTA}^{1-\sigma}$.

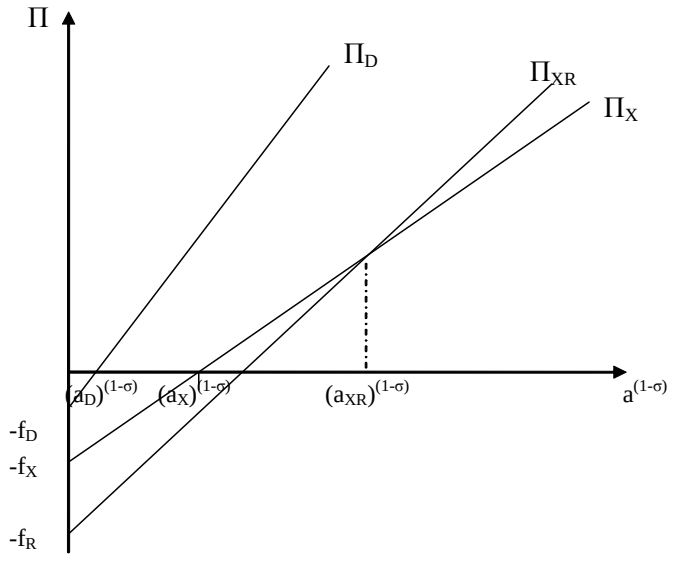
Due to the assumptions underlying the model, firms will be ranked according to the following regularity condition:

$$\Gamma^{-1} f_D \ < (\Gamma \phi_{MFN})^{-1} f_X < (\Omega \phi_{FTA})^{-1} f_R$$

this condition implies that the exporting profit functions, (8) and (9), will cross in a point, beyond which serving the FTA partner using rules of origin is profitable[10].

The profit functions are depicted in Figure 1, which helps clarify the analysis.

Figure 1: Profits



[10] More details are given in Appendix A.1

From Figure 1, we can see that there is a trade off between the preferential tariff, which offers a better market access, and the costs associated with respecting the originating status requirements. The costs associated with originating status refer to a high price for the intermediate goods and a high fixed cost. Restrictive ROO constrains the sourcing decision of the final good firms and it increases the fixed cost associated with exports. It follows that only large exporters can take advantage of a better market access while the small exporting firms, not able to cope with the higher costs, have to renounce to the preferential access.

In sum the model has three cut-offs which derive from the regularity condition, described previously. Namely, looking at Figure 1, least efficient firms exit, $a(v) > a_D$, most firms sell only locally, $a_X < a(v) < a_D$, and some firms export but using the MFN tariff, $a_{Roo} < a(v) < a_X$, while most productive exporters respect ROO and gain tariff preference, $a(v) \leq a_R$.

3 Equilibrium Conditions

We now formalize the statements illustrated in Figure 1.

3.0.2 The Cutoff Conditions

Let us define the threshold marginal costs for each market. Using the equilibrium operating profit for serving the domestic market (7), we can derive the domestic cutoff condition:

$$a_D = \left(\frac{f_D}{\Gamma B^o}\right)^{\frac{1}{1-\sigma}} \tag{10}$$

That is firms with $a(v)$ below a_D find it optimal to supply the local market while firms with $a(v) > a_D$ expect negative profits and exit the industry.

The choice in the case of the foreign markets is more complex, so it could be helpful to structure the discussion with the help of Figure 1. As we see from the figure the net operating profits of supplying the foreign market rises under both modes of exporting. Firms with $a_X < a(v) < a_D$ have positive operating profits from sales in the domestic market, but they lose money if they choose to serve foreign markets. We use the net operating profit from exporting under MFN (8) to derive the X-type firm cutoff without preferential access:

$$a_X = \left(\frac{f_X}{\Gamma B^d \phi_{MFN}} \right)^{\frac{1}{1-\sigma}} \tag{11}$$

Thus, only firms with $a(v) \leq a_X$ will consider export to the other spoke country and to the hub market when ROO are not fulfilled.

Notice, from Figure 1, that at $a(v) = a_X$, exporting without ROO yields a higher net operating profit then exporting with ROO. This ordering switches, however, for firms with $a(v) \leq a_{Roo}$, where this is defined as the $a(v)$ where:

$$a_R = \left(\frac{(f_R - f_X)}{B^d (\Omega \phi_{FTA} - \Gamma \phi_{MFN})} \right)^{\frac{1}{1-\sigma}} \tag{12}$$

This last cutoff is obtained by equating the operating profits from accepting ROO, (9) with the operating profit from doing export under MFN tariff, (8). This because by construction, a firm will choose to supply by accepting ROO only if the ROO strategy is more profitable than the export strategy under MFN, i.e. if this holds:

$$\Pi_R^d - \Pi_X^d \geq f_R - f_X$$

which can be rewritten as,

$$B^d a_R^{1-\sigma} [\Omega \phi_{FTA} - \Gamma \phi_{MFN}] = f_R - f_X$$

Notice that if $a(v) \leq a_R$, the export supply fulfilling ROO yields a higher net operating profit.

From the diagram it is clear that $a_X > a_R$. This implies that only the large exporters will use the preferential access while small exporters will continue to use the MFN tariff.

Free Entry

In order to characterize the general equilibrium results, we specify the free entry conditions and the Price Indexes of the final good sector.

Free entry ensures equality between the expected operating profits of a potential entrant and the entry cost, $E(\pi) - f_I$. This condition holds for all type of firms. The cumulative density function is $G(a)$, with support: $[0, ..., a_0]$, where for simplicity we can set $a_0 = 1$. The free entry condition for a

spoke country can be defined as:

$$\int_0^{a_{D\_s}} \Pi_D^o dG(a) + \int_{a_{R\_sh}}^{a_{X\_sh}} \Pi_R^d dG(a) + \int_0^{a_{R\_sh}} \Pi_X^d dG(a) + \int_0^{a_{X\_ss}} \Pi_X^d dG(a) \ = f_I \tag{13}$$

where s and h stand for spoke and hub respectively. The free entry condition for the hub country can be defined as:

$$\int_0^{a_{D\_h}} \Pi_D^o dG(a) + 2\int_{a_{R\_hs}}^{a_{X\_hs}} \Pi_X^d dG(a) + 2\int_0^{a_{R\_hs}} \Pi_R^d dG(a) \ = f_I \tag{14}$$

Note that the cutoff a_{X_hs} as well as a_{X_sh} represent the threshold marginal cost of exporting firms which do not export under ROOs.

Price Index

The Price Index of the final good in a spoke country is defined as:

$$P_s^{1-\sigma} = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \left[n_s\Gamma \left(\int_0^{a_{D\_s}} a^{1-\sigma} dG(a/a_{D\_s}) + \phi_{MFN} \int_0^{a_{X\_ss}} a^{1-\sigma} dG(a/a_{D\_s}) \right) + \right. \tag{15}$$

$$\left. n_h \left(\phi_{MFN}\Gamma \int_{aR\_hs}^{a_{X\_hs}} a^{1-\sigma} dG(a/a_{D\_h}) + \Omega\phi_{FTA} \int_0^{a_{R\_hs}} a^{1-\sigma} dG(a/a_{D\_h}) \right) \right]$$

The Price Index for the final good in the hub country is:

$$P_h^{1-\sigma} = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \left[n_h\Gamma \int_0^{a_{D\_h}} a^{1-\sigma} dG(a/a_{D\_h}) + 2n_s\phi_{MFN}\Gamma \int_{a_{R\_sh}}^{a_{X\_sh}} a^{1-\sigma} dG(a/a_{D\_s}) + \right. \tag{16}$$

$$\left. 2n_s\phi_{FTA}\Omega \int_0^{a_{R\_sh}} a^{1-\sigma} dG(a/a_{D\_s}) \right]$$

3.0.3 Parametrization: Pareto Distribution

In order to find closed form solutions, we use a specific parametrization for the distribution, the Pareto distribution, whose empirical importance has been proved (see Axtell 2001; Helpman et al. 2004; Del

Gatto et al. 2007). The cumulative distribution function of a Pareto random variable a is:

$$G(a) = \left(\frac{a}{a_0}\right)^k \tag{17}$$

where k and a_0 are the shape and scale parameter, respectively. The shape parameter k represents the dispersion of cost draws. An increase in k would imply a reduction in the dispersion of firm productivity-draws. Hence, the higher is k the smaller is the amount of heterogeneity[11].

We assume that the support of the distribution $[0, ..., a_0]$, where a_0 represents the upper bound of this distribution, is identical for every country. The properties of the Pareto distributions lead to a productivity distribution of surviving firms which is also Pareto with shape k. More precisely, since a firm will start producing only if it has at least a productivity of $1/a_D$, the probability distribution of supplying as an exporter is conditioned on the probability of successful entry in each market. Hence the truncated cost distribution is given by:

$$G(a/a_D) = \left(\frac{a}{a_D}\right)^k$$

where the fractal nature of the Pareto is exploited. Here the support is $[0, ..., a_D]$. Given the assumed parametrization, we can explicitly solve the free entry conditions and the Price Index of the final good[12].

4 General Equilibrium Analysis

We analyze the main implications of our model, by looking at the results obtained for the hub and one of the two spoke countries. We analyze one spoke country since we have assumed perfect symmetry between the two spokes. In Appendix A.2, we present the closed form solutions of the demand shifter (B^d and B^o), the corresponding equilibrium cut-offs and the number of varieties.

We turn now to comparative statics. We first look at the impact of a free trade area with restrictive ROOs. Afterwards, we relax the restrictiveness of ROOs by allowing diagonal cumulation among the countries.

[11] Note that k=1 implies a uniform distribution on $[0, a_0]$.
[12] See Appendix A.2

4.1 The Impact of Restrictive ROOs

In line with Krishna, Demidova and Loo Kee (2006), we find that the introduction of ROOs with bilateral cumulation results in a reduction of the aggregate productivity in both the hub and the spokes. Firms sort in three groups: domestic firms, exporting firms which do not fulfil ROOs and exporting firms which do fulfil ROOs.

4.2 The Impact of Relaxing ROOs via Diagonal Cumulation

To analyse the role of cumulation in reducing the distortionary impact of restrictive ROOs, we give a graphical intuition of the effect of diagonal cumulation on firms' productivity. Then we present a more general discussion of the impact of ROOs with diagonal cumulation in the hub and spoke situation.

Graphical Intuition. To build intuition we can use a partial equilibrium version of Figure 1, where the B's are held constant.

Figure 2

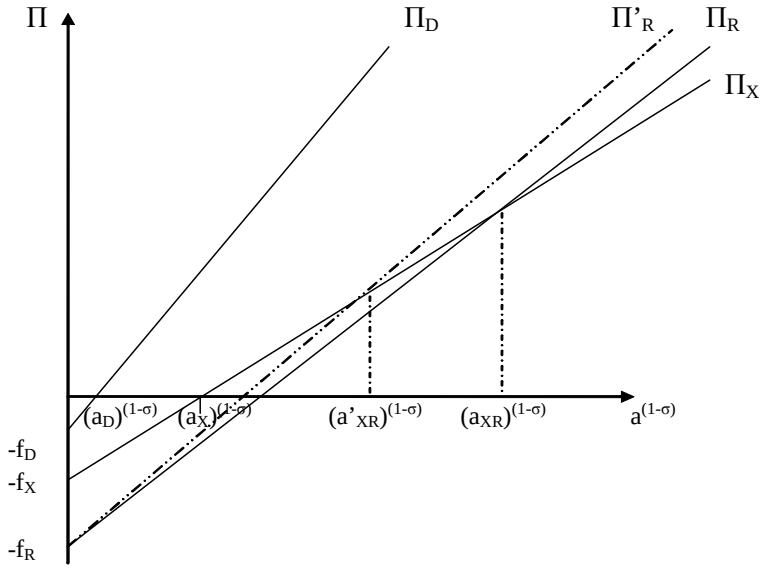


Figure 2 represents the passage from ROOs and bilateral cumulation to diagonal cumulation considering only the effect on the price index of intermediate goods. As a result of the relaxation of ROOs, the price index of intermediates when firms undertake diagonal cumulation becomes identical

to the standard CES price index for the intermediate. Hence: $\Gamma = \Omega$[13]. $\Pi_R^{'}$ and Π_R represent the situation with and without diagonal cumulation. The relaxation of ROOs, which makes the profit line $\Pi_R^{'}$ steeper than Π_R, reduces the threshold productivity required to export under ROOs.

General Equilibrium Analysis of ROOs and Diagonal Cumulation. In what follows we consider the general impact of diagonal cumulation, which passes through the price index of intermediate goods as well as the B's. As mentioned, the introduction of cumulation reduces the price of the intermediate input bundle, which now becomes the same for every final good producers and is equal to Γ. This means that the final good producers that ask for preferential access face now a lower intermediate price index. This in turn, allows them to charge a lower price, altering competition in both markets. The increase in competition changes the final outcomes.

The lowering of prices by the efficient firms will lower the demand shifter faced by all firms. This will force out the marginal D-type (i.e. lower a_D). It will also force the marginal exporters to stop exporting (i.e. a_X will fall). The impact on export productivity is slightly more subtle than in Melitz (2003) since the diagonal cumulation lowers intermediate input costs for some firms as well as drives out the least efficient ones. Unlike in Melitz (2003), trade liberalization drives some exporters to stop exporting since the liberalization only favours the most efficient firms.

In summary, relaxing ROOs via diagonal cumulation leads to three effects for the final good producers. First, least efficient firms are driven out from the market. Thus, the average productivity of the countries increases. Second, since the restriction on the intermediate good is relaxed, a larger range of exporting firms ask for preferential access (i.e. a_R will increase). Hence, the possibility of diagonal cumulation allows a larger number of exporting firms to take advantage of the FTA. Lastly, least productive exporters stop supplying the foreign markets.

Although it is not formalized in the model, it is possible to deduce the impact of diagonal cumulation on outside countries. As a consequence of increased competition within the hub and spoke countries, it is possible to predict that outsider exporters find it more difficult to supply the FTA partner.

Number of Firms. As a result of diagonal cumulation the total number of active firms is declining in both the hub and spoke countries. This is due to the increased level of competition.

[13] See Appendix A.3. for details.

4.3 Testable Implications: Extensive and Intensive Margins.

The results of this model yield a set of testable predictions concerning the productivity level, the number of firms, the extensive and the intensive margins of R-type and X-type firms[14]. In what follows we focus mainly on the extensive and the intensive margins of exports.

Testable Implication 1. *Diagonal cumulation leads to an increase in the number of firms exporting from the hub to the spoke, and from the spoke to the hub, and to a decrease in the number of firms exporting among the spokes.* This last result differs from what we find in the empirical part (where the extensive margin is positive). However, we should keep in mind that in the empirical part we mainly consider preferential trade among spokes, so we do not capture trade under MFN.

The number of varieties exported increases for the hub-spoke and spoke-hub trade because the relaxation of ROOs makes cheaper intermediate goods available without renouncing to the preference. On the other hand, the number of varieties exported decreases for the spokes, because few firms will now choose to export under MFN. Since we model the intermediate sector as homogeneous, we do not have any theoretical prediction regarding the intermediate good.

Testable Implication 2. *Diagonal cumulation leads to an increase in the intensive margin of the final good exported from the hub to the spoke, from the spoke to the hub and among the spokes.* The relaxation of ROOs is increasing the value of trade.

4.4 Welfare Effects of Trade Liberalization

From the indirect utility function we can examine the welfare of consumers. Since the indirect utility function[15] is given by $V = \beta E/P$, where P is the standard CES price index, we can examine the welfare effects simply by examining how P is changing. A greater openness will increase the welfare by lowering the price index[16], as well as a decrease in the domestic cutoff.

W/P?

[14] See Appendix A.4. for derivations.

[15] Without loss of generality, in this welfare analysis we are only concerned about the differentiated good.

[16] It can nevertheless happen that when trade costs are high and the number of foreign activities is strictly greater than the number of domestic firms, the effect of product varieties on welfare is negative (Melitz, 2002).

5 Empirical Framework

Our theoretical model predicts that diagonal cumulation relaxes ROOs leading to different effects among hub and spokes countries. Following our model, we find that relaxing the restrictive nature of ROOs induces an increase in the extensive and intensive margins of the final good for both the hub and the spoke.

Since we model the intermediate sector following the standard Krugman 1980, we do not have any predictions on the extensive and intensive margins of the intermediates. However, it is straightforward that in our model the introduction of diagonal cumulation leads to an increase in the extensive and intensive margin of the intermediate good for the spoke countries. Instead, for the hub countries, it is more difficult to make a clear prediction. Thus, we rely on the empirical model to identify the effect of cumulation on the intermediate good export.

We expect the following results. Firstly, following our theoretical predictions, we expect diagonal cumulation to increase the hub exports of the final good. The effects of diagonal cumulation are less straightforward for the intermediates. Indeed, on one hand diagonal cumulation reduces the protection granted to the hub intermediate producers; on the other hand the higher number of firms in the world might increase the demand for the intermediate. Secondly, diagonal cumulation increases spoke exports in both the intermediate and final good. Thirdly, for what concern the spoke-spoke trade, we expect that spoke-spoke exports increase as well. Finally, in line with our theoretical model, we expect that relaxing ROOs has the same effect on the extensive and intensive margin of trade for the final good.

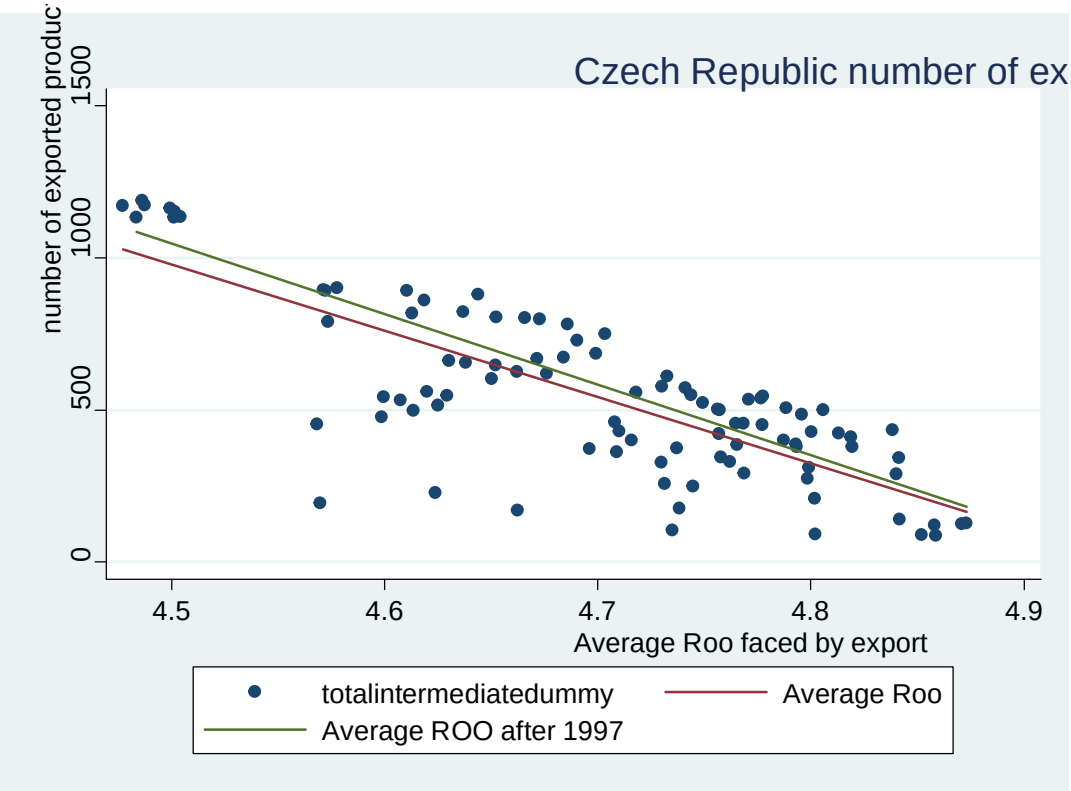
In what follows, we propose an empirical investigation of the effect of relaxing ROOs. More precisely, to test the predictions of the model, we look at the impact of diagonal cumulation taking as a natural experiment the Pan-European Cumulation System (PECS). The system introduced in 1997, has allowed the major part of the EU 15 FTA partners to cumulate stages of production in order to qualify for preferential access in the European market. Over the years the EU 15 signed different FTAs with EFTA, BAFTA, CEFTA and Med countries. ROOs with bilateral cumulation established that countries not belonging to the same FTA could not cumulate among each other if they wanted to export via preferential tariff to the EU 15 market. After 1997, the introduction of PECS relaxes the restrictive nature of ROOs. Indeed, countries are now allowed to diagonally cumulate while maintaining the originating status to the EU 15. To cumulate, the PECS countries need to be linked by FTA agreements which should include the Pan Euro Mediterranean protocol of origin. Among EFTA, BAFTA, CEFTA and Med countries these protocols have entered into force in different years

according to the country under consideration, leading to different possibility of cumulation. The EU 15 and the EFTA countries were the only members able to diagonally cumulate with all the Pan European nations by the end of 1997.

To analyze how the extensive and intensive margins of trade are affected by ROOs and ROCs, we consider the trade pattern among the EU 15, BAFTA, CEFTA, EFTA and MED countries during the 1995-2002. The estimation results will identify the pattern of export among the hub, which is represented by the EU 15, and the spoke countries, which are represented by the EFTA, BAFTA CEFTA and MED countries. Notice that the ROO Index variable captures also the effect of the preferential tariff. For this reason the effect of ROO Index variable in our estimation strategy needs to be interpreted as the overall effect of being part of the same FTA. We decided to omit preferential tariff for two main reasons: firstly preferential tariff would have been highly correlated with the ROO Index used and secondly due to the many missing values contained in the data on preferential tariff.

We intentionally analyze the trade pattern in the PECS zone by looking separately at the export from the EU 15 to the FTA partners and vice-versa. Finally, we look at the export among the EFTA, BAFTA, CEFTA and MED countries. We provide separate analysis since the model predicts different effect according to the direction of trade. The introduction of relaxed ROOs seems to increase trade in intermediate goods among the peripheral (spoke) countries. Figure 3 gives an idea of the effect of relaxing ROOs in a specific spoke country.

Figure 3:



The y axis measures the number of products exported by the Czech Republic to the EFTA, BAFTA, CEFTA countries in each year under study, while the x axis shows the average ROO Index faced by these products. The ROO Index has been developed by de Melo et al. (2007) and represents the restrictiveness of ROO imposed by the EU to its FTA partners. This Index varies from 1 to 7, with 7 being the higher value associated with more restrictive ROOs. The graph provides an example of the difficulty faced by peripheral countries to couple with restrictive ROOs. Since ROOs are more difficult to comply with, the number of intermediates exported to other peripheral countries decreases with ROOs (red line). After 1997, when the Czech Republic has already signed a great part of cumulation agreements, the number of intermediate goods exported to the peripheral countries is still decreasing with ROOs, but to a lesser extent (green line).

In order to examine whether the pattern of trade follows the theoretical predictions, we bring the model to the data. To do this we follow the two steps procedure adopted by HMR (2008) in order to correct for the sample selection effects and the presence of firms heterogeneity. Differently from

HMR, we applied the strategy using the HS 1992 classification, which disaggregates trade flows across 5019 tariff lines. In the following sections, we highlight the empirical strategy and the econometric specification of the model. In section 5.2 we provide the results that follow from the empirical setting and a comparison with the theoretical predictions.

5.1 Two Steps Procedure

Using a two step procedure we estimate the effect on trade of more relaxed ROOs. We consider separately changes in hub-spoke, spoke-hub and spoke-spoke trade as a consequence of ROOs with diagonal cumulation. To avoid the classical mistake we follow HMR to consider the firm heterogeneity aspect.

The fist step of this procedure consists in estimating the extensive margin of trade, i.e. the probability of exporting. Generally, the latent variable is determined by:

$$y^*_{odkt} = \mathbf{x}\boldsymbol{\beta} + e_{odkt}$$

where y^*_{odkt} represents the profit from exporting, o and d represent the origin and the destination country, k the tariff line at the HS6 (1992) and t the year, where $\mathbf{x}\boldsymbol{\beta}$ equal to $\beta_1+\beta_2 x_{odkt}+...+\beta_k x_{odkt}$. Following our theoretical model, positive trade flows are observed if firms export at least under MFN, since this represents the highest unit input requirement needed to become an exporter. Meaning that profits from export are positive only if the unit input requirement of the firm is lower than the export cutoff in 11. Since we do not observe the export cutoff we thus associate the presence of positive export profits with positive trade flows. Hence, we choose as an indicator variable y_{odkt}. When $y_{odkt} = 1$ we observe positive export flow from country o to country d for tariff line k in year t, so that:

$$y_{odkt} = \begin{cases} 1 \text{ if } y^*_{odkt} > 0 \\ 0 \text{ if } y^*_{odkt} \leq 0 \end{cases}$$

We can easily obtain the distribution of y_{odkt} given $\mathbf{x}$:

$$\Pr(y_{odkt} = 1|\mathbf{x}) = \Pr(y^*_{odkt} > 0|\mathbf{x}) = \Pr(\mathbf{x}\boldsymbol{\beta} + e_{odkt} > 0|\mathbf{x})$$

$$= \Pr(e_{odkt} > -(\mathbf{x}\boldsymbol{\beta})|\mathbf{x}) = 1 - \Phi(-\mathbf{x}\boldsymbol{\beta}) = \Phi(\mathbf{x}\boldsymbol{\beta}) \quad (18)$$

this represents the probability that country o exports to d, conditional on the observed variables, where $\Phi(.)$ is the cdf of the unit-normal distribution.

To simplify notation, we follow HMR in assuming the existence of a lower bound in the Pareto distribution[17]. More specifically, we set $G(a) = (a^k - a_L^k)/(a_D^k - a_L^k)$, $k > (\sigma - 1)$. As HMR, we allow for $a_x < a_L$ for some o-d pairs, inducing zero export from d to o[18]. This specification allows for asymmetric bilateral trade flows including zeros.

We define y_{odkt} as ratio between the export cutoff a_x and the lower bound, a_L.

Using 11 and the relationship existing between (3) and (4), we can express the probability of observing positive trade flows as follows[19]:

$$\Pr ob(y_{odkt} = 1|\mathbf{x}) = \Phi\left(\frac{a_L^{1-\sigma}\left((3/2)\,P_{M,Roo}^{(1-\sigma)}\right)^{\eta} B^d \phi_{FTA}\lambda)}{f_X}\right) \tag{19}$$

where $B^d = A/P_{f,d}^{1-\sigma}$and $A = (\mu E/\sigma)\,(\sigma/1-\sigma)^{1-\sigma}$ and $\lambda \geq (2/3)^{\eta}$[20]. Equation (19) is the ratio of the variable export profits for the most productive firm, i.e. with $a = a_L$, to the fixed export costs. Hence, we observe positive exports only when the elements inside Φ end up being larger than one. Using this specification we can rewrite the latent variable as:

$$y_{odkt}^* = \alpha + \iota(\phi_{FTA}p_{M,Roo}) + \kappa p_{f,d} + \varphi e + \gamma f_X$$

where lower case letters represent the variables in logarithmic form.

Let $\hat{\rho}$ be the predicted probability of export that is derived from equation (19), then $\hat{y}_{odkt}^* = \Phi^{-1}(\hat{\rho})$ is the predicted value of the latent variable. $\hat{\rho}$ and $\hat{y}_{odkt}^*$ can be used to construct the inverse Mills ratio, $\hat{\psi}_{odkt}^*$, which represent the standard Heckman correction for standard sample selection, which corrects for the bias generated by the unobserved country pair level shocks. On the other hand, following HMR, firm heterogeneity is taken into account by the introduction of the non linear term equal to the sum of the predicted latent variable and the Mills ration, i.e. $\hat{y}_{odkt}^* + \hat{\psi}_{odkt}^*$.

Controlling for both firms heterogeneity the selection of country pairs into trading partner we can estimate the bilateral trade flow. More precisely, in our model the values of per firm bilateral exports

[17] This assumption does not change any of our results.

[18] Where a_x represents the cutoff of being a successful exporter.

[19] Using equations (3) and (4), we find $P_M^{\mu(1-\sigma)} = \left[3/2P_{M,Roo}^{(1-\sigma)}\right]^{\mu}$.

[20] In the same way we want to express expressing ϕ_{MNF} in terms of ϕ_{FTA}, hence $\phi_{MNF} = \phi_{FTA}\lambda$. This relationship represents the reality since FTA tariff cannot be renegotiable.

equal:

$$\begin{aligned} v(a_X) &= a^{1-\sigma}\left((3/2)\,P_{M,Roo}^{(1-\sigma)}\right)^{\eta} B^d \phi_{FTA}\lambda \;\text{ if } a_R < a \leq a_X \\ v(a_R) &= a^{1-\sigma} P_{M,Roo}^{\eta(1-\sigma)} B^d \phi_{FTA} \;\text{ if } a \leq a_R \end{aligned} \tag{20}$$

Thus the total bilateral exports will be the sum of the value of export of firms that fulfil ROOs and firms which export under MFN. Thus, $V = \int_{a_L}^{a_R} v(a_R)dG(a/a_D) + \int_{a_R}^{a_x} v(a_X)dG(a/a_D)$, can be simplified to:

$$V = \left(\frac{\sigma}{1-\sigma}\right)^{1-\sigma} \phi_{FTA}\left(P_{M,Roo}\right)^{\eta(1-\sigma)} \frac{\mu E_d}{P_{f,d}^{1-\sigma}\sigma}\left\{\int_{a_L}^{a_R} a^{1-\sigma}dG(a/\bar{a}) + (3/2)^{\eta}\lambda\int_{a_R}^{a_x} a^{1-\sigma}dG(a/\bar{a})\right\}$$

Then, assuming $\lambda = (2/3)^{\eta}$, the total bilateral exports reduce to:

$$V = \left(\frac{\sigma}{1-\sigma}\right)^{1-\sigma} \phi_{FTA}\left(P_{M,Roo}\right)^{\eta(1-\sigma)} \frac{\mu E_d}{P_{f,d}^{1-\sigma}\sigma}\left[\left(\frac{a_x}{a_L}\right)^{k-\sigma+1} - 1\right]$$

Taking logarithm the expression can be rewritten as:

$$m_{odkt} = \alpha + \iota(\theta_{FTA}p_{M,Roo}) + \kappa p_{f,d} + \varphi E_d + \beta_{u\psi}\hat{\psi}^*_{odkt} + \ln(\exp(\boldsymbol{\delta}(\hat{y}^*_{odkt} + \hat{\eta}^*_{odkt}) - 1))$$

where E_d is expenditure and is proxied using nominal GDP. The price index of the final good is proxy with importers fixed effect. The price index of the intermediate is proxy by exporting country dummies and by the ROOs Index developed by de Melo et al. (2007). Since according to our model, diagonal cumulation relaxes ROOs, we create a slope dummy by interacting the ROOs Index with a dummy equal one when two countries can cumulate and obtain original status to enter the EU 15 market. The dummy was generated following the EU Commission notice (2002/C 100/05).

To account for the different predictions of the model which distinguish between intermediate and final goods, both the ROO Index and the slope dummy are interacted with a final good dummy and an intermediate good dummy. This generates a total of four variables: the ROO Index and the slope dummy for the intermediate good and the ROO Index and the slope dummy for the final good. This is equivalent to running two separate regressions for the intermediate and the final good, since the effect

of ROO is not associated with a single slope line.

The intermediate and final good dummy were generated following the CEPII classification, by transformation level based on Broad Economic Categories of the UN. The classification divides the products into five category: parts and accessories, processed goods, consumption , investment and primary goods. We consider intermediate goods the ones classified as parts and accessories, processed and investment goods. Additionally, we control for all the other supply factors by introducing the nominal GDP of the exporting country. The fixed cost is proxied by the quality of legal system[21]. Finally, we introduce year dummies to deal with business cycle and exchange rate fluctuations.

Note, that in the Panel that looks at the exports from the EFTA, BAFTA, CEFTA and MED countries to the EU 15, the GDP of the importing country and the importer country fixed effect is captured by the year dummies. Instead, in the panel that looks at the export from the EU 15 to the EFTA, BAFTA, CEFTA and MED countries, the GDP of the exporting country and the exporter fixed effect is captured by the year dummies.

5.2 Results

In the estimation procedure we divide the panel into three sub panels: export from EU 15 to the EFTA, BAFTA CEFTA and MED countries (called exports from hub to spoke), exports from these last countries to the EU 15 (called exports from spoke to hub), and finally the exports among FTAs (called exports among spoke).

In Tables 1, 2 and 3 we report the results of the first step procedure: the extensive margin of trade. These tables show the probability of exporting from hub to spoke, the probability of exporting from spoke to hub and the probability of exporting among spokes respectively. In Table 4 and 5 are provided the results concerning the second step procedure: the intensive margin of trade.

The model prediction concerning the exports from hub to spoke is that diagonal cumulation leads to an increase in the extensive margin of the final good. As anticipated above, we do not have any theoretical prediction regarding the intermediate good. Table 1, which tests the implication of the hub and spoke trade, confirms the theoretical prediction on the final good. The introduction of PECS has increased the probability of exporting the final good. Concerning the probability of exporting the intermediate, our result suggests that diagonal cumulation has worsened the likelihood of exporting the intermediate. Additionally, the result shows that the restrictiveness of ROOs restrain the probability

[21] See the Appendix 4 for data source

of exporting the intermediate good by the EU 15, while it increases the probability of exporting the final good. An increase in the ROOs leads to a 0.4% decrease in intermediate trade, while it increases by 1% the probability of exporting the final good.

The model's prediction concerning the exports from spoke to hub is that diagonal cumulation increases the extensive margin of trade of the final good. We also expect that there will be a similar effect on the extensive and intensive margins of the intermediate. In Table 2 we explore these predictions. In line with the theoretical predictions we find that restrictive ROOs increase the probability that EFTA, BAFTA, CEFTA and MED countries export the intermediate as well as the final good. More precisely the probability of exporting the intermediate good to the EU 15 increases by 1%, and by 0.5% for the final. Differently from the results in Table 1, the probability of exporting from the spoke to the hub country increases for both the final and the intermediate good with restrictive ROOs.

According to our results, the restrictive ROOs have different effect on the hub and on the spoke countries. For the hub countries, EU 15, the restrictive ROOs lead to an increase in trade only in final goods. For the spoke countries, the restrictive ROOs have a stronger impact on the intermediate sector. This suggests a reorganization of production as a consequence of the FTAs, where the EU 15 shifted the intermediate stage of production to peripheral countries.

A comparison between Table 1 and 2 highlights that the introduction of PECS seems to have accentuated the reorganization of production through the relaxation of ROOs. The total effect of ROOs, i.e. the sum of the ROO Index and the interaction term between the ROO Index and the Pan-European dummy, leads to a 1.1% increase in the probability that the hub exports the final good, while it decreases by 0.6% the probability of exporting. If we compare these results with the ones form Table 2, we can conclude that EFTA, BAFTA and CEFTA countries have gained the most from the possibility to diagonally cumulate. Indeed, the total probability of exporting the intermediate goods to the EU 15 has increased by 2% and by 1.5% for the final good. This last effect can be explained by the beneficial effect of diagonal versus bilateral cumulation.

The reason behind these results relies on the pattern of trade in Europe in the period under consideration. The establishment of a FTA with bilateral ROOs seems to have decreased the intermediate trade among spoke countries. Conversely, the introduction of diagonal cumulation leads to an increase in both final and intermediate good trade among spoke countries. The decrease in the price of the intermediate good, allows producers to use cheaper intermediates and still qualify for preferential access. This boosts final good trade also between the hub and the spoke countries.

The last prediction of the model concerns the effect of diagonal cumulation in the spoke-spoke trade. In the theoretical model we find that relaxing ROOs increases the spoke-spoke exports. Table 3, which tests the implication of the spoke-spoke trade, confirms these theoretical predictions. ROOs without diagonal cumulation restrain the probability of exporting the intermediate good among peripheral countries by 0.1%. The introduction of diagonal cumulation reverts this effect: diagonal cumulation increases by 0.2% the probability of exporting the intermediate good. Hence, the total effect of ROOs on the intermediate good is positive. Moreover, the total effect of ROOs on the final good adds up to 0.25% increase.

Concerning the effects of all the other variables, signs are as expected and all the coefficients are significant. Distance affects negatively the probability of export. Spoke countries not belonging to the same FTA are less likely to trade, while belonging to the same FTA increases the probability of export. Moreover, higher GDP of both the importing and exporting countries raises the probability of positive trade. Finally, the quality of the legal system, which in our estimation strategy represents the fixed cost, has a strong and positive effect on the probability of exporting. The average effect varies from 14% in the case of export from spoke to hub to 0.2% in the case of spoke-spoke trade. In line with HMR, the selection bias term as well as the heterogeneity term is positive and highly significant in all the panels analyzed. This implies that heterogeneous firms are indeed playing an important role in explaining trade flows, confirming that gravity equations should account for these factors.

Table 4 reports the second step estimation results for trade flows from hub to spoke countries. In Table 5 we have similar results for the export from the spoke to hub. Due to large amount of data involved in the spoke to spoke panel (more than 15 million data points), we were unable to perform this last step procedure for trade flows among spokes.

Trade volumes for both the intermediate and the final goods increase with ROOs and the effect is accentuated by diagonal cumulation. The volume of exports from the hub to the spoke increases by 17% for the intermediate good and by 8% for the final good. Considering Table 5, trade flows from spoke to hub country increase as well: by 10% for the intermediate and by 2.1% for the final good. Comparing the results of the second step with the first step procedure, all the signs are preserved for the final good as predicted by our model. It is worthwhile to notice that the effect of restrictive ROOs on the intermediate good exported from the hub to the spoke has a different sign for the extensive and intensive margins. It seems that restrictive ROOs has reduced the number of intermediate varieties exported by the hub while increase the volume of the already exported intermediates. A potential reason behind

this result could be attributed to the production shift from the hub to the spoke countries. This production shift could have occurred through the establishment of subsidiaries, leading to an increase in intra-firm trade.

Robustness checks

Table 6 to 11 show some sensitivity analysis. We perform two types of robustness checks: a logit and a tobit estimation. Logit estimations represent the probability of exporting and thus, look at the effects at the extensive margin of trade. Logit estimates confirm the results of the probit estimations. The only exception concerns the effect of being part to the same FTA in the case of spoke to spoke trade. There is not a rule of thumb for deciding whether logit or probit procedure should be preferred. We choose probit due to the fact that the normal distribution can be linked to the pareto distribution.

Turning to tobit estimates, results are confirmed. As in the previous section, the only exception concerns the effect of ROOs on the export of the intermediate good from the hub to the spoke. This exception could be linked to the previous results. Remember that the tobit regression represents the combined effect of the explanatory variables on both margins. In the previous section, we found that ROOs has a different effect on the extensive and intensive margin of the intermediate good exported from the hub to the spoke. Hence, tobit results would suggest that the intensive margin is more important than the extensive margin in explaining trade flows. This finding is confirmed by Hummels (), Baldwin and Harrigan (2007) and Brenton and Newfarmer (2007), which show that the intensive margin predominate the extensive margin in explaining trade flows.

6 Conclusion

Our paper makes four contributions to the literature. First, on the theory front, we analyse the impact of relaxing rules of origin (ROOs) in a simple setting with heterogeneous firms that buy intermediate inputs from domestic and foreign sources. In particular, we consider the impact of switching from bilateral to diagonal cumulation when using preferences (instead of paying the MFN tariff) involves a fixed cost. Due to this, relaxing the restrictiveness of the ROOs by moving to diagonal cumulation can move the extensive export margin in the opposite direction, i.e. liberalisation leads the least productive exporters to stop exporting. The reason is that wider cumulation boosts the competitiveness of the firms that are large enough to be constrained by them and this increased competitiveness pushes out the marginal exporters.

Second, empirically we are the first to estimate trade effects using the most recent techniques developed by Helpman, Melitz and Rubinstein (2007) on highly disaggregated data (HS6 digit). We show that the introduction of the Pan-European Cumulation System (PECS) has a positive effect on both the extensive and intensive margin of trade. This result is particularly strong for the Spoke countries who belong to the diagonal cumulation zone. In relation to Spoke to Spoke trade, the PECS reverses the negative impact of strict ROOs on intermediate trade which turns positive as a consequence of introducing diagonal ROCs.

Third, our particular application of HMR concerns the impact of rules of origin (ROOs). We find that relaxing the restrictiveness of ROOs by switching to diagonal cumulation increases trade, particularly among 'spoke' countries. The effect is particularly marked for intermediate goods; a result that suggests the ROOs were hindering the efficient organization of international supply networks. Fourth, our paper is the most comprehensive analysis to date of the trade effects of the Pan-European Cumulation System.

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Appendix

A.1. Regularity Condition

We discuss the condition which ensures that the operating profits from exporting under FTA is greater than the operating profits from exporting under MFN, namely:

$$O\Pi_R^d \geqslant O\Pi_X^d$$

substituting terms,

$$\frac{a^{1-\sigma}\left(2np_m^{1-\sigma}\right)^{\eta}\phi_{FTA}}{P_{f,d}^{1-\sigma}} \geqslant \frac{a^{1-\sigma}\left(3np_m^{1-\sigma}\right)^{\eta}\phi_{MFN}}{P_{f,d}^{1-\sigma}}$$

this can be rewritten as

$$1 > \phi_{FTA} \geqslant (3/2)^{\eta}\,\phi_{MFN}$$

when this condition holds we have that $O\Pi_R^d \geqslant O\Pi_X^d$, which ensures no deviations.

A.2. Free Entry and Price Index

Using the equilibrium cutoffs and the Pareto distributiuon we can rewrite (13) and (14) as:

$$\frac{\sigma-1}{k-\sigma+1}\left[f_D\left(\frac{f_D}{\Gamma B_{os}}\right)^{\frac{k}{1-\sigma}} + (f_R-f_X)\left(\frac{f_R-f_X}{(\Omega\phi_{FTA}-\Gamma\phi_{MFN})\,B_{dh}}\right)^{\frac{k}{1-\sigma}} + f_X\left(\frac{f_X}{\Gamma\phi_{MFN}B_{dh}}\right)^{\frac{k}{1-\sigma}}\right.$$

$$\left. + f_X\left(\frac{f_X}{\Gamma\phi_{MFN}B_{ds}}\right)^{\frac{k}{1-\sigma}}\right] = f_E \tag{21}$$

$$\frac{\sigma-1}{k-\sigma+1}\left[f_D\left(\frac{f_D}{\Gamma B_{oh}}\right)^{\frac{k}{1-\sigma}} + 2\,(f_R-f_X)\left(\frac{f_R-f_X}{(\Omega\phi_{FTA}-\Gamma\phi_{MFN})\,B_{dh}}\right)^{\frac{k}{1-\sigma}} + 2f_X\left(\frac{f_X}{\Gamma\phi_{MFN}B_{ds}}\right)^{\frac{k}{1-\sigma}}\right] = f_E \tag{22}$$

Then we solve this system of equations for B_s^* and B_h^* to obtain closed form solutions for the cut-offs.

After substituting in the Price indeces, 15 and 16, the closed form solutions for the cutoffs, 10-12, together with the solutions for B^*s, we can solve for the number of varieties produced in each countries.

A.3. ROOs with Diagonal Cumulation

The model is similar to the one solved before, what changes are the price indeces of the intermediates which now become identical: $P_M^{1-\sigma} = P_{M,Roo}^{1-\sigma} = 3np_m^{1-\sigma}$.

A.4. Extensive and Intensive Margins

The value of exports of a typical R-type firm tends to infinity as 'a' approaches zero, while for intermediate a's the value of exports equals to:

$$v\left(a\right) = \left[a\tau_{FTA}P_{M,Roo}^{\eta}\right]^{1-\sigma} \frac{\mu E}{P_{f,d}^{1-\sigma}} \left(\frac{\sigma}{1-\sigma}\right)^{1-\sigma} \tag{23}$$

From the R-type cutoff condition we can derive the following expression:

$$\frac{\mu E}{P_{f,d}^{1-\sigma}} \left(\frac{\sigma}{1-\sigma}\right)^{1-\sigma} = \frac{\sigma\left(f_R - f_X\right)}{a_R^{1-\sigma}\left(\phi_{FTA}P_{M,Roo}^{\eta(1-\sigma)} - \phi_{MFN}P_{M,Roo}^{\eta(1-\sigma)}\right)} \tag{24}$$

replacing (24) in (23) we have that:

$$v\left(a_R\right) = \left[a\tau_{FTA}P_{M,Roo}^{\eta}\right]^{1-\sigma} \frac{\sigma\left(f_R - f_X\right)}{a_R^{1-\sigma}\left(\phi_{FTA}P_{M,Roo}^{\eta(1-\sigma)} - \phi_{MFN}P_{M,Roo}^{\eta(1-\sigma)}\right)} \tag{25}$$

which represents the R-type value of exports per firm. A similar procedure gives the X-type value of exports per firm:

$$v\left(a_X\right) = \left(\frac{a}{a_X}\right)^{1-\sigma} \sigma f_X \tag{26}$$

The change in the total value of exports can be demposed in the following margins:

$$\Delta v\left(a\right) = \underbrace{\Delta\left(\text{value per exporter}\right)}_{\text{Intensive Margin}} + \underbrace{\Delta\left(\#\text{ exporters}\right)\cdot\ \text{own value}}_{\text{Extensive Margin}}$$

Using (25) and (26) we can derive the extensive and intensive margins of trade for R and X types of firms. We want to analyse how these these margins are affected by the transition to less restrictive ROOs. More precisely,

$$\text{Intensive Margin} = \int_0^{a_{type}^0} \left[v(a, P_M^{'}, n^{'}) - v(a, P_M^{0}, n^{0}\right] dG(a) \tag{27}$$

$$\text{Extensive Margin} = \left(n^{'}_{\text{exp}} - n^{0}_{\text{exp}}\right) \tag{28}$$

where $n^{'}_{\text{exp}}$ and n^{0}_{exp} represents the number of exporting firms in the different scenarios: with ROOs and when ROOs are relaxed. These margines are calculated for R-type firms in spoke and in hub countries, as well as for X-type firms in spoke countries exporting to the hub and X-type firms in spoke countries exporting to the spokes.

A.5. Countries and Data

Countries

Algeria	Iceland	Poland
Bulgaria	Israel	Romania
Czech Republic	Jordan	Slovak Republic
Egypt	Latvia	Slovenia
Estonia	Lebanon	Switzerland
EU 15	Lituania	Tunisia
Hungary	Norway	Turkey

Data

Export (1992 HS6):	CEPII (2008): BACI database
GDP (current USD):	World Bank (2008): World Development Indicators
Rules of Origin Index*:	Cadot O., Carrère C., de Melo J. and Bolormaa T. (2005)
Rules of Law Indicator:	World Bank (2007): Governance Indicator
Data Period:	1995-2002

* 1998 values of the Rules of Law Indicator have been used over the period 1995-1997

A.6. Tables

Table 1

Probit estimate		
Dependent variable: Export dummy from Hub to Spoke		
	Raw coefficients	Marginal effects
Ln GDP importer	0.488*	0.069*
Roo intermediate good	-0.027*	-0.004*
Roo final good	0.075*	0.010*
PanEuropean*Roo intermediate good	-0.011*	-0.002*
PanEuropean*Roo final good	0.005*	0.0008*
Rule of law	0.156*	0.022*
Number of observations	753920	
Pseudo R squared	0.2252	
Log Likelihood	-3075211.7	
Constant, Exporter, Importer, year and sector fixed effects not reported		

Table 2

Probit estimate		
Dependent variable: Export dummy from Spoke to Hub		
	Raw coefficients	Marginal effects
Ln GDP exporter	0.273*	0.108*
Roo intermediate good	0.029*	0.011*
Roo final good	0.012*	0.005*
PanEuropean*Roo intermediate good	0.023*	0.009*
PanEuropean*Roo final good	0.024*	0.010*
Rule of law	0.361*	0.142*
Number of observations	762584	
Pseudo R squared	0.2788	
Log Likelihood	-379476.03	
Constant, Exporter year and sector fixed effects not reported		

Table 3

Probit estimate		
Dependent variable: Export dummy Spoke Spoke		
	Raw coefficients	Marginal effects
Ln GDP exporter	0.122*	0.010*
Ln GDP importer	0.314*	0.026*
Roo intermediate good	-0.014*	-0.0012*
Roo final good	0.006*	0.0005*
PanEuropean*Roo intermediate good	0.024*	0.002*
PanEuropean*Roo final good	0.025*	0.002*
common FTAs	0.090*	0.008**
not common FTAs	-0.206*	-0.016*
Rule of law	0.050*	0.004*
lndistance	-0.619*	-0.051*
Number of observations 13721040		
Pseudo R squared 0.2813		
Log Likelihood -3075211.7		
Constant, Exporter, Importer, year and sector fixed effects not reported		

Table 4 and 5: Non Linear

Second step: Non linear least square		
Dependent variable: Ln Export from Hub to Spoke		
	Raw coefficients	Marginal effects
Ln GDP importer	0.439*	
Roo intermediate good	0.114*	
Roo final good	0.026*	
PanEuropean*Roo intermediate good	0.056*	
PanEuropean*Roo final good	0.054*	
eta	145.685*	
w	41.046*	
Number of observations 13721040		
Adj R squared 0.3492		
Constant, Importer, year and sector fixed effects not reported		

Second step: Non linear least square		
Dependent variable: Ln Export from Spoke to Hub		
	Raw coefficients	Marginal effects
Ln GDP exporter	0.620*	
Roo intermediate good	0.076*	
Roo final good	0.019*	
PanEuropean*Roo intermediate good	0.025*	
PanEuropean*Roo final good	0.002*	
eta	58.527*	
w	18.26*	
Number of observations 13721040		
Adj R squared 0.3889		
Constant, Exporter, year and sector fixed effects not reported		

Tables 6

Logit estimate		
Dependent variable: Export dummy from Hub to Spoke		
	Raw coefficients	Marginal effects
Ln GDP importer	0.843*	0.053*
Roo intermediate good	-0.050*	-0.003*
Roo final good	0.137*	0.009*
PanEuropean*Roo intermediate good	-0.016*	-0.001*
PanEuropean*Roo final good	0.013*	0.001*
Rule of law	0.240*	0.015*
Number of observations	753920	
Pseudo R squared	0.2245	
Log Likelihood	-235719.56	
Constant, Exporter, Importer, year and sector fixed effects not reported		

Tables 7

Logit estimate		
Dependent variable: Export dummy from Spoke to Hub		
	Raw coefficients	Marginal effects
Ln GDP exporter	0.444*	0.109*
Roo intermediate good	0.052*	0.013*
Roo final good	0.024*	0.005*
PanEuropean*Roo intermediate good	0.036*	0.009*
PanEuropean*Roo final good	0.038*	0.009*
Rule of law	0.614*	0.151*
Number of observations	762584	
Pseudo R squared	0.279	
Log Likelihood	-379399.3	
Constant, Exporter year and sector fixed effects not reported		

Table 8

Logit estimate		
Dependent variable: Export dummy Spoke Spoke		
	Raw coefficients	Marginal effects
Ln GDP exporter	0.320*	0.001*
Ln GDP importer	0.607*	0.020*
Roo intermediate good	-0.015*	-0.0005*
Roo final good	0.012*	0.0004*
PanEuropean*Roo intermediate good	0.022*	0.0007*
PanEuropean*Roo final good	0.036*	0.001*
common FTAs	-0.017**	-0.0006**
not common FTAs	-0.513*	-0.017*
Rule of law	0.107*	0.003*
lndistance	-1.210*	-0.040*
Number of observations	13721040	
Pseudo R squared	0.2789	
Log Likelihood	-3085837.1	
Constant, Exporter, Importer, year and sector fixed effects not reported		

Table 9

Tobit estimate				
Dependent variable: Ln Export from Hub to Spoke				
	Raw coefficients	Unconditional Exp. Value	Conditional on being uncens.	Probability uncensored
Ln GDP importer	1.018*	0.832*	0.613*	0.105*
Roo intermediate good	0.015*	0.013*	0.009*	0.002*
Roo final good	0.161*	0.132*	0.097*	0.017*
PanEuropean*Roo intermediate good	0.002*	0.003*	0.002*	0.004*
PanEuropean*Roo final good	0.039*	0.033*	0.024*	0.004*
Rule of law	0.418*	0.345*	0.254*	0.043*
Number of observations	753920			
Pseudo R squared	0.092			
Log Likelihood	-1642194.7			
Constant, Exporter, Importer, year and sector fixed effects not reported				

Table 10

Tobit estimate				
Dependent variable: Ln Export from Spoke to Hub				
	Raw coefficients	Unconditional Exp. Value	Conditional on being uncens.	Probability uncensored
Ln GDP exporter	0.848*	0.435*	0.314*	0.090*
Roo intermediate good	0.133*	0.068*	0.049*	0.014*
Roo final good	0.036*	0.019*	0.014*	0.004*
PanEuropean*Roo intermediate good	0.035*	0.018*	0.013*	0.004*
PanEuropean*Roo final good	0.021*	0.011*	0.008*	0.002*
Rule of law	1.184*	0.607*	0.439*	0.126*
Number of observations	762584			
Pseudo R squared	0.1216			
Log Likelihood	-1332487.7			
Constant, Exporter year and sector fixed effects not reported				

Table 11

Tobit estimate				
Dependent variable: Ln Export Spoke Spoke				
	Raw coefficients	Unconditional Exp. Value	Conditional on being uncens.	Probability uncensored
Ln GDP exporter	0.586*	0.050*	0.094*	0.021*
Ln GDP importer	1.182*	0.100*	0.189*	0.041*
Roo intermediate good	-0.042*	-0.003*	-0.007*	-0.001*
Roo final good	0.035*	0.003*	0.006*	0.001*
PanEuropean*Roo intermediate good	0.080*	0.007*	0.013*	0.003*
PanEuropean*Roo final good	0.097*	0.008*	0.016*	0.003*
common FTAs	0.345*	0.030*	0.055*	0.012*
not common FTAs	-0.833*	-0.070*	-0.134*	-0.030*
Rule of law	0.147*	0.012*	0.024*	0.005*
lndistance	-2.626*	-0.222*	-0.421*	-0.092*
Number of observations	15251680			
Pseudo R squared	0.1906			
Log Likelihood	-5667299.4			
Constant, Exporter, Importer, year and sector fixed effects not reported				