



**CEPII**

**CENTRE  
D'ÉTUDES PROSPECTIVES  
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INTERNATIONALES**

No 2009 – 26  
October

DOCUMENT DE TRAVAIL

## Oil Prices, Geography and Endogenous Regionalism: Too Much Ado About (Almost) Nothing

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<sup>a</sup>Funding for this research from CIREM is gratefully acknowledged by Daniel Mirza

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## **OIL PRICES, GEOGRAPHY AND ENDOGENOUS REGIONALISM: TOO MUCH ADO ABOUT (ALMOST) NOTHING**

### **NON-TECHNICAL SUMMARY**

Some observers have noted that one effect of oil shocks is to reverse globalization by reallocating flows in favor of more regionalism. Although the idea is appealing it has never been tested.

In this paper we examine the hypothesis that oil prices affect differently transportation costs across partners, leading to more regionalism. By distorting relative prices of goods, an increase in oil values provokes a *reallocation* of resources across countries and thus have implications for national and global welfare. More intuitively, if one believes that an increase in oil prices makes more distant partners less competitive, then one would expect oil prices to favor regionalism, thus acting as a resistance force against long distance trade. Oil price increases might then act on welfare as regional trade agreements (RTAs) would do. They would divert trade flows from more efficient (or low cost) partners to less efficient partners, resulting in a welfare loss for the importing country. For close exporters however, oil price increases would then be welfare creating. Nevertheless, there are two main differences between oil effects and RTAs effects. First, oil shocks would favor regionalism in an endogenous manner through market forces, while RTAs are government type interventions. The second difference is a corollary of the first one: oil price increases act as a tax on consumers' revenue, although without any compensation *via* government revenues.

The regionalism effect of oil prices has also implications for health and the environment. Although greenhouse gas emissions would be lowered globally because of less volumes shipped over long distances, the relocation of production should increase, in turn, local air pollution.

We consider a general transport cost function whereby the cost of shipping a good implies variable but also fixed costs and then take it to the test. This simple although realistic assumption makes the impact of oil shocks depend on the extent to which transport is governed by variable costs relative to fixed ones. We then discuss how oil prices in this more general form can be affecting the geography of trade. It turns out that more distant economies suffer more from an increase in oil prices than closer trading partners. That is because oil prices affect variable costs, which share in total costs increases with longer distance.

In a second step, we embody this new technology function of transport into a gravity equation and discuss how oil prices affect trade flows through changes in transportation charges.

In order to estimate empirically the oil impact on trade geography, we use Robert Feenstra's US bilateral imports and freight charges data at the SITC4 product level (over 1000 products). Alternatively, in order to account for transport modes in our equations, we use the same type of data by mode of transport kindly provided by David Hummels. The two series are available for the period 1974-2001. We first find that the elasticity of transport costs to oil prices to be around 0.1, where an observed country is at a median distance from the US. However, it is around 0.103 for long distance exporters (more than 10,000 kilometers) and around 0.088 for closer ones (less than 3,000 kilometers). Oil price changes lower then

close countries' relative transport costs at the expense of distant partners. This has implications for trade flows. After estimating an elasticity of export to US market shares to freight rates to be around 1.12, we estimate an elasticity of relative market shares to oil prices to be around 0,013 for close to the US countries and -0,004 for faraway ones. We then simulate the contribution of last years dramatic changes in oil prices to market share changes into the US market. We find that the recent oil shock have had a maigre contribution: it marginally narrowed the observed decrease in Canada and Mexico's shares and had a small if not almost insignificant negative contribution on India and China's relative growth shares. Besides, we also look at the extensive margins by trying to estimate and then simulate the impact of the shock on the relative probability to export. Here too, we find that Canada and Mexico increase their relative propensity to export following the shock compared to India and China's likelihood of exports. But these changes are very small with respect to the huge increase in oil prices observed during the last shock.

## **ABSTRACT**

This paper studies the effect of oil prices on the geography of international trade. We model transport costs as a function of variable and fixed costs. By affecting the first cost component, oil prices can then modify the structure of transportation costs across partners. This, we argue, acts as a factor of distortion in relative prices, thereby creating a reallocation of trade at the expense of remote countries. In that respect, an increase in oil prices should favor regionalism.

This mechanism is empirically tested using data on US bilateral imports and transportation costs. The empirical results are consistent with the theoretical intuition. But, the elasticity of freight rates to oil prices, directly linked to geographical distance, appears to be low: between 0.088 for close to US countries and 0.103 for faraway ones. We then estimate the contribution of the dramatic increase in oil prices, in recent years, to relative changes in the countries' probability to export to the US (extensive margins) along with their relative market shares (intensive margins). We find that the recent oil price increases that took place after 1999 have had only a maigre contribution: the last oil shock had contributed marginally to increase Canada and Mexico's relative performance.

*JEL Classification:* F15, F19, F20, L91

*Keywords:* Regionalism, Oil Prices, Geography, Transport

## PRIX DU PÉTROLE, GÉOGRAPHIE ET RÉGIONALISME ENDOGÈNE

### RÉSUMÉ NON TECHNIQUE

Certains analystes considèrent que les chocs pétroliers pourraient inverser le phénomène de globalisation au profit de la régionalisation des échanges. Bien que souvent mentionnée, cette idée n'a jamais été testée.

Dans ce papier, nous examinons l'hypothèse selon laquelle les prix pétroliers, en affectant différemment les coûts de transport selon la distance qui sépare les partenaires, favorisent la régionalisation. Une augmentation des prix du pétrole rendrait les partenaires distants moins compétitifs que les pays voisins. Ainsi, une augmentation du prix du pétrole agirait comme des accords commerciaux régionaux le feraient : elle détournerait les flux commerciaux des pays fournisseurs les plus efficaces (ou à plus faibles coûts) en faveur des partenaires plus proches mais moins efficaces, résultant ainsi en une perte de bien-être pour le pays importateur. En revanche, parce que les exportations des pays voisins tendrait à croître, leur bien-être augmenterait. Il existe néanmoins deux différences principales entre les effets du pétrole et ceux des accords régionaux de libre échange. A l'inverse de ces derniers dont la signature réduit directement les coûts à l'échange (baisse des droits de douane entre pays proches), les chocs pétroliers renforceraient la régionalisation non pas de manière institutionnelle mais par le simple jeu des marchés (via une baisse des coûts de transports). La deuxième différence est un corollaire de la première : l'augmentation du prix du pétrole a un effet sur les consommateurs comparable à celui d'une taxe, mais sans que celle-ci constitue une recette pour l'État.

La régionalisation que les prix du pétrole provoqueraient aurait aussi des conséquences pour la santé et l'environnement. Les émissions de gaz à effet de serre seraient abaissées au niveau mondial en raison de moindres volumes transportés sur de longues distances, mais la relocalisation de la production devrait augmenter localement les taux de pollution de l'air.

Nous considérons une fonction générale des coûts du transport formée de coûts fixes et de coûts variables puis la soumettons aux tests économétriques. Comme le prix du pétrole affecte directement les coûts variables générés pendant le temps de transport, son impact sur le coût de transport total (fixe et variable) dépend de la part de ce coût dans la facture totale. Parce qu'elles doivent supporter une charge relativement plus élevée de coûts variables les économies éloignées seraient alors plus affectées par les chocs pétroliers que les économies proches des marchés.

Dans une seconde phase, nous imbriquons cette fonction de coût dans l'équation de gravité du commerce bilatéral et montrons comment les prix du pétrole sont susceptibles de modifier les parts de marché.

Pour estimer l'impact distorsif du prix du pétrole sur le commerce international, nous utilisons la base de Feenstra reportant les données d'importation bilatérales des Etats Unis ainsi que les coûts de transport correspondants au niveau produit (SITC4 digits) sur la période 1974-2001. Nous montrons qu'une augmentation de 10% des prix du pétrole est associée à près d'1% de plus de taux de fret, pour un pays partenaire localisé à une distance médiane des Etats Unis (élasticité de 0,1). Cette élasticité augmente modérément avec la distance du pays aux Etats Unis : elle est de 0,103 pour les pays situés à une distance

de près de 10 000 km et descend à 0,088 pour des pays proches (autour de 3 000 km). Les prix du pétrole tendent alors à favoriser les pays proches aux dépens des pays éloignés.

Ce constat se traduit directement dans nos estimations d'impact sur les parts de marché. Nous montrons que 10% d'augmentation des prix du pétrole accroissent les parts de marché relatives des pays proches des Etats Unis (moins de 3 000km) de près de 0,1% tandis que ces parts baissent de 0,04% pour les pays éloignés (plus de 10 000 km). Ces résultats corroborent la théorie, mais montrent que les ordres de grandeur du phénomène sont trop faibles pour avoir un impact significatif sur la régionalisation.

## RÉSUMÉ COURT

Cet article étudie l'effet du prix du pétrole sur la géographie du commerce international. Nous modélisons les coûts de transport en fonction de coûts fixes et de coûts variables. En affectant les coûts variables qui dépendent directement de la distance de transport, les prix du pétrole peuvent distordre les prix relatifs et réallouer les flux aux dépens des pays éloignés. Ainsi, un accroissement des prix du pétrole pourrait favoriser le régionalisme.

Ce mécanisme est testé empiriquement sur données américaines d'importations et de coûts de fret. Les résultats sont conformes à l'intuition théorique. Mais l'élasticité du fret au prix du pétrole est faible : entre 0,088 pour les pays proches et 0,103 pour les pays éloignés des Etats Unis. Nous estimons ensuite l'impact de la contribution du choc pétrolier récent sur la probabilité d'exporter (marge extensive) et sur les parts de marchés des produits déjà exportés vers les Etats Unis (marge intensive). Nous montrons que les augmentations du prix du baril intervenues après 1999 ont très faiblement contribué aux effets de régionalisation: le prix du pétrole aurait favorisé très marginalement les parts de marché canadiennes et mexicaines, sans pour autant inverser la tendance à la baisse de ces dernières. "

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*Mots clés* : Régionalisme, Prix du pétrole, Géographie, Transport

## OIL PRICES, GEOGRAPHY AND ENDOGENOUS REGIONALISM: TOO MUCH ADO ABOUT (ALMOST) NOTHING<sup>1</sup>

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### 1. INTRODUCTION

Between 1999 and 2008 nominal oil prices have been multiplied by 7, raising from about 20US\$ per barrel to reach a peak of 146\$ during July 2008. Since then, oil market prices have been experiencing a sharp return. The 2008 financial crisis then reversed the expectations on oil demand and supply capacities, ending by the same token the speculation on oil prices. Many observers note, however, that in the medium run oil resources will experience a shortage, shifting again prices upward.<sup>2</sup>

What are the implications for globalization of changes in oil prices? Some observers already note that one effect of high oil prices is to reverse globalization by reallocating flows in favor of more regionalism.<sup>3</sup> Although appealing, this idea has never been tested. In the trade literature, three analytical papers we are aware of relate oil prices to trade. The first is that of Backus and Crucini (2000) who look at the impact of oil shocks on the trade balance through changes in terms of trade. The two other papers discuss the impact of oil prices on transportation costs by considering implicitly or explicitly, that oil price shocks can act as a global tax, affecting freights and trade flows at the same pace. Hummels (2007) shows regression results of freight costs where an oil price explanatory variable is independently included. It appears with a positive and statistically significant coefficient. More recently, Bridgman (2008) simulates a Ricardian model of trade where energy is used as an input in the shipping technology of trading the industrial good. In the simulated model, he shows that transportation costs slow the growth of international trade: during the seventies and beginning of the eighties oil shocks period, the simulated effect even offset that of the decline in tariffs.

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<sup>1</sup>We wish to thank Florent Pigeon and Emmanuel Milet for excellent research assistance as well as Matthieu Crozet and Agnes Benassy-Quéré for their very helpful comments on an earlier draft of this paper.

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<sup>2</sup>Hamilton's (2008) work is consistent with such a prediction. He tends to show very clearly that the scarcity of oil resources has been more relevant to explain recent years price increases than ever before.

<sup>3</sup>Rubin and Tal (2008) is one policy brief article we know about that considers the impact of oil prices on globalization. But the authors work remain too much descriptive to be able to draw out some solid conclusions on the nature and the extent of the link between oil prices, transportation and global/regional trade.

The present paper considers a different view. We are not interested here at estimating the impact of oil price changes on absolute trade volumes *per se* but by how much oil price increases are shaping the distribution of trade flows. We examine the hypothesis that oil prices affect differently transportation costs across partners, leading to more regionalism. By distorting relative prices of goods, an increase in oil values provokes a *reallocation* of resources across countries and thus has implications for national and global welfare. More intuitively, if one believes that an increase in oil prices makes more distant partners less competitive, then one would expect oil prices to favor regionalism, thus acting as a resistance force against long distance trade. Oil price increases might then act on welfare as regional trade agreements (RTAs) would do. They would divert trade flows from more efficient (or low cost) partners to less efficient but closer partners, resulting in a welfare loss for the importing country. For the close partners however, oil price increases would then be welfare creating. Nevertheless, there are two main differences between oil effects and RTAs effects. First, oil shocks would favor regionalism in an endogenous manner through market forces, while RTAs are government type interventions. The second difference is a corollary of the first one: oil price increases act as a tax on consumers' revenue, although without any compensation *via* government revenues.

The regionalism effect of oil prices has also implications for health and the environment. Although greenhouse gas emissions would be lowered globally because of less volumes shipped over long distances, the relocation of production should increase, in turn, local air pollution.

Now, if transport costs were to be proportionally linked to oil prices, trade theory suggests that an increase in the value of oil should reduce imports from all countries but without changing import distribution across partners. This is because a global oil shock should increase all prices proportionally, thus leaving all relative prices in the manufacturing sector unaffected.

If, however, transport costs do not respond proportionally to oil prices the distribution of trade costs and trade flows across partners can be altered. In this paper, we consider a general transport cost function whereby the cost of shipping a good implies variable but also fixed costs and then take it to the test. This simple although realistic assumption makes the impact of oil shocks depend on the extent to which transport is governed by variable costs relative to fixed ones. We then discuss how oil prices in this more general form can affect the geography of trade. It turns out that more distant economies suffer more from an increase in oil prices than closer trading partners. This is because oil prices affect variable costs, which share in total costs increases with longer distance.

In a second step, we embody this transport cost function into a gravity-like equation and discuss how oil prices affect trade shares through changes in relative transportation charges.

In order to estimate empirically the oil impact on trade geography, we use Robert Feenstra's US bilateral imports and freight charges data at the SITC4 product level (over 1000 products). Alternatively, in order to account for transport modes in our equations, we use the same type of data by mode of transport kindly provided by David Hummels. The two series are available for



the period 1974-2001.

Some macroeconomists would argue that oil prices can be, in turn, impacted by the globalisation process. As a matter of fact, higher global trade induces higher global demand for transportation and fuel, which would end-up raising the prices of the latter. Our product level data observed across trade pairs (US with each of their partners) has the advantage to control for the possible endogeneity of oil prices. In fact, we assume that US bilateral demand for a product as well as for its transportation are too small to affect the price of oil, set in global exchange markets.

We find, first, that the elasticity of transport costs to oil prices to be around 0.1, where an observed country is at a median distance from the US. However, it is around 0.103 for long distance exporters (more than 10,000 kilometers) and around 0.088 for closer ones (less than 3,000 kilometers). Then, oil price changes lower close countries' relative transport costs at the expense of distant partners. This has implications for trade flows. We estimate an elasticity of foreign suppliers market shares in the US to freight rates to be around 1.12. We infer from there the elasticity of relative market shares to oil prices. We find that a 10% increase in the oil price reduces the market share of distant partners by 0.04% while increasing close partner shares by 0.13%.

We then apply these elasticities to back-up the contribution of the oil shock to changes in the US imports distribution between 1999 and 2006.<sup>4</sup> We find that the recent oil shock had a maigre contribution: it marginally narrowed the observed decrease in Canada and Mexico's shares and had a small if not almost insignificant negative contribution on India and China's relative growth shares.

We also look at the extensive margins by trying to estimate and then simulate the impact of the shock on the relative probability to export to the US. Here too, we find that Canada and Mexico increase their relative propensity to export following the shock compared to India and China's likelihood of exports. But these changes are very small with respect to the huge increase in oil prices observed during the last period.

The paper is organized as follows: Section 2 displays the theoretical framework and develops the empirical specification. In Section 3, the data used is described and some stylized facts are presented. The econometric results are then presented in Section 4. Section 5 estimates the contribution of oil price increases over 1996-2006. The last section concludes.

## **2. THE ANALYTICAL FRAMEWORK**

### **2.1. The oil-price effect on transport costs**

In this section, we propose a theoretical formulation of transport costs in which we highlight the importance of fixed transport costs as a source of the non proportional response to oil prices.

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<sup>4</sup>Note that we could not have access to trade data for 2007 and 2008.

Transport costs in our framework are born out of variable costs,  $VC$ , and fixed costs,  $FC$ . Consider first, variable costs. As in Hummels and Skiba (2004), the freight charge per unit transported from  $i$  to a given importing country, say the  $US$ , involves two types of variable costs: a price-related component and a non-price related component. Secondly, let us assume that some fixed costs  $FC$  are spent over the year say, for vessel management and maintenance. The higher the quantities  $q$  that are shipped, however, the lower the fixed costs to bear per ton of transport. Hence, assume the following additive unit transport cost function (or per ton cost function):

$$uc_{i,US} = c_{i,US} + p_i^\beta + \frac{FC}{q_{i,US}} \quad (1)$$

where  $uc_{i,US}$  is the total cost of transporting one ton of merchandize and  $c_{i,US}$  represents the technology for transporting any given ton of good from  $i$  independently of its FOB price  $p_i$ . Besides,  $p_i^\beta$  is a premium charged that is a function of the price (with  $\beta \geq 0$ ). Prices reveal the quality of the goods to be shipped and high quality goods ask for higher insurance and handling costs in transportation.

Next, let us assume that the non-price related component  $c_{i,US}$  is proportional to distance. Indeed, if the shipping distance doubles one expects to use twice as more oil and, say, labor hours. Thus, let  $c_{i,US} = dist_{i,US} \cdot f(p_{oil}, w)$  where  $dist_{i,US}$  represents the distance between  $i$  and the  $US$ , and  $f$  being a technology function of transport per km, positively related to oil prices  $p_{oil}$  and on-board factor prices  $w$ . This specification is intuitive: for a zero distance, neither oil nor on-board labour are used to ship the merchandize.

Thus, oil affects the variable component  $c_{i,US}$  through its impact on the technology cost  $f(\cdot)$ . Nevertheless, the pass-through to the total (per unit) transportation cost  $uc_{i,US}$  depends on the extent to which the latter is governed by variable costs relative to fixed costs in the transport sector. Let  $s_c$  equal the variable share in total costs of shipping. A simple computation of the elasticity of transportation costs to the oil price gives the following:

$$\begin{aligned} \epsilon_{uc/p_{oil}} &= \frac{d(uc)/uc}{d(p_{oil})/p_{oil}} = s_c \cdot \frac{d(c_{i,US})/c_{i,US}}{d(p_{oil})/p_{oil}} \\ &= s_c \cdot \frac{d(f(\cdot))/f(\cdot)}{d(p_{oil})/p_{oil}} \end{aligned}$$

How can geographical distance affect the sensitivity of transport costs to oil prices ? Distance can make transport costs more sensitive to oil prices through  $s_c$ . The explanation is simple: an increase in the shipping distance of a given quantity and at a given price increases the variable costs while leaving fixed costs unaffected. As the share of variable costs is higher for distant

partners than for close ones, transportation costs from distant partners become more sensitive to oil shocks than transportation charge of goods that are shipped from close sources.

For estimation purposes, let us divide Equation (1) by the price of the good. We obtain an expression of freight rates,  $fr$ :

$$fr_{i,US} = \frac{1}{p_i} \left[ c_{i,US} + p_i^\beta + \frac{FC}{q_{i,US}} \right] \quad (2)$$

From (2), and expressing the fixed costs component by  $fc_{i,US} = (FC/q_{i,US})$  (i.e. fixed costs per ton of exported good), we can compute the proportional change in freight rates as a function of changes in variable and fixed rates and changes in the price of the good. Hence, let  $s_{fc}$  represent the share of fixed costs in total costs, and  $s_p$  represent the share of the good's price component of freight costs. We thus obtain:

$$\frac{d(fr_{i,US})}{fr_{i,US}} = s_c \cdot \frac{d(c_{i,US})}{c_{i,US}} + (s_{fc}) \cdot \frac{d(fc_{i,US})}{fc_{i,US}} + (\beta \cdot s_p - 1) \frac{d(p_i)}{p_i} \quad (3)$$

Equation (3) inspires our econometric specification. It tells that every increase in the variable costs component ( $c_i$ ) due to an oil price increase is passed through freight rates. This pass-through is higher when the share of this component in total costs is high. Geographical distance, as mentioned earlier, increases this share. Besides, because of returns to scale born by fixed costs, an increase in quantities that are shipped reduces the fixed costs of transport thereby reducing the freight charges. Finally, considering the reasonable assumption that the elasticity of transport costs to the prices of shipped goods to be lower than unity ( $0 < \beta < 1$ ), the corresponding elasticity of freight rates should be then negative and between 0 and -1. The lower the parameter  $\beta$  and the share of the price component in total costs of transports, however, the higher the negative relationship between goods' prices and freight rates. In the extreme case where prices do not affect transport charges per ton ( $\beta = 0$ ), all increases in prices should then proportionally reduce freight rates (i.e. cost of transport per dollar of the good).

To sum up, freight rates should depend positively on factor costs bared over the whole distance trip and negatively on the quantities and prices of the goods to be shipped. Thus, after adding a time subscript  $t$  and a product subscript  $k$  where suitable and removing the  $US$  subscript to simplify notations, we estimate the following log-linear equation:

$$\ln(fr_{ikt}) = \beta_1 + \beta_2 \ln(dist_i) + \beta_3 \ln(p_{oil})_t \ln(dist_i) + \beta_4 \ln(quantity_{ikt}) + \beta_5 \ln(UV_{ikt}) + u_{ikt} \quad (4)$$

As already mentioned, oil prices affect trade costs through distance: at zero distance, oil is not used and oil prices should not enter the equation. Besides, factors other than oil, also related to distance, are used in the transport technology  $f$  (like the number of hours worked by on-board

personnel). As we do not have access to factor prices other than oil we introduce distance on its own to capture the variation of these other factors.<sup>5</sup> The *quantity* variable, representing the quantity that is shipped, should capture economies of scale in the transport technology while Unit Values (*UV*), represent prices of goods and should reduce freight rates as mentioned above.

We also introduce some control variables to equation 4: First, we introduce a contiguity variable (*contiguity*), a dummy variable indicating if partners share a common border to take into account the fact that across border countries might have more developed transportation networks between them, thus exhibiting further reduction in transport costs. Besides, in order to better cover differences in transport technologies and their different impact on costs, we add three transport-mode dummies (*vessel*, *land* and *air*). We also add a time *trend* to our equation and where suitable, account for some product and/or exporting country fixed effects.<sup>6</sup>

For small variations in oil prices, the corresponding elasticity of freight rates to oil prices is then obtainable from equation (4) and equals

$$\widehat{\beta}_3 \cdot \ln(\text{dist}_j)$$

. Oil shocks imply large variations of oil prices, however. As log differences cannot be interpreted as growth rates in periods of large variations of oil prices, an adjustment is needed in this case.<sup>7</sup> The proportional change in freight rates consecutive to a change in the oil price can then be estimated by:

$$\frac{\Delta(fr_{kjt})}{(fr_{kjt})} = \left[ 1 + \frac{\Delta(p_{oil})}{p_{oil}} \right]^{\widehat{\beta}_3 \cdot \ln(\text{dist})} - 1$$

## 2.2. The trade equation

We are interested in studying the impact of oil prices on export market shares, through changes in transport costs. To this end, we need to model trade as a function of transportation costs, from which we can infer an impact on market shares.

We use a traditional standard monopolistic model of trade. Assume a representative US consumer with CES preferences over a given differentiated product *k* produced in different varieties

<sup>5</sup>One could imagine introducing wages in the transport sector for each partner country to represent on-board labour costs. This is not, however, a good idea because a big proportion of international transportation is served by ships and carriers that do not have the same nationality than the country of exports and/or imports.

<sup>6</sup>Ideally, we would have liked to include time fixed effects instead of a *trend*. Unfortunately, the inclusion of time effects resulted in a high multicollinearity between the distance variable and the interaction term (distance x oil prices) variable, producing a variation inflation factor (VIF) largely exceeding acceptable values.

<sup>7</sup>see proof in appendix A.

$v$ . The sub-utility function can be represented by:

$$U_{k,US} = \left[ \sum_i \int_v q_{i,v}^{(\sigma-1)/\sigma} dv \right]^{\sigma/(\sigma-1)}, \quad i = 1..I \quad v = 1..V \in k$$

Where  $q_{i,v}$  is consumption of variety  $v$  originating from country  $i$ .

Assume  $p_i$  is the FOB exporter's price of any variety  $v$  produced in country  $i$  (prices of all varieties equal at equilibrium) and  $\tau_{i,k} > 1$  is the trade cost (one plus ad-valorem costs) associated to exporting some variety of a product  $k$  to the  $US$ .

Maximizing the utility subject to budget constraint yields the following demand function per variety:

$$q_{i,v} = q_i = \left[ \frac{\tau_{i,k} p_i}{P_{US,k}} \right]^{-\sigma} \frac{Y_{US,k}}{P_{US,k}} \quad (5)$$

where  $P_{US,k} = \left[ \sum_i \int_v (p_{i,v} \tau_{i,k})^{-(\sigma-1)} \right]^{\frac{-1}{\sigma-1}}$  is the CES price index and  $Y_{US,k}$  is the importer's expenditure that is spent on all varieties of the product  $k$ .

Recall that in the standard model, each firm produces and exports one variety of good  $k$  from country  $i$  to the US market. After introducing a time subscript, total quantities of good  $k$  imported from  $i$  at time  $t$  is then given by the following expression:

$$m_{ikt} = n_{i,k,t} \tau_{ikt} q_{it} = n_{ikt} \tau_{ikt}^{-(\sigma-1)} p_{ikt}^{(-\sigma)} \frac{Y_{US,kt}}{P_{US,kt}^{1-\sigma}} \quad (6)$$

Many variables can approximate the trade costs ( $\tau_{ikt}$ ). Along with the transport costs ( $fr_{ikt}$ ), trade costs can also include ad-valorem tariff rates ( $tariff_{ikt}$ ) and a series of country and year effects. For more tractability, we assume  $\tau$  to take the following functional form  $\ln(\tau_{ikt}) = a \ln(1 + fr_{ikt}) + b \ln(1 + tariff_{ikt}) + fe_i + fe_t$  where  $a$  and  $b$  are two positive parameters while  $fe_i$  and  $fe_t$  are country and year fixed effects. Besides, we can ideally capture the  $\frac{Y_{US,kt}}{P_{US,kt}}$  term by (product\*time) cross effect ( $fe_{kt}$ ). But in most specifications we were constrained by STATA's difficulties of processing very big matrix calculations, and thus opted for a simple product effect  $fe_k$  as an alternative to our cross effect.

Taking the log of each variable, approximating the number of exporting firms by the GDP of the exporting country ( $GDP_{it}$ ), the prices by unit values ( $UV_{ikt}$ ), we can estimate the following basic equation:

$$\begin{aligned} \ln(m_{ikt}) = & -a.(\sigma - 1)\ln(fr_{ikt}) - b.(\sigma - 1)\ln(tariff_{ikt}) + (-\sigma)\ln(UV_{ikt}) + \lambda\ln(GDP_{it}) \\ & + fe_i + fe_k + fe_t + v_{ikt} \end{aligned} \quad (7)$$

This specification holds as long as freights are exogenous. But the preceding section shows that they are not: freight charges depend, in turn, on quantities and unit values, themselves being linked, by construction, to imports by the identity  $m_{ikt} = UV_{ikt} * quantity_{ikt}$ . Besides, freight charges and trade flows might be related to some common unobservable factors (think of the quality of reporting data at the US borders or a macroeconomic shock in some US partner country, hitting its transporters and producers alike). We handle these difficulties by running 3SLS regressions where both equations (7) and (4) are run simultaneously and where the residuals of both equations are taken to be also correlated to each other.

Our main purpose here is to link the variability of oil prices to changes in market shares, not changes in absolute values of trade flows. In other words, we do not want to look at how Canadian or Mexican exports to the US are affected in absolute values by oil shocks. Instead, we are more interested here in how Canadian and Mexican trade shares compared to those of other exporting countries to the US are affected after a jump in oil prices. In what follows, we define a strategy that allows us to do this work by estimating a relative (rather than absolute) equation of trade.

First, let us transform each of the variables into (geometric) means. Equation 6 becomes:

$$\overline{m}_{.,k} = \overline{n}_{.,k} \overline{\tau}_{.,k}^{-(\sigma-1)} \overline{p}_{.,k}^{(1-\sigma)} \left[ \frac{Y_{US,k}}{P_{US,k}^{1-\sigma}} \right] \quad (8)$$

where for each variable  $y$ :  $\overline{y}_{.,k} = \prod_i y_{i,k}^{1/I}$  represents the geometric mean over all exporting countries to the US.

Then, divide (6) by (8) in order to obtain a relative market shares equation:

$$Rm_{i,k} = Rn_{i,k} R\tau_{i,k}^{-(\sigma-1)} Rp_{i,k}^{(-\sigma)} \quad (9)$$

where for each variable  $y$ ,  $Ry_{ik} = \frac{y_{i,k}}{\overline{y}_{.,k}}$ . Notice from above that the term  $\frac{Y_{US,k}}{P_{US,k}}$  disappears when expressed in terms of the average exporter.<sup>8</sup>

Again, we approximate each theoretical variable by its observable counterpart (prices by unit values, trade costs by freights, tariffs and country fixed effects, etc...). We express them in relative terms and add a time index to obtain the following alternative specification to run:

$$\ln(Rm_{ikt}) = -a(\sigma-1)\ln(Rfr_{ikt}) - b(\sigma-1)\ln(Rtariff_{ikt}) - \sigma\ln(Rp_{ikt}) + \lambda\ln(RGDP_{it}) + Rfe_i \quad (10)$$

<sup>8</sup>As all exporters face the same demand (from US) and the same market price index,  $Y_{US,k}$  and  $P_{US,k}$  will then equal respectively  $\overline{Y}_{US,k}$  and  $\overline{P}_{US,k}$

Hence, whether we run the gravity specification in absolute values (7) or in relative values (10), the theory suggests that the coefficients one should obtain have to be comparable. From there, one can either compute changes in relative trade shares by using the coefficients obtained from running Equation (7) or by using the coefficients obtained from running Equation (10).

Nevertheless, in the last equation too, one still has to account for the endogeneity of transportation costs. We tried to run again a 3SLS where both equations of trade and transport cost were expressed in relative terms. But it turned out that in the transport cost equation, changes in the interaction variable (Oil prices\*distance) and changes in distance, when they were both expressed in relative terms, were highly collinear.<sup>9</sup> Instead, we account for endogeneity here by using an instrumental variable specification where freights are instrumented by variables which are supposed to shift the freight equation while being orthogonal to the residual of the trade share equation. The transport mode variables are good candidates since they affect freights via the supply side of the international transport market and without shifting *a priori* the trade shares' curve (and a fortiori its residual). More on this issue in the econometric section.

Finally, the effect of an oil-price change on relative imports can be recovered based on the following formulae:

- For small oil-price variations :

$$\frac{d\ln(R.m_{ikt})}{d\ln(p_{oil})_t} = \frac{d\ln(R.m_{ikt})}{d\ln(R.fr_{ikt})} \cdot \frac{d\ln(R.fr_{ikt})}{d\ln(p_{oil})_t} = -a(\widehat{\sigma} - 1)\widehat{\beta}_3 \cdot \ln(R.dist_i)$$

- For large variations (see appendix):

$$\frac{dR.m_{ikt}}{R.m_{ikt}} = -a(\widehat{\sigma} - 1) \left[ \left[ 1 + \frac{dp_{oil}}{p_{oil}} \right]^{\widehat{\beta}_3 \cdot \ln(R.dist_i)} - 1 \right] \quad (11)$$

The sign and magnitude of the impact on trade shares depends on the value of relative distance. A partner located at a distance from the US that is higher than the average ( $R.dist > 1$ ), should be negatively affected by an increase in the oil price. On the opposite, a partner country that is close enough to the US (i.e.  $R.dist < 1$ ) should be favored by an oil price increase. These mechanisms arise because relative distance impacts upon the relative cost of transport, which becomes lower for close to US countries, favoring the latter at the expense of remote ones.

### 3. DATA AND STYLIZED FACTS

We use Robert Feenstra's NBER US bilateral imports dataset. Bilateral imports are reported - in FOB *USD* values and physical quantities (tons)- along with the *USD* value of corresponding freight charges at the SITC 4-digits product level (over 1000 products).<sup>10</sup> The data is available

<sup>9</sup> The VIF computed in STATA reached around 100.

<sup>10</sup>Data is made available on the NBER website: <http://www.nber.org/data/>. It is described in Feenstra et al. (2001).

from 1974 to 2001. We drop all the observations for which quantities cannot be converted into tons. Besides, we are mainly interested in oil as an input in the international transport sector, not as an output to be traded. Hence, we exclude all oil-type products (sitc2 sectors 33 and 34) from the empirical analysis.

Feenstra's dataset does not distinguish between modes of transportation, generally undertaken by air, sea and/or land. It lists flows of goods and transport aggregated over all of these modes. Each mode implies a different technology of transport, however. In order to control for this in our empirical freight equation, we complete Feenstra's data by adding a mode of transport information provided by the US Bureau of Transportation Statistics and readily made available by David Hummels. These data distinguish between air and sea transportation to the US and is observed from each exporting country and for each SITC 4-digits level product reported over the considered period.<sup>11</sup> Finally, by merging both datasets and comparing figures, we could easily guess the products that were also shipped by land. So in our regressions, we will add three dummy variables (*land*, *vessel* and *air*) equal to 1 whenever positive flows for each transport mode are observed and 0 otherwise<sup>12</sup>.

Finally, we use the CEPII's database on distances freely available online.<sup>13</sup> As for macro variables, such as GDP, we use the World Development Indicators published by the World Bank.

Before turning to the econometric study, we display some stylized facts. Our main argument is that transport costs and market shares should not respond proportionally to oil-price variations across exporting countries to the US. More specifically, higher oil prices should favor closer countries by reducing their relative costs and increasing their market shares with respect to remote ones.

We thus split the countries into two groups: One *far from* the US group and another *close to* the US group and compute their relative average transport costs and market shares. The close countries' (*resp.* far) group comprises all countries which are at a distance that is less (*resp.* more) than 5000 km from the US. For each year, we compute average transport costs of close countries in terms of faraway countries<sup>14</sup>. We expect relative transportation costs of close countries to decline with oil prices. Figure 1 confirms the negative relationship between relative freight rates of close countries and oil-prices. In order to check for robustness, figure 2, offers the same picture by replacing freight rates by a measure of transportation charges per ton.

<sup>11</sup>The data is readily available from <http://www.mgmt.purdue.edu/faculty/hummels>

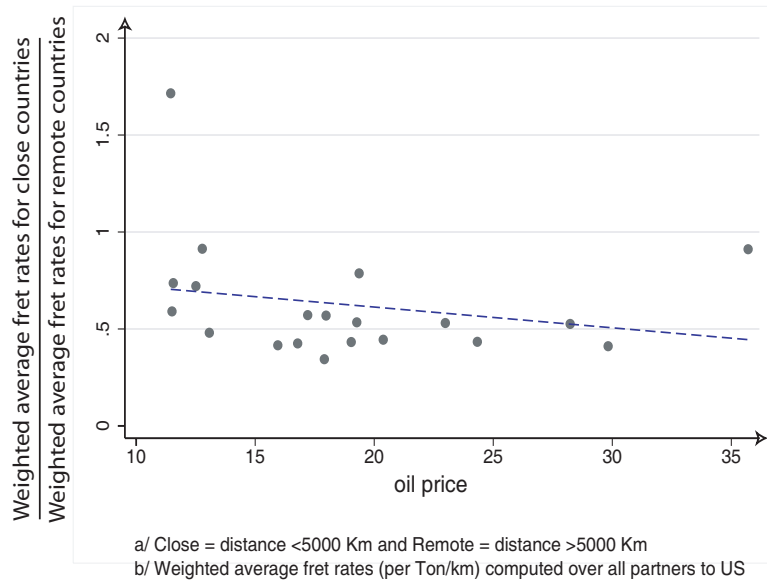
<sup>12</sup>By cross-checking Feenstra's data with that of Hummels we noticed that from 1982 to 1988, the aggregate data for Mexico and Canada reported in Feenstra were equal to the sum of air and sea values provided by Hummels. Thus, during these years, it appears that Feenstra's reported aggregates did not include land related figures. This is another reason why it has been important to include transport-mode dummy variables in our transport costs regressions. We have removed, however, these problematic observations from the stylised facts below.

<sup>13</sup><http://www.cepii.fr/francgraph/bdd/distances.htm>.

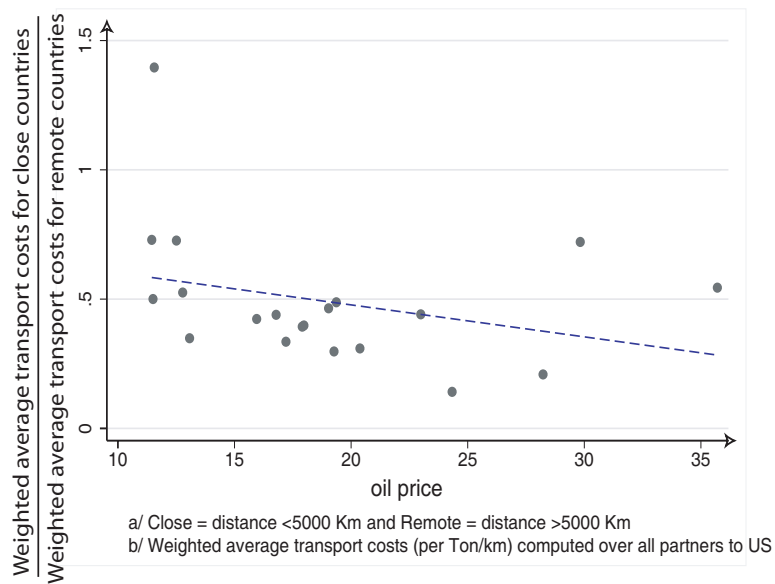
<sup>14</sup>Note that transport costs and freight rates are observed at the year, product and export country levels. In order to obtain a time varying representative indicator of transport costs over the whole samples of close and faraway countries, we compute weighted averages over the product and partner dimensions.

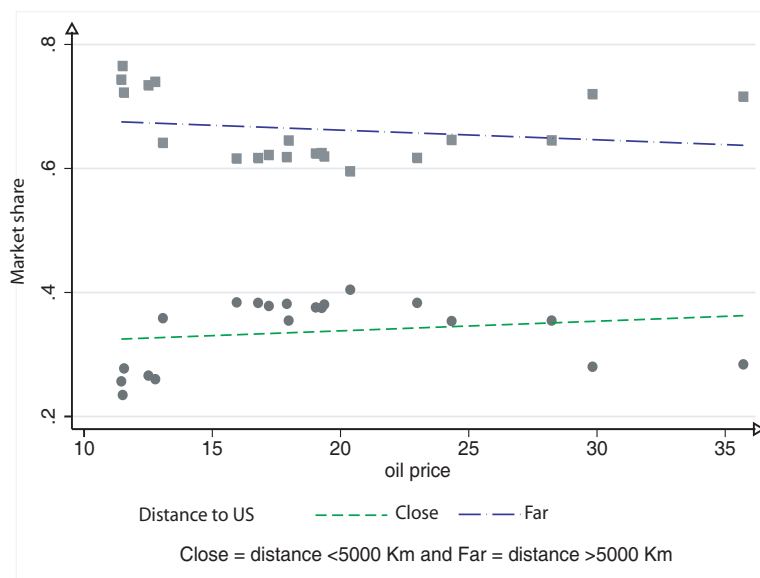


**Figure 1: Relative average freight rates & oil prices**



**Figure 2: relative average transport costs per Ton & oil prices**



**Figure 3: Market shares & oil prices**

In figure 3, using the same data, we illustrate the relationship between market shares and oil-prices. Again, countries are divided into the same two groups than previously. Figure 3 provides a message consistent with that revealed by the previous figures: an increase in the oil-price seems to be associated with an increase in the market share of close countries at the expense of faraway countries.

## 4. ECONOMETRIC RESULTS

### 4.1. Results for the Freight Equation

We want to assess the impact of the oil price on the distribution of trade costs and flows more properly by running econometric regressions. The first step of our econometrics is to begin running different formulations of the freight equation 4 where the dependant variable is the log of freight rates,  $\ln(fr_{ikt})$ . Results are reported in Table 1. Note that in all formulations, we control for heteroscedasticity by adjusting standard errors for intragroup correlations.

We first show the results of a benchmark equation where we do not include the oil price variable (column 1). The sign of the coefficients on quantities, unit values and distance appear to be in line with the set-up presented in subsection 2.1. Except for distance, the magnitude of these variables remain robust across all specifications. In particular, note that the transport technology exhibits scale economies (ie. negative coefficient on quantities). The coefficient is of about the same magnitude as that estimated in Hummels and Skiba (2004). Next, and as expected from our theory, the unit value coefficient is between 0 and -1, which means that prices of

Table 1: The Transport Cost Equation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>quantity</i>	-0.126 <sup>a</sup> (0.001)	-0.126 <sup>a</sup> (0.001)	-0.114 <sup>a</sup> (0.001)	-0.126 <sup>a</sup> (0.001)	-0.126 <sup>a</sup> (0.001)	-0.108 <sup>a</sup> (0.001)	-0.113 <sup>a</sup> (0.001)	-0.104 <sup>a</sup> (0.001)	-0.113 <sup>a</sup> (0.001)
<i>unit value</i>	-0.431 <sup>a</sup> (0.001)	-0.431 <sup>a</sup> (0.001)	-0.425 <sup>a</sup> (0.001)	-0.518 <sup>a</sup> (0.001)	-0.517 <sup>a</sup> (0.001)	-0.471 <sup>a</sup> (0.001)	-0.492 <sup>a</sup> (0.001)	-0.493 <sup>a</sup> (0.001)	-0.482 <sup>a</sup> (0.002)
<i>distance</i>	0.640 <sup>a</sup> (0.003)	0.622 <sup>a</sup> (0.004)	0.109 <sup>a</sup> (0.004)	0.169 <sup>a</sup> (0.004)	0.160 <sup>a</sup> (0.004)	0.183 <sup>a</sup> (0.004)	0.087 <sup>a</sup> (0.017)	0.109 <sup>a</sup> (0.018)	0.055 <sup>c</sup> (0.032)
<i>trend</i>	-0.001 <sup>a</sup> (0.000)	-0.001 <sup>a</sup> (0.000)	-0.002 <sup>a</sup> (0.000)	-0.002 <sup>a</sup> (0.000)	-0.002 <sup>a</sup> (0.000)	-0.002 <sup>a</sup> (0.000)	-0.002 <sup>a</sup> (0.000)	-0.007 <sup>a</sup> (0.000)	-0.025 <sup>a</sup> (0.001)
<i>dist.poil</i>		0.006 <sup>a</sup> (0.001)	0.007 <sup>a</sup> (0.001)	0.006 <sup>a</sup> (0.001)	0.008 <sup>a</sup> (0.001)	0.008 <sup>a</sup> (0.001)	0.008 <sup>a</sup> (0.001)	0.010 <sup>a</sup> (0.000)	0.011 <sup>a</sup> (0.001)
<i>contiguity</i>			-1.484 <sup>a</sup> (0.008)	-0.531 <sup>a</sup> (0.019)					
<i>vessel</i>				-0.120 <sup>a</sup> (0.005)	-0.120 <sup>a</sup> (0.005)	-0.128 <sup>a</sup> (0.005)	-0.132 <sup>a</sup> (0.005)	-0.202 <sup>a</sup> (0.005)	-0.078 <sup>a</sup> (0.007)
<i>land</i>				-1.047 <sup>a</sup> (0.020)	-0.982 <sup>a</sup> (0.019)	-1.038 <sup>a</sup> (0.018)	-0.983 <sup>a</sup> (0.019)		-0.686 <sup>a</sup> (0.041)
<i>air</i>				0.504 <sup>a</sup> (0.003)	0.504 <sup>a</sup> (0.003)	0.440 <sup>a</sup> (0.004)	0.490 <sup>a</sup> (0.004)	0.507 <sup>a</sup> (0.003)	0.597 <sup>a</sup> (0.006)
<i>contig.poil</i>					-0.203 <sup>a</sup> (0.006)	-0.176 <sup>a</sup> (0.006)	-0.311 <sup>a</sup> (0.014)		-0.052 <sup>c</sup> (0.030)
Constant	-6.467 <sup>a</sup> (0.029)	-6.461 <sup>a</sup> (0.029)	-1.909 <sup>a</sup> (0.037)	-2.356 <sup>a</sup> (0.036)	-2.319 <sup>a</sup> (0.035)	-2.733 <sup>a</sup> (0.035)	-2.276 <sup>a</sup> (0.184)	-2.383 <sup>a</sup> (0.195)	-1.728 <sup>a</sup> (0.318)
Observations	385859	385859	385859	385859	385859	385859	385859	357401	141337
R <sup>2</sup>	0.33	0.33	0.38	0.43	0.43	0.36			

All variables, except dummies are in logs

Robust standard errors in parentheses

columns (6) to (9) include product fixed effects

columns (7) to (9) include country random effects

<sup>c</sup> significant at 10%; <sup>b</sup> significant at 5%; <sup>a</sup> significant at 1%

the goods play some role in increasing the cost of shipment but these costs increase less than proportionally to prices (another result that is line with that of Hummels and Skiba (2004)). Hence, while unit values should increase the charge of transport per ton, the cost per dollar of a shipped good (i.e. its corresponding freight rate) ends-up decreasing.<sup>15</sup> Finally, distance appears with the expected sign and an elasticity of 0.64. This coefficient might be biased by some country and mode of transport composition effects, however: at small distances from the US, mainly the case of Mexico and Canada, most of the transportation is made by land and the road networks are extremely developed while at distances faraway from the US, the transportation mode is mainly made by Sea and/or Air. Hence, due to distance but also to the extent of networks, small distances might be associated with relatively small freight charges while long distances could be, in comparison, related to high transport charges not solely due to distance but also to a lack of route networks. Long distance shipment when it involves crossing oceans, rules out the possibility of land transportation, making the impact of oil price changes on freight transport barely comparable across countries linked by land with respect to countries linked by air and/or the sea. Thus, without accounting for all of these factors the distance elasticity could be biased.

Before accounting for these issues, column (2) introduces the oil price in an interaction term with distance as proposed by our theoretical framework. The interaction term enters with a positive coefficient and is statistically significant. Oil prices matter in explaining shipping costs, and this effect is the more important the more countries are remote from the market to reach. The elasticity of the interaction term surrounds 0.006.

Columns (3) and (4) progressively introduce contiguity and modes of transport to try to correct for the network and mode of transport composition effects embodied in the distance coefficient. While contiguity appears with a negative sign as expected, the land mode seems to be associated with the lowest freight rates, followed by sea and then air transportation. In particular, notice from column (3) that the introduction of the contiguity variable reduces drastically the distance coefficient but does not affect the coefficient on the interaction term, which value remains robust to all the remaining specifications.

Column (5) interacts contiguity with oil prices. As much as the distance interaction term should be associated with a positive coefficient, the new contiguity interaction term should –in a symmetric way– have a negative effect on freight rates. Our findings confirm this intuition. An increase in oil prices results in around 20% lower freight rates for Mexico and Canada with respect to freight charges sourced from the rest of the world.

Columns (6) and (7) progressively include product fixed effects and country random effects.<sup>16</sup>

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<sup>15</sup>We have run, further, a regression where the freight rate dependant variable was replaced by the transport charge per ton and retrieved a positive effect of unit values as expected. The rest of the variables exhibit qualitatively the same result.

<sup>16</sup>We could not include country fixed effects because we would have produced multicollinearity problems with distance and contiguity, both varying across the country dimension only.

The results remain mostly similar however with, in particular, a quasi unchanged elasticity of freight costs to the distance interaction term around 0.008. Taking the log of median distance to the US to be around 9, we estimate a median elasticity of oil prices to be around 0.07 again.

Some might argue that our effect of oil prices is underestimated because we do not take into account the endogenous changes in technologies of transportation triggered by the oil-price variation. Some exporters might want to switch from air to sea, air to land or land to sea transportation, the latter being less costly than land, itself being less costly than air for similar distances. Hence, the relative small impact of oil prices we obtain might be due to this unobservable switch in technology modes. One way to partly account for these switching modes argument is to run a regression where Canada and Mexico are excluded. By doing so, we exclude at least the possibility of switching between alternative modes for countries that are very close to the US. For the rest of the countries, where the number of switching combinations is reduced to air vs sea, the switch to sea is rather unlikely after an oil price jump because products being already transported by air to the US, are known to be very sensitive to time of shipping (see Hummels 2001). Column (8) presents the results of a similar specification than (7), except that Canada and Mexico are now being removed from the country sample at hand.<sup>17</sup> The coefficient obtained on the interaction variable is still small although it is now slightly higher as it jumps up to 0.010.

Some researchers (Blanchard and Gali (2007)) have shown that the recent oil shock have had less macroeconomic impacts in the 1990s than in the 1970s thanks, among other reasons, to the use of less oil-intensive technologies in their production activities. This can also be true for changes towards oil-saving technologies in the transport industry, and within a particular mode of transportation. Trucks and sea cargoes in the 1990s might have become less intensive in oil input than their pairs in the 1970s. If this is true, it means that in the 1990s the impact of oil price increases has been affecting less transportation costs. Column (9) shows the result of a specification replicating column (7) but where we consider only the period 1995 to 2001. As it can be seen from table 2, for each additional kilometer run by a transporter, the coefficient on oil prices (interaction term) has been rather stable if not slightly higher not lower than its counterpart in column (7) (coefficient around 0.011).

What can we learn from all these results? As the log of median distance to the US is around 9, then we can estimate the median elasticity of freight rates to oil prices to be around 0.1: Every 10% increase in oil prices raises freight rates of the median distant country from US by about 1% ( $0.11 \times 9$ ). The variance of this elasticity with respect to geographical distance does not appear to be high: a simple calculation shows an elasticity around 0.088 for close to US countries (say around 3,000 km) and of 0.103 for faraway ones (say around 10,000 km).

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<sup>17</sup>For obvious reasons, contiguity and/or its contiguity-interaction variable have been removed from the regression.

## 4.2. Results of the Trade Equation

We now turn to the gravity equation. In the theory section, we presented two different equations of trade flows: one in absolute value terms (trade flows specification) and another in relative terms (trade shares specification). The trade flows specification corresponds to Equation (7) while the trade shares one is that of Equation (10).

Table 2 presents the main results relative to both specifications. We begin with the trade flows specification. Before accounting for endogeneity of transport costs, column (1) describes first a fixed effects regression where freight costs are deliberately assumed to be exogenous to trade. They enter the equation as they are observed. All variables appear with the expected sign and are all statistically significant. In particular, the coefficient on relative GDP is positive while the parameters on freights, FOB unit values and tariffs are negative. In particular, the estimated coefficient on unit value is higher than 1 in absolute value, which is what the theory predicts<sup>18</sup>. However, as long as we are particularly interested in the coefficient on freights, we focus in what follows on this coefficient.

Columns (2) and (3) present the results of the 3SLS regression. Here, the transport and imports equations are run together. Column (2) presents the results of the transport equation delivered by the 3SLS, where the coefficients appear to be comparable again, in sign and magnitude, to those produced in table 1 above. Column (3) shows the coefficients of the trade equation delivered by 3SLS. In particular, the freight coefficient appears to be more than 50% higher than in column (1), which suggests that the impact of freights on imports would have been underestimated if freights had been considered exogenous to trade flows. An omitted variable in both equations might have caused this underestimation (think for instance of some unobserved product and country specific demand shock which increases at the same pace freight charges and trade flows). More plausibly however, it might be that the underestimated coefficient obtained on freights –when endogeneity is not accounted for– reflects a mix of a (two way) causality between freights and flows where it appears from the 3SLS to be negative in both directions.

The results for the relative trade shares' equation are reported in column (4). As explained earlier in the text (see theory section), to correct again for the endogeneity of freights, an IV specification has been undertaken here. Freight costs are instrumented by variables from the freight equation (except obviously, import quantities). Hence, modes of transportation dummies, unit values and distance along with the interaction terms (distance\*oil prices and contiguity\*oil prices) were taken as instruments.<sup>19</sup> Here, the coefficients appear to be qualitatively similar to those obtained from the 3SLS regression. The parameter on freights is estimated to be around -1.12, again higher than the coefficient obtained in column (1) where freight was considered to be exogenous. However, it appears lower than the estimate obtained in the 3SLS regression. However there are two main reasons why we prefer the trade shares' specification:

<sup>18</sup>see Erkel-Rousse and Mirza (2002) for a survey on price and substitution elasticities.

<sup>19</sup>We have also run IV specifications where subsets of these instruments were considered. The results are very similar and are available upon request.

Table 2: The Trade Flows Equation

	Trade Flows Eq.			Trade Shares Eq.
	Fixed Effects	3SLS		Deviation from Means
	(1)	(2)	(3)	(4)
	<i>imports</i>	<i>transport costs</i>	<i>imports</i>	<i>Rimports</i> <sup>1</sup>
<i>price</i>	-1.624 <sup>a</sup> (0.003)	-0.578 <sup>a</sup> (0.002)	-1.783 <sup>a</sup> (0.005)	-1.613 <sup>a</sup> (0.004)
<i>freight</i>	-0.795 <sup>a</sup> (0.004)		-1.454 <sup>a</sup> (0.017)	-1.124 <sup>a</sup> (0.012)
<i>tariffs</i>	-2.078 <sup>a</sup> (0.091)		-1.445 <sup>a</sup> (0.070)	-3.191 <sup>a</sup> (0.085)
<i>GDP</i>	0.339 <sup>a</sup> (0.026)		0.354 <sup>a</sup> (0.020)	0.796 <sup>a</sup> (0.008)
<i>quantity</i>		-0.182 <sup>a</sup> (0.002)		
<i>distance</i>		0.149 <sup>a</sup> (0.004)		
<i>dist.p<sub>oil</sub></i>		0.008 <sup>a</sup> (0.001)		
<i>contig.p<sub>oil</sub></i>		-0.175 <sup>a</sup> (0.005)		
<i>vessel</i>		-0.419 <sup>a</sup> (0.006)		
<i>land</i>		-1.146 <sup>a</sup> (0.016)		
<i>air</i>		0.174 <sup>a</sup> (0.004)		
<i>trend</i>		0.003 <sup>a</sup> (0.000)		
Constant	0.549 (4054.266)	-1.198 <sup>a</sup> (0.038)	2.193 <sup>a</sup> (0.702)	0.245 <sup>a</sup> (0.007)
<i>R</i> <sup>2</sup>	0.56	0.39	0.52	0.46
<b>Method</b>	<b>OLS</b>	<b>3SLS</b>	<b>3SLS</b>	<b>IV</b> <sup>2</sup>
time effects	YES	–	YES	YES
country effects	YES	–	YES	–
product effects	YES	–	YES	–
product-country effects	–	–	–	YES

<sup>1</sup> all explanatory variables are expressed in deviation from the means  
<sup>2</sup>Instruments: *unit value*, *trend*, *vessel*, *land*, *air*, *distance*, *dist.p<sub>oil</sub>* and *contig.p<sub>oil</sub>*  
Standard errors in parentheses  
<sup>c</sup> significant at 10%; <sup>b</sup> significant at 5%; <sup>a</sup> significant at 1%

Firstly, we are more interested here in market share' changes not trade flows changes, even though one can still derive the impact on shares while using the coefficients obtained from the 'flows' equation; Secondly, we also believe that the 'shares' specification is more in line with theory because it accounts for factors that are only partly accounted for in the 3SLS specification. For instance, while US demand and the US price index at product levels are perfectly accounted for as they are swept out from the trade shares equation (see deviation from means, theory section), they are only approximated by 2-digits industry level and time fixed effects in the trade flows equation (columns (1) and (3)).

Considering  $-1.12$  as to be the elasticity of trade shares to relative freight rates, the oil-price effect on relative imports is:

$$\frac{d\ln(R.m_{kjt})}{d\ln(p_{oil})_t} = (0.011).(-1.12).\ln(dist_j)$$

The sign of the elasticity depends on that of  $\ln(R.dist_j)$ . For countries located nearby the US, the relative distance is smaller than 1, and the impact of an oil price increase on their market shares is positive. The contrary applies to faraway countries. Thus, for close to US countries (say under 3,000 km), the elasticity of relative market shares to the oil-price is around 0.013. On the opposite, for far to US countries (say above 12,000 km), the elasticity value of relative market shares to oil-prices is around -0.004.

For a large variation of the oil price, we can estimate the effect on market shares by:

$$\frac{dR.m_{kjt}}{R.m_{kjt}} = -1.12 \left[ \left[ 1 + \frac{dp_{oil}}{p_{oil}} \right]^{0.011(\ln(R.dist_j))} - 1 \right]$$

Hence, an oil price shock that results in a doubling of oil prices would increase the relative share of close to US countries (under 3,000km) by around 0.8% and decrease far to US partner shares (over 12,000 km) by around 0.047%.

### 4.3. Oil prices, the Extensive Margins of Trade and Selection Bias

A jump in oil prices might also affect the extensive margins of trade flows. For instance, some existing flows in the past might have ceased to exist after an oil shock. Symmetrically, reductions in oil prices might have produced new flows. This has two implications for our study, one conceptual and the other technical: On the conceptual side, it seems important to estimate not only the impact of oil prices on ex-post observed market shares but also their contribution to the changes in the probability of exporting to some markets. On the technical side, oil prices like other variable and fixed cost factors might contribute to self select positive flows which might produce inefficient estimators if this selection bias is not accounted for. We deal with the first concern by running a probit equation where the probability of exporting a particular product



from one country to the US is investigated. As for the second concern, we use the results of the probit regression to construct a Mills ratio which is then inserted into our market shares equation. By doing so, we are controlling for the selection bias by treating it as an omitted variable (Heckman specification).

The "new new" trade literature focusing on firm heterogeneity shows how variable but also fixed costs should affect the status of an exporting firm. By a symmetric reasoning, one can think of a situation where countries selling some product  $k$  on the US market are heterogeneous in their variable (but also possibly) fixed costs. Hence, at some given distribution of fixed costs, an exogenous shock on variable costs might drive some producing- $k$  countries out of the US market, leaving only those more productive and/or higher quality ones in the market. We approach variable costs by distance, distance\*oil prices and a trend. We also introduce a common language variable that should capture a bit of both variable and fixed costs.

The fixed costs are difficult to observe in general. We consider three different proxies, each representing a particular type of fixed costs. The first proxy is chosen in order to capture an exporter and product specific fixed cost. The choice of the second is drawn to approach costs that are importer and product specific. The last one is considered to capture a fixed cost born by trading pairs. All three measures vary over time.

Let us present the first proxy. Pick first a measure representing the number of destinations served by an exporting country, for a given product. We think that when a product from one country reaches more destinations, the likelihood to serve the US market becomes higher. Now of course, this measure does not only capture fixed costs, it might also capture variable costs like factor and geography costs. Indeed, the more central is a country location the higher the destinations it can reach and the more it exports to each of these destinations. One way to condition out factor and geography costs, is to express this variable with respect to the average number of destinations served by a country, computed across exported products. Hence, our first measure to enter the probit regression as a proxy for fixed costs is the ratio of the number of destinations a product reaches to the average number of destinations reached by all of the products exported from a given country. We conjecture that the higher is this ratio, the lower would be the fixed cost beared by an exporter to sell out this product to foreign countries.<sup>20</sup>

We also consider two other alternative measures of fixed costs. To do so, we follow a recent article by Crozet *et al* 2009 who propose a new way to capture fixed costs. While they apply it on firm level data, we believe that the same method could also work at the product level. They show indeed that the fixed costs for French Champaign to be exported to some destination market can be simply approximated by the minimum value of exports (minimum revenue from exporting) that might well have covered these costs. Under this value, no flow is observed: precisely lower revenues are not high enough to cover the fixed costs. The minimum value of exports, by construction, designs the cut-off between firms which export and firms which

<sup>20</sup>To construct this variable, we use the International Trade Database at the Product Level (BACI) from CEPII (<http://www.cepii.fr/anglaisgraph/bdd/baci.htm>).

Table 3: Extensive and Intensive Margins

	Probit Equation				Heckman Specification		
	(1)	(2)	(3)		(1') <sup>1,2</sup>	(2') <sup>1,2</sup>	(3') <sup>1,2</sup>
<i>distance</i>	-0.032 <sup>a</sup> (0.001)			<i>tariffs</i>	-3.264 <sup>a</sup> (0.086)	-3.191 <sup>a</sup> (0.085)	-3.134 <sup>a</sup> (0.084)
<i>dist.poil</i>	-0.004 <sup>a</sup> (0.000)			<i>GDP</i>	0.786 <sup>a</sup> (0.008)	0.797 <sup>a</sup> (0.008)	0.774 <sup>a</sup> (0.008)
<i>language</i>	0.002 <sup>a</sup> (0.001)			<i>freights</i>	-1.131 <sup>a</sup> (0.012)	-1.120 <sup>a</sup> (0.012)	-1.068 <sup>a</sup> (0.011)
<i>Rel. destinations served</i> <sup>3</sup>	0.081 <sup>a</sup> (0.001)			<i>price</i>	-1.614 <sup>a</sup> (0.004)	-1.613 <sup>a</sup> (0.004)	-1.587 <sup>a</sup> (0.004)
<i>trend</i>	0.012 <sup>a</sup> (0.000)			<i>mills1</i>	1.108 <sup>a</sup> (0.030)		
<i>country min value (by pdt)</i>		-0.003 <sup>b</sup> (0.001)		<i>mills2</i>		-1.680 <sup>a</sup> (0.161)	
<i>pdt. min value (by cty)</i>			-0.025 <sup>a</sup> (0.000)	<i>mills3</i>			-4.641 <sup>a</sup> (0.043)
Observations	1296140	1035840	1035840	Constant	1.180 <sup>a</sup> (0.027)	-0.995 <sup>a</sup> (0.119)	-3.188 <sup>a</sup> (0.033)
(pseudo) <i>R</i> <sup>2</sup>	0.08	0.08	0.09		0.46	0.46	0.48
time effects	–	YES	YES		YES	YES	YES
country effects	–	YES	YES		–	–	–
product effects	YES	YES	YES		–	–	–
product-country effects	–	–	–		YES	YES	YES
Marginal effects reported.							
<sup>1</sup> all explanatory variables are expressed in deviation from the means							
<sup>2</sup> Instruments: <i>unit value</i> , <i>trend</i> , <i>vessel</i> , <i>land</i> , <i>air</i> , <i>distance</i> , <i>dist.poil</i> and <i>contig.poil</i>							
Standard errors in parentheses							
<sup>3</sup> by product and country							
<sup>c</sup> significant at 10%; <sup>b</sup> significant at 5%; <sup>a</sup> significant at 1%							

do not. Such intuition can also be transposed to product-level data: suppose for now that the fixed costs are product and import country specific. If so, then for a given product shipped to the United States (the importing country), as long as the revenue from exporting exceeds some minimum value that equals that of the fixed costs, it is worth it. Otherwise, the product is not shipped to the US. Thus, for a given product  $k$ , one can reasonably consider the minimum value of  $k$ -exports across all exporting countries to proxy the fixed costs. The cross-country minimum value for product  $k$ , presents then a cutoff between those countries that export the product to the US (positive country flows) and the countries that do not (zero country flows).

Alternatively, assume now that the fixed costs are not product specific, but country-pairs specific. We can then define a cross-product minimum value per country exporting to the US. It would represent the cutoff between those products which export revenue passes the fixed cost (positive product flows) and those which not (zero product flows).

Before presenting the estimation results for the probit regression, it is important though to explain how our zero flows have been generated. In fact, we have US bilateral import data at the product level. It is obvious that all countries cannot trade all products not only because of trade barriers but simply because of production capacities and mix of resources. France is unable to export diamonds to the US just because it does not produce diamonds. As our main concern here is to look at how trade costs and in particular, how oil prices affect exports to the US through transport costs, the zero flows that interest us are those that could be potentially positive if variable and fixed trade costs were to be sufficiently low. One simple way to capture potential exporters is to pick at least one particular year where we observe a positive flow of some product exported by a given country. When so, we treat the country as potential exporter of that product by incrementing the dataset with corresponding zero flows for the whole period at hand. For instance, if we observe that Egypt exported potatoes to the US in say, 1986 and 1987, we consider that Egypt is potentially capable to export its potatoes to the US every year from 1974 to 1986 and from 1988 to 2001. We then add 12 zero lines for Egypt's trade in potatoes for years below 1986 and 14 another zero lines after 1987.

Table 4 shows the result of the probit regressions in columns (1), (2) and (3) where marginal effects at the sample means were computed. Before going through the results, note that we could not introduce distance, language, trend and the interaction terms in specifications 2 and 3 because they were multicollinear to the product-minimum value variable that varies across time and country. We have replaced them by country, year and product fixed effects. Column (1) shows first and as expected, that while distance affects negatively the probability to export, common language affects it positively. More interestingly though, the effect of oil prices appears to be negatively related to the likelihood of exporting and the effect is again increasing with distance. In particular, a 10% increase in the price of oil for a median distant country reduces the probability to export by 0.36% ( $0.04\% \times 9$ ). This effect is actually similar to that of distance itself (ie. coefficient on distance=0.32%). It is as if, after an increase in oil prices of about 10%, a median distant country becomes 10% farther away from the US. Finally, as also

conjectured above, the number of destinations variable increases the likelihood to export.

Columns (2) and (3) present the results of the probit specification including the minimum value variables. Here again, as expected, both variables appear with the same negative effect on the propensity to export. The higher the minimum value observed, the higher the fixed cost is to export and the lower is the probability for a good to be exported from one country to the United States.

Columns (1') to (3') in table 3 reproduce the IV relative market share specification already presented in table 2, but now it is augmented with the Mills ratios obtained correspondingly from columns (1) to (3) (respectively noted mills1 to mills3). Importantly, while these ratios are statistically significant, which suggests a selection bias that has to be handled, the coefficients of the variables of interest (especially that of freights) are almost not altered. This means that these variables are simply not correlated with those provoking the selection bias. In particular, while oil prices seem to be affecting the probability to export they do not seem to be responsible for the selection bias.

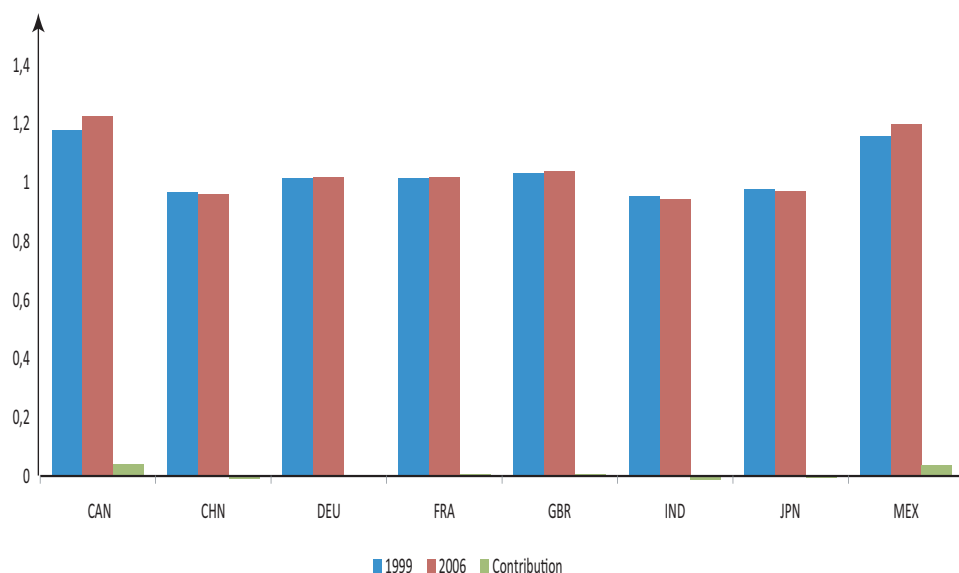
## 5. CONTRIBUTION OF OIL PRICES TO REGIONAL TRADE

In this section, we want to estimate the contribution of the oil-price shock to the North-American regional trade in the recent years. More precisely, by using the coefficients estimated in our market share equation and those estimated from the probability to export equation we can estimate by how much market shares and the relative probability to export have been affected by the oil shock between 1999 (date before the shock) and 2006 (last observation we have). Note that during this period, oil prices have been multiplied by 4.5.

We first simulate the impact of the increase in oil prices on each country's probability to export. Prices went up from 20 dollars in 1999 to around 90 dollars in 2006. By applying this change, and holding all other variables equal, the following figure shows the changes in the *relative* probability to export for some countries of interest<sup>21</sup>. The relative probability of exporting is obtained for a given year (say 1999) by computing the estimated propensity to export for a given country and then dividing it by the mean estimated probability of exporting (computed over the whole sample in that year).

As it stands, Canada, Mexico, Great Britain and France had in 1999 propensities to export to the US that were above the average (since the relative probability to export in this year is greater than 1) while the relative probabilities for the rest of the countries represented here were below unity. After the shock, the simulated change in the probability of exporting indicates a maximum gain of around 4% for Canada and 3.5% for Mexico. On the other extreme of the spectrum, China loses 0.8%, Japan 0.6% and India 0.1%. The rest of the countries are almost unaffected. Thus, a multiplication by a factor of 4.5 of oil prices does not appear to change much the probabilities of exporting to the US.

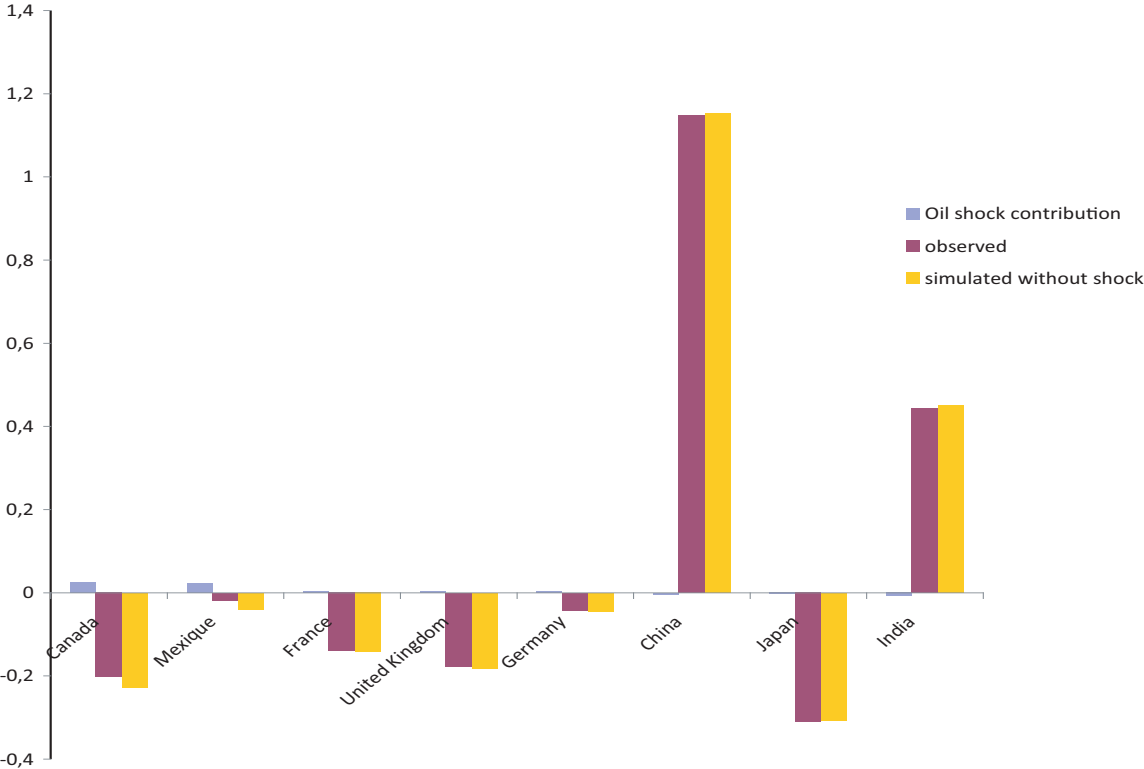
<sup>21</sup>We do not present the outcomes for all the countries in order to save space. They are available upon request.

**Figure 4: Oil Shock and Changes in the Relative Probability to Export**

Next, we turn to the observed trade shares and try to estimate the contribution of the shock to changes in these shares. The following bar chart graph (Figure 5) compares the variation of the observed *relative* shares for some countries with the estimated *relative* shares that would have prevailed in the absence of a shock. The difference between both bars is the contribution of oil price increases. It is represented by an additional bar in the graph. We estimate the shock contribution to each country's share by using the formulae 11 in the theoretical section above. Thus we chose the coefficient on oil prices obtained from table 1 for the 1995-2001 period (see last column (9), coefficient=0.011). We interact it then with the average coefficient we obtain on freights in table 3 (coefficient=-1.12) together with the relative distance to the US of the considered country.

As it stands, oil prices did not contribute much to all the partner countries' shares into the US in general, and in particular to Canada's and Mexico's relative market shares. Between 1999 and 2006, these shares decreased respectively by around 20% and 1.8% and would have decreased anyway by a bit more (23% and 4%) had the shock never took place. At most, oil prices have been a factor of small resistance to globalization, but could not contribute at all to reverse it. Pick India and China as remarkable examples. Their relative share went up respectively by 44% and 115% over the period. Such figures are extremely high and could easily resist the very weak (negative) contribution of oil prices (-0.4 and -0.7% respectively).

Figure 5: Contribution of oil prices increases to market shares



## 6. CONCLUSION

This paper contributes to the debate regarding the effects of oil prices. We study the link with the geography of trade flows.

Our theoretical idea states that because of the existence of fixed costs, prices of shipping a good do not respond proportionally to oil prices. This alters the distribution of trade costs and trade flows among partners: Close countries should benefit from oil shocks at the expense of faraway countries. This should reverse globalization and leads to a relocation of activities in regional markets.

We then test this intuition on US bilateral imports data from 1974 to 2001. For a country located at a median distance to the US, we find a low elasticity of freight rates to oil prices (around 0.011). The variance of these elasticities across countries' locations does not appear to be high neither: we find an elasticity of 0.088 for close to US countries (under 3,000 km) and 0.103 for faraway ones (above 10,000 km). We then apply an estimation strategy to correctly assess the induced impact on market shares of these countries. We estimate an elasticity value of relative market shares to oil-prices around 0.013 for close to US countries around -0.004 for faraway countries. If one considers the sign related to these figures, one can deduce easily that they are consistent with the idea that oil prices are regionalizing trade. But as it stands, the magnitude of these figures is very small.

To have a better idea of the driving force of regionalism behind oil price increases, we estimate the contribution of oil prices, between 1999 and 2006, to changes in the extensive and intensive margins of the relative shares of US partners. We find that the oil price increases in this period have had a maigre contribution. The oil shock contributed positively to Mexico and Canada's export shares by 2.2 to 3 percentage points and had a small if not almost insignificant negative contribution on India and China's market shares (between -0.4 to -0.7 percentage points). It also increased Canada and Mexico's relative likelihood of exporting by almost similar amounts (3.5 to 4 percentage points) while leaving Japan, India and China's exports propensity almost unaffected with reductions that did not exceed 0.8%

Our conclusion is that oil-price variations, even when they happen to be very large, are unable to contribute extensively to trade regionalization. Globalization forces seem much stronger and appear to resist easily to oil shocks.

## APPENDIX

**A. Computation of proportional changes in freight rates for big oil price changes (price shocks)**

Define  $fr$  as the freight rate and  $p_{oil}$  the oil price. Define  $\beta' = \beta \cdot \ln(dist)$ . We can present the freight equation as follows:

$$\ln(fr) = \beta' \ln(p_{oil}) + V$$

where  $V$  represents all other explaining variables.

In period 0, before changes in oil prices,  $p_{oil}$ , we have the following relation:  $fr_0 = e^{\beta' \cdot \ln(p_{oil})_0} \cdot e^V$

In period 1, after the oil price change, we have the following relation:  $fr_1 = e^{\beta' \cdot \ln(p_{oil})_1} \cdot e^V$ .

The growth rate of  $fr$  due to a change in oil prices, leaving all other things equal, equals:

$$\frac{df_r}{fr} = \frac{e^{(\beta' \cdot \ln(p_{oil})_1)} - e^{(\beta' \cdot \ln(p_{oil})_0)}}{e^{(\beta' \cdot \ln(p_{oil})_0)}} = \left[ \frac{(p_{oil})_1}{(p_{oil})_0} \right]^{\beta'} - 1$$

Recall  $\beta' = \beta \cdot \ln(dist)$ . Besides, prices in time 1 are actually the sum of prices in time 0 plus the change in prices that has occurred (i.e.  $(p_{oil})_1 = (p_{oil})_0 + dp_{oil}$ ). After removing the 0 subscript we thus obtain:

$$\frac{df_r}{fr} = \left[ 1 + \frac{dp_{oil}}{p_{oil}} \right]^{\beta \cdot \ln(dist)} - 1$$

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ISSN : 1293-2574