Essays on asymmetric subsidy effects, green protectionism and hedging of exchange rate risk

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1 Introduction

The recent global economic crisis brought protectionism back to the discussion table of policymakers, academics and the media. Some commentators feared that tariff protectionism could reach high levels similar to those during the great depression in the 1930s after the passage of the Smoot-Hawley Tariff bill in the United States. The months after the onset of the crisis proved that multilateral rules on tariffs resisted the challenges most countries faced and tariffs were not increased, at least not as much as some had expected. However, the statistics of the Global Trade Alert (GTA), an initiative monitoring state interventions around the globe, show that protectionist measures implemented since the first G20 crisis summit in November 2008 reached a cumulative number of almost 1,500 and the share of less regulated forms of protectionism, such as bailouts, export subsidies, competitive devaluations and other non-tariff measures, exceeded 58 percent of measures implemented in any year since 2009. Protectionism was thus not absent during recent years, but the composition has been altered since the 1930s. These "murky" forms of protectionism potentially distort large amounts of trade and translate into lost commercial opportunities, threatened jobs, and slower economic recoveries. It is therefore of utmost importance to understand the drivers and consequences of contemporary protectionism.

This is where the present thesis aims to make a contribution. The first two essays focus on political economy aspects of recent protectionist dynamics. Specifically, these studies contribute to the understanding of why government leaders did not protest when other countries introduced discriminatory state measures during the crisis. The first essay shows, for example, that foreign exporters may in some cases benefit - or may not be negatively affected - when other countries support domestic firms through bailouts or other export subsidies, which could explain the reluctance of complaints against these measures. The second essay puts an emphasis on so-called "green" protectionism. It proved to be a widely used tool to introduce state measures under the guise of "green" growth strategies. The essay makes a step towards the understanding of whether "green" measures indeed have beneficial effects on the environment. Or whether the use of such measures may be a consensual way to introduce new discrimination against trading partners - especially if climate change mitigation action is widely supported among policymakers.

The first two essays can also be seen as starting points for further research in their respective fields and may be important in a more general context than simply for the understanding of crisis-era dynamics. The first essay, for example, introduces the notion of asymmetric

subsidy effects on foreign commercial interests. While previous literature generally argued that export subsidies are always negative for foreign exporters, the essay shows that these subsidies may not affect all foreign partners symmetrically and under some circumstances could even have beneficial effects for partners. Using the period 2008/09 as a natural experiment in which Germany and the UK were simultaneously affected by sector-specific third-country subsidies, the evidence from a parametric difference-in-difference estimation strategy shows that these subsidies have asymmetric effects on German and British export patterns in all international markets; that is, in those of implementing countries (bilateral markets) and in world markets in which German and British exporters compete with firms from implementing countries (deflection markets). The exercise further shows that vertical economic integration and informational ties with subsidy implementing countries improve relative export positions in affected sectors and thereby explain some of these asymmetries. Naturally, more research is needed to confirm the existence of asymmetric subsidy effects and to elaborate on the identification of their determinants as well as on the development of a proper theoretical framework.

The second essay is one of the first to investigate the environmental consequences of "green" trade policies (such as "green" subsidies to targeted firms or tariff reductions for environmental friendly goods) as well as the extent of trade distortion of these policies. Specifically, for the Asia-Pacific region the first part estimates the impact of "green" crisis-era measures on energy intensity of imports and the extent of discrimination of these policies against foreign suppliers. The results are surprising: "Green" measures whose purpose of implementation was not driven by the environmental policy agenda are associated with an increase of sourcing from more - rather than less - energy intensive countries. "Green" measures mainly implemented to mitigate climate change are more effective, or at least neutral, in making imports more climate friendly. The present study is, however, restricted to environmental effects along the import channel and ignores potentially important benefits, for example, through local development of energy efficient technologies or through local energy saving incentives. Hence, future research could pursue other and ideally a broader set of possible channels in order to get a deeper understanding of the environmental consequences of "green" measures. The second part investigates whether "green" policies have distortive effects on imports: The evidence reveals that direct foreign competitors lose import share when "green" measures are implemented, while indirect competitors gain. Direct (compared to indirect) competitors are defined as foreign suppliers with quality or technology levels similar to those of implementing countries, where energy intensity is found to be a

useful proxy for sectoral quality or technology levels. Nonetheless, improvements to this study can easily be made once more detailed data becomes available, especially with regard to measures of competitive proximity. Given that climate change and economic stability issues will make political leaders busy at least for the next couple of years, questions similar to those targeted in the second essay may receive prior attention in current research agendas.

The third essay - co-authored work with Dario Fauceglia, University of St. Gallen, and Anirudh Shingal, World Trade Institute - contributes to the understanding of the drivers and consequences of recent protectionism in a more indirect way. The principal aim of the essay is to study to what extent exporters are able to "naturally hedge" exchange rate risk when sourcing inputs from abroad rather than domestically. The study shows that "natural hedging" is effective in the sample used for the estimations to an extent that firms may not lose much competitive advantage when their home currency appreciates. Hence, the results of this essay are, for example, consistent with the claim that governments should be reserved to support selected exporting industries, or that the central bank should be reluctant to apply instruments to depreciate a potentially overvalued home currency. Thereby, the essay indirectly contributes to debates around discriminatory state interventions.

Exploring the role of imported inputs in exchange rate adjustments of exports has a relatively long tradition in the empirical trade literature. Nonetheless, these studies do not look at actual price developments of imported inputs as a result of exchange rate shocks; stated differently, they implicitly assume full exchange rate pass-through (ERPT) into imported input prices. Using disaggregated quarterly trade data for Switzerland over 2004-2011, the third essay investigates how imported input prices faced by exporting industries develop over time and studies the effectiveness of "natural hedging" of exchange rate risk by quantifying the effect of exchange rate fluctuations on these imported input prices. Finally, it examines total pass-through effects on export prices; that is, the combined effect of pricing-to-market behaviour (the simple effect of exchange rate movements on export prices) and the cost-changing effects of exchange rate changes through imported inputs. The results indicate high ERPT into imported input prices in all sectors implying that prices fall when the CHF appreciates. This could be due to low input demand elasticities with respect to local prices and/or low shares of distribution costs for inputs. On the export side, although exporters in many sectors are not able to pass on exchange rate shocks completely to foreign consumers, which results in reduced profit margins, cheaper imported input prices at least partly offset these adverse developments. Thus, imported inputs act as a natural

means for hedging exchange rate risks. Furthermore, Swiss exporters may not have adjusted export pricing practice in response to a strong CHF in the wake of the euro crisis. A better understanding of the most recent challenges of Swiss exporters can be reached once data over a longer period of a strong CHF becomes available and by investigating whether the results are influenced by extensive margin adjustments, that is, firms that exit the export market or products that are no longer exported. If this is the case, central bank intervention may be appropriate and necessary to avoid irreversible structural damage of the exporting industry.

2 Third-country subsidies and asymmetric effects on exports[1]

Abstract

This chapter introduces the notion of asymmetric effects of subsidies on foreign exporters and shows that some foreign exporters may even benefit from third-country subsidies. Using the period 2008/09 as a natural experiment in which Germany and the UK were simultaneously affected by the same sector-specific third-country subsidies, the chapter shows that these subsidies have asymmetric effects on German and British export patterns. Across all affected sectors, German exporters compared to British exporters improved their relative position. The exercise shows further that vertical economic integration and informational ties with subsidy implementing countries improve relative export positions in affected sectors and thereby determine these asymmetries. From a policy perspective, asymmetric subsidy effects may help to explain the reluctance of some government leaders to complain against other countries' recent discriminatory interventions.

Keywords: international trade, export subsidy, protectionism, asymmetric effect

JEL classification: C13, F11, F13

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2.1 Introduction

The global trade collapse and economic crisis in 2008/09 has led to a rise in discriminatory state intervention. While the spread of protectionism slightly calmed down during the recovery in 2010, it experienced another peak with the aggravated euro crisis (Evenett, 2012). Given the international rules on more transparent and traditional instruments such as tariffs and trade defence measures, new discrimination was often introduced in murky forms such as bailouts, export subsidies and other non-tariff measures (Baldwin and Evenett, 2009, or Evenett, 2009 and 2012). The share of these less regulated forms of protectionism exceeded 58 percent of measures implemented in any year since 2009 and these measures potentially distort large amounts of exports - in particular through deflection.[2] Deflected distortion exists when subsidized firms export their goods at an artificially low price and/or increase their market shares artificially to the rest of the world. As a consequence, exports of firms from foreign rivals selling to the same world markets are potentially distorted (Evenett and Jenny, 2009).[3] [4]

While the welfare effects of export subsidies for the implementing country depend on the market structure and design of the subsidy in existing theoretical work, there is a broad consensus with regard to discriminatory effects of export subsidies on foreign competitors (see Feenstra, 2004, for an overview). This chapter extends the conceptual framework with regard to the effects of export subsidies on foreign competitors. It allows that subsidies introduced by third countries affect exports of foreign competitors differently/asymmetrically and may thus be beneficial or - at least - neutral for one competitor while being discriminatory for another.

Hints that such a pattern may exist are given by G20's reaffirmed no-protectionist pledge at each of its summits since 2008 while being responsible for over 65 percent of discriminatory measures introduced during the same period (Evenett, 2009 and 2012). The failure of G20's pledge raises suspicion that some member countries may not be harmed (or even

[2]Estimates of exports covered by murky protectionism are 15 percent of total world exports by June 2010 (Evenett and Fritz, 2010), 10 percent of Chinese exports by September 2010 (Evenett and Wermelinger, 2010) and more than 40 percent of Swiss exports by May 2012 (Evenett and Fritz, 2012).

[3]Henn and McDonald (2011) show that export support measures implemented during the crisis had a positive effect on export flows of subsidized firms/sectors. This positive relationship may also translate into a market share increase for a subsidized firm in its export markets.

[4]Not only per unit export subsidies distort international trade. Subsidies to firms that postpone the day when capacity reductions are made shift the burden of adjustment on to unsubsidised foreign rivals. Slower capacity reductions and associated higher levels of production depresses prices in all markets the subsidized firms sell into (Evenett and Jenny, 2009 and Evenett and Fritz, 2012).

benefit) when others introduce murky measures. If the opposite holds, more revolt against protectionist action within the G20 would be expected. Furthermore, Boffa and Olarreaga (2012) show that retaliation against foreign discriminatory policies affecting home exports is not taking place during recent protectionist dynamics. While they argue that countries may not retaliate as it would potentially lead to an even worse outcome for the home country, this chapter argues that foreign protectionist policies (in the form of export subsidies) may not symmetrically harm (or may even be beneficial for some) competitors. At least for those who benefit, retaliation would then be obsolete in the first place.

To illustrate the existence of such asymmetries more systematically, the study makes use of the natural experiment setting in which sectoral third-country subsidies simultaneously affect German and British exports and were implemented short after the trade collapse (at the beginning of 2009). The setting allows to test empirically to what extent these third-country subsidies have asymmetric effects on German and British export patterns - to the implementing country (bilateral effect) as well as to the rest of the world (deflection effect). The estimation strategy is similar to a parametric difference-in-difference approach, where Germany is set as the pseudo treatment group and the UK as the pseudo control group.

Moreover, the chapter develops hypotheses as to the determinants of asymmetric third-country effects and tests them within the same empirical setting. Hypotheses question whether differences in economic and other ties between the subsidy implementing country and affected countries can explain some of the asymmetries. More integrated foreign competitors/partners may indirectly benefit from third-country subsidies through cheaper imported inputs or information advantage (combined with *per se* better business conditions and thus lower business uncertainties).[5] Another hypothesis asks whether more direct foreign competitors in terms of technology or quality suffer relatively more than indirect competitors when third-countries implement subsidies.[6]

The chapter proceeds as follows. The next section develops the conceptual and empirical framework to identify asymmetric subsidy effects and presents the results. Section 2.3 introduces and tests possible determinants of asymmetries. Section 2.4 concludes.

[5]For example, Cohen-Meidan (2009) introduces the notion of asymmetric effects of antidumping duties on foreign exporters in the context of vertical integration and trade in intermediates. Or, Rauch and Casella, 2003 emphasize that the absence of informational barriers within a group of countries increases trade and income between these countries, but hurt countries outside the group disproportionately.

[6]For example, Hallak (2006) shows that direct compared to indirect competitors in terms of quality are more likely to compete for the same foreign markets.

2.2 Identification of asymmetries

2.2.1 Conceptual framework

In line with existing theories on export subsidies, it is assumed that countries are in competition with each other for (profitable) international markets. From the perspective of the implementing country, an export subsidy may be attractive if countries compete on market shares (under Cournot competition; see Brander and Spencer, 1985) or if it is targeted to a certain range of goods (under perfect competition in a Ricardian setting with many goods; see Itoh and Kiyono, 1987). An export subsidy is however welfare decreasing even for the implementing country if, for example, prices are used as strategic variables (under Bertrand competition; see Eaton and Grossman, 1986).

From the perspective of foreign competitors/partners, third-country export subsidies are always welfare decreasing in existing models: Exports are distorted bilaterally, that is, exports to the subsidy implementing country are discriminated; and exports are distorted through deflection, where deflected distortion exists when firms in the subsidy implementing country export their goods at artificially low prices and/or increase market shares artificially to (the rest of) the world. Moreover, existing models are framed such that a home (subsidy implementing) and a foreign country compete in international markets (or the rest of the world). It is thereby implicitly assumed that export subsidies symmetrically distort foreign exports.

This chapter contests this assumption and introduces a second foreign country, which also competes in international markets and may be differently/asymmetrically affected by third-country subsidies. Third-country subsidies can thus be beneficial or neutral for one partner while being discriminatory for another, or alternatively, subsidies may be relatively more discriminatory for one partner compared to another.

To identify whether exporters of two countries i and j are asymmetrically affected when a third country m provides subsidies to its firms, any gravity-type model could in principle serve as guidance (see for example Anderson and Van Wincoop, 2003 or Eaton and Kortum, 2002, and a recent review of the theoretical gravity literature by Anderson, 2011); in this chapter, the Eaton-Kortum (2002) model is used. Its supply-side structure with explicit expressions for unit production costs C_i and trade constraints $D_{n,i}$, make the model particularly helpful to illustrate possible channels through which production subsidies may lead to asymmetric effects for foreign rivals. In particular, subsidies provided by country m

may indirectly lower unit production costs in country i or in country j, if i or j source their intermediates from subsidized firms in m. If i and j firms have different sourcing patterns, the subsidy may have asymmetric implications for their export success in all international markets n.

Alternatively, country m subsidies may work as an ad-valorem trade cost for country i and j firms, essentially as an export tariff worsening export competitiveness for firms of i and j. If competitive proximity between country i and m firms and between country j and m firms is different, for example in terms of quality, it may also have implications for the relative export success between i and j firms in any export market n.[7]

These channels are illustrated more formally using Eaton-Kortum's gravity-style expression of the probability, $\Pi_{n,i}$, that country i supplies a good at the lowest price in country n:

$$\Pi_{n,i} = \frac{T_i * [C_i * D_{n,i}]^{-\theta}}{\Phi_n}, \tag{1}$$

where $T_i > 0$ and $\theta > 1$. Distributions are treated as independent across countries. The country-specific parameter T_i governs the location of the distribution. A bigger T_i implies that a high efficiency draw for any good is more likely. The parameter θ (which is treated as common for all countries) reflects the amount of variation within the distribution. A bigger θ implies less variability of efficiency levels. These parameters allow to depict a world of many countries that differ in the basic Ricardian ways of absolute (T_i) and comparative advantage (θ) across a continuum of goods. In particular, the parameter θ regulates heterogeneity across goods in countries' relative efficiencies. Furthermore, C_i are unit production costs in country i and $D_{n,i} > 1$ denote unit trade constraints for exports from country i to n. The parameter Φ_n of country n's price distribution is defined as $\Phi_n = \sum_{i=1}^{N} T_i(C_i * D_{n,i})^{-\theta}$ and can be interpreted as the so-called multilateral resistance term in other gravity-type models (Anderson, 2011). The model assumptions further yield that $\Pi_{n,i}$ is also the fraction of goods that country n buys from country i: $\Pi_{n,i} = X_{n,i}/X_n$, where X_n is country n's total spending of which $X_{n,i}$ is spent on goods from i.

To compare the relative import positions of two source countries i and j in country n, (1) is divided by the analogous expression for j:

$$\frac{\Pi_{n,i}}{\Pi_{n,j}} = \frac{\frac{X_{n,i}}{X_n}}{\frac{X_{n,j}}{X_n}} = \frac{X_{n,i}}{X_{n,j}} = \frac{T_i * [C_i * D_{n,i}]^{-\theta}}{T_j * [C_j * D_{n,j}]^{-\theta}}. \tag{2}$$

[7] Section 2.3 provides more details on these and other channels and tests the derived hypotheses.

It is useful that importer's total expenditure on goods (including domestic goods) X_n and its price parameter Φ_n, which are often unknown to researchers, can be dropped. It should be noted that the Eaton-Kortum model is a multilateral general equilibrium model. In this chapter, general equilibrium effects are however conditioned out by normalising in (2) (and using fixed effects in the regressions, see also Section 2.2.3); thus, asymmetric subsidy effects are studied in a partial equilibrium.

It is further assumed that an export subsidy provided to country m firms affects unit production costs and/or trade constraints of i and j, as described above. The subsidy can be interpreted both as an ad-valorem unit production cost reduction or an ad-valorem export tariff and its impact depends on source country i or j, importing country n and subsidy implementing country m characteristics. Accordingly, equation (2) is augmented by ad-valorem subsidies $S_{m,n,i}$ and $S_{m,n,j}$, respectively:

$$\frac{\Pi_{n,i}}{\Pi_{n,j}} = \frac{X_{n,i}}{X_{n,j}} = \frac{T_i}{T_j} * \left[\frac{S_{m,n,i}}{S_{m,n,j}} * \frac{C_i * D_{n,i}}{C_j * D_{n,j}}\right]^{-\theta}, \tag{3}$$

where $S_{m,n,i} \in (0,1)$ and $S_{m,n,j} \in (0,1)$ if the subsidy reduces unit production costs and/or trade costs in i and j, respectively. $S_{m,n,i} = 1$ and $S_{m,n,i} = 1$ if the subsidy has no effect on costs in i and j; and $S_{m,n,i} > 1$ and $S_{m,n,j} > 1$ if unit cost of exports for i and j firms increase due to the subsidy. Furthermore, $S_{m,n,i} = S_{m,n,j}$ if the subsidy implemented by m has the same ad-valorem cost implication for firms in i and j in market n; $S_{m,n,i} \neq S_{m,n,j}$ if the subsidy has different implications on either unit production costs or export constraints for i and j along the possible channels of asymmetric subsidy effects described above. Furthermore, the subsidy implemented by m may have different implications for exports of i or j that are bilaterally affected ($m = n$) and for exports that are affected through deflection (that is, in the rest of the world), where $m \neq n$.

2.2.2 Data

The crisis period 2008/09 builds an interesting natural experiment setting to study asymmetric effects of third-country subsidies on German versus British export patterns at the extensive and intensive margin. Short after the trade collapse (first half of 2009) German and British exporters were simultaneously affected by the same third-country subsidies. According to the Global Trade Alert (GTA), these subsidies were "almost certainly" discriminatory, were implemented by 11 different countries and targeted a total of 326 HS

4-digit product lines (mostly manufacturing) or around 40 percent of all observations in the dataset. Appendix Table 6 provides an overview of these subsidies. In the empirical exercise below, it is assumed that these subsidies affected trade patterns in 2009 and - given that they were not announced and implemented in 2008 - they did not affect trade in 2008.[8]

Table 1 shows parallels and differences of the two countries in terms of export dynamics, which are calculated from UN Comtrade data. Both countries reported robust annual export growth figures in the pre-crisis period (see Panel 1): in 2008 export growth was 10 percent in Germany and 4 percent in the UK. In the crisis year 2009, both German and British exports collapsed at a similar rate of more than 20 percent and the collapse was to a great extent synchronized across sectors; for example, a stronger fall in the machinery sector and a smaller fall in the footwear sector in both countries. Similar growth dynamics can be studied in the remaining top-10 export countries.

Panel 2 and 3 report extensive margin adjustments of exports in top-10 countries. Extensive margin adjustments are defined as changes in terms of product-country pairs exported, where a product-country pair is defined as 1 HS 6-digit product exported to 1 trading partner. The contribution of extensive margin adjustments to positive (pre-crisis) or negative (crisis) export growth was between 1 and 4 percent in Germany and the UK (see Panel 2). While this contribution was higher for the UK during pre-crisis years compared to 2009, Germany experienced the opposite scenario. Note that, for example, the 3 percent growth contribution of the extensive margin for Germany during the crisis mean that 3 percent of the export collapse are explained by extensive margin adjustments. Patterns were similar in the remaining top-10 countries; except in Russia, where the extensive margin has slowed down positive export growth during pre-crisis years, and in the US, where the growth contribution was above 6 percent in 2008 and almost 20 percent in 2009. Finally, Panel 3 shows growth figures in terms of number of product-country pairs exported. While all countries (including the UK) reported smaller positive or even negative growth figures in 2009 compared to pre-crisis periods, Germany was able to considerably increase its set of product-country pairs exported during the crisis and this growth was clearly

[8] Caveats of such an approach include that the subsidy variable is constructed as a dummy and thus the economic significance of the respective measures is not considered. Furthermore, the identification of the subsidy effect is challenged given that subsidies implemented in the second half of 2009 may also affected export patterns in 2009 and/or measures implemented at the end of 2008 may affected export flows of 2008 and 2009. Restricting the analysis to subsidies implemented in the first half of 2009 can be regarded as a conservative approach and thus the true subsidy effect is likely to be underestimated (rather than overestimated).

Table 1: Export dynamics in top-10 export countries, before and during the crisis

	Pre-crisis $\emptyset$ (2003-2008[a])	Pre-crisis (2008)	Crisis (2009)
Panel 1: Annual export growth (in %)			
Germany	15.68	10.33	-23.07
UK	8.64	4.04	-23.53
Belgium	13.73	10.78	-22.50
China	28.59	17.38	-16.05
France	11.68	10.17	-21.97
Italy	12.31	8.34	-24.98
Japan	11.28	9.41	-25.69
Netherlands	15.88	14.32	-20.97
Russia	30.34	32.85	-35.51
US	10.90	11.85	-18.72
Panel 2: Growth contribution of extensive margin adjustments[b] (in %)			
Germany	0.93	1.88	2.96
UK	2.25	3.82	1.02
Belgium	0.19	3.38	0.77
China	1.76	1.08	2.75
France	2.71	2.08	3.13
Italy	1.68	1.13	0.18
Japan	2.31	1.26	1.07
Netherlands	4.11	2.65	0.04
Russia	-12.87[c]	-5.03[c]	14.30
US	2.89	6.86	18.73

Table 1: continued

	Pre-crisis $\emptyset$ (2003-2008[a])	Pre-crisis (2008)	Crisis (2009)
Panel 3: Growth in number of product-country pairs[b] exported (in %)			
Germany	1.60	1.14	5.65
UK	1.31	1.77	0.49
Belgium	5.10	8.60	2.43
China	6.98	3.34	1.76
France	0.61	-0.73	-3.56
Italy	1.54	0.33	-2.34
Japan	0.47	-0.54	-7.69
Netherlands	1.99	1.26	-0.74
Russia	-0.77	-3.13	-1.19
US	2.99	4.62	-2.69

Notes: [a]Average ($\emptyset$) annual pre-crisis figures are calculated without 2007 data. In 2007 the harmonized system nomenclature was revised. Extensive margin adjustments in terms of changes in product-country pairs are therefore not identified for 2007; [b]Extensive margin adjustments are defined as changes in terms of product-country pairs exported, where a product-country pair is defined as 1 HS 6-digit product exported to 1 trading partner; [c]Negative growth contributions of extensive margin adjustments in pre-crisis periods for Russia illustrate that Russian (positive) export growth in pre-crisis periods was combined with (or slowed down by) a decrease in diversification. (*Source:* UN Comtrade)

larger compared to all pre-crisis periods.[9] [10]

These stylized facts call for more attention on the determinants of German export patterns and reveal that any other top-10 export country could be taken as a comparison - given the rather symmetric dynamics in these other countries. In the end, the natural experiment setting described above is the reason for using German versus British export patterns in this study.

2.2.3 Empirical strategy

This section describes the empirical strategy, which fits into the natural experiment setting and uses the conceptual framework - introduced in Section 2.2.1 - as guidance.Log-linearising (3), taking the first difference (over 2008 and 2009) and adding product line dimension p, the following reduced-form estimation equation can be adopted:

$$d\left[\pi_{n,i,p} - \pi_{n,j,p}\right] = d\left[x_{n,i,p} - x_{n,j,p}\right] = \lambda_s + \mu_n + \beta_1 * b_{m,q} + \beta_2 * f_{n,q} + \epsilon_{n,p}, \qquad (4)$$

where smaller case (Greek-)letters denote logs, d is is the first difference operator, n is the partner (or importing country) and $n = m$ if the partner implemented an export subsidy, p refers to *hs4* (HS 4-digit product line) and $p = q$ if product line q is affected by an export subsidy. On the left-hand side,$d\left[\pi_{n,i,p} - \pi_{n,j,p}\right]$is the first-difference of the log ratio of probabilities that n imports a good in product line p from Germany (i) and the UK (j). Similarly, $d\left[x_{n,i,p} - x_{n,j,p}\right]$ corresponds to the first-difference of the log ratio of expenditures of n on goods in p from Germany (i) and the UK (j) and can be constructed from i and j's log export values to n in product line p and will be taken as the dependent variable in the so-called intensive margin regressions. Furthermore, it is assumed that the ratio

[9] Almost 30 percent of Germany's increase in export diversification in 2009 was due to products, which were not exported by Germany during the pre-crisis period 2008.

[10] Recent papers also found that the great trade collapse was largely driven by intensive rather than extensive margin adjustments (see for example, Haddad et al., 2010 for Brazil, the EU, Indonesia and the US using sectoral data, or Behrens et al., 2010 and Bricongne et al., 2009 for Belgium and France using firm data). None of the existing studies has, however, found that a country was able to increase its product set exported and thereby to increase diversification during the crisis. Furthermore, this study acknowledges that the fall in demand is the main culprit of the collapse, but trade frictions, such as protectionism, also played a role (see Behrens et al., 2010 and Eaton et al., 2010). In the difference-in-difference specification derived in the next section it is assumed that the demand fall is common for Germany and the UK and eliminated by taking differences over time and between the two countries. While this study puts focus on the role of third-country subsidies, other frictions such as financial constraints may also explain (asymmetric) trade patterns - especially during a crisis (see for example Auboin, 2009, Iacovone and Zavacka, 2009 and Chor and Manova, 2012).

of probabilities that country n imports a good in product line p from country i and j is correlated with the relative numbers of *hs6* products that are exported to n in p. These number-of-product ratios are used to construct an alternative dependent variable in the so-called extensive margin regressions. It should be noted however that Eaton and Kortum's (2002) model (which serves as guidance for the estimations in this essay) is not one of the extensive margin in principal. That is, it does not provide predictions as to the extent that one particular product is or is not exported; or whether a firm is an exporter, serves the domestic market only or disappears (like for instance in Melitz, 2003). Therefore, the extensive margin measure used in this essay should simply be regarded as an alternative way to proxy for the left-hand side variable in (4).

On the right-hand side of (4), $\lambda_s + \mu_n$ are *hs2* (sector s) and partner country dummies controlling for unobserved technology, unit production cost and trade constraint differences between Germany and the UK. It should be noted that these dummies do not account for factors that are at the same time sector and partner country specific (e.g. tariff adjustments). At the end of Section 2.2.4, such factors are discussed and included in robustness checks.

Furthermore, $b_{m,q}$ is the bilateral dummy for subsidy affected exports to the implementing country m in product line q; and $f_{n,q}$ is the dummy for export patterns affected through deflection, that is, exports to foreign markets in which Germany and the UK compete with subsidy implementing country m; $\epsilon_{n,p}$ is the error term. From an econometric point of view, (4) is a parametric two-period difference-in-difference specification, where differences are taken over German export patterns (pseudo treatment group) and British export patterns (pseudo control group) as well as over the pre-crisis (2008) and crisis (2009) period. β_1 and β_2 are the treatment/subsidy effects assuming common trend between German and British export patterns conditional on λ_s and μ_n.

2.2.4 Results

Table 2 presents the results for extensive and intensive margin specifications in line with (5). Panel 1 reports estimates of the original setting, where third-country subsidies are implemented at the beginning of 2009 and, accordingly, relative export patterns of Germany and the UK are compared for 2008 versus 2009. Panel 2 reports the estimates of a robustness check, where third-country subsidies (affecting the same product lines as in the original setting) are assumed to be implemented at the beginning of 2006 and accordingly

Table 2: Asymmetric effects of third-country subsidies

	Extensive margin		Intensive margin	
	(1)	(2)	(3)	(4)
Panel 1: Original setting (subsidies implemented in Q1 and Q2 2009)				
Third-country subsidy	0.052***		0.087***	
	(0.012)		(0.025)	
Bilateral		0.057*		0.088
		(0.032)		(0.082)
Deflection		0.052***		0.087***
		(0.012)		(0.025)
Observations	60564	60564	60564	60564
R-squared	0.042	0.042	0.015	0.015
Panel 2: Placebo setting (subsidies implemented in Q1 and Q2 2006)				
Third-country subsidy	-0.007		-0.015	
	(0.014)		(0.032)	
Bilateral		0.084		0.017
		(0.091)		(0.102)
Deflection		-0.007		-0.016
		(0.014)		(0.032)
Observations	49942	49942	45316	45316
R-squared	0.012	0.012	0.012	0.012

Notes: Dependent variable for extensive margin: First difference of German-British relative numbers of products exported per product line to each country, where products are defined as *hs6* and product lines as *hs4*; dependent variable for intensive margin: first difference of German-British log export value differences per *hs4* in each destination country; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit = export destination]; sector and export destination dummies included, where sectors are defined as *hs2*; constant included but omitted in the table.

relative exports of Germany and the UK are investigated for 2005 versus 2006. Given that third-country subsidies were not actually implemented in 2006, the exercise corresponds to a placebo test and subsidy effects are expected to be insignificant. To account for possible correlation of the errors for observations of one export partner, robust-clustered standard errors with cluster unit export destination are used.[11]

For the original setting (Panel 1), the overall effect of third-country subsidies, that is, direct and deflection effects together, is statistically different from zero and positive for extensive and intensive margin specifications. While the magnitude and sign remain similar when looking at bilateral and deflection channels separately, stronger statistical support for a positive effect is found through deflection at both the extensive and intensive margin.[12]

Given the statistically significant estimates, German and British exporters were asymmetrically affected by third-country subsidies implemented soon after the trade collapse. The positive signs are consistent with the argument that the Germans relatively benefited from these subsidies compared to the British at both the extensive and intensive margin. At the extensive margin, the relative position of Germany in terms of numbers of exported *hs6* products improved by 5 percentage points due to subsidies, and at the intensive margin, it improved in terms of log export values by 9 percentage points. According to the stylized facts described in 2.2.2, the Germans may thus managed to increase export diversification in terms of number of product-country pairs, among other things, due to the subsidies while British exporters kept diversification relatively constant (extensive margin). At the intensive margin, the Germans compared to the British may have experienced a relatively

[11]The results are robust to specifications accounting for possible correlation of errors within product lines. Those results are not reported, but can be received upon request.

[12]The R-squared is low for all specifications: 0.042 for the extensive margin and 0.015 for the intensive margin. These figures remain low for specifications with additional variables (see Tables 4 and 5). Why do the sector and export destination dummies (and other control variables) explain so little of the variation in the dependent variable? While sector and exporter-importer dummies nicely control for time-constant factors such as distance in level estimations of trade flow (see recent gravity studies such as Eaton and Kortum, 2002 and Helpman et al., 2008), these dummies no longer control for time-constant factors in difference-in-difference estimations. The trade collapse during the investigated period 2008-2009 was to a large extent synchronized across all products and destinations, which is captured by the difference-in-difference specifications. Accordingly, the dummies in this chapter control for changes in demand or trade constraints, which are not equal across all sectors and destinations. This remaining variation is typically difficult to capture and leads to low R-squared figures. Additionally, each component of the difference-in-difference variable has its own measurement error, which translates into considerably larger total measurement error of variables in differences compared to variables in levels. This may be another reason for low R-squared figures in the estimations. This chapter is interested in the point estimate of asymmetric subsidy effects rather than a model, which nicely fits the variation in the dependent variable as a whole. As long as measurement error is random, low R-squared figures are not problematic for the identification of the point estimate.

smaller export collapse in the affected product lines, again among other things, due to third-country subsidies.

The placebo tests support these conclusions. When export patterns of Germany and the UK are compared for 2005 versus 2006, the placebo asymmetric effects of third-country subsidies are zero. None of the estimated coefficients in Panel 2 is statistically significant. As no evidence for the implementation of subsidies at the beginning of 2006 exists, these zero estimates are expected and make the statistically significant effects in the original setting (where asymmetries are potentially expected) more reliable.

Nevertheless, it could be argued that asymmetric subsidy effects arise from other observed policies (e.g. tariffs, public procurement measures or local content requirements), which affect only one of the two countries. Table 2 estimations are therefore repeated with two additional dummies indicating whether either German or British exporters were affected by such policies (during time period Q1 and Q2 2009). Furthermore, not controlling for unobserved protectionist action against the two countries may lead to wrong conclusions. Assuming that the probability that Germany is more affected by unobserved protectionism (compared to the UK) is a function of total observed discrimination against them, the ratio of observed measures can be used as a proxy for unobserved measures in Table 2 estimations. In both of these additional robustness checks, the main coefficients of interest (including their statistical significance) remain almost equal, which is consistent with the argument of asymmetric subsidy effects.[13]

Finally, export support measures implemented by Germany and the UK themselves may lead to asymmetric effects in product lines affected by third-country subsidies. At least for the time period used in this study, export support measures of the two countries are, however, not sector-specific and should therefore not alter the results in Table 2.

2.3 Determinants of asymmetries

2.3.1 Hypotheses and data

Section 2.2 introduced the notion of asymmetric third-country effects and provided first evidence of such asymmetries for German versus British exports during the crisis period 2008/09. This section focuses on possible determinants of asymmetric effects of third-country subsidies on exports. While theoretical derivations are left aside, the section

[13]Estimation results of these robustness checks are not reported, but can be received upon request.

verbally develops several hypotheses how the asymmetries may be determined and tests them within the empirical setting of Section 2.2. The expected effects for each hypothesis and causal factor are summarised in Table 3.

The first set of hypotheses questions whether differences in economic and other ties between the subsidy implementing country and affected countries can explain asymmetries. The argument for economic ties is motivated by recent work on the relationship between vertical structure, trade policy and firm/industry outcomes (see for example theories on the impacts of tariffs and trade agreements on international hold-up problems by Antràs and Staiger, 2008 and Ornelas and Turner, 2008 and studies investigating the effect of trade frictions on the choice of organizational form of firms contemplating offshoring by Antras and Helpman, 2004 and Diez, 2008). However, related to economic integration disparate effects of trade policy on outcomes of foreign competitors are rarely investigated explicitly. Cohen-Meidan (2009) is probably the first and finds that non-integrated foreign firms are more likely than vertically integrated firms to exit the US market following the imposition of antidumping duties.

To study this channel in the context of export subsidies, it is assumed that more integrated foreign competitors/partners may indirectly gain from export subsidies through imports of cheaper intermediate inputs from subsidy implementing countries. Cheaper inputs will lower production costs resulting in competitiveness gains in export markets. For example, German compared to British auto manufacturers/exporters are more likely to benefit from the state support measures to General Motors by Argentina and the United States as well as from Slovakia's state aid to Volkswagen given that the supported firms have strong ties with German car producers.[14] For the empirical exercise in this study, hypothesis 1 ensues as follows:

Hypothesis 1 *If German exporters increase input sourcing from subsidy implementing countries, they improve their export position compared to British exporters in bilateral and deflection markets affected by subsidies; and vice versa.*

The following two proxies of economic ties are used to test the mechanism (see Table 3): (i) Log of German-British relative outward FDI stocks in the subsidy implementing countries, *FDI*, and (ii) German-British relative shares of intermediate inputs sourced from implementing countries, *Input*. The underlying data for these proxies is taken for year 2007

[14] The three bailouts mentioned here are included in the dataset.

from Eurostat and UN Comtrade, respectively, where 2007 is before the investigation period and thus endogeneity problems are diminished.[15] While proxy (ii) directly checks to what extent Germany and the UK depend on inputs from subsidy implementing countries, proxy (i) assumes that higher outward FDI stocks mean higher interaction between firms/plants of FDI sending and receiving countries - including interactions through import sourcing.

Hypothesis 1 always holds for deflection markets, however, the linkage between FDI and subsidies may be ambiguous in bilateral markets. Typically, local firms in implementing countries face stronger competition from foreign firms who origin from strongly integrated partners compared to those from less integrated partners. Therefore, implementing countries may target discrimination directly to those more integrated partners. For example, state-owned sugar firms in Indonesia are supported to buy new machinery under the condition that it is completely assembled in Indonesia and contains at least 40 percent local contents (again a measure included in the dataset). Given that Germany (compared to the UK) has more FDI stocks in Indonesia and Germany exported machinery for the production of sugar to Indonesia before (but not after) the implementation of the measure, the new requirements may have affected German compared to British machinery (or parts of machinery) exporters relatively more. Hypothesis 2 is thus formulated as follows:

Hypothesis 2 *If German exporters are more FDI-integrated with subsidy implementing countries, they worsen their export position compared to British exporters in bilateral markets affected by subsidies; and vice versa.*

It should be emphasised that hypothesis 1 and 2 have opposite predictions for FDI integration and the bilateral channel (see Table 3). It is therefore an empirical question which one is true, if any, or which channel dominates the effect.

Other ties (not driven by the private sector) may also explain asymmetric effects between affected countries. Recent theoretical literature emphasize that the absence of informational barriers within a group of countries increase trade and income between these countries, but hurt countries outside the group disproportionately (Casella and Rauch, 2002 and Rauch and Casella, 2003). This is confirmed by empirical studies who find that bilateral

[15] The main caveat of both economic integration proxies is that data is not available at the product line/sector level. It is therefore implicitly assumed that German-British relative economic integration in terms of FDI and input sourcing is constant across (subsidy affected) sectors. Furthermore, the nature (e.g. horizontal versus vertical dimension) of direct investments is unknown, which builds another challenge to identification of the proposed effects.

Table 3: Expected effects of determinants of asymmetries

		Expected effect	
Hypothesis	Causal factor	Bilateral	Deflection
H1	FDI	+	+
	Input	+	+
H2	FDI	−	..
H3	Euro	+	+
	Mainland	+	+
	German	+	+
	English	−	−
H4	Unit value, Germany closer	−	−
	Unit value, UK closer	+	+
	Energy int., Germany closer	−	−
	Energy int., UK closer	+	+

Notes: More details on hypotheses 1-4 and the interpretation of the causal factors can be found in Section 2.3.1.

trade volumes are higher between countries that share larger immigration flows and ethnic populations or have a common language (see for example, Gould, 1994, Rauch and Trindade, 2002 and Feenstra et al., 2004). In the context of this chapter, one affected country may benefit from (or may not be harmed by) third-country subsidies through informational advantages (combined with *per se* better business conditions and thus lower business uncertainties), while another country where informational ties are absent may be hurt. The third hypothesis states as follows:

Hypothesis 3 *If Germany has stronger informational ties with implementing countries, German exporters improve their export position compared to British exporters in bilateral and deflection markets affected by subsidies; and vice versa.*

Without making claim to be complete, such ties may exist if affected and implementing countries have the same currency, are geographically close and have the same language. To test such ties in the given empirical framework, the following dummies are included one by one: (iii) *Euro,* (iv) *Mainland*, (v) *German* and (vi) *English.* The dummies are one for product lines affected (bilaterally or through deflection) by an implementing country,

which is (iii) in the euro zone, (iv) in mainland Europe (including Russia), has (v) German or (vi) English as its official language. Indicating ties with Germany, estimates for (iii), (iv) and (v) are expected to be positive. Accordingly, estimates for (vi) should be negative given the indication of ties with the UK (see also Table 3).

Besides determinants with regard to economic and informational ties, competitive proximity may explain asymmetric subsidy effects. Direct foreign competitors in terms of technology or quality may suffer relatively more than indirect competitors when third countries implement subsidies as they are more likely to compete in the same international markets (Hallak, 2006). The competitive proximity hypothesis is thus:

Hypothesis 4 *If German and subsidy implementing country producers are direct competitors, German exporters worsen their export position compared to British exporters in bilateral and deflection markets affected by subsidies; and vice versa.*

Measures for technology or quality proximity between subsidy implementing and affected countries are constructed from unit values and energy intensity. Unit values as quality proxies are widely used in literature (see for instance studies that seek to divide intra-industry trade into vertical and horizontal components by Greenaway et al., 1995, Schott, 2004 and Fontagné et al., 2006, or empirical research on international competitiveness by Aiginger, 2001, Dulleck et al., 2005 and Harding and Javorcik, 2011).[16] In this chapter average unit values (export value to the world divided by kg) for Germany and the UK as well as for each subsidy implementing country are calculated at the *hs4* (product line) level. If German (compared to British) unit values are closer to unit values of subsidy implementing countries in a affected product line, dummy variable (vii) *Unit value, Germany closer* is one and zero otherwise. Similarly, if British (compared to German) unit values are relatively closer to implementing countries', (viii) *Unit value, UK closer* is constructed.

Alternatively, such dummy variables are based on closeness of energy intensity levels between Germany and implementing countries as well as between the UK and implementing countries: (ix) *Energy int., Germany closer* and (x) *Energy int., UK closer*. Section 3.4.2 motivates why energy intensity may be an appropriate proxy to measure sectoral quality

[16] Nevertheless, unit values are imperfect proxies for product quality and may vary for reason other than quality, such as production costs or market power. Unit values may also be noisy due to both aggregation and measurement error (see Szczygielski and Grabowski, 2009 and Harding and Javorcik, 2011, for critical assessments). Most caveats are diminished by including sectoral and destination specific dummies in the estimations.

(or technology) differences between countries. Sectoral energy intensity data for 2004 is taken from the Global Trade Analysis Project. Again 2004 is before the investigation period and thus endogeneity should not be a problem.

2.3.2 Empirical strategy and results

Hypotheses 1-4 are tested by interacting the proposed causal factors, z_m, for each hypothesis with the bilateral dummy, $b_{m,q}$, and the deflection dummy, $f_{n,q}$, of specification (4). Each hypothesis is studied separately; that is, the interaction terms (causal factors) for each hypothesis are added one by one to the benchmark model.[17] The estimation equation (4) is thus augmented as follows:

$$d\left[x_{n,i,p} - x_{n,j,p}\right] = \lambda_s + \mu_n + \beta_1 * b_{m,q} + \gamma_1 * (b_{m,q} * z_m) + \beta_2 * f_{n,q} + \gamma_2 * (f_{n,q} * z_m) + \sigma_{n,p}. \quad (5)$$

Table 4 presents the results on channels of integration, which may have determined asymmetric effects of third-country subsidies (Hypotheses 1-3). Again, to account for possible correlation of the errors for observations to the same export partner, robust-clustered standard errors with cluster unit export destination are used.

Both extensive and intensive margin specifications (Panel 1 and 2) yield stronger support to the proposed hypotheses through deflection rather than for bilaterally affected product lines. The main deflection effect is reduced by 1-2 percentage points, when interaction terms are added (except for *English*). For the bilateral channel, the proposed causal factors alter the outcome of the main effect - at least at the extensive margin -, but these factors increase the asymmetric subsidy effect rather than decreasing it. Against expectations, the causal factors do thus not absorb some of the main effect, but make it even more important.

[17] If the interaction terms would be included together, multi-collinearity would probably be a problem given that pair-wise correlation coefficients of the interaction terms are larger than 0.8 for most pairs. Furthermore, the aim is to investigate whether one or several of the proposed hypotheses help to explain the asymmetries found in the previous section. No argument is made that these hypotheses should hold all together; therefore, misspecification issues due to the one-by-one approach should not be a problem. Finally, some interactions used in the estimations are alternative variables to investigate the same hypothesis (for example *FDI* and *Input*; or *Eur* and *Mainland*). Adding them together would thus not be appropriate. An exception is the investigation of hypothesis 4, where the interaction terms for *Unit value, Germany closer* and *Unit value, UK closer* (as well as *Energy int., Germany closer* and *Energy int., UK closer)* are studied together.

For deflection, specifications 1 and 2 in both panels are supportive to Hypothesis 1 that the more a country is economically integrated with a subsidy implementing country, the more it is likely to benefit from cheaper imported inputs and can thereby gain competitive advantage in export markets. If Germany's FDI position in subsidy-implementing countries is increased by 1 percent relative to Britain's, the export position of Germany (compared to the UK) is improved by 3 percentage points at the extensive margin and 7 percentage points at the intensive margin. Similarly, if the ratio of implementing countries' import share in Germany and the UK is increased by 1 unit, the export position of Germany (compared to the UK) is improved by 3 percentage points at both the extensive and intensive margin; the coefficient is however not statistically significant for the intensive margin.

Focusing on extensive margin results for bilaterally affected markets, Hypothesis 2 that stronger FDI integration leads to stronger discrimination of bilaterally affected exports is supported (see Specification 1), while Hypothesis 1 still holds when looking at imported inputs in Specification 2: The FDI coefficient is negative and significant (-0.04), while the imported input share coefficient is positive and significant (0.04). Accordingly, in this sample, the effect through hypothesis 2 dominates the effect through hypothesis 1 for FDI integration and the bilateral channel.

The results for specifications 3-6 are consistent with Hypothesis 3 that other ties with the subsidy implementing country (such as common currency, geographic proximity and common language) may involve information advantages when third countries implement subsidies. While the evidence is very clear for deflection markets (signs are according to expectations and coefficients are statistically significant in most cases), effects investigating bilaterally affected exports are generally insignificant. Accordingly, for deflection markets, if subsidy implementing countries are members of the euro zone, belong to mainland Europe or German is the official language, Germany's export position (compared to UK's) is improved by 17, 10 and 19 percentage points at the extensive margin and 11, 12 and 14 percentage points at the intensive margin when third countries implement subsidies.

Table 5 reports the estimation results for Hypothesis 4, which states that more direct (compared to indirect) foreign competitors with the subsidy implementing country worsen their export position relatively more, when third countries implement subsidies. While statistical significance is again higher for the deflection channel (compared to the bilateral), the coefficients signs are against expectations throughout the estimations. In affected product lines, where German (compared to British) exporters are more direct competitors, the German exporters are expected to worsen their relative export position; and vice versa.

Table 4: Economic and other ties as determinants of asymmetric effects

Panel 1: Extensive margin

	(1)	(2)	(3)	(4)	(5)	(6)
Bilateral	0.156***	0.052	0.132***	0.095***	0.126***	0.041
	(0.052)	(0.036)	(0.031)	(0.036)	(0.034)	(0.031)
FDI	-0.041*					
	(0.021)					
Input		0.044*				
		(0.024)				
Euro			-0.123			
			(0.079)			
Mainland				0.010		
				(0.043)		
German					-0.053	
					(0.035)	
English						0.046
						(0.043)
Deflection	0.044***	0.034**	0.0335***	0.036***	0.033***	0.056***
	(0.013)	(0.013)	(0.012)	(0.013)	(0.0123)	(0.013)
FDI	0.027***					
	(0.009)					
Input		0.029***				
		(0.009)				
Euro			0.173***			
			(0.021)			
Mainland				0.103***		
				(0.023)		
German					0.191***	
					(0.022)	
English						-0.029
						(0.019)
Observations	60564	60564	60564	60564	60564	60564
R-squared	0.042	0.041	0.043	0.042	0.043	0.042

Notes: Dependent variable for extensive margin: First difference of German-British relative numbers of products exported per product line to each country, where products are defined as *hs6* and product lines as *hs4*; dependent variable for intensive margin: first difference of German-British log export value differences per *hs4* in each destination country; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit = export destination]; sector and export destination dummies included, where sectors are defined as *hs2*; constant included but omitted in the table.

Table 4: continued

Panel 2: Intensive margin

	(1)	(2)	(3)	(4)	(5)	(6)
Bilateral	-0.044	0.113	0.110	0.091	0.129	0.163***
	(0.0550)	(0.111)	(0.108)	(0.165)	(0.111)	(0.063)
FDI	0.133***					
	(0.035)					
Input		-0.007				
		(0.084)				
Euro			0.141			
			(0.135)			
Mainland				0.105		
				(0.162)		
German					0.137	
					(0.117)	
English						-0.272***
						(0.069)
Deflection	0.066**	0.072**	0.076***	0.069***	0.073***	0.086***
	(0.026)	(0.029)	(0.025)	(0.026)	(0.025)	(0.027)
FDI	0.072***					
	(0.021)					
Input		0.025				
		(0.016)				
Euro			0.105**			
			(0.045)			
Mainland				0.118**		
				(0.047)		
German					0.144***	
					(0.051)	
English						0.015
						(0.049)
Observations	60564	60564	60564	60564	60564	60564
R-squared	0.015	0.015	0.015	0.015	0.015	0.015

Notes: Dependent variable for extensive margin: First difference of German-British relative numbers of products exported per product line to each country, where products are defined as *hs6* and product lines as *hs4*; dependent variable for intensive margin: first difference of German-British log export value differences per *hs4* in each destination country; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit = export destination]; sector and export destination dummies included, where sectors are defined as *hs2*; constant included but omitted in the table.

Table 5: Competitive proximity as determinants of asymmetric effects

	Extensive margin		Intensive margin	
	(1)	(2)	(3)	(4)
Bilateral	0.027	0.049	0.186	0.433
	(0.039)	(0.115)	(0.121)	(0.296)
Unit value, Germany closer	0.068		-0.247	
	(0.075)		(0.308)	
Unit value, UK closer	0.098***		-0.306*	
	(0.035)		(0.157)	
Energy int., Germany closer		0.045		0.192
		(0.080)		(0.285)
Energy int., UK closer		-0.037		-0.375
		(0.124)		(0.272)
Deflection	0.051***	0.069***	0.088***	0.076***
	(0.013)	(0.014)	(0.025)	(0.028)
Unit value, Germany closer	0.046**		0.001	
	(0.021)		(0.049)	
Unit value, UK closer	-0.048**		-0.002	
	(0.021)		(0.054)	
Energy int., Germany closer		0.045		0.111
		(0.044)		(0.088)
Energy int., UK closer		-0.075***		0.050
		(0.015)		(0.040)
Observations	60564	60564	60564	60564
R-squared	0.042	0.042	0.015	0.015

Notes: Dependent variable for extensive margin: First difference of German-British relative numbers of products exported per product line to each country, where products are defined as *hs6* and product lines as *hs4*; dependent variable for intensive margin: first difference of German-British log export value differences per *hs4* in each destination country; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit = export destination]; sector and export destination dummies included, where sectors are defined as *hs2*; constant included but omitted in the table.

Using the available measures of the competitive environment at the product line level (based on unit values or energy intensities as proxies for quality and technology), such a pattern is not found. For example, at the extensive margin and in deflection markets, Table 5 shows that Germany relatively improves its export position in product lines where unit values and/or energy intensities are closer to those of the implementing country. Similarly, the UK relatively improves its position in product lines where the proxies for quality or technology are closer to those of the implementing country.[18] On top of the puzzling signs of the effects, it should also be noted that the competitive proximity variables do not help to explain much of the asymmetries identified in the benchmark models; the main deflection effect stays relatively constant when adding these variables. One reason for this result could be measurement error: The available proxies may insufficiently measure the competitive environment between investigated countries.

[18] In a more detailed analysis, it is additionally checked whether both Germany and the UK have higher (or lower) values of the respective proxies compared to the implementing country or whether Germany has a higher and the UK a lower value (and vice versa). Interestingly, the puzzling results reported in Table 5 are to a large extent independent of these additional investigations. Again, Germany improves its export position in subsidy-affected product lines with German unit values and/or energy intensities closer to those of the implementing country independent of the ranking of these measures. The same pattern is found when British unit values and/or energy intensities are closer to those of the implementing country.

2.4 Conclusions

Although the intellectual community agrees that export subsidies are discriminatory against foreign commercial interests, political leaders did not revolt much against the wide use of other countries' bailouts and state aid measures since the global economic crisis. Furthermore, the failure of G20's no-protectionist pledge raises suspicion that some member countries may not be harmed (or even benefit) when others introduce discrimination. If the opposite holds, again more revolt against protectionist action within the G20 would be expected. Against this background, this essay empirically investigate whether subsidies introduced by third countries may have asymmetric effects on different foreign rivals.

Using the period 2008/09 as a natural experiment in which Germany and the UK were simultaneously affected by sector-specific third-country subsidies, this chapter shows that these subsidies have asymmetric effects on German and British export patterns in all international markets; that is, in those of implementing countries (bilateral markets) and in world markets in which German and British exporters compete with firms from implementing countries (deflection markets). Across all subsidy affected sectors, German (compared to British) exporters improved their export position both at the intensive and extensive margin.

What factors may determine these asymmetries? Recent work indicate that international fragmentation, informational ties or competitive proximity may matter for the relationship between export subsidies and the outcome of foreign exporters. Tests of these linkages within the same natural experiment setting show that German (compared to British) exporters improve their export position in subsidy affected deflection markets when their relative vertical integration with the subsidy implementing countries in terms of FDI and input sourcing increases. Informational ties (such as common currency, geographic proximity or language) with the subsidy implementing countries also prove to be important for the relative export performance in deflection markets after the implementation of subsidies. The investigated causal factors are generally insignificant in bilateral markets, but the main bilateral effect increases when adding these factors. This is against the expectation that economic and informational ties explain some of the overall asymmetry. The results for competitive proximity (in terms of technology or quality) with the implementing country are also puzzling. While a negative relationship between this proximity and the relative export positions is expected, data indicates a positive connection.

This study is probably the first to show that asymmetric export subsidy effects may exist

and may to some extent be determined by economic and informational ties. The exercise in this chapter has several limitations though. Firstly, the asymmetries may be restricted to the special case Germany versus the UK and to the great trade collapse period 2008/09. Future research may therefore investigate whether asymmetric subsidy effects exist more generally, that is, for other affected countries and for export subsidies that are implemented during quiet times (and not during big recessions). Secondly, this study is limited to a short-run perspective. Other studies could also focus on middle- and long-run effects. Knowledge on the long-run influence of export subsidies is crucial for a comprehensive understanding of such interventions. If export subsidies involve persistent trade distortions, it would be particularly alarming for countries whose commercial interests are more severely harmed. Thirdly, the empirical exercise has important data restrictions, which make the estimated effects to some extent vulnerable. Among others, measurement error is probably an issue for our subsidy variable as countries generally not report which foreign countries and which narrowly defined product lines are affected by their state support measures. Trade policy analysts may therefore not perfectly identify the truly affected countries and product lines. Aggregation may also lead to measurement error problems. For example, the FDI and imported input variables are not available at the the product line level. Assuming these variables to be constant across affected product lines may be contested. No indications for systematic measurement error exist though, which diminish the data related problems. Nevertheless, if more detailed data (optimally at the firm level) is available, future studies on asymmetric subsidy effects will certainly be more precise. Fourthly and finally, theoretical research could follow up on the findings of this study to build the conceptual cornerstone in particular related to the determinants of asymmetries. Clear-cut theoretical predictions will then help the empiricists to produce theory-grounded empirical results.

To understand the effects of export subsidies is indispensable for the agenda of multilateral trade policy setting. If recently implemented export subsidies do involve asymmetric effects, the absence or reluctance of complaints against other countries' crisis-related state intervention may partly be explained by the fact that some exporters indeed gained competitive advantage or were at least not harmed due to subsidies. However, the zero-sum (or even positive-sum) game may not apply to all affected exporters in the world and thus recently implemented subsidies are likely to induce considerable harm to some countries. Government leaders should therefore rethink multilateral trade rules and may initiate negotiations on stricter rules on subsidies including those implemented behind-the-border.

2.5 Appendix

Table 6: Subsidies affecting Germany and the UK, implemented Q1 and Q2 2009

Implementing jurisdiction	**Measure title**	**Measure type**	**No. of ATL**	**ASC**
Argentina	Argentina grants US$ 70M credit to General Motors	Bail out / state aid measure	2	Transportation (HS 87)
Austria	Rescue Aid for Eybl Austria GmbH	Bail out / state aid measure	19	Textiles (HS 58, 59)
Finland	Temporary Accelerated Depreciation for productive investments	Bail out / state aid measure	83	Metals (HS 73), Machinery / Electrical (HS 84, 85), Transportation (HS 87), Miscellaneous (HS 93)
India	Incentives for leather and textile sector exports	Export subsidy	84	Raw Hides, Skins, Leather, & Furs (HS 41, 42), Textiles (HS 51-63)
Indonesia	State aid to state-owned sugar firms	Bail out / state aid measure	3	Foodstuff (HS 17), Machinery / Electrical (HS 84)
Italy	Rescue aid to Antonio Merloni S.p.A. in Amministrazione Straordinaria	Bail out / state aid measure	7	Metals (HS 73), Machinery / Electrical (HS 84)
	Aid scheme for the promotion of renewables, energy saving, cogeneration and district heating in Tuscany	Bail out / state aid measure		Machinery / Electrical (HS 84)
Poland	Rescue Aid to Tarchominskie Zaklady Farmaceutyczne "POLFA" S.A.	Bail out / state aid measure	9	Chemicals & Allied Industries (HS 30)
	Rescue Aid for Diora Swidnica Sp. z o.o.	Bail out / state aid measure		Machinery / Electrical (HS 84)

Table 6: continued

Implementing jurisdiction	Measure title	Measure type	No. of ATL	ASC
Russia	Subsidized loans to producers of certain type of machineries	Bail out / state aid measure	110	Machinery / Electrical (HS 85)
	The programme of the anti-crisis measures of the Russian Government - 2009	Bail out / state aid measure		Animal & Animal Products (HS 03, 05), Vegetable Products (HS 07-15)
	Injection of 25 billion rubles (560 million Euros) into the charter capital of the "Russian Technologies" to support the domestic car industry	Bail out / state aid measure		Transportation (HS 87), Miscellaneous (HS 93)
	Subsidies to the Russian domestic car producers for technology update	Bail out / state aid measure		Transportation (HS 87)
Slovakia	State aid to Volkswagen Slovakia	Bail out / state aid measure	2	Transportation (HS 87)
Spain	Competitiveness plan of the automotive sector - Realization of investments aimed at the manufacturing of more environmental friendly products	Bail out / state aid measure	4	Transportation (HS 87)
United States	Support for General Motors and Chrysler	Bail out / state aid measure	3	Transportation (HS 87)

Notes: Retrieved from GTA (www.globaltradealert.org) in August 2010; ATL = Affected tariff/product lines (HS 4-digit); ASC = Affected sector categories (HS 2-digit)

3 Recent green policies - contested environmental benefits and import distortions[19]

Abstract

For the Asia-Pacific region, this chapter estimates the impact of "green" crisis-era measures on energy intensity of imports and the extent of discrimination of these policies against foreign suppliers. The results are surprising: "Green" measures whose purpose of implementation was not driven by the environmental policy agenda are associated with an increase of sourcing from more - rather than less - energy intensive countries. "Green" measures mainly implemented to mitigate climate change are more effective, or at least neutral, in making imports more climate-friendly. While the environmental benefits are limited based on the study of the import channel, these policies may have distortive effects on imports: Direct foreign competitors lose import share when "green" measures are implemented while indirect competitors gain. Direct (compared to indirect) competitors are defined as foreign suppliers with quality or technology levels similar to those of implementing countries.

Keywords: international trade, trade policy, protectionism, green growth, climate change

JEL classification: F13, F18

[19] I'm grateful to Simon Evenett, Michael Lechner, Mia Mikic and participants at the ARTNeT Symposium in Bangkok, 25-26 July 2011, the ETSG conference in Copenhagen, 8-10 September 2011, and the Ph.D. seminar in St. Gallen, 24 November 2011, for valuable comments and suggestions. An earlier version of this chapter was the basis for Wermelinger (2011), an ARTNeT policy brief.

3.1 Introduction

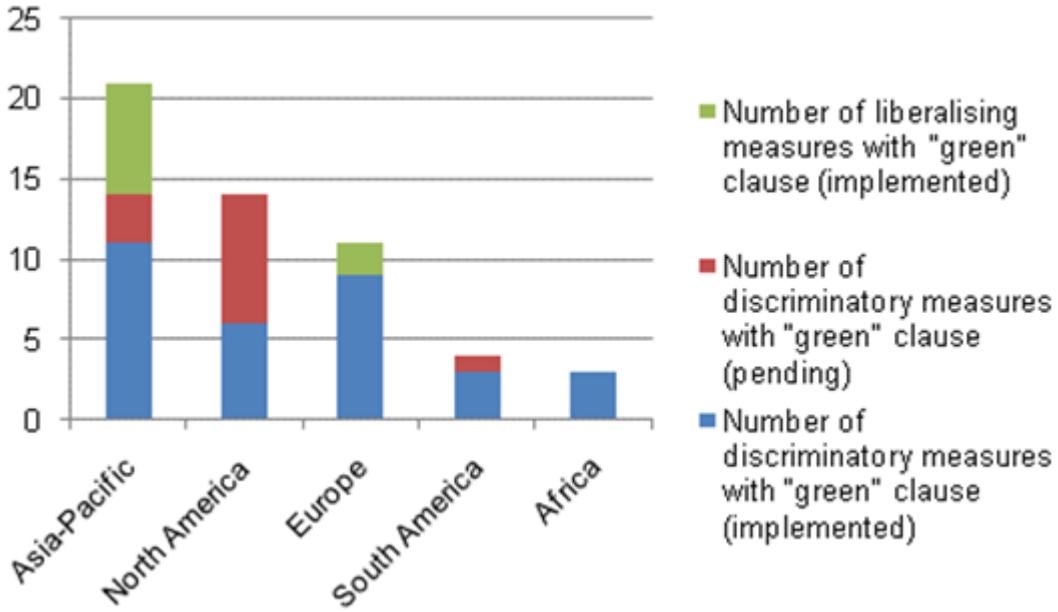
Climate change mitigation and adaptation actions are of a high priority in multilateral and unilateral policy agendas of governments around the globe (see for example, Wermelinger and Barnes, 2010). This trend was not stopped by the recent global economic crisis and the succeeding period marked by increasing market uncertainties. Governments intervened to help and save domestic industries with the introduction of bailouts, export subsidies, local content requirements and investment incentives, among others. Many of these state actions involve some clause regarding climate mitigation or energy efficiency/conservation objectives (henceforth called "green" measures).[20] The recently published Asia-Pacific Trade and Investment Report 2011 (ESCAP, 2011) provides an overview of "green" measures introduced worldwide since November 2008. Figure 1 illustrates that the Asia-Pacific region used "green" clauses most often - to liberalise trade or introduce beneficial effects for the partner countries, but also to introduce new discriminatory measures against commercial interests of their trading partners.[21]

Some trade policy commentators have questioned whether state measures provided under the guise of "green growth" strategies actually target or promote environmental friendly production, consumption or investment. Or whether the use of such measures is just a consensual way to introduce new discrimination against some trading partners - especially if climate change mitigation action is widely supported around the globe (see for example, Aggarwal and Evenett, 2009 and 2010, Evenett and Whalley, 2009 and Steenblik 2009).

[20]The phrases "green measure", "green clause", "green policy" or "green state intervention" are always related to the environmental aspect in this chapter. It should not be mistaken with the classification of the Global Trade Alert (GTA), from which the data on recent state measures is taken. GTA a priori classifies "green measures" as liberalising measures and "red measures" as discriminatory measures. Without assigning colours to recent state measures, this chapter also makes use of GTA's a priori classification of liberalising and discriminatory/distortive measures. To what extent these measures in fact distort international trade is, however, an empirical question.

[21]"Green" clauses in combination with discriminatory measures are most prominently used in the Republic of Korea (4 measures), China (3 measures), Japan (2 measures) and the Russian Federation (2 measures). For two-thirds of the discriminatory "green" measures clauses are combined with several other (mostly trade distortive) policies that have no climate or environmental purpose. This finding supports the argument that it is more accepted to use discriminatory measures and to protect domestic producers from foreign competition (particularly during economic downturns and during heated debates on climate change), if some environmental or climate objective is mentioned in the regulation. Interestingly, the "green" aspect is the main purpose of implementation for most liberalising measures and thereby shows that climate-friendly and trade-enhancing policies can in fact be merged. Finally, 46 trading partners, 6 sectors and 42 product lines are, on average, affected by distortionary "green" measures. This illustrates the likely economic and political importance of these measures. (Sectors are defined as CPC 2-digits codes and product lines as HS 4-digit codes. This is the classification used by the Global Trade Alert.)

Figure 1: Number of "green" measures since November 2008, by region



Notes: Data retrieved from GTA (www.globaltradealert.org) in April 2011, figure previously published in ESCAP (2011).

This chapter provides some answers to these questions for the case of the Asia-Pacific region. In particular, it firstly estimates the impact of "green" crisis-era measures on energy-intensity of imports and secondly the extent these policies discriminate against foreign suppliers of goods in the domestic market.[22]

The chapter proceeds as follows. The next section describes three channels through which "green" measures may contribute to climate change mitigation or greenhouse gas emission reduction and discusses how international trade is likely to be affected through these channels. More formally, Section 3.3 and 3.4 get granular on import effects providing theo-

[22]While Evenett and Whalley (2009) and Steenblik (2009) define, discuss the risk of and describe the patterns of "green" protectionism in the wake of the global economic crisis, Aggarwal and Evenett (2009 and 2010) assess that most crisis-era protectionist measures targeted sectors which are typically not associated with "growth poles" or "green growth", but were highly protected even before the crisis. The (legitimate) rationale for crisis intervention in light of "green growth" strategies is thus not supported by these studies. This study is probably the first to investigate the environmental effectiveness (limited to the study of the import channel) and the extent of import distortion of recent "green" state measures. The aim of this study should not be mistaken with others investigating competitiveness and carbon leakage issues related to national carbon taxes or energy efficiency standards (see for example, Kee et al., 2010, Mattoo et al., 2009, Wooders and Cosbey, 2010 and, for an overview of that literature, Ratnayake et al., 2011). While those studies are concerned that carbon taxes would negatively affect competitiveness of domestic companies and may result in carbon leakage, this chapter addresses the question of whether "green" state interventions are environmentally effective and may (negatively) affect foreign commercial interests.

retical predictions, deriving the empirical strategy and discussing data and econometric issues. Section 3.5 and 3.6 present the results and conclusions.

3.2 Green measures and possible effects on trade

All reported "green" measures for the Asia-Pacific region affect consumption and investment related to production processes. The following three channels describe how these measures may contribute to climate change mitigation or greenhouse gas emission reduction:

Fostering research and development of environmental friendly goods and technologies: *"Green" subsidies may provide financial incentives to domestic firms for research and development of environmental friendly goods and technologies.*

Using environmental friendly technologies for the production of other goods: *Domestic firms may receive financial support from their governments if they improve production processes by using new technologies and thus reducing energy consumption of production.*

Using environmental friendly inputs into production: *Incentives are provided for the use of environmental friendly inputs (or environmental friendly intermediary goods) into production. That is, inputs that are themselves produced with less energy and better technologies.*

It should be noted that a comparative definition of environmental friendly goods and technologies is used.[23] Goods or technologies produced more energy efficiently by one firm or one country compared to the same (or similar) goods somewhere else are regarded as environmental friendly goods. For example, Thailand produces electronics more energy efficiently than the Russian Federation; thus, Thai electronics are environmental friendly in comparison to their Russian equivalents. However, Australia is more energy efficient than Thailand in the same sector, therefore, Australian electronics are environmental friendly compared to Thai electronics.[24] [25]

[23]The phrases "environmental friendly", "climate friendly" and "climate smart" are treated as synonyms in this chapter.

[24]This classification is made with 2004 GTAP data on energy consumption at country and industry levels.

[25]An alternative definition of environmental friendly goods and technologies exists if goods are per se

All described channels also influence patterns of international trade - or the "climate friendliness" of trade. While increased research and development in the environmental sector (channel 1) should attract foreign expertise through consulting activities, channels 2 and 3 are likely to increase the share of imports of environmental friendly goods and/or technologies. Subsequently, after the full implementation of the new production processes exports should become more environmental friendly as a result of all three channels: Domestic goods will be produced more energy efficiently due to newly developed or acquired technologies. Consequently, inputs into production are more environmental friendly and thus exports of such goods would ultimately be regarded as more energy efficient (with regard to their complete production cycle). Due to these sequential effects - that is, that imports are affected before exports - and given that the implementation of these measures is still recent, only the effects of technologies (channel 2) and inputs (channel 3) on import patterns can be considered.[26] Thus, "green" measures without potentially important import effects (such as per unit export subsidies) are not considered in this study.

Furthermore, it cannot be directly observed to what extent the implementation of "green" measures extends preferences to domestic suppliers at the expense of foreign suppliers. As a remedy, this chapter firstly shows to what extent "climate-friendly" foreign suppliers (in terms of energy intensity) are preferred compared to less "climate-friendly" ones. Secondly it presents findings on whether foreign suppliers, which compete closely with domestic suppliers in terms of quality or technology levels, are more negatively affected by "green" measures than less direct ones.

3.3 Conceptual framework

As in Chapter 2, the supply-side structure of Eaton and Kortum (2002) provides some guidance to illustrate how "green" production policies may affect average energy intensity of imports in the implementing country. While the empirical setting strongly resembles a standard gravity setting (in particular, the effects of "green" policies on import shares are estimated, see also Section 3.4), a modified Eaton-Kortum expression, suitable to motivate the empirical strategy, is defined as follows:

regarded as environmentally friendly or climate-smart. Among others, Ratnayake et al. (2011) provide a list of 64 climate smart goods and technologies; wind turbines and solar collectors are examples. This definition is not used in this chapter.

[26] The effects on imports through channel 1 are not investigated as data on services trade is not available for this study.

$$\frac{X_{n,i}^a}{X_n^a} = \frac{T_i^a * \left[G_{n,i}^a * (C_i^a * D_{n,i}^a)\right]^{-\theta}}{\Phi_n^a}, \tag{6}$$

where a stands for the product group affected by a specific "green" policy. $X_{n,i}^a/X_n^a$ is the share of affected imports from source country i; that is, X_n^a is the sum of $X_{n,i}^a$ across all i and - in contrast to Eaton-Kortum - excludes domestic spending. Non-availability of data on domestic spending makes this ad hoc reformulation necessary and introduces important and limiting implications for this study. First and foremost, it cannot be studied how "green" policies affect spending on more environmental friendly goods from domestic producers. Furthermore, $T_i^a > 0$ and stands for the country-specific technology level in the affected sectors, parameter $\theta > 1$ and reflects the amount of variation within the distribution (which is treated as common for all countries). A bigger θ implies less variability of efficiency levels across countries. C_i^a are unit production costs in country i and $D_{n,i}^a > 1$ denote standard iceberg trade constraints for exports from country i to n.

In essence, this study assumes that "green" policies make imports more environmental friendly. Thus, in equation (6) the "green" production policy is introduced as an additional ad-valorem and source-country-specific import tariff, $G_{n,i}^a$, which is higher (essentially $G_{n,i}^a > 1$) for a source countries with more energy intensive production and lower (essentially, an import subsidy, $G_{n,i}^a < 1$) for source countries with less energy intensive production. According to equation (6), a "green" import tariff, $G_{n,i}^a > 1$, ceteris paribus, leads to a lower share of imports, $X_{n,i}^a/X_n^a$, of i in n; while a "green" import subsidy, $G_{n,i}^a < 1$, leads to a higher share of imports. Hence, the average energy intensity of imports becomes more environmental friendly with the "green" subsidy.

In opposition to Chapter 2, the parameter Φ_n^a of country n's price distribution, defined as $\Phi_n^a = \sum_{i=1}^N T_i^a * \left[G_{n,i}^a * (C_i^a * D_{n,i}^a)\right])^{-\theta}$, which can be interpreted as the so-called multilateral resistance term in other gravity-type models (Anderson, 2011), does not cancel in (6). As a remedy and in line with recent empirical gravity studies, importer and exporter fixed effects correct for multilateral resistance in this paper (see Section 3.4). Both the departure from the original Eaton-Kortum model on the left-hand side of (6) and conditioning out multilateral general equilibrium effects using fixed effects imply that "green" policy effects are studied in a reduced form partial equilibrium setting in this essay.

3.4 Empirics

3.4.1 Empirical strategy

Guided by the conceptual framework in Section 3.3, the log-linear estimation equation is defined as follows:

$$x^a_{n,i,t} - x^a_{n,t} = \lambda_{n,t} + \delta_{i,t} + \eta^a_t + \nu_t + \mu_{n,i} + \beta_1 * e^a_i + \beta_2 * (e^a_i * g^a_{n,t}) + \epsilon^a_{n,i,t}, \tag{7}$$

where lower case letters designate logarithms. Index a stands for the product group affected by a specific "green" policy; that is, only imports of product groups that are affected at some point during the investigation period are considered in the estimations, but the affected product groups may vary for different "green" policies. $x^a_{n,i,t} - x^a_{n,t}$ is the log of country i's share of total country n imports in product group a and time t. Furthermore, $\lambda_{n,t} + \delta_{i,t} + \eta^a_t + \nu_t + \mu_{n,i}$ is a set of time-varying fixed effects that capture technology differences and marginal production costs of source countries, differences in import patterns, general economic and demand conditions, affected product group specific conditions as well as trade constraints between i and n.[27] The (time-varying) fixed effect approach for the identification of the effect of interest is standard in the empirical trade literature and motivated by recent developments in the gravity literature (see for example, Anderson and van Wincoop, 2003, 2004; Eaton and Kortum, 2002; Helpman et al., 2008).

Furthermore, e^a_i controls for energy intensity related technology and/or production cost differences of source countries in the "green" policy affected product group (see Section 3.4.2 for details on the link between energy intensity and costs). No expectation for β_1 is needed for the investigation of "green" measure effects. It is not necessary to know whether higher or lower energy intensity sources have higher or lower import shares before the implementation of measures. The main variable of interest is the interaction term $(e^a_i * g^a_{n,t})$. It accounts for the change in trade costs that "green" policies are likely to induce depending on the level of energy intensity of the source country. The dummy $g^a_{n,t} = 1$ in the period when the "green" policy is implemented as well as in all succeeding periods; and $g^a_{n,t} = 0$ in all periods before "green" policy implementation. Hence, the baseline estimation strategy in (7) corresponds to a before-after estimation. Recalling from Section 3.3, the

[27] In particular, the following and extensive set of time-varying fixed effects is used in the estimations: time-varying implementer dummies; time-varying source dummies; time-varying affected product group dummies; time dummies; implementer-source pair dummies. This specification allows for sufficient degrees of freedom and is robust to other specifications.

expected sign of the interaction term coefficient β_2 is negative; that is, the more energy intensive source i is, the less it exports to n given that n introduced a "green" measure.

3.4.2 Data and econometric issues

The dataset was retrieved from the UN Comtrade database in June 2011 for import data, the Global Trade Alert (GTA) database for data on "green" crisis-era state measures, the Global Trade Analysis Project (GTAP) database for data on sectoral energy intensity of goods production in 2004 and CEPII for distances between trading partners (which are used for alternative specifications, see below).

For imports (or the product group, a) affected by a specific "green" measure at some point during the investigation period, the dataset includes yearly bilateral import shares of source countries i in the respective "green" measure implementing country n for the period 2005-2010. The affected product group a may vary for each measure. In particular, the import shares $X^a_{n,i}/X^a_n$ are calculated for the aggregate of all product lines affected by a specific state measure. A product line is defined at the HS 4-digit level, which is the level of disaggregation reported by the Global Trade Alert. For example, Japan's "Green tax incentive on environmentally friendly cars" affects 17 product lines and thus the US import share in Japan is calculated for the aggregate of these 17 product lines.[28] It should be noted that imports not affected by "green" policies (at some point during the investigation period) are not considered. The natural logarithm of these import shares is used as the dependent variable $x^a_{n,i,t} - x^a_{n,t}$, in line with equation (7).[29] [30] Table 7 provides

[28]Total import values affected may vary considerably by measure (not least due to the big variation of the number of product lines affected by each measure). To deal with this issue, observations are weighted by import values in alternative specifications. Conclusions from the unweighted benchmark remain existent. It should be noted that the main purpose in this chapter is to study whether "green" policies are environmentally effective through the import channel - independent of their economic significance.

[29]If import shares are in natural logarithms, it may be that "green" measure effects on very low import shares drive the overall estimation results. In such a case, the environmental and economic effect would be insignificant. Therefore, the dependent variable (log import shares) are trimmed to the left at the 5th percentile in robustness checks. This adjustment does not alter the results reported in this chapter.

[30]An alternative dependent variable is used in robustness checks to study "green" policy effects on the propensity of importing from a specific source (in this essay called the extensive margin of importing). This variable is constructed as a dummy indicating whether or not affected product lines are at all imported from a specific source in a specific year. The extensive margin results are largely in line with the benchmark results, but are slightly more promising as to environmental effectiveness of "green" policies. All models yield the expected negative sign: Given "green" measures are implemented, the more energy intensive the source is the less likely an importing country is to import from that source. The extensive margin results, however, do not have very strong statistical and economic significance. Furthermore, the preferred set of time-varying fixed effects cannot be applied at the extensive margin due to a lack of degrees of freedom.

more details on the calculation of the import shares and reports descriptive statistics for different sub-samples (more details on these sub-samples are given below). In the sub-samples, the average import shares (in levels) are between 1 and 3 percent and property $X^a_{n,i}/X^a_n \in (0,1)$ holds. The maximum import share is 72 percent.

Patterns of "green" crisis-era state measures in the Asia-Pacific region are described in the introduction and separately listed in Appendix Table 14 for discriminatory and implemented (Panel 1), discriminatory and pending (Panel 2) as well as liberalising and implemented measures (Panel 3). The last column of these tables indicates whether or not a specific measure is included in the dataset for the estimations. Measures may not be included if the date of implementation is after the 30th of June 2010 and if measures are only announced and not yet implemented (all measures in Table 14, Panel 2). It is assumed that measures implemented after June 30th have no impact on aggregate imports in 2010.[31] The "green" measure dummy is weighted according to the month of implementation, where months falling later in the year receive smaller weights. For example, China's "Restructuring of equipment in the manufacturing industry" measure was implemented in May 2009 and thus receives a weight of $^7/_{12}$ in 2009 and 1 (or $^{12}/_{12}$) in 2010. Similarly, Russia's "Injection of 4.33 billion rubles into Russian RUSHYDRP (green energy) company" implemented in November 2009 receives a weight of $^2/_{12}$ in 2009 and 1 (or $^{12}/_{12}$) in 2010.[32]

Moreover, this paper differentiates between types of "green" crisis-era measures. Besides a separate analysis for liberalising and discriminatory "green" measures, a difference is made with regard to the strictness of the "green" objective. While some schemes introduce clear-cut criteria outlining how the environmental standard has to improve, others have only a superficial "green" justification (or their implementation is not mainly driven by the environmental policy agenda, but by other and potentially distortive purposes). Column "Main" in Table 14 indicates whether or not the "green" clause was the main purpose of implementation.[33] Descriptive statistics in Table 7 are reported separately for each of these four sub-samples.

Energy intensity levels for the production of goods (in toe/1'000 USD) are available for the year 2004, for all 57 GTAP sectors and for all countries in the sample. Making use

[31] The critical date is June 30th, 2009 for the Republic of Korea as 2010 import data was not available when constructing the dataset (in June 2011).

[32] Alternative "green" measure variables are used in robustness checks. For example, a lagged "green" measure variable/dummy is constructed, where observations with a weight smaller than one in the benchmark specification (described above) receive a value of zero and and observation with weight $^{12}/_{12}$ a value of 1. Results are robust to benchmark specifications.

[33] This chapter is the first to classify "green" policies into these two groups.

Table 7: Descriptive statistics

Dependent variable: Log import share

Formula: $x^a_{n,i,t} - x^a_{n,t}$ in logs; $X^a_{n,i}/X^a_n$ in levels (import shares in levels not used in estimations)
Description: Log of source country i's import share of country n total imports affected by a specific "green" measure; affected imports (or the affected product group, a) may vary for each "green" measure
Dimensions: Time t (6 years, 2005-2010), Importer/policy implementer n (7 countries), Exporter/source country i (103 countries), Affected product group for each "green" measures a (11 groups; that is, 11 "green" measures)
Source: UN Comtrade, Global Trade Alert (GTA)

	Reduced	Mean	Std. Dev.	Min.	Max.
Liberalising measures (4 measures; 1730 obs.; 497 obs. in reduced sample)					
$x^a_{n,i,t} - x^a_{n,t}$ (in logs)	Yes	-8.48	4.65	-20.62	-0.43
	No	-7.73	4.10	-21.08	-0.43
$X^a_{n,i}/X^a_n$ (in levels)	Yes	0.03	0.09	1e-9	0.65
	No	0.02	0.06	6e-10	0.65
Discriminatory measures (7 measures; 2341 obs.; 907 obs. in reduced sample)					
$x^a_{n,i,t} - x^a_{n,t}$ (in logs)	Yes	-8.93	4.60	-23.26	-0.33
	No	-8.37	4.55	-23.93	-0.33
$X^a_{n,i}/X^a_n$ (in levels)	Yes	0.02	0.06	7e-11	0.72
	No	0.02	0.05	4e-11	0.71
"Green" aspect main purpose (7 measures; 2434 obs.; 761 obs. in reduced sample)					
$x^a_{n,i,t} - x^a_{n,t}$ (in logs)	Yes	-8.36	4.55	-20.62	-0.33
	No	-7.72	4.09	-21.08	-0.33
$X^a_{n,i}/X^a_n$ (in levels)	Yes	0.03	0.09	1e-9	0.72
	No	0.02	0.06	7e-10	0.72
"Green" aspect not main purpose (4 measures; 1637 obs.; 643 obs. in reduced sample)					
$x^a_{n,i,t} - x^a_{n,t}$ (in logs)	Yes	-9.25	4.67	-23.26	-0.98
	No	-8.81	4.71	-23.93	-0.98
$X^a_{n,i}/X^a_n$ (in levels)	Yes	0.01	0.04	7e-11	0.37
	No	0.01	0.04	4e-11	0.37

Notes: Column "Reduced" indicates whether the sample is reduced to source countries whose measure of energy intensity is in the 1st and 5th quintile. All estimations reported in this essay use the reduced sample.

Table 7: continued

Independent variable: Log energy intensity

Formula: e_i^a in logs; E_i^a in levels (energy intensity in levels not used in estimations)
Description: Exporter and product-group-specific log energy intensity of production in toe per 1'000 USD for year 2004
Dimensions: Exporter/source country i (103 countries), Affected product group for each "green" policy a (11 groups; that is, 11 "green" policies)
Source: Global Trade Analysis Project (GTAP)

	Reduced	Mean	Std. Dev.	Min.	Max.
Liberalising measures (4 measures; 1730 obs.; 497 obs. in reduced sample)					
e_i^a (in logs)	Yes	-2.71	2.32	-8.83	2.11
	No	-2.73	1.50	-8.83	2.11
E_i^a (in levels)	Yes	0.54	1.19	1e-4	8.26
	No	0.25	0.75	1e-4	8.26
Discriminatory measures (7 measures; 2341 obs.; 907 obs. in reduced sample)					
e_i^a (in logs)	Yes	-1.80	2.50	-8.82	2.67
	No	-2.01	1.75	-8.83	2.67
E_i^a (in levels)	Yes	1.50	2.54	1e-4	14.50
	No	0.69	1.71	1e-4	14.50
"Green" aspect main purpose (7 measures; 2434 obs.; 761 obs. in reduced sample)					
e_i^a (in logs)	Yes	-2.71	2.32	-8.83	2.11
	No	-2.73	1.51	-8.83	2.11
E_i^a (in levels)	Yes	0.56	1.23	1e-4	8.26
	No	0.26	0.77	1e-4	8.26
"Green" aspect not main purpose (4 measures; 1637 obs.; 643 obs. in reduced sample)					
e_i^a (in logs)	Yes	-1.43	2.46	-6.39	2.67
	No	-1.71	1.75	-6.39	2.67
E_i^a (in levels)	Yes	1.82	2.83	1e-3	14.50
	No	0.87	1.93	1e-3	14.50

Notes: Column "Reduced" indicates whether the sample is reduced to source countries whose measure of energy intensity is in the 1st and 5th quintile. All estimations reported in this essay use the reduced sample.

of the GTAP vs. HS sector correspondence table, energy intensity levels for each of the 1200 HS 4-digit product lines can be determined. The average energy intensity for each affected product group (previously defined as the aggregate of product lines affected by one "green" policy) is then calculated as a simple average of product line energy intensity levels within that product group. It is assumed that energy efficiencies are rigid and therefore treated as constant across the whole study period. In fact, the use of energy efficiency data for the year 2004 (one year before the investigated period 2005-2010) is preferable as the endogeneity problem of energy efficiency is diminished: trade data in the period 2005-2010 has no influence on energy efficiencies in 2004. The second panel in Table 7 reports descriptive statistics for the energy intensity variable used in this chapter. The average energy intensity levels lie between 0.3 and 1.8 toe/1'000 USD depending on the sub-sample used. Average energy intensity levels are higher in the sub-sample of "not main" purpose measures and that of discriminatory measures; and lower in the sub-sample of "main" purpose measures and that of liberalising measures.

Furthermore, energy intensity may vary considerably among firms in a sector within a country, which makes average sectoral energy intensity measures (as described in the previous paragraph) problematic for the identification of the "green" policy effect under study.[34] As variances of sectoral energy intensities are not available from GTAP data, this issue is tackled by reducing the sample to 1st and 5th quintile source country energy intensity levels for each measure and implementing country. It is thereby assumed that distributions of firm-level energy intensity levels (measured across source countries) between the 1st and 5th quintiles do not overlap, and thus identification can be achieved. While estimating the effect more precisely, this strategy does not allow conclusions to be drawn on environmental import effects for 3/5 of the import flows.[35]

Despite the conservative empirical approach, which de facto corresponds to a before-after estimation, misspecification due to limitations in data availability and measurement error may still be a concern. In order to make the results more convincing, a whole set of robustness checks is performed. Table 8 provides an overview.[36]

[34]For example, if Germany has a lower average energy intensity in the manufacturing sector compared to France, but manufacturing firms in both countries vary considerably in their energy intensity levels and thus the distributions of firm-level energy intensities have a high overlap, the "green" policy effect may not be identified. As a result, an increasing import share of Germany relative to France may or may not correspond to more environmental friendly imports.

[35]Benchmark results reported in this chapter, however, are robust to specifications including all observations (all energy intensity levels).

[36]Notice that the results of all robustness checks mentioned in Table 8 are reported prominently in

Table 8: Matrix of robustness checks performed

		Original effect (in 2009 and 2010) (1)	Placebo effect (in 2006 and 2007) (2)	Original and placebo effect (3)	Intermediates as "pseudo" control group (4)
		Effect of "green" measures on energy intensity of imports			
(a)	Benchmark	Table 8, Panel 1	Table 8, Panel 2	Table 8, Panel 3	Table 8, Panel 4
(b)	Dummy (clean vs. dirty suppliers)	Table 9, Panel 1	Table 9, Panel 2	Table 9, Panel 3	Table 9, Panel 4
(c)	Benchmark with distance	Table 10, Panel 1	Table 10, Panel 2	Table 10, Panel 3	Table 10, Panel 4
		Discrimination of "green" measures against foreign suppliers			
(d)	Benchmark	Table 11, Panel 1	Table 11, Panel 2	Table 11, Panel 3	Table 11, Panel 4
(e)	Dummy (direct vs. indirect compet.)	Table 12, Panel 1	Table 12, Panel 2	Table 12, Panel 3	Table 12, Panel 4

Notes: The following additional robustness checks are performed: Alternative sets of time-varying fixed effects (footnote 27); weighted least squares with weight = import value (footnote 28); trimming dependent variable to the left at the 5th percentile (footnote 29); extensive margin analysis (footnote 30); alternative constructions of the "green" measure variables (footnote 32); inclusion of all observations/energy intensity levels (footnote 35). The results of these additional checks are not reported in the chapter, but can be received upon request. Conclusions from benchmark specifications remain overwhelmingly existent.

Two main research questions are investigated: Firstly, the impact of "green" crisis-era measures on the energy intensity of imports. Secondly, the extent of discrimination of "green" policies against foreign suppliers in the domestic market are studied (see vertical dimension of Table 8). Research question 1 is tackled with (a) the benchmark specification corresponding to equation (12); (b) a dummy variable specification, where the (continuous) energy intensity variable is replaced by dummies indicating whether a foreign supplier is "clean" (1st quintile energy intensity level) or "dirty" (5th quintile energy intensity level); and (c) a specification accounting additionally for distance (used as a proxy for transportation emissions).[37] Using this proxy will not yield the correct size of the transportation emission effect; thus, the magnitude cannot be compared to other estimates. However, it is possible (and sufficient) to draw conclusions on the direction/sign of the distance/transportation effect.

Research question 2 is addressed with (d) a benchmark specification and (e) a dummy variable specification. The benchmark specification uses the absolute value difference of the energy intensity levels between the foreign supplier and the interventionist country as a proxy for quality or technology differences between the two trading partners.[38] Thereby, it can be investigated whether more direct foreign competitors (smaller differences) lose relatively more import share compared to more indirect competitors (bigger differences) due

Section 3.5. Results for other robustness checks mentioned in several footnotes above are not reported, but a list of these checks is provided in the notes of Table 8.

[37] Importing countries may also contribute to climate mitigation by sourcing their goods from trading partners, which are geographically closer and thus emissions from transportation are reduced. It is not easy to quantify the exact level of emissions, or energy intensity, of transportation as the means of transportation varies from one trade relationship to another and from one good traded to another. Truong and Mikic (2010) provide an elegant calculation of trade emission intensity indexes incorporating both emissions from production and transportation. Cristea et al. (2011) also provide detailed comparisons of greenhouse gas emissions associated with output versus international transportation of traded goods. They found that transport is responsible for 33 percent of worldwide trade-related emissions and over 75 percent of emissions for major manufacturing categories like machinery, electronics and transport equipment. As detailed data for transportation emissions is not available for this study, distance is used as a proxy for transportation emissions.

[38] Quality or technology levels are defined as the extent companies in a country obtain technology from licensing or imitating foreign companies versus conducting formal research and pioneering their own new products and processes (for example, through investments in R&D). A Spearman rank correlation analysis for all sectors considered in this study (mostly manufacturing sectors) shows: (i) Sectoral energy intensity levels within countries are strongly positively and significantly correlated; all rank correlation coefficients are above 0.65 (ii) Country-specific measures regarding the extent of company spending on R&D and company capacity of innovation (taken from the World Economic Forum, Executive Opinion Survey, 2011) strongly negatively and significantly correlate with the sector- and country-specific measures of energy intensity; all rank correlation coefficients are below -0.50. This simple analysis supports the use of sectoral energy intensity level as an (inverse) proxy for quality or technology level (i.e. the capacity of innovation).

to "green" policies. This examination yields some evidence as to the extent of discrimination against more direct foreign competitors, compared to indirect ones, in the domestic market. In the dummy variable specification, the (continuous) absolute value differences of energy intensities are replaced by dummies for direct (1st quintile differences) and indirect (5th quintile differences) foreign competitors.

Furthermore, each of the five specifications is estimated four times (see horizontal dimension of Table 8): (1) approach with the original effect in 2009 and 2010; (2) placebo approach where it is assumed that "green" measures are implemented in 2006 and 2007 instead of 2009 and 2010; (3) approach with both the original and the placebo effect; and (4) approach in which the aggregate of intermediary imports is used as a "pseudo" control group. Robustness checks (2) - (4) are performed to be more convinced that the main effects of interest in (1) are (statistically) different to the placebo effects in (2) and (3) and the control group effect in (4). It should be noted that all robustness checks listed in Table 7 have their own caveats and should be regarded as complementary/supportive to the results of the main estimation model.[39]

3.5 Results

3.5.1 Effect of green policies on energy intensity of imports

Table 9 presents the estimated effects of "green" measures on energy intensity of imports for our benchmark specification. The table includes four panels, where Panels 2 - 4 are performed to challenge the main effects of interest in Panel 1. Additionally, separate results are reported for "green" liberalising and discriminatory measures (column 1 and 2) as well as for measures whose implementation was mainly driven by the environmental policy agenda (hereafter, classified as "main"; column 3) and for measures whose implementation has other non-environmental purposes (hereafter, classified as "not main"; column 4). To account for possible correlation in the errors within a panel unit (defined in terms of "green" measure, implementing country and foreign supplier country), robust-clustered standard errors are reported in parentheses. Furthermore, the number of predicted import share values for which the property $\widehat{X^a_{n,i}/X^a_n} \in (0,1)$ does not hold is reported. Given that linear regressions are run on a log-linearised dependent variable with level property $X^a_{n,i}/X^a_n \in (0,1)$, the predicted values may exceed these bounds. In the regression of this

[39]For example, the "pseudo" control group in column 4 may include some import flows which are at the same time treated (affected by "green" measures). As a result, estimates may be biased.

Table 9: Effect of green measures on energy intensity of imports (Benchmark)

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 1: Original effect (in 2009 and 2010)				
Log energy intensity	0.840***	-3.766***	-0.428**	-3.742***
	(0.161)	(0.743)	(0.169)	(0.762)
(Log energy intensity)(Green)	-0.0372	0.753***	-0.0260	1.485***
	(0.214)	(0.284)	(0.140)	(0.425)
Observations	497	907	761	643
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	0	2	0
R-squared	0.981	0.936	0.976	0.931
Panel 2: Placebo effect (in 2006 and 2007)				
Log energy intensity	1.669***	-3.690***	-0.121	-3.686***
	(0.177)	(0.814)	(0.241)	(0.829)
(Log energy intensity)(Placebo green)	-0.315	0.262	0.0288	0.311
	(0.234)	(0.228)	(0.222)	(0.449)
Observations	245	455	381	319
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	0	2	0
R-squared	0.984	0.937	0.980	0.926

Notes: Dependent variable is *Log import share* (; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies included but not reported; green measure effect/dummy weighted by month of implementation; sample reduced to 1st and 5th quintile source country energy intensity levels per implementing country.

Table 9: continued

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 3: Original and placebo effect				
Log energy intensity	0.332**	-3.750***	-0.0210	-3.729***
	(0.154)	(0.738)	(0.168)	(0.761)
(Log energy intensity)(Green)	-0.114	0.810***	-0.0308	1.502***
	(0.256)	(0.284)	(0.167)	(0.432)
(Log energy intensity)(Placebo green)	-0.194	0.308*	-0.0130	0.273
	(0.252)	(0.185)	(0.208)	(0.353)
H0: original = placebo, p-Value	0.747	0.086*	0.921	0.001***
Observations	497	907	761	643
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	0	2	0
R-squared	0.981	0.936	0.976	0.931
Panel 4: Intermediates as pseudo control group				
Treated log energy intensity	0.360**	-0.176	0.418***	-0.823**
	(0.178)	(0.237)	(0.155)	(0.341)
(Log energy intensity)(Treated green)	0.322**	0.501***	0.185*	0.892***
	(0.162)	(0.122)	(0.107)	(0.149)
Control log energy intensity	0.220	-0.123	0.268	-0.572*
	(0.189)	(0.229)	(0.164)	(0.301)
(Log energy intensity)(Control green)	0.0383	0.239**	0.0101	0.488***
	(0.190)	(0.0953)	(0.117)	(0.115)
H0: treated = control, p-Value	0.031**	0.001***	0.063*	0.000***
Observations	1153	1996	1792	1357
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	0	2	3
R-squared	0.793	0.658	0.782	0.637

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies included but not reported; green measure effect/dummy weighted by month of implementation; sample reduced to 1st and 5th quintile source country energy intensity levels per implementing country.

chapter, the predictions exceed these bound only in very few cases; generally not more than two. Therefore, the linear estimation strategy is regarded as appropriate for this study. The described structure of reporting is used for all results.

The results are surprising (see Panel 1): Implemented "green" measures, which are classified as discriminatory or "not main", are associated with an increase of sourcing from more - rather than less - energy intensive countries. A 10 percent increase in energy intensity yields an import share increase of 7.5 percent for discriminatory measures and 15 percent for "not main" measures. These findings are contrary to expectations that "green" crisis-era measures decrease the share of imports from energy intensive producers. According to these results, the efforts of Asian governments to mitigate climate change through "green" crisis-era measures in general may not have resulted in making imports more environmental friendly.[40] Given the significant and highest positive estimate in column 4, the reason may be that governments have often titled state interventions as "green", although the "main" purpose of implementation was not an environmental aspect.

"Green" measures whose implementation was mainly driven by the environmental policy agenda – and less by other and potentially distortive purposes – are effective, or at least neutral, in making imports more environmental friendly. The expected negative sign is found in column 1 and 3 for liberalising and "main" measures. The effect may be "neutral" as none of the estimated numbers is statistically significant. In the sample considered, these measures are among others the "removal of the local content requirement on wind turbines" in China, the "import duty reduction for green cars and components" in Thailand or the "green tax incentive on environmentally-friendly cars" in Japan.

The main findings are reaffirmed when considering the robustness checks in Panel 2 - 4. In Panel 2, the placebo test is insignificant for all sub-samples. Moreover in Panel 3, the actual effects yield similar magnitudes, signs and significance levels as in Panel 1, and the placebo effects remain insignificant. Finally, Panel 4 shows the results for the approach in which the aggregate of intermediary imports is used as a control group and the aggregate of product lines affected by "green" policies as the treated group. The estimated coefficients for the treated group are now all positive and statistically significant, which is an even stronger result in opposition to the expectations compared to the original model in Panel 1. The coefficients for the control group are insignificant in column 1 and 3 and significantly

[40] More specifically, import shares from countries with more environmental friendly production became smaller and import shares from countries with less environmental friendly production became bigger - at least in the sub-samples of column 2 and 4.

smaller than for the treated group in column 2 and 4. These robustness checks support the results in Panel 1 that the estimated effects are non-spurious and that the environmental effectiveness of "green" policies in the Asia-Pacific region is contested; at least for a priori classified discriminatory and "not main" measures.

Table 10 and 11 report more robustness checks. In Table 10, the results of the dummy variable specification, for which the (continuous) energy intensity variable is replaced by dummies indicating whether a foreign supplier is "clean" (1st quintile energy intensity level) or "dirty" (5th quintile energy intensity level), are presented. In Table 11, the benchmark specifications are repeated accounting additionally for distance, which is used as a proxy for transportation emissions. The conclusions from the benchmark models in Table 9 still hold. In the samples of discriminatory and "not main" measures, the "green" policy is associated with a statistically significant increase of import shares for "dirty" and with a decrease for "clean" foreign suppliers. Insignificant results are found for the liberalising and "main" measure sub-samples (see Table 10, Panel 1). Placebo and "pseudo" control group tests reaffirm these results (see Table 10, Panel 2 - 4). All models accounting for distance are consistent with the benchmark specifications (see Table 11). Estimated coefficients also included in the benchmark models are similar, and no relationship between "green" measures and import shares is found through the distance/transportation channel.[41]

3.5.2 Discriminatory effect of green policies against direct foreign competitors

While the environmental benefits of the implemented "green" measures are limited, it might be that some of these "green" policies have trade distortive effects through their mercantilist characteristics. Therefore, it is tested whether foreign suppliers, which are in close competition with domestic suppliers, are discriminated against. Stated differently, it is checked whether the indirect competitors can relatively increase their market shares in the interventionist country. Direct (compared to indirect) competitors are defined as producers from the source countries with energy intensity levels similar to those of implementing countries. Energy intensity is thus used as a proxy for quality or technology.[42]

In most models (see Table 12), bigger energy intensity gaps between local and foreign suppliers are associated with smaller import shares from the foreign sources. This finding

[41] It is not surprising that any given "green" policy does not lead to input sourcing from geographically closer foreign suppliers, although the carbon-footprint of a manufactured final good would in fact improve with this practice.

[42] See footnote 42 for a discussion of this proxy.

Table 10: Effect of green measures on import shares of dirty vs. clean sources (Dummy approach)

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 1: Original effect (in 2009 and 2010)				
Dirty	-0.261	0.538	2.310***	7.616**
	(0.623)	(1.250)	(0.875)	(3.750)
(Dirty)(Green)	-2.183	..	-1.983	8.796***
	(1.735)	..	(1.364)	(2.587)
(Clean)(Green)	-0.938	-5.358***	-1.127	..
	(1.225)	(1.584)	(1.170)	..
Observations	499	907	763	643
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	0	0	0	1
R-squared	0.981	0.906	0.977	0.893
Panel 2: Placebo effect (in 2006 and 2007)				
Dirty	1.550	3.087***	3.847**	4.652***
	(1.239)	(1.032)	(1.625)	(1.439)
(Dirty)(Placebo Green)	1.611	1.768	2.071**	2.218
	(1.431)	(1.784)	(0.963)	(3.561)
(Clean)(Placebo green)	1.843	-1.112	1.269*	-3.475**
	(1.123)	(1.049)	(0.693)	(1.336)
Observations	247	455	383	319
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	0	1	0	1
R-squared	0.984	0.910	0.981	0.893

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies included but not reported; green measure dummy weighted by month of implementation; sample reduced to 1st and 5th quintile source country energy intensity levels per implementing country, where dummies Clean and Dirty are equal to one for the 1st and 5th quintile, respectively.

Table 10: continued

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 3: Original and placebo effect				
Dirty	1.237	-3.547***	4.646***	0.391
	(0.932)	(1.181)	(0.838)	(3.239)
(Dirty)(Green)	-1.751	..	-1.327	..
	(1.807)	..	(1.396)	..
(Clean)(Green)	-0.576	-5.936***	-0.692	-9.724***
	(1.273)	(1.595)	(1.224)	(2.535)
(Dirty)(Placebo Green)	1.903	1.642	2.655*	4.931
	(1.342)	(1.595)	(1.394)	(3.421)
(Clean)(Placebo green)	1.598	-1.372	1.965	-0.831
	(1.025)	(1.159)	(1.305)	(2.157)
Observations	499	907	763	643
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	0	2	0	2
R-squared	0.981	0.909	0.977	0.898
Panel 4: Intermediates as pseudo control group				
Treated dirty	-3.667***	-2.753***	-1.209**	-0.121
	(0.721)	(0.778)	(0.493)	(0.504)
(Dirty)(Treated green)	-1.586**	..	-0.892	..
	(0.740)	..	(0.593)	..
(Clean)(Treated green)	-1.143	-3.979***	-1.144**	-5.833***
	(0.691)	(0.676)	(0.570)	(0.991)
Control dirty	-0.742	1.693***	1.800***	4.786***
	(0.516)	(0.539)	(0.332)	(0.303)
(Dirty)(Control green)	0.0771	-1.888***	-0.227	-2.165***
	(0.713)	(0.334)	(0.579)	(0.401)
(Clean)(Control green)	1.537**	-2.569***	1.037*	-4.548***
	(0.716)	(0.655)	(0.608)	(0.985)
Observations	1153	1996	1792	1357
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	11	12	20	0
R-squared	0.847	0.783	0.831	0.782

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies included but not reported; green measure dummy weighted by month of implementation; sample reduced to 1st and 5th quintile source country energy intensity levels per implementing country, where dummies Clean and Dirty are equal to one for the 1st and 5th quintile, respectively.

Table 11: Effect of green measures on energy intensity of imports (Distance benchmark)

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 1: Original effect (in 2009 and 2010)				
Log energy intensity	0.543***	-3.764***	-0.189	-3.737***
	(0.145)	(0.739)	(0.124)	(0.755)
(Log energy intensity)(Green)	-0.0938	0.755***	-0.0628	1.506***
	(0.227)	(0.285)	(0.147)	(0.428)
Log distance	-0.879*	-2.121**	-0.691*	-5.590***
	(0.457)	(0.933)	(0.361)	(1.003)
(Log distance)(Green)	-0.126	0.407	-0.139	0.660
	(0.166)	(0.486)	(0.147)	(0.697)
Observations	497	907	761	643
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	0	2	0
R-squared	0.981	0.936	0.976	0.931
Panel 2: Placebo effect (in 2006 and 2007)				
Log energy intensity	1.093***	-3.685***	0.410***	-3.682***
	(0.215)	(0.801)	(0.154)	(0.818)
(Log energy intensity)(Placebo green)	-0.275	0.253	0.0637	0.297
	(0.277)	(0.225)	(0.232)	(0.453)
Log distance	-3.513***	0.110	-1.469	-3.688***
	(0.246)	(0.905)	(0.893)	(0.673)
(Log distance)(Placebo green)	0.0536	0.613	0.144	0.620
	(0.152)	(0.697)	(0.132)	(0.843)
Observations	245	455	381	319
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	0	2	0
R-squared	0.984	0.938	0.981	0.927

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies and log oil price variable included but not reported; green measure dummy weighted by month of implementation; sample reduced to 1st and 5th quintile source country energy intensity levels per implementing country.

Table 11: continued

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 3: Original and placebo effect				
Log energy intensity	-0.505***	-3.747***	-0.154	-3.719***
	(0.127)	(0.735)	(0.147)	(0.752)
(Log energy intensity)(Green)	-0.154	0.812***	-0.0493	1.535***
	(0.274)	(0.286)	(0.176)	(0.440)
(Log energy intensity)(Placebo green)	-0.141	0.309	0.0381	0.337
	(0.304)	(0.192)	(0.214)	(0.417)
Log distance	-0.799*	-2.705***	-0.819	-0.00114
	(0.477)	(0.561)	(0.827)	(0.109)
(Log distance)(Green)	-0.112	0.401	-0.0869	0.757
	(0.180)	(0.514)	(0.158)	(0.723)
(Log distance)(Placebo green)	0.0913	0.0619	0.187	0.296
	(0.118)	(0.245)	(0.139)	(0.417)
H0: original = placebo (en. intensity), p-Value	0.964	0.089*	0.649	0.004***
H0: original = placebo (distance), p-Value	0.247	0.491	0.109	0.524
Observations	497	907	761	643
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	0	2	1
R-squared	0.981	0.936	0.977	0.932

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies and log oil price variable included but not reported; green measure dummy weighted by month of implementation; sample reduced to 1st and 5th quintile source country energy intensity levels per implementing country.

Table 11: continued

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 4: Intermediates as pseudo control group				
Treated log energy intensity	-0.354*	-0.915***	-0.352**	-1.302***
	(0.188)	(0.190)	(0.155)	(0.271)
(Log energy intensity)(Treated green)	0.112	0.720***	0.117	1.047***
	(0.166)	(0.122)	(0.130)	(0.152)
Control log energy intensity	0.114	-0.131	0.137	-0.392
	(0.142)	(0.168)	(0.124)	(0.238)
(Log energy intensity)(Control green)	0.109	0.194**	0.0369	0.404***
	(0.172)	(0.0811)	(0.108)	(0.0988)
Treated log distance	-0.245	-3.119***	-2.535***	-0.587**
	(0.475)	(0.0695)	(0.152)	(0.234)
(Log distance)(Treated green)	-0.0241	0.358*	0.0286	0.341
	(0.0734)	(0.184)	(0.0646)	(0.216)
Control log distance	0.0947	-2.675***	-2.179***	-0.142
	(0.497)	(0.0736)	(0.125)	(0.221)
(Log distance)(Control green)	0.159**	0.183	0.101*	0.162
	(0.0715)	(0.181)	(0.0595)	(0.215)
H0: treated = control (en. intensity), p-Value	0.987	0.000***	0.560	0.000***
H0: treated = control (distance), p-Value	0.987	0.000***	0.560	0.000***
Observations	1153	1996	1792	1357
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	5	7	8	2
R-squared	0.852	0.793	0.842	0.789

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies and log oil price variable included but not reported; green measure dummy weighted by month of implementation; sample reduced to 1st and 5th quintile source country energy intensity levels per implementing country.

demonstrates a stiff competition with some "direct" foreign competitors in the market: import shares of "direct" competitors are on average higher than import shares of indirect competitors. Interestingly, the coefficients are smaller in size, have the opposite sign and/or are insignificant when measures studied have a liberalising character or have been implemented directly for the environmental impact. As import competition is not very intense in these markets ("indirect" competitors have higher import shares), governments may face less opposition from lobbies to liberalise.

Import shares of more "indirect" competitors gain market share when "green" measures are implemented. Governments may discriminate against commercial interests of the more "direct" foreign competitors with their implementation of (alleged) "green" measures. As expected, evidence for such a pattern is clearest for measures whose purpose is not (or not only) an environmental aspect and are labelled as distortive; magnitudes of those estimates are highest and more often significant across specifications (column 2 and 4). However, the statistical significance is generally very low in most models of Table 12. Overall, the performed placebo and "pseudo" control group tests reaffirm the described conclusions. Furthermore, Table 13 reports the results for models in which the (continuous) absolute value differences of energy intensities are replaced by dummies for direct (1st quintile difference levels) and indirect (5th quintile difference levels) foreign competitors. The evidence from those models again supports the benchmark specification. When considering discriminatory or "not main" measures, "direct" foreign competitors lose import share when "green" policies are introduced while "indirect" competitors gain import share. The statistical significance is generally higher compared to the benchmark specification.[43]

[43]Investigating these effects separately in cases where local suppliers are always less energy intensive than foreign suppliers and vice versa, the above described results are confirmed for both sub-groups. However, in the case where local suppliers are always less energy intensive, "green" measures involve a stronger relative gain in import share for indirect competitors than in the opposite case where local suppliers are always more energy intensive. Thus, besides the confirmed discrimination against close competitors, the "green" measures may also decrease the "climate-friendliness" of imports, which was also found in the results discussed in Section 3.5.1. Results are not reported, but they can be received upon request.

Table 12: Discrimination of green policies against direct foreign competitors (Benchmark)

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 1: Original effect (in 2009 and 2010)				
|Diff. log energy intensity|	-0.232	-2.906**	-0.381***	-2.909*
	(0.162)	(1.440)	(0.0871)	(1.505)
(|Diff. log energy intensity|)(Green)	0.169	0.322	0.167	0.854*
	(0.297)	(0.207)	(0.206)	(0.459)
Observations	643	930	915	658
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	1	2	1
R-squared	0.971	0.953	0.966	0.942
Panel 2: Placebo effect (in 2006 and 2007)				
|Diff. log energy intensity|	-1.336***	-3.263**	0.0853	-3.228**
	(0.263)	(1.365)	(0.227)	(1.397)
(|Diff. log en. int.|)(Placebo green)	0.153	0.0621	0.00898	-0.140
	(0.460)	(0.259)	(0.309)	(0.576)
Observations	312	469	452	329
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	0	2	0
R-squared	0.974	0.957	0.974	0.944

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies included but not reported; green measure dummy weighted by month of implementation; expressions in |...| are absolute values; sample reduced to 1st and 5th quintile absolute value diff. in energy intensity levels betw. implementing and source country.

Table 12: continued

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 3: Original and placebo effect				
|Diff. log energy intensity|	-0.162	-2.908**	-0.446***	-2.908*
	(0.131)	(1.438)	(0.121)	(1.500)
(|Diff. log energy intensity|)(Green)	0.142	0.337	0.134	0.848
	(0.331)	(0.226)	(0.228)	(0.588)
(|Diff. log en. int.|)(Placebo green)	-0.0797	0.0395	-0.0941	-0.0146
	(0.260)	(0.208)	(0.182)	(0.424)
H0: original = placebo, p-Value	0.466	0.210	0.288	0.010***
Observations	643	930	915	658
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	1	2	1
R-squared	0.971	0.953	0.966	0.942
Panel 4: Intermediates as pseudo control group				
|Treated diff. log energy intensity|	0.190	-1.191***	0.0789	-1.508***
	(0.184)	(0.273)	(0.158)	(0.337)
(|Diff. log en. int.|)(Treated green)	-0.0572	0.567***	0.0133	0.643***
	(0.137)	(0.142)	(0.131)	(0.210)
|Control diff. log energy intensity|	0.666***	0.0692	0.615***	0.0391
	(0.180)	(0.196)	(0.147)	(0.273)
(|Diff. log en. int.|)(Control green)	0.351**	0.0525	0.100	0.107
	(0.144)	(0.0771)	(0.0976)	(0.134)
H0: treated = control, p-Value	0.005***	0.000***	0.425	0.000***
Observations	1466	2047	2118	1395
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	10	1	5
R-squared	0.810	0.798	0.810	0.790

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies included but not reported; green measure dummy weighted by month of implementation; expressions in |...| are absolute values; sample reduced to 1st and 5th quintile absolute value diff. in energy intensity levels betw. implementing and source country.

Table 13: Discrimination of green policies against direct foreign competitors (Dummy approach)

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 1: Original effect (in 2009 and 2010)				
Direct	-1.526**	-2.917*	1.321***	-2.414
	(0.665)	(1.570)	(0.343)	(1.711)
(Direct)(Green)	-1.934*	-1.382**	-1.856**	..
	(1.078)	(0.639)	(0.844)	..
(Indirect)(Green)	-1.376*	..	-1.465**	3.484**
	(0.797)	..	(0.711)	(1.545)
Observations	645	930	917	658
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	0	6	0	5
R-squared	0.971	0.945	0.966	0.932
Panel 2: Placebo effect (in 2006 and 2007)				
Direct	-2.279***	-1.957	-1.558	-1.470
	(0.718)	(1.854)	(1.085)	(2.225)
(Direct)(Placebo green)	0.0759	5.890***	0.363	5.727***
	(1.524)	(0.690)	(1.243)	(0.728)
(Indirect)(Placebo green)	0.457	6.863***	0.222	7.802***
	(1.169)	(1.029)	(1.108)	(2.150)
Observations	314	469	454	329
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	0	2	0	2
R-squared	0.974	0.949	0.974	0.933

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies included but not reported; green measure dummy weighted by month of implementation; sample reduced to 1st and 5th quintile absolute value diff. in energy intensity levels betw. implementing and source country, where dummies Direct and Indirect are equal to one for the 1st and 5th quintile, respectively.

Table 13: continued

	Liberal.	Discrim.	Main	Not main
	(1)	(2)	(3)	(4)
Panel 3: Original and placebo effect				
Direct	1.811**	-2.641*	1.110**	-1.869
	(0.806)	(1.586)	(0.488)	(1.872)
(Direct)(Green)	-1.623	-1.727**	-1.221	..
	(1.105)	(0.778)	(0.988)	..
(Indirect)(Green)	-1.236	..	-1.023	4.191**
	(0.863)	..	(0.875)	(2.008)
(Direct)(Placebo green)	1.210	3.144	2.662	3.669
	(1.093)	(2.644)	(2.320)	(2.363)
(Indirect)(Placebo green)	0.756	3.976	2.204	5.275*
	(0.967)	(2.708)	(2.319)	(2.713)
Observations	645	930	917	658
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	0	5	0	5
R-squared	0.971	0.946	0.966	0.933
Panel 4: Intermediates as pseudo control group				
Treated direct	-4.772***	-1.954***	2.601***	-1.913***
	(1.616)	(0.599)	(0.677)	(0.632)
(Direct)(Treated green)	-1.616	1.291***	-0.995	..
	(1.058)	(0.419)	(0.952)	..
(Indirect)(Treated green)	-2.361**	..	-2.452**	-0.316
	(1.052)	..	(0.945)	(0.632)
Control direct	-2.396	-0.272	4.514***	0.122
	(1.582)	(0.555)	(0.654)	(0.569)
(Direct)(Control green)	0.0268	1.340***	-0.280	0.227
	(1.073)	(0.420)	(0.946)	(0.347)
(Indirect)(Control green)	1.060	3.529***	0.891	3.395***
	(1.031)	(0.590)	(0.925)	(0.652)
Observations	1466	2047	2118	1395
Predictions with $\widehat{X^a_{n,i}/X^a_n} \notin (0,1)$	2	2	2	4
R-squared	0.813	0.719	0.793	0.689

Notes: Dependent variable is *Log import share*; significance levels [*** p<0.01, ** p<0.05, * p<0.1]; robust-clustered standard errors in parentheses [cluster unit: panel id]; constants included but not reported; time-varying implementer, source and affected product group dummies as well as time and implementer-source pair dummies included but not reported; green measure dummy weighted by month of implementation; sample reduced to 1st and 5th quintile absolute value diff. in energy intensity levels betw. implementing and source country, where dummies Direct and Indirect are equal to one for the 1st and 5th quintile, respectively.

3.6 Conclusions

For the Asia-Pacific region, this chapter estimates the impact of "green" crisis-era measures on energy intensity of imports and the extent of discrimination of these policies against foreign suppliers. Focusing on the Asia-Pacific region is of particular interest as the introduction of state measures with environmental justifications was most prevalent in that region since the beginning of the global economic crisis.

The dataset includes yearly bilateral import shares of supplier countries in the respective "green" measure implementing countries for 2005-2010. Import shares are calculated for the aggregate of all product lines affected by a specific measure. Sector-specific energy intensity levels of production in source countries are used to assess the environmental friendliness of imports before and after the implementation of "green" measures. To investigate the extent of discrimination of "green" policies against foreign suppliers, these energy intensity levels are used again to construct a measure of competitive proximity between supplier and implementing countries. The benchmark before-after estimation results are challenged by several robustness checks; including placebo tests for which the "green" measures are pretended to be implemented in 2006/07 instead of 2009/10, and "pseudo" control group tests for which aggregate intermediate imports are used as a control group and "green" measure affected product bundles as the treatment group.

The results are robust and surprising: Implemented "green" measures whose purpose of implementation was not driven by the environmental policy agenda - but other and potentially distortive purposes - are associated with an increase of sourcing from more rather than less energy intensive countries. A 10 percent increase in energy intensity yields an import share increase of 7 to 15 percent depending on the specification. These findings contradict the expectations that "green" crisis-era measures decrease the share of imports from energy intensive producers. Hence, the efforts of Asian governments to mitigate climate change through "green" policies may not have resulted in making imports more environmental friendly. However, "green" measures whose implementation was mainly driven by the environmental policy agenda are more effective or at least neutral in making imports compatible with environmental challenges. The effect may be "neutral" as none of the estimated numbers are statistically significant.

While the environmental benefits of "green" measures are limited based on the study of the import channel, it might be that some of these policies have trade distortive effects through their mercantilist characteristics. Therefore, whether source country suppliers being in

close/direct competition with domestic suppliers are discriminated against is also tested. Direct (compared to indirect) competitors are defined as producers from source countries with energy intensity levels similar to those of implementing countries; where energy intensity is used as a proxy for quality or technology. Import shares of indirect competitors increase when "green" measures are implemented, while those of direct competitors decrease. Overall, this evidence is thus consistent with the argument that governments have introduced discrimination against commercial interests of direct foreign competitors under the guise of "green" growth strategies. As expected, the results in support of this argument are clearest for measures whose purpose is not, or not only, an environmental aspect.

This study should be regarded as an attempt to better understand recent dynamics and effects of "green" state interventions. However, one has to bear in mind important caveats leaving room for improvements for future research. Firstly, among others, energy intensity is most likely measured with an error as every country reports these figures separately and the methods of calculation may vary. Also, energy intensity is reported at a very aggregate sectoral level and no information on the variance is available, which makes identification of the proposed effects more difficult. Although some of these limitations can be diminished when focusing on sub-samples for which identification assumptions may hold better, important improvements for this study could be reached with more detailed data on energy intensity or other measures for environmental friendliness of production. It could also be improved with alternative proxies for competitive proximity, which may not be based on energy intensity. Secondly, the available data on product lines affected by "green" measures may also be measured with an error as governments rarely report exactly which products are eligible to benefit (or have benefited) from "green" measures. The performed placebo and pseudo control group tests are used as a remedy to make the benchmark before-after estimations more convincing. Nevertheless, if detailed data would be available for one "green" measure indicating which products/firms have really benefited from the intervention, future studies may more accurately identify the correct "green" measure effects. Thirdly and finally, the study is limited to the investigation of "green" measure effects on imports and cannot assess the environmental effectiveness of these measures through other channels. For example, the environmental goal of "green" measures may also be reached when more environmental friendly technologies and inputs are sourced domestically, or when energy efficient technologies are developed domestically even without the use of more environmental friendly inputs. Future research may therefore investigate "green" policy effects for other channels or a broader set of possible ones.

3.7 Appendix

Table 14: Overview of green crisis-era measures

Panel 1: Discriminatory and implemented measures

Implementing jurisdiction	**Measure title**	**Measure type**	**Main**	**ATP**	**AS**	**ATL**	**Incl**
Belarus	Temporary tariff measures on trucks and tractors imports	Tariff measure	no	39	1	3	yes
China	Accreditation of suppliers of certain high-tech products	Local content requirement	no	33	1	2	yes
China	General Analysis on Several Opinions of the State Council on Further Utilizing Foreign Capital	Investment measure	no	na	3	200	yes
China	Restructuring of equipment manufacturing industry	Export subsidy	no	125	13	213	yes
Japan	Green tax incentive on environmentally friendly cars	Non tariff barrier	yes	32	4	17	yes
Kazakhstan	State Program for the Forced Industrial Development for 2010-2014	Export subsidy	no	na	18	na	no
Malaysia	Trade implications of the 2011 Budget	Export subsidy	no	37	10	44	no
Republic of Korea	Special financing scheme for "Hidden National Champions"	Trade finance	no	na	8	na	no
Republic of Korea	Joint financing initiative for trade and investment in "green" products	Bail out / state aid measure	yes	45	6	17	yes
Russian Federation	Injection of 4,33 billion rubles (96 million Euro) into Russian RUSHYDRO (green energy) company	Bail out / state aid measure	yes	4	1	1	yes
Russian Federation	The Strategy of the power machine building for 2010-2020 and up to 2030	Export subsidy	no	55	3	na	no

Table 14: continued

Panel 2: Discriminatory and pending measures

Implementing jurisdiction	Measure title	Measure type	Main	ATP	AS	ATL	Incl
Japan	New stimulus package	Bail out / state aid measure	no	na	na	na	no
Republic of Korea	Key Economic Policy Statement for 2010	Bail out / state aid measure	yes	56	6	24	no
Republic of Korea	Tax plans for 2010	Investment measure	no	9	1	2	no

Panel 3: Liberalising and implemented measures

Implementing jurisdiction	Measure title	Measure type	Main	ATP	AS	ATL	Incl
Belarus, Kazakhstan, Russian Federation	Import duty reduction on some materials used for production of solar energy modules	Tariff measure	yes	19	2	2	yes
China	Removal of local content requirement on wind turbines	Local content requirement	yes	41	2	4	yes
India	Union Budget 2010-11 announces Tariff measures	Tariff measure	no	23	8	50	yes
Pakistan	Tariff reductions on intermediate products, tariff exemption of energy saver lamps	Tariff measure	yes	31	6	11	yes
Republic of Korea	Tariff reductions on "green goods"	Tariff measure	yes	16	3	2	yes
Thailand	Import duty reduction for green cars and components	Tariff measure	yes	37	3	7	yes
Thailand	Reduction of import duties on eco-car parts and materials.	Tariff measure	yes	3	4	16	yes

Notes: Retrieved from GTA (www.globaltradealert.org) in April 2011; keywords used to identify "green" measures: green, environment, energy, climate, emission, wind and solar; the "green" clause of each identified measure is carefully studied; two groups are distinguished: group (a) that includes measures for which the "green" clause is the main purpose of implementation, and group (b) that includes measures for which the "green" clause is of secondary importance (see column Main); ATP = Affected trading partners; AS = Affected sectors (CPC 2-digit); ATL = Affected tariff/product lines (HS 4-digit); Incl = Included in dataset used for econometric part.

4 Natural hedging of exchange rate risk - the role of imported input prices[44]

Abstract

Recent empirical trade literature on the role of imported inputs in exchange rate adjustments of exports implicitly assumes full exchange rate pass-through (ERPT) into imported input prices, which is a rather strong assumption. In this paper, we use self-constructed indices of intermediate input prices to investigate the effect of exchange rate fluctuations using disaggregated quarterly trade data for Switzerland over 2004-2011. While our results indicate high ERPT into imported input prices in all sectors, we do not find evidence of full pass-through for all sectors either in the short- or long-run. We also find strong sectoral ERPT heterogeneity on the export side in both the short- and long-run. Our results also suggest the use of "natural hedging" as an effective strategy to reduce exchange rate risks. Moreover, Swiss exporters may not have adjusted export pricing and "natural hedging" practice in response to a strong CHF in the wake of the Euro crisis.

Keywords: exchange rates, exchange rate pass-through, international trade, prices

JEL classification: F31, F41

[44]This is co-authored work with Dario Fauceglia, University of St. Gallen, and Anirudh Shingal, World Trade Institute. We are grateful to Simon Evenett, Giovanni Mellace and Andreas Steinmayr and participants at the PhD seminar in St. Gallen for helpful comments and suggestions.

4.1 Introduction

Exploring the role of imported inputs in exchange rate adjustments of exports has a relatively long tradition in the empirical trade literature (see for example sector-level studies by Athukorala and Menon, 1994and Goldberg and Campa, 2010, or more recently, firm-level studies by Greenaway et al., 2010 and Berman et al., 2012). The rationale for studying this channel is the potential role of exchange rate appreciation/depreciation not just in raising/lowering the foreign export prices of traded goods and services, but also in lowering/raising the prices of imported inputs. Domestic firms exporting abroad may thus have the means to offset some of the adverse effect of exchange rate appreciations on profit margins through cheaper imported inputs ("naturally hedge" exchange rate risks). However, this rationale only holds if exchange rate pass-through (ERPT) into imported input prices and/or export prices is non-zero.

It turns out that the recent empirical literature mainly focuses on (semi-)final goods price adjustments and investigates the cost effect due to imported inputs only indirectly using measures such as the share of imported intermediate inputs in total intermediate inputs (Greenaway et al., 2010), or in studies with firm data, the ratio of total imports to total sales (Berman et al., 2012). These studies however do not look at actual price developments of imported inputs as a result of exchange rate shocks. Thus, they implicitly assume full ERPT into imported input prices[45], which is a rather strong assumption, given the overwhelming existing evidence of partial ERPT into import prices in general (see for instance Campa and Goldberg, 2005).

In a significant departure from this literature, we study ERPT into imported input prices using bilateral and disaggregated unit values as proxies for import prices. We then use these unit values to calculate indices of average imported input prices that are faced by each sector over time and investigate their role in the price setting behaviour of exporters. To the best of our knowledge, this paper is the first (i) to investigate in detail how imported input prices faced by each (exporting) industry develop over time and (ii) to study the effectiveness of "natural hedging" of exchange rate risk by quantifying the effect of exchange rate fluctuations on these imported input prices. Finally, (iii) we examine total pass-through effects on export prices; that is, the combined effect of pricing-to-market behaviour (the simple effect of exchange rate movements on export prices) and the cost-changing effects of exchange rate changes through imported inputs. The last step is also used to

[45] To the best of our knowledge, the only exception to this are Athukorala and Menon, 1994 but they do not use disaggregated indices for imported input prices as we do.

identify whether exporters used "natural hedging" to stabilize profit margins (mark-ups) in a specific export market.

We use monthly/quarterly product level trade data at the 8-digit level for Switzerland between 2004 and 2011. Analysing imported input prices in Switzerland is particularly interesting as the Swiss economy has high ratios of imported intermediate inputs relative to total intermediate inputs, especially in the manufacturing sector (see Table 15), and about half of total imports are processed and re-exported (see Seco, 2011). In the event of significant "natural hedging" it is thus a relevant question whether Swiss exporters are (at least to some extent) spared from losing competitive advantage despite the strong appreciation of the Swiss Franc (CHF). Last but not least, investigating this issue with Swiss data also contributes to the on-going debate on the "strong" CHF. According to a recent study by the State Secretariat for Economic Affairs (Seco, 2011), imported goods prices fell by 40 percent three or four quarters after the appreciation. However, the prices did not fall as much as the CHF appreciated. While the focus of the on-going discussion is more related to imported consumer goods, it might be that prices of imported inputs did not - or not yet - fully adjust as well, which provides another motivation for this study and a reason to also investigate the recent "Strong Franc" period separately.

The paper proceeds as follows. Section 4.2 provides a brief review of the relevant literature. Section 4.3 introduces the theoretical framework which forms the basis for the empirical set up in Section 4.5. Section 4.4 presents the recent evolution of imported input prices and describes the data. Section 4.6 describes the results from estimation and Section 4.7 concludes.

4.2 Related literature

This section highlights results and empirical issues from previous work closely related to our study. A complete overview of the extensive pass-through literature is beyond the scope of this brief review (for more extensive literature reviews see for example Goldberg and Knetter, 1996 and Greenaway et al., 2010).

Athukorala and Menon (1994) examine the pricing behaviour of Japanese exporters by taking into account the aggregate changes of intermediate costs arising from exchange rate movements. Their investigation of quarterly export prices reveals that if the cost-saving effect of exchange rate appreciations is considered the pass-through rate into foreign currency prices for total manufacturing exports declines from 0.78 to 0.67. Separate estimations for

seven manufacturing sub-industries reveal a substantial upward aggregation bias: At the disaggregated level, total ERPT ranges from 0.04 for textiles to 0.53 for transport equipment. All estimates are thus lower than 0.67 at the aggregated level. In this essay, we go a step further by investigating average ERPT into export prices for 15 goods sectors using price data (unit values) at a highly disaggregated (HS 8-digit) and bilateral level. Moreover, we explicitly include disaggregated proxies of imported input prices faced by exporting industries in each period. Finally, we also estimate how these intermediate import prices react to exchange rate changes (again using highly disaggregated data) to investigate whether "natural hedging" is effective.

In a recent study using a panel of French firms, Berman et al. (2012) find a positive net "natural hedging" effect (defined as the interaction between the real exchange rate and firm intermediate imports over sales) on EUR export prices, and thus - in line with Athukorala and Menon (1994) - smaller ERPT into foreign currency prices when taking the cost adjustment into account. Similarly, Greenaway et al. (2010) investigate a panel of UK manufacturing firms and suggest that the negative effect of an exchange rate appreciation on firm exports is lower in industries that import a greater share of inputs. According to Greenaway et al. (2010), their imported-input-weighted exchange rate, which varies at the sectoral-level, should account for import price changes resulting from exchange rate changes. They implicitly assume that an appreciation of the domestic currency would lower import prices. A shortcoming of both studies is that they draw conclusions on the behaviour of import prices without actually studying them.

As indicated by Athukorala and Menon (1994) and Greenaway et al. (2010), industry variation in the pass-through rates are likely to reflect differences in the cost structures across industries. Along the same line, Campa and Goldberg (1997) and Hummels et al. (2001) point to the increasingly important role of global supply chains, and accordingly to the share of imported inputs as an important determinant of industry cost structure. Acknowledging the cost contribution of imported inputs, we emphasize the cost sensitivity of imported inputs to exchange rate movements and its subsequent effect on export pricing. The sensitivity of prices at the importer side also influences the ERPT at the exporter side, but this interconnection has surprisingly not received adequate attention in the empirical ERPT literature. Aksoy and Riyanto (2000) formalize this issue and show that ERPT in the downstream export market depends on the pricing behaviour of foreign upstream suppliers. Finally, Ihrig et al. (2006) argue that the decline of pass-through rates into domestic prices experienced in all G-7 countries over the last two decades may also be a

consequence of the steady rise of cross-border production arrangements.

In other related work, Goldberg and Campa (2010) calibrate a model of the CPI sensitivity to exchange rates with data from 21 OECD countries. They find that the goods cost shares of imported inputs are the dominant channel through which exchange rate shocks are transmitted into consumer prices. For the calibration exercise, they use the strong assumption that an exchange rate change is completely passed through into the imported input prices. This contrasts, for instance, with the low pass-through rate of 0.22 into US import prices reported by Gopinath and Rigobon (2008). Campa and Gonzalez Minguez (2006) show that differences of ERPT into domestic prices in the euro area countries may be explained by the degree of openness to non-euro imports of each country. Campa and Goldberg (1995) and Campa and Goldberg (1999) provide evidence for the US, UK, Japan and Canada that suggests that sectoral investment rates respond to exchange rate fluctuations depending primarily on a sector's exposure to imported inputs and export markets. Their empirical findings suggest that a depreciation of the domestic currency tends to reduce investments particularly in competitive sectors that employ a large fraction of imported inputs, whereas high mark-up sectors with lower imported input shares are less affected by exchange rates. A possible explanation is again that the sensitivity of imported input prices to exchange rates differs across sectors, probably reflecting distinct competitive environments. Yet the issue remains unresolved in all the cited studies. Our study fills this gap in the pass-through literature by recognizing explicitly in the empirical framework that the exporters' pricing decisions have become inextricably intertwined with the pricing behaviour of foreign suppliers.

4.3 Theoretical framework

This section develops the analytical framework from which we derive our pass-through estimating equations with regard to imported input prices in 4.4.1 and export prices in 4.4.2. More details on the empirical strategy and econometric techniques are discussed in Section 4.5.

4.3.1 Import price equation

We assume an exporting sector s specific Cobb-Douglas production function with the share α_s corresponding to imported inputs and the share $1 - \alpha_s$ to domestic inputs including labour services.

$$Q_s = (K^*)^{\alpha_s} \cdot (K)^{1-\alpha_s}, \tag{8}$$

The marginal cost function dual to (8) is given by :

$$MC_s(W, W^*(E), \alpha_s, E) = A_s \cdot W^{1-\alpha_s} \cdot (EW^*(E,Z))^{\alpha_s}, \qquad A_s = \alpha_s^{-\alpha_s} \cdot (1-\alpha_s)^{\alpha_s - 1}, \tag{9}$$

where W is the price of domestic inputs, W^* denotes the price of imported inputs denominated in the foreign currency and E is the bilateral exchange rate between Switzerland and the import source country defined as CHF per unit of the foreign currency. Z includes all factors that affect the foreign currency price of imported inputs W^*; such as the state of the business cycle or increases in producer prices due to changes in foreign wages or commodity prices. Taking logs and then totally differentiating (9) leads to the following expression:

$$\tilde{MC}_s = \widetilde{A} + (1-\alpha_s)\widetilde{W} + \alpha_s \left(\tilde{E} + \frac{\partial w^*}{\partial W^*} \frac{\partial W^*}{\partial e} \tilde{E} + \frac{\partial w^*}{\partial W^*} \frac{\partial W^*}{\partial z} \tilde{Z} \right) \tag{10}$$

where a "$\backsim$" over a variable denotes percentage changes and small letters denote the log of the variables. It is clear from (10) that a higher share of imported inputs, α_s, results in a higher sensitivity of marginal costs to exchange rate fluctuations. Price changes of imported inputs in CHF can be decomposed into the direct effect $\widetilde{E}$ on the Swiss price of imported inputs and the indirect consequence of an exchange rate change on the pricing behaviour of foreign suppliers, $\tilde{W}^* = \frac{\partial w^*}{\partial W^*} \frac{\partial W^*}{\partial e} \tilde{E}$. An interesting limiting case is local currency pricing (LCP) in which the pass-through rate is zero or formally:

$$\widetilde{E} + \frac{\partial w^*}{\partial W^*} \frac{\partial W^*}{\partial e} \tilde{E} = 0 \tag{11}$$

The price reducing effect of an appreciation is here completely offset by the price increases of the foreign suppliers. More generally, percentage changes of imported input prices in CHF, $\tilde{P_s^m}$, due to exchange rates movements, which corresponds to the term in brackets in (10), can be defined as follows:

$$\tilde{P_s^m} = \left(1 + \frac{\partial w^*}{\partial e}\right) \cdot \tilde{E} + \frac{\partial w^*}{\partial z} \cdot \widetilde{Z}, \tag{12}$$

Thus the effect of a percentage change in the bilateral exchange rate $\tilde{E}$ depends on the elasticity of the foreign currency input prices to exchange rates or equivalently on the elasticity of mark-ups to exchange rates, $\frac{\partial w^*}{\partial e}$. If this elasticity equals zero, we obtain full pass-through. Conversely, if foreign suppliers adjust foreign prices and mark-ups when the exchange rate fluctuates, pass-through will be less than complete, $\frac{\partial w^*}{\partial e} < 0$, or amplified, $\frac{\partial w^*}{\partial e} > 0$. In line with equation (12), the simplified empirical equation takes the following logarithmic specification using first-differences and adding time dimension t (see more details in 4.5.1):

$$dp^m_{t,s} = \theta_t + \lambda_s + \beta_s de_t + \epsilon_{t,s} \tag{13}$$

where d is the first-difference operator, β_s corresponds to the sector-specific pass-through coefficient. $\beta_s = 1$ would mean that this sector is characterized by full pass-through or producer currency pricing (PCP). In contrast, $\beta_s = 0$ indicates zero pass-through or local currency pricing (LCP) of foreign input suppliers in the Swiss market as illustrated in equation (11).[46] In the intermediate case, $\beta < 1$, we have incomplete pass-through, which suggests that foreign input suppliers raise their prices and mark-ups when the CHF appreciates. Knetter (1989) points out that this occurs when foreign input suppliers' perceived elasticity of demand rises with the local price (CHF). Then, a depreciation of the supplier‘s currency, $\tilde{E} < 0$, induces foreign suppliers to increase their profit margins. This relationship would be reflected in the negative elasticity between the foreign input price and the exchange rate in equation (12), $\frac{\partial w^*}{\partial e} < 0$. Conversely, a $\beta > 1$ shows that exchange rate changes are transmitted into imported input prices in an amplified manner. This could indicate that the foreign input suppliers' demand elasticity may fall with the Swiss price of foreign inputs resulting in $\frac{\partial w^*}{\partial e} > 0$. Full pass-through, $\frac{\partial w^*}{\partial e} = 0$, indicates that the perceived demand elasticity does not change with the local price.[47] A set of fixed effects $\theta_t + \lambda_s$ in (13) captures changes in foreign input prices in a specific sector s and over time t that can be attributed to changes in the economic conditions, the production costs ($\tilde{Z}$ in equation 12) in the exporting country, demand conditions in the importing country or changes in commodity prices.

[46] All exchange rate movements are fully absorbed in the mark-ups of foreign suppliers in this case.

[47] This would be the case with a CES demand function.

4.3.2 Export price equation

In an imperfectly competitive environment such as the popular monopolistic competition framework, economic agents are price setters and their first order conditions from profit maximization can be stated in the following way:

$$P^e_{j,s} = MK_{js}\left(\frac{P^*_{js}(E)}{P_j}, Z_j, MC_s(E,W)\right)\cdot MC_s(E,W), \qquad MK_{js} = \frac{P^e_{js}}{MC_s}, \quad P^*_{j,s} = \frac{P^e_{j,s}(E)}{E}, \tag{14}$$

where $P^e_{j,s}$ is the FOB average export price in CHF of sector s delivering to country j, $P^*_{j,s}$ is the corresponding price in local currency, MC_s denotes the sector-specific marginal cost (see also equations 9 and 10) and $MK_{j,s}$ represents the sector-destination specific mark-ups. Taking logs and totally differentiating (14) with respect to the bilateral exchange rate in terms of CHF per unit of the destination currency E, the destination price index P_j, the demand-shifter Z_j and the domestic input prices W we obtain:

$$\tilde{P}^e_{j,s} = \left(\frac{\partial mk_{j,s}}{\partial P^*_{j,s}}\frac{\partial P^*_{j,s}}{\partial e}\right)\cdot\tilde{E} + \left(\frac{\partial mk_{j,s}}{\partial MC_s}\frac{\partial MC_s}{\partial e} + \frac{\partial mc_s}{\partial e}\right)\cdot\tilde{E} + \tag{15}$$

$$+\frac{\partial mk_{j,s}}{\partial p_j}\cdot\tilde{P}_j + \left(\frac{\partial mk_{j,s}}{\partial MC_s} + 1\right)\cdot\frac{\partial mc_s}{\partial w}\cdot\tilde{W} + \frac{\partial mk_{j,s}}{\partial z_j}\cdot\tilde{Z}_j,$$

$$\frac{\partial mk_{j,s}}{\partial MC_s} \leq 0, \quad \frac{\partial mc_s}{\partial e} \geq 0, \quad \frac{\partial mk_{j,s}}{\partial P_j} > 0, \quad \frac{\partial mk_{j,s}}{\partial Z_j} > 0, \quad \frac{\partial mc_s}{\partial W} > 0$$

The exporter's price equations (14) and (15) show that the mark-up is a function of the ratio between the price of the Swiss export good price in local currency, $P^*_{j,s}$, divided by an average price index, P_j, that encompasses close substitutes available in market j. The export price reaction to exchange rate changes depends on the reaction of the mark-ups to currency movements, $\frac{\partial mk_{j,s}}{\partial P^*_{j,s}}\frac{\partial P^*_{j,s}}{\partial e}$. As on the import side, this elasticity depends on how exporters perceive the demand schedule in a specific export market. For instance, a positive relationship between a CHF depreciation and the mark-up, $\frac{\partial mk_{j,s}}{\partial P^*_{j,s}}\frac{\partial P^*_{j,s}}{\partial e} > 0$, holds whenever a firm is confronted with a residual demand that exhibits an increasing elasticity with the price - this is the case for demand functions that are less convex than in the

CES case - irrespective of the form of imperfect competition as highlighted by Knetter (1989) and illustrated by Yang (1997) and Dornbusch (1987) for extended Dixit-Stiglitz and Cournot frameworks.[48] [49] With such a perceived demand function, exporters that face an appreciated currency , $\tilde{E} < 0$, try to remain competitive by reducing mark-ups. A mark-up elasticity of one, $\frac{\partial mk_{j,s}}{\partial P^*_{j,s}} \frac{\partial P^*_{j,s}}{\partial e} = 1$, corresponds to local currency pricing (LCP) wherein the mark-up fully absorbs exchange rate movements. If the demand curve is more convex than in the CES case, it could occur that exporters increase the mark-up when the exporter's currency appreciates leading to an overreaction of local prices to exchange rate changes. The second term in (15) illustrates the effect of exchange rate changes on marginal costs and mark-ups working through imported input prices.[50] Contingent on the imported input price reactions (see equations 12 and 13), exporters may benefit from lower marginal costs through cheaper foreign inputs when their currency appreciates, $\frac{\partial mc_s}{\partial e} \geq 0$, and may also increase profit margins, $\frac{\partial mk_{j,s}}{\partial MC_S} \frac{\partial MC_s}{\partial e} \leq 0$. The mark-up adjustment depends again on the perceived demand elasticity. Furthermore, as in Melitz and Ottaviano (2008), more competitive export markets are characterized by lower local prices, P_j, for similar goods, and thus higher demand elasticities which force exporters to reduce export prices, $\frac{\partial mk_{j,s}}{\partial p_j} > 0$. From (15) one can also note that controlling for differences and changes of marginal costs, preferably at the product level, is important due to their direct impact on export prices and through their effect on the price-cost margins since sectors with lower marginal costs MC_j are able to set higher mark-ups, $\frac{\partial mk_{j,s}}{\partial MC_s} \leq 0$.[51] Z_j is a demand shifter related to destination-specific preferences for a good but also on general economic conditions in market j. Stronger preferences and better conditions both increase the exporters' ability to raise export prices and margins, $\frac{\partial mk_{j,s}}{\partial z_j} > 0$.

Equation (15) leads us directly to our simplified empirical specification (see more details in 4.5.1):

$$dp^e_{t,j,s} = \theta_{t,j} + \eta_s + \gamma_1 * de_{t,} + \gamma_2 * dp^m_{t,s} + \varepsilon_{t,j,s}, \tag{16}$$

[48] In the extended Dixit-Stiglitz framework of Yang (1997) based on Dornbusch (1987), firms take into account their non-negligible effect of quantity decisions on the aggregate industry price index. Atkeson and Burstein (2008) show that the endogenous mark-up in our sense, $\frac{\partial mk_{j,s}}{\partial e} > 0$, that leads to incomplete pass-through can be even introduced in a CES-framework with small modifications.

[49] Our derivation of the exporter's pricing and pass-through in (19) and (20) is therefore not limited to monopolistic competition frameworks but holds more generally as well.

[50] Please note that the bilateral exchange rate variable, $\tilde{E}$, in the first and second term of (20) can differ according to the origins of the imported inputs used and the specific destination of an export good.

[51] This holds again for demand curves that are less convex than in the CES case (i.e. elasticity increases with price).

where γ_1 denotes the pricing-to-market coefficient (PTM) and corresponds to the mark-up elasticity to exchange rates in equation (15), $\gamma_1 = \frac{\partial mk_{js}}{\partial P^*_{js}} \frac{\partial P^*_{js}}{\partial e}$. A PTM coefficient equalling one, $\gamma_1 = 1$, represents local currency pricing (LCP) in the sense that export prices in CHF and mark-ups move one-to-one with exchange rates. As a consequence, a CHF appreciation erodes profit margins. Exchange rate pass-through into local prices (in FCU) would then be zero. More specifically, the pass-through effects (in local/foreign prices) are calculated as $1 - \gamma_1$, and therefore are negatively related to PTM behaviour. γ_2 corresponds to the cost-adjustment coefficient and shows how export prices change when imported input prices change. As a result, it should be clear that not accounting for the cost-effect of exchange rate movements on the prices of imported inputs may create a bias in the pass-through estimations on the export side - as also argued by Goldberg and Knetter (1996). The remaining variables affecting export prices as emphasized in equation (15) are captured by a set of fixed effects $\theta_{t,j} + \eta_s$ to account for changes of marginal costs, demand conditions at destination and product-specific differences of competitive pressure, preferences and production costs.

4.4 Data

Sub-section 4.4.1 documents the extent to which Swiss goods industries use imports of intermediate inputs, among other things, as a means to lower exchange rate risks ("natural hedging"), explains the calculation of our sectoral input price indices and traces the evolution of imported input prices that Swiss industries have faced since 2005 compared to that of nominal effective exchange rates and crude oil prices. In 4.4.2, we discuss the data used in the empirical estimations and provide descriptive statistics.

4.4.1 Calculation and evolution of imported input price indices

Prima facie, our data suggest that Swiss industries practised considerable "natural hedging". The first column of Table 15 shows ratios of imported inputs relative to the sum of total inputs and total compensation to employees (or total production costs) while the second column shows ratios of imported inputs relative to total inputs. Data and the sector classification are taken from the 2001 input-output table (I-O table) for Switzerland published by the OECD. As Table 15 highlights, imported inputs make up more than 10 percent of total production costs in all Swiss sectors and are particularly high in some manufacturing sectors (e.g. Textiles 27 percent, or Electrical machinery 25 percent). By

Table 15: Share of imported inputs of total production costs in Switzerland by sector

		(Imported inputs) / (Total inputs + Compensation of employees)	(Imported inputs) / (Total inputs)
1	Agriculture	0.18	0.22
2	Mining & quarrying	0.09	0.13
3	Food & beverages	0.14	0.17
4	Textiles	0.27	0.38
5	Wood products	0.11	0.18
6	Paper products	0.14	0.21
7	Chemicals & pharmaceuticals	0.24	0.29
8	Rubber & plastics products	0.19	0.27
9	Mineral products	0.18	0.27
10	Iron & steel	0.25	0.35
11	Fabricated metal products	0.21	0.35
12	Machinery & equipment	0.17	0.25
13	Electrical machinery	0.25	0.31
14	Communication equipment	0.21	0.32
15	Precision instruments	0.16	0.22

Source: OECD

construction, these figures are even higher when looking at the simple ratios of imported relative to total intermediate inputs (e.g. Textiles 38 percent, or Electrical machinery 31 percent).

"Natural hedging" is only an effective tool to lower exchange rate risks if imported input prices react to exchange rate fluctuations. To gain more insight into the price and exchange rate developments, we calculate indices of imported input prices faced by Swiss industries and plot them against the nominal effective exchange rate index (calculated by the Bank of International Settlement) over January 2005-September 2011 (see Figure 2). Imported input price indices are calculated using unit values at the 8-digit level and for each month and each trading partner separately. Solely imported intermediate 8-digit goods are considered in these calculations, for which the WTO classification of intermediate goods (published by UN Comtrade[52]) is used. We then construct import-weighted unit values for each 2-digit ISIC product group, and aggregate them to the I-O table sector-level using import volume shares .[53] To calculate the average imported intermediate input prices (or unit values) faced by Swiss industries, the constructed sector price averages are re-weighted according to the share of imports from each input sector in each output sector. These weights are taken from the 2001 I-O table for Switzerland.[54]

Despite their well-known shortcomings, using unit values as proxies for import or export prices is standard in the exchange rate pass-through literature because of their relatively wide availability (see for example Berman et al., 2012). Compared to most earlier studies, unit values in this paper more accurately reflect prices as products are highly disaggregated (8-digit level) and separate unit values are calculated for imports of each trading partner. Furthermore, unit values allow us to discriminate between intermediate and consumer

[52] http://wits.worldbank.org/wits/data_details.html

[53] Each I-O table sector consists of one up to five 2-digit ISIC product groups.

[54] More formally, these price indices are constructed as follows:

$$P^m_{t,so} = \left[\sum_{t,so,si,isic2} \left\{ \left[\sum_{t,isic2,k,i} \left(\left(\frac{IV_{t,isic2,k,i}}{IV_{t,isic2}} \right) (UV_{t,isic2,k,i}) \right) \right]_{t,isic2} * \left(\frac{IV_{t,si,isic2}}{IV_{t,si}} \right) * \left(R^{si}_{so} \right) \right\} \right]_{t,so},$$

where t is the time period (month), i is the source country of imports, k is the HS 8-digit input product, $isic2$ is the ISIC 2-digit sector, si is the I-O imported input sector and so is the I-O output sector. IV stands for import volumes in CHF, UV are unit values (or import volumes divided by weight of imported goods in kg) and R^{si}_{so} is the share of imported inputs from I-O input sector si in I-O output sector so. A limiting feature of our data is that these I-O weights do not vary over time, and thus are assumed to remain constant across the whole study period. Finally, $P^m_{t,so}$ is the average imported intermediate input price faced by each (output) sector io in each period t. In Figure 2 these price indices are set to 100 for January 2005 and correspond to averages over the previous 12 months. In the export side estimations in Section 4.5.2, these imported input price indexes are again used as an independent variable.

Figure 2: Development of imported input prices faced by output sectors: 2005-2011

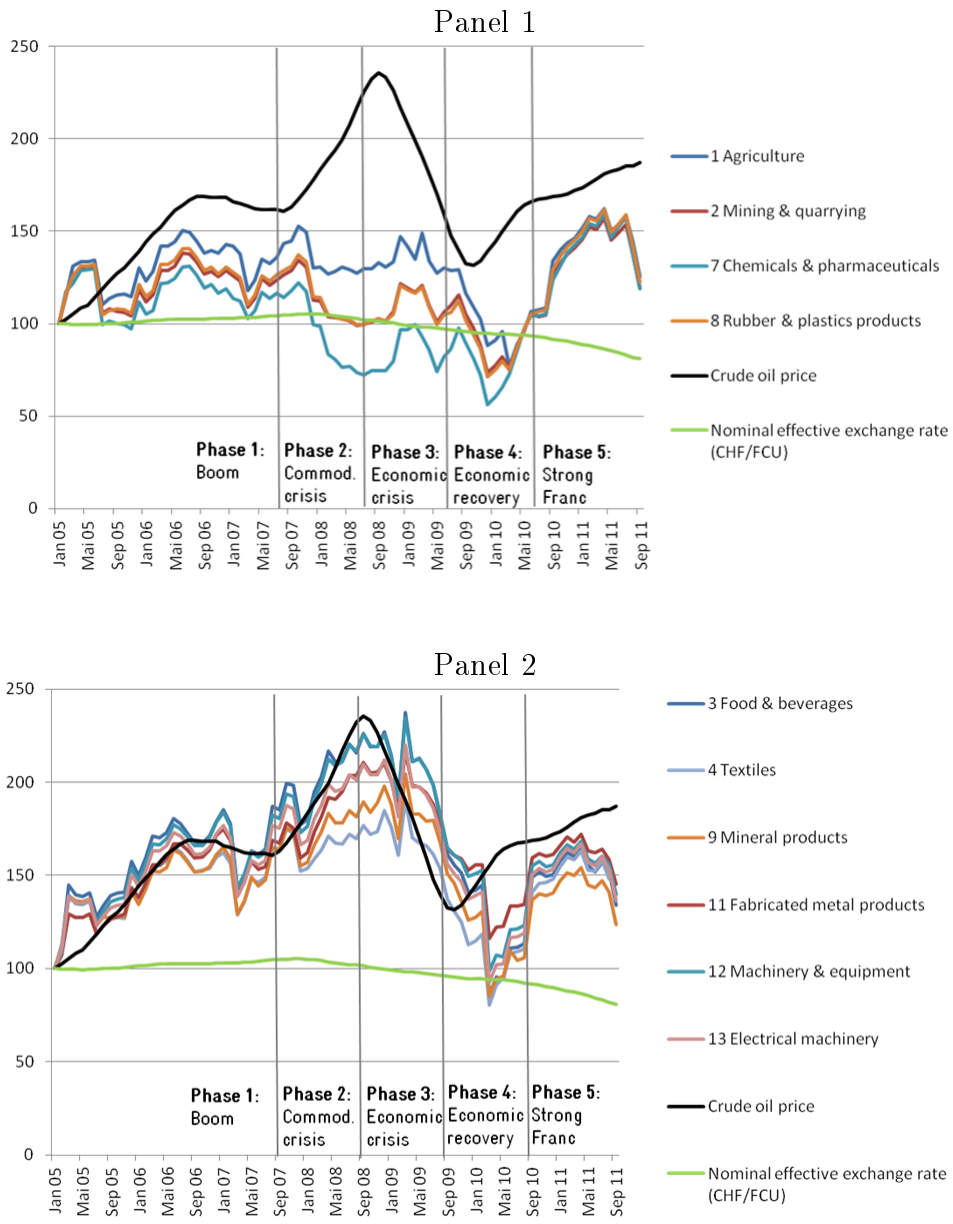
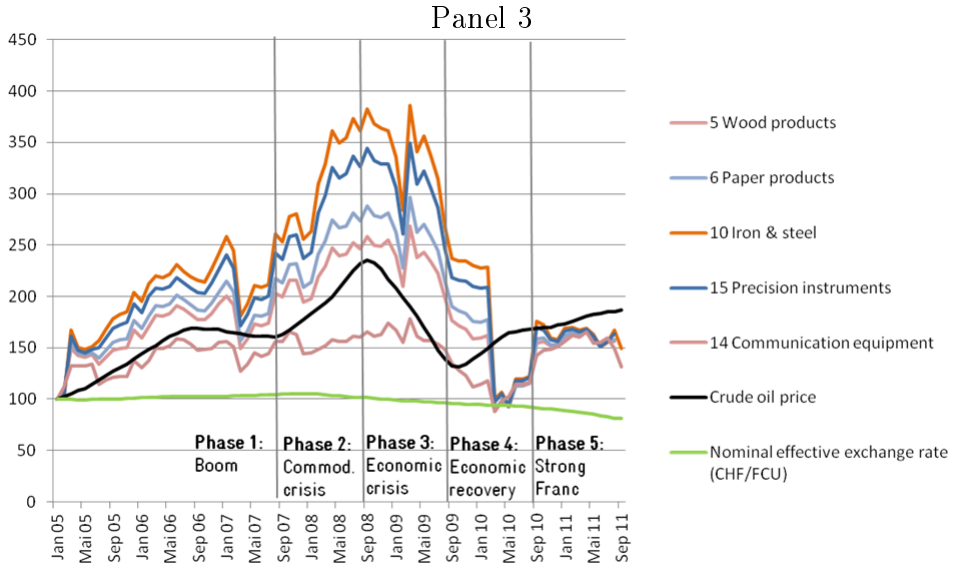


Figure 2: continued



Notes: Figures are averages of the last 12 months; all price indexes are based on prices in CHF; FCU denotes foreign currency units.
Source: Swiss Federal Customs Administration, Bank for International Settlements

goods. This enabled us to be the first to construct industry-level imported input price indexes as genuine price indexes are not available either at the aggregate or at the sectoral level.

Trade data is obtained from the Swiss Federal Customs Administration. As energy prices are likely to make up a significant amount of production costs, imported input prices faced by Swiss industries are likely to be correlated with energy prices. To visualize this relationship, Figure 2 also includes a line for a crude oil price index (calculated as the simple average of three spot crude oil prices in CHF; Dated Brent, West Texas Intermediate, and the Dubai Fateh). All indices are set to 100 in January 2005. To eliminate seasonal fluctuations, all reported figures correspond to averages of the last 12 months (e.g. the oil price index for March 2005 corresponds to the average oil price index between April 2004 and March 2005).

The figure is divided into three panels (1-3). Each panel looks at imported input price developments for sectors facing a similar pattern. The time axis is roughly divided into five phases: boom, commodity crisis, economic crisis, economic recovery, strong Franc. Panel 1 sectors import intermediates with the least price fluctuations and are at first

sight the least responsive to oil price shocks, in particular from January 2008 to May 2009. During the commodity crisis, imported input prices even decreased slightly while crude oil prices almost doubled. Panel 2 and Panel 3 sectors clearly show the expected positive relationship between oil prices and imported input prices. Panel 3 sector prices are relatively more volatile (in both directions) than Panel 2 sectors. For some Panel 3 sectors (e.g. Iron & steel) imported input prices increased by a factor of four between January 2005 and September 2008, which is a considerably larger price hike compared to the oil shock during the same period.

Figure 2 also shows that the nominal effective exchange rate index is relatively stable from January 2005 to January 2009, and is followed by a steady appreciation of the CHF over 2009 and a sharp appreciation in 2010 and 2011. Interestingly, during 2009 input prices show a decline during the period of steady CHF appreciation but a rise in the "strong" CHF phase up until May 2011; this suggests that these prices were more correlated with oil prices during this period (with approximately a six month lag). It was only after May 2011 that the price decreasing impulse of the strong Franc seemed to overcompensate for the price increasing tendencies of the oil price hike. Thus, in the course of continued CHF appreciation, prices of imported inputs started to fall, which is likely to have decreased the exposure of Swiss exporters to the adverse exchange rate.

4.4.2 Descriptive statistics

This section describes the two datasets used in the import and export price equations, respectively. We use quarterly and bilateral trade data based on HS 8-digit products between Q4-04 and Q3-11 taken from the Swiss Federal Customs Administration. The dataset is reduced to the 37 most important trading parters for Switzerland (including all OECD countries and the BRICS and accounting for more than 90 percent of import and exports, respectively).

On the import side (Table 16), the dependent variable, imported input price, is constructed as the first-difference of log imported input unit values (CHF/kg). The main independent variable, exchange rate, is constructed as the first-difference of log nominal exchange rates. Similarly, on the export side (Table 17), the dependent variable, export price, corresponds to the first-difference of log export product unit values (CHF/kg) and the exchange rate variable is constructed in the same way as on the import side. Additionally, the export side dataset includes imported input price indices introduced in Section 4.4.1 and constructed

for the empirical estimations as the first-difference of log indices of sectoral imported input unit values, which are faced by exporters in each sector. Thus, the variables of interest in both datasets correspond to growth rates (that is, first-differences of logs) of the underlying level variables. The dependent variables in both datasets are on average (almost) zero in each sector. The growth rates of exchange rates have naturally no variation across sectors and are also zero on average. The price indices of imported inputs are weighted averages at the sectoral level (that is, they vary only across time and not across products within sectors). Average growth rates of these indices are more heterogeneous across sectors than the other variables, for example -2 percent for Chemicals & pharmaceuticals or +6 percent in the Iron & steels sector. The standard deviation and the minimum and maximum bounds are however lower compared to those of the dependent variables in both datasets.

4.5 Empirical strategy and econometric issues

Our theoretical derivations in Section 4.3 directly lead to estimations in first differences in line with equations (13) and (16). Most other studies in the ERPT literature, however, introduce theoretical considerations that require estimations in levels (see for example, Campa and Goldberg, 2005 or Gaulier et al., 2008). These studies often perform unit root tests and generally cannot reject the null of unit roots in price and exchange rate series. To avoid the problem of spurious regression in dealing with potentially non-stationary time series, these researchers estimate their empirical models in first differences.[55]

To be consistent with the existing literature and to emphasize the need for estimations in first differences not only from a theoretical but also from an econometric point of view, we perform panel unit root tests on our import and export price as well as exchange rate series. Taking account of cross-sectional dependence (particularly important in our exchange rate series) and seasonalities (particularly important in our price series), we cannot decisively reject the null of unit roots and thus the non-stationarity of our time series. Appendix 4.8.1 describes these preliminary diagnostics in greater detail.

The stationarity tests convince us even more to estimate first-difference models, which

[55]Previous ERPT studies often test and reject the existence of theory-grounded co-integration relationships (see for instance Campa and Goldberg, 2005 and Campa and Gonzalez Minguez, 2006). Aside from the generally low power of panel co-integration tests, additional severe testing and aggregation difficulties arise in large cross-sectional heterogeneous panels as ours in order to establish a robust sector-level co-integration relationship (see for instance Trapani and Urga, 2010). Moreover, our theoretical framework does not lead to an equation in levels on which a co-integration relationship is usually based. For these reasons, we decided against testing for co-integration.

Table 16: Descriptive statistics of data used in import price equation

Dependent variable: Imported input price

Formula: $dp^m_{t,i,k}$
Description: First-difference of log imported input unit value (CHF/kg)
Dimensions: Time t (28 quarters, Q4-04 to Q3-11), Geography i (37 source countries), Product k (2'366 HS 8-digit intermediate input products)
Source: Swiss Federal Customs Administration

		Mean	Std. Dev.	Min.	Max.
1	Agriculture (3'378)	-0.00	0.62	-3.97	3.83
2	Mining & quarrying (279)	-0.02	1.51	-5.15	6.09
3	Food & beverages (17'918)	-0.00	0.60	-6.10	6.08
4	Textiles (53'111)	-0.00	0.74	-5.51	6.63
5	Wood products (4'572)	0.01	0.74	-4.52	5.41
6	Paper products (16'495)	0.00	0.78	-6.25	6.78
7	Chemicals & pharmaceuticals (104'450)	-0.00	1.19	-11.77	10.33
8	Rubber & plastics products (13'408)	-0.00	0.88	-7.36	6.75
9	Mineral products (6'895)	-0.00	1.03	-7.04	6.31
10	Iron & steel (50'285)	0.00	0.81	-8.78	8.44
11	Fabricated metal products (16'567)	0.00	0.97	-7.42	8.16
12	Machinery & equipment (2'754)	-0.01	0.99	-6.19	6.35
13	Electrical machinery (3'634)	0.00	0.99	-5.00	5.74
14	Communication equipment	..	..	..	..
15	Precision instruments (9'125)	0.01	1.09	-7.57	8.56

Independent variable: Nominal exchange rate

Formula: $de_{t,i}$
Description: First-difference of log nominal exchange rate
Dimensions: Time t (28 quarters), Geography i (37 source countries)
Source: Swiss National Bank

	Mean	Std. Dev.	Min.	Max.
All sectors	-0.01	0.03	-0.24	0.19

Notes: Figures in parentheses correspond to the number of observations in the respective sectors; reported statistics for the nominal exchange rate variable are equal across different sectors and are therefore not reported separately; figures missing for input sector 14 as no *hs8* input product classified within sector 14.

Table 17: Descriptive statistics of data used export price equation

Dependent variable: Export product price

Formula: $dp^{e}_{t,j,f}$
Description: First-difference of log export product unit value (CHF/kg)
Dimensions: Time t (28 quarters), Geography j (37 destination countries), Product f (5'505 HS 8-digit intermediate and final products)
Source: Swiss Federal Customs Administration

		Mean	Std. Dev.	Min.	Max.
1	Agriculture (10'944)	0.00	0.97	-8.90	10.13
2	Mining & quarrying (9'403)	0.00	1.14	-10.95	10.83
3	Food & beverages (73'240)	0.00	0.57	-7.58	8.17
4	Textiles (185'355)	-0.00	0.84	-8.51	9.35
5	Wood products (10'457)	-0.01	0.95	7.11	8.11
6	Paper products (47'404)	-0.00	0.98	-11.42	8.80
7	Chemicals & pharmaceuticals (190'038)	0.00	0.98	-12.10	12.32
8	Rubber & plastics products (58'638)	0.00	0.90	-9.29	10.24
9	Mineral products (36'427)	-0.00	1.07	-9.93	9.82
10	Iron & steel (60'706)	0.01	0.96	-9.28	9.34
11	Fabricated metal products (133'608)	0.00	0.92	-8.74	9.14
12	Machinery & equipment (209'033)	-0.00	1.00	-10.91	11.87
13	Electrical machinery (97'780)	-0.00	0.98	-10.35	10.35
14	Communication equipment (27'876)	0.00	1.21	-11.67	12.51
15	Precision instruments (103'826)	0.00	0.93	-8.43	9.64

Independent variable: Nominal exchange rate

Formula: $de_{t,i}$
Description: First-difference of log nominal exchange rate
Dimensions: Time t (28 quarters), Geography i (37 destination countries)
Source: Swiss National Bank

	Mean	Std. Dev.	Min.	Max.
All sectors	-0.01	0.04	-0.24	0.19

Table 17: continued

Independent variable: Imported input price

Formula: dp_t^m
Description: First-difference of log of sectoral imported input price index (CHF/kg)
Dimensions: Time t (28 quarters), Geography (37 source countries), Product (variation across sector 1-15, but not within sectors)
Source: Swiss Federal Customs Administration

		Mean	Std. Dev.	Min.	Max.
1	Agriculture (10'944)	0.00	0.65	-1.61	1.09
2	Mining & quarrying (9'403)	-0.01	0.70	-1.61	1.33
3	Food & beverages (73'240)	0.03	0.68	-1.58	1.35
4	Textiles (185'355)	0.02	0.65	-1.60	1.15
5	Wood products (10'457)	0.03	0.72	-1.59	1.48
6	Paper products (47'404)	0.04	0.76	-1.59	1.60
7	Chemicals & pharmaceuticals (190'038)	-0.02	0.83	-1.85	1.96
8	Rubber & plastics products (58'638)	-0.01	0.71	-1.61	1.39
9	Mineral products (36'427)	0.02	0.63	-1.58	1.15
10	Iron & steel (60'706)	0.06	0.92	-1.56	1.93
11	Fabricated metal products (133'608)	0.03	0.49	-1.19	1.03
12	Machinery & equipment (209'033)	0.03	0.60	-1.41	1.25
13	Electrical machinery (97'780)	0.02	0.61	-1.48	1.22
14	Communication equipment (27'876)	0.01	0.58	-1.48	1.04
15	Precision instruments (103'826)	0.05	0.84	-1.54	1.79

Notes: Figures in parentheses correspond to the number of observations in the respective sectors; reported statistics for the nominal exchange rate variable are equal across different sectors and therefore not reported separately for each sector.

will be further described in this section. Section 4.5.1 introduces the empirical strategy for ERPT into imported input prices and Section 4.5.2 for ERPT into export prices taking into account the cost adjustments through imported inputs. This two-step approach allows us to investigate on the one hand whether exporters potentially benefit from "natural hedging" practice (i.e. whether imported input prices adjust with exchange rates) and on the other hand whether exporters use such input cost/price adjustments to stabilize profit margins in the export markets.

4.5.1 ERPT into imported input prices

The empirical equation (13) for ERPT into imported input prices is estimated for each I-O input sector si separately. The HS 8-digit input product dimension k and partner country dimension i are introduced and lagged exchange rate terms are added to allow for the possibility of gradual adjustment of these prices. Thus, we estimate regressions based on bilateral import data at the HS 8-digit level and the estimated parameters are pooled at the I-O input sector level si, as follows:

$$dp^m_{t,i,k} = \theta_{p,i} + \lambda_{hs6} + \sum_{t=0}^{-2}(\beta_t * de_{t,i}) + u_{t,i,k}. \tag{17}$$

where the index si is omitted, d is the first-difference operator, t is the time component defined as one quarter, p is time phase including four quarters (Q4 of one year to Q3 of the next year), i is the foreign supplier and k refers to the intermediate product. Notations are consistent with the previous section, where lower case letters designate logarithms. Namely, $p^m_{t,i,k}$ is the log of imported input price indexes defined as unit values (import value in CHF per kg, which are set to 100 in Q1-2004) and $e_{t,i}$ is the log of the nominal bilateral exchange rate index defined as CHF per unit of the foreign supplier i's currency. The average short-run relationship between exchange rates and the imported input prices in each si is given by the estimated coefficient β_0. The long-run elasticity is given by the sum of the coefficients on the contemporaneous exchange rate and two lags of exchange rate terms $\sum_{t=0}^{-2}\beta_t$.[56] Finally, the set of fixed effects $\theta_{p,i}+\lambda_{hs6}$ capture all other factors affecting intermediate input prices. In particular, $\theta_{p,i}$ capture aggregate changes in production costs (including commodity price changes) in source country i as well as the evolution of demand

[56] Variable deletion F-tests have confirmed that these high sectoral long-run pass-through rates are mostly achieved within three quarters. In the benchmark specifications, we thus only used two lags for the long-run analysis.

conditions in the importing country, Switzerland.[57] It is thereby assumed that the time- and supplier-varying fixed effects are homogeneous across all $hs8$ products of a given si sector, so that the k dimension can be neglected. Marginal costs and demand conditions are difficult to measure - especially at the product level. As a remedy, other researchers have used aggregate measures such as consumer-price- , producer-price- or labour-cost-indexes as marginal cost proxies and GDP as proxies for demand conditions (see for example Campa and Goldberg, 2005 or Auer and Chaney, 2009). Given that our data includes the product dimension, we add fixed effects for each HS 6-digit product group, λ_{hs6}, to control for time and supplier invariant determinants of price adjustments within a product group $hs6$.

In order to see to what extent I-O output sectors so face imported input price adjustments when exchange rates change, the estimated short- and long-run ERPT effects on imported input prices have to be re-weighted according to each si's share of each so's total imported inputs. These shares are calculated from the I-O table 2001 for Switzerland and are denoted as R_{so}^{si}, where $\sum_{si}[R_{so}^{si}] = R_{so}$. Average short-run ERPT effects on imported input prices per I-O output sector so are thus given as follows:[58]

$$\beta_0^{so} = \sum_{si} \left[R_{so}^{si} * \beta_0^{si} \right]; \tag{18}$$

and the long-run effects as follows:

$$\sum_{t=0}^{-2} \beta_t^{so} = \sum_{si} \left[R_{so}^{si} * \sum_{t=0}^{-2} \beta_t^{si} \right]. \tag{19}$$

After estimating (17), we calculated the standard errors of the linear combinations (18) and (19) that take into account the variance-covariance structure of the estimated coefficients β_t^{si}.

[57] The time component is pooled to phase p including four quarters. Each phase corresponds to a time period in which crude oil prices have on average either hiked, remained relatively constant or decreased during the 12 previous months (see Section 4.4 and Figure 2). Thus, the underlying assumption is that marginal costs of inputs, which are captured by the fixed effects and are likely to be driven by energy prices or crude oil prices, have changed in each of these phases but remained constant within a phase.

[58] As I-O tables are not updated each period, it is assumed that the import structure of inputs per so is not varying over time, which is a necessary but restrictive limitation of our analysis. Comparisons of Swiss I-0 tables between 2001 through 2008 show that the import structure of inputs in fact remains relatively stable over time.

4.5.2 ERPT into export prices

Our export regressions estimate ERPT on export prices in line with our theoretical considerations and equation (16). Similar to the estimation strategy applied for the import side, first-difference equations, based on bilateral export data at the HS8-digit level with lagged exchange rate terms to allow for the possibility of gradual adjustment of export prices, are estimated separately for each I-O output sector level *so*, as follows:

$$dp^e_{t,j,f} = \theta_{p,j} + \lambda_{hs6} + \sum_{t=0}^{-2}(\gamma_{1,t} * de_{t,j}) + \sum_{t=0}^{-2}(\gamma_{2,t} * dp^m_t) + v_{t,j,f}, \tag{20}$$

where index j stands for export destination, f for export product at the $hs8$ level and *so* is omitted[59]. Letters or expressions already used in equation (21) have the same interpretation; lower case letters still designate logarithms. The variable $p^e_{t,j,f}$ is the log of the export price index, $e_{t,j}$ is the nominal and bilateral exchange rate index defined as CHF per unit of export destination j's currency and p^m_t is the log of the imported input price index in time t. Section 4.4 explains in detail how p^m_t is constructed.[60] The fixed effects $\theta_{p,j}$ control for phase and destination dependent demand shifts, for instance, due to changes in general economic conditions. As in the import side equation (17), these fixed effects absorb all relative cost and demand changes between Switzerland and one specific destination country.[61] Fixed effects λ_{hs6} capture variations in domestic marginal costs for different export products at the *hs6*-level.

Short-run total exchange rate pass-through, TPT, (on foreign currency export prices) per *so* is in line with our theoretical framework defined as:

$$1 - \left[\gamma^{so}_{1,0} + \gamma^{so}_{2,0}\right]; \tag{21}$$

[59]Note that $f = k$ if the input k is exported by Swiss exporters and $j = i$ if source country i is also a destination country for Swiss exports.

[60]Notice that the imported intermediate input price indexes for each I-O output sector have been used in Section 4.2 and have only variation over time for each *io* sector and not variation across products. This data shortcoming requires the assumption that input price developments faced by different producers/products within a *so* are the same.

[61]As an example, if domestic sourcing becomes more expensive for whatever reason (e.g. domestic agricultural intermediates get more expensive for the food sector), this changes the relative demand and cost conditions for Swiss exporters vs. foreign producers and are hence captured by the $\theta_{p,j}$ dummies. In robustness checks, we also estimated models with *(non-time varying) destination country dummies* but *time-varying product dummies* instead. The ERPT coefficients turned out to be similar.

and for the long-run it is defined as:

$$1 - \left[\sum_{t=0}^{-2} \left[\gamma_{1,t}^{so} + \gamma_{2,t}^{so} \right] \right], \tag{22}$$

where the first terms within the brackets in (21) and (22) correspond to mark-up adjustments due to exchange rate changes, or PTM effects. The second terms show the cost-adjustment effects through imported inputs, CAE.[62]

4.6 Results

Table 18 presents sectoral ERPT coefficients for imported input prices. The first two columns display average short- and long-run elasticities in each input sector, while the the last two columns report the responses of imported input prices faced by each output/export sector. These latter figures are calculated as weighted averages of pass-through coefficients across input sectors according to their import weight in a respective output sector. The weights are taken from Swiss 2001 I-O-tables (see equation 18 and 19). To account for possible auto-correlation in the errors within trading partner countries, we report robust-clustered standard errors using the partner country as the clustering unit. The argument for this clustering strategy is that nominal exchange rates are country-pair-specific but not product-specific. Unless the pricing of products differs greatly in terms of which currency it is denominated in, 'partner country' is the preferred clustering unit.[63] This strategy is followed in all regressions reported in this paper.

Looking firstly at the results in column 1 and 2, we find high ERPT into imported input

[62] It should be noted that the theoretically derived CAE term is defined as follows: $\gamma_{2,t}^{so} * \beta_t^{so}$. These beta and gamma coefficients are however estimated in two different samples, the imported input price sample and the export price sample. As a result, obtaining the appropriate standard errors for these estimates (i.e. the product of the estimates) is a non-trivial task and cannot be accomplished with conventional bootstrapping methods. One possible remedy is to construct firstly all variables needed for the import regression within the export price sample, which does however substantially reduce variation in the data. Secondly, the new import regression and the export regression is estimated through seemingly unrelated equations (SUR) in order to apply new post-estimation simulations to calculate non-linear combinations and their standard errors. We estimated such models and came to the same conclusions as with the simpler and straightforward approach described in the main text. Not least, estimates from the two alternatives do not substantially differ as the $\gamma_{2,t}^{so}$ coefficients are not significantly different from zero for most sectors and/or the magnitude is close to zero. The combined effects $\gamma_{2,t}^{so} * \beta_t^{so}$ are thus also close to zero. We are grateful to Giovanni Mellace for important suggestions on these issues.

[63] Our results are robust to estimations using (partner country)*(hs8-product) as the clustering unit. The results can be received upon request.

Table 18: ERPT into imported input prices (in CHF)

		By input sector		By output sector*	
		Short-run	Long-run	Short-run	Long-run
1	Agriculture	0.49	0.71	$0.50^{a/b}$	1.34^{a}
		(0.35)	(0.63)	(0.20)	(0.51)
2	Mining & quarrying	2.78	6.54	1.09	3.09^{a}
		(3.78)	(4.04)	(1.05)	(1.21)
3	Food & beverages	0.72^{a}	1.51^{a}	0.61^{a}	1.18^{a}
		(0.24)	(0.49)	(0.20)	(0.43)
4	Textiles	0.79^{a}	1.33^{a}	$0.71^{a/b}$	1.45^{a}
		(0.12)	(0.32)	(0.12)	(0.38)
5	Wood products	1.13^{a}	1.71^{a}	0.97^{a}	1.79^{a}
		(0.20)	(0.37)	(0.15)	(0.40)
6	Paper products	$0.58^{a/b}$	1.37^{a}	$0.61^{a/b}$	1.60^{a}
		(0.11)	(0.38)	(0.15)	(0.41)
7	Chemicals & pharmaceuticals	0.18^{b}	1.79^{a}	0.75	$2.65^{a/b}$
		(0.45)	(0.81)	(0.72)	(0.90)
8	Rubber & plastics products	$0.72^{a/b}$	1.56^{a}	0.34^{b}	1.81^{a}
		(0.11)	(0.32)	(0.33)	(0.68)
9	Mineral products	0.86^{a}	1.62^{a}	1.46	3.48^{a}
		(0.326)	(0.38)	(1.36)	(1.48)
10	Iron & steel	1.12^{a}	$2.32^{a/b}$	1.18^{a}	$2.65^{a/b}$
		(0.28)	(0.57)	(0.43)	(0.63)
11	Fabricated metal products	$0.73^{a/b}$	$1.99^{a/b}$	1.03^{a}	$2.27^{a/b}$
		(0.12)	(0.45)	(0.22)	(0.52)
12	Machinery & equipment	0.55	1.85	0.68^{a}	$1.88^{a/b}$
		(0.98)	(1.13)	(0.30)	(0.41)
13	Electrical machinery	0.30	1.59^{a}	0.61^{a}	$1.84^{a/b}$
		(0.49)	(0.44)	(0.24)	(0.32)
14	Communication equipment	..	..	0.73^{a}	$1.89^{a/b}$
		..	..	(0.15)	(0.39)
15	Precision instruments	0.88^{a}	0.92	0.85^{a}	1.76^{a}
		(0.38)	(0.87)	(0.13)	(0.39)

Notes: *Weighted average ERPT faced by each output sector [weights from I-O table]; by input sector: short-run = β_0^{si}, long-run = $\sum_{t=0}^{-2} \beta_t^{si}$; by output sector: short-run = β_0^{so}, long-run = $\sum_{t=0}^{-2} \beta_t^{so}$; $^{a/b}$H0 of zero/full pass-through rejected at the 95%-level; estimated with WLS [weight = import value], robust-clustered standard errors in parentheses [cluster unit = source country]; phase-source varying fixed effects as well as $hs6$ varying fixed effects; coefficients missing for input sector 14 as no *hs8* input product classified within sector 14.

prices in all sectors.However, contrary to assumptions made in the recent empirical literature, we do not find evidence of full pass-through for all sectors either in the short- or long-run, though we are able to reject zero ERPT in a majority of sectors. There is some sectoral heterogeneity in the short-run, but the estimated long-run coefficients are not significantly different from one in 7 out of 14 sectors and statistically above one in 3 sectors (Wood products, Iron & steel and Fabricated metal products). With regard to imported input prices faced by each output sector in the third and fourth column, the picture remains unchanged with complete pass-through or exchange rate amplification (coefficients above one) being the appropriate characterization of the input price reactions to exchange rate movements.[64]

The magnitudes of the pass-through coefficients into imported input prices may be surprisingly high, but they are in line with the existing evidence of high pass-through into Swiss import prices. For instance, Campa and Goldberg (2005) estimate a long-run pass-through rate of 0.94, which is not significantly different from one, for the Swiss manufacturing sector as a whole. Gaulier et al. (2008) estimate ERPT for each HS 4-digit product line separately and obtain an average ERPT of 0.7 for Switzerland. Only about 30 percent of the estimated pass-through coefficients are statistically different from one. For countries in the euro area, Campa and Gonzalez Minguez (2006) conclude that industry-specific pass-through rates into import prices are on the order of 0.8 and that many industries within a country reach full pass-through after only four months. Furthermore, Campa and Gonzalez Minguez (2006) show that pass-through into producer price indexes is more than double the size of transmission into consumer prices suggesting higher pass-through into imported input goods compared to consumer goods. However, our results somewhat contradict the recent study conducted by the State Secretariat for Economic Affairs (Seco, 2011) that estimated fairly low average ERPT into Swiss import price indexes of 0.4 after three to four quarters.[65]

How can this high pass-through rate at the upper bound of prior estimates be explained? It is important to bear in mind that we only included input (intermediate) goods in the import regressions, while studies employing more aggregate price indexes are likely to be biased towards consumer goods. In line with equation 13 in Section 4.3, high ERPT can be explained by a input demand elasticity that changes little with local prices (in CHF). This is reasonable for highly customized input goods tailored to specific needs of firms. Recent

[64]For instance, a coefficient of 1.33 for the Textiles sector in the long-run (column 2 of Table 18) indicates that foreign suppliers increase CHF prices by about 13.3 percent when the CHF depreciates by 10 percent.

[65]Stulz (2007) also obtains an ERPT of 0.4.

theoretical advances complement the imperfect competition model of mark-up pricing from Section 4.3 with distribution costs in the local market in order to explain ERPT (see for example, Corsetti and Dedola, 2005 in a general-equilibrium framework or in Berman et al., 2012 in a Melitz-type model). According to Goldberg and Campa (2010) and Berman et al. (2012), 30-60 percent of local consumer goods prices are made up by distribution costs as opposed to a much lower distribution cost share for intermediate goods. This is important because a lower share of distribution costs incurred in local currency lowers the incentive for pricing-to-market (PTM), and thus increases pass-through rates in all models emphasizing distribution costs.[66] Our import side results support this class of models and suggest that prices of imported inputs faced by Swiss output/export industries are mainly invoiced in currencies of the foreign suppliers (PCP). As a consequence, Swiss industries highly benefit from exchange rate appreciations through cheaper imported inputs, in particular in those industries with a higher share of foreign inputs. Hence, exporters can potentially benefit from "natural hedging" practices in times of currency appreciations if imported price changes are not transmitted to foreign consumers. Moreover, variable deletion F-tests confirmed that these high sectoral long-run pass-through rates are mostly achieved within three quarters, therefore, we used only two lags for the long-run analysis.[67]

As a robustness check, we performed the same estimations adding interaction terms for each exchange rate variable with a dummy that equals one for all observations during the "strong Franc" period (Q1 2010 - Q3 2011, or since the nominal CHF/EUR exchange rate reached a level below 1.25 for the first time). This was done in order to study the pricing behaviour during this exceptional time. However, we could not find statistical evidence that the pricing strategies of foreign suppliers changed during the strong CHF period in the wake of the euro crisis.

Table 19 displays the short-run PTM and pass-through coefficients as well as cost-adjustment effects due to imported input price changes on the export side. We find substantial sectoral heterogeneity indicating along the lines of Knetter (1993) that sectoral differences are important factors in explaining ERPT. The results for direct ERPT (DPT, column 4) show that 6 sectors out of 15 report partial ERPT (Food & beverages, Textiles, Rubber & plastics products, Fabricated metal products, Mineral products and Electrical machinery), 4 sectors are characterized by full pass-through (Paper products, Iron & steel, Machinery &

[66] Previous empirical studies come to similar conclusions: Using French firm-level data, Berman et al. (2012) show that ERPT is substantially higher for intermediate goods than for consumer goods. Gaulier et al. (2006) reach the same conclusion using disaggregated trade data.

[67] We also estimated equations with four lags which yielded similar results.

Table 19: ERPT into export prices (in CHF and in foreign currency units, FCU) - short-run

		In CHF			In FCU	
		Direct (PTM)	Indirect (CAE)	Total (1-TPT)	Direct (DPT)	Total (TPT)
1	Agriculture	0.59	-0.00^{b}	0.59	0.41	0.41
		(0.67)	(0.02)	(0.68)	(0.67)	(0.68)
2	Mining & quarrying	0.70	-0.01^{b}	0.69	0.30	0.31
		(0.47)	(0.01)	(0.47)	(0.47)	(0.47)
3	Food & beverages	0.33$^{a/b}$	-0.01$^{a/b}$	0.32$^{a/b}$	0.67$^{a/b}$	0.68$^{a/b}$
		(0.12)	(0.00)	(0.12)	(0.12)	(0.12)
4	Textiles	0.62$^{a/b}$	0.02$^{a/b}$	0.65^{a}	0.38$^{a/b}$	0.35^{b}
		(0.18)	(0.01)	(0.18)	(0.18)	(0.18)
5	Wood products	1.08^{a}	-0.00^{b}	1.08^{a}	-0.08^{b}	-0.08^{b}
		(0.34)	(0.01)	(0.35)	(0.33)	(0.35)
6	Paper products	0.18^{b}	0.01^{b}	0.19^{b}	0.82^{a}	0.81^{a}
		(0.22)	(0.01)	(0.22)	(0.22)	(0.23)
7	Chemicals & pharmaceuticals	0.69^{a}	-0.02^{b}	0.67^{a}	0.31^{b}	0.33^{b}
		(0.32)	(0.03)	(0.30)	(0.32)	(0.30)
8	Rubber & plastics products	0.44$^{a/b}$	0.00^{b}	0.44$^{a/b}$	0.56$^{a/b}$	0.56$^{a/b}$
		(0.10)	(0.00)	(0.10)	(0.10)	(0.10)
9	Mineral products	0.52$^{a/b}$	-0.02^{b}	0.49$^{a/b}$	0.48$^{a/b}$	0.51$^{a/b}$
		(0.21)	(0.01)	(0.22)	(0.21)	(0.22)
10	Iron & steel	-0.14^{b}	-0.03$^{a/b}$	-0.17	1.14^{a}	1.17
		(0.49)	(0.01)	(0.49)	(0.49)	(0.419)
11	Fabricated metal products	0.30$^{a/b}$	-0.01^{b}	0.29$^{a/b}$	0.70$^{a/b}$	0.71$^{a/b}$
		(0.12)	(0.00)	(0.12)	(0.12)	(0.12)
12	Machinery & equipment	0.27^{b}	-0.00^{b}	0.26^{b}	0.73^{a}	0.74^{a}
		(0.22)	(0.01)	(0.22)	(0.22)	(0.22)
13	Electrical machinery	0.62$^{a/b}$	-0.02^{b}	0.60$^{a/b}$	0.38$^{a/b}$	0.40$^{a/b}$
		(0.16)	(0.02)	(0.17)	(0.16)	(0.16)
14	Communication equipment	0.73	-0.03^{b}	0.70	0.27	0.30
		(0.40)	(0.02)	(0.40)	(0.40)	(0.40)
15	Precision instruments	0.16^{b}	-0.00^{b}	0.16^{b}	0.84^{a}	0.84^{a}
		(0.19)	(0.01)	(0.20)	(0.19)	(0.20)

Notes: PTM (pricing to market coefficient) = $\gamma^{so}_{1,0}$, CAE (cost-adjustment effect) = $\gamma^{so}_{2,0}$, 1-TPT = $\gamma^{so}_{1,0} + \gamma^{so}_{2,0}$, DPT = $1 - \gamma^{so}_{1,0}$, TPT (total pass-through coefficient) = $1 - \left(\gamma^{so}_{1,0} + \gamma^{so}_{2,0}\right)$; $^{a/b}$H0 of zero/one PTM, CAE or pass-through (DPT and TPT) rejected at the 95%-level, respectively; estimated with weighted least squares [weight = import value], robust-clustered standard errors in parentheses [cluster unit = partner country]; phase-source varying fixed effects as well as *hs6* varying fixed effects.

equipment and Precision instruments) and ERPT for 2 sectors is not statistically different from zero (Wood products and Chemicals & pharmaceuticals).

According to Yang (1997), sectors with differentiated goods, which have no close substitutes available that prevent foreign costumers from switching to other products when local prices in foreign currency units (FCU) rise, should attain higher ERPT rates. As displayed in Supposition 1 of Table 20, this is the case in the short-run for sectors containing a high share of differentiated and customized products such as Precision instruments, Machinery & equipment, Fabricated metal and Rubber & plastics products. In contrast, more competitive sectors with less product differentiation, for example Textiles or Wood products, are less able to pass-through exchange rate changes to foreign customers. In the short-run total, the supposition is confirmed in 9 sectors and rejected in 6 sectors. This indicates that the degree of firm rivalry within a sector in home and foreign markets may be indeed an important determinant of the pricing behaviour of exporters. This hypothesis is also confirmed when comparing average sectoral profit margins - as an indicator for firm rivalry within a sector - and ERPT rates. Supposition 2 that sectors with higher average profits are more able to pass through exchange rate changes into prices holds again in 9 out of 15 sectors in the short-run (see Table 20). It is further assumed that sectors in which differentiation and thus specialised skills and equipment are relatively more important (e.g. Precision instruments and Machinery & equipment) are also those sectors paying higher average wages to their employees. Sectors with higher average hourly wages should thus also be those having higher ERPT rates; and vice versa. However, this supposition is not well supported in our data(see Supposition 3, Table 20).

An alternative explanation for sectoral heterogeneity would be that distribution costs (incurred in the local currency) as a share of marginal costs are higher in some sectors increasing the incentives to set prices directly in the local currency (LCP) (see Corsetti and Dedola, 2005). Also, this second rationalization of sectoral ERPT heterogeneity holds remarkably well in the short-run (see Supposition 4 in Table 20).Having lower distribution costs , the Machinery & equipment, Fabricated metal and Rubber & plastics products sectors also have higher ERPT rates. In opposition, sectors with low ERPT rates, such as Mineral products and Textiles, also report higher distribution cost shares according to Supposition 4. Overall, this supposition is confirmed in 11 sectors and rejected in 4 sectors.[68]

[68]However, one should be cautious in the interpretation of all suppositions in Table 20 because the number of sectors included in the analysis is too small (15 sectors) for proper statistical inference. The

Table 20: Descriptive analysis of sectoral ERPT heterogeneity

Supposition 1:
Sectors exporting more differentiated products have higher ERPT rates; and vice versa

	Confirmed	Rejected
Short-run ERPT (see Table 16, Direct DPT)		
High ERPT rates (>50%); high share of differentiated goods exported (>80%)	Precision instruments[a]; Fabricated metal products[a/b]; Machinery & equipment[a]; Rubber & plastics products[a/b]	Electrical machinery[a/b]; Mineral products[a/b]; Communication equipment
Low ERPT rates (<50%); low share of differentiated goods exported (<80%)	Textiles[a/b]; Wood products; Chemicals & pharmaceuticals; Agriculture; Mining & quarrying	Food & beverages[a/b]; Paper products[a]; Iron & steel[a]
Long-run ERPT (see Table 17, Direct DPT)		
High ERPT rates (>50%); high share of differentiated goods (>80%)	Precision instruments[a]; Machinery & equipment[a]	Fabricated metal products[a/b]; Electrical machinery[b]; Mineral products; Rubber & plastics products[b]; Communication equipment
Low ERPT rates (<50%); low share of differentiated goods (<80%)	Textiles[a/b]; Wood products[b]; Mining & quarrying	Food & beverages[a/b]; Paper products; Chemicals & pharmaceuticals; Agriculture; Iron & steel

Notes: Share of differentiated goods = Share of differentiated goods exported of all goods exported in a sector; supposition is confirmed if sectors in the group of high shares of differentiated goods are also in the group of high ERPT rates, and vice versa; [a/b]H0 of zero/full ERPT rejected at the 95%-level

Table 20: continued

Supposition 2:
Sectors with higher profit margins have higher ERPT rates; and vice versa

	Confirmed	Rejected
Short-run ERPT (see Table 16, Direct DPT)		
High ERPT rates (>50%); high profit margins (>3%)	Precision instruments[a]; Fabricated metal products[a/b]; Machinery & equipment[a]; Rubber & plastics products[a/b]	Chemicals & pharmaceuticals; Electrical machinery[a/b]; Communication equipment
Low ERPT rates (<50%); low profit margins (<3%)	Textiles[a/b]; Wood products; Agriculture; Mining & quarrying; Mineral products[a/b]	Food & beverages[a/b]; Paper products[a]; Iron & steel[a]
Long-run ERPT (see Table 17, Direct DPT)		
High ERPT rates (>50%); high profit margins (>3%)	Chemicals & pharmaceuticals; Precision instruments[a]; Machinery & equipment[a]	Fabricated metal products[a/b]; Electrical machinery[b]; Rubber & plastics products[b]; Communication equipment
Low ERPT rates (<50%); low profit margins (<3%)	Textiles[a/b]; Wood products[b]; Mining & quarrying; Mineral products;	Food & beverages[a/b]; Paper products; Agriculture; Iron & steel

Notes: Average sectoral profits margins between 2005-2010 taken from Accenture (2012); supposition is confirmed if sectors in the group of high profit margins are also in the group of high ERPT rates, and vice versa; [a/b]H0 of zero/full ERPT rejected at the 95%-level

Table 20: continued

Supposition 3:
Sectors with higher hourly wages have higher ERPT rates; and vice versa

	Confirmed	Rejected
Short-run ERPT (see Table 16, Direct DPT)		
High ERPT rates (>50%); high hourly wages (> 27 USD)	Iron & steel[a]; Precision instruments[a]; Machinery & equipment[a];	Mining & quarrying; Chemicals & pharmaceuticals; Electrical machinery[a/b]; Communication equipment
Low ERPT rates (<50%); low hourly wages (< 27 USD)	Textiles[a/b]; Wood products; Agriculture; Mineral products[a/b]	Food & beverages[a/b]; Paper products[a]; Rubber & plastics products[a/b]; Fabricated metal products[a/b]
Long-run ERPT (see Table 17, Direct DPT)		
High ERPT rates (>50%); high hourly wages (> 27 USD)	Chemicals & pharmaceuticals; Precision instruments[a]; Machinery & equipment[a]; Iron & steel	Mining & quarrying; Electrical machinery[b]; Communication equipment
Low ERPT rates (<50%); low hourly wages (< 27 USD)	Textiles[a/b]; Wood products[b]; Mineral products; Rubber & plastics products[b]; Fabricated metal products[a/b];	Food & beverages[a/b]; Paper products; Agriculture;

Notes: Average sectoral hourly wages in the US between 2005-2010 taken from the Bureau of Labor Statistics; supposition is confirmed if sectors in the group of high hourly wages are also in the group of high ERPT rates, and vice versa; [a/b]H0 of zero/full ERPT rejected at the 95%-level

Table 20: continued

Supposition 2:
Sectors exporting products with smaller shares of distribution costs have higher ERPT rates; and vice versa

	Confirmed	Rejected
Short-run ERPT (see Table 16, Direct DPT)		
High ERPT rates (>50%); low share of distribution costs (10-14%)	Iron & steel[a]; Rubber & plastics products[a/b]; Paper products[a]; Fabricated metal products[a/b]; Machinery & equipment[a]	Electrical machinery[a/b]; Wood products
Low ERPT rates (>50%); high share of distribution costs (14-27%)	Communication equipment; Agriculture; Chemicals & pharmaceuticals; Mineral products[a/b]; Mining & quarrying; Textiles[a/b]	Food & beverages[a/b]; Precision instruments[a]
	Long-run ERPT (see Table 17, Direct DPT)	
High ERPT rates (>50%); low share of distribution costs (10-14%)	Iron & steel; Paper products; Machinery & equipment[a]	Electrical machinery[b]; Wood products[b]; Rubber & plastics products[b]; Fabricated metal products[a/b]
Low ERPT rates (>50%); high share of distribution costs (14-27%)	Communication equipment; Mineral products; Mining & quarrying; Textiles[a/b]	Agriculture; Chemicals & pharmaceuticals; Food & beverages[a/b]; Precision instruments[a]

Notes: Share of distribution costs = Distribution cost share of final price (taken from Goldberg and Campa, 2010); supposition is confirmed if sectors in the group of low shares of distribution costs are also in the group of high ERPT rates, and vice versa; [a/b]H0 of zero/full ERPT rejected at the 95%-level

The cost-adjustment effects denoted by Indirect (CAE) in the second column of Table 19 are overwhelmingly insignificant meaning that exporters do not pass on imported input price changes to foreign consumers. Given full pass-through rates in almost all sectors on the imported input side (see Table 18), these insignificant CAE coefficients imply that an appreciation of the exporter currency (CHF) leads to higher profit margins. This supports the view of imported inputs as a natural means for hedging exchange rate risks.

Table 21 shows the corresponding long-run results and gives additional insights with regard to PTM and cost-adjustment behaviour at the sectoral level. Consistent with the short-run results and in line with Yang (1997), the Machinery & equipment and Precision instruments sectors are able to keep profit margins stable by passing on exchange rate shocks completely to foreign clients. Conversely, the average exporter in the Wood products, Textiles or the Food & beverages sectors engages at least partly in PTM (see column 1, Table 21), thereby stabilizing local prices and absorbing some of the exchange rate movements in the mark-up. Overall, our explanation of the sectoral ERPT heterogeneity based on product competition and distribution margins is, however, less supported in the long-run (see again Table 22 for more details).

The cost-adjustment coefficients CAE in the second column of Table 21 have no statistical significance and/or small magnitudes confirming the corresponding short-run CAE results described above. In sum, the cost-savings accrued on the inputs from the recent CHF appreciation period compensate for the partly squeezed profit margins on the export side.

Tables 22 and 23 report the results of export price regressions in which imported input prices are replaced with an imported input weighted exchange rate for the short- and long-run. This set of regressions is intended to check the robustness of the results concerning the responsiveness of export prices to imported input price adjustments. The CAE results reported in Table 22 and 23 corroborate the general finding about small or non-responsiveness of export and local prices to imported input price changes. The magnitudes of the CAE coefficients are generally higher, but except for three (mostly commodity intensive) sectors in the short- and long-run, the CAE are not statistically significant. It is therefore safe to conclude that in the vast majority of the investigated goods sectors firms do not adjust export prices in response to exchange rate driven changes of production costs. As price

small number of sectors means that the aggregation level is probably too high, and covers the underlying heterogeneity in terms of distribution costs and product differentiation of more disaggregated product groups within a sector. One would thus need more observations for a regression analysis that controls for other confounding factors (see for instance Campa and Goldberg, 2005 and Gaulier et al., 2008). This was, however, not our main research focus and thus beyond the scope of this study.

Table 21: ERPT into export prices (in CHF and in foreign currency units, FCU) - long-run

		In CHF			In FCU	
		Direct (PTM)	Indirect (CAE)	Total (1-TPT)	Direct (DPT)	Total (TPT)
1	Agriculture	0.31	-0.05^{b}	0.26	0.69	0.74
		(0.83)	(0.06)	(0.85)	(0.83)	(0.85)
2	Mining & quarrying	0.99	-0.14$^{a/b}$	0.85	0.01	0.15
		(0.75)	(0.04)	(0.78)	(0.75)	(0.78)
3	Food & beverages	0.35^{b}	-0.02$^{a/b}$	0.33^{b}	0.65^{a}	0.67^{a}
		(0.19)	(0.01)	(0.19)	(0.19)	(0.12)
4	Textiles	0.71^{a}	0.05$^{a/b}$	0.76^{a}	0.29^{b}	0.24^{b}
		(0.23)	(0.01)	(0.23)	(0.23)	(0.23)
5	Wood products	1.40^{a}	0.01^{b}	1.41^{a}	-0.40^{b}	-0.41^{b}
		(0.41)	(0.03)	(0.43)	(0.41)	(0.43)
6	Paper products	0.33	0.04^{b}	0.37	0.67	0.63
		(0.44)	(0.03)	(0.46)	(0.44)	(0.46)
7	Chemicals & pharmaceuticals	0.49	-0.09^{b}	0.40	0.51	0.60
		(0.58)	(0.07)	(0.53)	(0.58)	(0.53)
8	Rubber & plastics products	0.85^{a}	-0.02^{b}	0.83^{a}	0.15^{b}	0.17^{b}
		(0.32)	(0.01)	(0.33)	(0.31)	(0.33)
9	Mineral products	0.55	-0.01^{b}	0.53	0.45	0.47
		(0.37)	(0.03)	(0.39)	(0.37)	(0.39)
10	Iron & steel	0.47	-0.04^{b}	0.43	0.53	0.57
		(0.63)	(0.02)	(0.63)	(0.63)	(0.63)
11	Fabricated metal products	0.55$^{a/b}$	-0.03^{b}	0.52$^{a/b}$	0.45$^{a/b}$	0.49$^{a/b}$
		(0.16)	(0.02)	(0.16)	(0.16)	(0.16)
12	Machinery & equipment	-0.04^{b}	0.01^{b}	-0.02^{b}	1.04^{a}	1.02^{a}
		(0.34)	(0.03)	(0.34)	(0.34)	(0.34)
13	Electrical machinery	0.94^{a}	-0.07^{b}	0.87^{a}	0.06^{b}	0.13^{b}
		(0.38)	(0.05)	(0.35)	(0.38)	(0.35)
14	Communication equipment	0.73	0.01^{b}	0.74	0.27	0.26
		(0.73)	(0.05)	(0.73)	(0.73)	(0.73)
15	Precision instruments	-0.09^{b}	-0.00^{b}	-0.09^{b}	1.09^{a}	1.09^{a}
		(0.29)	(0.02)	(0.30)	(0.29)	(0.30)

Notes: PTM (pricing to market coefficient) $=\sum_{t=0}^{-2}\gamma_{1,t}^{so}$, CAE (cost-adjustment effect) $=\sum_{t=0}^{-2}\gamma_{2,t}^{so}$, 1-TPT $=\sum_{t=0}^{-2}\left(\gamma_{1,t}^{so}+\gamma_{2,t}^{so}\right)$, DPT $=1-\sum_{t=0}^{-2}\gamma_{1,t}^{so}$, TPT (total pass-through coefficient) $=1-\sum_{t=0}^{-2}\left(\gamma_{1,t}^{so}+\gamma_{2,t}^{so}\right)$; $^{a/b}$H0 of zero/one PTM, CAE or pass-through (DPT and TPT) rejected at the 95%-level, respectively; estimated with weighted least squares [weight = import value], robust-clustered standard errors in parentheses [cluster unit = partner country]; phase-source varying fixed effects as well as *hs6* varying fixed effects.

Table 22: ERPT into export prices (in CHF and in foreign currency units, FCU) - short-run (with import weighted exchange rates)

		In CHF			In FCU	
		Direct (PTM)	Indirect (CAE)	Total (1-TPT)	Direct (DPT)	Total (TPT)
1	Agriculture	0.21	0.47	0.69	0.79	0.32
		(1.34)	(1.28)	(0.36)	(1.34)	(0.36)
2	Mining & quarrying	-0.02^{b}	2.78$^{a/b}$	2.76$^{a/b}$	1.02^{a}	-1.76$^{a/b}$
		(0.13)	(0.32)	(0.29)	(0.13)	(0.29)
3	Food & beverages	0.42$^{a/b}$	-0.04^{b}	0.38$^{a/b}$	0.58$^{a/b}$	0.62$^{a/b}$
		(0.14)	(0.15)	(0.13)	(0.14)	(0.13)
4	Textiles	0.75^{a}	-0.65$^{a/b}$	0.10^{b}	0.25^{b}	0.90^{a}
		(0.24)	(0.30)	(0.17)	(0.24)	(0.17)
5	Wood products	0.52	0.94^{a}	1.46$^{a/b}$	0.48	-0.46$^{a/b}$
		(0.29)	(0.37)	(0.22)	(0.29)	(0.22)
6	Paper products	-0.04^{b}	0.11^{b}	0.07^{b}	1.04^{a}	0.93^{a}
		(0.31)	(0.46)	(0.20)	(0.31)	(0.20)
7	Chemicals & pharmaceuticals	0.64^{a}	0.31	0.95	0.36^{b}	0.05
		(0.25)	(0.52)	(0.62)	(0.25)	(0.62)
8	Rubber & plastics products	0.40$^{a/b}$	0.41^{b}	0.81^{a}	0.60$^{a/b}$	0.19^{b}
		(0.19)	(0.24)	(0.11)	(0.19)	(0.11)
9	Mineral products	0.62$^{a/b}$	0.06^{b}	0.69^{a}	0.38$^{a/b}$	0.31^{b}
		(0.17)	(0.25)	(0.24)	(0.18)	(0.24)
10	Iron & steel	-0.54^{b}	1.61^{a}	1.07^{a}	1.54^{a}	-0.07^{b}
		(0.43)	(0.32)	(0.37)	(0.43)	(0.37)
11	Fabricated metal products	0.25^{b}	0.32^{b}	0.57$^{a/b}$	0.75^{a}	0.43$^{a/b}$
		(0.16)	(0.21)	(0.16)	(0.16)	(0.16)
12	Machinery & equipment	0.26^{b}	-0.05^{b}	0.21^{b}	0.74^{a}	0.79^{a}
		(0.24)	(0.34)	(0.28)	(0.24)	(0.28)
13	Electrical machinery	0.51$^{a/b}$	0.60	1.11^{a}	0.49$^{a/b}$	-0.11^{b}
		(0.20)	(0.36)	(0.35)	(0.20)	(0.35)
14	Communication equipment	0.87^{a}	-0.24	0.64	0.13^{b}	0.36
		(0.41)	(0.71)	(0.71)	(0.41)	(0.71)
15	Precision instruments	0.20^{b}	-0.14^{b}	0.06^{b}	0.80^{a}	0.94^{a}
		(0.15)	(0.32)	(0.36)	(0.15)	(0.36)

Notes: PTM (pricing to market coefficient) = $\gamma^{so}_{1,0}$, CAE (cost-adjustment effect) = $\gamma^{so}_{2,0}$, 1-TPT = $\gamma^{so}_{1,0} + \gamma^{so}_{2,0}$, DPT = $1 - \gamma^{so}_{1,0}$, TPT (total pass-through coefficient) = $1 - \left(\gamma^{so}_{1,0} + \gamma^{so}_{2,0}\right)$; $^{a/b}$H0 of zero/one PTM, CAE or pass-through (DPT and TPT) rejected at the 95%-level, respectively; estimated with weighted least squares [weight = import value], robust-clustered standard errors in parentheses [cluster unit = partner country]; phase-source varying fixed effects as well as *hs6* varying fixed effects.

Table 23: ERPT into export prices (in CHF and in foreign currency units, FCU) - long-run (with import weighted exchange rates)

		In CHF			In FCU	
		Direct (PTM)	Indirect (CAE)	Total (1 - TPT)	Direct (DPT)	Total (TPT)
1	Agriculture	-0.47	1.50	1.02	1.47	-0.03
		(1.40)	(1.23)	(0.94)	(1.40)	(0.95)
2	Mining & quarrying	0.05^{b}	$7.70^{a/b}$	$7.75^{a/b}$	0.95^{a}	$-6.75^{a/b}$
		(0.30)	(0.72)	(0.91)	(0.30)	(0.91)
3	Food & beverages	$0.48^{a/b}$	0.08^{b}	0.56	$0.52^{a/b}$	0.45
		(0.12)	(0.33)	(0.33)	(0.12)	(0.32)
4	Textiles	0.78^{a}	-0.38^{b}	0.40	0.22^{b}	0.60
		(0.27)	(0.43)	(0.38)	(0.27)	(0.39)
5	Wood products	0.69	1.25^{a}	$1.94^{a/b}$	0.31	$-0.95^{a/b}$
		(0.36)	(0.44)	(0.31)	(0.36)	(0.31)
6	Paper products	-0.23	0.33	0.11^{b}	1.23	0.89^{a}
		(0.68)	(0.87)	(0.34)	(0.68)	(0.34)
7	Chemicals & pharmaceuticals	0.54	-0.70	-0.15	0.46	1.15
		(0.45)	(1.44)	(1.43)	(0.47)	(1.43)
8	Rubber & plastics products	0.32^{b}	$2.20^{a/b}$	$2.52^{a/b}$	0.68^{a}	$-1.52^{a/b}$
		(0.28)	(0.33)	(0.31)	(0.28)	(0.31)
9	Mineral products	0.63	0.43	1.06^{a}	0.37	-0.06^{b}
		(0.36)	(0.54)	(0.45)	(0.36)	(0.45)
10	Iron & steel	0.51	-1.48^{b}	-0.97^{b}	0.49	1.97^{a}
		(0.60)	(0.62)	(0.88)	(0.61)	(0.88)
11	Fabricated metal products	0.32^{b}	1.18^{a}	1.50^{a}	0.68^{a}	-0.50^{b}
		(0.18)	(0.32)	(0.30)	(0.18)	(0.30)
12	Machinery & equipment	0.02^{b}	-0.46	-0.44^{b}	0.98^{a}	1.44^{a}
		(0.38)	(0.73)	(0.66)	(0.38)	(0.66)
13	Electrical machinery	0.72	1.37	2.10^{a}	0.28	-1.10^{b}
		(0.43)	(0.87)	(0.95)	(0.43)	(0.95)
14	Communication equipment	0.96	-0.75	0.21	0.04	0.79
		(0.64)	(1.24)	(1.54)	(0.64)	(1.54)
15	Precision instruments	0.06^{b}	-0.85^{b}	-0.79^{b}	0.94^{a}	1.79^{a}
		(0.19)	(0.84)	(0.84)	(0.19)	(0.84)

Notes: PTM (pricing to market coefficient) $=\sum_{t=0}^{-2}\gamma_{1,t}^{so}$, CAE (cost-adjustment effect) $=\sum_{t=0}^{-2}\gamma_{2,t}^{so}$, 1-TPT $=\sum_{t=0}^{-2}\left(\gamma_{1,t}^{so}+\gamma_{2,t}^{so}\right)$, DPT $=1-\sum_{t=0}^{-2}\gamma_{1,t}^{so}$, TPT (total pass-through coefficient) $=1-\sum_{t=0}^{-2}\left(\gamma_{1,t}^{so}+\gamma_{2,t}^{so}\right)$; $^{a/b}$H0 of zero/one PTM, CAE or pass-through (DPT and TPT) rejected at the 95%-level, respectively; estimated with weighted least squares [weight = import value], robust-clustered standard errors in parentheses [cluster unit = partner country]; phase-source varying fixed effects as well as *hs6* varying fixed effects.

adjustments are costly and a large bulk of the production costs is likely to be incurred in CHF (including compensation of employees, see Table 15), Swiss exporters optimally choose to absorb changes of the imported input prices in their mark-ups. Put differently, looking at direct (DPT) and total (TPT) pass-through coefficients in Table 19 and 21, we recognize that imported input price changes are not passed on to foreign consumers and do hence not significantly change ERPT behaviour. This finding differs with the results of Athukorala and Menon (1994) and Berman et al. (2012) which report diminished ERPT coefficients when imported inputs are considered. As a consequence, their results imply that "natural hedging" of exchange rate risks is less pronounced.

As with the import estimations, we also tested whether pricing behaviour on the export side differed during the "strong Franc" period and again found no convincing support for this hypothesis. Thus, our results also hold for the period of the recent CHF appreciation.

4.7 Conclusions

This study uses highly disaggregated trade data for Switzerland over 2004-2011 to examine at length whether Swiss exporters systematically respond to exchange rate changes by adjusting their prices. Given the high share of imported intermediates in total intermediate inputs in Swiss manufacturing, of underlying significance is the impact of exchange rate changes on the prices of these imported inputs. This could be due to the possibility that the latter may serve as a "natural" channel by which exporters can maintain their competitive advantage despite an appreciation of the CHF.

Our empirical results, that are impervious to various robustness checks, firstly indicate high ERPT into imported input prices in all sectors. However, contrary to assumptions made in the recent empirical literature, we do not find evidence of full pass-through for all sectors either in the short- or long-run, though we are able to reject zero ERPT in a majority of sectors. The high magnitudes of pass-through coefficients into imported input prices are in line with related literature, but depart from Stulz (2007) and SECO (2011) who study ERPT into import prices more generally (not only intermediate imports). This difference could be due to low input demand elasticities with respect to local prices and/or a low share of distribution costs for inputs.

On the export side, our results indicate strong sectoral ERPT heterogeneity in both the short- and long-run. It is shown that differentiated and customized products such as Machinery & equipment or Rubber & plastics products generally have higher ERPT rates. This is consistent with Yang's (1997) argument that sectors with differentiated goods should attain higher ERPT rates. Our results also hold remarkably well with recent ERPT explanations based on distribution costs by Corsetti and Dedola (2005). Sectors with high distribution costs shares (incurred in the local currency) such as Mineral products and Textiles, tend to have low ERPT rates and to engage more in local currency pricing (LCP).

Moreover, the cost-adjustment effects are found to be overwhelmingly insignificant implying that exporters do not pass on imported input price changes to foreign consumers. Thus, an appreciation of the CHF leads to higher profit margins through the import channel and imported inputs act as a natural means for hedging exchange rate risks.

e The appreciation of the CHF began in 2009 and progressed steadily until the middle of 2010 after which it accelerated in response to the ensuing euro crisis. In the last year the Swiss National Bank (SNB) has intervened to assuage Swiss exporters of the adverse effects of this appreciation. However, our final empirical result suggests that the pricing

strategies of Swiss exporters may not have changed in response to the strong CHF in wake of the euro crisis. Significantly, a similar result at the extensive margin would strongly question the SNB's intervention during this period.

Future research could elaborate on some limitations of our study. Firstly, we proxied export and import prices by unit values. Compared to most earlier studies, unit values in our study more accurately reflect prices as products are highly disaggregated (8-digit level) and separate unit values are calculated for each trading partner. Nevertheless, measurement error and aggregation issues may be a problem. Secondly, our matching of imported input prices faced by each exporting industry is done with relatively aggregated I-O table data. This may be a constraint in identifying the cost-adjustment effect on the export side. Future studies may improve on both of these caveats using firm-level panel data, which would ideally include export revenues and prices of firms as well as the share and price of their imported inputs. Thirdly, while we could not identify changes in the pricing strategy during the recent strong CHF period, such adjustment may be observed over a longer time period. Therefore, one can reach a deeper understanding of the recent challenges of Swiss exporters once data on a strong CHF become available over a longer time period. Fourthly, we did not directly investigate whether our results of the most recent period are partly driven by extensive margin adjustments - firms that exit the export market or products that are no longer exported. If this is the case, central bank intervention may be appropriate and necessary to avoid irreversible structural damage of the exporting industry as emphasised by hysteresis theories (see for instance Baldwin and Krugman, 1989). Future research could therefore work along the analysis of the extensive margin. Finally, it would be useful to extend this analysis to an enlarged country sample. To the extent that these results hold across countries and at the extensive margin, they would also have significant implications for monetary policy and for the policy debate on the impact of misaligned exchange rates on trade imbalances.

4.8 Appendix

4.8.1 Preliminary diagnostics - unit root tests

Although our theoretical framework leads us to an estimation in first-differences, we reconfirm this approach from an econometric point of view in this appendix section. Our panel data has a significant time series component, which raises the risk of spurious regression when estimating a model in levels. We thus tested our panel series for unit roots/non-stationarity. This is done for consistency with other studies in this field, which are often modelled in levels and therefore had to perform such tests. In general, other ERPT studies find non-stationary series and thus also estimate in first differences.

Recent studies by O'Connell (1998) and Breitung and Das (2005) have highlighted that in the presence of contemporaneous correlation standard panel unit root tests, like those proposed by Maddala and Wu (1999), Levin et al. (2002) and Im et al. (2003), suffer from severe oversize problem. Our panel unit root tests, therefore, needed to be preceded by tests for cross-sectional dependence. We performed these tests for each HS-6 digit product line separately for both the import and the export side. Using the Modified Lagrange Multiplier test for cross-sectional dependence in Pesaran (2004), we found that the null of cross-sectional independence was non-surprisingly rejected in all cases of the nominal exchange rate (NER) series but in only 27 percent of the tests in the case of the import price series. On the export side, we found the null of cross-sectional independence to be decisively rejected in 99 percent of these tests in the case of NER and in 39 percent of the tests in the case of export prices. Our results thus provided evidence of cross-sectional dependence in our data on NER and to a limited extent on import and export prices.

If cross-sectional dependence is weak, literature suggests using robust panel unit root tests such as the one proposed by Im et al. (2003) or Breitung and Das (2005) depending on the data and sample size. However, if cross-sectional dependence is strong, estimation would require either decomposing the time series into common and idiosyncratic factors and testing them separately for the presence of unit roots (e.g. Bai and Ng, 2004) or using cross-sectional demeaned tests such as the IPS test (CIPS) suggested by Pesaran (2007). Unfortunately, though, there seems to be no consensus in the literature on the definition of weak or strong dependence (Sarafidis and Wansbeek, 2010).

In view of the above, the first method used to test for unit roots was the Im et al. (2003) panel unit root test. Once again, we performed these tests at the HS-6 digit level for both

the import and export side. We found that the null of "all panels contain unit roots" was rejected in only 3 percent of the tests for the NER data but in 97 percent of the tests for import prices. On the export side, the null was rejected in only 5 percent of the cases for the NER data but in 95 percent of the tests for export prices. This first set of tests points to our NER data being a random walk and suggests that our import and export prices may be stationary.

Under the assumption of strong cross-sectional dependence, we next used the cross-sectional demeaned version of the IPS test (CIPS) suggested by Pesaran (2007) which accounts for the dynamics in the common factor by using cross-sectional averages and their lagged values (without having to estimate the common factor first). The results from the CIPS corroborated those from Im et al. (2003). The null of unit root was rejected in only 1 percent of the tests for NER; on the export side, the null of unit root was rejected in all of cases for NER but in 72 percent for export prices.

However, it is probably more appropriate to consider long-run data to adjust for seasonal variations. Including four lags for each panel series while performing the CIPS test, we found the the null of unit root was never rejected for NER on both the import and export side and rejected in only 1 percent and 2 percent of the tests for imported input prices and export prices, respectively. Thus, all our panel series seem to be non-stationary when adjusting for seasonalities.

Having performed various unit root tests, we could not rule out non-stationarity in our data; therefore, even from an econometric point of view, we were on the safe side to estimate our empirical models in first-differences.

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