US Safeguards on Steel and the Markups of European Producers

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Abstract: This paper is among the first to explore the microeconomic impacts of a trade policy on foreign firms. We empirically investigate the effects of the US safeguard protection of steel imports in 2002 on the markups of EU steel firms. Using a large panel of affected EU steel firms between 1995 and 2005, we find that the protection they faced abroad significantly reduced their markups. Our results indicate smaller adverse effects on multi-product EU firms. Our study has wider implications as it quantifies the cost that trade protection imposes on trading partners, an externality currently not considered in any trade regulation. The US safeguard protection also resulted in some diversion of EU steel especially towards China, aggravating the situation on the Chinese steel market and ultimately resulting in the Chinese trade protection of steel imports. JEL no. F13, L13, L61
Keywords: Firm data; price-cost margins; safeguard measures; steel industry; trade diversion

1 Introduction

In March 2002, the US president imposed safeguard tariffs to protect the US steel industry from an alleged influx of steel imports. The European Union (EU) opposed this protection, since it feared that world steel exports would divert from the United States (US) to the EU. Consequently the European Commission (EC) filed a complaint to the World Trade Or-

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ganization (WTO), putting forward the potential adverse effects of the US safeguard protection for the EU steel industry.[1] The protection was ended in December 2003, because it was ultimately declared inconsistent with the WTO law due to a lack of evidence of an absolute increase in imports, which is a necessary condition for the legal imposition of safeguards.[2]

The primary interest of this paper is to estimate the impact of the US safeguard protection on the markups of European steel firms. Currently none of the existing trade regulations pays any attention to the potentially adverse externalities on trade partners. Our evidence shows that the US safeguard protection adversely affected the EU steel industry. To guide our empirical work, we use a modification of the existing reciprocal dumping model by Brander and Krugman (1983). A model like this clearly predicts a drop in the EU markups resulting from the US safeguard protection.

We mainly focus on the EU price markups over marginal costs as a measure of firm level performance and estimate them with the Roeger (1995) methodology. The main advantage of this method is that it does not suffer from endogeneity issues when estimating markups, as shown by Roeger and Warzynski (2004) and Konings and Vandenbussche (2005). Our empirical analysis confirms the theoretical predictions. We find a negative effect of the US safeguards on the markups of European steel producers. A further decomposition of the markup change shows that the decline in EU markups is strongly associated with the EU exports to the US rather than with other trade flows, which suggests that the EU steel firms were affected directly by the US safeguard tariffs. We also find that the EU market was to some extent exposed to diversion of trade flows previously shipped to the US. Resulting from that, we observe heterogeneity in markups' changes among EU steel firms with single-product firms suffering more than multi-product firms. This seems to suggest that multi-product firms are better equipped to deal with adverse market reactions. Controlling for unobserved

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[1] In 2002, the EC estimated diversion could be as much as 15 million tons per year or 56 per cent of current import level (EC 2006); producing 193 million tons of crude steel, the EU accounts for 18 per cent of the world production. At that time, China was the largest producer with 272 million tons (26 per cent of world production), followed by Japan with 113 million tons and the US with 99 million tons. While the EU total imports have risen by 18 per cent through 1998–2002, US imports of steel have fallen by 33 per cent in the same period (EC 2002).

[2] Certain prerequisites are required for the imposition of safeguard measures: first, the injury determination, and second, the determination of a surge in imports either absolutely, relatively to the market or its consumption, unanticipated, or non-attributed, if low industry performance is associated with the economic downturns.

firm heterogeneity with fixed effects, our results are robust to alternative specifications and are not driven by an EU industry effect common to manufacturing firms.

This paper contributes to the literature on trade protection and firm-related aspects. Feenstra (1995) and Gawande and Krishna (2003) are among the few to document the impact of trade remedy measures on the performance of domestic firms. Hansen and Prusa (1995) find that the US safeguard measures across different sectors from 1980 to 1988 decreased trade volumes by an average of 34 per cent.[3] Konings and Vandenbussche (2005) more recently find that trade protection restricts imports and raises markups of domestically protected firms. In contrast to this literature, our paper is the first to document the effects of one country's administered protection on the markups of firms in another country.

A few economic studies on the US safeguard protection have been recently conducted from the perspective of the US steel industry. Liebman (2006) investigates the effect of the US safeguard protection on steel imports on the price of steel in the US. His results suggest that the US steel price was largely unchanged during the protection. This would imply that the EU steel exporters to the US partially absorbed the US safeguard tariffs by suppressing their own markups. Liebman's findings further suggest that China's increasing demand for steel played an important role in the market conditions of the US steel industry. In this paper we find some evidence that the US safeguard protection resulted in some rerouting of European steel notably towards China. Bown and Crowley (2006) consider the impact of one country's use of trade policy on a foreign country's exports to third markets. They find that US trade protection against Japan not only significantly depressed Japanese exports to the US but also deflected their exports to third countries.

The remainder of our paper is organized as follows. Section 2 provides an overview of the situation in the EU steel market and provides a description of the steel industry. Section 3 presents a simple theoretical framework to guide the empirical analysis. Section 4 discusses earlier literature on estimating firm markups and develops an empirical model based on the Roeger (1995)

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[3] Both antidumping (AD) and safeguard measures (SG) may result in ad valorem tariffs, expressed as a percentage of cif import price. However, AD and countervailing (CVD) measures are distinguishable from SG measures in their attempt to remedy injury caused by dumping or actionable subsidies. While "red and yellow" subsidies, such as export subsidies, can be countervailed, the "green-light" subsidies, such as construction subsidies, cannot be countervailed.

approach. Section 5 concludes with a brief summary of our empirical results and their implications.

2 The Situation in the EU Market for Steel

2.1 The US Safeguard Measures

We start by taking a closer look at the statistics on EU steel firms and trade flows involved.[4] The US president imposed the safeguard protection (under the GATT Article XIX) on steel imports in March 2002, following the recommendation of the US International Trade Commission's (ITC) investigation that established serious injury to the US steel industry.[5] The US steel industry obtained an import relief through safeguard tariffs as described in Table 1.

In the first column of Table 1 we report the ten steel categories covered by the safeguards along the entire vertical chain of products, starting with the more upstream products like slabs and flat steel listed at the top of the column and processed steel such as stainless steel wire at the bottom, with their corresponding Harmonized Tariff Schedule (HTS) codes in column 2. The third column gives the safeguard tariffs imposed during the protection years 2002–2003 with the more upstream products receiving the highest tariffs of 30 per cent in 2002 while the most downstream product category received 8 per cent in that same year. Tariffs were somewhat lower in 2003 ranging from 24 to 7 per cent. We also list the US import market share of the steel products from the rest of the world (RoW) and from the EU-15. In total, the safeguard protection covered about 75 per cent of the world's steel

[4] Appendix A describes the information collected from the White House Press on the US Steel Products Proclamation, the company accounts data from Amadeus (Bureau van Dijk 2006), the trade and tariff data from the US ITC (2006), from which these statistics are taken for the period 1995–2005. We use additional information on the EU steel industry based upon the documents and annual reports of European Confederation of Iron and Steel Industries (EUROFER 2007; http://www.eurofer.org/).

[5] The ITC investigation of serious injury leads to a recommendation to the President which he can reject or accept to varying degrees. This is a higher standard than the material injury condition under the antidumping (AD) legislation approved by the Department of Commerce. Firms will consider filing for safeguard protection only if the expected value of protection is high (Hartigan 2005). Earlier literature suggests that the strictness of injury criteria (Baldwin 1988) or the retaliation threat (Blonigen and Bown 2003) also condition the decision of which measure to impose. Unlike antidumping protection, safeguard protection is not based upon the selectivity principles; it covers a large scope of products or industries and is rarely extended.

Table 1: *Protected Steel Products, Tariff Levels, and the US Import Market Shares (per cent)*

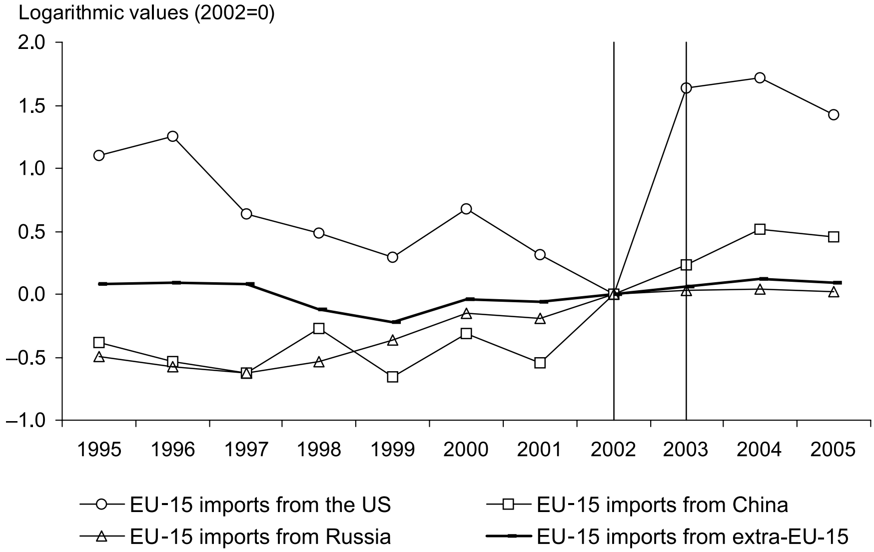
Product group	HTS[a]	US tariff		US market share[b]		ΔUS imports[c]	
		2002	2003	2002–2003		2002–2003	
				RoW[d]	EU-15	RoW[d]	EU-15
Total[e]	9903.72.30-73.96	—	—	59.2	16.0	−26.7	−38.4
Slabs[f]	9903.72.30-48	TRQ	TRQ	21.6	0.9	7.9	−70.8
Flat steel	9903.72.50-73.14	30	24	22.2	8.9	−47.8	−42.8
Tin mill products	9903.73.15-27	30	24	0.5	1.1	−62.5	−13.2
Hot-rolled bars & rods	9903.73.28-38	30	24	2.4	2.6	−26.9	14.5
Cold-finished bars & rods	9903.73.39-44	30	24	0.3	0.5	−26.9	−37.0
Reinforcing bars	9903.73.45-50	15	12	5.0	0.4	−20.5	−32.1
Stainless steel bars & rods	9903.73.74-89	15	12	0.4	0.4	−22.7	−24.1
Welded tubular products	9903.73.51-62	15	12	6.1	1.0	−0.1	−28.0
Fittings & flanges	9903.73.66-72	13	10	0.6	0.2	7.2	−5.2
Stainless steel wire	9903.73.91-96	8	7	0.2	0.1	20.8	−19.5

Note: [a] HTS stands for the classification under the Harmonized Tariff Schedule of the US. — [b] The share of the US imports of steel products, covered by the US protection, in the total US imports of steel products during the US safeguard protection. — [c] The change in the US imports during the US safeguard protection with respect to the period 1995–2005. — [d] The US imports from the rest of the world (RoW), excluding the NAFTA countries and the EU-15 for better comparability with the US imports from the EU-15. — [e] All steel products covered by the US safeguard protection. — [f] Tariff rate quota (TRQ) imposed on imports of slabs was 5.4 million tons in 2002, 5.9 million tons in 2003. A tariff of 30 and 24 per cent in 2002 and 2003, respectively, were imposed after quota volume.

exports to the US. Over 16 per cent of the protected steel imports originated from the EU. The bulk of the EU steel exports consists of upstream flat steel which is relatively unprocessed but amongst the steel categories most heavily taxed. Finally, the last column in Table 1 shows the change in import share in the US from the rest of the world and the EU during protection compared to the average market share over our sample period 1995–2005. This last column documents the loss of the EU market share in the US by as much as 38 per cent during the US protection.

The EU steel industry largely opposed the US safeguards. Steel is an important industry for the EU as it employs around 350 thousand EU citizens, generates more than €100 billion in annual turnover and accounts for one fifth of the world's crude steel production (EUROFER 2007). Consequently, the EC filed a complaint to the WTO, putting forward the argument that additional protection of the US steel market would result in diversion of steel from the rest of the world to the EU. Some trade statistics may give us an idea as to whether this complaint was substantiated. Let's first look

Figure 1: *Evolution of the EU Imports of Steel Products in 1995–2005 Relative to 2002*



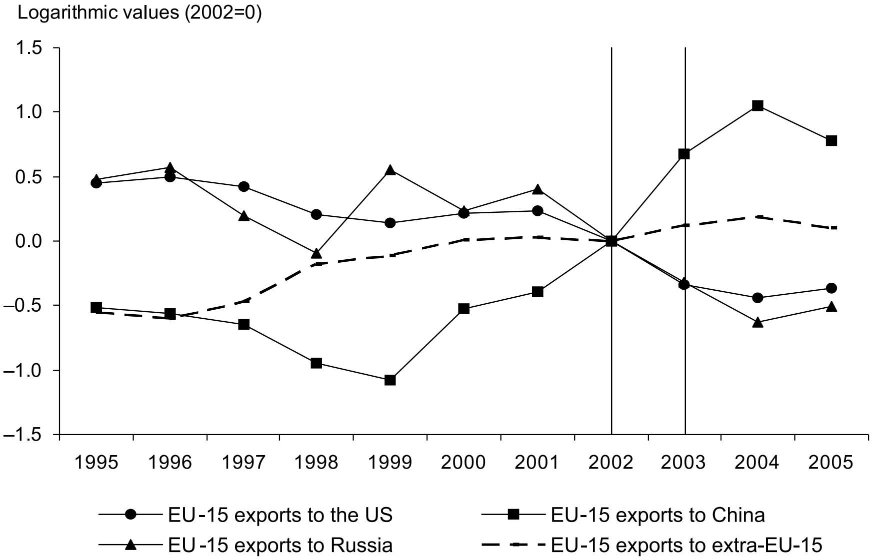
Note: Vertical lines indicate the duration of the US protection, initiated in March 2002 and terminated in December 2003. Imports and exports are measured in logarithms and expressed with respect to the initial year of the US protection. The selection of countries is based upon the EU trade statistics (Eurostat 2006). The largest steel exporting countries during the protection were the EU-15 (31.8 mt), Russia (30.4 mt), and China (20.0 mt).

at the EU imports and exports of steel in Figures 1 and 2. Figure 1 depicts EU steel imports. We see that after 2002 an increase in EU steel imports can be observed in general but notably from the US and China. Figure 2 shows EU exports on steel. It depicts a decline in EU exports to the US but an almost simultaneous increase of EU exports to China. The latter reflects the surging demand for steel in China, which may have rerouted some of the EU steel from the US to China during the US safeguard protection. Figures 1 and 2 seem to suggest that indeed the EU market for steel was exposed to diversion of trade flows from the US.

2.2 The EU Steel Industry

In the years before the safeguard, the EU steel industry underwent a complete restructuring. Around that time, it was estimated that the EU steel industry was about 30 per cent more cost-efficient than the US steel indus-

Figure 2: *Evolution of the EU Exports of Steel Products in 1995–2005 Relative to 2002*



Note: Vertical lines indicate the duration of the US protection, initiated in March 2002 and terminated in December 2003. Imports and exports are measured in logarithms and expressed with respect to the initial year of the US protection. The selection of countries is based upon the EU trade statistics (Eurostat 2006). The largest steel importing countries during the protection were China (33.2 mt), the US (32.8 mt), and the EU-15 (30.4 mt).

try.[6] This had been achieved through an intensive use of new technologies, including the efficient production of crude steel through the electric arc furnace (EAF) route. Traditionally, crude steel used to be produced solely by vertically integrated producers from iron ore and coking coal via the blast-oxygen furnace route (BOF), but gradually more and more EU steel is produced through the EAF route not only by large integrated producers but also smaller mini-mills.[7] The BOF route is capital-intensive and

[6] See Durling and Prusa (2003) for an excellent description of the US steel industry.

[7] Rather than making raw steel in form of semi-finished products and slabs electricity is used in electric arc furnace to melt scrap steel and virgin metals. This leads to a reduction in costs, because the recycled products are used for production of downstream steel products. Upstrem products like slabs, flat steel and tin-mill products used to be produced solely through the capital-intensive BOF route, but the EU steel industry restructured toward more efficient way of producing them through the EAF route (EUROFER 2007). See also Durling and Prusa (2003) on discussion of the US production of steel.

dependant on the supply of raw materials (i.e. iron ore and coking coal), while the EAF route requires recycling of scrap steel, which is intrinsically profitable due to energy savings and efficient use of materials. The availability of these new technologies led to a significant reduction in start-up costs which resulted in a large number of small and medium-sized steel firms and relatively fewer large integrated producers. The EU steel sector remains much less concentrated than its major suppliers or client industries, therefore it is less likely that the effect of the US safeguard tariff was passed on the secondary downstream users of steel.[8] According to the European Steel Association, EUROFER (2007), top ten producers worldwide represent about 30 per cent in the steel industry and much more in the iron ore mining (95 per cent) and aluminum (70 per cent) sectors or automotive (95 per cent) and domestic appliances (80 per cent) sectors.

2.3 The EU Firm-Level Data

We identify a representative sample of 2,263 EU steel firms directly affected by the US safeguard protection, using the EU company-accounts database Amadeus.[9] This data set does not distinguish between integrated producers and mini-mills, but it allows identification of more and less diversified firms, which we respectively define as multi- and single-product firms.[10] In Table 2, we provide descriptive statistics on these firms over the sample period 1995–2005 by presenting the main indicators of the firm's size in terms of sales and employment, performance in terms of return on total assets and Lerner index, and measured labour productivity in terms of value added per employee.

Table 2 shows that our data set consists mostly of single-product firms and about one quarter of multi-product firms. Multi-product firms are

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8 Upstrem crude steel mainly involves slabs, flat steel and tin-mill products, while primary downstream products include hot- and cold-rolled bars and rods, tubes, stainless steel bars, and wires. Secondary downstream products relate to fabricated steel used mainly in construction, transport, machinery & equipment, appliances, and street furniture manufacturing industries.

9 The data set and identification of firms are discussed in greater detail in Appendix A.

10 The US safeguard tariffs hit hardest not only the steel produced at the top of production chain, namely slabs, flat steel and tin-mill products, but also primary downstream products, in particular hot- and cold-rolled bars and rods (see Table 1). Since these products constitute the bulk of the EU steel exports to the US, we expect the effect of US safeguards to vary across different types of EU steel producers.

Table 2: *Summary Statistics*

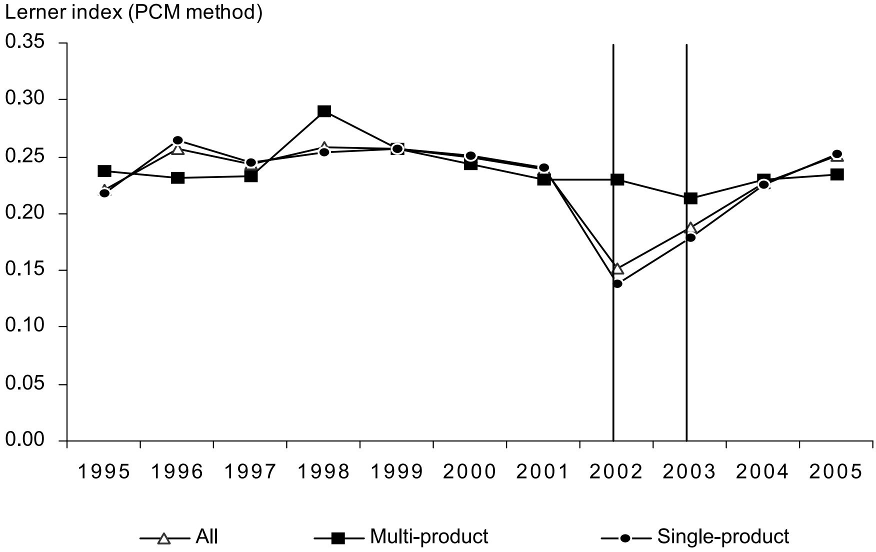
Affected EU steel producers	Total	Obs.	Sales[a]	L[b]	K/L[c]	VA/L[d]	Lerner[e]	ROA[f]
All firms	2,263	13,399	33,900 (1,511)	129 (6.410)	58.026 (1.673)	55.001 (1.006)	0.224 (0.023)	4.684 (0.099)
Single-product firms	1,846	10,827	31,107 (1,522)	118 (6.253)	58.882 (1.796)	55.288 (1.168)	0.221 (0.029)	4.649 (0.112)
Multi-product firms	417 (100%)	2,572	45,655 (4,568)	180 (20.600)	54.363 (4.350)	53.752 (1.768)	0.239 (0.003)	4.832 (0.213)
Basic and fabricated metals (NACE 27 & 28)	280 (67%)	1,805	43,794 (5,600)	164 (23.036)	53.938 (4.525)	53.738 (1.913)	0.235 (0.003)	4.926 (0.248)
All manufacturing (NACE 15–36)	319 (76%)	2,068	41,473 (4,934)	153 (20.233)	50.358 (3.984)	52.353 (1.713)	0.234 (0.003)	5.046 (0.230)
Non-manufacturing (All but NACE 15–36)	98 (24%)	504	62,815 (11,535)	293 (65.309)	71.255 (15.247)	59.632 (5.725)	0.259 (0.008)	3.954 (0.534)

Note: The first two columns refer to the number of firms and observations respectively. Other columns report mean values of variables with standard errors in brackets.
[a] Sales are expressed in thousands of Euros in real terms. — [b] The number of employees. — [c] Total fixed assets over the number of employees. — [d] Value added per employee. — [e] The Lerner index is calculated by the PCM method (Tybout 2003) as the value added over sales. — [f] ROA denotes returns on total assets.

on average larger than single-product firms in terms of sales and employment. In terms of performance we do not observe large differences between single- and multi-product firms as the latter perform only slightly better in terms of higher returns on assets at very similar levels of capital intensity and measured labour productivity. This is likely due to the restructuring the industry went through as discussed above, which led to a substantial reduction of capital through the EAF route with the use of recycled scrap steel by large integrated firms and smaller mini-mills. Referring to classification of steel categories in Table 1, we see that multi-product firms are active in both upstream and downstream steel categories. But about one third of single-product firms exclusively produce upstream steel categories, such as flat steel and tin-mill products. In particular, Table 2 shows that the multi-product firms are not only active in basic and fabricated steel manufacturing, but also in other manufacturing (9 per cent) and non-manufacturing (24 per cent) sectors, i.e. construction, financial, marketing and retail sectors. These diversified firms are among the largest, the most capital intensive and have the largest market power, as proxied by the Lerner index.

We plot the Lerner index over time in Figure 3 and distinguish between single- and multi-product firms. This figure indicates a drop in the Lerner

Figure 3: *The Lerner Index for the EU Steel Firms during 1995–2005*



Note: Figure 3 plots the annual mean values of the Lerner index calculated by the price-cost margin method (PCM) discussed in Tybout (2003). The observed firm-level Lerner index is defined as sales net of expenditures on labour and materials over sales. Vertical lines indicate the duration of the US protection, initiated in March 2002 and terminated in December 2003.

index for all EU steel firms during the US protection starting from 2002.[11] The decline is most pronounced for the single-product firms, which constitute the majority of our sample. Figure 3 is already suggestive that the single-product firms may have suffered relatively more than multi-product firms from the US safeguard protection.

The descriptive statistics above motivate our analysis by implying downward pressure of the US protection on the markups of European steel producers due to increased world exports to the EU and decreased EU exports to the US, which can be observed in Figures 1 and 2. In what follows we will look more formally for causality between the US safeguard protection in the steel sector and the drop in the EU markups.

[11] Figure 3 reports the annual mean values of the Lerner index calculated by the price-cost margin method (PCM) discussed in Tybout (2003). The observed firm-level Lerner index is defined as sales net of expenditures on labour and materials over sales.

3 Theoretical Framework

We use a modification of the existing reciprocal dumping model by Brander (1981) and Brander and Krugman (1983) to guide our empirical work and formulate our hypotheses. We consider the two countries in the model to be the EU and the US and introduce a safeguard tariff imposed by the US government on each unit of the EU shipments to the US, denoted by τ.

We consider an EU and a US firm which produce the same steel product at the unit variable cost c.[12] Both firms are located in their home countries, the EU and the US, respectively. Imperfect competition generates trade in this product. While competing in a Cournot fashion in shipments of the steel product, the firms face iceberg transport costs, so that the marginal cost of exports is c/g, where $0 \leq g \leq 1$. It is essential that the EU and US markets are segmented, so firms set prices independently in each market. The solution of the best reply functions of each firm is the trade equilibrium. Consider that the EU firm's market share in the US market is defined by $\sigma^* = x^*/Q^*$ and the US firm's market share in the EU market is defined by $\sigma = y/Q$, where Q and Q^* denote the total outputs at the output prices P in the EU and P^* in the US. Define the price elasticity of demand as $\varepsilon = -(P/Q)(\partial Q/\partial P)$ and similarly for the US denoted by an asterisk. Consider now US safeguard tariff on EU imports. It can be shown that with the US safeguard tariff in place, the market share of the US firm in the EU will exceed the market share of the EU firm in the US, i.e. $\sigma^* < \sigma$.[13]

The model suggests two channels through which the markup of the EU firm is affected by the US safeguard tariff. We consider a vector of EU markups, $\tilde{\mu}$, that consists of the markup associated with the EU market, $\mu = P/c$, and the markup associated with the EU exports to the US, $\mu^* = P^*/(c/g + \tau)$. Let us define the equilibrium import penetration ratio as the share of the EU imports over the total EU output, denoted by $m = y/(x + y)$. Hence, we can express the markup of the EU

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[12] The product is considered homogeneous in line with the "like product" rule. In accordance with this rule, the WTO makes decisions on the basis of appearance, use, and process of production. The first two considerations are emphasized by the WTO, meaning that if products look the same and are used in the same way, then they are considered to be homogeneous.

[13] See Appendix B for a more detailed description of the theoretical model.

firm as:

$$\tilde{\mu} = \begin{bmatrix} \mu \\ \mu^* \end{bmatrix} = \begin{bmatrix} \left(1 - \frac{1-m}{\varepsilon}\right)^{-1} \\ \left(1 - \frac{\sigma^*}{\varepsilon^*}\right)^{-1} \end{bmatrix}. \tag{1}$$

The EU firm has a lower markup on its exports due to the trade costs c/g and τ. Equation (1) leads to the following proposition.

PROPOSITION: *The introduction of US safeguard tariff into the reciprocal dumping model affects the EU markup negatively, moreover, the markup of the EU firm:*

1. decreases with the level of the US safeguard tariff, and
2. decreases with the US import penetration to the EU.

PROOF:

1. $$\frac{\partial \mu^*}{\partial \tau} = -\frac{g^2}{c(1+g+g\tau/c)^2\left(1 - \frac{g}{1+g+g\tau/c}\right)^2} < 0, \text{ given } c \wedge \tau > 0,$$

where $0 \leq g \leq 1$;

2. $$\frac{\partial \mu}{\partial m} = -\frac{m\varepsilon}{(m+\varepsilon-1)^2} < 0, \text{ given } \varepsilon \wedge m > 0.$$

Now that the model has shown that the markup of an EU firm is negatively affected by the level of the US safeguard tariff and the US import penetration, we take these results to the data. Using a large panel of European steel producers, we expect both the import penetration and the US safeguard tariff to have a negative effect on the markups of EU firms.[14]

4 Empirical Analysis

4.1 The Model

We use the Roeger (1995) methodology to estimate whether the US safeguard protection had a negative impact on the markups of European steel

[14] Empirical literature provides support that markups fall with import competition, since foreign competition increases the price elasticity of demand that domestic firms face. For a more detailed survey of this literature, see Feenstra (1995) and Tybout (2003).

producers. The advantage of this approach is that it can be used to directly measure the markups of firms, as shown by Roeger and Warzynski (2004) and Konings and Vandenbussche (2005).

Roeger (1995) similar to Hall (1988) decomposes the Solow residual (Solow 1957) into a markup component and a pure technology component. The Hall approach is less suited for our analysis, because it requires instruments that control for the simultaneity bias coming from the firm's adjustment of factor demands in response to productivity shocks.[15] Roeger (1995) and Olley and Pakes (1996) suggest models that go beyond the Hall approach. Olley and Pakes (1996) circumvent the selection and simultaneity biases by developing a semi-parametric estimator for the production function parameters within the behavioural framework. Because their approach requires longer time spans and can be applied only to firms with positive capital investments, it is less appropriate for our case.

Roeger (1995) argues that the dual Solow residual, consisting of output and production factor prices, nests the same productivity term that will cancel out if the dual Solow residual is deducted from the primal Solow residual (Martins et al. 1996; Konings and Vandenbussche 2005). Hence, the markup is included in the measurement of the total factor productivity growth that is the output growth not accounted for by the growth in inputs.

Similar to Hall (1988) and Konings and Vandenbussche (2005), we consider a log-linear homogeneous production function G(K_{it},L_{it},M_{it}) for the output Q_{it}, where K_{it}, L_{it}, and M_{it} are capital, labour and material inputs of a firm i at time t. Using the Solow residual (SR_{it}), Hall (1988) measures the productivity growth as the output growth net of weighted growth of the production factors:

$$SR_{it} = \Delta q_{it} - (1 - \alpha_{Lit} - \alpha_{Mit})\Delta k_{it} - \alpha_{Lit}\Delta l_{it} - \alpha_{Mit}\Delta m_{it}\,, \quad (2)$$

where small letters refer to the logarithms and the shares of labour and material costs in total sales ($P_{it}Q_{it}$) of a firm i at time t are denoted by $\alpha_{Lit} = F_{Lit}L_{it}/P_{it}Q_{it}$ and $\alpha_{Mit} = F_{Mit}M_{it}/P_{it}Q_{it}$ with F and P representing input and output prices respectively. A decomposition of the markup and technology component is a crucial step in the Roeger approach and (2) can be expressed in the following form:

$$SR_{it} = \lambda_{it}(\Delta q_{it} - \Delta k_{it}) + (\xi_{it} - \lambda_{it})\Delta e_{it}\,, \quad (3)$$

15 It is hard to find plausible instruments that control for pure demand shocks and they may be correlated with factor stock growth but not with transitory productivity growth, causing spurious correlation with the trade regime as found out by Abbott et al. (1989).

where Δe_{it} is a change in productivity efficiency, $\lambda_{it} = (P_{it} - c_{it})/P_{it}$ is the Lerner index and ξ_{it} is the sum of input cost shares in production function of a firm i at time t.[16] The right-hand side is decomposed in the markup and the pure technology component.[17] The price-based or the dual Solow residual (SRP_{it}) is then defined from the relationship between the marginal cost and the output price and can be expressed in the following form:

$$SRP_{it} = (1 - \lambda_{it})\Delta e_{it} - \lambda_{it}(\Delta p_{it} - \Delta F_{Kit}), \tag{4}$$

where F_{Kit} denotes the price of capital employed in the production function. The innovation of Roeger (1995) comes from using the dual Solow residual (SRP_{it}) to substitute for a change in productivity efficiency of a firm i at time t denoted by Δe_{it} in (3). Subtracting the dual Solow residual from the primal Solow residual yields the following expression:

$$(\Delta q_{it} + \Delta p_{it}) - (\Delta k_{it} + \Delta F_{Kit}) = \mu_{it}(\phi_{Lit}\Delta\Omega_{Lit} + \phi_{Mit}\Delta\Omega_{Mit}), \tag{5}$$

where $\Delta\Omega_{Lit}$ and $\Delta\Omega_{Mit}$ represent the growth rates in labour and material costs per value of capital costs in a firm i at time t.[18] We can directly estimate the price markup term (μ_{it}) in (5). Our core model is thus specified as $\Delta Y_{it} = \mu_{it}\Delta X_{it}$, where the left-hand side variable (ΔY_{it}) represents the growth rate in sales per value of capital for a firm i at time t and the right-hand side explanatory variable (ΔX_{it}) represents a vector of the growth rate in inputs weighted by their shares in total sales.

4.2 Results

We estimate (5) in a log-linear fixed-effects model, using annual and country fixed effects to control for any changes in markups that are common across

[16] Roeger (1995) assumes the constant returns to scale (CRS), implying an estimation bias depending on the actual returns to scale. Relaxing the CRS assumption, the markup could be discounted for the term ξ_{it} and therefore expressed as $P_{it}/c_{it} = \mu_{it}/\xi_{it}$. The Roeger method leads to overestimated markup levels and underestimated markup changes in case of increasing returns to scale.

[17] Roeger (1995) shows that the change in the marginal cost (Δc_{it}) is a weighted average of the changes in input prices (ΔF_{it}) with respect to their relative cost shares in the firm's cost function (Φ_{it}), accounting for the change in technology (e_{it}), i.e. $\Delta c_{it} = \phi_{Iit}\Delta F_{Iit} - \Delta e_{it}$. Hence, $c_{it} = P_{it}(1 - \lambda_{it}) \Leftrightarrow P_{it}/c_{it} = \mu_{it} = (1 - \lambda_{it})^{-1}$.

[18] For brevity reasons we express $\Delta\Omega_{Lit}$ and $\Delta\Omega_{Mit}$ as $\Delta\Omega_{Lit} = (\Delta l_{it} + \Delta F_{Lit}) - (\Delta k_{it} + \Delta F_{Kit})$ and $\Delta\Omega_{Mit} = (\Delta m_{it} + \Delta F_{Mit}) - (\Delta k_{it} + \Delta F_{Kit})$.

firms.[19] In our basic empirical specification, we estimate whether there is a statistically significant change in the markups in the period of the US safeguard protection (*SG*) with respect to the sample period 1995–2005:

$$\begin{aligned}\Delta Y_{it} = \alpha_i + \mu_1 \Delta X_{it} + \mu_2 \, [\Delta X_{it} SG] + \mu_3 [\Delta X_{it} GDP_{jt}] \\ + \beta_1 GDP_{jt} + \varepsilon_{it} \, . \end{aligned} \tag{6}$$

Our dependent variable, ΔY_{it}, represents the output growth per value of capital. Our composite explanatory variable, ΔX_{it}, includes the growth of nominal inputs weighted by factor shares in the output for each firm i at year t. The results from estimating (6) for each group of the EU steel producers are reported in Table 3. In the first column we report results where we estimate the markups jointly for *all* EU producers of steel products. In column (2) we focus on the multi-product firms and finally in column (3) we show the results for the single-product firms. The coefficient μ_1 refers to the *level* of the markups of the EU firms in the absence of the protection. From column (1) we see that the coefficient is statistically different from 1 and implies that the output price exceeded the marginal costs roughly by 38 per cent when we look at the entire sample of firms.[20] From column (2), which refers to the multi-product firms, it becomes clear that the level of the markups (μ_1) of around 46 per cent is on average larger than the level for the single-product firms, which is around 38 per cent. Previous empirical findings of Lenway et al. (1996) and Bernard et al. (2007) already suggested superior performance of multi-product firms that benefit from scale and scope economies.[21]

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[19] Following the results of the Hausman test we prefer a fixed-effects model over a random-effects model. The F-test indicated that fixed effects were significant in all model specifications. We control for business cycles with the real GDP growth rates to proxy for country-level shifts of demand as in Konings and Vandenbussche (2005). Appendix B describes the data and variables in more detail.

[20] In Table 3 we show also the results for the fixed-effects regressions, denoted by primes, where standard errors are not adjusted for intra-industry correlation. Table 3 shows that the results are robust to alternative specifications.

[21] Lenway et al. (1996) find that more diversified US steel firms performed better and were less likely to petition for protection, although they could not find strong evidence that diversification impacts share price fluctuations in response to public announcements of protection. Moreover, multi-product firms use their basic steel further into the fabrication process, allowing for larger markup differentials. A further fabrication of steel increases the degree of product differentiation, where firms can charge different markups according to product characteristics and quality differences, unobserved to an econometrician; see Berry et al. (1995) and Verboven (1996) for supporting empirical evidence. Bernard et al. (2007) consider trade as a rather concentrated activity around multi-product

Table 3: *Estimates of Markups of the EU Steel Producers*

Variable[a]	All firms[b]		Multi-product firms[c]		Single-product firms[d]	
	Robust FE (1)	FE (1′)	Robust FE (2)	FE (2′)	Robust FE (3)	FE (3′)
Markup (μ_1)	1.384 (0.033)***	1.397 (0.014)***	1.461 (0.069)***	1.495 (0.034)***	1.380 (0.036)***	1.387 (0.015)***
Markup change (μ_2)	−0.108 (0.030)***	−0.105 (0.014)***	−0.106 (0.056)*	−0.116 (0.027)***	−0.119 (0.034)***	−0.115 (0.016)***
Markup × GDP (μ_3)	−0.072 (0.013)***	−0.078 (0.005)***	−0.095 (0.023)***	−0.109 (0.011)***	−0.071 (0.016)***	−0.074 (0.005)***
GDP (β_1)	−0.017 (0.004)***	−0.021 (0.004)***	−0.008 (0.008)	−0.006 (0.008)	−0.022 (0.006)***	−0.028 (0.005)***
R-squared	0.880	0.871	0.919	0.913	0.870	0.864
Observations	10,447	10,447	2,025	2,025	8,422	8,422
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes

Note: *** and * indicate statistical significance at the 1 and 10 per cent level respectively. Standard errors are reported in parentheses and corrected for serial correlation and heteroskedasticity in the robust fixed effects regression. FE denotes a regression using the fixed-effects estimator.

[a] Estimated coefficients in parentheses refer to equation (5). — [b] All firms refer to all affected EU steel producers engaged in production of steel products subject to the US safeguard measures. — [c] Multi-product firms refer to all affected EU steel producers reporting their production activity in more than one 4-digit industries. — [d] Single-product firms refer to all affected EU steel producers reporting their production activity within one 4-digit industry.

To analyze the effect of the US safeguards on markups, we interact our composite variable ΔX_{it} with a binary variable *SG* denoting safeguard measures, taking values 1 in 2002–2003 and 0 otherwise. The estimated coefficient μ_2 is of particular interest to us as it captures the change in EU markups due to the US safeguards. From column (1) we see that for all EU steel firms in the sample, the US safeguards resulted in a statistically significant decrease in the average markup of about 11 percentage points during the period 2002–2003.[22] The point estimates for the single-product firms in column (3) suggest a larger decline in markups than for the multi-product firms in column (2). Given the larger initial level of markups for the multi-

firms that likely export to many different destinations, trade more than single-product firms and discriminate in prices between different international markets. Multi-product firms also tend to export their core products often associated with the highest markups.

[22] The negative sign on *GDP* suggests the counter-cyclicality of the markups consistent with Konings and Vandenbussche (2005). The real GDP growth rate in our data lies at 2 per cent. We prefer to use GDP as a measure of business cycles than the deviations from the industry averages due to a higher significance of results with the same direction of signs.

product firms, the single-product firms on average exhibit lower markup levels during the US protection than the multi-product firms. One possible reason for this difference is that the EU single product firms are more vulnerable since they either operate exclusively in relatively unprocessed steel categories, which incidentally faced the highest safeguard duties, or use heavily protected upstream steel in further processing. Multi-product firms are vertically integrated firms and produce both upstream and downstream steel products.[23] Their presence in downstream categories of products resulted in lower effects of safeguard tariffs on their total markups. But their presence in upstream flat steel suggests that they were also partly hit by the high tariffs imposed on the upstream steel. To shed more light on the issues discussed above, we next decompose the markup change to evaluate the direct effect of the EU exports to the US, affected by the US safeguard tariffs.

4.3 Robustness and Discussion of Results

4.3.1 Safeguard Tariffs, Import Penetration and Trade Diversion

We decompose the effect of the US safeguard on European markups with respect to the trade flows. For this purpose, we interact the markup change with three different trade flows. To know what part of the markup decline of the EU steel producers was associated with the reduced EU export volume of steel to the US, we interact the markup change with "EU exports of steel to the US". We also interact the markup change with two other trade flows: "EU imports of steel from the rest of the world" and with "EU exports of steel to the rest of the world". The extended model is the following:

$$\begin{aligned}\Delta Y_{it} = \alpha_i + \gamma_1 \Delta X_{it} + \gamma_2[\Delta X_{it}\tau_{kt}] + \gamma_3[\Delta X_{it} SGm_{kt}] \\ + \gamma_4[\Delta X_{it} SGx_{kt}] + \gamma_5[\Delta X_{it} GDP_{jt}] + \beta_1 m_{kt} + \beta_2 x_{it} \\ + \beta_3 GDP_{jt} + u_{it}\,.\end{aligned} \tag{7}$$

Hence, γ_2 in (7) is the markup change related to the "EU steel exports to the US" during 2002–2003 weighted by the tariff level, τ, imposed on each unit of product k exported to the US in year t. The coefficient γ_3 is the markup

[23] Durling and Prusa (2003) pointed out that upstream US steel producers could partly pass through the safeguard protection on downsteam processors of steel. Their paper shows that large firms that do not rely on imported slabs used the US safeguards to raise their rivals' costs. Since the largest tariffs were levied on vital inputs like the slab and flat steel, the protection raised the cost of those single-product firms processing steel the vertical chain of production.

change related to the "EU imports of a steel product k in year t from the rest of the world" during 2002–2003, denoted by m_{kt}. The coefficient γ_4 denotes the markup change associated with other "EU exports to the rest of the world", x_{kt}, during the US safeguard protection. These parameters are interacted with the safeguard dummy, taking values 1 during the US protection and 0 otherwise.[24]

A potential problem of our estimation strategy is the reverse causality between the growth in the firm's output on the left-hand side and trade on the right-hand side, arising from the relation between productivity and openness, as some highly productive EU firms could self-select themselves into exports. Similarly, some foreign firms could export to the EU because of the prevailing market structure. To circumvent this problem, we measure the EU imports and exports in terms of the import penetration, m_{kt}, and export intensity, x_{kt}, aggregated at the 4-digit industry level.[25]

The results presented in Table 4 clearly show that the largest decline in markups of the EU steel firms can be attributed to the reduced "EU exports to the US" affected by the safeguards (γ_2). The markup decline resulting from this direct effect is in the range of 7 per centage points for all firms which can be seen from column (1) in Table 4. The effect of lost EU exports to the US was felt more by the multi-product than single-product firms, which can be seen by comparing column (3) with column (5). This does not contradict our previous results. It means that of all the trade flows of multi-product firms, their markups suffered most from the exports to the US. This could indicate that particularly slabs and the flat steel produced by them is shipped to the US rather than to the rest of the world. And as discussed above, it was mainly this upstream steel that was hit by the highest tariffs. The multi-product firms are also likely to trade more upstream steel

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24 In models with interaction effects we always include the main effects of the variables (referring to β_1, β_2, and β_3) that were used to compute the interaction terms to exclude the possibility that main effects and interaction effects are confounded.

25 Import penetration is defined as $m_{kt} = \dfrac{imports_{kt}}{production_{kt} + imports_{kt}}$ and export intensity as $x_{kt} = \dfrac{exports_{kt}}{production_{kt} + imports_{kt}}$ where k refers to the 4-digit production activity where the steel product subject to the US protection is produced. The industry averages of trade flows in tons are aggregated across all firms reporting their activity in the 4-digit sector, where the 8-digit steel product is produced. On average, the import penetration and export intensity lay around 25 per cent over the whole sample period and across all 4-digit industries. The synthetic index of the Economic Freedom of the World or the Warner & Sachs index of openness are not appropriate instruments, since they do not directly measure the impact of the US safeguard measures.

Table 4: *Robustness Results: Decomposition of the Markup Change*

Variable[a]	All firms		Multi-product firms		Single-product firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Markup (γ_1)	1.405 (0.023)***	1.354 (0.019)***	1.520 (0.053)***	1.438 (0.044)***	1.386 (0.026)***	1.335 (0.021)***
Markup change interacted with the EU exports to the US weighted by tariffs (γ_2)	−0.067 (0.010)***	−0.057 (0.009)***	−0.070 (0.023)***	−0.055 (0.019)***	−0.057 (0.012)***	−0.051 (0.012)***
Markup change interacted with the EU imports from RoW[b] (γ_3)	−0.006 (0.003)**	—	−0.028 (0.007)***	—	−0.003 (0.003)	—
Markup change interacted with the EU exports to RoW, excluding US (γ_4)	−0.004 (0.002)**	—	0.012 (0.006)**	—	−0.007 (0.002)***	—
Markup change interacted with the EU imports from Russia (γ_3')	—	−0.032 (0.014)**	—	−0.101 (0.037)***	—	−0.027 (0.016)*
Markup change interacted with the EU exports to China(γ_4')	—	−0.048 (0.021)**	—	0.100 (0.059)*	—	−0.058 (0.024)**
Markup × GDP (γ_5)	−0.059 (0.006)***	−0.052 (0.006)***	−0.098 (0.012)***	−0.097 (0.012)***	−0.048 (0.007)***	−0.041 (0.007)***
R-squared	0.911	0.911	0.935	0.935	0.906	0.905
Observations	8,385	8,385	1,715	1,715	6,670	6,670
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, **, * indicate statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors from the fixed-effects regressions are reported in parentheses and corrected for serial correlation and heteroskedasticity. The main effects of the variables used to compute the interaction terms are included to exclude the possibility that main effects and interaction effects are confounded, but are not displayed in order to save space.
[a] Estimated coefficients in parentheses refer to (7). — [b] RoW denotes the rest of the world.

with the US than the single-product firms, because their primary activity is production of crude steel in which the EU has the largest import share in the US (see Table 1).

The markup decline resulting from an increase of the EU import penetration (γ_3) is around 3 per centage points for the multi-product firms, while the effect was not significant for the single-product firms. This could suggest that mainly heavily protected upstream steel was diverted from the US to the EU, which the single product firms produce to a much lesser extent than the multi-product firms. However, the “EU exports to the rest of the world” had a negative effect on the markups of the single-product firms as given by γ_4 in column (5), which is likely to capture the EU exports previously shipped to the US but during the safeguard protection re-routed to other countries.[26] From the above it is clear that the US safeguards had wider implications on trade flows than just on direct exports of the EU to the US.

In terms of destination of exports, we recall from Figure 2 that in particular the EU exports to China shot up around the time of the safeguards, suggesting that some EU firms might have diverted their exports from the US to China. In terms of origin of imports, Figure 1 reveals that the largest EU steel importers were the US, China and Russia. We experimented with all of the importers to find that in particular the imports of Russian steel affected markups of the EU producers during 2002–2003, which could be explained by the product composition of the trade flows.[27] Table 4 shows the results of an alternative specification where we include the EU imports from Russia (γ_3') and exports to China (γ_4') into (7). These estimates are reported in columns (2), (4) and (6) and measured in the same manner as the external EU trade flows denoted by m_{kt} and x_{kt}.

The estimation results in Table 4 suggest that while the EU multi-product firms' markups were squeezed by the EU imports from Russia during the US protection, markups increased with the EU exports to China. In contrast, the single-product firms suffered less from imports from Russia. This seems to be in line with the EUROFER (2007) report on fierce competition of Russian firms with integrated EU firms in flat steel products. However, the single-product firms were most affected by the EU exports to China. After the closure of the US border for steel imports, the former exporters to the US re-routed their steel to the Chinese market and made it tougher in terms of competition. This may explain why the EU single-product firms suffered from the shipments to China while the multi-product firms likely hedged such country-specific risks by exporting their core products with the highest markups to different destinations. By com-

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[26] In Table 4, we focus on the part of markup decline associated with trade flows to asses the direct effect of US safeguards and evaluate the effect of potential trade diversion from the US. The summation of different elements (γ_2, γ_3, γ_4) explains an important part of the markup decline related to trade flows, however, the information in Table 3 should instead be used to asses the difference in the total decline in markups between multi-product and single-product firms. The summation of different elements of markup decomposition indicates that trade flows mattered more for multi-product firms and to a lesser extent for single-product firms. This goes in line with Bernard et al. (2007), showing that trade is rather concentrated around multi-product firms.

[27] In response to Russian import penetration, the EU reached the agreement in the form of an Exchange of Letters with the Russian Federation in August 2003, establishing a double-checking system without quantitative limits in respect of the export of certain steel products from the Russian Federation to the EU (EC 22003A0828(01)).

paring the summation of different elements $\gamma_2, \gamma_3', \gamma_4'$ in columns (4) and (6), the single-product firms were hit harder by changes in these specific trade flows than the multi-product firms. In sum, multi-product firms appear to be less dependent on individual international markets and seem to adjust their markups to the high-variance trade shocks in the global trade arena.

4.3.2 Exit and Entry of Firms

We consider that exit and entry could affect the pattern of the average firm's markup response to the US protection. According to the recent literature on intra-industry heterogeneity (Bernard et al. 2003; Bernard et al. 2007; Melitz 2003), trade is not neutral to firms and may induce reallocation with lowly productive firms exiting the market and highly productive firms gaining market share. By the same token, an increase in trade protection may also induce some reallocation. The US safeguard protection may have driven some EU steel firms with low markups out of business. Intuitively this would result in an increase in the average markup of EU steel firms after the shake-out. Instead our results thus far without explicitly controlling for exit suggest that the US safeguard resulted in a reduction in EU markups. Therefore we expect that when controlling for exit, markup declines of those that stay in business during protection is even stronger.

In Table 5 we report estimates for two sub-samples of the EU steel firms. First, we estimate the average markup and its change during the US protection for a balanced panel of firms, where we control for any entry or exit of firms during 1995–2005 in terms of the employment data. The results are reported in columns (1)–(3) of Table 5. Second, in the last three columns of Table 5 we control exclusively for exit of the EU steel firms during the US protection period. In comparison to Table 3, we exclude about 14 per cent of observations on multi-product firms and 23 per cent of observations on single-product firms. When controlling for exit, our results remain qualitatively the same as in Table 3 with a decline in markups of 11 percentage points during the protection years 2002–2003. This suggests that exits are not driving the results. Also, the results in the last two columns of Table 5 confirm the earlier result that the single-product firms exhibited a larger decline in their markups than the multi-product firms. We find a significant decline in markups of 13 percentage points for the single-product firms even when

Table 5: *Robustness Results: Estimates of Markups Controlled for Exit and Entry of Steel Firms*

Variable	No entry & exit during 1995–2005			No exit during the US protection		
	All (1)	Multi (2)	Single (3)	All (4)	Multi (5)	Single (6)
Markup	1.418	1.480	1.414	1.393	1.482	1.375
	(0.045)***	(0.082)***	(0.050)***	(0.038)***	(0.075)***	(0.044)***
Markup change	−0.084	−0.083	−0.097	−0.109	−0.090	−0.127
	(0.042)**	(0.073)	(0.048)**	(0.035)***	(0.060)	(0.041)***
Markup × GDP	−0.085	−0.103	−0.084	−0.078	−0.107	−0.073
	(0.017)***	(0.028)***	(0.020)***	(0.015)***	(0.026)***	(0.018)***
GDP	−0.022	−0.017	−0.027	−0.018	−0.014	−0.030
	(0.005)***	(0.008)***	(0.006)***	(0.005)***	(0.008)*	(0.006)***
Observations	8,046	1,590	6,409	8,659	1,742	6,456
R-squared	0.866	0.911	0.852	0.882	0.918	0.881
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, ** and * indicate statistical significance at the 1, 5 and 10 per cent level respectively. Standard errors from the fixed effects regressions are reported in parantheses and corrected for serial correlation and heteroskedasticity.

controlling for exit, while the effect is not significant for the multi-product firms.

4.3.3 Counterfactuals

In order to verify that the markups of the EU steel producers declined due to the US safeguard protection and not due to some common phenomenon in the EU manufacturing sectors, we turn to the exact matching method following closely the work of Rosenbaum and Rubin (1984) and Angrist (1998). This method reduces the selection bias by choosing an appropriate counterfactual group of firms from a large pool of EU firms across manufacturing industries. By retrieving counterfactual firms that are similar to the EU steel firms but have not been subject to the US safeguard protection (treatment) we control for how markups would have changed in the absence of US protection (absence of treatment). The ultimate goal is to see whether the markups of the treated group of the EU firms declined more than markups of non-treated firms.

Denote the potential outcomes by S_1, if a firm is exposed to the treatment, and S_0, if a firm is not exposed to the treatment. The treatment status is denoted by a binary variable D taking value 1 during the US protection in

2002–2003 and 0 otherwise. The effect of treatment on treated steel firms could be estimated by the following expression (Rosenbaum and Rubin 1984):

$$E[S_1 - S_0|D = 1] = E[S_1|D = 1] - E[S_0|D = 1]\,. \qquad (8)$$

Equation (8) tells us if a treated firm on average experienced a change in its markup due to the US protection. We look closely at firms' characteristics to evaluate the effect of US safeguards on markups across different types of firms, in particular with respect to their size, capital intensity and measured labour productivity. In Table 6, we observe that markups of EU steel firms are positively related to the measured labour productivity of firms, which is in line with the recent literature on intra-industry firm heterogeneity stemming from differences in technical efficiency (Bernard et al. 2003; Bernard et al. 2007). More productive firms on average exhibit larger markup. High-productivity firms also respond stronger than low-productivity firms to the US protection, with a difference of about 5 percentage points in markup drop. This results are in line with the recent literature pointing out the heterogeneous responses to firms trade protection (Konings and Vandenbussche 2008).

A closer look at the steel firms at the bottom of Table 6 reveals that even within the cohort of high-productivity firms, the multi-product firms have higher markups than the single-product firms, i.e. 2.041 and 1.550 respectively. We show in Table 6 that size, capital intensity and productivity clearly determine the level of markups and the decline in EU markups resulting from US protection. Large steel firms that fall in this category are for example Arcelor, Riva Group and ThyssenKrupp. Their seize and multinational nature make them less vulnarable to country-specific shocks.[28]

Table 6 suggests that the effect of the US protection on the markups is conditional on a set of observed covariates (V), notably firm size, capital intensity and labour productivity. Using conditional independence, expressed

[28] For example, ArcelorMittal has large expansion plans referring not only to its acquisition strategy in Central and Eastern Europe, but also to direct investments in China, e.g. the shares of the Hunan Valin Tube and Wire mill. Besides, it has an aggressive strategy to increase capacity with joint ventures with Baosteel in China and Jindal in India, and take-overs of Erdemir in Turkey and Lucchini-Warsawa in Poland (EC 2005). The history of the world's largest steel enterprise dates back to February 2001, when Arcelor was created through the merger of Arbed (Luxembourg), Aceralia (Spain) and Usinor (France). In 2006, Arcelor merged with Mittal Steel that now together represent the world's largest steel corporation in terms of output, assets, and profits, producing more than 110 million tons annually (http://www.arcelormittal.com/).

Table 6: *Robustness Results: Estimates of Markups across Different Cohorts of the EU Steel Firms*

Cohort	All firms (1)		Multi-product firms (2)		Single-product firms (3)	
	Markup	Change[a]	Markup	Change[a]	Markup	Change[a]
Size[b]						
Small	1.531	−0.140	1.495	−0.171	1.533	−0.124
	(0.037)***	(0.031)***	(0.076)***	(0.052)***	(0.043)***	(0.038)***
Medium	1.373	−0.017	1.364	0.085	1.381	−0.077
	(0.021)***	−0.023	(0.056)***	(0.043)**	(0.023)***	(0.029)***
Big	1.454	−0.158	1.742	−0.341	1.389	−0.128
	(0.025)***	(0.032)***	(0.073)***	(0.099)***	(0.026)***	(0.032)***
Capital intensity[c]						
Low	1.530	−0.166	1.277	−0.047	1.605	−0.199
	(0.033)***	(0.026)***	(0.048)***	(0.037)	(0.041)***	(0.033)***
Medium	1.540	−0.121	1.677	−0.078	1.528	−0.175
	(0.031)***	(0.030)***	(0.080)***	(0.066)	(0.033)***	(0.034)***
High	1.293	−0.104	1.730	−0.422	1.258	−0.075
	(0.025)***	(0.031)***	(0.103)***	(0.112)***	(0.025)***	(0.032)**
Productivity[d]						
Low	1.273	−0.089	1.276	−0.071	1.278	−0.099
	(0.026)***	(0.020)***	(0.044)***	(0.032)**	(0.032)***	(0.026)***
Medium	1.445	−0.025	1.422	0.030	1.455	−0.055
	(0.029)***	(0.030)	(0.083)***	(0.066)	(0.031)***	(0.035)
High	1.613	−0.146	2.041	−0.484	1.550	−0.088
	(0.030)***	(0.039)***	(0.090)***	(0.118)***	(0.031)***	(0.042)**

Note: *** and ** indicate statistical significance at the 1 and 5 per cent level respectively. Standard errors from the fixed effects regressions are reported in parentheses and corrected for serial correlation and heteroskedasticity. All regressions include business-cycle controls together with country and year dummies. The cohorts of the EU steel firms (small, medium and large) refer to equal fractions in the density function of a corresponding variable.
[a] Change refers to the change in the markups of the EU steel firms during the US safeguard protection. — [b] Size is measured by the number of employees. — [c] Factor intensity is measured by total fixed assets per employee. — [d] Productivity is measured by value added per employee.

as $E[S_0|D, V] = E[S_0, V]$, the effect of treatment on the treated can therefore be estimated using the following expression (Angrist 1998):

$$E[S_1 - S_0|D = 1] = \int \{E[S_1|V, D = 1] - E[S_0|V, D = 0]\} \times df(V|D = 1)\,, \quad (9)$$

where $df(V|D = 1)$ is the density function for V during the US protection. The expression $E[S_1 - S_0|D = 1]$ is obtained as a weighted average of firm characteristics between treated steel and counterfactual firms at each

Table 7: *Summary Statistics for Treated and Counterfactual Groups of Firms*

Industry[a]	Size		Factor intensity		Productivity	
Treated group (steel)	3.129	(0.218)***	−1.941	(0.174)***	3.552	(0.159)***
All manufacturing[b]	3.081	(0.210)***	−1.984	(0.186)***	3.533	(0.156)***
Textiles	3.102	(0.206)***	−1.963	(0.191)***	3.545	(0.161)***
Apparel	3.064	(0.203)***	−2.066	(0.201)***	3.487	(0.189)***
Leather	3.056	(0.196)***	−2.021	(0.187)***	3.488	(0.173)***
Wood	3.014	(0.199)***	−1.935	(0.172)***	3.503	(0.149)***
Pulp & paper	3.141	(0.207)***	−1.915	(0.173)***	3.574	(0.140)***
Chemicals	3.118	(0.216)***	−1.954	(0.185)***	3.616	(0.152)***
Rubber & plastics	3.084	(0.205)***	−1.928	(0.172)***	3.549	(0.138)***
Other non-metalic	3.070	(0.202)***	−1.894	(0.174)***	3.563	(0.155)***
Fabricated metals	3.033	(0.196)***	−1.960	(0.179)***	3.507	(0.144)***
Machinery & equipment	3.082	(0.207)***	−2.038	(0.192)***	3.546	(0.145)***
Electrical machinery	3.102	(0.212)***	−2.041	(0.192)***	3.548	(0.147)***
Communication equipment	3.094	(0.209)***	−2.054	(0.199)***	3.533	(0.150)***
Medical & optical products	3.065	(0.219)***	−2.053	(0.195)***	3.548	(0.141)***
Vehicles	3.159	(0.224)***	−1.992	(0.186)***	3.532	(0.149)***
Furniture	3.043	(0.202)***	−1.996	(0.184)***	3.498	(0.159)***

Note: *** indicate statistical significance at the 1 per cent level. Mean values in logarithms are presented with standard errors reported in parentheses.
[a] Industry refers to the 2-digit manufacturing industry as classified under the NACE Rev.1.1. — [b] Includes a 10 per cent sample of all manufacturing firms (excl. steel firms), drawn by maintaining the proportions of firms across 4-digit manufacturing activities, years and countries.

value of V in different cohorts.[29] Summary statistics on the treated and counterfactual firms are presented in Table 7 and the results in Table 8.

The matching between steel and counterfactual firms is rather successful as counterfactual firms on average do not differ by more than 5 per cent from steel firms according to predetermined covariates captured by V. Table 8 reports the estimated levels of markups and markup changes for the treated steel firms and counterfactual firms from different manufacturing industries. We find the decline in markups of the EU steel firms, directly targeted by the US safeguard protection, to be about 4 per centage points stronger than of counterfactual firms during the US protection. Despite the downward trend in the EU manufacturing industries, we conclude that the EU steel firms exhibited a larger decline in their markups during the

[29] We use population cell sizes, referring to the number of observations for treated steel firms in each of the cohorts, excluding missing values. Consequently we end up with 7,517 observations across all cohorts. According to Angrist (1998), the estimator is unbiased and consistent, because of the sampling conditions on V of the treated steel firms. An alternative approach would be a propensity-score matching method, which is less appropriate when a large population pool of counterfactual firms is available as in our data.

Table 8: *Robustness Results: Estimates of Markups across Counterfactual Groups of Firms*

Industry[a]	Markup		Markup change[b]	
Treated group (steel)	1.428	(0.003)***	−0.085	(0.002)***
All manufacturing[c]	1.417	(0.002)***	−0.044	(0.001)***
Textiles	1.372	(0.002)***	−0.047	(0.001)***
Apparel	1.194	(0.002)***	−0.021	(0.002)***
Leather	1.319	(0.002)***	−0.046	(0.001)***
Wood	1.347	(0.002)***	−0.074	(0.001)***
Pulp & paper	1.252	(0.002)***	−0.028	(0.001)***
Chemicals	1.421	(0.003)***	−0.034	(0.002)***
Rubber & plastics	1.377	(0.002)***	−0.051	(0.001)***
Other non-metalic	1.461	(0.002)***	−0.021	(0.001)***
Fabricated metals	1.508	(0.002)***	−0.027	(0.001)***
Machinery & equipment	1.375	(0.002)***	−0.047	(0.001)***
Electrical machinery	1.428	(0.002)***	−0.026	(0.001)***
Communication equipment	1.481	(0.003)***	−0.004	(0.002)*
Medical & optical products	1.521	(0.002)***	−0.044	(0.002)***
Vehicles	1.324	(0.002)***	−0.058	(0.001)***
Furniture	1.314	(0.002)***	−0.052	(0.001)***

Note: *** and * indicate statistical significance at the 1 and 10 per cent level respectively. Standard errors from the fixed effects regressions are reported in parentheses and corrected for serial correlation and heteroskedasticity.
[a] Industry refers to the 2-digit manufacturing industry as classified under the NACE rev.1.1. — [b] Markup change refers to the change in the markups of the EU steel firms during the US safeguard protection. — [c] Includes a 10 per cent sample of all manufacturing firms (excl. steel firms), drawn by maintaining the proportions of firms across 4-digit manufacturing activities, years, and countries.

protection years 2002–2003 than firms in the rest of EU manufacturing industries.

5 Conclusion

Previous research on trade protection has focused on the effect that trade protection had on domestic producers. This paper is one of the few to consider the externality effects of trade protection on foreign producers. For this purpose we have turned to the US safeguard protection on steel imports that started in 2002. Our evidence shows that the US safeguard protection on steel adversely affected the markups of European steel producers. We find that the markups of European steel producers on average declined by 11 percentage points during the US safeguard protection. We show that higher levels of the US safeguard tariffs were associated with larger declines in the markups of EU steel producers. This result can usefully be compared to the results obtained by Konings and Vandenbussche (2005). They estimate the positive markup effects for domestic producers protected by antidumping duties in the range of 9 per centage points incurred during the protection period. Despite the crudeness of the comparison this would seem to suggest that the gain to domestic producers estimated earlier is comparable to the loss of foreign producers estimated in our paper.

Our results have interesting implications. The evidence suggests that the US safeguard protection triggered domino effects.[30] We find that the US safeguard protection resulted in some re-routing of European steel notably towards China. This later resulted in a call for import protection by Chinese steel producers (EUROFER 2007). In 2003, China itself imposed safeguard measures on certain steel products in response to a large influx of steel from the rest of the world during the US safeguard protection. Similar to China's case, Poland also imposed safeguard protection on steel in 2003 (EUROFER 2007).

In addition, our results have shown that the response to the US safeguard protection amongst the EU steel firms was heterogeneous. The fact that single-product firms suffered more from protection than multi-product firms can be explained by a different product composition and a larger dependency of single-product firms on adverse market reactions. Multi-product firms appear to be less dependent on individual international markets and seem to have a better ability to adjust their markups to the high-variance trade shocks in the global trade arena.

In conclusion, we find a considerable negative effect of the US safeguards on the EU markups, suggesting that one country's safeguard protection imposes adverse externalities on its trading partners. Our paper is among the few to explore microeconomic impacts of protection on trade partners in terms of markups. We demonstrate that trade protection has an additional cost which has not been pointed out before—that is the cost to the trading partner.

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[30] The concept of domino effects in the multilateral trade framework has been introduced in the early nineties by Baldwin (1993). His paper presents a theoretical model where an established trade agreement can trigger requests from countries that were previously non-members. His model implies that one country's trade policy action can trigger echoing trade actions by other countries.

Appendix A: Description of the Data

The data used in this study are the annual company accounts data reported at the end of each year which are compiled from Amadeus (September 2006) organized by the Bureau van Dijk. The data cover the steel industry across the EU-15 countries for the period 1995–2005. We focus our study on those firms that have reported their primary activity in this sector. The additional annual data on control variables, i.e. the real GDP growth rates and the product-level trade data, are downloaded from Ameco and Eurostat.

The information on steel products covered by the US safeguards was retrieved from the official statements from the White House Press on the US Steel Products Proclamation from March 2002. From this source, we also obtained all the necessary information about the type, the level, and the length of the US safeguard tariffs. We identify 2,263 affected EU firms as those that are engaged in the production of steel products, accounting for 42 per cent of all firms in the steel sector.[31] Each firm in Amadeus has a trade description that enables the identification of the activities pertinent to production of steel products subject to the US safeguard protection. Firms that do not report any secondary activities are referred to as "single-product firms". "Multi-product firms" by contrast refer to firms reporting at least one secondary activity. For example, most of them are active in crude steel production (NACE 2710), but for example also report their activity in other basic metal sectors (see Table 2).

The variables in real values used in our econometric models are the following. The firm-level operating revenue in each year provided in Amadeus is used to proxy the output variable. For the value of capital we use the book value of tangible fixed assets for each firm in each year. The labour costs reported in Amadeus proxy the wage bill variable. The material costs variable is simply proxied by the firm-level total material costs consisting of the factor price multiplied by the quantity of materials. The country-level real GDP growth rates, the real long-term interest rates, and the price index of investment goods are obtained from the Ameco database from the ECFIN department at the European Commission.

We construct our capital variable in line with Konings and Vandenbussche (2005) as the user cost of capital multiplied by its nominal value. We define the user value of capital as $Z_{jt}(r_t + d_{it})$, where we consider a country-level price index of investment goods, Z_{jt}, a long-term real interest rate r_t at time t, and depreciation of capital d_{it} of the average rate of 10 per cent. We simulated the sensitivity of markups towards different depreciation rates, price indices of investment goods, and real interest rates in (6) and (7). Allowing for 5 per cent changes, our point es-

[31] We use the services of the Tariff Information Center to classify protected products according to the 8-digit HTS of the US. Under Chapter 99 within Section XXII on Special Temporary Legislation, we identify subject products and match them with products specified in the Section XV on Base Metals and Articles of Base Metal product descriptions. Using the UN correspondence tables between the HTS and the PRODCOM industry classifications we identify groups of activities at the 4-digit NACE Rev.1.1 level. The firms are identified at the 4-digit production activity level.

timates vary within the range of 1 per cent, without altering the signs of estimated coefficients.

The data are clean of clearly wrong entries, such as extremely high growth rates in employment, material or labour costs. We only consider observations where the share of material costs and the share of labour costs in turnover is larger than 1 per cent and smaller than 100 per cent and exclude the extreme values of nominal growth in input and output. By doing so, we excluded 2 per cent of observations from the raw data retrieved from Amadeus. We use only unconsolidated financial statements to avoid double-counting firms and subsidiaries and thus focus on the local operations of firms and do not overestimate the values of variables. Since not all EU countries require consolidation of accounts for all firms, it increases the comparability of steel and counterfactual firms.

Appendix B: Description of the Theoretical Model in Section 3

An EU and a US firm compete in Cournot fashion and face iceberg transport costs per unit of their shipments. The EU firm's exports to the US are additionally constrained by the US safeguard tariff. The EU firm produces the output x for the EU market and the output x^* for the US market, denoted by the asterisk *. The US firm produces the output y for the EU and the output y^* for the US market. Each firm sells its output at the price P in the EU and at the price P^* in the US and maximizes its profits with respect to the output in each market taking into account shipments of the other competitor. The first order conditions for profit maximization imply:

$$P(Q)\left[1 - \frac{x}{\varepsilon Q}\right] = c\,, \tag{A1}$$

$$P^*(Q^*)\left[1 - \frac{x^*}{\varepsilon^* Q^*}\right] = \frac{c}{g} + \tau\,, \tag{A2}$$

where $P(Q)$ and $P^*(Q^*)$ are the inverse demand functions in the EU and the US markets, respectively. Consider that the European firm's market share in the US market is defined by $\sigma^* = x^*/Q^*$ and the US firm's market share in the EU market is defined by $\sigma = y/Q$, where Q and Q^* denote total outputs at the output prices P in the EU and P^* in the US. Defining the price elasticity of demand with $\varepsilon = -(P/Q)(\partial Q/\partial P)$, the best response functions for both firms in the US market can be implicitly expressed as:

$$x^*(y^*) : P^* = \frac{c\varepsilon^* + \tau g \varepsilon^*}{g(\varepsilon^* - \sigma^* - 1)}\,, \tag{A3}$$

$$y^*(x^*) : P^* = \frac{c\varepsilon^*}{\varepsilon^* + \sigma^* - 1}\,, \tag{A4}$$

and analogously best reply functions can be derived for the EU market. The above equations imply that the European firm needs to consider the tariff τ imposed on each unit of its output shipped to the US. The equilibrium market shares and prices are then given in the US market as:

$$\sigma^* = \frac{\varepsilon^*(g - 1 - \tau g/c) + 1 + \tau g/c}{1 + g + \tau g/c}, \tag{A5}$$

$$P^* = \frac{c\varepsilon^*(1 + g + \tau g/c)}{g(2\varepsilon^* - 1)}. \tag{A6}$$

And the equilibrium in the EU is defined as:

$$P = \frac{c\varepsilon(1 + g)}{g(2\varepsilon - 1)}, \tag{A7}$$

$$\sigma = \frac{\varepsilon(g - 1) + 1}{1 + g}. \tag{A8}$$

Rewriting best reply functions and solving (A3) and (A4) for price levels and market shares with respect to demand elasticities yields expressions for the Nash equilibrium market shares of the EU and the US firm in each other's market:

$$\left.\begin{aligned} \sigma^* &= \frac{\varepsilon^*(g - 1 - \tau g/c) + 1 + \tau g/c}{1 + g + \tau g/c} \\ \sigma &= \frac{\varepsilon(g - 1) + 1}{1 + g} \end{aligned}\right\} \sigma^* < \sigma. \tag{A9}$$

The equilibrium prices in both markets can then be expressed as:

$$\left.\begin{aligned} P^* &= \frac{c\varepsilon^*(1 + g + \tau g/c)}{g(2\varepsilon^* - 1)} \\ P &= \frac{c\varepsilon(1 + g)}{g(2\varepsilon - 1)} \end{aligned}\right\} P^* > P. \tag{A10}$$

The price in the US market will exceed the EU price due to the tariff τ imposed on the US imports. Under free trade both prices would be equal and firms would have equivalent shares in exporting markets. By contrast under the US safeguard protection, the EU firm will supply less to the US than the US firm to the EU, i.e. $\sigma^* < \sigma$. Each firm will export as long as it can charge a price that covers the variable cost of each unit shipped. There is an anti-competitive effect of the safeguard tariff, assuming that the price elasticity of demand ε^* falls as the EU firm's market share in the US decreases.

In equilibrium, the European firm will maintain its market share in the US as long as it will find it profitable to export. In other words, the European firm needs to cover its costs per each unit of product supplied to the US, so that $P^* > c/g + \tau > 0 \wedge \sigma^* > 0$. Analogously will the US firm export to the EU market as long as it gilts that $P > c/g > 0 \wedge \sigma > 0$. Rewriting the equilibrium price levels, the price elasticities of demand can be expressed as:

$$\varepsilon^* < \frac{1 + \tau g/c}{1 - g + \tau g/c}\,, \tag{A11}$$

$$\varepsilon < (1 - g)^{-1}\,. \tag{A12}$$

Furthermore, the EU firm will export to the US market as long as the tariff τ is set below its prohibitive level, i.e. as long as $\tau < c(\varepsilon^*(g-1)+1)/g(\varepsilon^*-1)$. This is an important implication of the model, showing that the elasticity of demand in the US is lower than in the US due to the US safeguard tariff, i.e. $\varepsilon^* < \varepsilon$. The adverse effect of the safeguard tariff on the markups of the European firm can be shown from the inverse relationship between price markups and the price elasticity of demand $P - \bar{c}/P = 1/\varepsilon^*$, where $\bar{c} = c + c/g + \tau$denotes the aggregate marginal costs of the EU firm that exceed marginal costs of the US firm by amount of the US tariff.

The US safeguard tariff moreover adversely affects the European firm's profits, whereas its magnitude depends on the elasticity of demand in the US and the size of its exports to the US, that is:

$$\frac{\partial\pi}{\tau} = -x^*\left(\frac{\varepsilon^* - 1}{2\varepsilon^* - 1}\right) < 0\,. \tag{A13}$$

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