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**Working Paper**

## Whom to Send to Doha? The Shortsighted Ones!

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# Working Papers

Kiel Institute  
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Whom to Send to Doha?  
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by **Mario Larch and Wolfgang  
Lechthaler**

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## Whom to Send to Doha? The Shortsighted Ones!

Mario Larch<sup>†</sup> and Wolfgang Lechthaler<sup>‡</sup>

Abstract:

Why are empirically observed tariffs so much lower than theoretically calculated Nash-equilibrium tariffs? We argue that this gap can be narrowed by using a dynamic model instead of a static model. This approach has two advantages. (i) It allows us to take account of the transitional process after a change in tariffs. (ii) It allows us to take account of the shortsightedness of policy makers. We show that Nash-equilibrium tariffs based on a dynamic trade model are lower than Nash-equilibrium tariffs based on a static model. We also show that shortsighted politicians tend to set lower tariffs than politicians with a long planning horizon.

Keywords: Bubbles, fiscal theory of the price level, collateral constraints, neutrality, transversality conditions.

JEL classification: F11, F12, F13.

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Mario Larch<sup>†</sup>, Wolfgang Lechthaler<sup>‡</sup>

April 8, 2011

## Abstract

Why are empirically observed tariffs so much lower than theoretically calculated Nash-equilibrium tariffs? We argue that this gap can be narrowed by using a dynamic model instead of a static model. This approach has two advantages. (i) It allows us to take account of the transitional process after a change in tariffs. (ii) It allows us to take account of the shortsightedness of policy makers. We show that Nash-equilibrium tariffs based on a dynamic trade model are lower than Nash-equilibrium tariffs based on a static model. We also show that shortsighted politicians tend to set lower tariffs than politicians with a long planning horizon.

**Key words:** Nash-equilibrium tariffs; static; dynamic

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# 1 Introduction

The *Economist's* print edition of January 27th, 2011 featured an article headed “A deadline for Doha”. The main question of the article was how to finish the Doha round of trade talks that started in November 2001: “*The German chancellor, Angela Merkel, and Britain's prime minister, David Cameron, joined by the heads of government of Turkey and Indonesia, asked a group of experts to work out how on earth to get a Doha deal done.*” The group of experts argued that a firm timetable, the importance of removing trade barriers in service industries, and the rise of agricultural commodity prices should help to conclude the Doha Round. We have an additional suggestion in order to speed up the conclusion: Let shortsighted politicians negotiate the deal.

In their prominent and widely cited “Trade Costs”-paper Anderson and van Wincoop (2004) report that tariffs are low in most countries. For rich countries tariffs are on average (trade-weighted or arithmetic) below 5 percent. For most developing countries tariffs lie between 10 percent and 20 percent. These observed low levels of tariffs do not fit to the much higher Nash-equilibrium tariffs found by using calibrated computed general equilibrium models (CGE). With a few exceptions, CGE models yield tariffs at 30 percent or above.<sup>1</sup>

We narrow the gap between theoretically predicted and empirically observed tariffs by bringing back the time horizon of the underlying model. The results of the theoretically derived Nash-equilibrium tariffs so far are based on static models (Krugman (1991), Bond and Syropoulos (1996), Bagwell and Staiger (1999), Yi (2000), Ornelas (2005), Demidova and Rodriguez-Clare (2009)). Hence, they only take account of the long-run, steady-state effects of tariff changes. This seems to be a serious shortcoming for at least two reasons. (i) The adjustment processes after trade policy changes are diverse and it often takes a long time to converge to a new steady state. (ii) It is typically politicians who decide about tariffs and politicians rarely care about the infinite future.

Therefore, we use a dynamic general equilibrium model, where tariffs are set in order to maximize the net present value of utility.<sup>2</sup> In order to capture the

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<sup>1</sup>For example, Frankel (1997, pp. 167–168) gives a rationale for assuming Nash-equilibrium tariffs to be set at 30 percent. Kennan and Riezman (1990) also suggest Nash-equilibrium tariffs of at least around 30 percent. Perroni and Whalley (2000) find extremely high Nash-equilibrium tariffs ranging from 38 percent to over 1000 percent. Hamilton and Whalley (1983) calculate Nash-equilibrium tariffs for different import price elasticities. In the case of very inelastic import prices the Nash-equilibrium tariff is over 200 percent. For very high import price elasticities this drops to about 8 percent. Markusen and Wagle (1989) find Nash-equilibrium tariff of 18 percent for the United States and 6 percent for Canada. None of these studies yields estimates lower than 5 percent.

<sup>2</sup>We are certainly not the first to explore the relationship between the short run and long run in the context of a general-equilibrium model of trade. Seminal papers by Jones (1971), Mayer (1974), Mussa (1974, 1978), Neary (1978), Leamer (1980), and Mussa (1986), have all enriched our understanding of this connection. More recent contributions are Staiger (1995),

relevant transmission mechanisms of changes in trade costs, such as market size, entry and exit, as well as productivity changes of firms, we build on the work by Melitz (2003) and specifically rely heavily on the dynamic version introduced by Ghironi and Melitz (2005). While the basic Melitz (2003) framework only allows for comparisons of different steady-states, the Ghironi and Melitz (2005) framework is well suited for the present analysis since it explicitly takes into account the transitional dynamics.

We show that Nash-equilibrium tariffs in the static model and the dynamic model differ, where the latter are lower than the former. The reason is that a decrease in tariffs can have temporarily positive effects on consumption even though the long-run effects are negative.<sup>3</sup> The temporary increase in consumption is mainly explained by the fact that after a reduction in tariffs, imports increase immediately, while it takes much longer until inefficient firms are driven out of the market. Starting from the Nash-equilibrium of the static model, the temporary increase in consumption outweighs the long-run decrease in consumption and thus a decrease in tariffs is beneficial. Additionally, with decreasing time horizon of the decision making agents the Nash-equilibrium tariff in the dynamic model *decreases*. This result is interesting in the light of the discussion whether trade liberalization is politically feasible or not. It implies that impatient policy makers promote trade liberalization rather than hindering it. Hence, calculating Nash-equilibrium tariffs in a dynamic model helps to close the gap between empirically observed and theoretically predicted tariffs.

Note, that there were other ways proposed in the literature to close the gap between observed tariffs and predicted Nash-equilibrium tariffs. One may consider the effects of customs unions or free trade agreements (Bond, Riezman and Syropoulos (2004)) or focus on other equilibrium concepts, such as dynamic games (Dixit (1987), Riezman (1991)) to name just two prominent examples. Note the difference between our approach and the papers dealing with dynamic games. Whereas they focus on the dynamics of the strategic decision, we focus on the dynamic effects of a tariff change in a static game.

Additionally, there is a similarity between our results and the predictions of dynamic macroeconomic growth models. One basic message is the same in both models: in dynamic settings it is not proper to carry out economic analysis by

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Bacchetta and Dellas (1997), Furusawa and Lai (1999), Albuquerque and Rebelo (2000), Ghironi and Melitz (2005), Davidson and Matusz (2006), Brůha and Podpiera (2007), Costantini and Melitz (2007), Antras and Caballero (2009), Antras and Caballero (2010). All these papers investigate the transition from one steady state to another after a decrease in trade barriers. They do not look at Nash-equilibrium tariffs.

<sup>3</sup>Qualitatively this result is similar to the consumption overshooting in Bergin and Lin (2010) and the productivity overshooting in Chaney (2005). Empirical evidence distinguishing the short- and long-run effects of trade liberalization is very scarce. Indirect evidence is provided by Bergin and Lin (2010) who show that the increase at the extensive margin is larger in the short-run than in the long-run. Chen, Imbs and Scott (2009) find conclusive evidence for short-run but not for long-run competitiveness effects.

focusing on the long-run outcomes only. It really matters how the economy gets from one steady state to the other. This is well understood in macroeconomics. The capital stock that maximizes steady-state utility satisfies the Golden Rule, whereas the capital stock that maximizes a consumer's discounted utility over her lifetime satisfies the Modified Golden Rule.<sup>4</sup> This result is introduced right at the beginning of most macro textbooks highlighting the importance of the short-run transitions. Due to this, it is rare to see comparative statics carried out in macroeconomics these days. Instead, the concept of comparative dynamics is employed. In contrast, in international trade the focus remains on comparative statics and long-run equilibria.

When it comes to actual trade negotiations, we have to take into account that politicians negotiate the deal. At a first glance one may conclude that the shortsightedness of politicians hurts the economy, since they possibly undervalue negative long-run effects. Note, however, that the strategic setting of tariffs between two countries is a prisoner's dilemma. An increase in import tariffs leads to welfare-increasing tariff revenues and to a welfare-decreasing increase of the price of imported goods. However, as long as we do not consider very small economies, a tariff increase will not lead to an equal increase of the import price. Part of the costs is born by the producers of the imported good. Hence, through increasing tariffs a country imposes a negative terms-of-trade externality on its trading partners. Therefore, the non-cooperative outcome of this interaction leads to higher than socially optimal tariffs. We show that the game played between two short-sighted politicians yields a lower tariff compared to the game played by agents with a long planning horizon. Thus, in this case the shortsightedness of politicians actually brings the economy closer to the socially optimal outcome.

The main reason is that different effects take different time spans to materialize. While it is likely that the effects due to lower employment, i.e., adjustments at the intensive margin, occur right after the trade liberalization, increased productivity due to increased specialization and adjustments on the extensive margin, i.e., the number of firms, may take longer to become effective. Treffer (2004), for example, reports that after the North American Free Trade Agreement (NAFTA) was formed, for industries subject to large tariff cuts (which are typically "low-end" manufacturing industries), the costs included a 12 percent decline in employment. Balanced against these large adjustment costs were labor productivity gains of 14 percent largely due to exit of less productive plants. Chen, Imbs and Scott (2009) employ data from seven European Union countries and ten manufacturing sectors for the period 1989 to 1999 and find strong supportive evidence for a pro-competitive effect of relative openness in the short

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<sup>4</sup>The Modified Golden Rule takes into account the impatience of consumers, reflected by the discount rate, leading to a lower steady-state capital stock and consumption level as compared to the Golden Rule level. Taking into account the impatience, consumers are saving less because they do not want to sacrifice more of current consumption in order to obtain a higher steady-state consumption level.

run. Domestic import penetration tends to lower price inflation, accelerate productivity and reduce profit margins in the short run. The long run effects are less conclusive, but the results do suggest that the pro-competitive effects of openness are more pronounced in the short run. Davidson and Matusz (2006) focus in their theoretical contribution on the different short and long run effects of trade liberalization, and conclude that free trade may be sustainable only when the short run gains are large enough in order to compensate for any long run losses.

The remainder of the paper is organized as follows. The next section introduces the dynamic trade model with tariffs. Section 3 describes the calibration of the model. Section 4 presents Nash-equilibrium tariffs in the static model and the dynamic model. Section 5 investigates the relationship between the Nash-equilibrium tariffs and the time horizon of decision-makers. Section 6 lays out the conditioning effects of trade costs, country size, firm heterogeneity and gradual reforms. The last section concludes.

## 2 A Dynamic Trade Model with Tariffs

In this section we describe our model framework which extends the Ghironi and Melitz (2005) model by non-resource consuming, revenue-generating tariffs.

### 2.1 Household Preferences and Intra-temporal Choices

We assume two countries, labeled home and foreign. Foreign variables are denoted by an asterisk. Each country is populated by a unit mass of atomistic households. Prices are in nominal terms and flexible. In the following, we only solve for the real variables. However, as the composition of consumption baskets in the two countries changes over time, which affects the definitions of the consumption-based price indexes, money is introduced as a convenient unit of account for contracts. However, as money plays no other role, the demand for cash currency is not modeled, following Ghironi and Melitz (2005).

The representative home (foreign) household supplies  $L$  ( $L^*$ ) units of labor inelastically in each period at the nominal wage rate  $W_t$  ( $W_t^*$ ), denominated in units of the home (foreign) currency. Every household maximizes expected intertemporal utility from consumption (C):  $E_t[\sum_{s=t}^{\infty} \beta^{s-t} C_s^{1-\gamma} / (1-\gamma)]$ , where  $\beta \in (0, 1)$  is the subjective discount factor and  $\gamma > 0$  is the inverse of the intertemporal elasticity of substitution. At time  $t$ , the household consumes the basket of goods  $C_t$ , defined over a continuum of goods  $\Omega$ :  $C_t = (\int_{\omega \in \Omega} c_t(\omega)^{(\theta-1)/\theta} d\omega)^{\theta/(\theta-1)}$ , where  $\theta > 1$  is the elasticity of substitution across goods. Note that only a subset of goods  $\Omega_t \subset \Omega$  is available at any given time  $t$ . We denote  $p_t(\omega)$  the home currency price of a good  $\omega \in \Omega_t$ . The consumption-based price index for the home economy is then  $P_t = (\int_{\omega \in \Omega_t} p_t(\omega)^{1-\theta} d\omega)^{1/(1-\theta)}$ , and the household's demand for



each individual good  $\omega$  is given by  $c_t(\omega) = (p_t(\omega)/P_t)^{-\theta} C_t$ .

We assume that the foreign country has identical parameters, leading to a similar price index and demand function. However, the subset of goods available for consumption in the foreign economy during period  $t$  is  $\Omega_t^* \subset \Omega$  and can differ from the subset of goods that are available in the home economy.

## 2.2 Production, Pricing, and the Export Decision

There is a continuum of firms in each country, each producing a different variety  $\omega \in \Omega$ . There is only one factor of production, labor. Aggregate labor productivity is indexed by  $Z_t(Z_t^*)$ , which represents the effectiveness of one unit of home (foreign) labor. Firms are heterogeneous with respect to their unit cost of production, following Melitz (2003), where a home firm with relative productivity  $z$  produces  $Z_t z$  units of output per unit of labor employed. Hence, the unit cost of production, measured in units of the consumption good  $C_t$ , is  $w_t/(Z_t z)$ , where  $w_t \equiv W_t/P_t$  is the real wage. Similarly, unit costs of production for foreign firms are given by  $w_t^*/(Z_t^* z)$ , where  $w_t^* \equiv W_t^*/P_t^*$  is the real wage of foreign workers.

Before entering the market firms have to incur a sunk entry cost of  $f_{E,t}(f_{E,t}^*)$  effective labor units, equal to  $w_t f_{E,t}/Z_t (w_t^* f_{E,t}^*/Z_t^*)$  units of the home (foreign) consumption good. Upon entry, firms at home and abroad draw their productivity level  $z$  from a common distribution  $G(z)$  with support on  $[z_{\min}, \infty)$ , which stays constant thereafter. In contrast to Melitz (2003) there are no fixed production costs, which implies that all firms produce in every period. Every firm may be hit by a “death” shock, which occurs with probability  $\delta \in (0, 1)$  in each period. It is assumed that this exit-inducing shock is independent of the firm’s productivity level, so  $G(z)$  also represents the productivity distribution of all producing firms.

Beside serving the domestic market, a firm may export. Exporting involves variable iceberg trade cost  $\tau_t \geq 1$  ( $\tau_t^* \geq 1$ ) as well as period-by-period fixed costs  $f_{X,t}(f_{X,t}^*)$ , measured in units of effective labor. Both, variable and fixed costs are covered by domestic labor. These costs, in real terms and unit of the home (foreign) consumption good, are then  $w_t f_{X,t}/Z_t (w_t^* f_{X,t}^*/Z_t^*)$  for home (foreign) firms. Additionally, countries levy import tariffs on goods from abroad  $t_t \geq 1$  ( $t_t^* \geq 1$ ), which are not resource consuming, but revenue-generating.

Given the demand function with constant elasticity ( $\theta$ ) and monopolistic competition, optimal pricing behavior of all firms is given by a constant markup  $\theta/(\theta - 1)$  over marginal cost. Let  $p_{D,t}(z)$  and  $p_{X,t}(z)$  denote the nominal domestic and export prices of a home firm, where the export prices are denominated in the currency of the export market. Prices, in real terms relative to the price index in the destination market, are then given by

$$\rho_{D,t}(z) \equiv \frac{p_{D,t}(z)}{P_t} = \frac{\theta}{\theta - 1} \frac{w_t}{Z_t z}, \quad \rho_{X,t}(z) \equiv \frac{p_{X,t}(z)}{P_t^*} = Q_t^{-1} \tau_t^* t_t^* \rho_{D,t}(z), \quad (1)$$

where  $Q_t \equiv \varepsilon_t P_t^*/P_t$  is the consumption-based real exchange rate, i.e., units

of home consumption per unit of foreign consumption, where  $\varepsilon_t$  is the nominal exchange rate in units of home currency per unit of the foreign currency.

Due to the fixed export cost, firms with low productivity levels  $z$  may decide not to export. Total profits  $d_t(z)(d_t^*(z))$  are distributed to households as dividends and expressed in terms of the home consumption basket. They are given by  $d_t(z) = d_{D,t}(z) + d_{X,t}(z)$ , where

$$d_{D,t}(z) = \frac{1}{\theta} [\rho_{D,t}(z)]^{1-\theta} C_t, \quad (2)$$

$$d_{X,t}(z) = \begin{cases} \frac{Q_t}{\theta t^*} [\rho_{X,t}(z)]^{1-\theta} C_t^* - \frac{w_t f_{X,t}}{Z_t} & \text{if firm } z \text{ exports,} \\ 0 & \text{otherwise.} \end{cases} \quad (3)$$

Foreign firms behave in a similar way. As in Melitz (2003), more productive firms earn higher profits (relative to less productive firms) and set lower prices (see equation (1)). A home (foreign) firm will export when productivity  $z$  is above a cutoff level  $z_{X,t} = \inf\{z : d_{X,t}(z) > 0\}$  ( $z_{X,t}^* = \inf\{z : d_{X,t}^*(z) > 0\}$ ). The lower bound productivity  $z_{\min}$  is assumed to be low enough relative to the export costs so that  $z_{X,t}$  and  $z_{X,t}^*$  are both above  $z_{\min}$ . This ensures that firms with productivity levels between  $z_{\min}$  and  $z_{X,t}$  ( $z_{X,t}^*$ ) decide not to export. Note that this set of firms as well as  $z_{X,t}$  and  $z_{X,t}^*$  fluctuates over time with changes in the profitability of the export market.

## 2.3 Firm Averages

In every period, a mass  $N_{D,t}(N_{D,t}^*)$  of firms produces in the home (foreign) country. These firms have a distribution of productivity levels over  $[z_{\min}, \infty)$  given by  $G(z)$ . Among these firms, there are  $N_{X,t} = [1 - G(z_{X,t})]N_{D,t}$  and  $N_{X,t}^* = [1 - G(z_{X,t}^*)]N_{D,t}^*$  exporters. Following Melitz (2003), we define two special ‘‘average’’ productivity levels - an average  $\tilde{z}_D$  for all producing firms (in each country), and an average  $\tilde{z}_{X,t}$  for all home exporters:

$$\tilde{z}_D \equiv \left[ \int_{z_{\min}}^{\infty} z^{\theta-1} dG(z) \right]^{\frac{1}{\theta-1}}, \quad \tilde{z}_{X,t} \equiv \left[ \frac{1}{1 - G(z_{X,t})} \int_{z_{X,t}}^{\infty} z^{\theta-1} dG(z) \right]^{\frac{1}{\theta-1}}. \quad (4)$$

The definition of  $\tilde{z}_{X,t}^*$  is analogous to that of  $\tilde{z}_{X,t}$ . As shown in Melitz (2003), these productivity averages - based on weights proportional to relative firm output shares - summarize all the information about the productivity distributions which is relevant for the macroeconomic variables. In essence, this implies that the model is isomorphic to one where  $N_{D,t}(N_{D,t}^*)$  firms with productivity level  $\tilde{z}_D$  produce in the home (foreign) country and  $N_{X,t}(N_{X,t}^*)$  firms with productivity level  $\tilde{z}_{X,t}(\tilde{z}_{X,t}^*)$  export to the foreign (home) market.

In particular,  $\tilde{p}_{D,t} \equiv p_{D,t}(\tilde{z}_D)$  ( $\tilde{p}_{D,t}^* \equiv p_{D,t}^*(\tilde{z}_D)$ ) represents the average nominal price of home (foreign) firms in their domestic market, and  $\tilde{p}_{X,t} \equiv p_{X,t}(\tilde{z}_{X,t})$  ( $\tilde{p}_{X,t}^* \equiv$

$p_{X,t}^*(\tilde{z}_{X,t}^*)$ ) represents the average nominal price of home (foreign) exporters in the export market. The price index at home reflects the prices of the  $N_{D,t}$  home firms (with average price  $\tilde{p}_{D,t}$ ) and the  $N_{X,t}^*$  foreign exporters to the home market (with average price  $\tilde{p}_{X,t}^*$ ). The home price index can thus be written as  $P_t = [N_{D,t}(\tilde{p}_{D,t})^{1-\theta} + N_{X,t}^*(\tilde{p}_{X,t}^*)^{1-\theta}]^{1/(1-\theta)}$ . This is equivalent to  $N_{D,t}(\tilde{\rho}_{D,t})^{1-\theta} + N_{X,t}^*(\tilde{\rho}_{X,t}^*)^{1-\theta} = 1$ , where  $\tilde{\rho}_{D,t} \equiv \rho_{D,t}(\tilde{z}_D)$  and  $\tilde{\rho}_{X,t}^* \equiv \rho_{X,t}^*(\tilde{z}_{X,t}^*)$  represent the average relative prices of home producers and foreign exporters in the home market. Similar equations hold for the foreign price index.

The productivity averages  $\tilde{z}_D$ ,  $\tilde{z}_{X,t}$ , and  $\tilde{z}_{X,t}^*$  are constructed in such a way that  $\tilde{d}_{D,t} \equiv d_{D,t}(\tilde{z}_D)$  ( $\tilde{d}_{D,t}^* \equiv d_{D,t}^*(\tilde{z}_D)$ ) represents the average firm profit earned from domestic sales for all home (foreign) producers; and  $\tilde{d}_{X,t} \equiv d_{X,t}(\tilde{z}_{X,t})$  ( $\tilde{d}_{X,t}^* \equiv d_{X,t}^*(\tilde{z}_{X,t}^*)$ ) represents the average firm export profits for all home (foreign) exporters. Thus,  $\tilde{d}_t \equiv \tilde{d}_{D,t} + [1 - G(z_{X,t})]\tilde{d}_{X,t}$  and  $\tilde{d}_t^* \equiv \tilde{d}_{D,t}^* + [1 - G(z_{X,t}^*)]\tilde{d}_{X,t}^*$  represent the average total profits of home and foreign firms, since  $1 - G(z_{X,t})$  and  $1 - G(z_{X,t}^*)$  represent the proportion of home and foreign firms that export and earn export profits.

## 2.4 Firm Entry and Exit

In every period there is an unbounded mass of prospective entrants in both countries. These entrants are forward looking, and correctly anticipate their future expected profits  $\tilde{d}_t$  ( $\tilde{d}_t^*$ ) in every period (the preentry expected profit is equal to postentry average profit) as well as the probability  $\delta$  (in every period) of incurring the exit-inducing shock. Entrants at time  $t$  only start producing at time  $t + 1$ , which introduces a one-period time-to-build lag in the model. The exogenous exit shock occurs at the very end of the time period (after production and entry). A proportion  $\delta$  of new entrants will therefore never produce. Home entrants in period  $t$  compute their expected postentry value given by the present discounted value of their expected stream of profits  $\{\tilde{d}_s\}_{s=t+1}^\infty$ :

$$\tilde{v}_t = E_t \sum_{s=t+1}^{\infty} [\beta(1 - \delta)]^{s-t} \left( \frac{C_s}{C_t} \right)^{-\gamma} \tilde{d}_s. \quad (5)$$

This also represents the average value of incumbent firms after production has occurred, since both new entrants and incumbents then face the same probability  $1 - \delta$  of survival and production in the subsequent period. Firms discount future profits using the household's stochastic discount factor, adjusted for the probability of firm survival  $1 - \delta$ . Entry occurs until the average firm value is equalized with the entry cost, leading to the free entry condition  $\tilde{v}_t = w_t f_{E,t} / Z_t$ . This condition holds as long as the mass  $N_{E,t}$  of entrants is positive. Following Ghironi and Melitz (2005), it is assumed that macroeconomic shocks are small enough for this condition to hold in every period. Finally, the timing of entry and

production we have assumed implies that the number of home-producing firms during period  $t$  is given by  $N_{D,t} = (1 - \delta)(N_{D,t-1} + N_{E,t-1})$ . A similar free entry condition, requirements for the size of shocks, and law of motion for the number of producing firms hold in the foreign country.

## 2.5 Household Budget Constraint and Intertemporal Choices

Households in each country hold two types of assets: shares in a mutual fund of domestic firms and domestic and foreign risk-free bonds. Bonds at home and abroad pay risk-free, consumption-based real returns.  $x_t$  denotes the share in the mutual fund of home firms held by the representative home household entering period  $t$ . The mutual fund pays a total profit in each period (in units of the home currency) that is equal to the average total profit of all home firms that produce in that period,  $P_t \tilde{d}_t N_{D,t}$ . During period  $t$ , the representative home household buys  $x_{t+1}$  shares in a mutual fund of  $N_{H,t} = N_{D,t} + N_{E,t}$  home firms (those already operating at time  $t$  and the new entrants). Only  $N_{D,t+1} = (1 - \delta)N_{H,t}$  firms will produce and pay dividends at time  $t + 1$ . Since the household does not know which firms will be hit by the exogenous exit shock  $\delta$ , it finances the continuing operation of all preexisting home firms and all new entrants during period  $t$ . The date  $t$  price (in units of home currency) of a claim to the future profit stream of the mutual fund of  $N_{H,t}$  firms is equal to the average nominal price of claims to future profits of home firms,  $P_t \tilde{v}_t$ .

The home household enters period  $t$  with home (foreign) bond holdings  $B_t$  ( $B_{*,t}$ ) in units of consumption and mutual fund share holdings  $x_t$ . It receives gross interest income on bond holdings, dividend income on mutual fund share holdings and the value of selling its initial share position, and labor income. The household allocates these resources between purchases of bonds and shares to be carried into next period and consumption. Thus, the period budget constraint (in units of consumption) is

$$B_{t+1} + Q_t B_{*,t+1} + \frac{\eta}{2}(B_{t+1})^2 + \frac{\eta}{2}Q_t(B_{*,t+1})^2 + \tilde{v}_t N_{H,t} x_{t+1} + C_t = (1 + r_t)B_t + Q_t(1 + r_t^*)B_{*,t} + (\tilde{d}_t + \tilde{v}_t)N_{D,t}x_t + T_t^f + w_t L + T_t, \quad (6)$$

where  $r_t$  is the consumption-based interest rate on holdings of bonds between  $t - 1$  and  $t$  (known with certainty as of  $t - 1$ ) and  $(\eta/2)(B_{t+1})^2$  ( $(\eta/2)(B_{*,t+1})^2$ ) is the cost of adjusting home (foreign) bonds. The assumption of fees that are quadratic functions of the stock of bonds is sufficient to uniquely pin down the steady state and deliver stationary model dynamics in response to temporary shocks (for more details see Ghironi, 2006).  $T_t^f$  is the rebate of fees, taken as given by the household, and equal to  $(\eta/2)[(B_{t+1})^2 + Q_t(B_{*,t+1})^2]$  in equilibrium.  $T_t$  are tariff revenues that are redistributed in a lump sum fashion to consumers.

Specifically,  $T_t$  is given by  $(t_t - 1)/t_t(\tilde{\rho}_{x,t}^*)^{1-\theta}C_tN_{X,t}^*$ , where  $\tilde{\rho}_{x,t}^*$  is the real price of the average (foreign) exporting firm and, thus,  $(\tilde{\rho}_{x,t}^*)^{1-\theta}C_tN_{X,t}^*$  are total imports.

A similar constraint holds for the foreign country:

$$\begin{aligned} \frac{B_{t+1}^*}{Q_t} + B_{*,t+1}^* + \frac{\eta}{2} \frac{(B_{t+1}^*)^2}{Q_t} + \frac{\eta}{2} (B_{*,t+1}^*)^2 + \tilde{v}_t^* N_{F,t}^* x_{t+1}^* + C_t^* = \\ \frac{(1+r_t)}{Q_t} B_t^* + (1+r_t^*) B_{*,t}^* + (\tilde{d}_t^* + \tilde{v}_t^*) N_{D,t}^* x_t^* + T_t^{f*} + w_t^* L^* + T_t^*, \end{aligned} \quad (7)$$

where  $B_{t+1}^*$  denotes holdings of the home bond,  $B_{*,t+1}^*$  denotes holdings of the foreign bond,  $T_t^{f*} = (\eta/2)[(B_{t+1}^*)^2/Q_t + (B_{*,t+1}^*)^2]$  in equilibrium, and  $T_t^* = (t_t^* - 1)/t_t^*(\tilde{\rho}_{x,t}^*)^{1-\theta}C_t^*N_{X,t}^*$ .

The home and foreign households maximize their expected intertemporal utility subject to (6) and (7), respectively.

The Euler equations for share holdings at home are

$$\tilde{v}_t = \beta(1-\delta)E_t \left[ \left( \frac{C_{t+1}}{C_t} \right)^{-\gamma} (\tilde{v}_{t+1} + \tilde{d}_{t+1}) \right]. \quad (8)$$

The Euler equations for bond holdings at home are

$$(C_t)^{-\gamma} (1 + \eta B_{t+1}) = \beta(1 + r_{t+1})E_t[(C_{t+1})^{-\gamma}], \quad (9)$$

$$(C_t)^{-\gamma} (1 + \eta B_{*,t+1}) = \beta(1 + r_{t+1}^*)E_t \left[ \frac{Q_{t+1}}{Q_t} (C_{t+1})^{-\gamma} \right]. \quad (10)$$

Similar relationship for the Euler equations for share and bond holdings apply abroad.

As expected, forward iteration of the equation for share holdings and absence of speculative bubbles yield the asset price solution in equation (5).

## 2.6 Aggregate Accounting and Labor Market Clearing

Aggregating the budget constraint (6) and (7) across home (foreign) households and imposing the equilibrium conditions under international bond trading ( $B_{t+1} + B_{t+1}^* = B_{*,t+1} + B_{*,t+1}^* = 0$  and  $x_{t+1} = x_t = 1$ ) yields the aggregate accounting equation

$$B_{t+1} + Q_t B_{*,t+1} = (1+r_t)B_t + Q_t(1+r_t^*)B_{*,t} + w_t L + N_{D,t} \tilde{d}_t + T_t - N_{E,t} \tilde{v}_t - C_t. \quad (11)$$

This condition shows that in equilibrium, the markets for home and foreign bonds clear, and each country's net foreign assets entering period  $t+1$  depend on interest income from asset holdings entering period  $t$ , labor income, net investment income (where  $N_{E,t} \tilde{v}_t$  is the value of home investment in new firms), and consumption

during period  $t$ . The change in asset holdings between  $t$  and  $t+1$  is the country's current account. A similar equation holds abroad:

$$\frac{B_{t+1}^*}{Q_t} + B_{*,t+1}^* = \frac{(1+r_t)}{Q_t} B_t^* + Q_t(1+r_t^*)B_{*,t}^* + w_t^* L^* + N_{D,t}^* \tilde{d}_t^* + T_t^* - N_{E,t}^* \tilde{v}_t^* - C_t^*. \quad (12)$$

Multiplying (12) with  $Q_t$  and subtracting the resulting equation from (11) yields an expression for home net foreign asset accumulation as a function of interest income and of the cross-country differentials between labor income, net investment income, and consumption:

$$B_{t+1} + Q_t B_{*,t+1} = (1+r_t)B_t + Q_t(1+r_t^*)B_{*,t} + \frac{1}{2}(w_t L - Q_t w_t^* L^*) + \frac{1}{2}(N_{D,t} \tilde{d}_t - N_{D,t}^* Q_t \tilde{d}_t^*) + \frac{1}{2}(T_t - Q_t T_t^*) - \frac{1}{2}(N_{E,t} \tilde{v}_t - N_{E,t}^* Q_t \tilde{v}_t^*) - \frac{1}{2}(C_t - Q_t C_t^*). \quad (13)$$

Home and foreign current accounts add to zero when expressed in units of the same consumption basket.

To close the model, we have to impose labor market clearing at home and abroad, given for the home country by:

$$L = \frac{\theta-1}{w_t} (N_{D,t} \tilde{d}_{D,t} + N_{X,t} \tilde{d}_{X,t}) + \frac{1}{Z_t} (\theta N_{X,t} f_{X,t} + N_{E,t} f_{E,t}), \quad (14)$$

and similarly abroad.

## 3 Calibration

### 3.1 Parametrization of Productivity Draws

To solve the model numerically, we assume that productivity  $z$  is distributed Pareto with lower bound  $z_{\min}$  and shape parameter  $k > \theta - 1$ :  $G(z) = 1 - (z_{\min}/z)^k$ . The assumption of a Pareto distribution for productivity induces a size distribution of firms that is also Pareto, which fits firm-level data quite well.  $k$  indexes the dispersion of productivity draws: dispersion decreases as  $k$  increases, and the firm productivity levels are increasingly concentrated toward their lower bound  $z_{\min}$ . Letting  $v \equiv \{k/[k - (\theta - 1)]\}^{1/(\theta-1)}$ , the average productivities  $\tilde{z}_D$  and  $\tilde{z}_{X,t}$  are given by  $\tilde{z}_D = v z_{\min}$  and  $\tilde{z}_{X,t} = v z_{X,t}$ . The share of home-exporting firms is then  $N_{X,t}/N_{D,t} = 1 - G(z_{X,t}) = (v z_{\min}/\tilde{z}_{X,t})^k$ , and the zero export profit condition (for the cutoff firm),  $d_{X,t}(z_{X,t}) = 0$ , implies that average export profits must satisfy  $\tilde{d}_{X,t} = (\theta - 1)(v^{\theta-1}/k)w_t f_{X,t}/Z_t$ . Analogous results hold for  $\tilde{z}_{X,t}^*$ ,  $N_{X,t}^*/N_{D,t}^*$ , and  $\tilde{d}_{X,t}^*$ .

## 3.2 Parametrization of Preferences and Costs

Every period represents a quarter and  $\beta$  is set equal to 0.99 and  $\gamma = 2$ .  $\delta$ , the exogenous firm exit shock, is set equal to 0.025, which matches the U.S. empirical level of 10 percent job destruction per year.  $\theta$  is set equal to 3.8 following Bernard, Eaton, Jensen, and Kortum (2003). They also report that the standard deviation of log U.S. plant sales is 1.67. As in the given model this standard deviation is equal to  $1/(k - \theta + 1)$ , the choice of  $\theta = 3.8$  implies that  $k = 3.4$ . Consistently with Obstfeld and Rogoff (2001) we set the steady-state value of trade costs  $\bar{\tau}$  equal to 1.2.

The steady-state fixed export cost  $f_X$  is set to 10.9 percent of the per-period, amortized flow value of the entry cost,  $[1 - \beta(1 - \delta)]/[\beta(1 - \delta)]f_E$ , such that the proportion of exporting plants matches the 21 percent reported in Bernard, Eaton, Jensen, and Kortum (2003). We set the scale parameter for the bond adjustment cost to  $\eta = 0.0025$ , which is enough to generate stationarity in response to transitory shocks but small enough to avoid overstating the role of this friction in determining the dynamics of the model.

Entry costs  $f_E$  are set to 1 without loss of generality, as changing  $f_E$  while maintaining the ratio  $f_X/f_E$  does not affect any of the impulse responses. For similar reasons, we normalize  $z_{\min}$  to 1. Labor endowments are also normalized to 1, i.e.,  $L = 1$  and  $L^* = 1$ .

## 4 Nash-Equilibrium Tariffs

### 4.1 Nash-Equilibrium Tariffs in the Static Model

Nash-equilibrium tariffs in static trade models rely on three effects: i) a positive terms-of-trade effect, ii) a positive tariff revenue effect, iii) a negative effect due to an increase of import prices. As long as there is a positive terms-of-trade effect, there exists a positive Nash-equilibrium tariff (Feenstra, 2004). These effects are calculated by assuming that all transitional adjustments have already taken place. Or alternatively, that they occur instantaneously.

The Nash-equilibrium tariff in the static model is calculated as usual. We take the steady-state values of consumption, and look for the tariff leading to the highest steady-state consumption for each possible tariff of the trading partner. In other words, we simulate the best-response functions for both countries. Afterwards we calculate the Nash-equilibrium tariff by intersecting the best-response functions of the two countries. This yields a Nash-equilibrium of 35.1 percent, which lies in the range of earlier results in the literature, as highlighted above.

## 4.2 Is the Nash-Equilibrium of the Static Model Dynamically Stable?

As discussed in the introduction, the diverse effects of trade liberalization may need different time spans to materialize. Whereas tariff revenues appear instantaneously in each period, the terms-of-trade effects, the change in import prices and the adjustment of average productivity among firms may occur delayed. Hence, taking a dynamic perspective has to take into account these different speeds of adjustment of gains and losses.

This naturally poses the question whether there might be an incentive to deviate from the Nash-equilibrium of the static model, even though this would lower steady-state consumption. Using the present discounted value of the stream of consumption as our welfare measure, the question to this answer is a clear yes and demonstrated in Figure 1.<sup>5</sup> Starting from the Nash-equilibrium of the static model a further decrease in tariffs lowers steady state consumption by construction (otherwise it would not be a Nash-equilibrium). However, the tariff reduction implies temporary gains in consumption at the beginning, which turn into losses only very late. Since consumers (and policy makers) are impatient and discount future periods, these immediate gains outweigh the future losses. Hence, welfare is increased.

Let us describe the dynamic effects underlying this result in more detail. In Figure 1 we lower the tariff from the Nash-equilibrium tariff in the static model (which is 35.1 percent) to the Nash-equilibrium tariff in the dynamic model (which is 33 percent and described further below). Hence, the import tariff is reduced by 2.1 percentage points. Due to lower tariffs, foreign goods become cheaper for consumers at home. Hence, consumption goes up due to increased imports. Since adjustment via the intensive margin is very flexible, this happens immediately. In other words, the foreign exporters react immediately to the increase in demand. On the other hand, the reduction in the number of domestic firms happens relatively slowly. In line with Melitz (2003) trade liberalization reduces the number of firms because of the increased competition through foreign exporters. However, this increased competition mainly affects the entry decision of new firms. Potential entrants realize that competition has increased and thus the number of firms entering the market goes down. To the contrary, for already existing domestic firms the entry costs are already sunk. Thus, they keep on operating, although with reduced profits, until they are hit by the exogenous death shock.<sup>6</sup> Nevertheless, the total number of firms goes down because the reduced number of entrants is no longer large enough to make up for the exit of firms. Thus, the number of firms slowly converges to its new steady-state level

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<sup>5</sup>This and all the following simulations were conducted by using the Dynare package for Matlab, see Juillard (1996).

<sup>6</sup>Note that firms selling only domestically do not pay fixed costs. Hence, they always make profits.



(and with it output and consumption).

Another way to look at the result of increased short-run consumption is to interpret the entry of firms as an investment and the number of firms as the capital stock. With high tariffs it pays off to invest a lot in new firms because the economy has to rely more on its own production. When tariffs decrease, it no longer pays off to invest so much in new firms because a larger share of domestic demand is met by foreign production and because domestic firms become larger. However, in the transitional period the economy still draws from the high capital stock (the large number of firms) due to past investments. Thus, it can boost consumption and production until the capital stock (the number of firms) has depreciated below a certain level.

Concerning exports, there are three effects. First, the real exchange rate appreciates, making home products relatively cheaper than foreign goods. This increases foreign demand for domestic products. Second, the import tariff cut leads to a permanently higher income and permanently higher consumption in the trading partner. As the foreign country spends part of its income on goods from abroad, exports will increase. Third, in order to balance trade in the long-run, exports have to increase to offset the increase in imports, described above.

Besides this sluggish replacement of less productive domestic firms, there is a second dynamic aspect in our model, stemming from the fact that trade only has to be balanced in the long-run. As mentioned above, the country lowering the import tariff will be importing more than it exports in the early periods, building up debt against its trading partner. In the later periods it will export more than import to pay back the debt.

The short-run increase in consumption is central for our results concerning Nash-equilibrium tariffs. Hence, the question arises whether the prediction of the short-run increase in consumption is supported by the data. However, to the best of our knowledge empirical evidence on this aspect is not available. Therefore, we provide empirical findings supporting other predictions of our model. Bergin and Lin (2010) show that the European Monetary Union increased the extensive margin of trade stronger in the first few years than in later years. Importantly, the reaction at the extensive margin is immediate and large which is in line with our theoretical model. Chen, Imbs and Scott (2009) find conclusive evidence for short-run but not for long-run competitiveness effects using disaggregated data for EU manufacturing over the period 1989–1999. This is in line with the predictions of our model concerning the number of firms and the profits of domestic firms.

After explaining the intuition of the model, let us repeat the main message of this experiment. Taking account of transitional dynamics implies an incentive to deviate from the the Nash-equilibrium of the static model. Thus, the Nash-equilibrium of the static model is not dynamically stable.

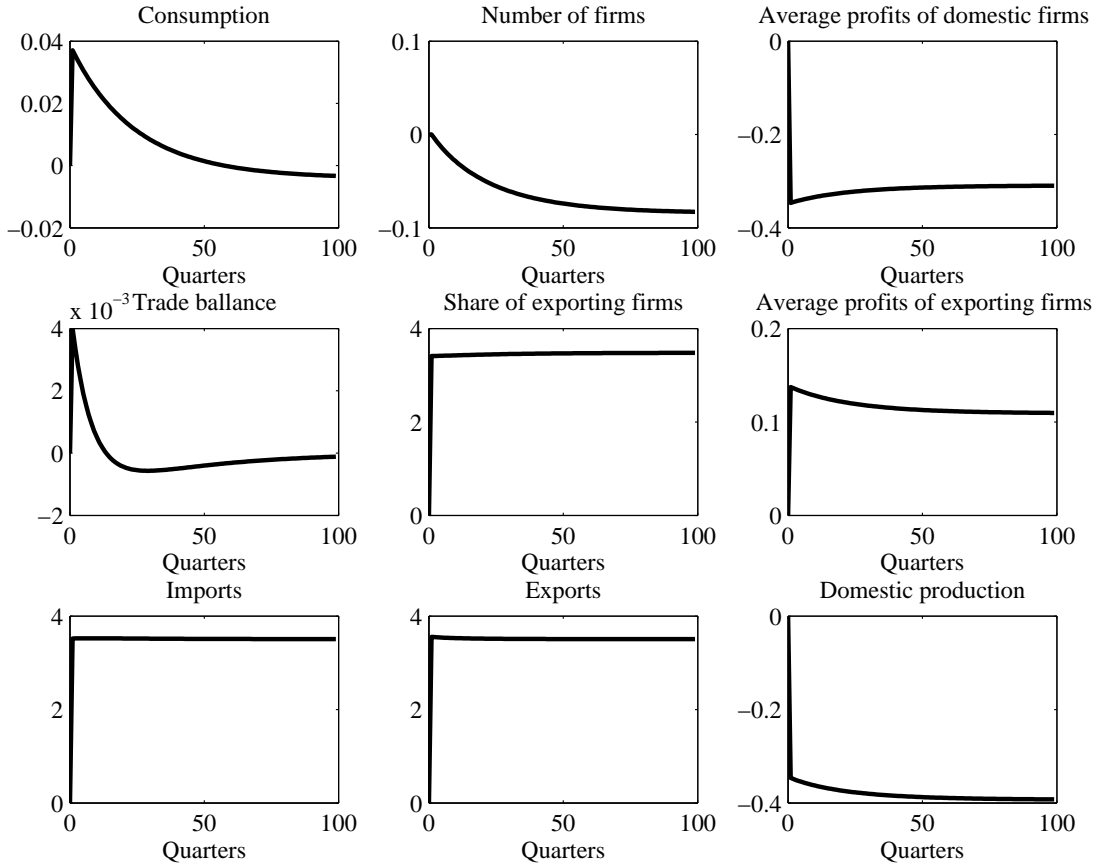


Figure 1: Effects of a 2.1 percentage point reduction from the Nash-equilibrium tariff in the static model.

### 4.3 Nash-equilibrium Tariffs in the Dynamic Model

The Nash-equilibrium tariff in the dynamic model is calculated similarly as the Nash-equilibrium in the static model. However, in contrast to the Nash-equilibrium tariff in the static model, we take the net-present value of consumption over all periods, including the periods of transition to the new steady state. Hence, the timing of increases and decreases in consumption becomes important, as earlier periods count more than later ones due to discounting of future periods. From that we proceed similarly as in the static case. We look for the tariff leading to the highest net-present value of consumption for each possible tariff of the trading partner. In other words, we simulate the best-response functions based on net-present values of consumption. Afterwards we calculate the Nash-equilibrium tariff by intersecting the best-response functions of the two countries. It turns out that the Nash-equilibrium tariff in the dynamic model is 33 percent, lower than the Nash-equilibrium tariff in the static model.

In order to demonstrate that there is no longer an incentive to deviate from

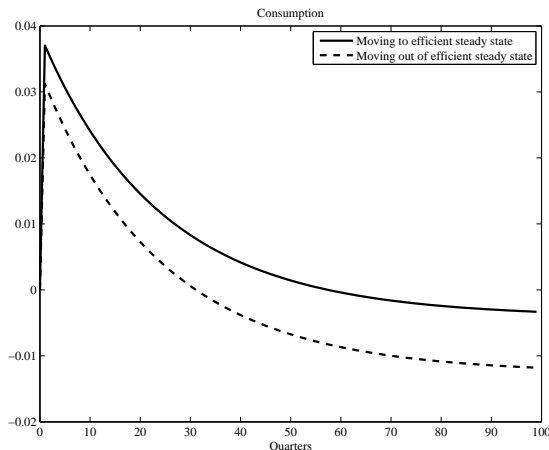


Figure 2: Comparison of consumption path for a 2.1 percentage point reduction starting from the static (consumption path labeled “moving to efficient steady state”) and dynamic (consumption path labeled “moving out of efficient steady state”) Nash-equilibrium tariff.

this equilibrium, we undertook the following comparison of experiments. As in Figure 1, our first experiment is to lower tariffs from of 35.1 percent, the Nash-equilibrium of the static model, to 33 percent, the Nash-equilibrium of the dynamic model. The second experiment starts from 33 percent and lowers the tariff by the same magnitude, i.e., by 2.1 percentage points.

The effects on consumption are shown in Figure 2. The consumption path labeled “moving to efficient steady state” corresponds to the first experiment, whereas the consumption path labeled “moving out of efficient steady state” corresponds to the second experiment. We can infer from this picture that the positive consumption changes in any period are lower and the negative consumption changes in any period are larger in the second experiment. Furthermore, it can be seen that the initial gains are sooner turned into losses in the second experiment (after around 7.5 years) than in the first experiment. Altogether, it is quite obvious that the deviation from the Nash-equilibrium of the dynamic model is not beneficial, whereas the deviation from the Nash-equilibrium of the static model increases welfare.

## 5 Nash-Equilibrium Tariffs and the Time Horizon of Decision-Makers

So far we calculated the net-present value of consumption over all periods, i.e., from period one to infinity. However, one may argue that politicians do not care about the (very) long-run, as is standard in political economy models. Baldwin

argues in a VOXEU-column on January 28th, 2011:<sup>7</sup> “*The Doha Round is likely to conclude this year as long as world leaders show leadership and get down to making the few final trade-offs needed to move multilateral trade governance into the 21st century. This will not require Herculean feats of political sacrifice – it just requires leaders to embrace the sort of ‘enlightened self-interest’ that has been necessary to close every round of multilateral trade talks since the 1940s.*” Here we want to make the point that it is in the self-interest of short-sighted politicians to negotiate lower tariffs, because of the positive short-run effects of tariff reductions. This explains our recommendation to *send the shortsighted ones to Doha.*

To prove this point, we investigate the dependence of the Nash-equilibrium tariffs on the considered time horizon. Figure 3 plots the Nash-equilibrium tariffs ( $y$ -axis) for different time horizons ( $x$ -axis). First, note that the Nash-equilibrium tariff in the static model is independent of the time horizon, as it is calculated based on the steady-state consumption values. Hence, it is a constant over the time horizon, taking always the value 35.1 percent. In contrast, the Nash-equilibrium tariff in the dynamic model does depend on the time horizon. Specifically, it is increasing in the time horizon. This means that the Nash-equilibrium tariff in the dynamic model is lower the shorter the considered time horizon.

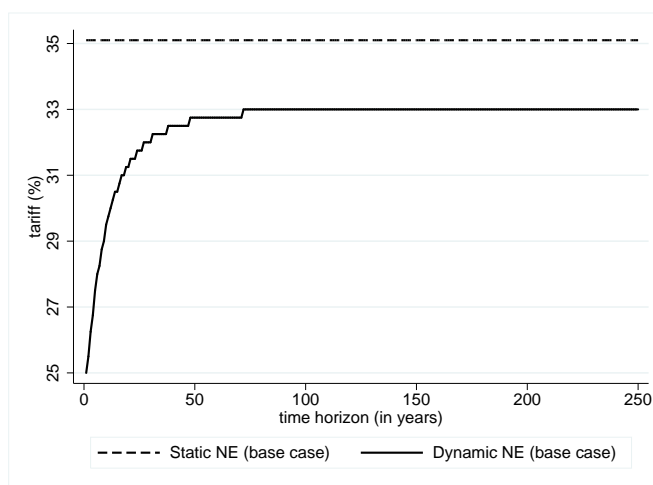


Figure 3: Comparison of Nash-equilibrium tariffs in the static model and the dynamic model.

The reason for the increase of the Nash-equilibrium tariff in the dynamic model with the time horizon considered is the underlying adjustment of firms. As motivated above, we allow firms to enter as soon as it is profitable for them. But

<sup>7</sup>Available at <http://www.voxeu.org/index.php?q=node/6066>

exit is only possible by an exogenous death shock. Hence, after a tariff change, firms that are too unproductive to survive in the new steady-state will continue to stay in the market for a couple of periods as they have already incurred sunk costs. However, at some point in time they will be wiped out of the market. The zero-profit cutoff productivity increases due to lower tariffs. Hence, new firms will only enter if they are sufficiently productive. Understanding these effects at the extensive margin explains the higher Nash-equilibrium tariffs in the dynamic model for lower time horizons. Immediately after the tariff cut firms will still stay in the market, but consumers will already enjoy the greater variety of goods at lower net-prices. However, the market cleansing effect only materializes after a couple of periods. Hence, a tariff cut is more attractive the shorter the considered time horizon.

Thus, short-sighted politicians, *ceteris paribus*, hurt the economy, since they ignore the long-run costs of tariff reductions and therefore set tariffs at a level too low. However, it should be noted that in the end this kind of behavior can improve the welfare of everybody (even in the long-run). The reason is that politicians in neighboring countries behave similarly, also setting their tariffs *ceteris paribus* at a lower level than socially optimal. This decrease in tariffs of neighboring countries offsets and overturns the losses due to tariff reduction in the home country. In the end both countries are better off. In this way the Nash-equilibrium tariff in the dynamic model, accounting for the adjustments after tariff changes, is one of the rare instances where shortsightedness of politicians can actually be welfare-improving.

At this point, let us draw your attention to the similarity in the argumentation to Davidson and Matusz (2006). They show that the short-run increase in income triggered by liberalization may swamp any long-run loss from expanding the low-wage sector. Hence, in their model with labor market turnover free trade would only be good when focusing on the short-run behavior of the economy and ignoring the long-run properties. This fits well to our finding of lower Nash-equilibrium tariffs in the dynamic model.

What can we take away from this result? Politicians that only care about a short period of time may end up to be more pro-trade than someone who cares about the long-term perspective, everything else equal. Is this something which is in line with real world behavior? A formal test of this theory is still missing, but at least the rapid expansion of large trading blocs, like NAFTA (North American Free Trade Agreement) and the EU (European Union), hints at the preference for lower tariffs for the deciding agents, in charge only for short time periods. It is also a matter of fact that the FTAA (Free Trade of the Americas) was initiated by politicians only elected for a couple of years, and stalled by massive anti-corporatization and anti-globalization protests, such as senior citizens, labor groups, environmentalists, human rights advocates and peace advocates. Which group would you assign a longer planning horizon?

## 6 Conditioning Effects of Trade Costs, Country Size, Firm Heterogeneity and Gradual Reforms

In this subsection we will investigate how trade costs, country size, firm heterogeneity and gradual reforms affect our result that Nash-equilibrium tariffs in the dynamic model are lower than Nash-equilibrium tariffs in the static model, and that the former fall the shorter the time horizon considered.

**The Influence of Trade Costs.** As mentioned in the introduction, tariffs are low for most products and most countries already. Hence, one may wonder whether there is a scope for the World Trade Organization (WTO). Among other things, the WTO cares about upper limits for tariffs and the extension of tariff reductions granted to one member to all WTO members through the most favored nation clause. This upper limit of tariffs may become binding in the course of a fall of trade costs.

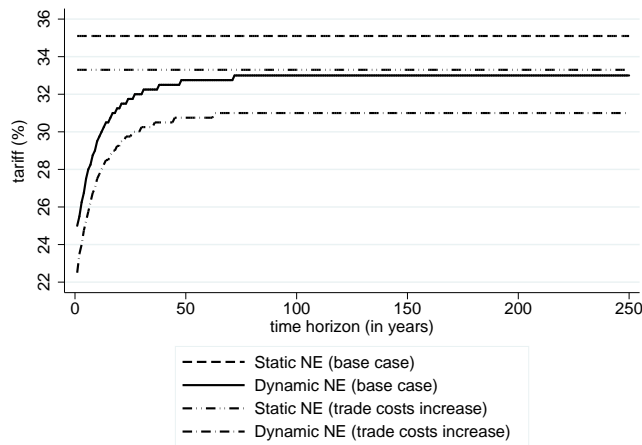


Figure 4: Comparison of Nash-equilibrium tariffs for different trade cost values.

In order to demonstrate this point, let's investigate the role of trade costs. We increase trade costs from our base scenario of 20 percent to 40 percent. As can be seen in Figure 4 this increase leads the Nash-equilibrium tariff in the static model to fall from 35.1 percent to 33.3 percent. The Nash-equilibrium tariff in the dynamic model also falls for all time horizons. Hence, higher trade costs come with lower Nash-equilibrium tariffs in the both models. Or, the other way round: A fall in trade costs and non-tariff barriers to trade will lead to higher Nash-equilibrium tariffs. Hence, in the course of lower trade costs, there would be an incentive to increase tariffs.

This is exactly where the WTO can contribute. By insisting on upper bounds and the extension to all member countries, the WTO ensures that a fall of trade costs in the future does not cause an increase of tariffs. However, without institutional bindings at the supranational level representative of countries would have an incentive to increase tariffs if trade costs fall.

**The Role of Country Size.** It is a standard result in the literature on optimal tariffs that larger countries set higher tariffs than smaller ones (see chapter 7 in Feenstra, 2004, for example). We undertake a similar experiment by increasing the labor endowment in country one from 1 to 1.33, and decreasing at the same time labor endowment of country two from 1 to 0.67. This ensures that the world endowment of labor is constant. We change labor as our measure for the size of countries, as income is endogenous in our model. As can be seen from Figure 5, it also holds for the Nash-equilibrium tariff in the dynamic model that the larger country sets a higher import tariff than the smaller one. The intuition is the usual one: A larger country faces a lower elasticity of foreign export supply than a smaller country, or, in other words, the foreign market is less important for a large country.

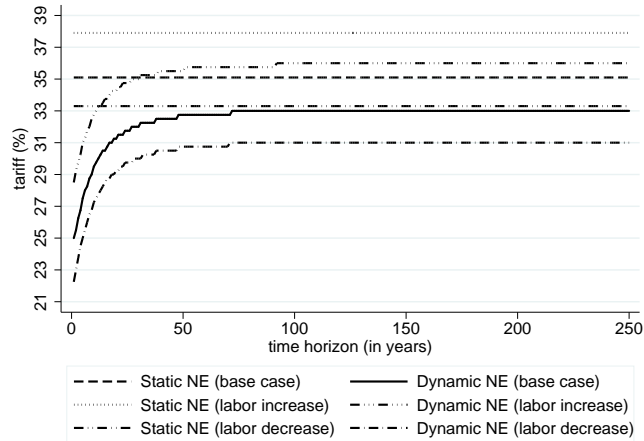


Figure 5: Comparison of Nash-equilibrium tariffs for different country sizes.

**The Role of Firm Heterogeneity.** We have chosen a model with heterogeneous firms in order to be able to account for changes at the extensive as well as the intensive margin. In order to highlight the role of firm heterogeneity, we now want to demonstrate how an increase in heterogeneity effects Nash-equilibrium tariffs. We therefore increase the shape parameter of the Pareto distribution  $k$

from 3.4 to 4. This leads to a more equal distribution of firm productivities.<sup>8</sup> In Figure 6 we see that a more equal distribution of firms with a lower mean leads to lower Nash-equilibrium tariffs in the static model and in the dynamic model for all time horizons. The reason is that less firms will export due to the lower mean, and that due to the greater similarity, only few firms are productive enough to incur the exporting fixed costs. An increase of import tariffs leads therefore to a larger change in the number of firms (extensive margin), as competition is more severe and firms are more sensitive to exporting costs. This explains the lower Nash-equilibrium tariffs.

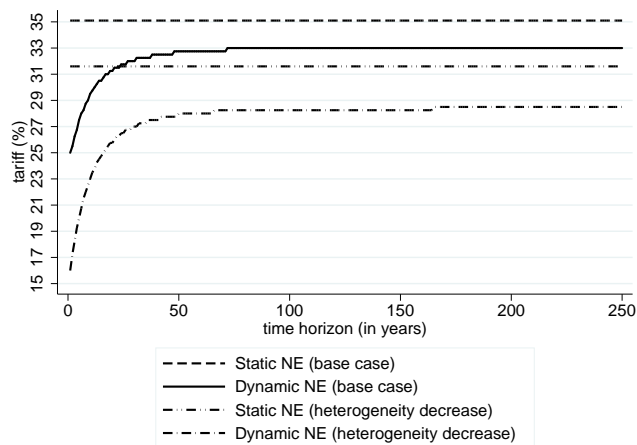


Figure 6: Comparison of Nash-equilibrium tariffs for different degrees of heterogeneity.

**Gradual Tariff Reforms.** In the introduction we discussed a couple of papers dealing with the question whether it is welfare-improving to gradually reduce tariffs. So far we focused on once-and-for all tariff reductions in the first period only. Whereas this discussion does not affect our Nash-equilibrium tariff in the static model at all, it may effect our Nash-equilibrium tariff in the dynamic model. Note, however, that we do not have any adjustment costs for workers, any self-enforceability problems of agreements, or any distributional effects of income in our framework. Hence, there is no scope for delaying a favorable tariff reduction. Whenever it is welfare-improving in net-present value terms to reduce tariffs in the future, the same decrease of the tariff now will lead to an even larger welfare increase.

<sup>8</sup>Note, however, that a change in  $k$  also changes the mean of the Pareto distribution. This is a drawback of the one-parameter Pareto distribution. Specifically, an increase of  $k$  decreases the mean.



## 7 Conclusions

Economic adjustments due to a policy intervention take time to materialize. This is well known in macroeconomics, but rarely considered in evaluating Nash equilibrium tariffs. We employ a dynamic trade model with revenue-generating tariffs in order to investigate Nash-equilibrium tariffs accounting for adjustment dynamics.

Nash-equilibrium tariffs based on the net-present value of consumption of the dynamic model, that do take into account the time to adjust, are shown to be lower than Nash-equilibrium tariffs based on steady-state consumption levels. We also demonstrate that the time horizon considered leads to different Nash-equilibrium tariffs in the dynamic model, whereas Nash-equilibrium tariffs in the static model are unaffected. Interestingly, Nash-equilibrium tariffs in the dynamic model are lower for shorter time horizons.

Our results help to explain four puzzles: (i) It helps to close the gap between the theoretically predicted level of tariffs and observed tariffs. Predictions on Nash-equilibrium tariffs in the static model exceed empirically observed tariffs, but Nash-equilibrium tariffs in the dynamic model are substantially lower than Nash-equilibrium tariffs in the static model. (ii) Why tariffs are reduced so heavily and so fast. Tariff reductions are negotiated by politicians that are elected for a couple of years. As we have shown, a shorter time horizon leads to a higher incentive to lower tariffs. (iii) Why some tariff reductions may not become effective. While politicians may promote trade liberalization, interest groups with a larger time horizon may stall negotiations. This answers the question “Whom to send to Doha?”. (iv) Why a supranational organization like the WTO is important. As soon as a given level of trade liberalization is reached, future trade cost changes may lead to an incentive to set higher tariff levels. An organization like the WTO ensures that this will not happen.

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