# Reforms and the Real Exchange Rate:
# The Role of Pricing-to-Market

Lise Patureau[*]        Céline Poilly[†‡]

September 2018

## Abstract

The paper investigates how endogenous markups affect the ability of policy reforms to play on international competitiveness. In a two-country model where trade costs allow for international market segmentation, we show that the endogenous pricing-to-market behavior of firms plays as an important transmission channel of the policies. By strengthening the degree of competition between firms, a product market deregulation at Home leads to a reduction in the domestic markups, which tends to improve international competitiveness for the Home country. Conversely, the ability of the competitive tax policy to depreciate the real exchange rate is dampened, as the domestic firms take the opportunity of the labor tax cut to increase their markups. Markups' variability also affects the normative implications of the reforms. This points out the importance of taking into account the endogenous pricing-to-market behavior if willing to correctly evaluate the overall effects of the reforms.

*JEL classification*: E32, E52, F41

*Keywords*: Exchange Rate, Product Market Deregulation, Fiscal reform, Endogenous firm entry, Pricing-to-Market, Endogenous markups.

# 1 Introduction

The severity of the recession that hit a large number of countries over the last decade forced policy-makers and economists to gauge the structural fragilities that expanded in developed countries throughout the 2000s. Current account imbalances and sustained real exchange appreciation have notably been pointed out as serious failures for the peripheral euro-zone countries (Lane & Milesi-Ferretti, 2011). Accordingly, the literature attests a renewed interest for studying the effects of fiscal and/or structural policies on external imbalances. Playing on the fiscal tool has thus been studied as a way to depreciate the real exchange rate in the short run (Farhi et al., 2014). Deregulating the goods market may also help firms compete on the international markets (see Cacciatore et al. (2015a) for a survey).

In this paper, we investigate the channels through which policy reforms – as a product market deregulation or a payroll tax cut – affect the real exchange rate, in both the long- and the short-run perspectives. As pointed out by several empirical studies, the firms' "pricing-to-market" behavior (PTM hereafter) has key implications on the real exchange rate (see Burstein & Gopinath, 2014 for a survey). In this context, it is likely that the ability of a given reform to reduce prices depends on markup adjustments, which differ across destination markets in presence of international markets segmentation. A main contribution of the paper is thus to shed light on the role of endogenous markup adjustments on the effectiveness of the reforms to affect international relative prices.

We address this question on theoretical grounds. Precisely, we develop a two-country dynamic model with imperfect competition and endogenous firm entry featuring international trade costs and sunk entry cost, close to Corsetti et al. (2007). With this setup, we capture the two dimensions that have been shown to be key elements in shaping the real exchange rate behavior, the relative price of exported goods and the relative number of exporters (i.e., the extensive margin of trade, see the seminal contribution of Ghironi & Mélitz (2005)). This theoretical framework is enriched with a structure of oligopolistic competition that generates endogenous markups, in a similar way as Atkeson & Burstein (2008). Further, international trade costs allow firms to discriminate across countries by charging different markups specific to the destination market. We thus show that the markup extracted on each market depends on two elements. First, the "competition effect", i.e. on the number of competitors in the market: The lower the number of competitors, the lower the price-elasticity of demand for a given variety, hence the higher the markup extracted by its producing firm. Due to the open-economy structure, markups are also determined by the "relative-price effect": When imported varieties are more expensive than local ones, the price-elasticity of demand for the goods produced at Home contracts, allowing domestic firms to extract higher markups. We then show how these markup adjustments intervene as a major transmission channel of the reforms onto international relative prices. Precisely, we study the effects of the Home country carrying out either a reform to alleviate the goods market entry cost (i.e. product market deregulation) or to reduce the labor tax wedge by switching from direct labor taxation to indirect consumption taxes (i.e. the competitive tax policy), contrasting the cases where markups are constant or endogenously adjust to the economic policy. For our benchmark calibration, we find that that competitive tax

policy is successful in improving international competitiveness through a permanent reduction in the terms of trade and a real exchange depreciation while a product market deregulation is not. This result also holds all along the transitional dynamics and in the long-run. Importantly, we stress the key role of the endogenous PTM behavior of firms as a propagation channel of both reforms. Specifically, endogenous markups lessen the impact of both reforms of international relative prices. The underlying transmission mechanisms behind these results can be accounted for as follows. In the long run, the product market deregulation at Home improves the market position of domestic firms which pushes towards a real exchange depreciation everything else equal. Yet, this effect is counteracted by a rise in the relative labor cost at Home, which is detrimental on the price-competitiveness of Home goods (the terms of trade, i.e. the relative price of exports go up). The competitive tax policy also works on these two transmission channels, but in the opposite direction, entailing a reduction in the relative unit labor cost at Home, to balance with a reduction in the relative number of domestic firms on the world market. For our benchmark calibration, the relative labor cost effect dominates, such that the competitive tax policy induces a real exchange rate depreciation versus an appreciation for the product market deregulation. These responses of international relative prices hold in the long run as well as throughout the transitional dynamics. Specifically, both reforms induce an overshooting dynamics of the real exchange rate, as the magnitude of its instantaneous response is larger than its permanent one. This is attributable to the immediate reaction of the labor cost contrasting with the sluggishness in firm entry.

A key contribution of the paper is to show the importance of the endogenous PTM behavior of firms as a propagation channel of both reforms. Precisely, endogenous markup adjustments dampen the impact of both reforms on international relative prices. The intuition is the following. By reducing the entry cost, product market deregulation pulls the trigger of the competition effect: The larger number of competitors on the domestic market exerts a downward pressure on the markups that can be extracted at Home. This, in turn, moderates the real exchange appreciation. By contrast, domestic firms take the opportunity of the labor tax cut to increase their markups, in particular on the local market. Under international goods market segmentation, markups extracted at Home increase more than abroad, which lessens the real exchange rate depreciation. Endogenous PTM also has implications in a normative perspective. While both reforms are welfare-improving under constant markups, allowing for endogenous PTM behavior amplifies the welfare gains of the competitive tax policy while it reduces those of the product market deregulation, in both countries. Through different angles, our results thus point out the importance of taking into account the endogenous PTM behavior if willing to correctly evaluate the overall effects of the reforms.

Our paper contributes to the growing recent literature on the effects of fiscal and structural reforms in an open-economy setting. Farhi et al. (2014) and Engler et al. (2017) focus on the effects of the competitive tax policy on the price competitiveness of the home goods in the short run, leaving aside the potential long-run effects that also incorporate those on firm entry. Conversely, Auray et al. (2018) point out the importance of also taking into account the effects of this tax policy on the extensive margin of trade. Studying the role of firm entry also lies at the heart of numerous papers investigating the effects of the product market deregulation. Forni et al. (2010), Andrés

et al. (2017) or Eggertsson et al. (2014) investigate the effects of product market deregulation in various open-economy contexts. However, they adopt a "reduced-form approach" by modeling market deregulation by an exogenous markup reduction. Conversely, our paper demonstrates the importance of taking into account the endogeneity of markups adjustment. Closest to us, the series by Cacciatore et al. (2015, 2016) extensively study the open-economy effects of a product market deregulation in interaction with monetary policy. We focus on the effects of the structural reforms *per se*, leaving aside the interaction with monetary policy. This is consistent with the view that many countries, in particular in Europe, are currently facing severe structural inefficiencies that require more than a stabilization policy. Overall, while the literature has studied either product market deregulation or labor tax policy in a separate manner, we study the two policies in a unified framework. We then provide a deep understanding on the transmission channels they work through. In particular, we show the importance of taking into account the endogenous pricing behavior of firms on internationally segmented markets. In a two-country context close to ours, Bergin & Feenstra (2001), Corsetti & Dedola (2005) or Atkeson & Burstein (2008) point out the importance of the PTM behavior of firms to account for deviations from the law of one price and the imperfect exchange rate pass-through.[1] Our paper differentiates from these papers in two main aspects. First, we explicitly relate endogenous PTM decisions to firm entry in an international setup. In this respect, it bridges a wedge between Floetotto & Jaimovich (2008) (in a closed-economy framework) and Atkeson & Burstein (2008) (in a two-country model with exogenous firm entry), to show the importance of both the extent of competition between firms and the relative price effect as key determinants of markups. Second, we confront this to an original question that focuses on how endogenous markups do affect the effects of structural/fiscal reforms.

The next section lays out the model. In Section 3, we evaluate the effects of the reforms on the real exchange rate's determinants and the current account, both over the long run and the short run. In Section 4, we ensure the robustness of our results before extending the analysis to the welfare comparison in Section 5. Section 6 concludes.

## 2  The Model

We model a world economy made of two countries, with $\bar{L}$ households in the Home country and $\bar{L}^*$ in the Foreign country.[2] We assume a cashless economy with one unit of account common to both countries. In each country, the final good consumed by the local household is made of two types of goods, both produced and sold locally. However, one is produced with local labor only, whereas the second is produced through a richer production structure that incorporates foreign

---

[1]Devereux & Lee (2001) and Edmond et al. (2015) investigate the gains of trade with a similar production structure. However, Devereux & Lee (2001) do not introduce international trade costs, which shuts down a potential pricing-to-market behavior. Edmond et al. (2015) deal with a different question since they stress the conditions under which trade affect markups distorsions.

[2]All Foreign country's variables are indexed with a star. Home and Foreign countries are symmetric in the sense that they feature the same preferences and technologies. When the Foreign decisions are identical to the Home one, we describe only the later.

inputs (as described below). Accordingly, we refer to these two goods as the "non-tradable" and the "tradable" final goods. These two sectors also differ by the type of competition. While the non-tradable homogenous good is produced in a perfect competition set-up, the tradable sector features imperfect competition with endogenous firm entry decision, as in Bilbiie et al. (2012) (among others), and the structure of competition also induces endogenous markups in the spirit of Atkeson & Burstein (2008) and Floetotto & Jaimovich (2008). Importantly, combining endogenous markups with international trade costs allows firms to adopt a pricing-to-market (PTM) behavior, i.e. to discriminate across markets' destination by charging different markups.

In this section, we provide a brief overview of the model, putting particular emphasis on the key aspects tied to the imperfect competition structure. More details are provided in Appendix and an extensive version of the model is made in the online Appendix, available on the authors' webpages.

## 2.1 Tradable Good: Competition Structure

The final tradable good (denoted $C_{Tt}$) is made of Home and Foreign intermediate inputs through a two-layer vertical production structure, namely industry and firm levels (with $t$ the temporal index). Precisely, there is a fixed range of industries of measure 1, indexed by $s \in [0,1]$ both in the Home and the Foreign country. In each industry, the industrial good $s$ ($C_{st}$ is produced by a continuum of competitive firms which bundle intermediate (firm-level) goods produced by a discrete number of domestic and foreign firms. Therefore, within each industry $s$, there is a mass $n_{st}$ of Home firms indexed by $k$, for $k = 1, 2, ...n_{st}$, and a mass $n_{st}^*$ of Foreign firms indexed by $k^*$, for $k^* = n_{st} + 1, n_{st} + 2, ,...n_{st} + n_{st}^*$, producing each one differentiated good. Intermediate goods producers behave like oligopolist within each industry, i.e. taking into account the effect of their pricing decision on the price index of the industry. Ultimately, the price-elasticity of the demand for their variety varies with the market share of the firm, at the root of endogenous markups. Endogenous pricing-to-market is modeled along the lines of Atkeson & Burstein (2008) or Floetotto & Jaimovich (2008), as this competition set-up enables us to retrieve the standard Dixit & Stiglitz (1977) case of a constant markup. We describe here the market structure of these two levels of aggregation.

### 2.1.1 Tradable Final Good

A time $t$, a continuum of perfectly competitive final-good producers produce the homogeneous tradable final good $C_{Tt}$ through a bundle of domestic industrial goods denoted by $C_{st}$ with $s \in [0,1]$ according to the CES aggregator such that

$$C_{Tt} = \left( \int_0^1 C_{st}^{\frac{\theta-1}{\theta}} \, \mathrm{d}s \right)^{\frac{\theta}{\theta-1}}, \tag{1}$$

where $\theta > 1$ is the elasticity of substitution across industries. Given $P_{Tt}C_{Tt} = \int_0^1 P_{st}C_{st}\mathrm{d}s$, with $P_t$ denoting the consumption price index and $P_{st}$ the price index of each industrial good, the optimal

demand for industrial goods and the associated aggregate price index can be written as

$$C_{st} = \left[\frac{P_{st}}{P_{Tt}}\right]^{-\theta} C_{Tt}, \quad \text{and} \quad P_{Tt} = \left(\int_0^1 P_{st}^{1-\theta} ds\right)^{\frac{1}{1-\theta}}. \tag{2}$$

Since all industries are identical, it turns out that $P_{st} = P_{Tt}$ and $C_{st} = C_{Tt}$ at the symmetric equilibrium.

### 2.1.2 Industrial Good Producers

For each industry $s \in [0,1]$, the industrial good $C_{st}$ is produced by a continuum of competitive representative firms: they bundle differentiated intermediate goods $c_{skt}$ and $c_{sk^*t}$, produced by a discrete number of type-$k$ Home and type-$k^*$ Foreign firms respectively, according to the production function

$$C_{st} = \left(\sum_{k=1}^{n_{st}} c_{skt}^{\frac{\sigma-1}{\sigma}} + \sum_{k^*=n_{st}+1}^{n_{st}+n_{st}^*} c_{sk^*t}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{3}$$

where $\sigma > 1$ is the elasticity of substitution between goods within an industry.

In the Home country, the optimal demand for each intermediate input, locally produced ($c_{skt}$) and imported from the Foreign country ($c_{sk^*t}$) as well as the associated price of the type-$s$ industrial good ($P_{st}$) have the usual expressions, with $p_{kt}$ and $p_{k^*t}$ the prices of the local and imported varieties

$$c_{skt} = \left[\frac{p_{skt}}{P_{st}}\right]^{-\sigma} C_{st}, \quad \text{and} \quad c_{sk^*t} = \left[\frac{p_{sk^*t}}{P_{st}}\right]^{-\sigma} C_{st}, \tag{4}$$

$$P_{st} = \left[\sum_{k=1}^{n_{st}} p_{skt}^{1-\sigma} + \sum_{k^*=n_{st}+1}^{n_{st}+n_{st}^*} p_{sk^*t}^{1-\sigma}\right]^{\frac{1}{1-\sigma}}, \tag{5}$$

with $k = 1, 2, ... n_{st}$ and $k^* = n_{st}+1, n_{st}+2, , ... n_{st}+n_{st}^*$. Similar expressions apply for the Foreign demand functions and CPI, as detailed in Appendix A.

## 2.2 Production of Intermediate Goods

We now turn to describe the production of the intermediate goods used as inputs for the industrial goods. Within a given industry, each individual firm produces a differentiated good using labor domestically supplied, given a linear production technology. For a Home firm producing the variety $k$, it is written as

$$y_{skt} = h_{skt}, \tag{6}$$

where $h_{skt}$ denotes firm's labor demand used to produce the type-$k$ variety in type-$s$ industry. Each variety is sold on the domestic and the foreign markets, with international trade being subject to iceberg trade costs. Firms are free to enter the market, provided that they pay a sunk cost to start producing, imputed in labor, as in Corsetti et al. (2007).

### 2.2.1 Optimizing program

The program of the intermediate firms may be decomposed in two steps. First, they take the decision to enter the market, given the fixed cost of entry which ultimately determines the number of firms within each country. Second, once entered, they maximize the operating profit. We solve the problem backwards.

**Profit Maximization**   Once entered, the type-$k$ Home firm maximizes its operational profit $\pi_{skt}$

$$P_t \pi_{skt} = \bar{L} p_{skt} c_{skt} + \bar{L}^* p^*_{skt} c^*_{skt} - \tau^w_t W_t h_{skt}, \tag{7}$$

with $p_{skt}$ and $p^*_{skt}$ the prices charged by firm $k$ of industry $s$ at home and abroad respectively, $W_t$ is the nominal wage and $\tau^w_t > 0$ denotes gross payroll taxes on labor paid by firms. Firm $k$ in industry $s$ maximizes its operational profit (7) subject to the technological constraint (6) and the equilibrium condition for its variety

$$y_{skt} = \bar{L} c_{skt} + \tau \bar{L}^* c^*_{skt}, \tag{8}$$

where $\tau > 1$ denotes the international trade costs. Further, in an imperfect competition setting, each type-$k$ firm knows the demand functions for its good that emanates from the final good industry in each country ($c_{skt}$, from Equation (4) and $c^*_{skt}$ from (A-33)).

International trade costs give rise to market segmentation, such that each firm is able to "price-to-market" by setting a price specific to each destination market. Accordingly, maximizing profit with respect to prices $p_{skt}$ and $p^*_{skt}$ given the demand functions (4) and (A-33), leads to the optimal pricing decisions for the local (Home) and export (Foreign) markets respectively

$$p_{skt} = \mu_{skt} \tau^w_t W_t, \quad \text{and} \quad p^*_{skt} = \tau \frac{\mu^*_{skt}}{\mu_{skt}} p_{skt}, \tag{9}$$

where $\mu_{skt}$ and $\mu^*_{skt}$ represent the markups extracted by the Home firm locally and abroad respectively. As standard, the markup rates are a decreasing function of the price-elasticity of demand on each market according to

$$\mu_{skt} = \frac{\varepsilon_{skt}}{\varepsilon_{skt} - 1}, \quad \text{and} \quad \mu^*_{skt} = \frac{\varepsilon^*_{skt}}{\varepsilon^*_{skt} - 1}, \tag{10}$$

where $\varepsilon_{skt}$ and $\varepsilon^*_{skt}$ denote the price-elasticity of demand for the Home variety $k$ from the Home and Foreign markets respectively, which we characterize deeper in Section 2.2.2.

**Firm Entry Decision**   Consider now the first step of entry decision at the symmetric equilibrium which allows us to drop the $k$ index. Firm's entry is subject to a sunk entry cost $f^e$ measured in labor units. As in Chugh & Ghironi (2011), we assume that the entry cost can be subsidized or taxed by public authorities at the gross rate $\tau^e_t \gtrless 1$. Adjusting from this tax system, the effective entry cost (in terms of composite good) is $\tau^e_t f^e W_t / P_t$, where $W_t / P_t$ is the real wage. The setting

up of $n_t^e$ startups requires $H_t^e$ units of labor, such that the labor demand for new firms creation is $H_t^e = f^e n_t^e$.

Ignoring the integer constraint, entry occurs until firm value $v_t$ is equalized with the entry cost, leading to the free-entry condition[3]

$$v_t = \tau_t^e f^e \frac{W_t}{P_t}. \tag{11}$$

Entrants at time $t$ only start to produce at time $t+1$. Both new firms and incumbents may be hit by an exogenous exit shock, that occurs at the very end of the period (after production and entry) with probability $\delta$. Accordingly, the law of motion for the number of firms in the Home country is given by

$$n_{t+1} = (1 - \delta)\left[n_t + n_t^e\right]. \tag{12}$$

### 2.2.2 Markups and PTM

Within a given industry, due to the limited number of firms, each firm takes into account the effects of its pricing decision on the industrial price index, which ultimately affects the price-elasticity of demand for its variety. This Bertrand competition setup establishes a link between the price-elasticity of demand for a variety and the firm's market share. Consider the case of the demand for a Home variety emanating from the Home and Foreign country respectively. Using the symmetry across industry – and therefore dropping the $s$ index – and defining the firm's market share on the local market $m_{kt} \equiv \frac{p_{kt}\bar{L}c_{kt}}{n_t p_{kt}\bar{L}c_{kt}+n_t^* p_{k^*t}\bar{L}^* c_{k^*t}}$, we obtain the following link between the price-elasticities of domestic and foreign demand $\varepsilon_{kt}$ and $\varepsilon_{kt}^*$, and the Home firm's market share on each market

$$\varepsilon_{kt} = \sigma - (\sigma - \theta)\, m_{kt}, \tag{13}$$

$$\varepsilon_{kt}^* = \sigma - (\sigma - \theta)\, m_{kt}^*, \tag{14}$$

where, making use of the optimal demand functions (4) and (A-33), the market shares of type-$k$ firm can be rewritten as

$$m_{kt} = \left[n_t + n_t^* \left(\frac{p_{k^*t}}{p_{kt}}\right)^{1-\sigma}\right]^{-1} \quad \text{and} \quad m_{kt}^* = \left[n_t + n_t^* \left(\frac{p_{k^*t}^*}{p_{kt}^*}\right)^{1-\sigma}\right]^{-1}. \tag{15}$$

**Price-elasticity, market share and PTM**  As noted by Atkeson & Burstein (2008), one advantage of this modeling structure is that it uncovers the standard Dixit-Stiglitz case in a very straightforward way. When goods are as substitutable within industries than across industries ($\sigma = \theta$), the competition structure reduces to a constant price-elasticity of demand ($\varepsilon_{kt} = \sigma \; \forall t$ in Equation (13)), hence a constant markup $\mu = \sigma/(\sigma - 1)$, identical across destination markets. In this case, the mill-pricing rule applies as result of optimal pricing decisions, such that: $p_{kt}^* = \tau p_{kt}$.

---

[3]As the number of firms is supposed to be an integer value, the free-entry condition does not holds exactly under oligopoly meaning that the net profit is not necessary zero. Following a large strand of the literature, we ignore the integer constraint by treating $n_t$ and $n_t^*$ as continuous variables at this stage (see for instance Brander & Krugman, 1983 or Devereux & Lee, 2001).

As long as $\sigma \neq \theta$, price-elasticities of demand, as well as markups, are no longer constant and endogenously vary with the economic environment. As in Atkeson & Burstein (2008), this setup implies that the price-elasticity of demand addressed to one firm, rather than constant, is negatively related to the market share of a firm (see Equations (13) and (14)). Precisely, we will focus on the case where $\sigma > \theta$, based on the empirical evidence of Broda & Weinstein (2006) that varieties are more substitutable within than across industries.

In a open-economy setting, this market structure also implies PTM as optimizing result of the firms' pricing behavior. Under $\sigma \neq \theta$, the price-elasticities of the local and the foreign demand for the same good are no longer necessary equal (Equations (4) and (A-33) for a domestic variety). Accordingly, it is optimal for firms to set a specific markup for each destination market (see Equation (9)). This bridges a supplementary price gap (on top of the iceberg trade cost) for the same variety across markets (i.e., $p_k^* \neq \tau p_k$ under $\sigma \neq \theta$, as shown with more details in Appendix A.2). In this respect, having $\sigma > \theta$ implies both endogenous markups and PTM, driving us to use both terms interchangeably.

**Markups determinants** Linking Equation (10) with Equations (13), (14) and (15) allows us to get some insights about the driving forces behind markup decisions. We focus here on the decisions made by a type-$k$ Home firm. From Equation (15), the firm's market share on a given market (hence its markup) depends on two dimensions: the number of competitors, both domestic and foreign, so-called "competition effect" and the price of its good relative to that of their foreign competitors on the market ($p_{k^*}/p_k$), which we refer to as the "relative-price effect". Combining the above set of equations and reasoning in deviation from the symmetric steady state, the (change in) the markups made by a Home firm on its local and export market can be written as[4]

$$\widehat{\mu}_k = -\frac{1}{\Delta_1} \overbrace{\left[\widehat{n} + \phi\bar{\kappa}^{1-\sigma}\widehat{n}^*\right]}^{\text{Competition effect}} + \frac{\sigma-1}{\Delta_1}\phi\bar{\kappa}^{1-\sigma} \overbrace{\left[-\widehat{RULC} + \widehat{\mu}_{k^*}\right]}^{\text{Rel. price effect}}, \tag{16}$$

$$\widehat{\mu}_k^* = -\frac{1}{\Delta_2} \left[\widehat{n}^* + \phi\bar{\kappa}^{1-\sigma}\widehat{n}\right] + \frac{\sigma-1}{\Delta_2}\left[-\widehat{RULC} + \widehat{\mu}_{k^*}^*\right] \tag{17}$$

where $\widehat{RULC}_t \equiv \hat{W}_t - \hat{W}_t^* + \hat{\tau}_t^w - \hat{\tau}_t^{w*}$ denotes the relative unit labor cost, and $\Delta_1$, $\Delta_2$ positive constant terms defined in Appendix A, which also reports similar expressions for the markups set by the Foreign firms. In the above expressions, $\bar{\varepsilon} \equiv \varepsilon_k = \varepsilon_{k^*}^*$ is the price-elasticity of Home demand for the good locally produced and $\bar{\varepsilon}_X \equiv \varepsilon_k^* = \varepsilon_{k^*}$ is the price-elasticity on the export market at the steady state.

From Equations (16) and (17), we can decompose markup changes in two components. The "competition effect" relates to the number of competitors the firm is confronted to. Given the oligopolistic-type of competition within each industry, a marginal firm entry (whatever the country it locates in) raises the price-elasticity of demand addressed to each producer in place, thereby exerting a downward pressure on its markup on both destination markets. However, due to trade costs, the

---

[4]In what follows, $\widehat{x}_t$ denotes the log-deviation of variable $x_t$ from the steady-state in a model with symmetric countries. We drop the time dimension subscript $t$ here for sake of notational simplicity.

weight of foreign competitors is dampened relative to that of local incumbents. Put it differently, *ceteris paribus* the Home firms reduce their markup set on the Home market when a marginal firm enters, but with a lower magnitude when the new competitor is a foreigner (Equation (16)). For the same reason (but working in the opposite direction), the markup extracted by Home firms abroad is more sensitive to the number of foreign competitors than to the number of other domestic firms that compete with her on its export market (see Equation (17)). Accordingly, both $\mu_k^*$ and $\mu_k$ reduce with a marginal domestic firm entry, but not to the same extent. This is a first source of markups divergence across market destinations.

The "relative-price effect" depends on both the relative unit labor cost and the markup charged by the foreign competitors on the local market. As reported in Equation (16) (and (A-35), an increase in the Home unit labor cost relative to Foreign reduces the price-competitiveness of the Home goods. This, in turn, pushes the domestic firms to reduce their markups on both destination markets; conversely, it enables foreign firms to raise theirs (Equations (16) and (17)), versus Equations (A-35) and (A-36)).

The relative-price effect also depends on the markup set by the foreign competitors on this market. On the Home market for instance, the lower the markup set by the Foreign competitors ($\mu_{k^*}$), the lower the price of imports everything else equal. In order to preserve their market share, Home firms have to reduce their own markup as well ($\mu_k$). Further, due to market segmentation, what matters for setting the markup on each destination market is the markup set by the foreign firms exporting to this market ($\mu_{k^*}$ for $\mu_k$, but $\mu_{k^*}^*$ for $\mu_k^*$). In case of an asymmetric shock across countries, this constitutes a second source that amplifies the divergence between countries by disconnecting markups set by the same firm across destination markets.

## 2.3   Non-Tradable Good

In contrast to the tradable sector, the non-tradable sector is assumed in perfect competition with costless firm entry. A continuum of identical firms produce a homogenous non-tradable good, $y_{NTt}$, sold at price $P_{NTt}$ and labor is perfectly mobile within tradable and non-tradable sectors. The representative firm chooses labor demand, $h_{NTt}$, so as to maximize its profit $\pi_{NTt}$, standardly defined by $P_{NTt}\pi_{NTt} = P_{NTt}y_{NTt} - \tau_t^w W_t h_{NTt}$, using the production function $y_{NTt} = h_{NTt}$. The optimization problem simply yields $P_{NTt} = \tau_t^w W_t$. Non-tradable consumption goods produced in perfect competition are consumed by local households and the local government with public spending denoted $G_t$ such that the non-tradable good market equilibrium condition writes as[5]

$$y_{NTt} = \bar{L}C_{NTt} + G_t. \tag{18}$$

---

[5]Assuming that public spending is allocated to the non-tradable sector is a convenient way to include government spending in the model so as to implement a public revenue-neutral policy. In the Euro Area in 2016, 75.8% of the general government expenditure consists in services as health, education, social protection and general public services (source: Eurostat, COFOG).

## 2.4 Households

The household's optimizing behavior can be decomposed into an consumption good allocation choice and an utility maximization program.

**Consumption Basket Allocation**  The final consumption good in the Home country $C_t$ is a basket of tradable and non-tradable goods, $C_{Tt}$ and $C_{NTt}$ respectively, bundled with the Cobb-Douglas aggregator

$$C_t = \left(\frac{C_{Tt}}{\varpi}\right)^{\varpi} \left(\frac{C_{NTt}}{1-\varpi}\right)^{1-\varpi}, \tag{19}$$

where $\varpi \in [0, 1]$ is the weight of tradable goods $C_{Tt}$ relative to the non-tradable one $C_{NTt}$ in the consumption basket. The representative household minimizes the total cost of its consumption basket, leading to the optimal demand function for each type of good

$$C_{Tt} = \varpi \left(\frac{P_t}{P_{Tt}}\right) C_t, \quad \text{and} \quad C_{NTt} = (1-\varpi)\left(\frac{P_t}{P_{NTt}}\right) C_t, \tag{20}$$

along with the consumption-based price index, $P_t$

$$P_t = (P_{Tt})^{\varpi}(P_{NTt})^{1-\varpi}. \tag{21}$$

**Intertemporal utility Maximization**  For a Home household, the intertemporal utility function is given by

$$\mathcal{W}_t = \sum_{t=0}^{\infty} \beta^t \left\{ \frac{C_t^{1-\frac{1}{\psi}}}{1-\frac{1}{\psi}} - \sigma_H \frac{H_t^{1+\eta}}{1+\eta} \right\}, \tag{22}$$

with $C_t$ aggregate consumption and $H_t$ total hours worked. $0 < \beta < 1$ is the subjective discount factor, $\psi > 0$ drives the curvature of the utility function, $\sigma_H$ is a scale parameter and $\eta^{-1} > 0$ is the Frisch labor supply elasticity. The household in the Home country maximizes the intertemporal flow of utility (22) subject to the sequence of flow budget constraint, expressed in terms of the final Home good

$$x_{t+1} \int_0^1 \left( \sum_{k=1}^{n_{st}+n_{st}^e} P_t v_{skt} \right) ds + \tau_t^c P_t C_t + B_{t+1} + P_t \frac{\psi_B}{2} \left(\frac{B_{t+1}}{P_t}\right)^2 \tag{23}$$
$$= x_t \int_0^1 \left( \sum_{k=1}^{n_{st}} P_t(\pi_{skt} + v_{skt}) \right) ds + (1+i_t)B_t + W_t H_t + P_t T_t.$$

The representative household can consume the Home final good bundle $C_t$, at the consumption price index $P_t$ and given the gross value added tax rate $\tau_t^c$. As standard in the literature (see Bilbiie et al., 2012 among others), we assume that households hold shares $x_t$ in a mutual fund, that covers all domestic intermediate firms in $t$ (both incumbents and new entrants). Savings can also be made through the buying/selling of nominal international bonds issued at the world level, $B_t$ denoting her non-contingent stock of bonds at the beginning of $t$, yielding the interest rate

$i_t$.[6] Issuing new bonds is subject to adjustments costs on portfolio, paid to the government and scaled by the parameter $\psi_B$, following the modeling of Cacciatore et al. (2016b). The household perceives labor income, the returns of financial assets as well as the return of past investments, that depend on the share invested $x_t$ and the value of the incumbent firms at the beginning of the period ($v_t$) plus the dividends (profits) perceived from them ($\pi_t$). Resources are also made of lump-sum transfers $T_t$ from the government.

Solving the household's intertemporal program with respect to $C_t$, $H_t$, $B_{t+1}$ and $x_{t+1}$ yields the set of first-order conditions

$$\frac{W_t}{\tau_t^c P_t} = \sigma_H H_t^\eta C_t^{\frac{1}{\psi}}, \tag{24}$$

$$1 + \psi_B \frac{B_{t+1}}{P_t} = \beta \left[ \frac{\tau_t^c P_t C_t^{\frac{1}{\psi}}}{\tau_{t+1}^c P_{t+1} C_{t+1}^{\frac{1}{\psi}}} (1 + i_{t+1}) \right], \tag{25}$$

$$v_t = \beta (1 - \delta) \left[ \frac{\tau_t^c C_t^{\frac{1}{\psi}}}{\tau_{t+1}^c C_{t+1}^{\frac{1}{\psi}}} (\pi_{t+1} + v_{t+1}) \right]. \tag{26}$$

## 2.5 Closing the Model

**Government** We assume that in each country, the government runs a balanced budget every period. Distortive and lump-sum taxes are collected to finance public spending according to the following budget constraint

$$\bar{L} P_t T_t + P_{NTt} G_t = (\tau_t^w - 1) W_t (n_t h_t + h_{NTt}) + (\tau_t^c - 1) \bar{L} P_t C_t + (\tau_t^e - 1) f^e n_t^e W_t + \bar{L} P_t \frac{\psi_B}{2} \left( \frac{B_{t+1}}{P_t} \right)^2, \tag{27}$$

given $h_t = y_t$ and $h_{NTt} = y_{NTt}$. The product market deregulation is modeled by a total entry cost subsidy through a reduction in $\tau_t^e$. The competitive tax reform consists in a reduction of the payroll tax rate $\tau_t^w$, that is financed by a rise in VAT rate $\tau_t^c$, so as to ensure the government's balanced budget (27).

**Market Clearing Conditions** At each period, the market for international financial assets clears, such that $\bar{L} B_{t+1} + \bar{L}^* B_{t+1}^* = 0$. In each country, labor market is perfectly competitive. Accordingly, labor supply is fully used either in the production of manufactured goods or for paying entry costs, implying the following labor market equilibrium condition

$$\bar{L} H_t = n_t y_t + f^e n_t^e + y_{NTt}. \tag{28}$$

From the Home household budget constraint, incorporating the firms' pricing decisions, the fact that, in the symmetric equilibrium, each household holds an equal share of the mutual funds (i.e., $x_t = 1/\bar{L}$ $\forall t$), the free-entry condition as well as the government budget constraint and the various

---

[6]In this setup, the two countries can be viewed as belonging to a monetary union. In the absence of nominal rigidities, the monetary policy is irrelevant and the interest rate ensures equilibrium in the bond market.

market equilibrium conditions, we can derive the balance of payments equilibrium condition for the Home country

$$\bar{L}B_{t+1} - (1+i_t)\bar{L}B_t = n_t\bar{L}^*p_{kt}^*c_{kt}^* - n_t^*\bar{L}p_{k^*t}c_{k^*t}, \tag{29}$$

with $n_t\bar{L}^*p_{kt}^*c_{kt}^*$ equal to Home exports and $n_t^*\bar{L}p_{k^*t}c_{k^*t}$ to Home imports (in value). Equation (29) states that a current account deficit (the RHS being negative) has to be financed by foreign indebtedness (the LHS should be negative). Notice that we can also express the GDP as (see online appendix for details)

$$P_tY_t = \bar{L}P_tC_t + \bar{L}^*n_tp_{kt}^*c_{kt}^* - \bar{L}n_t^*p_{k^*t}c_{k^*t} + P_{NTt}G_t. \tag{30}$$

# 3 Reforms, Real Exchange Rate and Endogenous Markups

A key objective of the paper is to assess the potential of the two reforms (the product market deregulation, through $\tau^e$ and the competitive tax policy, through the switch $(\tau^w, \tau^c)$) to affect the country's international competitiveness. In order to understand the deep mechanisms at work, we start examining the real exchange rate's determinants on analytical grounds.

## 3.1 A Decomposition of the Exchange Rate Effects

We define the real exchange rate $q_t$ as the relative price of the Foreign basket of goods in terms the Home one, such that $q_t \equiv P_t^*/P_t$. As explained in Ghironi & Mélitz (2005), endogenous firm entry induces changes in the composition of the consumption baskets across countries which are not captured in the data. Indeed, the empirical CPI measures do not reflect changes in the availability of new varieties which, in turn, induces a potential difference between the "welfare-based" and the "data-consistent" real exchange rate. This is not the case in our baseline model, where we can show that the welfare-based real exchange rate, $q_t$, and its data-consistent counterpart coincide exactly under Cobb-Douglas preferences (19).

In order to analyze the determinants of the real exchange rate, we rely on its expression in deviation from the symmetric steady state, incorporating the CPI expressions (5) and (A-34) so as to get:

$$\widehat{q} = \varpi\left[\hat{P}_T^* - \hat{P}_T\right] + (1-\varpi)\left[\hat{P}_{NT}^* - \hat{P}_{NT}\right],$$

$$= \varpi\frac{1-\phi\bar{\kappa}^{1-\sigma}}{1+\phi\bar{\kappa}^{1-\sigma}}\left[-\underbrace{\widehat{RULC}}_{(a)} + \frac{1}{\sigma-1}\underbrace{[\hat{n}-\hat{n}^*]}_{(b)} + \frac{1}{1-\phi\bar{\kappa}^{1-\sigma}}\underbrace{[\widehat{\tilde{\mu}}^* - \widehat{\tilde{\mu}}]}_{(c)}\right] - (1-\varpi)\widehat{RULC} \tag{31}$$

where $\widehat{\tilde{\mu}} \equiv \hat{\mu}_k + \phi\bar{\kappa}^{1-\sigma}\hat{\mu}_{k^*}$ is the Home-market markup, i.e. the weighted value of the markups set on the Home market by both local and foreign firms and $\widehat{\tilde{\mu}}^* \equiv \hat{\mu}_{k^*}^* + \phi\bar{\kappa}^{1-\sigma}\hat{\mu}_k^*$ is the Foreign-market markup, i.e. the weighted value of the markups in the Foreign market. In these expressions, $\bar{\kappa} \equiv \bar{\mu}_k^*/\bar{\mu}_k$ denotes the export markup ratio in the pre-reform steady state and $\phi \equiv \tau^{1-\sigma}$ the freeness of trade (between 0 and 1, decreasing in $\tau$).

Since Ghironi & Mélitz (2005), it is well understood that the real exchange rate not only relies on the terms of labor ($\hat{W}_t - \hat{W}_t^*$, through term $(a)$), but also on the relative number of exporting firms ($\hat{n}_t - \hat{n}_t^*$, term $(b)$). Provided $\phi\bar{\kappa}^{1-\sigma} < 1$, which we assume, the real exchange rate depreciates with a reduction in the relative unit labor cost at Home (term $(a)$) and/or an increase in the relative number of Home firms (term $(b)$), in line with the literature.[7] Further, the non-tradable sector ($\varpi \neq 1$) breaks the typical link between the real exchange rate and the relative price of traded goods. In a model with perfect competition in the non-tradable sector, we find that this sector reinforces the effects of the relative unit labor cost on exchange rate movements (see last term in (31)), as in Cacciatore et al. (2015b).

One originality of our work is to point out the role of a third determinant that channels through endogenous markups adjustment ($\sigma \neq \theta$) with Term $(c)$, at the root of markups differentiation across countries. Everything else equal, an increase in the Foreign-market markup relative to Home ($\widehat{\tilde{\mu}}^* - \widehat{\tilde{\mu}} > 0$) pushes individual prices in the Foreign country upwards in relative terms.[8] This induces an increase in the Foreign CPI (relative to Home), i.e. a real exchange rate depreciation.

To conclude this discussion, it is worth noticing that endogenous markups breaks the one-by-one relationship between the relative cost of labor and the terms of trade $s_t$ defined as the relative price of Home exports (to Home imports), i.e. $s_t \equiv p_{kt}^*/p_{k^*t}$. Using Equation (9) and its Foreign counterpart, one can show that

$$\hat{s} = \widehat{RULC} + \hat{\mu}_k^* - \hat{\mu}_{k^*}. \tag{32}$$

Higher labor costs in the Home country relative to Foreign lead to higher prices of the exported Home goods, hence a lower price-competitiveness of the Home firms abroad (the terms of trade deteriorate, $\hat{s} > 0$). Yet, this effect can be counterbalanced by endogenous markup adjustment, as long as it induces a reduction in the export markup set by the Home firms relative to Foreign ($\hat{\mu}_k^* - \hat{\mu}_{k^*} < 0$), since this loosens some pressure on the exporting price of Home firms and limits the deterioration of the terms of trade.

Having highlighted the connections between the number of firms, relative prices, markups and the real exchange rate, we now turn to studying the effects of the two reforms. This relies on the model's simulations given the calibrated values for the deep parameters as detailed in next section.

---

[7]Throughout the paper, we assume $\tau\bar{\kappa} > 1$, ensuring $1 - \phi\bar{\kappa}^{1-\sigma} > 0$. This condition has an economic interpretation tied to optimal pricing decisions (Equation (9)). When firms can price-to-market ($\sigma > \theta$), they have an incentive to absorb part of the trade costs (rather than reporting it on the foreign consumer), by reducing the export markup relative to the local one (pushing $\bar{\kappa} < 1$ everything else equal, as shown in Appendix A.2 with more details). The condition $\tau\bar{\kappa} > 1$ states that the endogenous reduction of the export-to-local markup gap is not sufficiently strong to overcome the trade costs, such that the steady state export price remains higher than the local one ($p_d^* > p_d$ in Equation (9)). Also notice that this condition is reminiscent of the condition that relates the extent of law of one price deviations to trade costs in Atkeson & Burstein, 2008.

[8]Given that the terms $1 - \phi\bar{\kappa}^{1-\sigma}$ at the numerator and the denumerator cancel each other in Equation (31), the elasticity of the real exchange rate to the markup gap (Term $(c)$) is always positive and lower than 1, decreasing with the term $\phi\bar{\kappa}^{1-\sigma}$.

## 3.2 Parametrization

We assume that at the pre-reform steady-state, the two countries are identical in all aspects, $\bar{L} = \bar{L}^*$ and $\tau^x = \tau^{x*}$ for $x = \{w, e, c\}$. The number of firms in both countries are identical ($n = n^*$) and all goods are sold abroad at an identical price, such that $q = 1$. As standard in the literature, we assume an initial zero-trade balance. We calibrate the model on a quarterly basis based on either values commonly retained in the literature or by making the steady-state model replicate some empirical targets. These are based on empirical evidences observed for European countries over the recent period.[9] Table 1 reports the set of calibrated structural parameters and empirical targets, as well as the implied values for the remaining deep parameters, that will be considered as fixed in our further experiments. Home labor is considered as numéraire, implying $W = 1$.

The elasticities of substitution across goods and across industries are set to $\sigma = 5$ and $\theta = 2$ respectively, in line with empirical estimates. There is no clear consensus on these values though. Broda & Weinstein (2006) estimate the elasticity of substitution among goods at the industry level for the US. Their median estimate of the substitution elasticity between 3-digit level goods (corresponding roughly to our $\theta$) is 2.50 over the sample 1972-1988. At a most disaggregated level (our $\sigma$), they estimate a median substitution elasticity equal to 3.7. Benkovskis & Wörz (2014) estimate $\sigma$ to a value close to 2 for the US and between 2 and 2.17 for several countries of the Euro Area (see also Soderbery (2017)). However, Anderson & van Wincoop (2004) suggest a range between 5 and 10 for $\sigma$. Atkeson & Burstein (2008) allow for a strong pricing-to-market behavior by setting $\sigma = 10$ and $\theta$ close to 1. We set $\psi = 1$, implying a log specification on consumption, as standard in the related literature (see Floetotto & Jaimovich (2008)). The Frisch labor supply elasticity is set to $\eta^{-1} = 0.5$, in line with the empirical estimates of MaCurdy (1981). The trade costs are set to $\tau = 1.2$ which is close to the value suggested by di Mauro & Pappadà (2014) for countries of the Euro Area and is in line with Ravn & Mazzenga (2004) who focus on the transportation cost. It is worth noticing that iceberg costs seem to be a reasonable representation of trade costs in a monetary union like the Euro Area since European trade excludes tariffs and quotas. The firm exit rate is set to $\delta = 0.029$, as standard in the literature (see for instance Cacciatore & Fiori, 2016). The bond adjustment costs parameter $\psi_b$ is set to a sufficiently small value to pin down the steady state and to ensure the model's stationarity without overstating the impact of this parameter on dynamics.

We also endogenously derive the values of some structural parameters so as the pre-reform steady state matches some empirical targets, the reference country being the GIIPS countries over the recent period. We set $\mu_k = 1.36$, based on the figures reported by Eggertsson et al. (2014) for Italy and Spain. The (gross) payroll tax rate is calibrated to $\tau^w = 1.36$, while the VAT rate is set to $\tau^c = 1.16$, in line with values observed in GIIPS countries over the period 2000-2012. The weight of tradable goods in total consumption, $\varpi$, matches the import share set to 30% as for

---

[9] We aim at targeting empirical data for the peripheral European countries, i.e. Greece, Ireland, Italy, Portugal and Spain (GIIPS), as long as we can get empirical targets suited to these countries (based on the GDP weighted average of the national data). If not, we retain data for the European Area. A detailed exposition of the model's steady state and the calibration procedure is provided in the online Appendix.

Table 1: Parametrization

| Deep parameters | | Value | Reference |
|---|---|---|---|
| $\sigma$ | Elast. of substitution. btw goods | 5 | Anderson & van Wincoop (2004) |
| $\theta$ | Elast.of substitution across industries | 2 | Broda & Weinstein (2006) |
| $\tau$ | Trade costs | 1.2 | di Mauro & Pappadà (2014) |
| $\delta$ | Firm destruction rate | 0.029 | Cacciatore & Fiori (2016) |
| $1/\eta$ | Frisch labor supply elasticity | 0.5 | MaCurdy (1981) |
| $\psi$ | Curvature of utility function | 1 | Floetotto & Jaimovich (2008) |
| $\psi_b$ | Bond adjustment cost | 0.001 | |
| | | | |
| **Pre-reform targets** | | | |
| $H$ | Hours worked | 0.3 | Normalization |
| $\mu_k$ | Markup on Home market by Home firms | 1.36 | Eggertsson et al. (2014) |
| $\tau^w$ | Gross payroll tax rate | 1.36 | Own calculations, Eurostat data |
| $\tau^c$ | Gross VAT rate | 1.16 | Own calculations, Eurostat data |
| $\tau^e$ | Firm entry cost subsidy | 1.00 | Normalization |
| $n_e f_T W/PY$ | R&D entry costs (% of GDP) | 1.94 | Cacciatore & Fiori (2016) |
| $\bar{L}W f_R/PY$ | Regulation entry costs (% of GDP per capita) | 22.74 | Ebell & Haefke (2009) |
| $P_{NT}G/PY$ | Public expenditure (% of GDP) | 19.4 | Own calculations, Eurostat data |
| $\varpi n \left(p_{k^*}/P_T\right)^{1-\sigma}(C/Y)$ | Imports (% of GDP) | 30 | Own calculations, Eurostat data |
| | | | |
| **Implied parameters** | | | |
| $f_R$ | Regulatory entry cost | 0.093 | |
| $f_T$ | R&D entry cost | 0.016 | |
| $\bar{L}$ | Home country size | 0.94 | |
| $\varpi$ | Share of non-tradable goods | 0.87 | |
| $\sigma_L$ | Scale parameter | 29.17 | |
| $G$ | Government spending | 0.005 | |

**Note:** In the pre-reform steady-state, Home and Foreign countries are symmetric.

GIIPS countries over 1995-2017. The regulation cost instrument $\tau^e$ is set to 1 in the pre-reform steady state. As in Cacciatore et al. (2016c), we assume that the fixed entry cost $f_e$ is made of regulation costs ($f_R$) and the R&D expenditures ($f_T$). Administrative entry costs, in terms of GDP per capita, are set equal to 22.74%, based on the values reported for the GIIPS countries by Ebell & Haefke (2009). The aggregate R&D expenditures to GDP is set to 1.94%, as observed in the Euro Zone (Cacciatore et al., 2016a). The public expenditure share to GDP is 19.4% as observed for the GIIPS countries over the period 1995-2017. As usual in the literature, we calibrate the aggregate hours worked as one third of the total amount of time, normalized to one, $H = 0.3$. Altogether, these targets allows us to deduce values for $f_R$, $f_T$ (hence $f_e$), $\sigma_H$, $\bar{L}$, $\varpi$ and $G$ from the model's steady state (see bottom of Table 1), which are thus invariant during the experiments.

We conduct our analysis by contrasting our benchmark model featuring endogenous markups ($\sigma > \theta$), with constant-markups setup (imposing $\theta = \sigma = 5$). Both reforms are set such that they imply

a 1 percentage point decrease in the long-run value of Home lump-sum transfer-to-GDP ratio in the endogenous markup case. The corresponding reduction of $\tau^e$ implies a decrease in total entry costs from 13.15% of GDP to 12.3%. The payroll tax cut is implemented together with a rise in VAT which ensures government revenues neutrality.[10] This amounts reducing the payroll tax rate from 34% to 19% and increasing the VAT from 16% to 24%.

## 3.3 Reforms and the Real Exchange Rate: Long-run impact

Figure 1 reports the long-run effects of a product market deregulation (left-hand side panel (1)) and a competitive tax policy (right-hand side panel (2)) on the real exchange rate under constant and variable markups. To get better insights on the transmission channels, we also report, for each reform, the change in the three determinants of the real exchange rate identified in Equation (31), namely the relative unit labor cost in the Home country (Term $(a)$), the relative number of Home firms (Term $(b)$) and the overall markup by country (i.e, Term $(c)$ decomposed in its two components, $\widehat{\mu}^*$ and $\widehat{\mu}$). In Appendix B, we also report the responses of the terms of trade (i.e., the relative price of Home exports to Home imports) and the different markups. Variables are expressed in percentage deviation from their pre-reform steady state.

Two main comments emerge from Figure 1. First, a competitive tax policy is successful in improving international competitiveness through a permanent real exchange depreciation while a product market deregulation is not. Second, endogenous markups lessen the impact of both reforms on the real exchange rate dynamics. This result thereby suggests an important role for the endogenous PTM behavior. We go deeper in the analysis by considering each reform successively.

**Product Market Deregulation**   Figure 1 (panel (1)) shows that a product market deregulation at Home generates a real exchange rate appreciation. This finding is consistent with results obtained by Ghironi & Mélitz (2005) or Cacciatore et al. (2015b) who provide a comprehensive discussion of the effects of an entry cost reduction on the real exchange rate under constant markups ($\sigma = \theta$). The primary effect of product market deregulation is to play on the number of active firms. By reducing the cost of entry, the reform induces more firms to enter the Home market, until the free-entry condition (11) is restored. In presence of trade costs, the induced variety effect should push to a real exchange rate *depreciation* everything else equal. Yet, this effect is counteracted by a rise in the relative labor cost in the Home country (panel (2-a)). This exerts a detrimental effect the price-competitiveness of Home goods, which leads ultimately to an *appreciation* of the real exchange rate. The reason is that more entry exerts upward pressures on Home labor demand which in turn raises the marginal cost for each incumbent firm. Under constant markups, this rise in the terms of labor ($\hat{W}_t - \hat{W}_t^*$) goes hand-by-hand with an increase in the terms of trade as shown in Equation (32) (see Figure 5, Appendix B) and therefore a deterioration of price competitiveness

---

[10]We calculate the values of $\tau^w$ and $\tau^e$ such that $\bar{L}T/Y$ decreases from by 1 p.p. in the long run (under $\sigma > \theta$), going from 15% to 14%. In the competitive tax policy case, the reduction in tax revenues led by the decrease in $\tau^w$ is compensated by a rise in VAT, $\tau^c$ to ensure that total government spending ($\bar{L}T/Y + P_{NT}G/PY$) - hence, total revenues, stay at their pre-reform value.

17

Figure 1: Reforms and International Competitiveness: Long-Run Effects
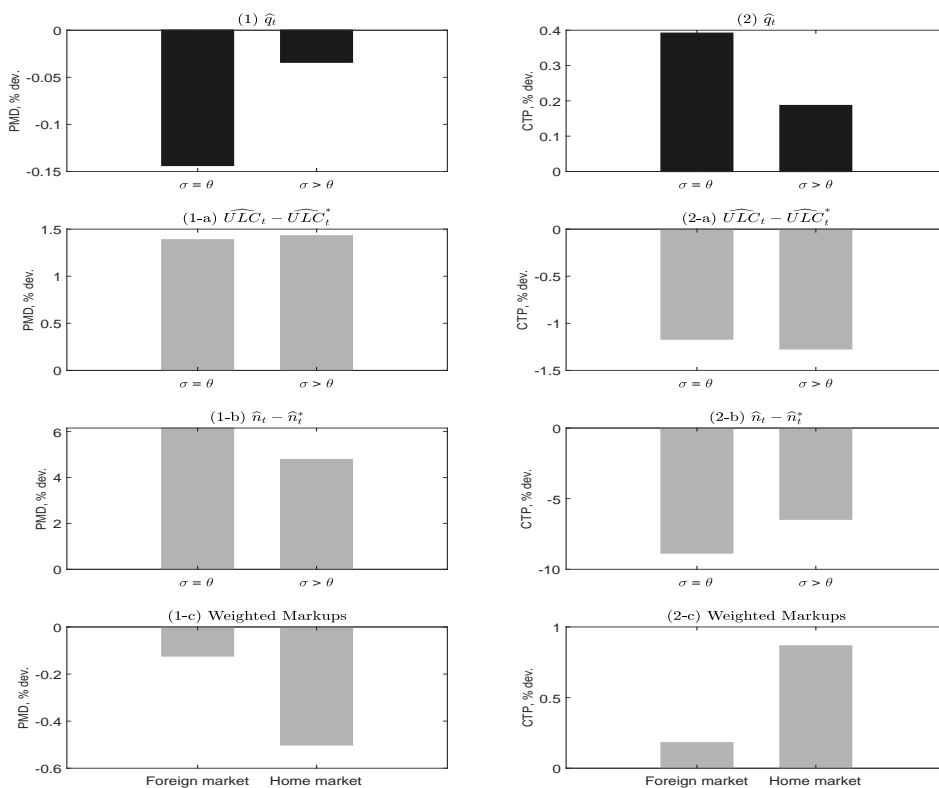


***Long-run responses to a permanent product market deregulation (PMD) and competitive tax policy (CTP) under constant ($\sigma = \theta$) and variable ($\sigma > \theta$) markups.*** Column 1 (2, resp.) displays the long-run effects of a permanent reduction in $\tau_t^e$ ($\tau_t^w$ combined with a rise in $\tau_t^c$, resp.). Both shocks are normalized in order to decrease the long-run Home lump-sum transfer to GDP ratio by 1 percentage point in the endogenous markups model. All deviations are expressed in percentage deviation from the pre-reform steady-state. The first line shows the real exchange rate, $\widehat{q}_t$. The second line shows the relative unit labor cost, with $\widehat{ULC}_t = \widehat{W}_t + \widehat{\tau}_t^w$ and $\widehat{ULC}_t^* = \widehat{W}_t^* + \widehat{\tau}_t^{w*}$. The third line shows the relative number of firms, $\widehat{n}_t - \widehat{n}_t^*$. The last line shows the total weighted markups extracted in the Home market ($\widehat{\bar{\mu}}_t = \widehat{\mu}_{kt} + \phi \bar{\kappa}^{1-\sigma} \widehat{\mu}_{k^*t}$) and in the Foreign market ($\widehat{\bar{\mu}}_t^* = \widehat{\mu}_{k^*t}^* + \phi \bar{\kappa}^{1-\sigma} \widehat{\mu}_{kt}^*$).

($s_t$ increases) in line with Corsetti et al. (2007), Cacciatore et al. (2016b) or Cacciatore et al. (2016c) findings.

How do variable markups affect this result? As explained in Section 2.2.2, markups' variations are driven by the "competition effect", as the reduction in the entry cost intensifies competitive pressures between oligopolistic producers and reduces the market share of incumbents on this market. Markup rents extracted on the Home market by both domestic and foreign firms thus decrease substantially ($\widehat{\mu}_k < 0$, $\widehat{\mu}_{k^*} < 0$, see Appendix B, Figure 5, panel (a)). As a result, endogenous markups limit the deterioration of the price-competitiveness for the Home firms (Appendix B, Figure 5, panel (c)). The transmission channel to the real exchange rate can be decomposed through the lens of Equation (31). On the one hand, the markup reduction at Home moderates the increase in the operational profit and therefore, less Home firms are needed to restore the free-entry condition. Consequently, the increase in the relative number of Home firms ($\widehat{n}_t - \widehat{n}_t^*$) is of lower magnitude when markups endogenously adjust (Figure 1, panel (1-b)). The extensive margin is therefore less powerful to counteract the deterioration of price-competitiveness, which should lead to an even stronger real exchange rate appreciation than under constant markups.[11] On the other hand, as illustrated by Term (c) in Equation (31), the direct effect of lower markups at Home is to drive the weighted markup at Home downwards ($\widehat{\widetilde{\mu}} < 0$). This is all the more at work, as the markup reduction is much weaker on the Foreign market. Indeed, in presence of trade costs, the price-elasticity of Foreign demand is less sensitive to a marginal entry from the Home country than Home demand. This enables the Home firms to reduce their export markups less than domestically ($\mu_k^*$ reduces but less than $\mu_k$). As a result, product market deregulation reduces markups in the Home country more than in the Foreign one (Figure 1, panel (1-c)). This markup contraction at Home, in turn, implies a marked reduction in the domestic CPI that translates into a smaller real exchange rate appreciation compared to the constant-markup case.

**Competitive Tax Policy**   As shown in the second column of Figure 1, the competitive tax policy induces a real exchange rate depreciation, whose magnitude is lessened under endogenous markups though. As shown in Equation (31), a payroll tax cut implemented in the Home country has a direct impact on the real exchange rate through a reduction in the relative unit labor cost (see Figure 1, panel (2-a)) while an increase in VAT works through general equilibrium effects. Consequently, the change in $\tau_t^w$ drives the results described here (we show in the online appendix that results are qualitatively similar in the case of a payroll tax cut along with constant VAT).

Consider first the case of constant markups ($\sigma = \theta$). The reduction in the relative Home unit labor cost driven by a reduction in $\tau_t^w$ pushes the relative price of Home goods down, inducing an improvement in price-competitiveness (Appendix B, Figure 5) which drives the real exchange depreciation. Yet, this direct effect is counteracted by a reduction in the number of Home firms (in relative terms, panel (2-b)). As discussed by Corsetti et al. (2007), this notably depends on

---

[11]Under endogenous markups, the lower Foreign firms' market share reduces the rent they can extract, inducing a contraction in the equilibrium number of Foreign firms. However, due to trade costs, the magnitude of the effect is small.

the strength of the substitution effect between consumption and leisure. Indeed, the reduction in the Home good prices pushes the Home CPI downward (see Equation (9)) hence the domestic real wage upward. When the substitution effect is small enough relative to the wealth effect in consumption choices, as in our calibration, the raise in real wages makes households favor leisure to consumption, which only moderately increases. This is amplified by the increase in the VAT burden supported by households which tends to reduce the domestic aggregate demand. The contraction in the value of total sales leads to a contraction in operational profit, leading to a firm entry reduction in order to restore the zero-profit condition. Accordingly, the equilibrium number of firms is lower after the competitive tax reform. From Equation (31), the negative effect on the trade extensive margin counters to the unit labor cost effect by limiting the magnitude of the real exchange rate depreciation. In this respect, the VAT hike lessens the effect of the payroll tax cut on the real exchange rate by making Home final consumption goods more expensive (see Figure 2 in the online appendix).

How are these mechanisms affected when markups endogenously adjust? As reported in Figure 1, the magnitude of the real exchange rate depreciation induced by the Home fiscal policy is substantially lowered in this case. The lessening of the depreciation can be attributed to the "relative-price effect" on markups, that increases the overall markup at Home relative to Foreign. As discussed in Section 2.2.2, the reduction in the relative unit labor cost for Home firms enables them to extract part of these competitiveness gains through higher markups on both destination markets. Conversely, this drives Foreign firms to cut their markups (see Appendix B, Figure 5). As a result, endogenous markup adjust limits the gain in price-competitiveness for the Home firms (see Appendix B, Figure 5, panel (e)). With regards to the real exchange rate, in the presence of trade costs, the strong increase in the markup extracted by the Home firms on the Home market drives the weighted average markup at Home upward, in absolute and in relative terms (Figure 1, panel (2-c)). This raises the relative CPI at Home, thereby limiting the magnitude of the real exchange rate depreciation induced by the gains in unit labor cost (see Term (c) in Equation (31)). Interestingly, this overcomes the fact that the negative extensive margin of trade effect is of lower magnitude under $\sigma > \theta$.

**Summary** Two main results emerge. First, the competitive tax policy succeeds in depreciating the real exchange rate in the long run while the product market deregulation does not. Second, these transmission channels are substantially affected by markups endogenous adjustments. With a product market deregulation, the "competition effect" (through the relative number of firms) reduces the weighted average markup at Home. This, in turn, lessens the real exchange rate appreciation.[12] The "relative-price effect" has an opposite effect on markups under the competitive tax policy. As Home firms partly compensate the reduction in relative unit labor cost by an increase in markups, this limits the ability of the reform to enhance a real exchange rate depreciation.

---

[12]The markup effect might even lead to an exchange rate depreciation for large values of $\tau$ or $\varpi$ (see Section 4).

## 3.4 Reforms and real Exchange Rate: Transitional effects

We now take advantage of the dynamic structure of our model to evaluate how endogenous markups affect the impact of the reforms on international relative prices along the transition. Figure 2 reports the transition paths of the real exchange rate and its determinants, the terms of trade and net exports to both reforms under the two cases of constant and varying markups.

**Product Market Deregulation** The increase in the relative number of Home firms (which pushes toward a real exchange rate depreciation, all things equal), is only progressive (Figure 2, panel (c)), consistently with Equation (12). In the period of the reform implementation, given the fixed number of active firms, the deterioration of the price-competitiveness of Home goods (Panel (e)) expands the real exchange rate appreciation, all the more as the increase in the relative unit labor cost at Home is maximal on impact (Panel (b)). From the free-entry condition (11), the reduction in entry costs $\tau_t^e$ reduces the value of the firm, thereby enticing the households to invest in firm creation, see Equation (26). Everything else equal, labor demand increases as required to pay the fixed cost, leading to an increase in the relative Home wage. As long as new firms are created, this effect progressively reduces, such that the relative unit labor cost decreases to come back to its new long-run value (which remains higher than initially, see also Figure 1). Accordingly, the maximum of the real exchange rate appreciation is reached on impact, to decrease progressively until reaching the new long-run value. All along the transition path, markups endogeneity moderates the magnitude of the appreciation through the dominant role of the competition effect. This reasoning also applies to the terms of trade, whose maximal increase is on impact, competitiveness losses being progressively dampened by the relative markup adjustment. Associated with the real exchange rate appreciation, net exports of the Home country become negative all along the transition path, even if of slightly lower magnitude under endogenous PTM (panel (f)).

**Competitive Tax Policy** On impact, with sluggishness in the number of firms, the real exchange rate is mostly driven by the reduction of the relative labor cost (Figure 2, panel (b)), leading to a large depreciation. The progressive downward adjustment in the relative number of domestic firms then reduces the extent of the immediate depreciation through the variety effect (Panel (c)). As for the product market deregulation (but working in the other direction), the endogeneity of markups alters the magnitude of the overshooting dynamics induced by the competitive tax policy (Figure 2, panel (d)). The endogenous PTM behavior progressively reduces the price-competitiveness gains of the Home firms, with a reduction in the relative price of Home exports being maximal on impact (panel (e)). Consistently with the dynamics of international relative prices, the fiscal reform induces a rise in net exports for the Home country, as reported in Panel (f).

**Summary** Consistently with Section 3.3, the endogenous markup effect is still valid on the short-run. Additionally, both reforms induce an overshooting dynamics of the real exchange rate which can be explained by the immediate reaction of the labor cost and the inertia in firm entry. In

# Figure 2: Reforms and International Competitiveness: Transition Dynamics
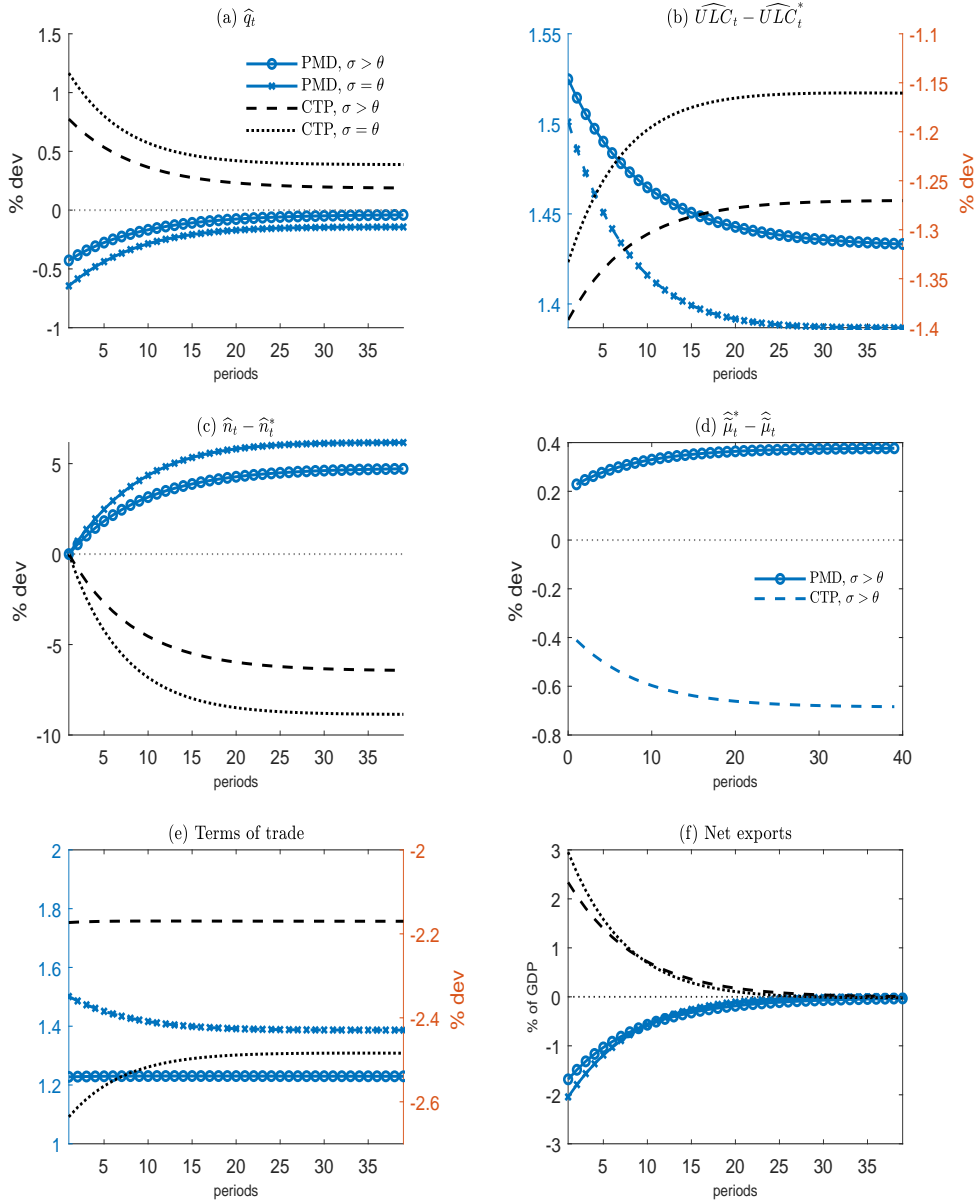


**Transitional responses to a permanent product market deregulation (PMD) and competitive tax policy (CTP) under constant ($\sigma = \theta$) and variable ($\sigma > \theta$) markups.** In panels (a) to (d), the variables are similarly defined as in Figure 1. The terms of trade refer to the relative price of Home exports to Home imports ($\widehat{s}$) and net exports are the Home exports minus imports, in terms of current GDP. Except for the net exports, all variables are expressed in percentage deviation from their pre-reform levels. In Panels (b) and (e), the response of the difference in unit labor costs and in the terms of trade reads on the left axis (in blue) for the product market deregulation, and on the right axis (in red) for the competitive tax policy.

this respect, the overshooting dynamics of the real exchange rate is reminiscent of the seminal Dornbusch's (1976) result, but in a setup without nominal price rigidity.[13]

# 4    Sensitivity Analysis

In this section, we perform a sensitivity analysis on our benchmark setup with endogenous markups, focusing on the key parameters that may affect the strength of the markup channel highlighted in Section 3. First, we study the role of the non-tradable sector since it directly impacts the real exchange rate dynamics as suggested by Equation (31). Second, we assess the role of trade costs, as they affect the extent of competition between local producers and their foreign competitors. For all robustness exercises, the sizes of the reforms are set to their values calibrated in Section 3.2 so as to make the results comparable.

## 4.1    Non-Tradable Sector

The model described in Section 2 puts into evidence the amplification effect of endogenous markups on the real exchange rate's dynamics. As shown in Equation (31), the magnitude of this markup channel is conditional on the relative weight of the tradable sector (where oligopolistic competition stands) in the consumption bundle. Movements in the real exchange rate are determined by the relative aggregate Home price of both tradable and non-tradable goods, whose weight in real exchange rate changes raises with their share in the consumption basket $(1 - \varpi)$. Whereas the relative price of tradable goods $(\hat{P}_T^* - \hat{P}_T)$ varies with the unit labor cost, but also with the extensive margin of trade and the relative markup, our stylized modeling of the non-traded sector (perfect competition, linear production function and exogenous firm entry) implies that the price of these goods are driven by the production cost only, i.e. the relative labor cost. Everything else equal, the larger the share of non-tradable goods (i.e., the lower $\varpi$), the larger the role of the relative price effect in driving real exchange rate changes. Accordingly, one may expect the product market deregulation to be less effective and the competitive tax policy more effective in depreciating the real exchange rate as $\varpi$ vanishes. We investigate the relevance of this intuition in quantitative terms. Figure 3 displays the long-run deviation of the real exchange rate (from its pre-reform value) following a product market deregulation (panel (a)) and a competitive tax policy (panel (b)) for different values of $\varpi$.[14] In the case of a product market deregulation, the rise in the relative unit labor cost overcomes the markup effect (combined with further entry of firms) and amplifies the real exchange rate appreciation. The other way round, the higher the share of tradable goods in the consumption basket (high $\varpi$), the weaker the real exchange rate appreciation after a product

---

[13]In Dornbusch's (1976) original setting, the delay of adjustment speeds lies between the financial markets adjusting instantaneously and the goods market, whose price is fixed.

[14]In our baseline calibration, $\varpi$ is set to 0.87. The case $\varpi = 1$ corresponds to a model without non-tradable goods and $\varpi = 0.7$ would correspond to an import share of 27.6%. The online appendix also offers a sensitivity analysis to the (non-unitary) elasticity of substitution between tradables and non-tradables assuming CES preferences.

market deregulation, consistently with our above reasoning. In the extreme case $\varpi = 1$ (model without non-tradable goods), this reform leads to a depreciation rather than an appreciation.

On the opposite, a competitive tax policy might lead to an appreciation in the case $\varpi = 1$ while the depreciation is strong for low value of $\varpi$.[15] The intuition explaining these results is straightforward. As the relative price of non-tradable goods $(\hat{P}_{NT}^* - \hat{P}_{NT})$ is driven by the unit labor cost, a large share of non-tradable goods in the consumption basket ($\varpi$ low) gives rise to a powerful unit labor cost channel on the real exchange rate. Accordingly, the lower $\varpi$, the more effective the fiscal policy in depreciating the real exchange rate through a dominant role to the relative price effect, as reported in Figure 3, panel (b). Also notice that, in all cases, the firms' endogenous PTM behavior mitigates the impact of the reforms on the real exchange rate. Whatever the values of $\varpi$ considered, the appreciation induced by the goods market reform and the depreciation induced by the tax reform are of lowered magnitude as firms endogenously adjust their markups ($\sigma > \theta$).

## 4.2 Trade Costs

We now turn to studying the role of trade costs. To that aim, we report in Figure 4 the long-run elasticity of the real exchange rate and its determinants to the product market deregulation (left panel) and the competitive tax policy (right panel) for several values of the trade cost $\tau$. The solid (dashed, resp.) lines correspond to the variable-markups (constant-markups, resp.) model. Figure 4 makes clear that trade costs strongly affect the effectiveness of the two reforms.

Let start looking at the effects of a product market deregulation. Figure 4 (panel (1)) shows that for sufficiently high values of $\tau$, subsidizing firm entry might generate an exchange rate depreciation, and an even more stronger under varying markups. Consider first the case of constant markups. From Equation (31), the elasticity of the real exchange rate to the relative unit labor costs (which pushes towards an appreciation) and the relative number of Home firms (which conversely pushes towards a depreciation) increases with trade costs. As the primary effect of the reform is to boost the relative number of firms, this drives the relative price of Home tradable goods down and ultimately lead to a real exchange rate depreciation when $\tau$ is large enough. This effect is strengthened by the action of endogenous markups. The markup channel $(\widehat{\widetilde{\mu}}_t^* - \widehat{\widetilde{\mu}}_t)$ weights more in the real exchange rate determination for large values of $\tau$, as illustrated by Term $(c)$ in Equation (31) since the elasticity of $\hat{q}_t$ to $(\widehat{\widetilde{\mu}}_t^* - \widehat{\widetilde{\mu}}_t)$, given by $(1 + \phi \bar{\kappa}^{1-\sigma})^{-1}$, increases with $\tau$. This direct effect is valid all other things being equal. On top of that, as explained in Section 2.2.2, the markup channel by itself is also sensitive to the trade costs causing an additional effect. When trade costs are large, firms have more room to price-discriminate between destination markets, inducing a stronger disconnect between average markups across countries (see also Edmond et al. (2015) and Behrens et al. (2018)). As a result, larger trade costs strengthen the cross-country divergence of markups, in favor of a larger real exchange rate depreciation everything else equal (Figure 4, panel (1-c)). Altogether, both effects implies that a product market deregulation depreciates the real exchange rate for $\tau \geq 1.22$

---

[15]The rationale behind the real exchange rate appreciation under $\varpi = 1$ is the following. The rise in VAT limits aggregate consumption, which reports solely to the tradable sector. The perspective of low sales hence plays against firm entry, thereby reinforcing the tendency towards appreciation.

Figure 3: Reforms and International Competitiveness: The role of non-tradable goods



(a) $\widehat{q}_t$

(b) $\widehat{q}_t$
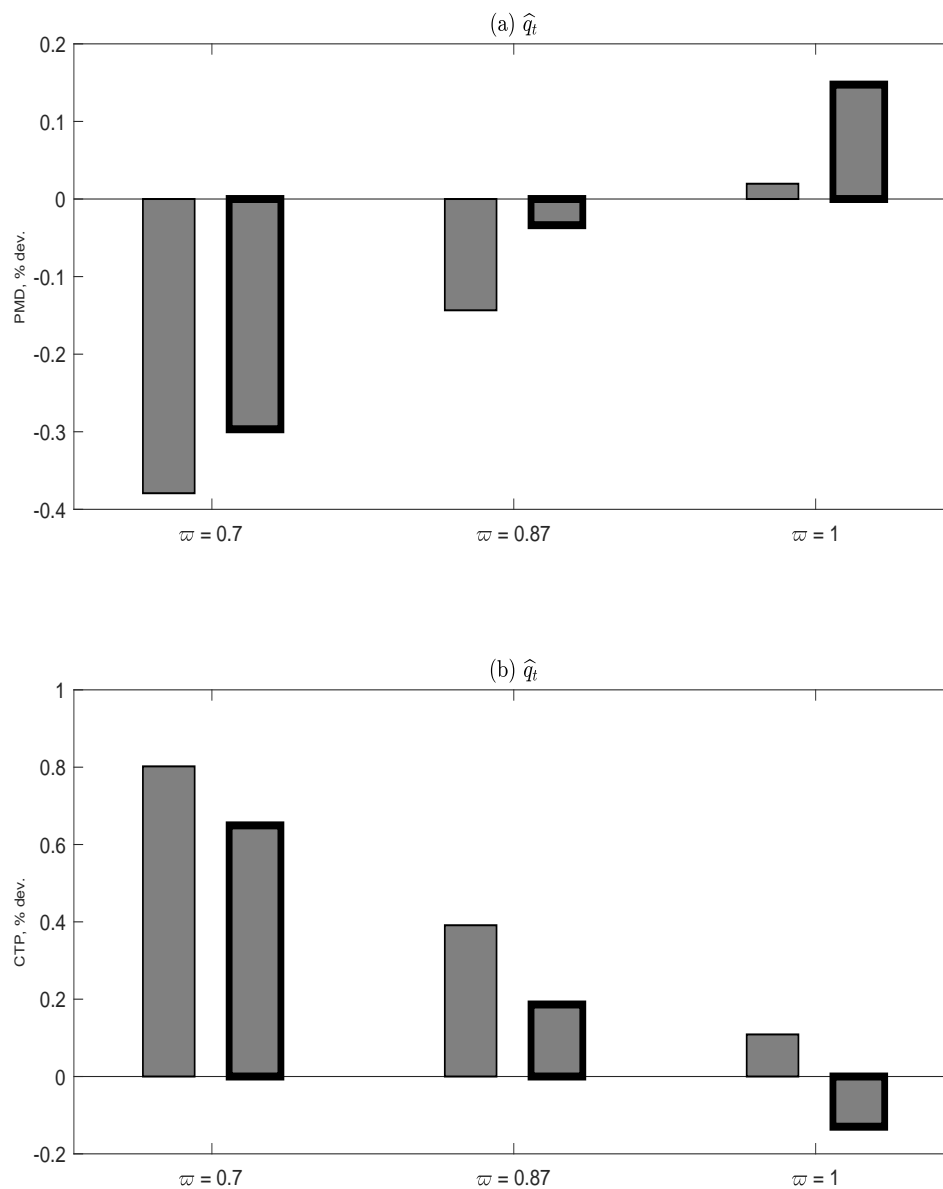
**Sensitivity to** $\varpi$ Long-run responses to a permanent product market deregulation (PMD, panel (a)) and competitive tax policy (CTP, panel (b)) under constant endogenous markups, for several values of tradable goods weight. For each value of $\varpi$, the left-side bar is the percentage deviation of $\widehat{q}_t$ from it pre-reform steady-state in the constant-markups model and the right-side (highlighted) bar is the one in the variable-markups model.

Figure 4: Reforms and International Competitiveness: The role of trade costs
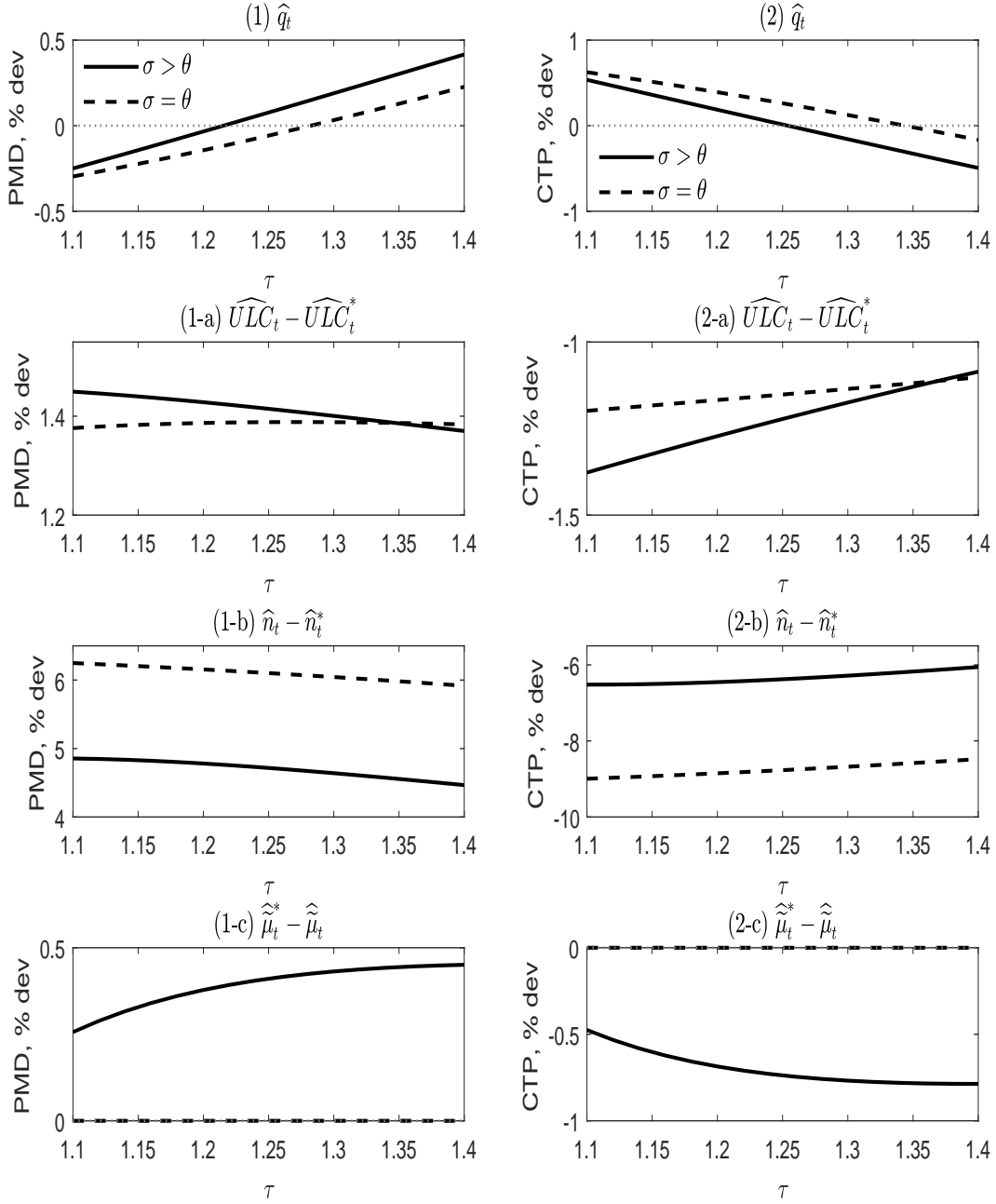


**Sensitivity to $\tau$** Long-run responses to a permanent product market deregulation (PMD, Column 1) and competitive tax policy (CTP, Column 2) in the model with endogenous markups, for several values of trade costs, expressed in percentage deviation from their pre-reform level.

under variable markups while the cut-off value was $\tau \geq 1.28$ under constant markups. Those values are in the range suggested by the literature (see Kehoe et al., 2017 for a survey).

Under a competitive tax policy, the real exchange depreciation is lessened for large values of $\tau$, especially under variable markups (Figure 4, panel (2)). Consider the case of constant markups first. Through general equilibrium effects, the competitive tax policy raises the relative terms of labor $(\hat{W}_t - \hat{W}_t^*)$ that partially offset the reduction in the payroll tax cut at Home, thereby dampening the total reduction in the relative unit labor cost. As reported in Panel (2-a), this is all the more the case as trade costs are large. Therefore, large trade costs limit the ability of the competitive tax policy to induce a real exchange rate depreciation. Endogenous markups play as a additional obstacle for the reform being effective. As explained in Section 3.3, the competitive tax policy boosts markups extracted domestically, firms taking advantage of the reduction in the relative unit labor cost. International markets being more segmented (i.e., $\tau$ large) amplifies the increase in the average markup at Home, which limits the magnitude of the real exchange rate depreciation. The markup channel is also sensitive to the value of $\tau$ since large trade costs raise the elasticity of the real exchange rate to cross-country markup differentiation. The markup channel can be strong enough for the fiscal reform to induce a real exchange rate appreciation for $\tau \geq 1.25$ (versus ($\tau \geq 1.34$ under constant markups). Consistently with Petroulakis (2017), we find that trade costs prevent the competitive tax policy to be effective while we stress the role of markups on this result.

To conclude on this section, the final effect of both reforms on the real exchange rate (whether it depreciates or appreciates) is found to depend on the underlying structural parameters of the economy. In this respect, the sensitivity analysis suggests that we cannot draw a clear-cut conclusion regarding the effect of the reforms on international relative prices. However, our finding that markups adjustments mitigate the impact of both reforms on the real exchange rate remains valid, for the various values of $\tau$ and $\varpi$ considered.

# 5 Welfare Analysis

We complete our analysis by investigating the welfare effects of the two reforms. Following Lucas (1987), we express welfare in terms of consumption equivalent units, i.e. we define the compensation $\Theta$ that should be given to the households each period for them to accept to stay in the unreformed economy, versus being in the economy under reform. Let $\{C_t^{reform}, H_t^{reform}\}_{t=0}^{\infty}$ denote the dynamic paths of consumption and worked hours in the economy under reform and $\mathcal{W}^{reform} \equiv \mathcal{W}\{C_t^{reform}, H_t^{reform}\}_{t=0}^{\infty}$ the associated welfare level. Let also $\{C_0, H_0\}$ be the levels of consumption and hours in the initial steady state (i.e. in the absence of reform). The welfare gain (loss) associated with a given reform is then the $\Theta$ solution to: $\mathcal{W}\left[\{(1+\Theta)\,C_0, H_0\}_{t=0}^{\infty}\right] = \mathcal{W}^{reform}$. Table 2 provides the compensation $\Theta$ needed after the two reforms, expressed in percentage points of the initial steady-state consumption, in both cases of constant and varying markups.

The welfare gains induced by the reforms are substantially affected by endogenous PTM, and in an opposite direction: In the Home country, the welfare gains of the product market deregulation are

27

Table 2: Welfare Analysis

| Reform | Home Country | | Foreign Country | |
|---|---|---|---|---|
| | $\sigma = \theta$ | $\sigma > \theta$ | $\sigma = \theta$ | $\sigma > \theta$ |
| Product market deregulation ($\tau^e$) | 0.223 | 0.068 | 0.033 | −0.015 |
| Competitive tax policy ($\tau^w, \tau^c$) | 0.597 | 0.954 | 0.058 | 0.166 |

*Note:* Both reforms are sized to decrease the long-run lum-sum tax to GDP ratio at Home by one percentage point in the endogenous-markups model. Welfare gains are expressed in terms of consumption equivalent units, i.e. $\Theta$, in % of the pre-reform consumption.

almost cancelled by the endogenous markup adjustment (going from 0.22% to 0.07%); by contrast, those induced by the competitive tax policy are doubled when markups endogenously adjust (going from 0.60% to 0.95%).[16]

The intuition is the following. Both reforms induce a reduction in the Home CPI, i.e. an increase in the real wage which pushes consumption and hours upwards in both cases of constant and varying markups. However, the markups' dynamics intervenes in the magnitude of the real wage increase, thereby impacting the welfare effects of the reforms substantially. With the product market deregulation, the decrease in the incumbents' markups boosts the reduction in the Home CPI. This magnifies the rise in the real wage relative to the constant-markup model. On the opposite, when it comes to the competitive tax policy, the rise in real wages is dampened under $\sigma > \theta$ due to the rise in domestic markups. Accordingly, the intuition behind our results is identical for both reforms but it plays in the opposite direction. Let focus on the product market deregulation. The larger increase in the real wage under variable markups boosts labor supply, thereby accounting for the larger increase in hours worked. One might expect a stronger rise in consumption since higher real wages push the household's income upwards. However, the larger surge in real wages combined to the markup decrease induces a reduction in the dividends distributed to the households. This tends to dampen this positive income effect and therefore consumption.[17] Consequently, the strong increase in hours worked comes along with a moderate increase in consumption, implying positive but lower welfare gains than under constant markups (Appendix B, Figure 6, panels (a) and (b)). Contrasting with the product market deregulation, the competitive tax policy entails larger welfare gains under endogenous markups as the dampened rise in the real wages limits the increase in hours

---

[16]Real final consumption expenditures in the Euro Area were by about 21 104 euros per person in 2015. Therefore, consumption would rise permanently by 47 euros (PMD) and 125 euros (CTP) per person and per year in the constant-markups models. Under variable markups, these gains amount to 14 euros (PMD) and 201 euros (CTP). In this respect, the effects of the product market reform are quite modest.

[17]By setting $\psi$ high enough (e.g., $\psi = 2$), we can reverse the result on consumption, which increases by more under varying markups relative to constant markups. As the income effect is strengthened for high values of $\psi$ (consumption reacts more greatly to the real wage), the stronger rise in real wages led by endogenous markups dominates the dividends effect. However, this does not reverse the final result on welfare because the stronger rise in consumption under varying markups comes along with an even stronger amplification effect on hours worked.

worked. Combined with the increase in the markups set by the Home firms, this pushes dividends upwards, inducing a larger increase in consumption as well (Figure 6, panels (e) and (f)).

The welfare effects in the Foreign country are much less substantial. The markups endogeneity still reduces the positive spillover gain of the product market deregulation (going from 0.03% to $-0.01\%$) while they amplify those of the competitive tax reform (going from 0.06% to 0.17%). From Figure 6, this result is mainly attributable to consumption since hours worked are virtually left unaffected by the reforms. The dynamics of the Foreign real wage plays a major role here as the income effect that channels through dividends is of a second order effect ($n_t^*$ slightly reacts to the Home reform). Precisely, the Home product market deregulation reduces the Foreign real wages under variable markups while it does not under constant markups. This is notably explained by the rise in markups extracted by the Foreign firms on their local market (Appendix B, Figure 5, panel (b)). Consequently, Foreign households bear a reduction in their income which pushes consumption downward when $\sigma > \theta$ and leads to welfare losses. On the opposite, the Home competitive tax policy forces the Foreign firms to reduce their markups (Figure 5, panel (d)) which stimulates consumption and magnifies the Foreign welfare gains.

# 6    Conclusion

This paper shows how PTM behavior affects the channels through which labor and good markets reforms affect the country's international competitiveness. We address this question in a theoretical way, by a developing a two-country dynamic model with endogenous firm entry. In presence of international trade costs, our modeling of the production structure implies that firms can endogenously adjust their pricing behavior on each destination market, i.e. generating endogenous PTM. In this setup, we study the effects of a competitive tax policy on one side, and a product market deregulation on the other side.

With this framework, we provide a careful understanding of the way both reforms operate on the real exchange rate. Two main results emerge. First, the two reforms work along very distinct channels. For our benchmark calibration, we thus find that that competitive tax policy is successful in improving international competitiveness through a permanent reduction in the terms of trade and a real exchange rate depreciation while a product market deregulation is not. This result also holds all along the transitional dynamics. Deregulating the goods market also deteriorates the country's trade balance, whereas it turns into surplus following the competitive tax policy. Second, we show the important role of the endogenous PTM behavior of firms as a propagation channel of both reforms on international relative prices. Specifically, endogenous markups lessen the impact of both reforms on the real exchange rate. We show that this effect is robust to alternative calibrations of the model. Further, endogenous markup adjustment also matters in the normative implications of the reforms. Our overall results thus point out the importance of taking into account the endogenous PTM behavior if willing to correctly evaluate the overall effects of the reforms.

# References

Anderson, J. & van Wincoop, E. (2004). Trade costs. *Journal of Economic Literature*, 42, 691–751.

Andrés, J., Arce, O., & Thomas, C. (2017). Structural reforms in a debt overhang. *Journal of Monetary Economics*, forthcoming.

Atkeson, A. & Burstein, A. (2008). Pricing-to-market, trade costs, and international relative prices. *American Economic Review*, 98, 1998–2031.

Auray, S., Eyquem, A., & Ma, X. (2018). Competitive tax reforms in a monetary union with endogenous entry and tradability. *European Economic Review*, 98, 126–143.

Behrens, K., Kichko, S., & Ushchev, P. (2018). *Intersectoral Markup Divergence*. Working paper series 6965, CESifo.

Benkovskis, K. & Wörz, J. (2014). *What Drives the Market Share Changes? Price versus Non-Price Factors*. Technical Report Working Paper 1640, ECB.

Bergin, P. & Feenstra, R. (2001). Pricing-to-market, staggered contracts, and real exchange rate persistence. *Journal of International Economics*, 54, 333–359.

Bilbiie, F., Ghironi, F., & Mélitz, M. (2012). Endogenous entry, product variety, and business cycles. *Journal of Political Economy*, 120(2), 304–345.

Brander, J. & Krugman, P. (1983). A reciprocal dumping model of international trade. *Journal of International Economics*, 15, 313–321.

Broda, C. & Weinstein, D. (2006). Globalization and the gains from variety. *The Quarterly Journal of Economics*, 121(2), 541–585.

Burstein, A. & Gopinath, G. (2014). International prices and exchange rates. In *Handbook of International Economics* chapter 4, (pp. 391). Elsevier.

Cacciatore, M., Duval, R., Fiori, G., & Ghironi, F. (2016a). Market reforms in the time of imbalance. *Journal of Economic Dynamics and Control*, 72, 69.

Cacciatore, M., Duval, R., Fiori, G., & Ghironi, F. (2016b). Short-term pain for long-term gain: Market deregulation and monetary policy in small open economies. *Journal of International Money and Finance*, 68, 358.

Cacciatore, M. & Fiori, G. (2016). The macroeconomi effets of good and labor markets deregulation. *Review of Economic Dynamics*, 20, 1–24.

Cacciatore, M., Fiori, G., & Ghironi, F. (2015a). The domestic and international effects of euro area market reforms. *Research in Economics*, 69, 555–581.

Cacciatore, M., Fiori, G., & Ghironi, F. (2016c). Market deregulation and optimal monetary policy in a monetary union. *Journal of International Economics*, 99, 120–137.

Cacciatore, M., Ghironi, F., & Stebunovs, V. (2015b). The domestic and international effects of interstate u.s. banking. *Journal of International Economics*, 95, 171–187.

Chugh, S. K. & Ghironi, F. (2011). *Optimal Fiscal Policy with Endogenous Product Variety*. Working Paper 17319, NBER.

Corsetti, G. & Dedola, L. (2005). A macroeconomic model of international price discrimination. *Journal of International Economics*, 67, 129–155.

Corsetti, G., Martin, P., & Pesenti, P. (2007). Productivity, terms of trade and the home market effect. *Journal of International Economics*, 73(1), 99–127.

Devereux, M. & Lee, K. (2001). Dynamic gains from international trade with imperfect competition and market power. *Review of Development Economics*, 5, 239–255.

di Mauro, F. & Pappadà, F. (2014). Euro area external imbalances and the burden of adjustment. *Journal of International Money and Finance*, 48, 336–356.

Dixit, A. & Stiglitz, J. (1977). Monopolistic competition and optimum product diversity. *American Economic Review*, 67(3), 297–308.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. *Journal of Political Economy*, 84, 1161–1176.

Ebell, M. & Haefke, C. (2009). Product market deregulation and the u.s. employment miracle. *Review of Economic Dynamics*, 12(3), 479–504.

Edmond, C., Midrigan, V., & Xu, D. Y. (2015). Competition, markups, and the gains from international trade. *American Economic Review*, 105(10), 31833221.

Eggertsson, G., Ferrero, A., & Raffo, A. (2014). Can structural reforms help Europe? *Journal of Monetary Economics*, 61, 2–22.

Engler, P., Ganelli, G., Tervala, J., & Voigts, S. (2017). Fiscal devaluation in a monetary union. *IMF Economic Review*, 65(2), 241–272.

Farhi, E., Gopinath, G., & Itskhoki, O. (2014). Fiscal devaluations. *Review of Economic Studies*, 81(2), 725–760.

Floetotto, M. & Jaimovich, N. (2008). Firm dynamics, markup variations, and the business cycle. *Journal of Monetary Economics*, 55(7), 1238–1252.

Forni, L., Gerali, A., & Pisani, M. (2010). Macroeconomic effects of greater competition in the service sector: The case of italy. *Macroeconomic Dynamics*, 14(5), 1–32.

Ghironi, F. & Mélitz, M. (2005). International trade and macroeconomic dynamics with heterogeneous firms. *The Quarterly Journal of Economics*, 120, 865–915.

Kehoe, T. J., Pujolas, P. S., & Rossbach, J. (2017). *Quantitative trade models: Developments and Challenges*. Working paper 22706, NBER.

Lane, P. R. & Milesi-Ferretti, G. M. (2011). The cross-country incidence of the global crisis. *IMF Economic Review*, 59(1), 77.

Lucas, R. (1987). *Models of Business Cycles*. Oxford: Basil Blackwell.

MaCurdy, T. (1981). An empirical model of labour supply in a life cycle setting. *Journal of Political Economy*, (61), 1059–1085.

Petroulakis, F. (2017). *Internal devaluation in currency unions: the role of trade costs and taxes*. Working Paper 2049, European Central Bank.

Ravn, M. O. & Mazzenga, E. (2004). International business cycles: the quantitative role of transportation costs. *Journal of International Money and Finance*, 23(4), 645–671.

Soderbery, A. (2017). *Trade Elasticities, Heterogeneity, and Optimal Tariffs*. Mimeo.

# A Complements on the model

## A.1 More on the Foreign country

**Optimal demand functions**  As in the Home country, the industrial good $C_{st}^*$ is produced by a continuum of competitive representative firms according to the production function (for each industry $s \in [0,1]$:

$$C_{st}^* = \left( \sum_{k=1}^{n_{st}} (c_{skt}^*)^{\frac{\sigma-1}{\sigma}} + \sum_{k^*=n_{st}+1}^{n_{st}+n_{st}^*} (c_{sk^*t}^*)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}},$$

with $c_{skt}^*$ (resp. $c_{sk^*t}^*$) a differentiated intermediate good produced by a domestic Home firm (resp. Foreign). Symmetrically as for the Home country, the optimal demand functions that emanate from the Foreign household for the Home and Foreign differentiated goods ($c_{k^*t}^*$ and $c_{kt}^*$, respectively) and the associated price index are given by:

$$c_{sk^*t}^* = \left( \frac{p_{sk^*t}^*}{P_{st}^*} \right)^{-\sigma} C_{st}^*, \quad \text{and} \quad c_{skt}^* = \left( \frac{p_{skt}^*}{P_{st}^*} \right)^{-\sigma} C_{st}^*, \tag{A-33}$$

$$P_{st}^* = \left[ \sum_{k=1}^{n_{st}} (p_{skt}^*)^{1-\sigma} + \sum_{k^*=n_t+1}^{n_{st}+n_{st}^*} (p_{sk^*t}^*)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}. \tag{A-34}$$

**Markups determinants**  Using a similar reasoning as for markups set by the Home firm (Section 2.2.2), one can show that the markups set by a Foreign firm on both its local and export market are:

$$\widehat{\mu}_{k^*}^* = -\frac{1}{\Delta_1} \left[ \widehat{n}^* + \phi \bar{\kappa}^{1-\sigma} \widehat{n} \right] + \frac{\sigma-1}{\Delta_1} \phi \bar{\kappa}^{1-\sigma} \left[ \widehat{RULC} + \widehat{\mu}_k^* \right], \tag{A-35}$$

$$\widehat{\mu}_{k^*} = -\frac{1}{\Delta_2} \left[ \widehat{n} + \phi \bar{\kappa}^{1-\sigma} \widehat{n}^* \right] + \frac{\sigma-1}{\Delta_2} \left[ \widehat{RULC} + \widehat{\mu}_k \right]. \tag{A-36}$$

with the positive constant terms $\Delta_1$ and $\Delta_2$ defined as:

$$\Delta_1 \equiv \frac{1}{\sigma - \bar{\varepsilon}} \left[ \bar{\varepsilon}(\bar{\varepsilon} - 1) + \phi \bar{\kappa}^{1-\sigma} \left[ \sigma(\bar{\varepsilon} - 1) + (\sigma - \bar{\varepsilon})^2 \right] \right] > 0,$$

$$\Delta_2 \equiv \frac{1}{\sigma - \bar{\varepsilon}_X} \left[ \bar{\varepsilon}_X(\bar{\varepsilon}_X - 1)(1 + \phi \bar{\kappa}^{1-\sigma}) + (\sigma - 1)(\sigma - \bar{\varepsilon}_X) \right] > 0.$$

Notice that these terms $\Delta_1$ and $\Delta_2$ are the same as those intervening in the markups expressions for the Home firm, i.e. Equations (16) and (17).

## A.2 Real exchange rate, markups: More details

In this section, we come back to the point relating endogenous markups and PTM made in Section 3.1. To this aim, we start considering the expressions of the price-elasticities of demand for the Home variety from the Home and Foreign markets (Equations (13) and (14)) in the initial symmetric

steady state, denoted $\bar{\varepsilon}$ and $\bar{\varepsilon}_X$ for notational simplicity[18]

$$\bar{\varepsilon} = \sigma - (\sigma - \theta)\overbrace{\frac{1}{\bar{n}(1 + \phi\bar{\kappa}^{1-\sigma})}}^{\bar{m}}, \tag{A-37}$$

$$\bar{\varepsilon}_X = \sigma - (\sigma - \theta)\underbrace{\frac{\phi\bar{\kappa}^{1-\sigma}}{\bar{n}(1 + \phi\bar{\kappa}^{1-\sigma})}}_{\bar{m}_X}, \tag{A-38}$$

with $\phi \equiv \tau^{1-\sigma}$ the freeness of trade (between 0 and 1), $\bar{\kappa} \equiv \bar{\mu}_X/\bar{\mu}$ the export-to-local markup ratio (with $\bar{\mu}_X = \mu_k^* = \mu_{k^*}$ and $\bar{\mu} = \mu_k = \mu_{k^*}^*$ in the symmetric steady state) and $\bar{m}$ and $\bar{m}_X$ the market shares of the firm on the local and the export markets respectively.

Consider first the standard CES case ($\sigma = \theta$). As noted above, in this case price-elasticities of demand and markups are constant and equal across destination markets. Trade costs yet induce an asymmetry between the market shares a firm can obtain depending on the destination market, as in this case

$$\bar{m} = \frac{1}{\bar{n}(1 + \phi)}, \qquad \bar{m}_X = \frac{\phi}{\bar{n}(1 + \phi)}.$$

As long as $\phi < 1$ (ie, in presence of trade costs), the market share of the firm is higher when it sells on the local market relative to abroad. As can be inferred from Equation (9), under constant markups ($\sigma = \theta$), markups are identical among destination ($\bar{\kappa} = 1$ and $\tau\bar{\kappa} = \tau$), such that local firms fully reports the trade cost on foreign households ($p_k^* = \tau p_k$). This mill-pricing strategy of firms on their export market (ie, firms passing on the iceberg trade costs to foreign consumers) raises the relative price of imports. This drives consumers to favor locally produced goods, hence an asymmetric market share in favor of local firms ($\bar{m} > \bar{m}_X$). Note that this holds in the absence of home bias in preferences within the basket of differentiated varieties.

As long as $\sigma > \theta$, positive trade costs ($\phi < 1$) also affect the price-elasticities of demand, hence the markups set by firms. As can be inferred from Equations (A-37) and (A-38), everything else equal an increase in trade costs raises the price-elasticity of the demand for imports, while it decreases the price-elasticity of the demand for the local good ($\frac{\partial \bar{\varepsilon}_X}{\partial \phi} < 0$, $\frac{\partial \bar{\varepsilon}}{\partial \phi} > 0$). From Equation (10), this, in turn, affects markups differently depending on the destination market. Precisely, trade costs tend to induce lower markup on the export market, due to a higher price-elasticity of demand than on the local market (ie pushing $\bar{\kappa} < 1$ everything else equal).

If in the initial steady state the magnitude of the PTM behavior is not strong enough to more than compensate the effects of trade costs, then firms face a more elastic demand on the export market, leading to a lower export markup. From Equations (A-37) and (A-38), this is the case when $\phi\bar{\kappa}^{1-\sigma} < 1$, or equivalently $\tau\bar{\kappa} > 1$. In this case further, the export price ($p_X$) remains higher than the local one ($p$), as

$$\frac{p_X}{p} = \tau\frac{\bar{\mu}_X}{\bar{\mu}} > 1.$$

Note that this is reminiscent of the condition $\frac{1}{\tau} < \frac{p_X}{p} < \tau$ for PTM to be sustainable in equilibrium pointed out by Atkeson & Burstein (2008). Transposed in terms of markups, this condition becomes: $1 < \tau \frac{\bar{\mu}_X}{\bar{\mu}} < \tau^2$. By imposing $\phi \bar{\kappa}^{1-\sigma} < 1$, we ensure the first part of the inequality condition holds analytically. In our simulations, our calibration $\tau \bar{\mu}_X / \bar{\mu} = 1.3 \times 0.97 = 1.26$ ensures the inequality holds.

# B   Complements on the effects of the reform

## Figure 5: Long-run effects of the reforms: Markups and the terms of trade
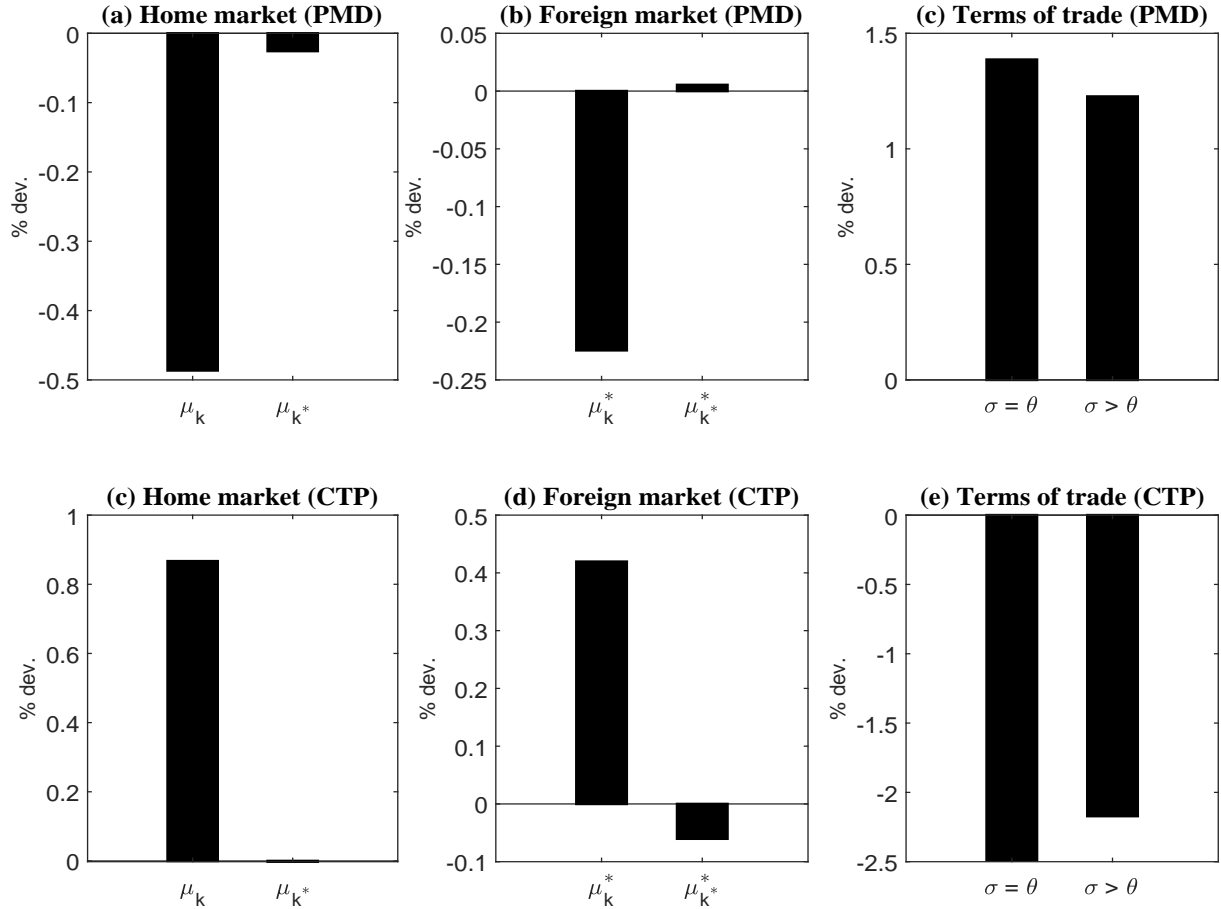


**Detailed view of markups changes** Long-run effects of the product market deregulation (first line, PMD) and the competitive tax policy (second line, CTP) on the markups by both Home and Foreign firms on the two destination markets, under constant markups ($\sigma = \theta$) and variable markups ($\sigma > \theta$).

Figure 6: Long-run effects of the reforms: Selected set of macroeconomic variables
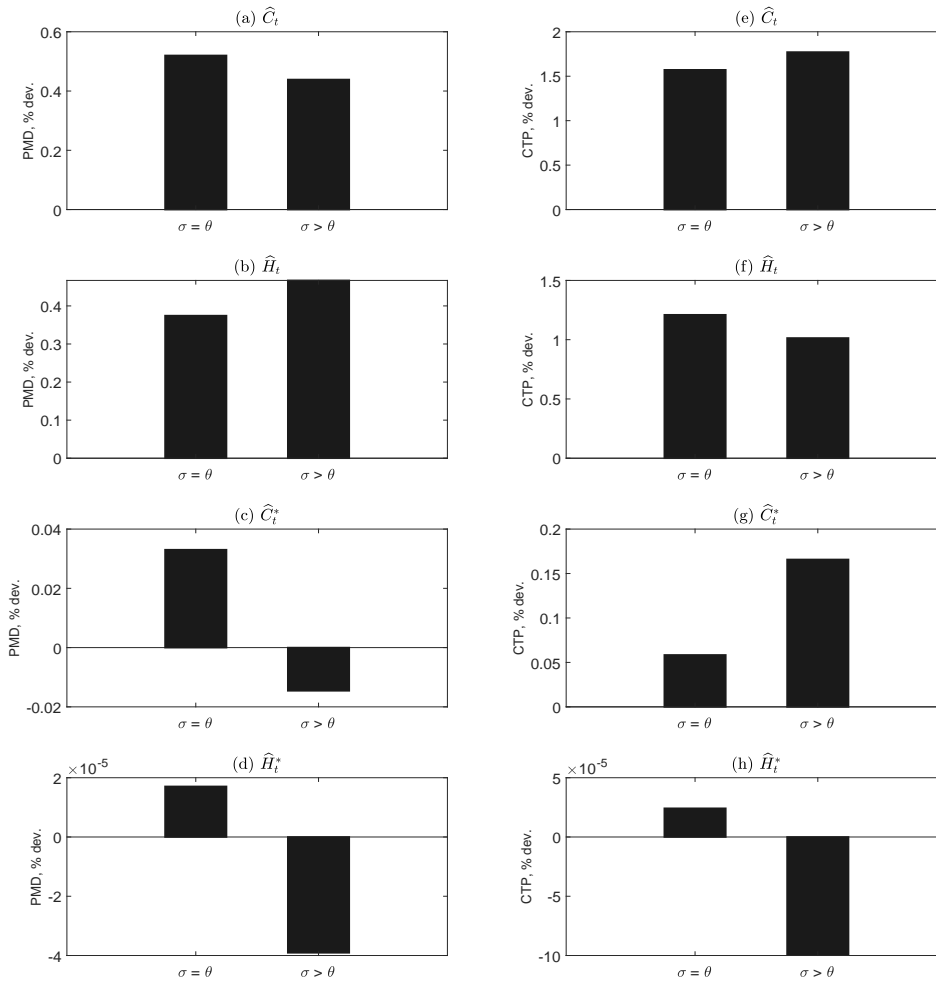


**Long-run effects on selected macroeconomic variables** Long-run effects of the product market deregulation (first line, PMD) and the competitive tax policy (second line, CTP) consumption and hours worked in the Home and Foreign country, under constant markups ($\sigma = \theta$) and variable markups ($\sigma > \theta$).