Reforms and the real exchange rate: The role of pricing-to-market

Lise Patureau, Céline Poilly

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October 2018

Abstract

The paper investigates how endogenous markups affect the extent to which policy reforms can influence international competitiveness. In a two-country model where trade costs allow for international market segmentation, we show that endogenous pricing-to-market behavior of firms acts as an important transmission channel of the policies. By strengthening the degree of competition between firms, product market deregulation at home leads to a reduction in domestic markups, which generally leads to an improvement in the international competitiveness of the Home country. Conversely, the power of competitive tax policy to depreciate the real exchange rate is dampened, as domestic firms take the opportunity of the labor tax cut to increase their markups. The variability of markups also affects the normative implications of the reforms. This indicates the importance of taking into account endogenous pricing-to-market behavior when intending 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.

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‡We would like to thank Philippe Bacchetta, Drago Bergholt, Mónica Correa-López, Mick Devereux, Julien Matheron, Mathieu Parenti and Carlos Thomas for their comments. We are also grateful to conference participants at RIEF (2015, Orléans), DEGIT Conference (2015, Geneva), T2M conference (2016, Paris), AMSE-BdF Policy Spillovers Workshop (2018, Marseille) and to several seminar participants at the Bank of Spain, the Université Paris-Dauphine, University of Lausanne, Aix-Marseille University, University of Pamplone, University Paris I. This research was funded by the French Agence Nationale de la Recherche (ANR) under grant ANR-11-JSH1002 01.

1 Introduction

The severity of the recession that hit a large number of countries over the last decade forced policy-makers and economists to evaluate the structural fragilities that have become apparent 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 to a renewed interest in studying the effects of fiscal and/or structural policies on external imbalances. Playing on the fiscal tool has thus been studied as a way of depreciating the real exchange rate in the short run (Farhi et al., 2014). Deregulating the goods market may also help firms compete on international markets (see Cacciatore et al. (2015a) for a survey).

In this paper, we investigate the channels through which policy reforms – such as product market deregulation or payroll tax cuts – affect the real exchange rate, in both long- and short-run perspectives. As pointed out by several empirical studies, 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 market segmentation. A main contribution to the existing literature is thus to shed light on the role of endogenous markup adjustments on the effectiveness of the reforms to affect international relative prices.

This question will be addressed 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 framework, we capture two dimensions that have been shown to be key elements in shaping 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 further expanded to include a structure of oligopolistic competition that generates endogenous markups, in a similar way to that described by Atkeson & Burstein (2008). Further, international trade costs allow firms to discriminate across countries by charging different markups specific to the destination market. The markup extracted on each market can thus be shown to depend 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 the producer. 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. Markup adjustments are shown to serve as a major transmission channel of these reforms onto international relative prices. More precisely, we study the effects of the Home country implementing 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. a competitive tax policy), contrasting the cases where markups are constant or endogenously adjusted to the economic policy. For our benchmark calibration, we find that a competitive tax policy is successful in improving international competitiveness through a permanent reduction in the terms of trade and a real exchange depreciation, while product market deregulation is not. Importantly, PTM behavior of firms is seen to play a key role in the propagation of both of the aforementioned reforms.

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 has been seen to contribute to a real exchange depreciation, all other things being equal. Yet, this effect is counteracted by a rise in the relative labor cost at Home, which is detrimental to the price competitiveness of Home goods meaning that the terms of trade, i.e. the relative price of exports, go up. The competitive tax policy has an effect on firms' market share and terms of trade, 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 country's domestic firms active on the world market. For our benchmark calibration, the relative labor cost effect dominates, such that a competitive tax policy engenders a real exchange rate depreciation while product market deregulation engenders an appreciation. These responses of international relative prices hold in the long run as well as throughout the transitional dynamics. Specifically, both reforms lead to an overshooting of the real exchange rate, as the magnitude of its immediate response is larger than its permanent one. This is attributable to the immediate adjustment 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 as follows: By reducing the entry cost, product market deregulation sets the competition effect in motion: A 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 can have an effect of welfare improvement under constant markups, an allowance for endogenous PTM behavior amplifies the welfare gains of the competitive tax policy whilst reducing those of the product market deregulation in both countries. Viewed from different perspectives, our results thus point out the importance of taking into account the endogenous PTM behavior when intending 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 term, leaving aside the potential long-term effects that also incorporate the effects on firm entry. Conversely, Auray et al. (2018) point out that it is also important to consider 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 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 shows the importance of taking into account the endogeneity of markup adjustment. Closest to us, Cacciatore et al. (2015, 2016) extensively study the open-economy effects of product market deregulation on 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 mere

stabilization policy. Overall, while the literature has studied either product market deregulation or labor tax policy as two distinct phenomena, we study the two policies in a unified framework. Our results help to understand the transmission channels of those two reforms. 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 differs from these others in two main aspects: First, we explicitly relate endogenous PTM decisions to firm entry in an international setup. In this respect, our study bridges a gap 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 interrogate our supposition, focussing on how endogenous markups may affect the outcomes of structural/fiscal reforms.

The following section lays out the model. In Section 3, we evaluate the effects of the reforms on the determinants of the real exchange rate 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 up 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 up 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 inputs (as

[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 affects markups distortions.

[2] All of the 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 those of Home one, we describe only the latter.

described below). Accordingly, we refer to these two goods as "non-tradable" and "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 destination market 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 the appendix and an extensive version of the model is made in an online appendix, available on the authors' webpages.

2.1 Tradable Good: Competition Structure

The final tradable good (denoted C_{Tt}) is made up 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 oligopolists 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

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

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 labor, 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 broken down into two steps. First, they take the decision to enter the market, given the sunk cost of entry which ultimately determines the number of firms within each country. Second, once entered, they maximize the operating profit. We now solve the problem backwards.

Profit Maximization Once entered, the type-k Home firm maximizes its operational profit π_{skt}

$$P_t \pi_{skt} = \bar{L} p_{skt} c_{skt} + \bar{L}^* p_{skt}^* c_{skt}^* - \tau_t^w W_t h_{skt}, \tag{7}$$

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 $\tau_t^w > 0$ denotes gross payroll taxes on labor paid by firms. Firm k in industry s maximizes its operational profit (7) subject to 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 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 μ_{skt} and μ^*_{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 ε_{skt} and ε^*_{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 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^e_t startups requires H^e_t units of labor, such that the labor demand for new firm creation is $H^e_t = f^e n^e_t$.

Ignoring the integer constraint, entry occurs until firm value v_t is equalized with the entry cost,

leading to 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 δ. 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 ε_{kt} and ε_{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

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

[3] As the number of firms is supposed to be an integer value, free-entry condition cannot not hold 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).

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 as 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: $p^*_{kt} = \tau p_{kt}$.

As long as $\sigma \neq \theta$, price-elasticities of demand, as well as markups, are no longer constant and vary endogenously with the economic environment. As in Atkeson & Burstein (2008), this setup implies that the price elasticity of demand, rather than being 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 industries than across them.

In a open-economy setting, this market structure also implies PTM being optimal for price makers. Under $\sigma \neq \theta$, the price-elasticities of local and 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, implying that one can use both terms interchangeably.

Markup 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 $\widehat{RULC}_t \equiv \hat{W}_t - \hat{W}^*_t + \hat{\tau}^w_t - \hat{\tau}^{w*}_t$ denotes the relative unit labor cost, and Δ_1, Δ_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 locally-produced goods 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 with. Given the oligopolistic type of competition within each industry, a marginal firm entry (whatever the country it is located in) raises the price elasticity of demand addressed to each domestic producer, thereby exerting a downward pressure on its markup on both destination markets. However, due to trade costs, the weight of foreign competitors is dampened relative to that of local incumbents. Put 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 it on its export market (see Equation (17)). Accordingly, both μ^*_k and μ_k reduce with a marginal domestic firm entry, but not to the same extent. This is a first source of markup divergence across market destinations.

The "relative-price effect" depends on both the relative unit labor cost and the markup charged by foreign competitors on the local market. As reported in Equation (16) (and (A-35), an increase in Home unit labor cost relative to Foreign reduces the price-competitiveness of Home goods. This, in turn, pushes 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)).

[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 the sake of notational simplicity.

The relative-price effect also depends on the markup set by Foreign competitors on this market. On the Home market for instance, the lower the markup set by the Foreign competitors (μ_{k^*}), the lower the price of imports, all other things being equal. In order to preserve their market share, Home firms have to reduce their own markup as well (μ_k). Further, due to market segmentation, the factor exerting the most influence on markup setting on each destination market is the markup set by the foreign firms (μ_{k^*} for μ_k, but $\mu^*_{k^*}$ for μ^*_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 π_{NTt}, standardly defined by $P_{NTt}\pi_{NTt} = P_{NTt}y_{NTt} - \tau^w_t W_t h_{NTt}$, using the production function $y_{NTt} = h_{NTt}$. The optimization problem simply yields $P_{NTt} = \tau^w_t W_t$. 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]

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

2.4 Households

The household's optimizing behavior can be decomposed into a 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-

[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).

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 ones 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, σ_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

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

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 τ_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 the non-contingent stock of bonds at the beginning of t, yielding the interest rate i_t.[6] Issuing new bonds is subject to adjustment costs on portfolio, paid to the government and scaled by the parameter ψ_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 (π_t). Resources are also made up 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 taxes are collected to finance public spending and lump-sum transfers 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 τ_t^e. The competitive tax reform consists in a reduction of the payroll tax rate τ_t^w, that is financed by a rise in VAT rate τ_t^c, so as to ensure the government's balanced budget (27).

[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-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, the 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

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

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

$$P_t Y_t = \bar{L} P_t C_t + \bar{L}^* n_t p^*_{kt} c^*_{kt} - \bar{L} n^*_t p_{k^*t} c_{k^*t} + P_{NTt} G_t, \tag{30}$$

see online appendix for details.

3 Reforms, the Real Exchange Rate and Endogenous Markups

A key objective of this paper is to assess the potential of the two reforms (product market deregulation, through τ^e and competitive tax policy, through the switch (τ^w, τ^c)) to affect the country's international competitiveness. In order to better understand the underlying mechanisms at work here, we will conduct an analysis of the real exchange rate's determinants.

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 of that of the Home country, such that $q_t \equiv P_t^*/P_t$. As explained in Ghironi & Mélitz (2005), endogenous firm entry induces changes in the composition of 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:

$$\begin{aligned}\widehat{q} &= \varpi\left[\hat{P}_T^* - \hat{P}_T\right] + (1-\varpi)\left[\hat{P}_{NT}^* - \hat{P}_{NT}\right], \\ &= \varpi\frac{1-\phi\bar{\kappa}^{1-\sigma}}{1+\phi\bar{\kappa}^{1-\sigma}}\left[-\underbrace{\widehat{RULC}}_{(a)} + \frac{1}{\sigma-1}\underbrace{\left[\widehat{n}-\widehat{n}^*\right]}_{(b)} + \frac{1}{1-\phi\bar{\kappa}^{1-\sigma}}\underbrace{\left[\widehat{\widetilde{\mu}}^* - \widehat{\widetilde{\mu}}\right]}_{(c)}\right] - (1-\varpi)\widehat{RULC} \quad (31)\end{aligned}$$

where $\widehat{\widetilde{\mu}} \equiv \hat{\mu}_k + \phi\bar{\kappa}^{1-\sigma}\hat{\mu}_{k^*}$ 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 $\widehat{\widetilde{\mu}}^* \equiv \hat{\mu}_{k^*}^* + \phi\bar{\kappa}^{1-\sigma}\hat{\mu}_k^*$ 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 τ).

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

[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 passing it onto 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 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

($\varpi \neq 1$) 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).

The originality of our work in relation to the existing literature is that we point out the role of a third determinant that channels through endogenous markup adjustment ($\sigma \neq \theta$) with Term (c), at the root of markup differentiation across countries. All else being equal, an increase in the Foreign-market markup relative to Home ($\widehat{\widetilde{\mu}}^* - \widehat{\widetilde{\mu}} > 0$) 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.

In conclusion, it is worth noting that endogenous markups break the equality 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, $\widehat{s} > 0$). 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 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.

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 out 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. The model is calibrated on a quarterly basis based on either values commonly retained in the literature or by ensuring that the steady-state model matches several empirical targets. These are based on empirical evidence gathered in European countries over the recent period.[9] Table 1 illustrates 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 subsequent experiments. Home labor is considered as numeraire, 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, though there is no clear consensus on these values. 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 θ) is 2.50 over the sample 1972-1988. At their most disaggregated level (our σ), they estimate a median substitution elasticity equal to 3.7. Benkovskis & Wörz (2014) estimate σ 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 σ. Atkeson & Burstein (2008) allow for strong pricing-to-market behavior by setting $\sigma = 10$ and θ close to 1. We set $\psi = 1$, implying a log specification on consumption, as is standard in the related literature (see Floetotto & Jaimovich (2008)). The Frisch elasticity of labor supply 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 noting 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).

[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 representation of the model's steady state and the calibration procedure is provided in the online appendix.

Table 1: Parametrization

Deep parameters		Value	Reference
σ	Elast. of substitution. btw goods	5	Anderson & van Wincoop (2004)
θ	Elast.of substitution across industries	2	Broda & Weinstein (2006)
τ	Trade costs	1.2	di Mauro & Pappadà (2014)
δ	Firm destruction rate	0.029	Cacciatore & Fiori (2016)
$1/\eta$	Frisch labor supply elasticity	0.5	MaCurdy (1981)
ψ	Curvature of utility function	1	Floetotto & Jaimovich (2008)
ψ_b	Bond adjustment cost	0.001	
Pre-reform targets			
H	Hours worked	0.3	Normalization
μ_k	Markup on Home market by Home firms	1.36	Eggertsson et al. (2014)
τ^w	Gross payroll tax rate	1.36	Own calculations, Eurostat data
τ^c	Gross VAT rate	1.16	Own calculations, Eurostat data
τ^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	
$\overline{L}$	Home country size	0.94	
ϖ	Share of non-tradable goods	0.87	
σ_L	Scale parameter	29.17	
G	Government spending	0.005	

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

The bond adjustment costs parameter ψ_b is set at a value sufficiently small to enable the steady state to be pinned 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 that 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, ϖ, matches the import share set to 30% as was the case for GIIPS countries over 1995-2017. The regulation cost instrument τ^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 up

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 in GDP is set to 1.94%, as observed in the Euro Zone (Cacciatore et al., 2016a). The public expenditure share in 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), σ_H, $\bar{L}$, ϖ 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-term value of Home lump-sum transfer-to-GDP ratio in the case featuring the endogenous markup. The corresponding reduction of τ^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 revenue neutrality.[10] This amounts to a reduction in the payroll tax rate from 34% to 19% and increasing the VAT from 16% to 24%.

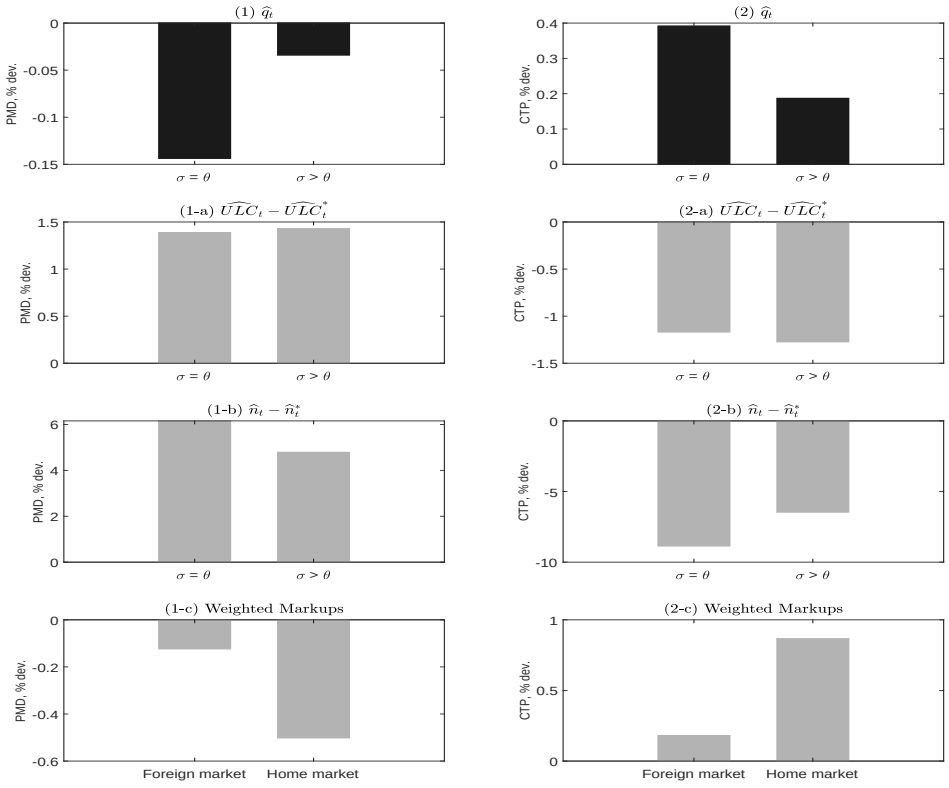
3.3 Reforms and the Real Exchange Rate: Long-run impact

Figure 1 reports the long-run effects of 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 allow a better insight into 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) broken down into its two components, $\widehat{\widetilde{\mu}}^*$ and $\widehat{\widetilde{\mu}}$). In Appendix B, we also report on 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 as 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

[10] We calculate the values of τ^w and τ^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 case featuring the competitive tax policy, the reduction in tax revenues led by the decrease in τ^w is compensated by a rise in VAT, τ^c to ensure that total government spending ($\bar{L}T/Y + P_{NT}G/PY$) - hence, total revenues, stay at their pre-reform value.

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 τ_t^e (τ_t^w combined with a rise in τ_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 model featuring endogenous markup. 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 ($\widehat{\widetilde{\mu}}_t = \widehat{\mu}_{kt} + \phi\bar{\kappa}^{1-\sigma}\widehat{\mu}_{k^*t}$) and in the Foreign market ($\widehat{\widetilde{\mu}}_t^* = \widehat{\mu}_{k^*t}^* + \phi\bar{\kappa}^{1-\sigma}\widehat{\mu}_{kt}^*$).

international competitiveness through a permanent real exchange rate 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 endogenous PTM behavior. We will now go deeper into the analysis by considering each reform successively.

Product Market Deregulation Figure 1 (panel (1)) shows that product market deregulation at Home generates an appreciation in the real exchange rate. 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 entry cost reduction on the real exchange rate under constant markups ($\sigma = \theta$). The primary effect of product market deregulation is the impact 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 the presence of trade costs, the induced variety effect should push to a real exchange rate *depreciation* all else being 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 higher 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 (s_t increases) in line with Corsetti et al. (2007), Cacciatore et al. (2016b) or Cacciatore et al. (2016c) findings.

How do variable markup affect this result? As explained in Section 2.2.2, markups' variations are driven by the "competition effect", as reducing 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 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 operational profit and therefore, fewer Home firms are needed to restore free-entry condition. Consequently,

the increase in the relative number of Home firms ($\widehat{n}_t - \widehat{n}_t^*$) is of lower magnitude when endogenous markups adjustment (Figure 1, panel (1-b)). The extensive margin is therefore less powerful in counteracting the deterioration of price-competitiveness, which should lead to an even stronger real exchange rate appreciation than would be the case 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 effect is all the more pronounced, as the markup reduction is much weaker on the Foreign market. Indeed, in the presence of trade costs, a marginal entry from the Home country has a lower impact on the price elasticity of Foreign demand than on Home demand elasticity. This enables the Home firms to reduce their export markups less than domestically (μ_k^* reduces but less than μ_k). The result of deregulation of the product market is a stronger markup reduction in the Home country 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 case featuring constant markups.

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 however lessened under endogenous markups. 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 τ_t^w engenders the results we describe (and we also 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 τ_t^w pushes the relative price of Home goods down, inducing an improvement in price-competitiveness (Appendix B, Figure 5) which drives real exchange rate 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 the strength of the substitution effect between consumption and leisure. Indeed, the reduction in the

[11] Under endogenous markups, Foreign firms' lower 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 limited.

Home good price pushes the Home CPI downward (see Equation (9)) and the domestic real wage upward. As illustrated by our calibration, we can see that when the substitution is small enough relative to the wealth effect in consumption choices, the rise in real wages causes households to favor leisure to consumption, the latter only moderately increasing. This effect is amplified by the increase in the VAT burden borne 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 and therefore a reduction in firm entry 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 extensive margin of trade counters the effect of unit labor cost 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 goods more expensive (see Figure 2 in the online appendix).

How are these mechanisms affected when markups endogenously adjust? As illustrated in Figure 1, the magnitude of 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 in Home country 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 Home firms (see Appendix B, Figure 5, panel (e)). With regard to the real exchange rate, in the presence of trade costs, a 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 real exchange rate depreciation induced by gains in unit labor cost (see Term (c) in Equation (31)). Interestingly, this compensates the fact that the negative extensive margin of trade effect is of lower magnitude under $\sigma > \theta$.

Summary become apparent: First, a competitive tax policy succeeds in depreciating the real exchange rate in the long run while product market deregulation does not. Second, these transmis-

sion channels are substantially affected by endogenous markup adjustments. With 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 possibility that the reform will engender a real exchange rate depreciation.

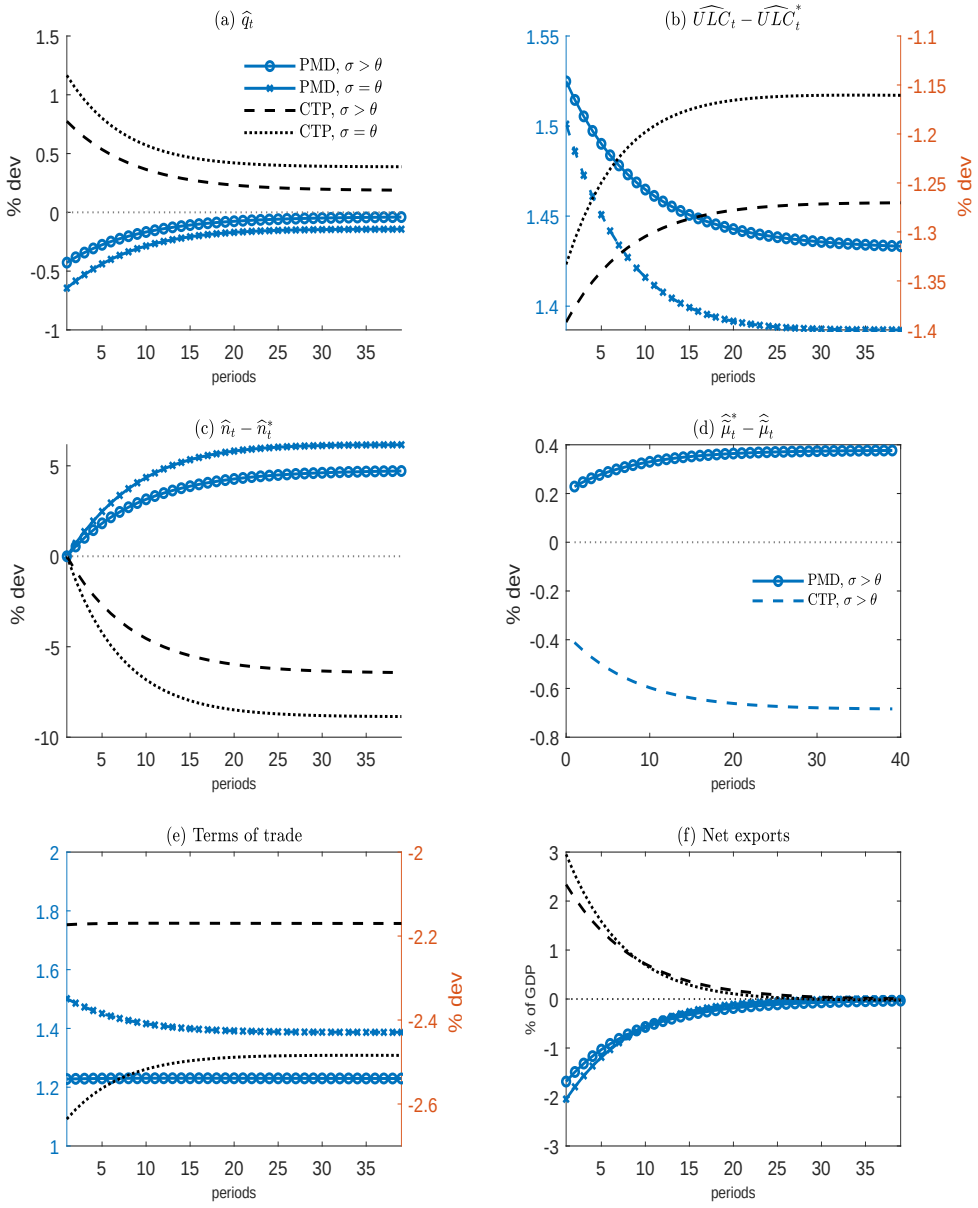
3.4 Reforms and Real Exchange Rate: Transitional Effects

Our model's dynamic structure enables an evaluation of how endogenous markups affect the impact of reforms on international relative prices throughout 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 all seen 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 other things being equal), is only progressive (Figure 2, panel (c)), in line with Equation (12). In the period during which the reform is to be implemented, given the fixed number of active firms, the deterioration of the price-competitiveness of Home goods (Panel (e)) expands the real exchange rate appreciation. This impact is all the more pronounced in the case where the response of the unit labor cost is maximal (Panel (b)). From the free-entry condition (11), the reduction in entry costs τ_t^e reduces the value of the firm, thereby encouraging households to invest in firm creation, see Equation (26). All other things equal, the demand for labour 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 its initial value, see also Figure 1). Accordingly, the maximum of the level of real exchange rate appreciation is attained on impact, to decreasing progressively until reaching a new long-run value. All along the transition path, markup 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

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

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 can be read on the left axis (in blue) for the product market deregulation, and on the right axis (in red) for the competitive tax policy.

by the relative markup adjustment. Associated with real exchange rate appreciation, net exports from the Home country are negative all along the transition path, even if they are 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 a reduction in relative labor cost (Figure 2, panel (b)), leading to a large depreciation. Progressive downward adjustment in the relative number of domestic firms then reduces the extent of immediate depreciation through the variety effect (Panel (c)). Similarly to product market deregulation but working in the other direction, the endogeneity of markups alters the magnitude of the degree of overshooting induced by the competitive tax policy (Figure 2, panel (d)). Endogenous PTM behavior progressively reduces the price-competitiveness gains of the Home firms, with reduction in the relative price of Home exports being maximal on impact (panel (e)). Consistent with the dynamics of international relative prices, such fiscal reform induces a rise in net exports for the Home country, as reported in Panel (f).

Summary Consistent with Section 3.3, the effect of endogenous markup is still visible on the short run. Additionally, both reforms induce an overshooting of the real exchange rate which can be explained by the immediate reaction of the labor cost and the inertia in firm entry. In this respect, the overshooting dynamics of the real exchange rate reminiscent of results from Dornbusch's (1976) seminal paper, 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 magnitude 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 size of the reforms are set to their values calibrated in Section 3.2 so

[13] In Dornbusch's (1976) original setting, the delay of adjustment speeds is a product of the difference between the instantaneous adjustment of financial markets and the slugglish prices of the good market.

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 real exchange rate 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. Their relative weight on real exchange rate changes with their share in the consumption basket $(1 - \varpi)$. Where the relative price of tradable goods $(\hat{P}_T^* - \hat{P}_T)$ varies with the unit labor cost and also with the extensive margin of trade and 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. All else being equal, the larger the share of non-tradable goods (i.e., the lower ϖ), the more significant 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 ϖ 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 ϖ.[14] In the case of product market deregulation, the rise in relative unit labor cost compensates 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 ϖ), the weaker the real exchange rate appreciation after a product market deregulation, consistent with the above reasoning. In the most 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 a depreciation is strong in the case of a lower value of ϖ.[15] The intuition explaining these results is

[14] In our baseline calibration, ϖ 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.

[15] The rationale behind the real exchange rate appreciation under $\varpi = 1$ is the following. From Equation (31), the higher ϖ is, the lower the impact of the relative unit labor cost channel on the real exchange. While this channel

straightforward: Because 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 (ϖ low) gives rise to a unit labor cost channel which has a large influence on the real exchange rate. Accordingly, the lower the ϖ, 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). It is also worth noting that in all cases, firms' endogenous PTM behavior mitigates the impact of reforms on the real exchange rate. Whatever the values of ϖ are considered, the appreciation induced by goods market reform and the depreciation induced by tax reform are of lowered magnitude as firms endogenously adjust their markups ($\sigma > \theta$).

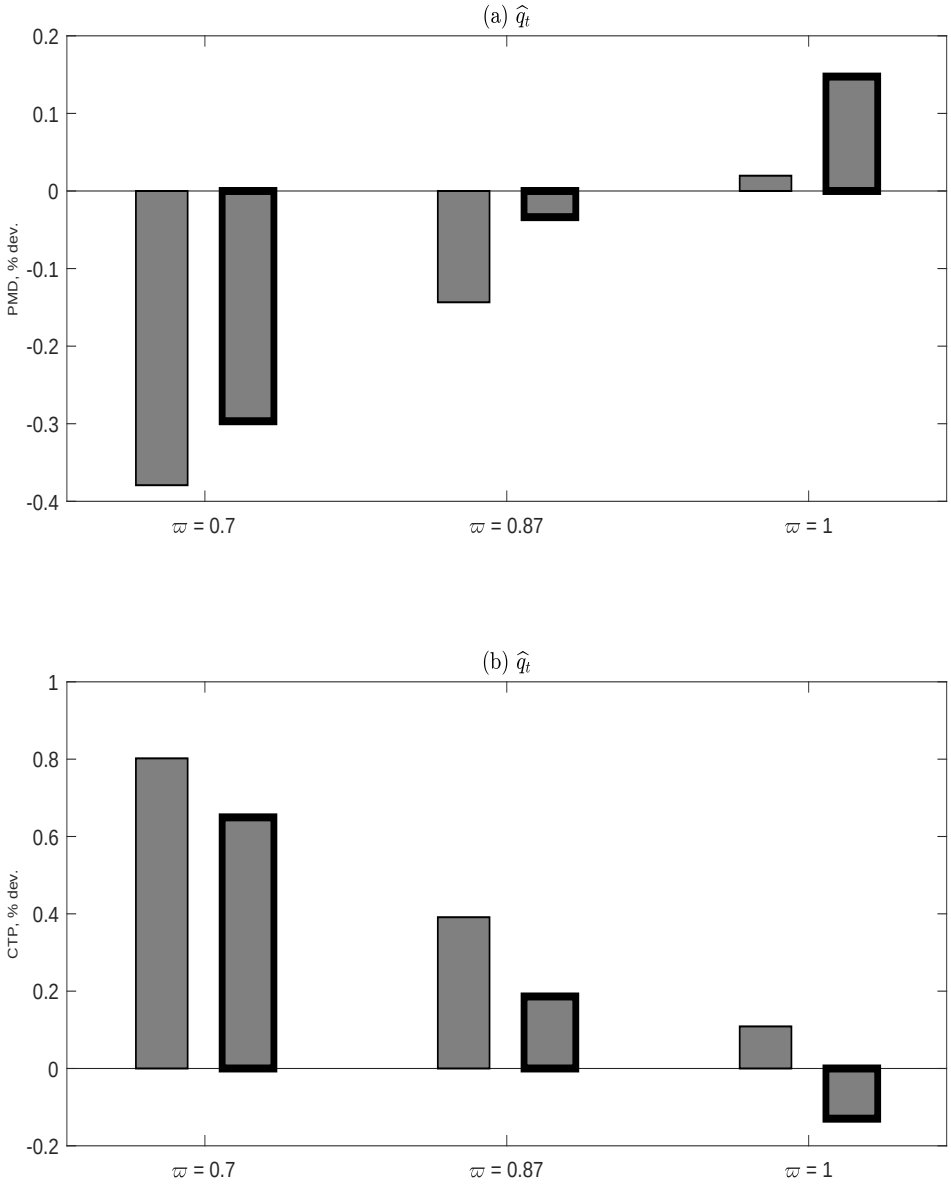
4.2 Trade Costs

We now turn to studying the role of trade costs. With this aim in mind, we report in Figure 4 the long-run elasticity of the real exchange rate and its determinants in the case of product market deregulation (left panel) and competitive tax policy (right panel) for several values of the trade cost τ. 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.

We start looking at the effects of a product market deregulation. Figure 4 (panel (1)) shows that for sufficiently high values of τ, subsidizing firm entry might generate an exchange rate depreciation, which is stronger under varying markups. A case featuring constant markups should be considered first: from Equation (31), the elasticity of the real exchange rate to the relative unit labor costs (which drives an appreciation) and the relative number of Home firms (which conversely drives 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 tradable goods at Home down and ultimately lead to a real exchange rate depreciation when τ is large enough. This effect is more apparent when endogenous markups are at play. The markup channel ($\widehat{\widetilde{\mu}}^*_t - \widehat{\widetilde{\mu}}_t$) carries more weight in the real exchange rate determination for large values of τ, 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 τ. This direct effect is valid all other things being equal. Equal, and furthermore, as explained in Section 2.2.2, the markup

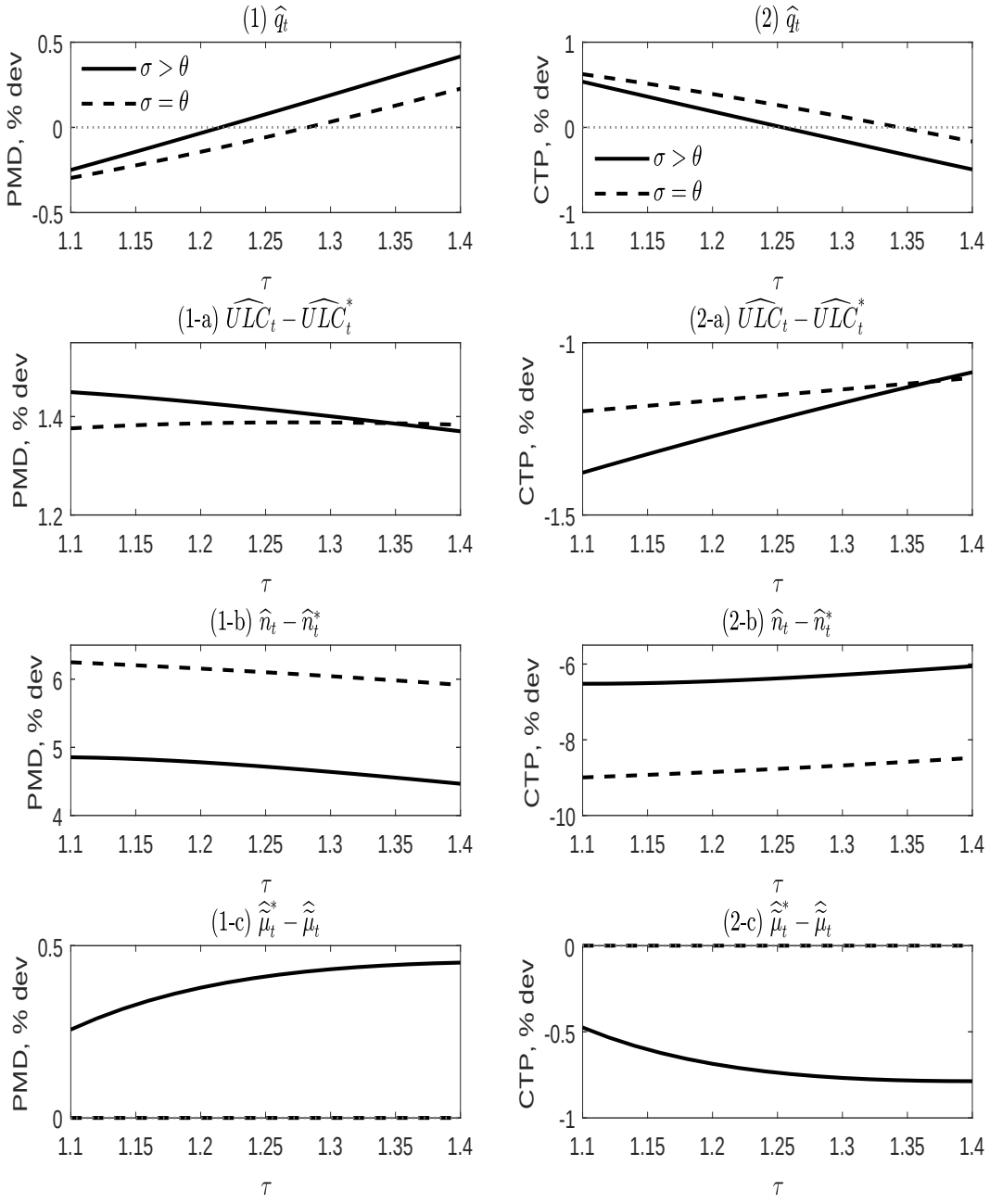
drives a depreciation following the CTP policy, the two opposite other forces (the relative number of Home firms and the markup channel) dominate for $\varpi = 1$, ultimately leading to a real exchange rate appreciation.

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



Sensitivity to ϖ Long-run responses to 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 ϖ, 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 τ Long-run responses to permanent product market deregulation (PMD, Column 1) and competitive tax policy (CTP, Column 2) in the model featuring variable markups, for several values of trade costs, expressed as in percentage deviation from their pre-reform level.

channel by itself is also sensitive to trade costs, causing an additional effect. When trade costs are high, firms have more freedom 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, higher trade costs strengthen the cross-country divergence of markups, in favor of more marked real exchange rate depreciation everything else equal (Figure 4, panel (1-c)). Altogether, both effects imply that product market deregulation depreciates the real exchange rate for $\tau \geq 1.22$ under variable markups while the cut-off value is $\tau \geq 1.28$ 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 less important for large values of τ, especially under variable markups (Figure 4, panel (2)). Consider the case of constant markups first. Through the effects of general equilibrium, a competitive tax policy raises the relative terms of labor ($\hat{W}_t - \hat{W}_t^*$) that partially offset a reduction in payroll tax cuts at Home, thereby dampening the total reduction in the relative unit labor cost. As reported in Panel (2-a), this effect becomes more marked the higher the trade costs. Therefore, high trade costs limit the effect of the competitive tax policy in inducing a real exchange rate appreciation. Endogenous markups act as an additional obstacle for the reform being effective. As explained in Section 3.3, the competitive tax policy boosts extracted-domestically markups, with firms taking advantage of the reduction in the relative unit labor cost. Higher segmentation of international markets (i.e., τ large) amplifies the increase in the average markup at Home, limiting the magnitude of the real exchange rate depreciation. The markup channel is also sensitive to the value of τ since high trade costs raise the elasticity of the real exchange rate to cross-country markup differentiation. The magnitude of the markup channel may be sufficient that the fiscal reform induces 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 from being effective while we stress the role of markups on this result.

To conclude this section, the final effect of both reforms on the real exchange rate - that is, whether it results in an appreciation or depreciation - 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 markup adjustments mitigate the impact of both reforms on the real exchange rate, for the various values of τ and ϖ considered, remains valid.

5 Welfare Analysis

An investigation of the welfare effects of the two reforms will complete this analysis. Following Lucas (1987), we express welfare in terms of consumption equivalent units, i.e. we define the compensation Θ 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 hours worked 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 Θ solution to: $\mathcal{W}\left[\{(1+\Theta)\, C_0, H_0\}_{t=0}^{\infty}\right] = \mathcal{W}^{reform}$.

Table 2 provides the compensation Θ needed after the two reforms, expressed in percentage points of consumption in the initial steady state, in both cases of constant and varying markups.

Table 2: Welfare Analysis

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

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

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

[16]Real final consumption expenditure in the Euro Area in 2015 were by about 21 104 euros per person. Therefore,

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 worked upwards in the cases of both constant and varying markups. However, markup dynamics intervene with regard to the magnitude of the real wage increase, thereby impacting substantially the welfare effects of the reforms. With product market deregulation, a decrease in the incumbents' markups powers a reduction in the Home CPI. This magnifies the rise in the real wage relative to the model featuring constant markups. On the contrary, when it comes to the competitive tax policy, a rise in real wages is dampened under $\sigma > \theta$ due to a rise in domestic markups. Accordingly, the intuition behind the results is identical for both reforms. Allow us to focus on product market deregulation. A more marked increase in the real wage under variable markups boosts the labor supply, thereby accounting for a stronger increase in hours worked. One might expect a sharper rise in consumption since higher real wages push household income upwards. However, this surge in real wages combined with the decrease in markup induces a reduction in dividends distributed to the households. This tends to dampen this positive income effect and therefore cause a slowdown in consumption.[17] Consequently, the considerable increase in hours worked comes with 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 product market deregulation, the competitive tax policy entails larger welfare gains under endogenous markups because the dampened rise in the real wages limits the increase in hours worked. In combination with the increase in 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 endogeneity of the markups still reduces the positive spillover gain of product market deregulation (going from 0.03% to -0.01%) while they amplify those of competitive tax reform (going from 0.06% to 0.17%). From Figure 6, this result is mainly attributable to consumption since hours worked are left virtually unaffected by the reforms. The dynamics of the Foreign real wage plays a major role here as the

consumption would rise permanently by 47 euros (PMD) and 125 euros (CTP) per person and per year in the model featuring constant markups. 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 ψ 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 ψ (consumption reacts more greatly to the real wage), the stronger rise in real wages led by endogenous markups dominates the effect of dividends. 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 the number of hours worked.

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 Foreign real wages under variable markups while it does not under constant markups. This is notably explained by the increase 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 other hand, the Home competitive tax policy forces Foreign firms to reduce their markups (Figure 5, panel (d)) which stimulates consumption and magnifies Foreign welfare gains.

6 Conclusion

This paper shows how PTM behavior affects the channels via which labor and good markets reforms affect a country's international competitiveness. We address this question in a theoretical way, by 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 for each destination market, i.e. generating endogenous PTM. The effects of competitive tax policy on the one hand, and product market deregulation on the other, are examined in the context of this setup.

By way of this framework, we provide a careful understanding of the manner in which 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 find 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 throughout the transitional dynamics. Deregulating the goods market also leads to a deterioration in the trade balance, whereas it turns into surplus following a competitive tax policy. Secondly, the endogenous PTM behavior of firms is demonstrated to have an important role on international relative prices, as a propagation channel of both these reforms. Specifically, endogenous markups lessen the impact of both reforms on the real exchange rate. This effect is shown to be robust to alternative calibrations of the model. Further, endogenous markup adjustment is also a factor 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.

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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 $s \in [0,1]$:

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

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:

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

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

Markup determinants Using a similar reasoning as for markups set by the Home firm (Section 2.2.2), the following formula shows 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 Δ_1 and Δ_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 Δ_1 and Δ_2 are the same as those intervening in the markup expressions for the Home firm, i.e. Equations (16) and (17).

A.2 Real exchange rate, markups: More details

This section aims to revisit the relation between endogenous markups and PTM which we made in Section 3.1. With this aim in mind, we start considering the expressions of the price elasticity 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 elasticity of demand and markups are constant and equal across destination markets. Trade costs however 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 $\phi < 1$ (i.e., 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 pass on the trade cost on foreign households ($p_k^* = \tau p_k$). This mill-pricing strategy of firms on their export market (i.e., 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), all else being 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 (i.e. pushing $\bar{\kappa} < 1$ all else being equal).

[18] In the initial symmetric steady state, payroll tax rates are identical ($\tau^w = \tau^{w*}$) and the wage ratio $\frac{W}{W^*} = 1$, implying a ratio of unit labor cost equal to 1.

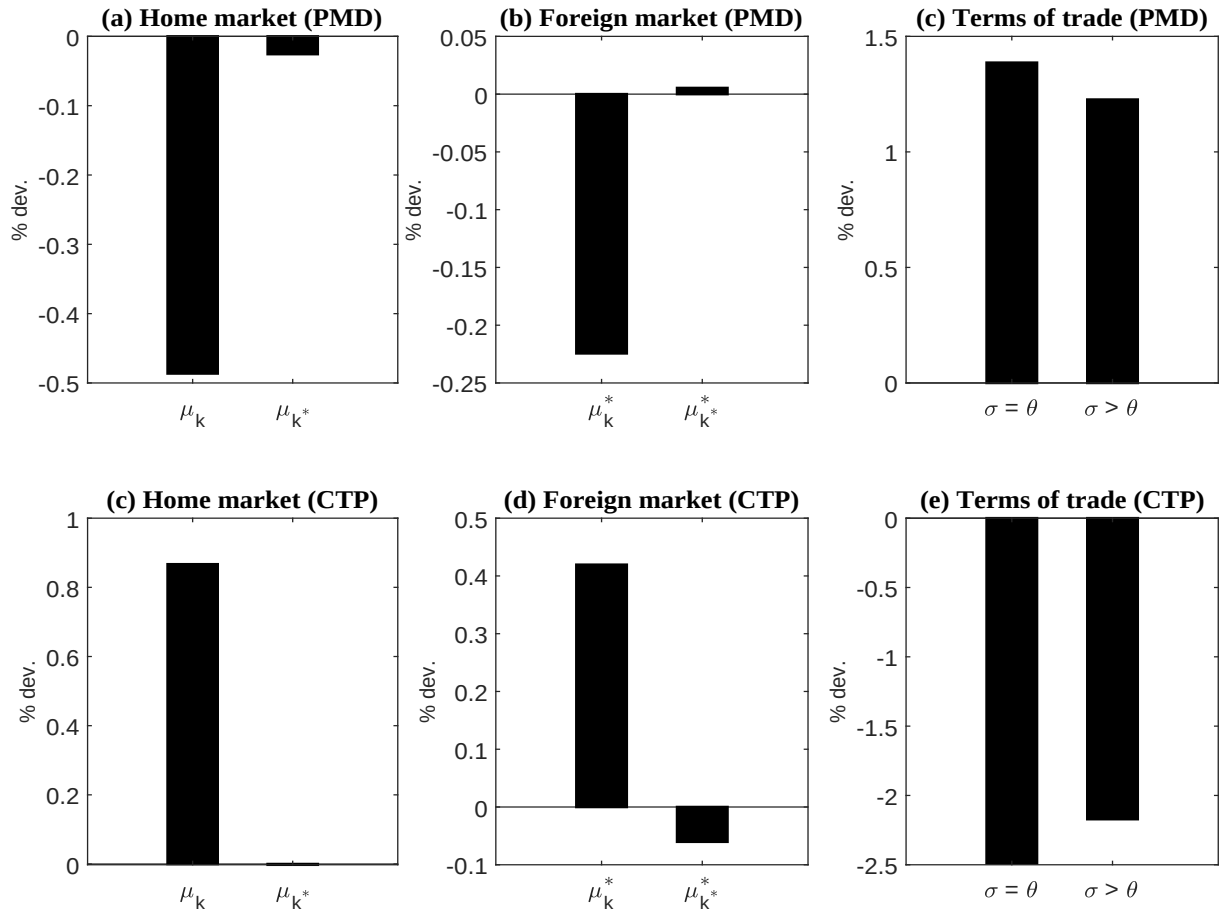
If in the initial steady state the magnitude of the PTM behavior is not strong enough to more than compensate for the effects of trade costs, then firms face a more elastic demand on the export market, leading to a lower export markup. From Equations (A-37) and (A-38), this is the case when $\phi\bar{\kappa}^{1-\sigma} < 1$, or equivalently $\tau\bar{\kappa} > 1$. In this case, 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: $1 < \tau\frac{\bar{\mu}_X}{\bar{\mu}} < \tau^2$. When $\phi\bar{\kappa}^{1-\sigma} < 1$ is imposed, the first part of the inequality condition is certain to hold analytically. In our simulation, the calibration $\tau\bar{\mu}_X/\bar{\mu} = 1.3 \times 0.97 = 1.26$ works to ensure that the inequality holds.

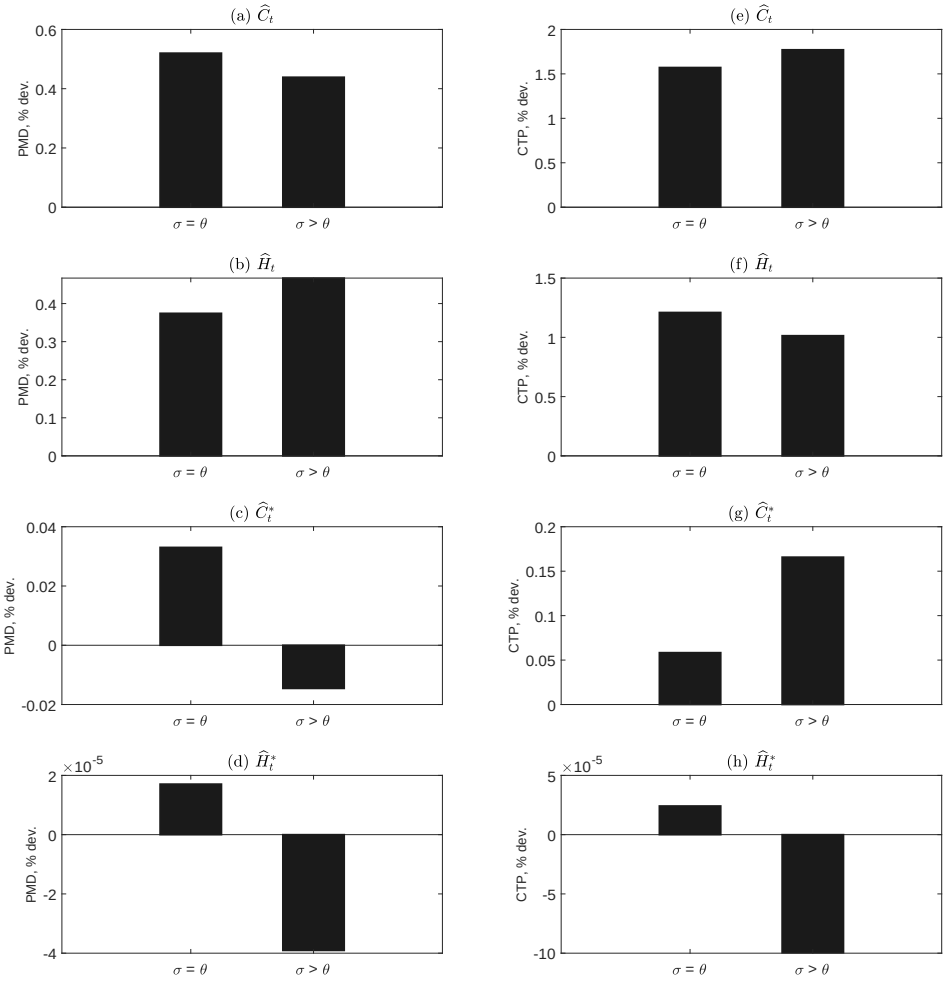
B Complements on the effects of the reform

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



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