Globalization, markups and the natural rate of interest

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Abstract

In this paper, we investigate how, in a stylised theoretical framework, an increase in the degree of globalization - modelled as a decline in trade costs - affects the real natural rate of interest by impacting firms markups. Outlining a two-country dynamic general equilibrium model with endogenous elasticity of substitution between goods, we suggest two main propositions:

1) Globalization - via the implied variation in markups - has a potentially significant impact on the natural rate of interest.

2) Simple, plausible markup dynamics may have contributed to explain the recent 'conundrum' of low world interest rates.

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1 Introduction

In the last four years, real interest rates have been unusually low despite historically rapid rates of growth of the world economy (see Figure 1 and 2).

< Figure 1 and 2 here >

Standard explanations for this 'conundrum' have relied extensively on imperfections in capital markets. In particular, a popular[1] hypothesis suggests the appearance of a 'glut' of global savings (Bernanke 2005). These excess savings may have come from a strong appetite of Asian central banks for US assets and from the windfall of high crude prices in the high-saving oil producing countries. Another standard line of argument ascribes the low level of real bond rates to a decline in the term premium.[2]

In this paper, we propose a complementary perspective which relies on goods markets developments only to explain the low level of real interest rates. We argue that increased integration of trade in goods (and services)

[1] More formal approaches have also been proposed. In Caballero, Fahri and Gourinchas (2006), where fast-growing economies (e.g. emerging or oil producing countries) have a limited ability to supply high-quality tradeable assets to absorb domestic savings. The authors argue that the deterioration in the quality of financial assets of Asian and Russian debtors after the Asian crisis led to a reduced global supply of saving vehicles and hence to a decline in yields. Imperfect financial markets is here a key assumption, as it allows relative prices of assets to vary in the face of supply or demand shocks. Caballero, Fahri and Hammour (2006) present models of rational speculative investment booms in the U.S. under low interest rates. There, the emphasis is on investment, notably on situations conducive to bring an economy from a 'normal' steady-state to an equilibrium characterized by high investment and low cost of capital. The authors show that such an equilibrium may arise when the rest of the world has lower expansion potential or high saving needs. Kraay and Ventura (2005) build a link between rational bubbles and the interest rate. Their model gives a beneficial role to bubbles in a world where pockets of dynamically inefficient investments exist - a crucial assumption - , whose rates of return are below the growth rate of the economy. In the context, bubbles are a device to displace inefficient investments by holding-up interest rates. Whenever bubbles collapse, a 'glut' of savings appears, leading to a surge in inefficient investments and to a decline in the return on capital and in interest rates.

[2] See e.g., Rudebush, Swanson and Wu (2006), and Kim and Wright (2005) for a macro-finance perspective on the issue.

has led to a global erosion of markups, which in turn has depressed a crucial, although non-observable, variable for the conduct of monetary policy, namely the real natural interest rate.[3] The 'conundrum' of the low level of real bond rates may thus be interpreted as reflecting a persistent drop in the natural real rate of interest, i.e. a decline in expected future short-term real rates.

But how does globalization affect markups in equilibrium? In a two-country general equilibrium framework, we show that advancing globalization, modelled as a decrease in trade costs, leads to an increase in the number of firms offering new varieties of consumption goods. As the number of available goods augments, the elasticity of substitution between goods tends to rise - a key feature - and firms' ability to charge high markups diminishes. Hence, one contribution of this paper is to introduce an 'extensive margin' element, i.e., the increase in the scale of the global economy through deeper trade integration, into an otherwise standard neoclassical dynamic analysis.

The paper has three more parts. In section 2 below, we characterize the impact of markups on the natural real interest rate, assuming, to ease exposition, exogenous markups dynamics. In particular, we show that expected and unexpected markup changes have opposite effects on the equilibrium real interest rate. Section 3 then models markups dynamics as a consequence of increased globalization, i.e. declining trade costs. Finally, section 4 summarizes our main findings and concludes.

2 Markups dynamics and the natural interest rate

In this section, we ask what is the impact of an exogenous change in markups on households' intertemporal optimal allocations and therefore on the real natural interest rate. The discussion of the effect of globalization on equilibrium markups is postponed until section 3.

[3] The real natural rate of interest is the interest rate necessary to bring demand in line with supply with firms having no incentive to move prices (see Woodford 2003).

The basic economic mechanism linking changes in the natural interest rate to markup variations stems from the tension between variations in income and the households' desire to smooth consumption, as is standard in the neoclassical literature (see King and Rebello 2000). In a nutshell, variations in markups - which act like changes in distortionary taxation - affect output and income by altering the degree of inefficiency in the economy. In particular, a decrease in markups implies that the economy operates closer to its efficient production level and generates additional income. As households want to smooth consumption overtime, they will not be willing to alter their consumption patterns to match intertemporal variations in output unless the relative price of future consumption - the natural interest rate - changes correspondingly. In other words, the natural interest rate is the intertemporal allocation mechanism required to clear the goods market in all time periods.

While globalization can reasonably be thought of as a gradual process[4], some observers have argued that its pace may not be entirely predictable: Trade costs may unexpectedly fall and new competitors erupt, squeezing firms markups. As suggested by Figure 3, global economic integration - crudely measured by the world share of total imports in GDP - does not always evolve smoothly. In particular, according to this metrics, its pace seems to have recently accelerated.[5]

< Figure 3 here >

The distinction between expected and unexpected variations in markups is crucial as the former tends to raise the natural rate of interest, while the latter tends to depress it. Intuitively, an *expected* decline in markups acts very much like an expected future increase in productivity: Both induce a rise in expected real income and lead to a comparatively higher natural rate

[4]See Nicoletti et al. (2005) and Blanchard et al. (2003) for empirical evidence on the erosion of markups.

[5]On the stronger momentum in globalization read for instance Kohn (2005, 2006).

of interest, which forces optimizing forward looking households to postpone consumption. This is what we call the 'globalization premium' to the natural rate of interest. We will show that it can be sizeable.

By contrast, an *unexpected* drop in markups results in a sudden increase in output and requires a decline in the natural rate of interest to induce optimizing forward looking households to consume it. In what follows, we argue that an *un*anticipated compression of markups in goods markets may have contributed to the recent decline in interest rates.

2.1 A two-country model of the world economy

In this section, we outline a two-country (Home and Foreign) model with trade costs for shipping goods across borders. Given our focus on the real natural interest rate, we assume that prices and wages are perfectly flexible and that both countries are fully symmetric.[6] This last simplification allows to look, without loss of generality, at the world equilibrium solution from the perspective of the Home economy only.

Because Home households j are forward looking, they maximize their lifetime intertemporal expected utility $\mathcal{U}$ at time t

$$\mathcal{U}_t = E_t \left[\sum_{\tau=t}^{\infty} \beta^{\tau-t} U_\tau (j) \right], \tag{1}$$

where $U_\tau (j) = U_\tau \left[C_\tau (j), l_\tau (j) \right]$ is the period utility function of per capita consumption $C_\tau (j)$ (which includes Home and Foreign goods) and of the proportion of time dedicated to labor $l_\tau (j) \in [0, 1]$.

Households choice is bounded by the following flow budget constraint denominated in world currency units

$$e \left[P_\tau (h), P_\tau (f), C_\tau (j) \right] + B_\tau (j) \leq (1 + i_{\tau-1}) B_{\tau-1} (j) + W_\tau l_\tau (j) + \mathcal{P}_\tau (j), \tag{2}$$

[6] Both countries have the same size, the same preferences and production technology and are subject to identical shocks. There is therefore no international risk sharing.

where $e\left[P_\tau\left(h\right), P_\tau\left(f\right), C_\tau\right]$ denotes the expenditure function, which depends on the price of Home goods $P_\tau\left(h\right)$, the price of Foreign goods $P_\tau\left(f\right)$ and overall consumption.[7] The nominal yield $i_{\tau-1}$ on the one-period internationally traded riskless bond $B_{\tau-1}$ is known at time $\tau-1$ and received at the beginning of period τ. The wage rate W_τ is homogeneous across households. Profits from Home production $\mathcal{P}_\tau\left(j\right)$ are handed back to Home households in form of dividends.[8]

Maximizing (1) subject to (2) and dropping j indices, gives rise to the following three optimality conditions, which determine Home households' consumption, leisure and saving decisions:

$$\frac{\partial U_\tau}{\partial C_\tau} - D_\tau \frac{\partial e\left[.\right]}{\partial C_\tau} = 0, \tag{3}$$

$$\frac{\partial U_\tau}{\partial l_\tau} + D_\tau W_\tau = 0, \tag{4}$$

$$\left(1+i_\tau\right)\beta E_\tau D_{\tau+1} = D_\tau, \tag{5}$$

for D_τ the Lagrange multiplier of the flow budget constraint.

In the Foreign country, households solve a similar utility maximization problem, namely maximizing

$$\mathcal{U}_t^* = E_t\left[\sum_{\tau=t}^{\infty}\beta^{\tau-t}U_\tau^*\left(j\right)\right],$$

subject to

(6)

$$e^*\left[P_\tau^*\left(h\right), P_\tau^*\left(f\right), C_\tau^*\left(j\right)\right] + B_\tau^*\left(j\right) \leq \left(1+i_{\tau-1}^*\right)B_{\tau-1}^*\left(j\right) + W_\tau^* l_\tau^*\left(j\right) + \mathcal{P}_\tau^*\left(j\right),$$

[7] Because of the CARA functional form underlying consumption choices in our model (see section 3.2), the expenditure function does not take the usual simple multiplicative form PC, characteristic of traditionnal Dixit-Stiglitz (1977) CES environments. Our expenditure function will be derived explicitly in section 3.2.

[8] Because of the free entry assumption, these profits are always zero in equilibrium.

where variables with a star denote Foreign variables, also denominated in world currency.

Flexible prices and perfect symmetry imply that $W_\tau^* = W_\tau$, $e^*[.] = e[.]$ for $C_\tau(j) = C_\tau^*(j)$, and $l_\tau(j) = l_\tau^*(j)$. As shocks are assumed identical across countries, net assets positions never vary: $B_\tau(j) = B_\tau^*(j) \equiv 0$ for all τ such that trade across both countries is always balanced. Under these assumptions, it becomes obvious that, by comparing flow budget constraints, $i_t = i_\tau^* = i_t^w$ (for i_t^w the world nominal interest rate in terms of the world currency).

2.2 The natural rate of interest

Using households' and firms' first order conditions, we now derive an analytical expression for the world real natural interest rate. As we assume perfect symmetry, we can solve for the natural real interest rate from the perspective of either the Home or the Foreign economy. In order to obtain a closed form analytical solution, we assume the following separable utility function

$$U_\tau(C_\tau, l_\tau) = f(C_\tau) - v(l_\tau),$$

where we posit

$$f(C_\tau) \equiv \ln C_\tau \text{ and } v(l_\tau) \equiv k l_\tau.$$

Our conclusions, though, do not depend on this specific functional form as long as $f'(\cdot), v'(\cdot) > 0$ and $f''(\cdot), v''(\cdot) \leq 0$, a very standard requirement for an interior solution to the maximization problem.

Plugging the labor supply equation (4) into the Euler equation (5) and using the definition of the real wage $w_\tau \equiv \frac{W_\tau}{P_\tau}$, we obtain the following Euler equation linking tomorrow's and today's marginal (dis)utilities of labor

$$\beta E_\tau \left[\frac{\frac{\partial U_{\tau+1}(j)}{\partial l_{\tau+1}(j)}}{\frac{\partial U_\tau(j)}{\partial l_\tau(j)}} \frac{w_\tau P_\tau}{w_{\tau+1} P_{\tau+1}} \right] = \frac{1}{1+i_\tau}, \tag{7}$$

where P_τ denotes the overall, consumption-based, Home price index, defined as the marginal expenditure needed to buy one unit of consumption

basket C_τ. When we derive its exact form in section 3.3, we will see that the overall price level P_τ is an increasing function of the prices of Home goods and Foreign goods. A decline in trade costs affects P_τ via two different mechanisms: Directly, via the price of imported Foreign goods, and indirectly, via the increase in competition in the Home market. This increase in competition squeezes markups and thus prices Home firms set on goods they sell in the Home market.

To compute P_τ, we combine the optimal pricing behavior of Home and Foreign firms (see section 3.3) with the symmetry assumption. This yields the familiar-looking price equation

$$P_\tau = \Phi_\tau \frac{W_\tau}{A_\tau},$$

where Φ_τ stands for what can be seen as an 'overall markup', which depends on Home and Foreign markups. Dividing both sides of the preceding equation by P_τ, we get

$$\Phi_\tau = \frac{A_\tau}{w_\tau}, \tag{8}$$

which means that the 'overall markup' is equal to the inverse of the real marginal cost.

Using equation (8) for eliminating w_τ in (7), and exploiting the linear form of the disutility of labor, we can write

$$\beta E_\tau \left[\frac{A_\tau}{A_{\tau+1}} \frac{\Phi_{\tau+1}}{\Phi_\tau} \frac{P_\tau}{P_{\tau+1}} \right] = \left[(1+r_\tau) E_\tau \left(\frac{P_{\tau+1}}{P_\tau} \right) \right]^{-1}, \tag{9}$$

where r_τ stands for the real natural interest rate.

Taking logs and neglecting variance and covariance terms arising from Jensen's inequality, we obtain the fundamental expression for the real natural interest rate[9]

$$\ln(1+r_\tau) = -\ln\beta + E_\tau \Delta a_{\tau+1} - E_t \Delta \phi_{\tau+1}, \tag{10}$$

[9] Laubach and Williams (2003) estimate a version of equation (10). Their specification includes a latent variable that captures movements in the natural rate of interest that are not associated with productivity growth but possibly, as the authors suggest, with changes in households' rate of time preference or fiscal policy. Our specification implies that this latent variable may also reflect changes in the equilibrium markups dynamics.

where $\Delta\phi_{\tau+1} \equiv \ln \Phi_{\tau+1} - \ln \Phi_{\tau}$ and $\Delta a_{\tau+1} \equiv \ln A_{\tau+1} - \ln A_{\tau}$.

The last equation shows that, as in the standard growth model, the real rate of interest r_t depends negatively on the 'patience' parameter β and positively on expected productivity growth. The last term on the right hand side of (10) is the new feature. It shows that an *anticipated* increase in the degree of global competition (i.e. falling markups) tends to raise the natural rate of interest. This term represents what we call the 'globalization premium' in the real natural rate of interest. In what follows, we define the log of the 'globalization premium' r_{τ}^{p} as the expected variation in log of markups, or

$$\ln(1 + r_{\tau}^{p}) \equiv -E_{\tau}\Delta\phi_{\tau+1}. \tag{11}$$

2.3 Markups dynamics and simulations

In this section, we turn to simulations of the effect of markups dynamics on the natural rate of interest via the 'globalization premium', the main issue of this paper. We will in particular focus on the very different impact that expected vs unexpected variations in markups have on the 'globalization premium'.

Bear in mind, as it will become clear in section 3, that the postulated variations in Φ_{τ} could theoretically be mapped into corresponding variations in trade costs, the ultimate driving process of markups in our model.

It is very important to note that the (log) 'overall markup' ϕ_{τ} cannot decrease by a constant amount for ever: ϕ_{τ} has a lower bound corresponding, in our model, to perfectly integrated good markets between Home and Foreign, i.e. trade costs equal to zero. The positive impact of declining markups on the natural interest rate - our 'globalization premium' - must therefore diminish overtime, to vanish eventually as ϕ_{τ} approaches this lower bound. This is a fundamental difference with the dynamics of (log) productivity a_t. Variable a_t is indeed unbounded and can in principle grow (or shrink) by the same amount Δ for ever, allowing the secular drift compo-

nent of productivity to exert an eternal influence on the natural rate as in equation (10). Nonetheless, although the impact of declining markups on the interest rate ultimately dies out, it can last long and be sizeable. As seen from expression (11), an expected reduction in the 'overall markup' of 10 percentage points over 10 years would add on average approximately a 1-percentage-point 'globalization premium' per annum to the interest rate!

The modelling of the stochastic process of ϕ_τ has major consequences on the dynamics of the natural interest rate. Let's assume that markups ϕ_τ evolve according to the very general law of motion

$$\tilde{\phi}_{\tau+1} = g\tilde{\phi}_\tau + \epsilon_{\tau+1}, \tag{12}$$

where $\tilde{\phi}_\tau$ is precisely defined as the gap between ϕ_τ and its lower, full integration bound ϕ^{lb}. The parameter $g \in]0,1[$ reflects the anticipated monotone decrease in markups toward ϕ^{lb}.[10] The stochastic variable ϵ_τ is an innovation in markups with $E_\tau \epsilon_{\tau+1} = 0$, reflecting an unforeseen variation in trade costs. Process (12) insures that as long as (here negative) shocks ϵ_τ are not too large, the markup will tend to its lower bound from above.

For outlining the impact of declining markups on the natural rate of interest, we disentangle two effects: The first refers to the role of parameter g. The second focuses on the negative shock ϵ_τ.

2.3.1 Secular decrease in markups

In this section, we highlight the impact of an expected decline in markups on the 'globalization premium'. Plugging the markup law of motion (12) into our fundamental equation for the interest rate premium (11) yields

$$\ln(1 + r^p_\tau) = (1 - g)\,\tilde{\phi}_\tau. \tag{13}$$

The last expression shows that the premium depends positively on the (log) 'overall markup' ϕ_τ and negatively on parameter g.

[10] $\tilde{\phi}_\tau \equiv \phi_\tau - \phi^{lb}$. In what follows, we assume ϕ^{lb} constant. We also do not discuss the case of a gradual *increase* in margins.

To get a better feel of the potential magnitude of the premium as a function of markup dynamics, it may be convenient to recast the parameter g into a measure of the pace of decline, namely the half-life of $\tilde{\phi}_\tau$. The half-life h is the number of periods needed to halve $\tilde{\phi}_\tau$ in the absence of shocks or formally $g \equiv 2^{-\frac{1}{h}}$. The contour plot shown in Figure 4 depicts the combination of the half-live (expressed in years) and initial value for $\tilde{\phi}_\tau$ to give the corresponding initial interest rate premium. We can immediately see that given plausible ranges for markups and their half-lives, the initial premium is sizeable.

< Figure 4 here >

To our knowledge, the empirical literature gives little information on the aggregate level of markups and on their dynamics, which could serve to calibrate precisely our interest rate equation. It offers nonetheless some useful indications to perform a simulation. We assume that the initial - pre-shock - level of markups is 1.35, the figure used in Bayoumi and al. [2005] for Europe as they study the potential gain in utility for the Old Continent of increasing competition to American levels. Assuming it takes 20 years to halve this 35%-markup, the initial 'globalization premium' would therefore raise the natural rate of interest by 1.0 percentage point (point A in Figure 4).

Figure 5 depicts the dynamics of markups and those of the interest rate premium in two cases. The first corresponds to a 20-year half-life of markups (solid line, the benchmark) and the other to a half-life of 14 years (dashed line). The steeper pace in markup decline leads to an initial premium of 1.6 percentage points, which remains significantly above the benchmark during the first decade. In other words, anticipated faster globalization boosts the natural interest rate.

< Figure 5 here >

Note that, as it can be readily inferred from equation (13), the premium displays exactly the same persistence as the markups.

Given our specification, there is an interesting simple proportionality result between the pace of decline in markups and the 'globalization premium'. When the half-life h is reduced by a factor f, this raises the premium $r^p(.)$ by - approximately - the same factor or, formally, $r^p\left(\frac{h}{f},\phi\right) \simeq f r^p(h,\phi)$. Figure 6 illustrates this property by showing that the ratio $R \equiv \frac{r^p\left(\frac{h}{f},\phi\right)}{f r^p(h,\phi)}$ prints near 1 provided h is not too small.[11] In other words, last result asserts that the 'globalization premium' is directly proportional to the pace of globalization as defined by the half-life of markups.

< Figure 6 here >

2.3.2 Negative shock on markups

In this section, we investigate the effect of an unforeseen decline in markups on the 'globalization premium'.[12].

The case for an unexpected downward shift in markups reflects that - as recently argued by Kohn (2005, 2006) - the pace of globalization may in fact not always evolve smoothly: An unforeseen decrease in markups can be triggered by the entry of new competitors following, for instance, a sudden reduction in trade costs. Indeed, Chen and al. (2005) have empirically shown that an increased import penetration reflecting more intense international competition seems to strongly affect margins in the short run.

We assume that parameter g remains constant but a negative shock hits markups at initial time t, implying the following variation in the 'globalization premium'

$$\ln(1+r_t^p) - \ln(1+r_t^p) = -E_t\Delta\tilde{\phi}'_{t+1} + E_t\Delta\tilde{\phi}_{t+1} = (1-g)\,\epsilon_t, \tag{14}$$

[11] Figure 6 has been evaluated with a markup of 1.35. Other markup values give an almost identical picture.

[12] An unexpected *increase* in markups would have exactly the opposite effect.

where $r_t^{p\prime}$ is the 'globalization premium' right after the shock hit the economy. As illustrated in Figure 7, expression (14) implies that the premium shifts *downward* after a negative markup shock. This effect owes to the fact that after the shock, the markups are closer to their lower bound (i.e. $\tilde{\phi}'_{t+1} < \tilde{\phi}_{t+1}$). This, in turn, implies necessarily smaller future expected absolute declines in markups (see equation (13)). Note also in Figure 7 that after the shock, the 'globalization premium' remains persistently below its pre-shock path.

< Figure 7 here >

It is important to stress again here that the dynamic process for markups, while it assumes a constant rate of decrease g, cannot, by definition, imply a constant *absolute* decline in markups because of its lower bound. Expected absolute markup variations must therefore narrow when markups near their lower bound.

It is convenient to express last expression in terms of the initial premium or

$$\frac{\ln(1+r_t^{p\prime}) - \ln(1+r_t^{p})}{\ln(1+r_t^{p})} = \frac{\epsilon_t}{\tilde{\phi}_t}. \tag{15}$$

Equation (15) shows a second proportionality result: The relative change in the 'globalization premium' right after the shock on markups is precisely, but inversely, equal to the shock expressed in proportion of the initial (pre-shock) markup. In plain English, this means, that if, for instance, the 'globalization premium' was 1.2 percentage points before the shock, a sudden decline of 1/3 in $\tilde{\phi}_\tau$ would lead to a 0.4 percentage points fall in the 'globalization premium'. More generally, it is important to note that - as long as the persistence parameter g is comprised between 0 and 1 - the markup innovation ϵ_τ always has a persistent impact on the 'globalization premium'.

3 Equilibrium model of markups

But what actually does drive equilibrium markup dynamics? In this section, we outline the complete model, which shows how globalization affects firm's markups through the channel of declining trade costs.

The basic story is simple. As trade costs decline, goods markets become more integrated and more competitive, which puts pressure on markups. There are indeed two channels by which consumers benefit from lower trade costs. The first is simply trough the decline in the price of imported goods. The second is trough the decrease in markups set by Home firms in the Home market as they react to the rising penetration of Foreign competitors.

Borrowing from the preceding section, the world economy consists of two fully symmetric regions, Home and Foreign. The quantity of each good produced in equilibrium as well as the number of varieties is determined endogenously. In particular, there is entry or exit of firms until firms earn zero profits. For every firm, in equilibrium, operating profits cover the fixed entry costs.

In what follows, we solve for both firms' and households' optimal decisions and draw on the expressions for prices and expenditure functions to construct a measure of markups that is shown to be positively related to trade costs.

3.1 Firms

Firms in each country produce for both the Home and the Foreign market. Home firms produce a continuum of goods indexed by $h \in [0, N]$. Foreign goods are indexed by $f \in [0, N^*]$.

The production technology Home firms have access to is linear in Home labor and is identical across firms. Each representative Home firm produces an amount of differentiated variety according to

$$Y(h) = Al(h), \tag{16}$$

where A denotes labour productivity.

In addition to production costs, firms in both countries face fixed entry costs. These entry costs are modelled as the compensation paid to the -fixed- labor $\bar{l}$ used to develop the good, start the production and set-up the distribution channel, or

$$\text{entry costs} = W\bar{l}.$$

Each good h is sold to Home households or exported. Shipping goods abroad entails transportation ('iceberg') costs expressed in units of the exported good. The resource constraint for variety h is therefore

$$Y(h) \geq Lq(h) + \zeta L^* q^*(h), \tag{17}$$

where $q(h)$ denotes the per-capita consumption of h by Home residents, $q^*(h)$ is the per-capita consumption of h by Foreign residents and $\zeta \geq 1$ symbolizes trade costs.

Home firms' total profits $\mathcal{P}(h)$ are

$$\mathcal{P}(h) \equiv P(h) Lq(h) + P^*(h) L^* q^*(h) - Wl(h) - W\bar{l}, \tag{18}$$

for $P(h)$ ($P^*(h)$) the price in world currency of one unit of Home good sold in the Home (Foreign) market. Similar expressions hold for the Foreign country in terms of Foreign varieties.

Home firms set profit maximizing prices on the Home and the Foreign market at a markup over marginal costs $\frac{W}{A}$ by maximizing (18) subject to (17) and (16), which yields the optimal pricing rules

$$\begin{aligned} P(h) &= \Phi(h) \frac{W}{A}, \\ P^*(h) &= \zeta \Phi^*(h) \frac{W}{A}, \end{aligned} \tag{19}$$

where $\langle \Phi(h), \Phi^*(h) \rangle > 1$ denote the markups charged on Home goods at home and abroad. Markups have the standard form $\Phi(h) = \frac{\varepsilon(h)}{\varepsilon(h)-1}$ ($\Phi^*(h) = \frac{\varepsilon^*(h)}{\varepsilon^*(h)-1}$), where $\varepsilon(.)$ stands for the price-elasticity of demand. The markup is

therefore a decreasing function of the price elasticity of demand. When $\varepsilon(h)$ increases, the markup falls and tends towards one as $\varepsilon(h)$ goes to infinity. Notice that the price charged on the Foreign market includes trade costs, as they can be seen as pertaining to the marginal costs of production. Again, similar expressions hold for the Foreign country, where firms also set prices at a markup over marginal costs.

3.2 Households consumption

There are L (L^*) - identical- households in the Home (Foreign) country, which consume a basket of differentiated goods. Home (Foreign) households supply labor to Home (Foreign) firms only. They have a taste for variety and consume every good available. They also display a variable price elasticity of consumption, which means that, for a given income, an increasing mass of varieties available makes households' demand for every good more price elastic. This is the key feature of the model underpinning the endogenous variability of firms' markups.

Each representative Home household extracts utility out of a consumption basket C comprising Home and Foreign goods

$$C \equiv \int_0^N u\left[q\left(h\right)\right] dh + \int_0^{N^*} u\left[q\left(f\right)\right] df, \tag{20}$$

subject to the income constraint $I = \int_0^N P\left(h\right) q\left(h\right) dh + \int_0^{N^*} P\left(f\right) q\left(f\right) df$. We assume that the consumption basket is made of a continuum of horizontally differentiated varieties, where the utility out of a single variety

$$u\left[q\right] \equiv 1 - \exp\left[-\alpha q\right]$$

(with $\alpha > 0$) takes the form of a tractable CARA utility function (as in Behrens and Murata 2005, 2006), thus implying a variable elasticity of substitution (see equation (24) below).[13]

[13] Utility functions with variable elasticity of substitution between goods have been widely used in the literature on trade theory (see e.g. Krugman 1979, Melitz and Ottaviano 2005 and Chen et al. 2005, 2006).

The solution of the above optimization problem with respect to Home goods yields the following Home households optimal demand

$$q(h) = \frac{I + \alpha^{-1} N^* P(f) \ln \frac{P(f)}{P(h)}}{NP(h) + N^* P(f)}, \tag{21}$$

where symmetry in preferences and production technology insures a unique price level across all Home goods. Because of transportation costs, however, the price of Foreign varieties faced by Home consumers is *not* identical to the price of domestically produced goods ($P(h) \neq P(f)$). Home demand for Foreign goods is

$$q(f) = \frac{I - \alpha^{-1} NP(h) \ln \frac{P(f)}{P(h)}}{NP(h) + N^* P(f)}. \tag{22}$$

Combining (21) and (22) yields the simple relative demand expression

$$q(h) - q(f) = \alpha^{-1} \ln p(f), \tag{23}$$

where $p(f) \equiv \frac{P(f)}{P(h)}$ is the price of Foreign in terms of Home goods.

From both demand equations, we can easily compute the price-elasticities of demand for Home and imported goods

$$\begin{aligned} \varepsilon(h) &\equiv -\frac{\partial q(h)}{\partial P(h)} \frac{P(h)}{q(h)} = \frac{1}{\alpha q(h)}, \\ \varepsilon(f) &\equiv -\frac{\partial q(f)}{\partial P(f)} \frac{P(f)}{q(f)} = \frac{1}{\alpha q(f)}. \end{aligned} \tag{24}$$

In the CARA framework, thus, the elasticity of demand for any variety is not a constant, as it would be in the case of a CES utility function, but varies inversely with the per-capita consumption of the variety.

The expenditure function $e[P(h), P(f), C]$ that corresponds to our consumption basket C and which appeared in section 2.1 can be recovered using (20) and the demand equations (21) and (22)

$$e[P(h), P(f), C] = \alpha^{-1} N \left\{ \begin{array}{c} [P(h) + P(f)] \ln \left(\frac{N}{2N - C} \right) + \\ P(h) \ln [1 + p(f)] + \\ P(f) \ln [1 - p(f)] \end{array} \right\}.$$

Similar expressions hold for the Foreign economy.

3.3 Markups

What is the impact of trade costs on equilibrium markups? The answer to this question is crucial as changes in markups is the driving factor behind variations in the 'globalization premium' documented in section 2.3.

Again, as in section 2, the solution of the model is tremendously simplified by focusing on the case where both Home and Foreign countries are perfectly symmetric: Identical tastes, production technologies and sizes.[14] The symmetry assumption renders all behavioral and equilibrium conditions for the Foreign country redundant.

To see that, we first rewrite the zero profit condition for Home firms $Lq(h) + \frac{P^*(h)}{P(h)} L^* q^*(h) - \frac{W}{P(h)} l(h) - \frac{W}{P(h)} \bar{l} = 0$ using the production function (16), the constraint (17) and the symmetry assumptions ($L = L^*$, $q^*(h) = q(f)$, $P^*(h) = P(f)$). We obtain

$$q(h) + p(f)\, q(f) = \frac{w_h}{A} \left[q(h) + \zeta q(f) + \frac{A\bar{l}}{L} \right], \tag{25}$$

where $w_h \equiv \frac{W}{P(h)}$ is the (real) wage in terms of Home prices. The left hand side of the previous equation represents the revenue (per-capita) from producing for the Home and Foreign markets.[15] The right-hand side denotes overall per-capita costs of production.[16]

Moreover, making use of the symmetry assumptions ($A = A^*$, $W = W^*$), the pricing equations (19) yield an expression for $p(f)$ as a function of $\Phi(h)$, $\Phi(f)$ and ζ only

$$p(f) = \zeta \frac{\Phi(f)}{\Phi(h)}. \tag{26}$$

[14] i.e. $A_t^* = A_t, L_t^* = L_t, \bar{l}^* = \bar{l}, \alpha^* = \alpha, k^* = k$. Moreover, net bond holdings are zero for each country. One important consequence of the symmetry assumption is that trade is always balanced between both regions.

[15] Notice that, strictly speaking, $p(f)\, q(f)$ stands for the quantity of imports (measured in units of domestic goods). Nevertheless, it is by symmetry fully equivalent to exports $p^*(h)\, q^*(h)$.

[16] Notice here the negative cost impact of market size L: Holding everything else constant, an increase in the scale of production boosts profits.

Plugging the last expression into the zero profit condition (25) and into the relative demand equation (23) and using the normalized pricing equation (19) $1 = \Phi(h)\frac{w_h}{A}$ as well as the relation $\Phi(.) = \frac{1}{1-\alpha q(.)}$, we get the following nonlinear system of two equations

$$\Phi(h) - 1 + \zeta[\Phi(f) - 1] = \frac{\Phi(h) - 1}{\Phi(h)} + \zeta\frac{\Phi(f) - 1}{\Phi(f)} + \frac{\alpha A\bar{l}}{L},$$
$$\frac{\Phi(h) - 1}{\Phi(h)} - \frac{\Phi(f) - 1}{\Phi(f)} = \ln\left[\zeta\frac{\Phi(f)}{\Phi(h)}\right],$$

in the two unknowns $\Phi(h)$ and $\Phi(f)$. Given that a reduced form solution for the markups $\Phi(h)$ and $\Phi(f)$ as function of trade costs cannot be obtained, we rely on a numerical simulation presented in Figure 8.[17]

< Figure 8 here >

Figure 8 shows the clear positive relation between trade costs ζ and Foreign ($\zeta\Phi(f)$) and Home ($\Phi(h)$) markups.[18] The economic intuition is straightforward. Take the example of declining trade costs (smaller ζ), seen from the perspective of the Home country. Declining trade costs are passed into the price of Foreign goods, de facto reducing the Foreign markup set over marginal labor costs, therefore $\zeta\Phi(f)$ decreases. Moreover, lower Foreign prices enable Foreign firms to sell more on the Home market. This higher import penetration implies incremental competition pressure on Home firms, which forces them to decrease their markups (i.e. $\Phi(h)$ falls).

In order to relate the dynamics of Home and Foreign markups to the 'globalization premium' of section 2, we now need to find an expression for the 'overall markup' Φ found in equation (8) as a function of $\Phi(h)$ and $\Phi(f)$, and to check whether it also displays a positive relationship with trade costs. To this end, we rewrite the overall price level P as the marginal expenditure needed to obtain a unit of consumption or $P \equiv \frac{\partial e}{\partial C} = \alpha^{-1}\frac{N[P(h)+P(f)]}{2N-C}$. Using

[17] Parameterization is $A = 1$, $L = 10$, $\bar{l} = 1$ and $\alpha = 1.25$.

[18] The results are not altered by the parameterization chosen for A, L, $\bar{l}$ and α.

the definition of consumption under symmetry $C = N\{u[q(h)] + u[q(f)]\}$ and rearranging, we obtain

$$P = \alpha^{-1} \frac{P(h) + P(f)}{\exp[-\alpha q(h)] + \exp[-\alpha q(f)]}. \tag{27}$$

We then use equations (19) to substitute for Home prices $P(h)$ and Foreign prices $P(f)$ in (27)

$$P = \Phi \frac{W}{A},$$

where $\Phi \equiv \alpha^{-1} \frac{\Phi(h)+\zeta\Phi(f)}{\exp[-\alpha q(h)]+\exp[-\alpha q(f)]}$ corresponds to the 'overall markup' introduced in Section 2. Owing to $\Phi(h) + \zeta\Phi(f)$ being on the numerator, Φ depends positively on trade costs, as illustrated by the dotted line on Figure 8.

4 Summary and conclusion

In this paper, we show that globalization, modelled as a greater integration of world goods markets induced by a decrease in trade costs, can impact the natural real interest rate through the channel of declining markups. However, the sign of the impact depends crucially on whether the decline in markups has been anticipated or not.

The expectation of an advance in the degree of global competition tends to add a 'globalization-premium' to the natural interest rate, as households attempt to front load future consumption on the expectation of higher income. Our simple parametrization suggests that this premium may be sizeable, possibly up to one percentage point per annum, which, though declining over time, may last for decades. Indeed, a significant 'globalization premium' may well have been present during the 80's and 90's, a period of continuous deepening in economic integration in Europe, in East-Asia and in North America.

However, the process of increasing globalization does not behave in a totally predictable fashion: New competitors erupt as trade costs fall unexpectedly. In our framework, this induces markups to shrink causing the

natural interest rate premium to dip. In other words, our model suggests that the recent outburst in globalization, associated with the rapid integration of China's and other emerging economies may have contributed to depress the 'globalization premium' and therefore the natural rate of interest.

We believe that our attempt at modelling the inter-play between the trend-like advance in global competition and its sudden increase may not only contribute to shed light on the recent pattern of low world interest rates, but also provide some insights about their future trajectory. In particular, we can raise the question whether the period of arguably low real interest rates that we are contemplating will be sustained. On the one hand, we show that negative shocks on the level of markups tend to weaken the 'globalization premium' persistently. On the other, our analysis suggests that the premium may rise again if households start to interpret the latest spurt in globalization as representative of a future, more rapid pace of world integration, i.e. if they *anticipate* an ongoing stronger decline in markups. If this is the case, the dynamics of the model portend challenges lying ahead for monetary policy makers: The natural real interest rates may rise again and, if not spotted early enough, so may inflation risks.

Indeed, our approach may allow to draw additional conjectures regarding monetary policy issues. In particular, the fact that the rapid pace of money creation in most countries has (until today) not been followed by equivalent inflationary pressures might be related to a decline in the natural rate of interest which would have stimulated a non-inflationary increase in the demand for money. In our model, this develoment would be accompanied by a boost in real activity on a global scale and by the arrival of new varieties of goods in the market, both phenomena which have been observed in recent years.

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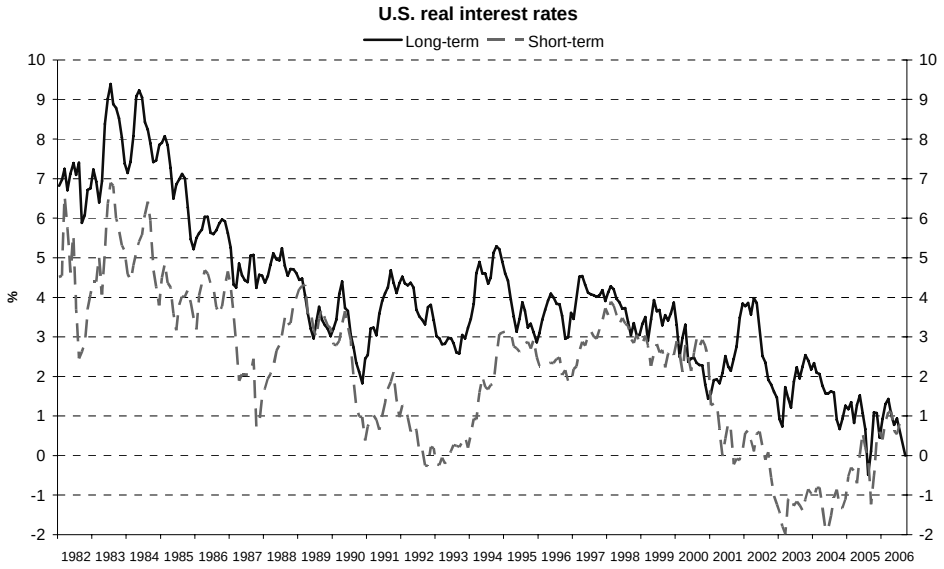

Figure 1: Real U.S. interest rates computed as the 3-month Bill rate and the 10-year Government Bond yield both deflated by the 12-month growth rate of the CPI.

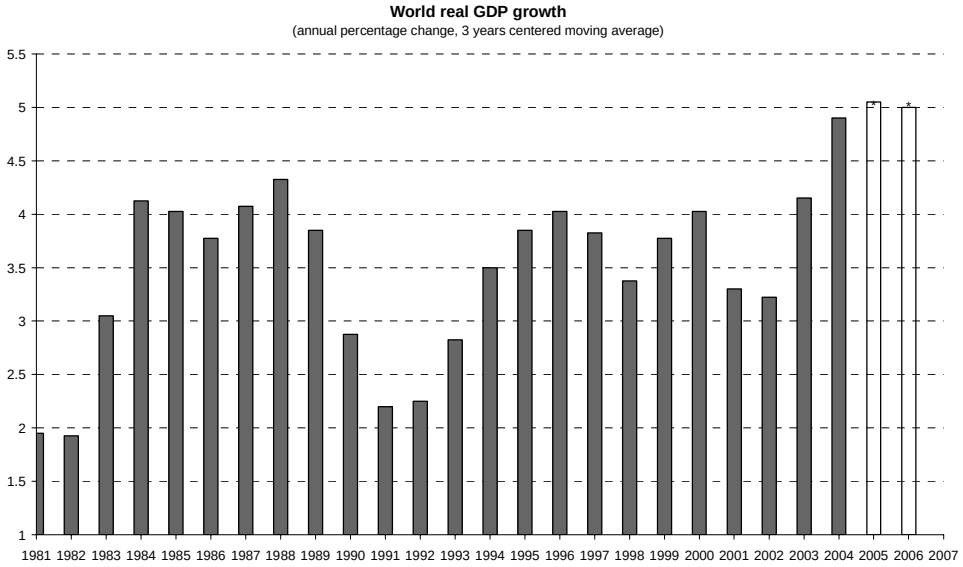

Figure 2: World real GDP growth; * Forecast; Source: IMF, World Economic Outlook Database, September 2006.

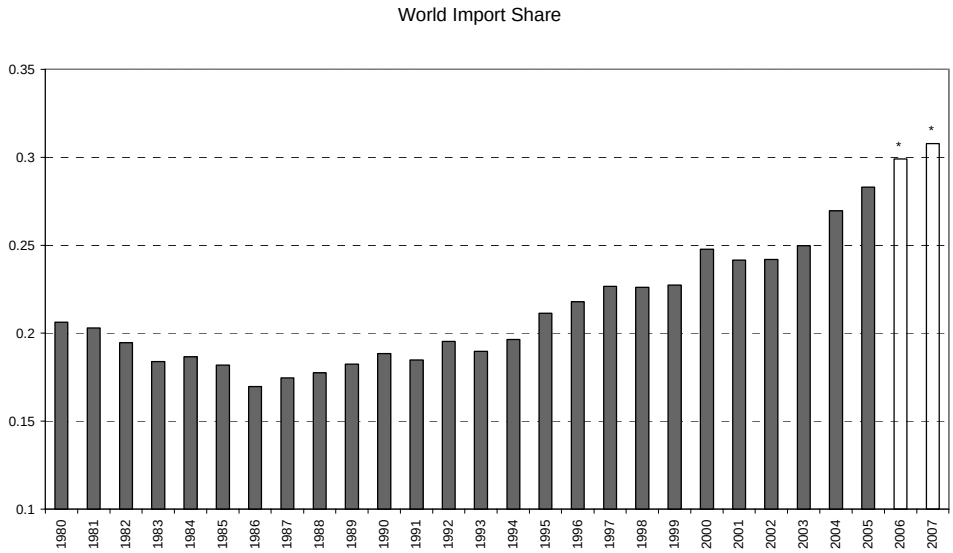

Figure 3: Ratio of world imports of goods and services to world GDP; Current prices in USD; * Forecasts; Source: IMF World Economic Outlook Database, September 2006.

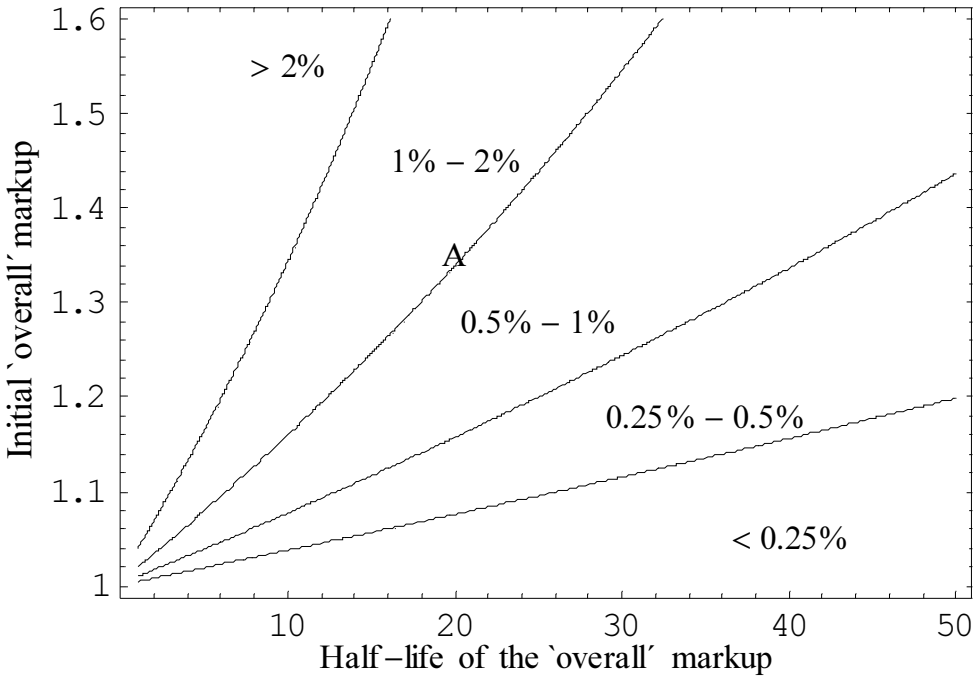

Figure 4: Contour plot of the level of the 'globalization premium' as a function of the 'overall' markup's half-life (x-axis) and initial level (y-axis). Point A corresponds to the example discussed in the text.

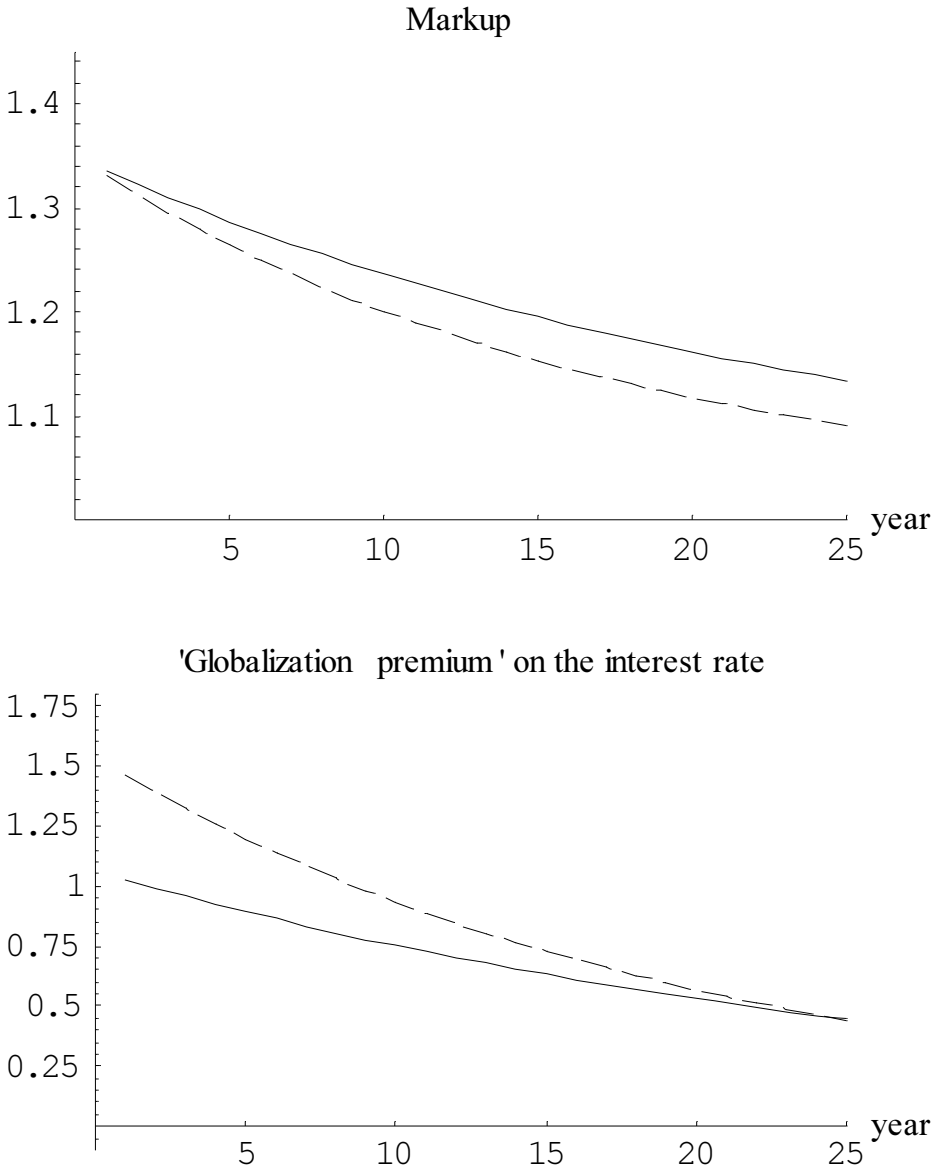

Figure 5: The dashed line in the lower panel depicts the jump in the interest rate on year 0 due to a fully anticipated accelerating decline in markups (half-life of 14 years instead of 20 (solid line), shown in upper panel).

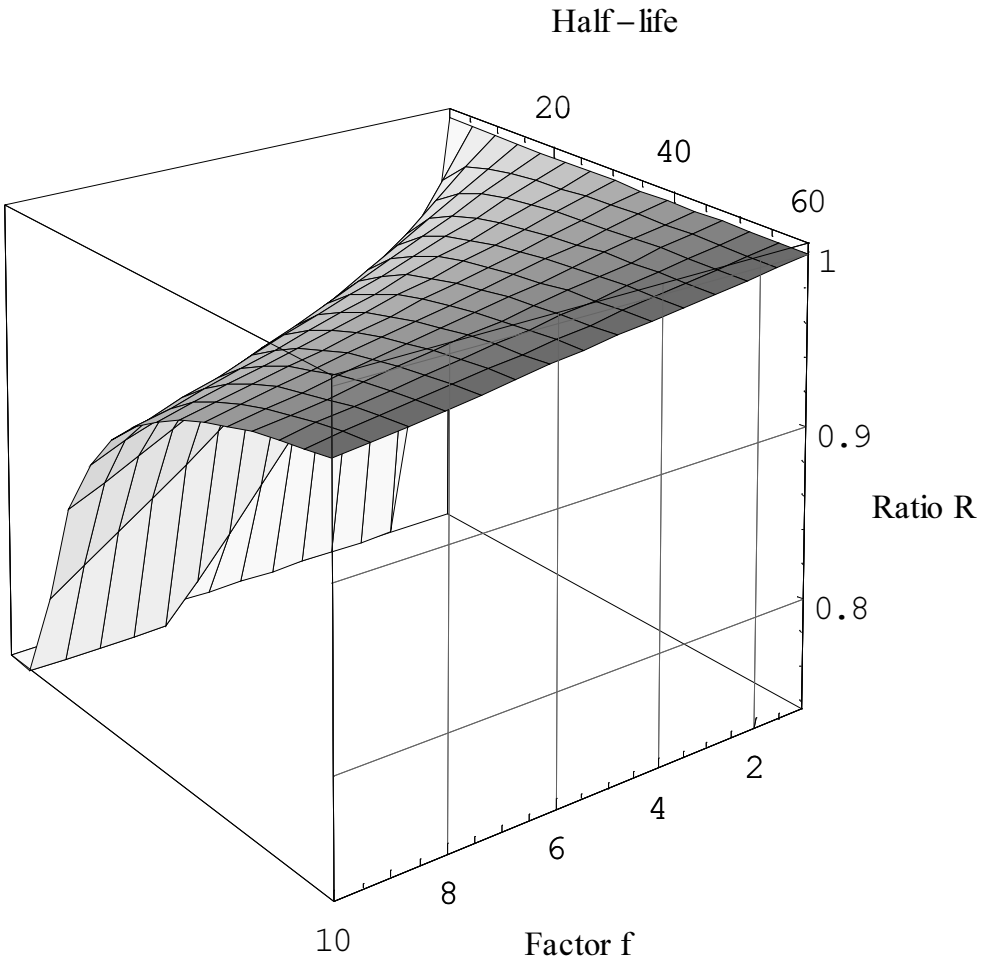

Figure 6: The ratio R is approximately 1 for high enough half-life h (upper region); evaluated at a markup equal to 1.35.

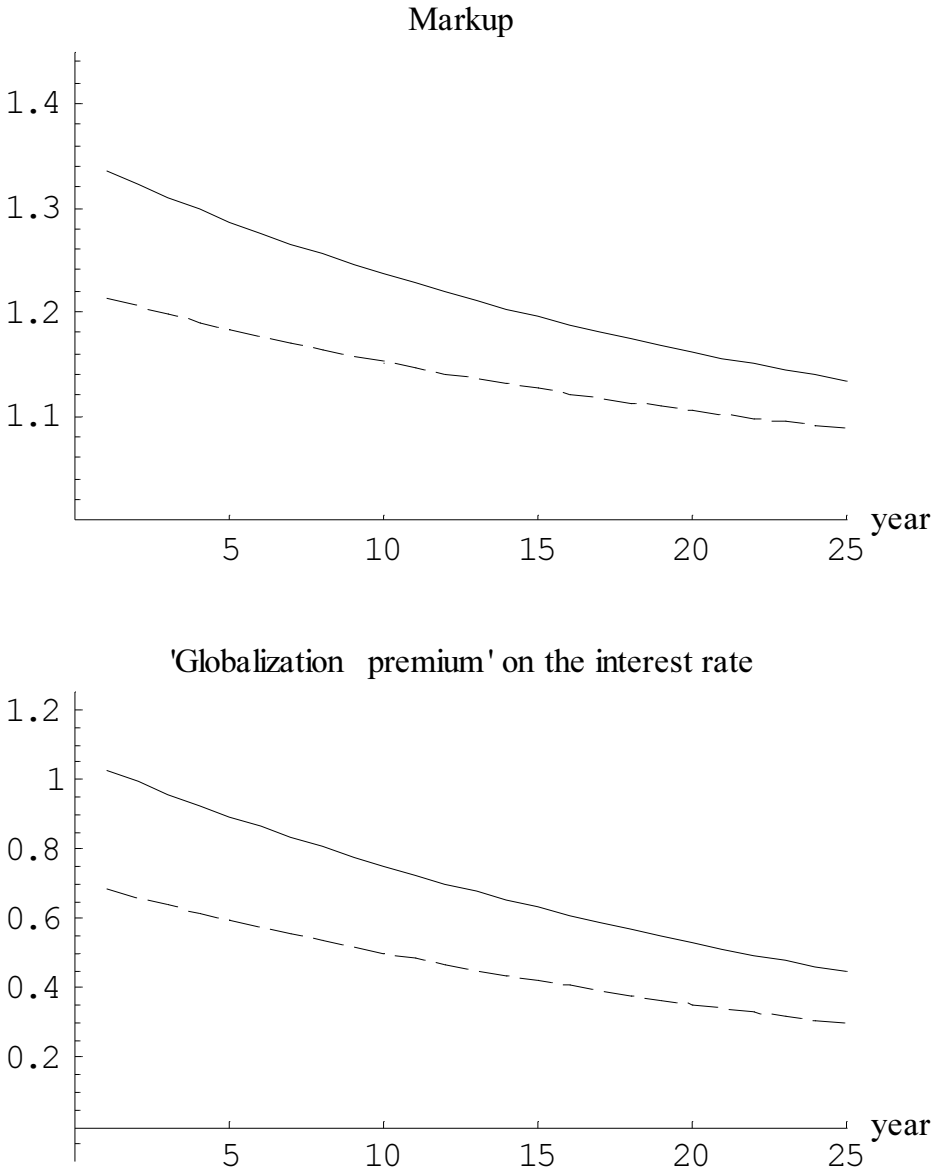

Figure 7: The dashed line in the lower panel depicts the drop in the interest rate on year 0 due to an unanticipated decline in markups (shown in upper panel). Solid 'benchmark' lines are identical to those in Figure 5.

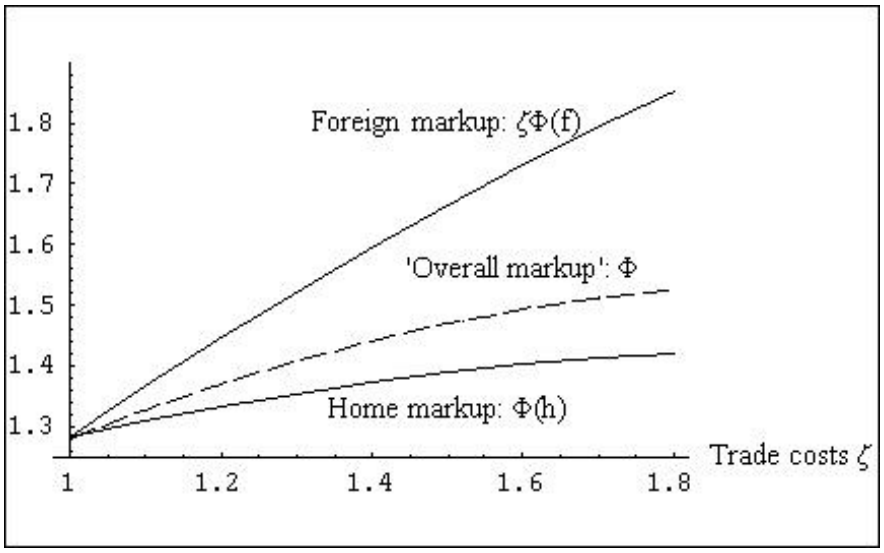

Figure 8: Markups (Home, Foreign and the 'Overall' markup) are positively related to trade costs.

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