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Abstract

Whether cross-border financial market integration has raised global insurance, is still a controversial issue in the literature. If this is so, what should we observe in the data? The insurance literature emphasizes that efficient risk-sharing requires financial markets to channel resources to countries that have been made temporarily poorer by some negative conjuncture, net of physical capital accumulation. This standard condition, which provides the basis for virtually every test of international insurance, is however derived focusing on only one of the two channels of cross-border insurance, the financial flows channel, implicitly assuming no interaction between this and the other channel, international relative price fluctuations.

This paper shows that testable conditions can only be derived theoretically placing the interaction between prices and financial flows centerstage in the analysis. Using a two-country general equilibrium model with endogenous portfolio diversification, I show that financial flows and relative prices can be either complements or substitutes in providing insurance. In the case of complementarity, financial inflows raise the international price of a country´s output. This implies the standard condition. In the case of substitutability prices and flows transfer purchasing power in opposite directions. This implies a different condition: efficient financial markets are required to channel resources «upstream», from relatively poorer to relatively richer countries. The conditions for substitutability appear to be quantitatively and empirically plausible.

Keywords: International financial flows, risk-sharing, terms of trade.

JEL classification: F3, F4, G1.

Resumen

La pregunta de si la integración internacional de los mercados financieros ha aumentado la cobertura del riesgo a nivel global o no, sigue siendo un tema controvertido en la literatura. Si fuera así, ¿qué deberíamos observar en los datos? La literatura enfatiza que una diversificación eficiente de riesgos requiere que los mercados financieros canalicen recursos hacia los países que se han empobrecido temporalmente por alguna coyuntura negativa, neto de la acumulación de capital físico. Esta condición estándar, que proporciona la base para casi todos los test estadísticos de cobertura del riesgo en al ámbito internacional, ha sido derivada centrándose sólo en uno de los dos canales de diversificación internacional del riesgo, el canal de los flujos financieros, asumiendo implícitamente que no hay interacción entre este y el otro canal, fluctuaciones de precios relativos internacionales.

Este trabajo muestra que sólo pueden deducirse teóricamente condiciones empíricamente contrastables colocando la interacción entre precios y flujos financieros en el centro del análisis. Utilizando un modelo de equilibrio general con dos países y diversificación endógena de cartera, se muestra que flujos financieros y precios relativos pueden ser complementos o sustitutos para proporcionar un seguro. En el caso de la complementariedad, los flujos financieros incrementan el precio internacional de la producción de un país. Esto implica la condición estándar. En el caso de la sustituibilidad, precios y flujos transfieren poder adquisitivo en direcciones opuestas. Esto implica una condición diferente: mercados financieros eficientes deberían canalizar los recursos desde los países relativamente más pobres a los relativamente más ricos. Las condiciones para la sustituibilidad parecen ser plausibles cuantitativa y empíricamente.

Palabras clave: Flujos financieros internacionales, diversificación del riesgo, términos de intercambio.

1 Introduction

Over the last decades, most restrictions to cross-border asset trade were removed. Financial integration increased dramatically the volume of activity in international financial markets. Lane and Milesi-Ferretti (2003) document that foreign assets and liabilities as a share of GDP increased by 250% among industrialized countries between 1970 and 2001. Cross-border financial flows due to external borrowing and portfolio returns rose by 50-100% during the same period. Many of the macroeconomic consequences of these stronger financial linkages still have to be fully evaluated. One of the crucial, still open issues is whether these developments in international financial markets actually raised global insurance.

As it is well-known, international financial markets may insure residents in different countries against the effects of national business cycle shocks. Local disturbances (affecting productivity, investment, government spending) may temporarily lower national income. If international financial markets are efficient, households can shed their consumption from national shocks by borrowing from abroad or by getting returns on their portfolio of foreign assets. A large body of literature has investigated whether financial integration actually increased cross-border insurance against national income shocks. These works have confronted with a basic *theoretical issue*: if international financial markets have become more efficient in providing insurance, what should we observe in the data? Several contributions proposed theoretical efficiency conditions for financial markets and compared them with the data – with mixed results.

What this literature has typically ignored is that international trade in assets is not the only channel of cross-border insurance. Also relative price fluctuations (terms of trade movements) may hedge consumers against national income shocks. For instance, consider a country hit by a fall in productivity that lowers the income of its residents. If the international price of their output rises, residents can sell it at a higher price in international good markets and recover some purchasing power. In this sense, relative price fluctuations can transfer purchasing power across countries.[1]

The idea behind this paper is that global insurance results from the *joint* operations of two channels – international financial markets (cross-border financial flows) and relative price fluctuations. Its purpose is to reconsider the basic issue in the insurance literature focusing precisely on the interaction between these two channels: how should we identify efficient financial markets if financial flows and relative price fluctuations provide insurance jointly?

The literature has suggested that well-functioning asset markets should channel resources to countries that (absent asset trade) would have been made temporarily poorer by national disturbances, net of physical capital accumulation. This condition provides the basis for virtually every test of international insurance (Appendix A describes how it has been brought to the data by several empirical methods). Yet, this "standard efficiency condition" for financial markets has been derived focusing on only one of the two channels of cross-border insurance, financial flows. Relative price fluctuations have been typically ignored or treated as exogenous, at best they have been credited for giving rise to valuation effects on foreign asset positions.[2] Is the standard condition still valid if

[1] This idea has been formalized by Cole and Obstfeld (1991).

[2] The efficiency benchmark for financial markets has been derived in frameworks with an infinite elasticity of substitution between commodities or with exogenous price fluctuations. One example is the so-called intertemporal approach to the current account, typically based on one-good models or setups in which terms of trade movements are treated as exogenous (see Razin (1993) and Obstfeld and Rogoff (1994)). The same applies to more recent approaches to the current account theory (Ventura (2002)). The few extensions of this theory to setups with traded and non-traded goods (in which price fluctuations

prices and flows provide insurance jointly? This paper gives a negative answer. It shows that endogenous feedbacks between prices and flows may require efficient asset markets to channel resources "upstream", from relatively poorer to relatively richer countries (net of physical capital accumulation). Thus the condition of insurance that has been used so far by the empirical literature on risk-sharing measurement, provides a partial and potentially misleading picture of the optimal pattern of financial flows. Testable conditions for cross-border insurance can only be derived placing the interaction between prices and flows centerstage in the analysis.

To derive these results, I write a two-country two-good DSGE model. Countries are inhabited by representative consumers and are specialized in the production of different varieties. National supply shocks create income risk for the representative households. The assumptions of product specialization and home bias in consumption guarantee that relative price fluctuations transfer purchasing power across countries. I assume that financial markets are efficient. Namely, I analyze the model under two different asset trade regimes, trade in uncontingent bonds and trade in two equities, representing respectively two functions through which asset markets may increase cross-border risk-sharing, consumption smoothing (through external borrowing) and ex-ante hedging (through portfolio diversification).[3] In both cases, I assume no frictions in international asset trade: agents optimize over their purchase of securities and have rational expectations; there are no costs associated to trade in assets. By construction the cross-country financial flows arising in these setups, provide the highest possible degree of risk-sharing achievable through, respectively, external borrowing and portfolio diversification. I use the model to study to which country efficient financial markets channel resources after national shocks. The first asset structure (trade in uncontingent bonds) allows to analyze the optimal pattern of flows from external borrowing. The second one (trade in two equities) makes asset markets effectively complete. I solve for optimal portfolios using the method of Devereux and Sutherland (2006), and study financial flows from equity returns and the composition of optimal portfolios.

The results show that the optimal pattern of financial flows depends crucially on the interaction between the two channels of cross-border insurance.

Consider a country that is hit by a negative conjuncture and gets temporarily poorer with respect to the rest of the world. The "standard efficiency condition" for financial markets states that, once asset trade in introduced, efficient financial flows should channel resources to this country, either through external borrowing or via returns on international portfolios.

However, receiving an inflow from abroad typically changes the international price of a country's output. I show that price fluctuations and financial flows can be either complements or substitutes in providing insurance. If an inflow from abroad raises the relative price of a country's output, the economy benefits twice from the transfer: both financial flows and price adjustments channel purchasing power to its residents – prices and flows are complements in providing insurance. Complementarity implies the "standard condition": financial markets are efficient if they channel resources to the relatively poorer country (absent asset trade).

are partially endogenized) have not been used as efficiency benchmarks by the insurance literature. See Viani (2010a) for a survey of empirical methods.

[3] As noted by Cole (1991), well-functioning financial markets play two roles. First, frictionless trade in uncontingent bonds allows consumers to smooth the effects of national disturbances on their consumption by borrowing and lending abroad. Second, frictionless trade in contingent assets allows households to form portfolios that hedge them ex-ante against shocks.

Yet, receiving an inflow from abroad may lower the international price of a country's output. In this case, while financial flows tend to channel purchasing power to this economy, relative price fluctuations transfer purchasing power abroad – the two channels of insurance are substitutes. Price swings are so strong that the net effect of an inflow is to lower the purchasing power of the receiving country. In this case financial markets are efficient if they transfer resources to the country that (absent asset trade) would have been made relatively richer by the shock – "upstream". Upstream flows raise global insurance and welfare. Yet, they contradict the standard condition of efficiency employed in the literature.

More specifically, if agents can trade only in uncontingent bonds, flows and prices being complements or substitutes determines to which economy efficient asset markets should channel resources through external borrowing, and the optimal cyclicality of the current account. If consumers can trade in two equities, the same relationship shapes the pattern of flows due to portfolio returns, and the composition of optimal portfolios. I also analyze the implications of complementarity and substitutability for equity home bias.

It is important to notice that the effects of upstream flows and the conditions that generate them are not new to the international literature. In our model the different price response to financial flows depends on the relative strength of substitution and income effect of price changes, which, in turn, hinges crucially on the value of the trade elasticity. In particular, optimal upstream flows arise for a relatively low trade elasticity, around 0.5. This value is in the range of macro estimates, as documented by Hooper et al. (2000). Corsetti et al. (2008a) use US data to estimate the trade elasticity to be slightly below 0.5. This low trade elasticity is essential for their open-macro model to match the empirical evidence on the so-called Backus-Smith puzzle, the low correlation between relative cross-country consumption and the real exchange rate observed in the data. In particular, Corsetti et al. (2008a) show that a trade elasticity around 1/2 is precisely what allows to reconcile standard international models, driven by business-cycle supply shocks, with the empirical evidence on consumption-real exchange rate correlations.[4]

On the other hand, whether financial inflows appreciate or depreciate countries' terms of trade in the short-run is still a controversial issue. While most works have estimated the impact of net foreign assets variations on relative prices in the long-run, Gagnon (1996) quantifies the short-run impact, the one that is relevant for the issue at handle. He finds that a deterioration in net foreign assets (which in the short-term can well correspond to a worsening in the trade deficit and a financial inflow from abroad) is associated with an impact depreciation of the terms of trade. These findings do not allow to draw conclusions about the impact of cross-border flows on international prices. Yet, they show that the data could indeed support the hypothesis of substitutability between flows and prices, which is necessary for upstream flows to be optimal.

This paper is related to three strands of literature. First, contributions developing theories of consumption smoothing and portfolio diversification (as Obstfeld and Rogoff (1994) and Ventura (2000) on, respectively, the intertemporal and the new theory of the current account). These approaches – mostly grounded in one-good or partial equilibrium frameworks – abstract from any interaction between financial flows and price fluctuations, and provide the theoretical basis for the "standard efficiency condition".

Second, contributions studying the insurance properties of relative price adjustments. Cole and Obstfeld (1991), the first ones to analyze this issue, abstract from financial

[4]An alternative would be a much higher trade elasticity (around 4, in line with estimates from the trade literature) and very persistent productivity shocks in an economy with capital accumulation. See Corsetti et al. (2008).

markets. Corsetti et al. (2008a) show how standard open-macro models can be reconciled with the Backus-Smith evidence. They study how the structure of financial markets affects relative price fluctuations in a model with international trade in uncontingent bonds.

Finally, the empirical literature on risk-sharing measurement. Obstfeld (1993), Sorensen and Yosha (1998), and Flood et al. (2008) are only some examples of contributions focusing on the direction of financial flows along the business cycle, and adopting empirical methods based on the "standard condition".

To my knowledge, this paper is the first one to study the interaction between financial flows and price fluctuations and its relevance for the mechanism of cross-border insurance. It is also the first one to relate the interplay between the two insurance channels to optimal portfolio composition.

The rest of the paper is organized as follows. The next section presents a measure of cross-border insurance from macro theory, which will be useful to study the effects of national shocks and the direction of optimal financial flows. Section 3 describes the two-country two-good DSGE model. Section 4 analyzes the model under Financial autarky, to study the impact of national disturbances on the cross-border allocation absent asset trade. Section 5 and 6 analyze the same model, respectively, under trade in uncontingent bonds and trade in two equities, to study optimal financial flows from external borrowing and portfolio returns. Section 7 presents some considerations on complementarity and substitutability, while 8 draws some conclusions.

2 A measure of cross-border insurance

Assume the world consists of several countries, each inhabited by a representative agent. Asset markets are complete as agents can trade internationally in a full set of Arrow-Debreu securities. Focus on two countries, Home and Foreign. In what follows $W(s\prime|s)$ denotes the price in state-of-the-world s of an Arrow-Debreu security paying 1 unit of some numéraire good in the following period if state-of-the-world $s\prime$ realizes. $U_C(s)$ and $U_C(s\prime|s)$ are the marginal utilities of consumption of the H consumer, respectively, in state s and in state $s\prime$. $P(s)$ and $P(s\prime|s)$ are the prices of the H consumption good in state s and $s\prime$. β denotes the discount factor of the H consumer, $\pi(s\prime|s)$ the conditional probability of state $s\prime$ given s. The Euler Equation of the H consumer, regulating her purchase in state s of Arrow-Debreu securities paying 1 unit of the numéraire in state $s\prime$, reads

$$U_C(s)\frac{W(s\prime|s)}{P(s)} = \beta \cdot \pi(s\prime|s) \cdot U_C(s\prime|s)\frac{1}{P(s\prime|s)}, \forall s.s\prime \tag{1}$$

The H consumer buys securities until the marginal cost of purchasing one more asset (left hand side in equation (1)) equals its expected marginal benefit (right hand side).

The analogous condition for the F agent is given by

$$U_C^{\star}(s)\frac{W(s\prime|s)}{P^{\star}(s)\cdot\omega(s)} = \beta^{\star} \cdot \pi(s\prime|s) \cdot U_C^{\star}(s\prime|s)\frac{1}{P^{\star}(s\prime|s)\cdot\omega(s\prime|s)}, \forall s, s\prime \tag{2}$$

where starred variables denote Foreign aggregates, and ω is the nominal exchange rate between the H and the F currency.

Combining (1) and (2) gives

$$\underbrace{\beta\frac{U_C(s\prime|s)}{U_C(s)}\frac{P(s)}{P(s\prime|s)}}_{m(s\prime|s)} = \underbrace{\beta^{\star}\frac{U_C^{\star}(s\prime|s)}{U_C^{\star}(s)}\frac{P^{\star}(s)}{P^{\star}(s\prime|s)}\frac{\varepsilon(s)}{\varepsilon(s\prime|s)}}_{m^{\star}(s\prime|s)} = \frac{W(s\prime|s)}{\pi(s\prime|s)}, \forall s, s\prime$$

where $m\left(s\prime|s\right)$ and $m^{\star}\left(s\prime|s\right)$ are the Stochastic Discount Factors (SDFs) of the H and the F consumer. Perfect cross-border risk-sharing against national income shocks (given by construction by complete asset markets) equates the SDFs of the two agents, for every states-of-the-world s and $s\prime$.[5] Equivalently, in terms of time-dependent notation, perfect insurance implies

$$m_t = m_t^{\star}, \forall t \tag{3}$$

On the contrary, if asset markets are not complete, Stochastic Discount Factors need not be equalized. Uninsurable shocks will drive a wedge between them in some states-of-the-world

$$m_t = \eta_t \cdot m_t^{\star}, \exists t \tag{4}$$

where η_t represents the wedge between H and F SDFs created by uninsurable disturbances. Taking logarithms on both sides of (4) I define the measure of cross-border insurance, the *gap*, as

$$gap_t \equiv \log\left(\eta_t\right) - \log\left(1\right) = \log\left(m_t\right) - \log\left(m_t^{\star}\right) \tag{5}$$

gap_t measures the percentage deviation of the wedge between H and F SDFs observed at time t from the wedge that would be observed if income risk was perfectly shared ($\eta = 1$). In any model, the *gap* arising in response to national shocks measures by construction the percentage deviation from the allocation corresponding to complete financial markets and full insurance against national income shocks.[6]

In the next sections I will prove that the *gap* quantifies changes in countries' relative wealth created by uninsurable shocks. Namely, the sign of the *gap* indicates which country has been made relatively richer (poorer) by national disturbances; its magnitude quantifies the size of the change in countries' relative wealth. Appendix B proves that in the DSGE model used in this paper, the *gap* is a proxy for the social welfare losses due to the fraction of country-specific risk that cannot be traded in financial markets. These properties make the *gap* a useful instrument for the analysis of optimal financial flows. In particular, it will be used to study the effects of national income shocks and the direction of financial flows in the model detailed below.

3 A two-country two-good model

The model is a two-country two-good DSGE framework with endowment shocks and home bias in consumption. Its core structure is the simplest one that allows to analyze, under different asset trade regimes, the interaction between real and financial channels of shocks transmission.[7] Its simplicity allows to get analytical closed form solutions when trade in more than one asset is introduced.

The model consists of two countries, Home and Foreign, each inhabited by a representative household. Countries are specialized in the production of different goods. Households in country H receive utility from consuming a bundle made up of the foreign and the domestic good, according to a CES aggregator

[5] See also Backus and Smith (1993), Gravelle and Rees (2004), and Cochrane (2005).

[6] More precisely, the *gap* is an insurance measure in any model tha features a representative consumer in each country.

[7] The model is closely related to frameworks employed in Cole and Obstfeld (1991), Kollmann (2006), and Corsetti et al (2008).

$$C_t = \left[(\delta)^{1/\theta} (C_{ht})^{\frac{\theta-1}{\theta}} + (1-\delta)^{1/\theta} (C_{ft})^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} ; \theta > 0, \delta > 1/2 \tag{6}$$

where C_{jt} denotes consumption of the good produced in country j and δ is a parameter capturing home bias in consumption. θ is the elasticity of substitution between H and F-produced goods; in this model it coincides with the trade elasticity, i.e., the elasticity of the import/export ratio with respect to relative price changes. The F consumption bundle is analogously defined. Starred variables denote the corresponding quantities consumed by Foreign agents. Goods are freely tradable but not storable. The period utility of both agents depends on current consumption only and is a Constant Relative Risk Aversion function with risk aversion coefficient ρ.

In each period H and F households receive a stochastic endowment according to the process

$$\log (Y_{jt}) = \zeta \log (Y_{jt-1}) + \varepsilon_{jt}$$

where Y_{jt} denotes the endowment received by consumer j and $\varepsilon_{jt} \sim iid(0, \sigma^{\varepsilon})$. For simplicity I assume $Cov(\varepsilon_{it}, \varepsilon_{jt}) = 0$ for $i \neq j$.

I assume that the law of one price holds and that the nominal exchange rate is constant and equal to one for simplicity. Due to home bias in consumption purchasing power parity does not hold outside a symmetric Steady State, and the two price indexes P_t and $P_t^{\star}$ are tied by the following condition defining the real exchange rate Q_t

$$Q_t \equiv \frac{P_t^{\star}}{P_t}$$

Terms of trade are defined as the ratio of the price of H imports and exports

$$tot_t \equiv \frac{P_{ft}}{P_{ht}}$$

where P_{ht}, and P_{ft} denote respectively the price of H and F-produced goods.

The relative value of F and H endowments can be written as

$$V_t^{\star} = \frac{P_{ft} Y_{ft}}{P_{ht} Y_{ht}} \frac{P_t}{P_t^{\star}} \tag{7}$$

Standard cost minimization delivers H households' demand for the H and the F variety

$$C_{ht} = \delta \left(\frac{P_{ht}}{P_t} \right)^{-\theta} C_t$$

$$C_{ft} = (1-\delta) \left(\frac{P_{ft}}{P_t} \right)^{-\theta} C_t$$

Analogous conditions hold for F agents. Good market clearing conditions read

$$Y_{ht} = C_{ht} + C_{ht}^{\star}$$

$$Y_{ft} = C_{ft} + C_{ft}^{\star}$$

The model is loglinearized around a symmetric Steady State in which endogenous variables are constant and exogenous ones are equal to their mean values.

In the following sections, I will analyze the model under different asset trade regimes. Households' budget constraints will be pinned down by the specific asset structure assumed. More specifically, I will assume the existence of efficient financial markets that allow agents to borrow from abroad or to diversify their portfolio. In these frameworks I will simulate a national income shock and study the direction of optimal financial flows. In all these exercises, the *gap* arising in the model in response to national disturbances will be a useful instrument to study the effect of the shocks and the direction of financial flows. For any possible asset structure, if the system is in Steady State up to time $(t-1)$, the *gap* arising at time t in response to shocks is given by

$$gap_t = \hat{q}_t - \rho\left(\hat{c}_t - \hat{c}_t^{\star}\right)$$

where ρ is the common risk-aversion coefficient and lowercase hatted variables denote percentage deviations from the Steady State.

As a first step, the next section analyzes the same model in Financial autarky to study the effect of national income shocks on the cross-country allocation if international financial markets were shut down.

4 Financial autarky and insurance from relative prices

In this section I analyze the model under Financial autarky, with two purposes. First, to trace the effects of national disturbances on the cross-country allocation if there were no financial markets. Second, to study insurance from relative price fluctuations.

As noted by Cole and Obstfeld (1991), if countries are specialized in the production of heterogenous goods, they may be compensated for negative shocks reducing their output by increases in the international price of their exports. Terms of trade volatility may transfer purchasing power across countries and provide some automatic insurance against national shocks.

Under Financial autarky relative price fluctuations represent the only channel of cross-border insurance. Households have no means of smoothing consumption over time and in each period their consumption must equal the value of their income. H and F budget constraints read

$$C_t P_t = P_{ht} Y_{ht}$$

$$C_t^{\star} P_t^{\star} = P_{ft} Y_{ft}$$

The relative value of F and H endowments, as defined in equation (7), can be written in linearized form as[8]

$$\hat{v}_t^{\star} = \left(\hat{y}_{ft} - \hat{y}_{ht}\right) + 2\left(1-\delta\right) \hat{tot}_t$$

An exogenous rise in the H endowment represents (in relative terms) a negative income shock for F consumers as it tends to decrease the relative value of the Foreign endowment, $\hat{v}_t^{\star}$. Price fluctuations can lessen or magnify this effect. If the terms of trade depreciate, F

[8] The relative value of endowments can be derived by substituting the solution for national CPIs

$$P_t = \left[\delta\left(P_{ht}\right)^{\eta-1} + \left(1-\delta\right)\left(P_{ft}\right)^{\eta-1}\right]^{\frac{1}{\eta-1}}$$

$$P_t^{\star} = \left[\left(1-\delta\right)\left(P_{ht}\right)^{\eta-1} + \delta\left(P_{ft}\right)^{\eta-1}\right]^{\frac{1}{\eta-1}}$$

in consumers' budget constraints.

consumers are partially compensated by a rise in the international price of their output. Price adjustments provide some automatic insurance to F agents by transferring them some purchasing power, and limit the fall in $\hat{v}_t^\star$. On the contrary, a terms of trade appreciation would contribute to hurt F consumers, by reducing the international price of their exports. In this case terms of trade fluctuations would magnify the fall in $\hat{v}_t^\star$ that would have occurred at constant prices.

Following the shock, deviations of relative prices from the Steady State map into deviations in relative consumption through their impact on relative income. The *gap* arising in the model in response to the disturbance measures the deviation from full risk-sharing created by the shock and quantifies the insurance properties of relative prices. The response of the *gap* reflects also changes in the relative wealth of the two countries created by the disturbance, as the following subsection shows.

4.1 Changes in relative wealth under Financial autarky

Agents' intra-temporal decisions can be solved through standard expenditure minimization. The inter-temporal problem of H consumers may be solved by setting up the Lagrangian

$$\max_{\{C_t,\chi_t\}}.: L = \frac{(C_t)^{1-\rho}}{1-\rho} + \chi_t \left(P_{ht}Y_{ht} - P_tC_t\right), \forall t$$

where χ_t is the multiplier attached to H agents' budget constraint, and represents the shadow value of current income, $P_{ht}Y_{ht}$. The first order condition with respect to consumption reads

$$(C_t)^{-\rho} = \chi_t P_t \tag{8}$$

Its analogue for F consumers is given by

$$(C_t^\star)^{-\rho} = \chi_t^\star P_t^\star \tag{9}$$

where ${\chi_t}^\star$ is the shadow value of F household's current income.

Taking the ratio of (8) and (9) gives

$$\left(\frac{C_t^\star}{C_t}\right)^{-\rho} = Q_t\left(\frac{\chi_t}{\chi_t^\star}\right)$$

Loglinearizing around the symmetric Steady State yields

$$\hat{q}_t - \rho\left(\hat{c}_t - \hat{c}_t^\star\right) \equiv gap_t = \left(\hat{\chi}_t - \hat{\chi}_t^\star\right)$$

The *gap* arising at time *t* in response to shocks reflects asymmetric responses of the shadow value of current income in the two countries. Its sign indicates the new ranking of wealth: if a shock raises more the shadow value of the F consumer's income (makes him relatively poorer), the *gap* is negative; positive if the disturbance makes the F agent relatively richer. Thus the *gap* reflects the change with respect to the Steady State of the relative wealth of F consumers.

4.2 Insurance from relative prices

From the expenditure minimization problem of F and H consumers, we get their demand for, respectively, H and F-produced goods, which in their loglinearized version read

$$\frac{1}{\theta}\hat{c}^{\star}_{ht} = (1-\delta)\, \hat{tot}_t + \frac{1}{\theta}\hat{c}^{\star} + \hat{q}_t \tag{10}$$

$$\frac{1}{\theta}\hat{c}_{ft} = -\delta \hat{tot}_t + \frac{1}{\theta}\hat{c} \tag{11}$$

Linearizing the Financial autarky budget constraints we can express Home and Foreign consumption as

$$\hat{c}_t = (\delta - 1)\, \hat{tot}_t + \hat{y}_{ht} \tag{12}$$

$$\hat{c}^{\star}_t = (1-\delta)\, \hat{tot}_t + \hat{y}_{ft} \tag{13}$$

Using the price indexes P_t and $P^{\star}_t$ derived from the expenditure minimization, the real exchange rate can be written as

$$\hat{q}_t = (2\delta - 1)\, \hat{tot}_t \tag{14}$$

From the balance trade condition, the terms of trade are given by

$$\hat{tot}_t = \hat{c}^{\star}_{ht} - \hat{c}_{ft}$$

Substitute for (10), (11), (12), (13), and (14) to get the response of the terms of trade to shocks to the H and F endowments

$$\hat{tot}_t = \frac{1}{1 - 2\delta\,(1-\theta)} \cdot (\hat{y}_{ht} - \hat{y}_{ft}) \tag{15}$$

Assume the system is in Steady State up to time $(t-1)$ and assume a national shock at time t, an exogenous increase in the H endowment.

Combining the solution for the response to the shock of Home and Foreign consumption and the real exchange rate, the *gap* arising at time t can be written as a function of the deep parameters of the model as

$$\begin{aligned} gap^{FA}_t &= \hat{q}_t - \rho\,(\hat{c}_t - \hat{c}^{\star}_t) = \\ &= -\frac{(2\delta\rho\theta - \rho - 2\delta + 1)}{(2\delta\theta - 2\delta + 1)} \cdot \varepsilon_{Ht} \end{aligned} \tag{16}$$

where ε_{Ht} is the *i.i.d.*. shock to the H endowment and the second line follows from substituting (15) in (12), (13), and (14). There are two values of the trade elasticity θ for which the terms in parentheses in equation (16) are equal to zero. These values define two thresholds for the trade elasticity that play a crucial role in shaping the wealth imbalances created by the shock.[9]

The first threshold is the value of θ for which the denominator in (16) is equal to zero

$$\tilde{\tau} \equiv 1 - \frac{1}{2\delta}$$

I will refer to $\tilde{\tau}$ as the *transmission threshold*, relating to the findings of Corsetti et al. (2008a) who analyze the behaviour of the same model under Financial autarky. If the trade elasticity is higher than $\tilde{\tau}$, an increase in the H endowment depreciates the terms of trade.

[9] The value of the trade elasticity is key in determining the equilibrium volatility of the terms of trade. Therefore, analyzing transmission through relative price fluctuations in terms of the trade elasticity seems a natural choice.

Foreign consumers benefit from the rise in the international price of their output and the bonanza in the H country raises consumption abroad – the international transmission of shocks is positive. For an elasticity lower than $\tilde{\tau}$ the same shock appreciates the terms of trade. F consumers are hurt by a fall in the relative price of their output and the windfall in the H country reduces consumption abroad – international transmission is negative.[10]

The second threshold is the value of θ for which the numerator in (16) is equal to zero

$$\tilde{\eta} \equiv \frac{\rho + 2\delta - 1}{2\delta\rho}$$

Since the *gap* is zero when $\theta = \tilde{\eta}$, I call this value the *efficiency threshold*. If the trade elasticity matches $\tilde{\eta}$, full risk-sharing is attained in response to the shock even in the absence of financial markets.

I simulate a 1% positive shock to the H endowment at time t. The following graphs show the time-t response of the terms of trade and the *gap*, both as a function of the trade elasticity θ.[11]

[10] The reason why relative prices respond differently over the two regions of the elasticity domain is the following. After the rise in the H endowment, world demand for the H good must increase, which requires relative prices to adjust. Corsetti et al. (2008) show that a fall in the relative price of the H good tends, on the one hand, to switch world expenditure towards the H variety, raising its demand (Pareto-Edgeworth *substitution effect*). On the other hand, the same fall in the H price lowers the value of the endowment of H consumers. Since H households are the biggest buyers of the H variety, world demand for the H commodity tends to fall (Pareto-Edgeworth *income effect*). When $\theta < \tilde{\tau}$ the degree of substitutability between goods is so low that the income effect prevails. For the H-good demand to increase, the income of H consumers must rise, which requires an increase in the relative price of the H variety.

As in Corsetti et al. (2008) strong income effects might give rise to multiple equilibria. It should be noted that this feature would not affect the main results of the analysis (see also the discussion in Corsetti et al. (2002) and (2008)).

[11] I assume $\delta = 0.9$, $\beta = (1/1.01)$, $\rho = 2$. The persistence of the shock does not influence the response of the *gap* and the terms of trade under Financial autarky.

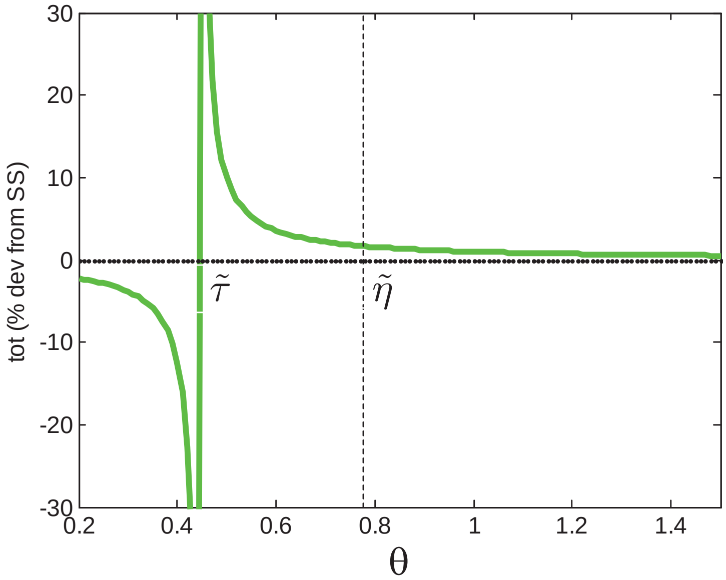

FIGURE 1
Terms of trade response as a function of θ (Financial autarky)

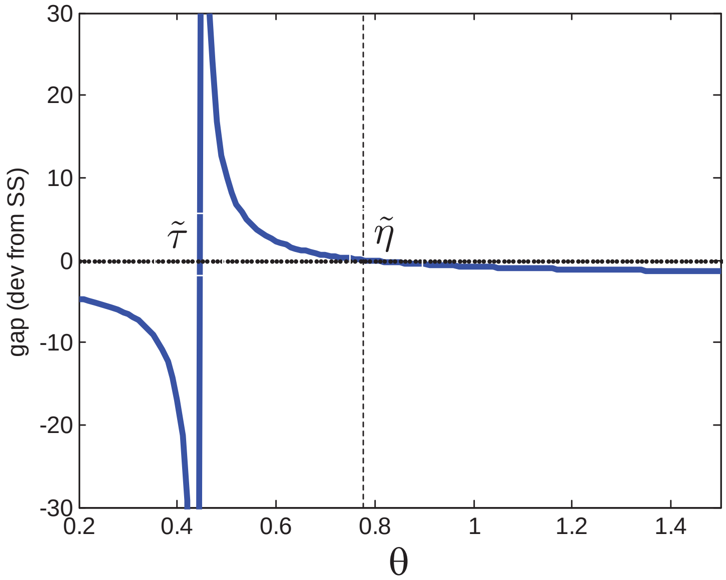

FIGURE 2
Gap response as a function of θ (Financial autarky)

If the two varieties were perfect substitutes (if the trade elasticity θ was infinite), relative prices would not react to the shock and the rise in the H endowment would make Foreign consumers relatively poorer. The *gap* arising in response to the disturbance – the change in the relative wealth of F consumers with respect to the Steady State – would be negative

$$\lim_{\theta\to\infty} gap_t^{FA} = \lim_{\theta\to\infty} -\frac{(2\delta\rho\theta - \rho - 2\delta + 1)}{(2\delta\theta - 2\delta + 1)} = -\rho$$

As long as the two goods are not perfect substitutes, however, relative price fluctuations transfer automatically purchasing power across countries. This can lead to a variety of outcomes.

If the trade elasticity coincides with the efficiency threshold ($\theta = \tilde{\eta}$), the shock raises the international price of the F good (the terms of trade depreciate). F consumers benefit from higher export prices. The extent of the depreciation is exactly sufficient to pool risk efficiently and relative wealth is not affected by the shock: the *gap* is zero. As in Cole and Obstfeld (1991), price fluctuations guarantee full risk-sharing even in the absence of financial markets.[12]

$$gap^{FA}_{t(\theta=\tilde{\eta})} = -\frac{(2\delta\rho\tilde{\eta} - \rho - 2\delta + 1)}{(2\delta\tilde{\eta} - 2\delta + 1)} \cdot \varepsilon_{Ht} = 0 \iff \hat{\chi}_t = \hat{\chi}_t^{\star}$$

If the trade elasticity is higher then the efficiency threshold ($\theta > \tilde{\eta}$), the relative price of the Foreign output rises in response to the shock, but due to the high degree of substitutability between commodities, only a small depreciation is needed to clear the good markets after the rise in the supply of the H good. Due to the insufficient terms of trade volatility, price fluctuations do not transfer enough purchasing power to F consumers. Their relative wealth falls with respect to the Steady State, as signaled by the negative *gap*. From (16)

$$gap_t^{FA} < 0 \iff \hat{\chi}_t < \hat{\chi}_t^{\star}$$

For a trade elasticity lower than the efficiency threshold, still higher than the transmission one ($\tilde{\tau} < \theta < \tilde{\eta}$), the relatively low degree of substitutability between varieties requires a strong depreciation of the terms of trade for good markets to absorb the excess supply of the H good. Due to the strong rise in the relative price of the Foreign output, the shock makes F consumers relatively richer (positive *gap*).

Finally, for a trade elasticity lower than the transmission threshold ($\theta < \tilde{\tau}$), the terms of trade appreciate in equilibrium. Price movements *enlarge* the wedge between the relative value of endowments that would have aroused at given prices. F consumers are hurt both by the relative fall in the quantity of their endowment and by the fall in the price of their output, and are made relatively poorer by the disturbance.

4.3 The interaction between prices and flows

Absent financial markets, national shocks typically make the real allocation diverge from the one corresponding to full risk-sharing. Local disturbances alter countries' relative wealth and cause aggregate welfare losses.[13] If asset trade was introduced, to which country should financial resources optimally flow after a national shock? As a first step to answer this question, it is useful to study the interaction between cross-border flows and price fluctuations. Proposition 1 describes how relative prices react to an exogenous marginal flow of resources across countries in Financial autarky.[14]

[12] The efficiency threshold generalizes specific models used in other contributions. Cole and Obstfeld (1991) assume a Cobb-Douglas consumption aggregator and no home bias: $\theta = 1$, $\delta = (1/2)$. The core building block of the monetary model of Corsetti and Pesenti (2005) is based on log utility and unitary trade elasticity, namely $\rho = 1$ and $\theta = 1$. In both papers asset markets are shown to be redundant.

[13] Appendix B proves that the *gap* reflects aggregate welfare losses due to imperfect insurance.

[14] Appendix C shows the Proofs to all the Propositions.

Proposition 1 *A marginal flow of resources from the H to the F country raises the price of the F output (depreciates the terms of trade) if the trade elasticity is above the transmission threshold $\tilde{\tau}$ – prices and flows are* ***complements****; lowers the price of the F output otherwise – prices and flows are* ***substitutes****.*

Figure 3 shows the response of the terms of trade to a marginal flow of resources to Foreign consumers, as a function of the trade elasticity θ.

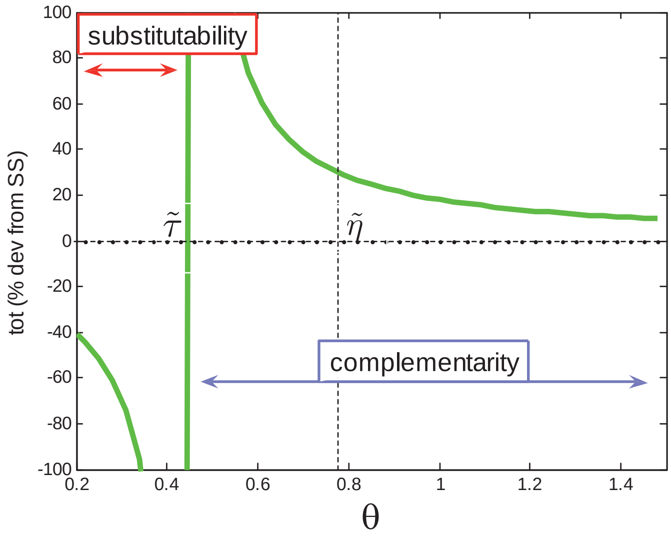

FIGURE 3
Terms of trade response to a marginal flow to the F country

The different response of relative prices along the elasticity domain can be explained as follows. Due to home bias in consumption, a flow of resources to F consumers raises relative world demand for the Foreign good. Relative prices must adjust to reduce this demand. As shown by Corsetti et al. (2008a), a rise in the price of the F good has a twofold effect on its demand. The Pareto-Edgeworth *substitution effect* tends to shift expenditure away from Foreign goods, lowering their demand. The Pareto-Edgeworth *income effect* raises the value of the endowment of Foreign consumers, the biggest buyers of the F good. The increase in their purchasing power tends to raise world demand for the F variety. For $\theta < \tilde{\tau}$, the income effect prevails.[15] In this case, reducing the demand for the Foreign good requires lowering the income of its biggest buyers, F consumers. The relative price of the F variety must fall in equilibrium.

Thus the threshold $\tilde{\tau}$ defines two areas of the trade elasticity domain, which correspond to different kinds of interactions between prices and flows. For $\theta > \tilde{\tau}$ receiving resources from abroad raises the price of a country's output on impact: both flows of resources and price fluctuations transfer purchasing power to F consumers – the insurance channels are *complements*. For $\theta < \tilde{\tau}$, when resources flow to the F country, price fluctuations tend to transfer purchasing power abroad – prices and flows are *substitutes*.

Proposition 2 describes how relative price fluctuations created by cross-border flows affect, in turn, the relative wealth of the two countries.

[15] See Corsetti et al. (2008) for a formal analysis of the relative strength of Pareto-Edgeworth substitution and income effect in the same model.

Proposition 2 *A marginal flow of resources from the H to the F country raises the relative wealth of Foreign consumers if the trade elasticity is above the transmission threshold $\tilde{\tau}$ (if prices and flows are **complements**); lowers the relative wealth of F consumers otherwise (if prices and flows are **substitutes**).*

The first statement is not surprising. When flows and prices are complements, F consumers benefit twice from an inflow of resources from abroad as the relative price of their exports rises. Thus the inflow increases their relative wealth.

The second statement is less obvious. When flows and prices are substitutes, they channel purchasing power in opposite directions and the net effect of a transfer on countries' wealth is in principle ambiguous. Proposition 2 shows that the low trade elasticity associated with substitutability, generates a high volatility of the terms of trade in response to a marginal transfer. The negative effect of price fluctuations on Foreign consumers' wealth prevails over the positive impact of the flow itself. Thus a transfer from abroad lowers the relative wealth of the receiving country.

5 Efficient financial flows from external borrowing

Given the interaction between cross-border flows of resources and price fluctuations, how should efficient financial markets be identified?

As noted by Cole (1991), well-functioning financial markets play two roles. First, frictionless trade in uncontingent bonds allows consumers to smooth the effects of national disturbances on their consumption by borrowing and lending abroad. Second, frictionless trade in contingent assets allows households to form a portfolio that can hedge them ex-ante against shocks.

In this and the next section I analyze the model under two different asset trade regimes, representing respectively the two functions of efficient financial markets, consumption smoothing (through external borrowing) and ex-ante hedging (through portfolio diversification). In both cases, I assume no frictions in international asset trade: agents are allowed to optimize over their purchase of securities and have rational expectations; there are no costs associated to asset trade. In both setups, price fluctuations and financial flows will transfer purchasing power across countries. Given the interaction between flows and prices, I will study to which economy efficient financial markets – allowing consumers to borrow from abroad or to diversify their portfolio – channel resources after national shocks.

This section studies optimal financial flows from external borrowing. Consider the model presented in section 3 under the following asset trade regime: agents can trade in uncontingent bonds paying 1 unit of the H consumption bundle in every state-of-the-world.[16] The budget constraint of H consumers reads

$$P_t^B B_{t+1} = \frac{P_{ht} Y_{ht}}{P_t} - C_t + B_t \tag{17}$$

[16] Self-insurance is typically defined as saving and borrowing activities carried out through a risk-free asset. In a two-good model that allows for deviations from purchasing power parity every asset, even an uncontingent one, bears some riskiness as endogenous price movements tend to alter its real returns. However when the model is approximated to the first order, the expected returns on all assets are equalized. Choosing a symmetric Steady State with a zero bond position as the approximation point, is sufficient to ensure that asset returns do not transfer resources across countries in response to shocks. In terms of allocation and dynamics of the model, it does not matter which particular uncontingent asset we assume to be used to self-insure. Hence, the assumption that the bond pays in unit of the H consumption bundle is unconsequential for the results.

where B_{t+1} denotes bonds purchased in period t, P_t^B their unitary price in terms of the H consumption bundle. Bonds are assumed to be in zero net supply. H households' inter-temporal problem is given by

$$\max_{\{C_t, B_{t+1}, \nu_t\}} . : L = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t)^{1-\rho}}{1-\rho} + \nu_t \left(P_{ht} Y_{ht} + P_t B_t - C_t P_t - P_t^B P_t B_{t+1} \right) \right] \right\} \tag{18}$$

H agent's first order conditions read

$$(C_t)^{-\rho} = \nu_t P_t \tag{19}$$

$$P_t^B = \beta E_t \left\{ \frac{\nu_{t+1}}{\nu_t} \frac{P_{t+1}}{P_t} \right\} \tag{20}$$

Combining (19) and (20) with their analogues for the F consumer and loglinearizing gives

$$-\rho E_t \{\hat{c}_{t+1}\} + \rho \hat{c}_t = -\rho E_t \{\hat{c}^\star_{t+1}\} - E_t \{\hat{q}^\star_{t+1}\} + \rho \hat{c}^\star_t + \hat{q}^\star_t$$

Assuming that at time t the system is in a symmetric Steady State with zero bond holdings yields

$$E_t \left\{ \hat{q}_{t+1} - \rho \left(\hat{c}_{t+1} - \hat{c}^\star_{t+1} \right) \right\} = E_t \{gap_{t+1}\} = 0$$

The possibility of self-insuring drives to zero the expected risk-sharing inefficiency by equating the expected Stochastic Discount Factors of the representative agents.

The following Proposition describes optimal financial flows from external borrowing

Proposition 3 *If flows and prices are complements, in response to national shocks efficient financial markets channel resources through external borrowing to the country that (absent asset trade) would have been made relatively poorer by the disturbance ("standard efficiency condition"). If flows and prices are substitutes, efficient financial markets transfer resources to the country that (absent asset trade) would have been made relatively richer by the shock.*

Figure 4 gives a graphical representation. I simulate a 1% increase in the H endowment at time t. The graph plots the time-t response of the Financial autarky *gap* (the relative wealth of F consumers absent asset trade) and F agents borrowing, $-\hat{b}^\star_t$ (the inflow of financial resources received by F consumers), both as a function of the trade elasticity θ.[17]

[17] I assume a persistent but temporary shock with autoregressive parameter $\zeta = 0.95$. The model with trade in uncontigent bonds is non-stationary because of the unit root in wealth accumulation. This feature does not have any bearings for the main results of the analysis. Indeed, it is easy to verify that Proposition 3 holds in the same model with stationarity-inducing features *à la* Schmitt-Grohé and Uribe (2003) (e.g. an endogenous discount factor).

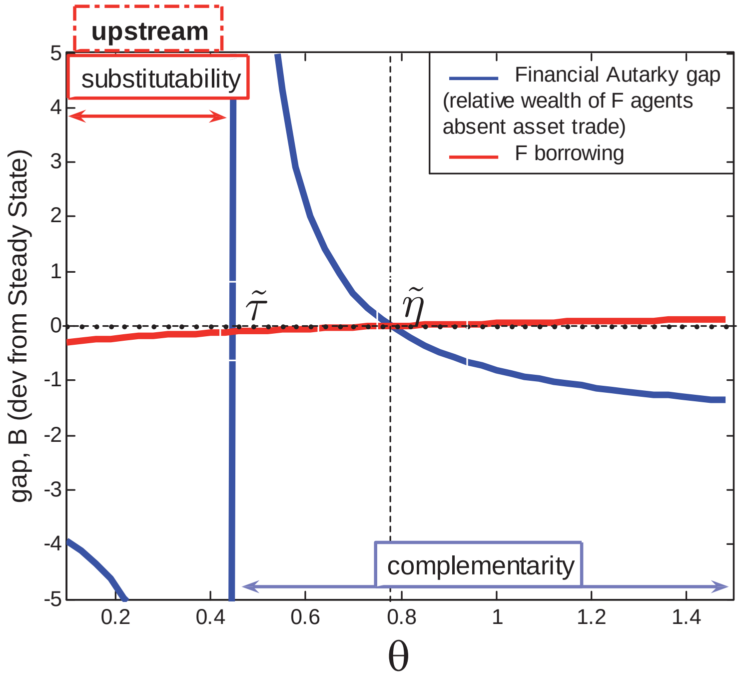

FIGURE 4
Response of the Financial autarky *gap* and
F current account deficit as a function of θ

If the trade elasticity is higher than the efficiency threshold $\tilde{\eta}$, absent financial markets a temporary bonanza in the H country would have made F consumers relatively poorer; once we introduce efficient external borrowing, F households import resources from abroad. If the trade elasticity is in between the two thresholds ($\tilde{\tau} < \theta < \tilde{\eta}$), due to the high terms of trade volatility F consumers would have been relatively richer under Financial autarky; once we allow for asset trade, financial flows channel resources to the H country. Thus in the region of the elasticity domain in which prices and flows are complements, in response to the shock efficient financial markets channel resources to the country that, absent asset trade, would have been made relatively poorer by the disturbance. Flows from external borrowing are consistent with the predictions of the "standard efficiency condition" for financial markets.[18]

On the contrary, in the area of the elasticity domain in which prices and flows are substitutes, efficient financial markets transfer resources "upstream", to the country that (absent asset trade) would have been relatively richer. Under Financial autarky, F consumers would have been hurt both by the relative fall in the quantity of their endowment and by the fall in the price of their output; once we introduce asset trade, F households export resources.[19] These flows from external borrowing are optimal by construction: they are the best possible transactions occurring in a decentralized equilibrium with borrowing and lending, since I assumed no restrictions, frictions or costs for international asset trade. Yet, these flows contradict the predictions of the "standard efficiency condition".

Upstream flows can be explained as follows. Focus on the region of the trade elasticity domain in which prices and flows are substitutes. Proposition 1 states that for $\theta < \tilde{\tau}$ a marginal flow of resources to the F country would lower the price of the Foreign

[18] Notice that the current account is procyclical.
[19] The current account is countercyclical.

commodity, moving the terms of trade against F consumers. Proposition 2 shows that if the F country – the one that would be relatively poorer absent asset trade – imported resources from abroad, relative prices would move substantially against it due to the low trade elasticity. Importing resources from abroad would lower so much the relative price of the F commodity that it would reduce the relative wealth of Foreign consumers. Therefore, efficient financial markets must transfer resources to the H country – upstream.[20]

5.1 External borrowing and equilibrium wealth imbalances

The previous section has derived a simple rule relating the financial flows we should observe if financial markets were efficient and countries' relative wealth absent asset trade. Here I study the relationship between efficient financial flows and *realized* wealth imbalances. If financial markets are efficient can we *observe* a temporarily richer country borrowing?

First, notice that the *gap* arising *in equilibrium* in the model with trade in uncontingent bonds, reflects the change in countries' relative wealth created by national shocks. To see this consider the inter-temporal problem described in equation (18). The Lagrange multiplier v_t represents the shadow value of time-t income. The income received at time t (minus current consumption), in turn, equals the present discounted value of wealth

$$(P_{ht}Y_t + B_tP_t - P_tC_t) = \sum_{j=1}^{\infty}\prod_{i=0}^{j-1} P_{t+j}^{B}\left[P_{t+j}C_{t+j} - P_{h,t+j}Y_{t+j}\right] \equiv PDV\ wealth$$

Hence, ν_t is the shadow value of wealth at time t. Combining H agent's first order condition with respect to consumption (equation (19)) with its analogue for the F consumer, and loglinearizing around the symmetric Steady State with zero bond holdings gives

$$\hat{q}_t - \rho\left(\hat{c}_t - \hat{c}_t^{\star}\right) \equiv gap_t^{SM} = \left(\hat{\nu}_t - \hat{\nu}_t^{\star}\right) \tag{21}$$

The *gap* arising in the smoothing economy, gap_t^{SM}, reflects asymmetric responses in the shadow value of wealth in the two countries.

In terms of the deep parameters of the model, gap_t^{SM} arising in response to an increase in the H endowment can be written as

$$gap_t^{SM} = -\left(\frac{\beta-1}{\zeta\beta-1}\right)\cdot\left(\frac{2\delta\rho\theta-2\delta-\rho+1}{2\delta\theta-2\delta+1}\right)\cdot\varepsilon_{Ht} = \underbrace{\left(\frac{\beta-1}{\zeta\beta-1}\right)}_{>0}\cdot gap_t^{FA} \tag{22}$$

where ζ and β denote respectively the persistence of the disturbance and households' discount factor. Setting the risk-sharing inefficiency to zero in expectations, which is the result of self-insurance, leaves it exposed to unexpected *i.i.d.* shocks. The *gap* arising in equilibrium in the smoothing economy has the same sign as the one that would have aroused after the same shock under Financial autarky.[21]

Proposition 3 then implies that we could *observe* a relatively richer country *optimally* borrowing from a relatively poorer one – financial resources optimally flowing upstream.

[20] Propositions 1 and 2 defining complementarity and substitutability are proved in the model under Financial autarky. It is important to notice that the relationship tying marginal flows of resources and price fluctuations, is preserved in the model with trade in uncontingent bonds. Propositions 7 and 8 in Appendix C give a formal proof.

[21] Exceptions may arise if households' discount factor β is endogenized or if the shock process is non-stationary. See Corsetti et al. (2008) for an example with trade in bonds in which the shock increases the endowment over time, reaching a higher permanent long-run level.

The following figure illustrates this point graphically by plotting the response to a 1% temporary rise in the H endowment, of gap^{SM} (the change in the relative wealth of Foreign consumers created by the shock) and F agents' current account deficit, both as a function of the trade elasticity θ

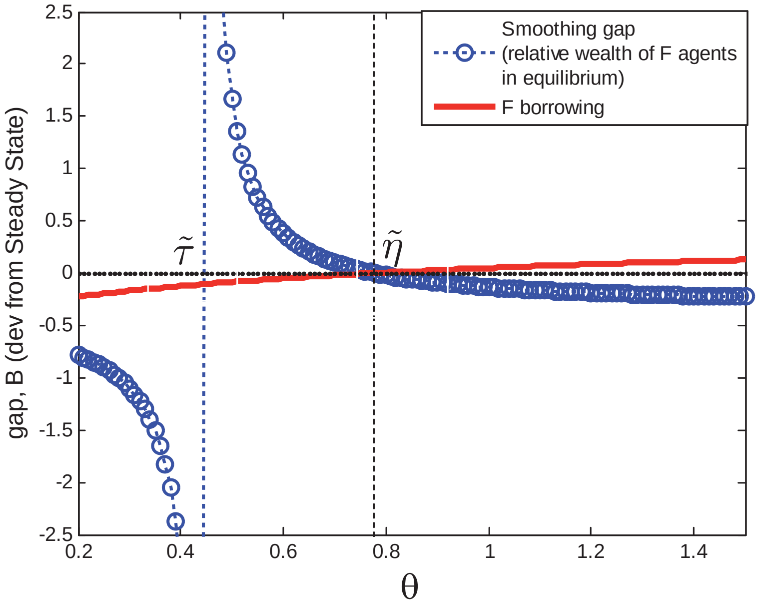

FIGURE 5
Response of the Smoothing *gap* and
F current account deficit as a function of θ

If the trade elasticity is lower than the transmission threshold $\tilde{\tau}$, we could observe a relatively poorer country, F, lending abroad.

Notice that in this setup the optimality of upstream financial flows and the countercyclicality of the current account are not due to a higher productivity in the temporarily richer country, as happens, for instance, in the standard Backus-Kehoe-Kydland type of models.[22] As explained in the previous subsection, the optimality of upstream flows is rather due to the particular kind of interaction between financial flows and price fluctuations.

Notice also that the so-called intertemporal approach to the current account (one of the theories at the basis of the "standard efficiency condition" for financial markets) developed traditionally in one-good or partial equilibrium settings, can be recasted as a special case within our framework. It is characterized by an infinite trade elasticity, which rules out any interaction between terms of trade adjustments and financial flows. The allocation it delivers would be on the far right in Figure 5: the country going through a temporary negative conjuncture would be poorer and borrowing from abroad in equilibrium.

5.2 External borrowing and welfare

Appendix B proves that in this model, under any asset trade regime, the *gap* is a measure of the social welfare losses due to imperfect insurance. The higher the welfare losses created by uninsurable shocks, the higher the *gap* arising in response to the disturbances.

[22] See Backus et al. (1995).

From equation (22) it is easy to verify that the equilibrium smoothing *gap* is lower than the *gap* that would have aroused after the same shock under Financial autarky.[23] Thus the cross-border flows created by external borrowing provide insurance against shocks, containing cross-country wealth divergences and reducing the welfare losses created by national disturbances.

Figure 6 compares the response to the same shock (a 1% increase in the H endowment) of the *gap* arising under Financial autarky and under trade in uncontingent bonds. Financial flows from external borrowing are beneficial even if they run upstream, as they increase cross-border insurance and reduce the welfare losses created by the shock, with respect to the ones that would have aroused absent asset trade ($gap^{SM} < gap^{FA}$ also for $\theta < \tilde{\tau}$, corresponding to upstream flows).

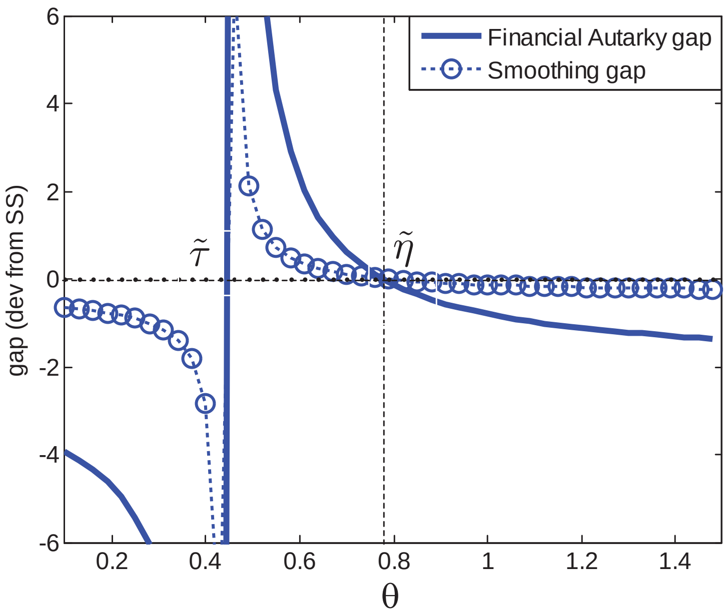

FIGURE 6
Response of the Financial autarky and
the Smoothing *gap* as a function of θ

6 Efficient financial flows from portfolio returns

In this section I analyze the model presented in section 3 under a different asset trade regime, representing the second function of efficient financial markets – ex-ante hedging through portfolio diversification. In particular, I choose an asset structure that allows agents to be fully insured against national shocks: assets markets are effectively complete by construction. As for the smoothing case, I assume no frictions in international asset trade. Given the interaction between flows and prices, I study to which economy efficient financial flows from portfolio returns channel resources in response to shocks.

Assume households can trade in two equities, H and F, representing respectively a claim to the H and F country's endowment. As we will verify in the next subsection, asset

[23] Again, exceptions may arise if households' discount factor β is endogenized or if the shock process is non-stationary.

markets are effectively complete.[24] The total quantity of each equity is normalized to 1. S_h, S_f, S_h^*, and S_f^* denote the fraction of H and F equities owned respectively by H and F consumers. Due to the normalization, the owner of S_h equities receives a share S_h of the H endowment. Equities real returns, expressed in terms of the H consumption good, are given by

$$R_t = \frac{(P_{ht}/P_t)Y_{ht} + Z_t}{Z_{t-1}}$$

$$R_t^* = \frac{(P_{ft}/P_t)Y_{ft} + Z_t^*}{Z_{t-1}^*}$$

where Z and Z^*denote the real price (in terms of the H consumption bundle) of the two assets.

The budget constraint of H households reads

$$NFA_t = NFA_{t-1} + \frac{Y_{ht}P_{ht}}{P_t} - C_t + R_t \cdot (S_{ht} - 1) + R_t^* S_{ft}$$

where $NFA_t \equiv [(S_{h,t+1} - 1) \cdot Z_t + S_{f,t+1} \cdot Z_t^*]$ denotes H net foreign assets.

Euler equations and asset market clearing conditions are given by

$$(C_t)^{-\rho} = \beta E_t \left\{(C_{t+1})^{-\rho} \cdot R_{t+1}\right\} = \beta E_t \left\{(C_{t+1})^{-\rho} \cdot R_{t+1}^*\right\} \tag{23}$$

$$\frac{(C_t^\star)^{-\rho}}{Q_t} = \beta E_t \left\{ \frac{\left(C_{t+1}^\star\right)^{-\rho}}{Q_{t+1}} \cdot R_{t+1} \right\} = \beta E_t \left\{ \frac{\left(C_{t+1}^\star\right)^{-\rho}}{Q_{t+1}} \cdot R_{t+1}^* \right\} \tag{24}$$

$$S_{h,t} + S_{h,t}^\star = 1$$

$$S_{f,t} + S_{f,t}^\star = 1$$

The model is loglinearized around a symmetric Steady State with $NFA = NFA^\star = 0$.[25] H consumers' budget constraint can be written as

$$\widehat{nfa}_t = \left(\frac{1}{\beta}\right) \widehat{nfa}_{t-1} + (\delta - 1)\,\widehat{tot}_t + \hat{y}_{ht} - \hat{c}_t + \underbrace{\widehat{rx}_t \alpha}_{\xi_t} \tag{25}$$

where $\widehat{rx}_t = \hat{r}_t - \hat{r}_t^\star$ is the percentage deviation of the realized return differential between H and F equities from its Steady State value. α denotes H agents' gross holdings of the H equity in Steady State. In response to shocks, excess returns rx deviate from their Steady State value and, combined with asset holdings α, deliver a transfer of resources in consumers' budget constraints. ξ_t in equation (25) denotes the financial flows from portfolio returns received by H consumers.

I find it convenient to derive a solution for the model using the method developed by Devereux and Sutherland (2006) – DS henceforth – to solve DSGE models with endogenous portfolio choice. Applying this method allows to study in detail how the interaction

[24] Also Kollmann (2006) proves that trade in two equities makes asset markets effectively complete in this model.

[25] Even if Steady State *net* foreign assets are zero, agents may hold a non-zero *gross* position. Therefore, they can receive flows of resources from the returns on their gross holdings in response to shocks.

between flows and prices determines (a) the direction of optimal financial flows via portfolio returns and (b) the composition of optimal portfolios.[26]

DS show that in a first-order approximation optimal portfolio choice can be decomposed in two steps.[27] The **first step** consists in solving the system linearized to the first order treating realized portfolio resource transfers (ξ), as exogenous disturbances.[28] Combine the Euler equations (23) and (24) linearized to the first order and assume that at time t the system is in a symmetric Steady State to get

$$E_t\left\{\hat{q}_{t+1}-\rho\left(\hat{c}_{t+1}-\hat{c}^{\star}_{t+1}\right)\right\}=0\Rightarrow E_t\left\{gap_{t+1}\right\}=0$$

The solution to this step delivers the same allocation that would arise if agents could only trade in uncontingent bonds.[29]

The **second step** is based on the macro dynamics of the first-order solution, and amounts to recover optimal asset holdings α as those satisfying second-order optimality conditions for portfolio choice.[30] Taking a second-order approximation of the H and F Euler equations and combining them, DS show that the optimal portfolio must satisfy the following condition

$$Cov_t\left\{\left[\hat{q}_{t+1}-\rho\left(\hat{c}_{t+1}-\hat{c}^{\star}_{t+1}\right)\right], r\hat{x}_{t+1}\right\}=0$$

Translating this equation in our framework, it is easy to see that it implies

$$Cov_t\left\{gap_{t+1}, r\hat{x}_{t+1}\right\}=0$$

The wealth asymmetry residual from smoothing decisions can be lowered exploiting movements in asset excess returns. Agents adjust the composition of their portfolio until comovements between excess returns and (endogenous) wealth asymmetries are driven to zero in equilibrium.

Having recovered the optimal portfolio through the second step, the final solution to the system is

$$\begin{bmatrix}\hat{q}_t\\ \hat{c}_t\\ \hat{c}^{\star}_t\end{bmatrix}=\underbrace{[A]\cdot\begin{bmatrix}\hat{y}_{ht}\\ \hat{y}_{ft}\end{bmatrix}}_{smoothing\ allocation}+\underbrace{[B]\cdot\begin{bmatrix}\varepsilon_t\\ \varepsilon^{\star}_t\end{bmatrix}}_{portfolio\ returns} \tag{26}$$

[26] Since asset markets are effectively complete, in principle I could solve for the Pareto optimal real allocation independently of asset holdings, and retrieve portfolios ex-post, as the ones that replicate a Social Planner solution to the model. However, by using the DS method we can provide an explanation for the direction of optimal flows (in Proposition 5). We are also able to provide a rationale for the composition of optimal portfolios (detailed in the Proof to Proposition 6).

[27] Although applying the DS algorithm to a first order approximation of the model allows to retrieve only the Steady State portfolio (and not its dynamic response to shocks), characterizing the time-invariant asset holdings that arise in a world of infinitesimally small noise is sufficient to analyse the first order dynamics of the macro variables of the system.

[28] In a first order approximation the expected returns on all assets are equalized: the expected return differential is zero. Therefore, $\widehat{rx}_t\alpha$, the transfer delivered by the Steady State portfolio in response to shocks, can be treated as a mean-zero *i.i.d.* random variable (ξ) and included in the system as an exogenous disturbance with these characteristics.

[29] Crucial to this identification is the fact that the system in this section and in the previous one is linearized around the same approximation point, corresponding to zero net foreign assets.

Notice that in the allocation resulting from this step (which is only a partial solution to the system), households can invest in assets but do not receive any transfer from their returns after national disturbances (ξ is exogenous and not responding to endowment shocks). Thus portfolio composition cannot be exploited to hedge against shocks. Intuitively, what drives households decisions is the desire to smooth over time the effect of national shocks on consumption.

[30] A second-order approximation is needed because assets yield equal expected returns in a first order approximation. Optimal portfolios would then be indeterminate.

Matrix A is the solution to the first step. It describes what would be the impact of national shocks on endogenous variables if agents could only trade in uncontingent bonds, pinning down dynamics that coincide with the smoothing ones. Matrix B, instead, results from the solution to the second step of the DS method. It traces the dynamics given *only* by resource flows generated by the optimal portfolios. Analogously we can write

$$gap_t = \underbrace{[C] \cdot \begin{bmatrix} \hat{y}_{ht} \\ \hat{y}_{ft} \end{bmatrix}}_{smoothing\ allocation} + \underbrace{[D] \cdot \begin{bmatrix} \varepsilon_t \\ \varepsilon_t^{\star} \end{bmatrix}}_{portfolio\ returns} \tag{27}$$

where matrices C and D result from combining the appropriate rows of A and B in (26). The *gap* arising in equilibrium in response to shocks can be decomposed in two parts. The first one corresponds to gap^{SM}, the *gap* that would arise if agents could only smooth consumption by varying their net foreign assets. The second part reflects the variations in relative wealth due to optimal portfolio returns. The DS method shows that we can rationalize optimal portfolio returns as those able to counterbalance the smoothing *gap* (the one resulting from the first part of the system), so as to reduce the equilibrium *gap* to zero.

6.1 Insurance from portfolio flows

Appendix D proves that when consumers can trade in contingent assets, the *gap* arising in *equilibrium* in response to shocks (the solution to the full system (26)) reflects changes in relative countries' wealth created by the disturbances. Clearly, these wealth imbalances are residual after portfolio returns have transferred resources across countries.

If asset markets are effectively complete, national shocks should not create any risk-sharing inefficiency, wealth asymmetry, and, in this model, welfare losses: the equilibrium *gap* should always be zero. The following figure shows that the asset structure we have assumed in this section effectively completes the market. The picture compares the *gap* arising after a 1% increase in the H endowment in Financial autarky, in the one-bond economy, and under trade in two equities. In the latter case, financial flows from portfolio holdings provide full insurance against national shocks. This happens over the whole elasticity domain, including the region in which flows and prices are substitutes ($\theta < \tilde{\tau}$). In this area of the elasticity domain optimal portfolio returns channel resources upstream, as shown in the next subsection.

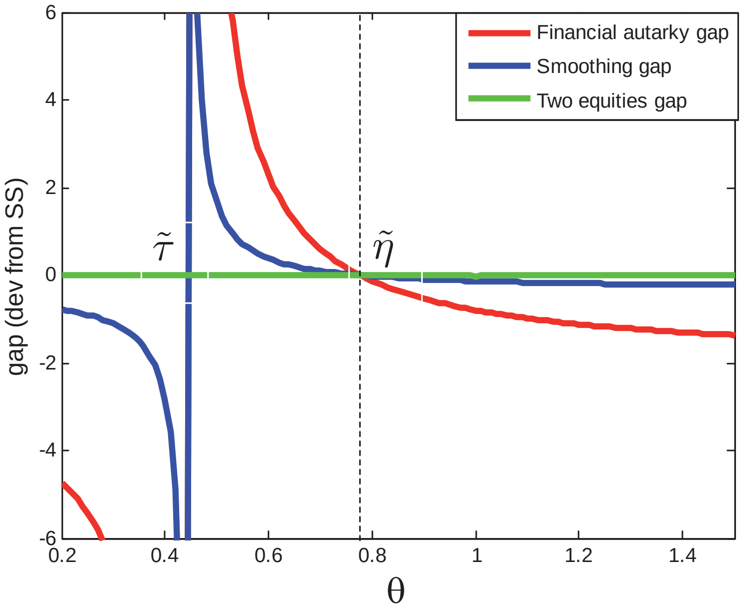

FIGURE 7
Financial autarky, Smoothing, and two-equity *gap*

6.2 The direction of optimal flows

From the solution to the full system (26), it is easy to prove the following Proposition

Proposition 4 *If flows and prices are complements, in response to national shocks efficient financial markets channel resources through portfolio returns to the country that (absent asset trade) would have been made relatively poorer by the disturbance ("standard efficiency condition"). If flows and prices are substitutes, efficient financial markets transfer resources to the country that (absent asset trade) would have been made relatively richer by the shock.*

Figure 8 illustrates this result. I simulate a 1% increase in the H endowment at time t. The graph plots the time-t response of the Financial autarky *gap* (the relative wealth of F consumers absent asset trade) and the portfolio returns received by F households, $\xi_t^{\star}$ (the inflow of financial resources received by F consumers), both as a function of the trade elasticity θ.[31]

[31] I assume the shock process has an autoregressive parameter $\zeta = 0.95$.

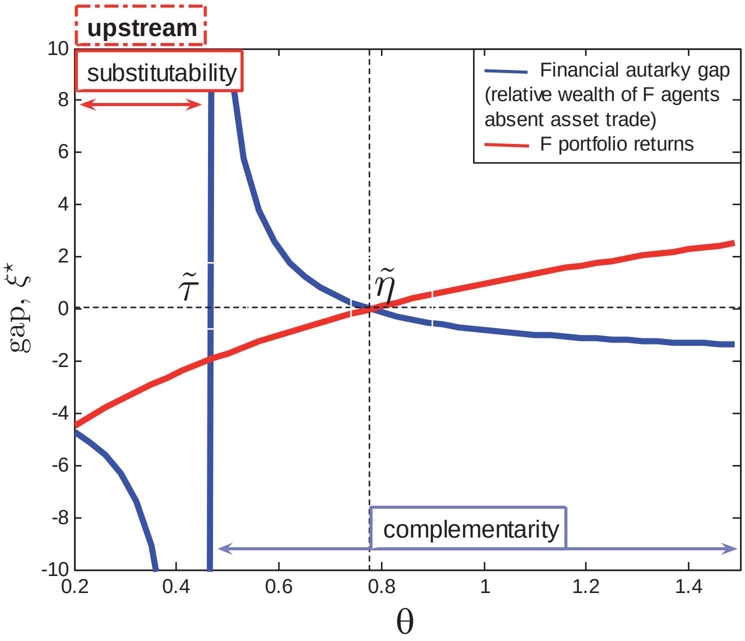

FIGURE 8
Response of the Financial autarky *gap* and
F portfolio returns as a function of θ

As it happens in the case of external borrowing, in the area of the elasticity domain in which prices and flows are substitutes, efficient financial markets transfer resources upstream through portfolio returns, to the country that (absent asset trade) would have been relatively richer. Notice that the flows from portfolio returns are optimal by construction: they are the best possible transfers arising in a decentralized equilibrium with portfolio diversification, since I assumed no restrictions, frictions or costs for international asset trade, and an asset structure that delivers full risk-sharing. But clearly these flows run against the predictions of the "standard efficiency condition" for financial markets.

The following Proposition, based on the first step of the DS method, shows that the intuition for optimal upstream flows is the same outlined for the smoothing case. The decomposition in (27) suggests that we can rationalize optimal portfolio flows as those able to counterbalance the smoothing *gap* (the one resulting from the first part of the system), so as to reduce the equilibrium *gap* to zero. Proposition 5 shows that a marginal portfolio flow has a different impact on the smoothing *gap* depending on whether flows and prices are complements or substitutes.

Proposition 5 *Receiving a marginal transfer of resources through portfolio returns raises the relative wealth of Foreign consumers absent portfolio flows (the smoothing gap) if and only if the trade elasticity is above the transmission threshold* $\tilde{\tau}$*, that is if and only if prices and flows are complements.*

As it happens for the smoothing case, the different response of relative prices to international transfers (here, the position of the trade elasticity relative to the transmission threshold) is what determines the direction of optimal financial flows.

6.3 The composition of optimal portfolios

Proposition 6 shows that the interaction between price fluctuations and financial flows has also important implications for the composition of optimal portfolios.

Proposition 6 *If flows and prices are substitutes, optimal portfolios exhibit home bias; if flows and prices are complements, optimal portfolios may exhibit home bias, "excessive" home bias, or foreign bias.*

Figure 9 represents the share of Home equities held in Steady State by H consumers as a function of the trade elasticity θ. A degree of home bias in equities consistent with the empirical evidence, is compatible with efficient financial markets if prices and flows are substitutes. Complementarity instead is not necessarily consistent with optimal home bias.[32]

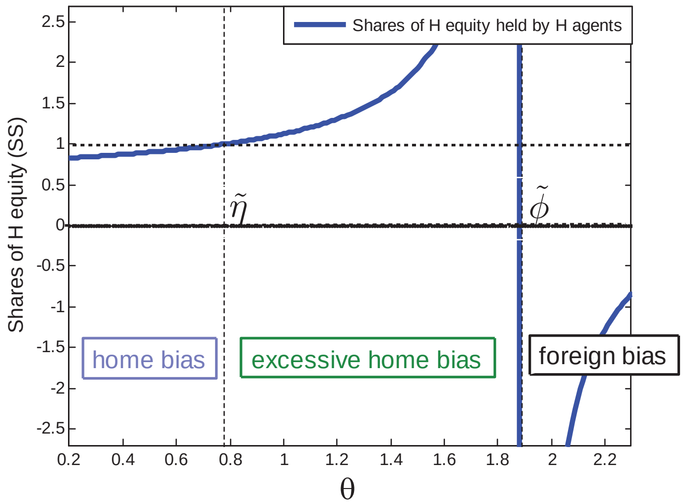

FIGURE 9
H consumers' share of the H equity, as a function of θ

7 Some remarks on complementarity and substitutability

This paper has shown that efficient financial markets can make resources flow from relatively poorer to relatively richer countries. These flows reduce the risk-sharing inefficiency created by national shocks. Even though upstream flows run against the "standard efficiency condition" for financial markets, their effects and the conditions that generate them are not new to the international literature.

In our model the interaction between flows and prices, which determines the optimal direction of financial flows, has been shown to depend crucially on the trade elasticity. In particular, optimal upstream flows arise for a relatively low trade elasticity, around 0.5. In the empirical literature, there is uncertainty regarding the value of this parameter. For G-7 countries estimates based on aggregate time series data range between 0.1 to 2, as documented by Hooper et al. (2000). Corsetti et al. (2008a) use US data to estimate the trade elasticity to be slightly below 0.5 – a value consistent with the existence of optimal upstream flows. Corsetti et al. (2008a) showed that this low trade elasticity is precisely what allows to reconcile standard international models, driven by business-cycle supply shocks, with the empirical evidence on consumption-real exchange rate correlations.

[32] The Proof to Proposition 6 uses the two steps of the DS method to provide a rationale for the composition of optimal portfolios in this model.

On the other hand, whether financial inflows appreciate or depreciate countries' terms of trade in the short-run is still a controversial issue. Several contributions have investigated directly the interaction between international wealth transfers and price fluctuations. While most works dealing with the so-called "transfer problem" have estimated the impact of net foreign assets variations on relative prices in the long-run, Gagnon (1996) quantifies the short-run impact, the one that is relevant for the issue at handle.[33] [34] Using panel data for 20 industrial countries for the period 1973-1995, this paper finds that a deterioration in net foreign assets is associated with an impact depreciation of the terms of trade. Notice that, contrary to the log-run interpretation, in the short-run a decumulation of net foreign assets can well correspond to a worsening in the trade deficit and a financial inflow from abroad.[35] Although these findings do not allow to draw conclusions about the impact of cross-border financial flows on international prices, they show that the data could support the hypothesis of substitutability between flows and prices, which is necessary for optimal upstream flows.

The model considered in this paper abstracts from capital accumulation. As it is well-known, cross-border asset trade may play two roles: it can insure residents in different countries against national income shocks, and it can transfer physical capital across countries towards its most productive destination. Tests of international risk-sharing are clearly focused on the former function of financial markets, and the "standard efficiency condition" is typically formulated net of physical capital accumulation. This is why abstracting from capital accumulation in the present analysis seemed a sensible (and parsimonious) choice. It should be noted, however, that the main theoretical results concerning complementarity and substitutability between prices and flows extend to production economies. Corsetti et al. (2008a) show that in a setup featuring capital accumulation, the income effect of price changes prevails over the substitution effect for low values of the trade elasticity. The prevalence of the income effect would imply substitutability between prices and flows and is likely to give rise to optimal "upstream" flows.

The results on complementarity and substitutability would apply also to frameworks featuring deviations from the law of one price (LOOP). Yet, the presence of frictions in goods markets would affect the relative strength of the two effects, changing the relevant threshold for the trade elasticity ($\tilde{\tau}$). For instance, consider a setup in which the LOOP holds at the producer but not at the consumer level. This would be the case, for instance, if deviations were due to the presence of distribution services intensive in local inputs. Consumer prices would respond less to fluctuations in the terms of trade (as measured at the producer level) with respect to a setup without deviations from the LOOP, so that the substitution effect is going to be lower. For the same reason, also income effects would be reduced. The net impact of LOOP deviations on the relative strength of the two effects would be in principle ambiguous. Therefore, the threshold of the trade elasticity that determines complementarity and substitutability may be higher or lower due to deviations from the LOOP.[36] The same would be true if LOOP deviations were due to optimal pricing-to-market and applied also at the wholesale level. This would be the case if variable distribution costs make the markup charged by domestic firms at home differ from the markup charged in the foreign market. Even absent price rigidities, the expenditure

[33] The definition of the transfer problem dates back to the 1920s when Keynes argued that the war reparations imposed on Germany after the First World War would have represented an excessive burden for the country. At the roots of the argument, there was the worry that transferring resources abroad would have moved international prices against Germany, raising the real cost of reparations.

[34] Contributions focusing on long-run effects comprise Obstfeld and Rogoff (1994), Broner et al. (1998), and Lane and Milesi-Ferretti (2008).

[35] This would be the case, for instance, in a model with trade in bonds.

[36] For a formal derivation of income and substitution effects in this setup, see Corsetti et al. (2008a).

switching motive of nominal exchange rate changes would be lower with respect to a model without pricing-to-market. Also in this setup, the effect of deviations from LOOP on the relative strength of substitution and income effect would be in principle ambiguous. A rise in the price of the domestic variety would give rise to a lower substitution effect, as foreign firms would lower the export price of their product less than proportionally to nominal exchange rate changes. At the same time, the optimal markup charged abroad by domestic firms would be smaller, which would dampen the income effect of price changes. Again, the net effect is likely to depend on the structure of the full-fledged model and its calibration.[37] As an aside, it is interesting to notice that in the presence of distribution costs we would not need to assume strong complementarity among varieties in consumers' preferences, in order to generate a low trade elasticity and thus substitutability.

Although the present analysis abstracts from nominal price rigidities, the main results on complementarity and substitutability are likely to go through in frameworks featuring price stickiness. See Corsetti et al. (2008b) and (2010) for the analysis of a production economy with trade in uncontingent bonds in which nominal price rigidities make prices sticky in local currency.[38] In this model, a positive productivity shock in either the tradable or the nontradable goods sector might result in an appreciation of the terms of trade. For a low trade elasticity this is made possible by an income effect that overcomes the substitution effect of price changes, implying substitutability between prices and flows. Whether the relevant threshold for the trade elasticity is increased or decreased relative to the benchmark case might again be a calibration issue.

8 Concluding remarks

A large body of literature has investigated the impact of financial market integration on international insurance. These tests are based on the presumption that risk-sharing requires financial markets to channel resources to countries that (absent asset trade) would be made relatively poorer by national shocks, net of physical capital accumulation. This condition of efficiency for financial markets is derived focusing on only one of the two channels of international insurance, cross-border financial flows, and assuming no interaction between this and the second channel, relative price fluctuations.

Against this literature, this paper shows that risk-sharing conditions can only be derived focusing on both channels and accounting for their interaction. In particular, financial flows and price fluctuations can be complements or substitutes in providing insurance, depending on the response of the price of a country's output to financial inflows from abroad. While complementarity implies the standard condition of efficiency, substitutability requires well-functioning financial markets to channel resources "upstream", from poorer to richer countries. These results seem to question the validity of existing empirical methods based on the "standard efficiency condition".

The results could also be related to the empirical rejection of the intertemporal approach to the current account. From a theoretical point of view, several works acknowledged the importance that terms of trade fluctuations may have in shaping current account dynamics (see e.g., Obstfeld and Rogoff (1994)). Yet, most empirical tests of the intertemporal theory of the current account abstracted from international price adjustments.[39]

[37] This would be the case if monetary policy has real effects. As long as money is neutral, nominal exchange rate adjustments would not affect the real allocation. The dynamics would coincide with those described in the previous paragraph, in which deviations from the LOOP affect substitution and income effects only through consumer prices. See Corsetti et al. (2008b).

[38] In that model firms face price adjustment costs *á-la* Rotemberg (1982).

[39] Among the other, Feldstein and Horioka (1980), "present value tests" in the spirit of Cambell and Shiller (1987) and Ghosh (1995), Glick and Rogoff (1995). Chinn and Prasad (2003) find that the impact

Our theoretical insights seem to open new challenges for the empirical literature dealing with current account dynamics and risk-sharing sharing measurement.

References

[1] ASDRUBALI, P., SORENSEN, B. and O. YOSHA (1996), "Channels of interstate risk-sharing: United States 1963-1990", *The Quarterly Journal of Economics* **111**: 1081-1110

[2] BACKUS, D., KEHOE, P. and F. KYDLAND (1995), "International business cycles: theory and evidence", in T. F .Cooley (ed.) *Frontiers of Business Cycle Research* (Princeton: Princeton University Press) 331-356

[3] BACKUS, D. and G. SMITH (1993), "Consumption and real exchange rates in dynamic economies with non-traded goods", *Journal of International Economics* **35** (3): 297-316

[4] BRANDT, M., COCHRANE, J. and P. SANTA CLARA (2006), "International risk-sharing is better than you think, or exchange rate are too smooth", *Journal of Monetary Economics* **53** (4): 671-698

[5] BRONER, F., LOAYZA, N. and H. LOPEZ (1998), "Misalignments and fundamentals: equilibrium exchange rates in seven Latin American countries", mimeo, World Bank

[6] COCHRANE, J. (2005), "Asset pricing", Princeton, N.J. : Princeton University Press

[7] COLE, H (1993), "The macroeconomic effects of world trade in financial assets", *Federal Reserve Bank of Minneapolis Quarterly Review* **17** (3), 12–21

[8] COLE, H. and M. OBSTFELD (1991), "Commodity trade and international risk sharing: how much do financial markets matter?", *Journal of Monetary Economics*, **28**, 3-24

[9] CORSETTI, G. and P. PESENTI (2005), "The simple geometry of transmission and stabilization in closed and open economies", CEPR discussion paper 5080

[10] CORSETTI, G. and L. DEDOLA (2002), "Macroeconomics of international price discrimination", ECB working paper 176

[11] CORSETTI, G., DEDOLA, L. and S. LEDUC (2008a), "International Risk-Sharing and the Transmission of Productivity Shocks", *Review of Economic Studies,* **75** (2): 443-473

[12] CORSETTI, G. DEDOLA, L. and S. LEDUC (2008b), "High exchange-rate volatility and low pass-through", *Journal of Monetary Economics*, **55**: 1113-1128

[13] CORSETTI, G., DEDOLA, L. and F. VIANI (2010), "Deconstructing the Backus-Smith puzzle: Nontraded goods prices, terms of trade and risk-sharing", mimeo

of terms of trade fluctuations on current account dynamics is significant for industrial and developing countries.

[14] DEDOLA, L. and F. DE FIORE (2005), "Risk sharing in the Euro area", mimeo, ECB

[15] DEVEREUX, M. and .A. SUTHERLAND (2006), "Solving for Country Portfolios in Open Economy Macro Models", NBER Working Paper No 14372

[16] FLOOD, R., MARION. N. and A. MATSUMOTO (2008), "International risk-sharing during the globalization era", IMF Working Paper 09/209

[17] GAGNON, J. (1996), "Net foreign assets and equilibrium exchange rates: panel evidence", Federal Reserve Board International Finance Discussion Paper 574

[18] GRAVELLE, H. and R. REES (2004), "Microeconomics", Harlow : Financial Times Prentice Hall

[19] HOOPER, P., JOHNSON, K. and J. MARQUEZ (2000), "Trade elasticities for the G-7 countries", Princeton Studies in International Economics No 87

[20] KALEMLI-OZCAN, S. SORENSEN, B. and O. YOSHA (2004), "Asymmetric shocks and risk-sharing in a monetary union: updated evidence and policy implications for Europe", CEPR discussion paper 4463

[21] KEHOE, P. and F. PERRI (2002), "International Business Cycles with Endogenous Incomplete Markets", *Econometrica* **70** (3), 907-928

[22] KOLLMANN, R. (1995), "Consumption, real exchange rate and the structure of international asset markets", *Journal of International Money and Finance,* **14** (2): 191-211

[23] KOLLMANN, R. (2006), "International portfolio equilibrium and the current account", mimeo, University Paris XII

[24] LANE, P. and G.M. MILESI FERRETTI (2004), "The transfer problem revisited: net foreign assets and real exchange rates". *Review of Economics and Statistics,* **86** (4): 841-857

[25] LJUNGQVIST, L. and T. SARGENT (2004), "Dynamic Macroeconomic Theory", Cambridge (Mass.) : Harvard University Press

[26] OBSTFELD, M. (1993), "Are industrial country consumption risks globally diversified?" in L. Lederman and A. Razin (eds), *Capital mobility: the impact on consumption, investment and growth*, Cambridge, UK, Cambridge University Press

[27] OBSTFELD, M. and K. ROGOFF (1994), "The intertemporal approach to the current account", NBER Working Paper 4893

[28] RAVN, M. (2001), "Consumption dynamics and real exchange rates", mimeo, London Business School

[29] RAZIN, A. (1993), "The dynamic-optimizing approach to the current account: theory and evidence", NBER Working Paper 4334

[30] REICHLIN, L. and D. GIANNONE (2006), "Trends and cycles in the euro area: how much heterogeneity and should we worry about it?" ECB Working Paper 595

[31] ROTEMBERG, J.J. (1982), "Monopolistic price adjustment and aggregate output", *Review of Economic Studies*, **49**: 517-531

[32] SCHMITT-GROHE', S. and M. URIBE (2003), "Closing small open economies," Journal of International Economics, **61**: 163-185

[33] SORENSEN, B. and O. YOSHA (1998), "International risk-sharing and European monetary unification", *Journal of International Economics,* **45** (2): 211-238

[34] SVENSSON, L.O. (1988), "Trade in Risky Assets", *American Economic Review*, **78** (3), 375-394

[35] VENTURA, J. (2002), "Towards a theory of current accounts", NBER Working Paper 9163

[36] VIANI, F. (2010a), "Assessing the performance of empirical methods to measure cross-border insurance", EUI thesis, European University Institute

[37] VIANI, F. (2010b), "Measuring international risk-sharing: empirical evidence for the US and OECD countries", EUI thesis, European University Institute

A Standard efficiency condition and empirical methods

According to the "standard efficiency condition", international financial markets are efficient if, in response to a national income shock, they channel resources to countries that (absent asset trade) would be made temporarily poorer by the disturbance. This section shows that this condition is at the basis of virtually every empirical framework measuring international insurance.[40]

Sorensen and Yosha (1998) (SY henceforth) assume no relative prices and rely on the following identity[41]

$$C = GDP + NFI - NSAV \tag{28}$$

where NFI and $NSAV$ denote respectively net financial income and net savings. From (28), full insurance – C and Y being uncorrelated, according to SY – requires a country experiencing a negative output shock (getting poorer absent asset trade) to receive income from abroad (either from portfolio returns or from external borrowing – net of physical capital accumulation). SY show that the decomposition in (28) allows to quantify the fraction of output shocks that is absorbed through different risk-sharing channels, by estimating

$$-\Delta \log NFI_t \equiv (\Delta \log GDP_t - \Delta \log GNP_t) = \alpha_f + \beta_f \cdot \Delta \log GDP_t + \varepsilon_{ft} \tag{29}$$

$$\Delta \log NSAV_t \equiv (\Delta \log GNP_t - \Delta \log C_t) = \alpha_s + \beta_s \cdot \Delta \log GDP_t + \varepsilon_{st} \tag{30}$$

$$\Delta \log C_t = \alpha_u + \beta_u \cdot \Delta \log GDP_t + \varepsilon_{ut} \tag{31}$$

where β_f is interpreted as the fraction of output shock that is absorbed through factor income flows, β_s is the share absorbed through consumption smoothing, and β_u the fraction left uninsured. In a two-country world (29) – (31) are equivalent to[42]

$$\left(\Delta \log NFI_t^j - \Delta \log NFI_t^i\right) = \alpha_f + \beta_f \cdot \left(\Delta \log GDP_t^i - \Delta \log GDP_t^j\right) + \varepsilon_{ft} \tag{32}$$

$$\left(\Delta \log NSAV_t^i - \Delta \log NSAV_t^j\right) = \alpha_s + \beta_s \cdot \left(\Delta \log GDP_t^i - \Delta \log GDP_t^j\right) + \varepsilon_{st} \tag{33}$$

$$\left(\Delta \log C_t^i - \Delta \log C_t^j\right) = \alpha_u + \beta_u \cdot \left(\Delta \log GDP_t^i - \Delta \log GDP_t^j\right) + \varepsilon_{ut} \tag{34}$$

where superscripts denote different countries (or country aggregates). Under the maintained assumption of no relative prices, equations (32) – (34) imply the same view of optimal financial flows underlying (28) and (29) – (31): efficient financial markets should

[40] Some tests aim only at verifying the null of full risk-sharing or perfectly integrated capital markets. In these cases, once the null is rejected, it is not clear how to derive implications for the actual degree of insurance. Most of these empirical frameworks test the equality of expected Stochastic Discount Factors across countries (Kollmann (1995), Ravn (2001)), and do not rely directly on the standard efficiency condition.

[41] Equation (28) implies that consumption and output have the same composition, hence the same price.

[42] See Dedola and De Fiore (2005).

channel resources to the countries that (absent asset trade) would have been made relatively poorer by national shocks. Estimating slopes in the interval $[0, 1)$ signals a relatively high degree of insurance. Instead, $\beta_u > 1$, $\beta_f < 0$, and $\beta_s < 0$ indicate that financial markets are highly inefficient, as they channel resources to relatively richer countries. Kalemli-Ozcan et al. (2004) estimate $\beta_f < 0$ among European countries during the Nineties, and interpret this finding as signaling bad insurance from cross-border ownership of securities.

Under the assumption of no relative price fluctuations Obstfeld (1993) also derive an empirical framework in the form[43]

$$\Delta \log C_t^i = \alpha + \beta \cdot \Delta \log C_t^j + \gamma \cdot \Delta \log GDP_t^j + \varepsilon_t$$

which underlies the same view of efficient financial markets as the methodology of SY. Both methods – adopted subsequently by a large body of followers – are based on the optimal pattern of financial flows described by the "standard efficiency condition".

This paper questions the validity of the "standard efficiency condition" in a setup in which relative prices (realistically) fluctuate in response to cross-border financial flows. It finds that this condition gives only a partial representation of the optimal pattern of financial flows. The main implications for existing empirical frameworks relying on the "standard efficiency condition" are the following. First, if relative prices are well-defined, identity (28) should be modified to take into account price fluctuations. Several refinements to the SY and Obstfeld approach have implemented this change, mainly deflating national output with the local CPI, so as to express all variables in terms of the country's consumption.[44] However – the second implication – once output is properly deflated, the theoretical results of the present paper apply: efficient financial markets can make resources flow "upstream", from relatively poorer to relatively richer countries. That is, estimating $\beta_f < 0$ in (32) (with output properly deflated, as found by Kalemli-Ozcan et al. (2004)), or $\beta_u > 1$ in (34) can indicate an *optimal* outcome and may signal a high degree of insurance. Intuitively, a negative GDP shock may optimally lead to an even larger fall in relative consumption, provided it is compensated by an appreciation of the real exchange rate. In other words, a country's wealth may be insulated from GDP fluctuations if a fall in its consumption is compensated by a strengthening of its currency. In this sense, the proper regression to run would be (see Viani (2010b) for further details and an empirical application of this method)

$$\left(\Delta \log C_t^i - \Delta \log C_t^j\right) - \frac{\Delta \log Q_t}{\rho} \equiv \frac{gap_t^{i,j}}{\rho} = \alpha + \beta \cdot \left(\Delta \log GDP_t^i - \Delta \log GDP_t^j\right) + \varepsilon_t$$

B Measure of insurance and welfare

This section is devoted to prove that in the DSGE model used in this paper, there exists a monotone relationship between the *gap* and the social welfare losses due to imperfect

[43]This regression is analogous to (31) in SY, but does not impose a unitary coefficient on country j consumption.

[44]See for example Sorensen and Yosha (1998), Del Negro (2000), and Kalemli-Ozcan et al. (2004). If relative prices are well-defined, identity (28) becomes

$$C = \frac{P_y \cdot GDP}{P} + NFI - NSAV$$

where P and P_y are respectively the prices of consumption and output, and I have assumed that net financial income and net savings are expressed in terms of real consumption. Kalemli-Ozcan et al. (2004) motivate the need for this adjustment in footnote (36).

insurance. I will show that the higher the *gap* that opens up at time t, the higher the deviation of the time-t allocation from the optimum of a social welfare function that weights the two countries according to their previous wealth.

Consider the model outlined in section 3. The first-best plan that delivers the maximum social welfare attainable in this model can be characterized as the outcome of a Social Planner maximization. The Social Planner must allocate consumption between the two countries and weights them symmetrically. She solves the following problem

$$\max.:E_0\left\{\sum_{t=0}^{\infty}\Omega\beta^t\frac{(C_t)}{1-\rho}^{1-\rho}+(1-\Omega)\,\beta^t\frac{(C_t^{\star})}{1-\rho}^{1-\rho}\right\} \tag{35}$$

$$s.t.:C_t=\left[(\delta)^{1/\theta}(C_{ht})^{\frac{\theta-1}{\theta}}+(1-\delta)^{1/\theta}(C_{ft})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{36}$$

$$C_t^{\star}=\left[(\delta)^{1/\theta}\left(C_{ft}^{\star}\right)^{\frac{\theta-1}{\theta}}+(1-\delta)^{1/\theta}(C_{ht}^{\star})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{37}$$

$$Y_t=C_{ht}+C_{ht}^{\star}$$

$$Y_t^{\star}=C_{ft}+C_{ft}^{\star}$$

where $\Omega=(1-\Omega)$. In what follows μ_t and $\mu_t^{\star}$ denote the multipliers attached to the CES bundle constraints (equations (36) and (37)), that is the shadow value of consumption, respectively, in the H and in the F country. In the decentralized problem whose solution coincides with the Social Planner allocation, the ratio $\left(\frac{\mu_t^{\star}}{\mu_t}\right)$ corresponds to the real exchange rate Q_t. The first order conditions with respect to C_t and $C_t^{\star}$ read

$$\Omega\cdot(C_t)^{-\rho}=\mu_t \tag{38}$$

$$(1-\Omega)\cdot(C_t^{\star})^{-\rho}=\mu_t^{\star} \tag{39}$$

The sequence of equations (38) and (39) evaluated at $t=0,...,\infty$ characterizes the first-best plan that (by construction) delivers the maximum social welfare attainable in this economy, that is the sequence of allocations that maximizes the Social Welfare function in (35). In particular, equations (38) and (39) identify the time-t allocation that is part of this plan. The first-best allocations may coincide with the ones attained in a decentralized model with complete asset markets. In particular, in order for the Planner's solution to correspond to a complete-markets decentralized allocation, the Planner's weights Ω and $(1-\Omega)$ should represent countries' relative wealth at time $t=-1$ determined by the initial conditions C_{-1}, $C_{-1}^{\star}$, μ_{-1}, and $\mu_{-1}^{\star}$.[45]

In economies in which asset markets are incomplete (or effectively incomplete) the Planner's first order conditions (38) and (39) need not hold with equality. Assume that the incomplete market allocations coincide with the first-best plan from $t=0$ up to time $(t-1)$, but at time t an idiosyncratic shock makes the incomplete market allocation deviate from the benchmark one. In this case

$$\Omega\cdot\left(C_t^{IM}\right)^{-\rho}\cdot\varphi_t=\mu_t^{IM} \tag{40}$$

$$(1-\Omega)\cdot\left(C_t^{\star IM}\right)^{-\rho}\cdot\varphi_t^{\star}=\mu_t^{\star IM} \tag{41}$$

[45] See Ljungqvist and Sargent (2004).

where φ and $\varphi^\star$ represent the wedge between marginal utility of consumption and CPI created by the shock, and the IM superscript denotes the incomplete markets allocation. Loglinearizing (40) and (41) around a symmetric Steady State with full risk-sharing gives

$$\hat{\varphi}_t^\star = \hat{\mu}_t^{\star IM} + \rho \hat{c}_t^{\star IM}$$

$$\hat{\varphi}_t = \hat{\mu}_t^{IM} + \rho \hat{c}_t^{IM}$$

Notice that if the shock is purely idiosyncratic, $\hat{\varphi}_t$ and $\hat{\varphi}_t^\star$ must have opposite signs (if $\hat{\varphi}_t$ is positive, $\hat{\varphi}_t^\star$ must be negative and viceversa).[46] The incomplete markets *gap* coincides with the difference between $\hat{\varphi}_t^\star$ and $\hat{\varphi}_t$

$$gap_t^{IM} = \hat{q}_t^{IM} - \rho\left(\hat{c}_t^{IM} - \hat{c}_t^{IM\star}\right) = \hat{\varphi}_t^\star - \hat{\varphi}_t$$

The opposite sign of $\hat{\varphi}_t^\star$ and $\hat{\varphi}_t$ is sufficient to ensure that a higher *gap* (in absolute value) must be generated by an incomplete markets allocation implying higher wedges between marginal utilities of consumption and CPIs, therefore a higher deviation from the Social Planner's (logged) optimality conditions (38) and (39). Due to the concavity of the Social Welfare function in (35) as a sum of concave functions, a higher deviation from the Social Planner's focs maps into a lower social welfare. Therefore, the higher the *gap* that arises in response to shocks in any incomplete markets setup, the higher the loss in social welfare caused by the disturbance with respect to the full risk-sharing benchmark.

C Appendix C: Proofs to the Propositions

C.1 Proposition 1

Proof. Introduce an exogenous transfer of resources in H and F budget constraints

$$C_t P_t = P_{ht} Y_{ht} - P_t T_t \qquad C_t^\star P_t^\star = P_{ft} Y_{ft} + \frac{P_t}{P_t^\star} T_t \tag{42}$$

The linearized model is solved around the symmetric Steady State in which $T = 0$.[47] The response of the terms of trade, the relative price of the F good, $\hat{tot}$, to a marginal flow $\hat{T}_t$ is given by

$$\hat{tot}_t = \frac{2\delta}{(1-\delta)(2\delta\theta - 2\delta + 1)} \cdot \hat{T}_t$$

This implies

$$\frac{\partial tot}{\partial T} > 0 \iff \theta > \tilde{\tau}$$

■

C.2 Proposition 2

Proof. Introduce an exogenous transfer of resources in H and F budget constraints. From the Proof to Proposition 1

$$\hat{tot}_t = \frac{2\delta}{(1-\delta)(2\delta\theta - 2\delta + 1)} \cdot \hat{T}_t$$

[46] If this was not the case, one of the resource constraints would be violated.

[47] In equation (42) I have assumed that the resources transferred are marginal units of the H consumption bundle. However, this assumption is unconsequential for the results. Since at the approximation point $T = 0$, it does not matter which good is transferred across countries.

From the solution to the system linearized around the symmetric Steady State with $T = 0$

$$\hat{c}_t = (\delta - 1) \cdot \hat{tot}_t - \hat{T}_t = \left(-2 \frac{\delta}{2\delta\theta - 2\delta + 1} - 1 \right) \cdot \hat{T}_t$$

$$\hat{c}_t^\star = (1 - \delta) \cdot \hat{tot}_t + \hat{T}_t = \left(2 \frac{\delta}{2\delta\theta - 2\delta + 1} + 1 \right) \cdot \hat{T}_t$$

$$\hat{q}_t = (2\delta - 1) \cdot \hat{tot}_t = -\left(2\delta \frac{2\delta - 1}{(\delta - 1)(2\delta\theta - 2\delta + 1)} \right) \cdot \hat{T}_t$$

Combining the solution for H and F consumption and the real exchange rate yields

$$gap_t = \hat{q}_t - \rho (\hat{c}_t - \hat{c}_t^\star) = \frac{2\rho\delta(\delta - 1) + \rho(2\delta\theta - 2\delta + 1)(\delta - 1) - \delta(2\delta - 1)}{(2\delta\theta - 2\delta + 1)(\delta - 1)} \cdot \hat{T}_t \qquad (43)$$

For $\theta > \tilde{\tau}, (2\delta\theta - 2\delta + 1) > 0$. Both numerator and denominator in equation (43) are negative for $0.5 < \delta < 1$. A marginal transfer to F consumers raises the *gap*, their relative wealth.

For $\theta < \tilde{\tau}$, the denominator in (43) is positive. The numerator is negative for $\rho > 0, \delta > 0, \theta > 0$. A flow to the F country lowers the relative wealth of its inhabitants. ■

C.3 Proposition 3

Proof. Assume the system is in Steady State up to time $(t - 1)$ and assume an increase in the supply of the H good at time t. The bonds purchased by H consumers in response to the disturbance (coinciding with the borrowing of F agents) are given by

$$\hat{b}_t = -\hat{b}_t^\star = \underbrace{\left[\frac{(\delta - 1)(\zeta - 1)}{(4\delta - 4\delta^2 + 4\delta^2\rho\theta - 4\delta\rho\theta - 1)(\zeta\beta - 1)} \right]}_{>0} \cdot \underbrace{\{2\delta\rho\theta - 2\delta - \rho + 1\}}_{>0 \iff \theta > \tilde{\eta}} \cdot \varepsilon_{Ht} \qquad (44)$$

It is easy to verify that the term in square brackets is positive for all $\delta < 1, \theta > 0, \zeta < 1$. What determines whether F consumers borrow or lend is the position of the trade elasticity relative to the efficiency threshold $\tilde{\eta}$ – which pins down the sign of the term in braces.

For $\theta > \tilde{\eta}$, $gap^{FA} < 0$ (from equation (16) – the relative wealth of Foreign consumers would fall in Financial autarky) and $\hat{b}_t^\star < 0$ (from (44)). For $\tilde{\tau} < \theta < \tilde{\eta}$, $gap^{FA} > 0$ and $\hat{b}_t^\star > 0$. Thus, if prices and flows are complements $(\theta > \tilde{\tau})$ the F country imports resources through external borrowing if and only if the shock would have made it relatively poorer absent asset trade.

For $\theta < \tilde{\tau}$, $gap^{FA} < 0$ and $\hat{b}_t^\star > 0$. If prices and flows are substitutes, F consumers (the relatively poorer ones absent asset trade) export resources through financial markets. ■

C.4 Proposition 4

Proof. In the full solution to the system (26), the portfolio flow received by Foreign consumers $(\xi^\star)$ after an exogenous increase in the H endowment is given by

$$\xi_t^\star = -\xi_t = \underbrace{\left[\frac{(\delta - 1)}{(\zeta\beta - 1)(4\delta(\delta - 1)(\theta\rho - 1) - 1)} \right]}_{(+)} \underbrace{\{2\delta\rho\theta - \rho - 2\delta + 1\}}_{>0 \iff \theta > \tilde{\eta}} \cdot \varepsilon_{ht} \qquad (45)$$

It is easy to verify that the term in brackets is positive $\forall \delta < 1, \zeta < 1, \beta < 1$. What determines if Foreign consumers receive an inflow from optimal portfolio returns after a windfall in the Home country, is the position of the trade elasticity relative to the efficiency threshold $\tilde{\eta}$ – which pins down the sign of the term in braces.

For $\theta > \tilde{\eta}$, $gap^{FA} < 0$ (from equation (16) the relative wealth of Foreign consumers would fall in Financial autarky) and $\xi_t^\star > 0$ (from equation (45)). For $\tilde{\tau} < \theta < \tilde{\eta}$, $gap^{FA} > 0$ and $\xi_t^\star < 0$. Thus, if prices and flows are complements ($\theta > \tilde{\tau}$) the F country receives resources through portfolio returns if and only if the shock would have made it relatively poorer absent asset trade.

For $\theta < \tilde{\tau}$, $gap^{FA} < 0$ and $\xi_t^\star < 0$. If prices and flows are substitutes, F consumers (the relatively poorer ones absent asset trade) export resources through financial markets. ■

C.5 Proposition 5

Proof. From the solution to the first step of the DS method we can retrieve the impact on the smoothing *gap* (gap^{SM}, the first element of the right hand side of equation (27)) of a marginal flow of resources to Foreign consumers via portfolio returns ($\xi_t^\star$, equivalent to $-\xi_t$ in equation (25)).[48]

$$\begin{aligned} \frac{\partial gap^{SM}}{\partial \xi^\star} &= \left[\frac{(4\delta(\delta-1)(1-\theta\rho)+1)(\beta-1)}{(\delta-1)}\right] \cdot \left\{\frac{1}{2\delta\theta - 2\delta + 1}\right\} > 0 \iff \\ &\iff (2\delta\theta - 2\delta + 1) > 0 \iff \theta < \tilde{\tau} \end{aligned}$$

Receiving a marginal transfer of resources through portfolio returns raises the relative wealth of Foreign consumers (the *gap*) if and only if the trade elasticity is above the transmission threshold $\tilde{\tau}$, that is if and only if prices and flows are complements.

Optimal portfolio returns should counterbalance gap^{SM}, in order to reduce the equilibrium *gap* to zero (from (27)).

For $\theta > \tilde{\eta}$, $gap^{SM} < 0$ (from equation (22)) and $\frac{\partial gap^{SM}}{\partial \xi^\star} > 0$. For $\tilde{\tau} < \theta < \tilde{\eta}$, $gap^{SM} > 0$ and $\frac{\partial gap^{SM}}{\partial \xi^\star} > 0$. Thus, if prices and flows are complements ($\theta > \tilde{\tau}$) the F country should receive resources through portfolio returns if and only if the shock would have made it relatively poorer absent portfolios (in the smoothing allocation).

For $\theta < \tilde{\tau}$, $gap^{SM} < 0$ and $\frac{\partial gap^{SM}}{\partial \xi^\star} < 0$. If prices and flows are substitutes, portfolio returns should subtract resources to F consumers (the relatively poorer ones in the smoothing allocation). ■

C.6 Proposition 6

Proof. Consider the second step of the DS method. In equilibrium, optimal cross-border flows arise endogenously from variations in assets excess returns and Steady State gross portfolio positions. Namely

$$\xi_t = -\xi_t^\star = \widehat{rx}_t \alpha$$

where α are the gross Steady State holdings of H consumers of the H equity ($\alpha \equiv Z \cdot (1 - S_h)$, where Z is the H security's price in Steady State). Notice that, by definition, α is the share of the H commodity that H consumers *buy in excess* of what they receive as endowment. Linearized excess returns of the H equity with respect to the F stock read

$$\widehat{rx}_t \equiv (\hat{r}_t - \hat{r}_t^\star) = (1-\beta)(\hat{y}_{ht} - \hat{y}_{ft}) - (1-\beta)\widehat{tot}_t + \beta(\hat{z}_t - \hat{z}_t^\star) - \left(\hat{z}_{t-1} - \hat{z}_{t-1}^\star\right)$$

[48] In the first step of the DS method $\xi^\star$ is an *i.i.d.* shock. It is sufficient to combine the appropriate vectors of the solution to get the impact of a marginal transfer to F consumers on the *gap*.

A depreciation of the terms of trade in response to an increase the H endowment, tends to lower the relative returns from the H equity. If the trade elasticity is low, relative price volatility is high and offsets the positive impact on excess returns of an increase in the relative quantity of the H good. In this case excess returns from the H equity tend to fall after a rise in the H endowment. From the analytical solution for $\widehat{rx}_t$, it is possible to show that an increase in the H endowment raises the excess returns on the H equity only for

$$\theta > \tilde{\phi} \equiv \frac{4\delta\left(\delta-1\right)-\rho+1}{4\delta\rho\left(\delta-1\right)} > \tilde{\eta}$$

The optimal gross position (α) is the one that, combined with the endogenous response to shocks of asset excess returns (rx_t), generates the optimal cross-border flows described in Proposition 4. The following graph represents along the domain of the trade elasticity, the response to an increase in the H endowment of the excess returns on the H equity ($\widehat{rx}$); the direction of optimal resource transfers (from Proposition 5); and H agents' gross holdings of the H equity (α, computed through the DS method).

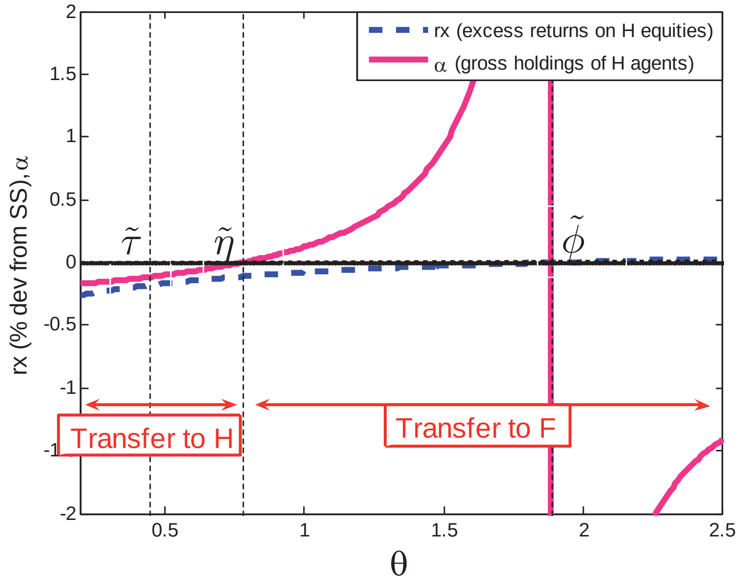

FIGURE 10

Response of H excess returns, optimal direction of portfolio flows, and optimal gross holdings (α), as a function of θ

For $\theta < \tilde{\eta}$, following a positive shock to the H endowment, portfolio returns should channel resources to H consumers. Due to the low degree of substitutability between varieties, the strong depreciation of the terms of trade lowers the relative return on the H stock. By selling claims to the H endowment ($\alpha < 0$) H consumers receive an inflow of resources if their own endowment increases. For $\tilde{\eta} < \theta < \tilde{\phi}$, portfolio returns should transfer resources to Foreign agents. Thus, H households should go long on their own equity, whose relative return falls: $\alpha > 0$. For $\theta > \tilde{\phi}$ F consumers should still receive a transfer of wealth. The high trade elasticity requires only a small depreciation of the terms of trade and the relative returns on the H equity rise. H consumers should then hold claims to the Foreign endowment: $\alpha < 0$.[49]

[49] Notice that $\tilde{\phi}$ represents an asymptot for H gross holdings. When the trade elasticity matches $\tilde{\phi}$ Home and Foreign equities yield the same returns in response to any shock. The closer the elasticity to

The share of the Home equity optimally held by H consumers (S_h) can be easily computed from their gross holdings α.[50]

$$S_h = 1 + (1-\delta)\underbrace{\left[\frac{1}{4\delta(\delta-1)(\rho\theta-1)+\rho-1}\right]}_{<0 \iff \theta>\tilde{\phi}} \cdot \underbrace{\{2\delta\rho\theta-\rho-2\delta+1\}}_{>0 \iff \theta>\tilde{\eta}} \qquad (46)$$

For $\theta < \tilde{\eta}$, H households sell part of the claims to their own endowment and their portfolio exhibits home bias $(0.5 < S_h < 1)$.[51] For $\tilde{\eta} < \theta < \tilde{\phi}$, H agents go long on the Home equity ($S_h > 1$), a counterfactual "excessive" home bias. For $\theta > \tilde{\phi}$, H consumers hold less than a half of the claims to their own endowment ($S_h < 0.5$), which gives rise to foreign bias.[52] Thus $\tilde{\phi}$ represents a *foreign bias threshold.*[53] ■

C.7 Propositions 7 and 8

Proposition 7 *Under trade in uncontingent bonds, a marginal flow of resources from the H to the F country raises the price of the F output (depreciates the terms of trade) if the trade elasticity is above the transmission threshold $\tilde{\tau}$; lowers the price of the F output otherwise.*

Proof. Introduce an exogenous transfer of resources in H and F budget constraints

$$P_t^B B_{t+1} = \frac{P_{ht}Y_{ht}}{P_t} - C_t + B_t - T_t$$

$$\frac{P_t^B B_{t+1}^\star}{Q_t} = \frac{P_{ft}Y_{ft}}{P_t^\star} - C_t^\star + \frac{B_t^\star}{Q_t} + \frac{T_t}{Q_t}$$

The linearized model is solved around the symmetric Steady State in which $B = B^\star = T = 0$. The response of the terms of trade, the relative price of the F good, $\hat{tot}$ to a marginal flow $\hat{T}_t$ is given by

$$\hat{tot}_t = (1-2\delta)(\beta-1)\cdot\frac{2\delta-\beta\delta+1}{2\delta-2\delta\theta-1}$$

This implies

$$\frac{\partial tot}{\partial T} > 0 \iff \theta > \tilde{\tau}$$

■

this threshold, the larger the amount of assets agents need to hold.

[50] Namely, $S_h = 1 + \alpha(1-\beta)$.

[51] The low degree of substitutability between goods implies a high volatility of excess returns. The share of Foreign equities held by H households does not need to exceed (1/2).

[52] Intuitively, S_h is smaller than (1/2) because the high trade elasticity implies a small depreciation of the terms of trade and a low volatility of excess returns. H consumers must hold a *large* share of the Foreign stock in order to hedge optimally.

[53] This model is very similar to the one analysed in Kollmann (2006). As Kollmann (2006) and Coeurdacier (2005) notice, in order for this framework – and in general all models reconducing equity home bias only to biased consumption expenditures – to generate a realistic degree of equity home bias, the elasticity of substitution between H and F goods should be sufficiently low. Kollmann finds that when the elasticity is high enough, still below unity in his calibration, the model delivers a counterfactual "excessive" home bias in equities ($S_h > 1$). For an elasticity sufficently above unity, he finds that this kind of models generates an equally counterfactual foreign bias ($S_h < 0.5$).

The interpretation of optimal portfolio formation detailed in the text, provides a rationale for foreign bias and excessive home bias. It shows that only for an elasticity lower than the efficiency threshold, the model can generate a realistic degree of equity home bias. Thus when prices and flows are substitutes, equity home bias is consistent with efficient financial markets. Instead complementarity between flows and prices may well imply "excessive" home bias or foreign bias.

Proposition 8 *A marginal flow of resources from the H to the F country raises the relative wealth of Foreign consumers if the trade elasticity is above the transmission threshold $\tilde{\tau}$; lowers the relative wealth of F consumers otherwise.*

Proof. Combining the solution for the response of C_t, $C_t^\star$, and Q_t to a marginal transfer to the Foreign country, yields

$$\begin{aligned}\frac{\partial gap}{\partial \xi^\star} &= \left[\frac{(4\delta(\delta-1)(1-\theta\rho)+1)(\beta-1)}{(\delta-1)}\right]\cdot\left\{\frac{1}{2\delta\theta-2\delta+1}\right\}>0 \iff \\ &\iff (2\delta\theta-2\delta+1)>0 \iff \theta<\tilde{\tau}\end{aligned}$$

Receiving a marginal transfer of resources through external borrowing raises the relative wealth of Foreign consumers (the *gap*) if and only if the trade elasticity is above the transmission threshold $\tilde{\tau}$. ■

D Wealth effects with endogenous portfolios

I write consumers' utility maximization for a general case in which agents can trade in multiple contingent securities and form a portfolio that hedges them ex-ante – to some extent – against national shocks. The formulation of the problem abstracts from the degree of completeness of asset markets. I leave the characterization of portfolios indeterminate. This allows for the greatest degree of generality, and is sufficient to show that the *gap* maps into changes in countries' relative wealth. It should be clear that the purpose of this section is not to *find* optimal portfolios, nor to derive a full solution to the model, but rather to show that also in the case of trade in multiple contingent assets, the insurance measure reflects cross-border wealth imbalances.

Assume agents can trade in n assets with state-contingent payoffs r_t^i, $i=1,...,n$, expressed in H consumption units. For our purposes, payoffs can be generally characterized as a function of the realization of national shocks at time t. Define α_t as the vector of gross holdings of the first $(n-1)$ assets purchased by Home consumers at time t. Optimal portfolios α are not specified, and can be thought of as a function of shock realizations.[54] H households' budget constraint reads

$$NFA_t = r_t^n NFA_{t-1} + \frac{Y_{ht}P_{ht}}{P_t} - C_t + \underbrace{\alpha_{t-1}r_{xt}}_{\xi_t}$$

where NFA are net foreign assets, α_{t-1} is a function of the realization of shocks Y and $Y^\star$ at time $(t-1)$, $r_{xt}=[r_{xt}^1,...,r_{xt}^{n-1}]$ is the vector of realized excess returns, and r_t^n is the *n-th* asset payoff. ξ_t is the transfer of resources delivered at time t by portfolio returns in response to shocks.[55] Since we are not interested in finding the optimal portfolio, we can abstract from its composition, and write the inter-temporal problem of H consumers as

$$\max_{\{C_t,NFA_t,\nu_t\}}.:L=E_0\left\{\sum_{t=0}^{\infty}\beta^t\left[\frac{(C_t)^{1-\rho}}{1-\rho}+\nu_t\left(P_t r_t^n NFA_{t-1}+P_{ht}Y_t+P_t\xi_t-P_tC_t-P_tNFA_t\right)\right]\right\}$$

[54] In a *full* solution to the model and up to a second-order approximation, portfolio composition would depend both on exogenous shocks and on second and third-order moments. See Devereux and Sutherland (2006).

[55] ξ_t depends on the realization of the shocks at time t (through asset returns) and $(t-1)$ (through α_{t-1}).

where ν_t is the shadow value of income at time t, including endowment income, returns from previous period net foreign assets, and flows from portfolio holdings. As for the smoothing case analyzed in the main text, it is easy to show that ν_t represents the shadow value of the present discounted value of lifetime income. Following the same steps as in the smoothing case yields

$$\hat{q}_t - \rho\,(\hat{c}_t - \hat{c}_t^{\star}) \equiv gap_t = (\hat{\nu}_t - \hat{\nu}_t^{\star})$$

The wealth imbalances reflected in $(\hat{\nu}_t - \hat{\nu}_t^{\star})$ are *residual* after portfolio returns have delivered contingent transfers of resources. When asset markets are effectively complete, the wealth distribution stays constant in response to any shock, and the multipliers ν and $\nu^{\star}$ do not vary over time and states.[56]

[56] This is clearly the case with a full set of Arrow-Debreu securities. See Ljungqvist and Sargent (2004).

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