Nontraded goods prices, terms of trade and international risk-sharing: an empirical investigation.*

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Abstract

Accounting for the pervasive evidence of limited international risk-sharing is an important hurdle for open-economy models. This paper reconsiders the empirical evidence on the consumption-real exchange rate "anomaly" for OECD countries, distinguishing between real exchange rates for the traded and the nontraded goods. In fact, one of the mechanisms proposed by the literature to reconcile the open economy models with the data features a dominant role of the relative price of nontraded goods: consistent with the Harrod-Balassa-Samuelson effects, the response of this price to tradable output fluctuations results in an inverse correlation between cross-country consumption and the real exchange rate. Other contributions point to another mechanism, emphasizing endogenous income effects of output fluctuations, which cause especially tradable prices to appreciate with a rise in relative domestic consumption. We show that, in the data, an overall low or negative association tends to result from a low or negative correlation of relative consumption with both tradable and nontradable real exchange rates. Using spectral analysis techniques, we also show that this finding is starker at business cycle and lower frequencies, arguably the most relevant ones for assessing the performance of international business cycle models. In most countries the correlation with tradable prices appears to play a dominant role in driving the overall correlation, but this pattern is not exclusive: for some countries the key role is played by nontraded goods prices.

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1 Introduction

With the development of the literature on the international business cycle, cross-border risk sharing has emerged as one of the key dimensions for assessing the performance of alternative models — see e.g. Obstfeld and Rogoff [2001]. Standard models indeed tend to predict a high and positive correlation between relative consumption across countries and the real exchange rate — closely in line with the theory-consistent condition for perfect risk sharing, linking movements in the ratio of marginal utility of consumption across agents to fluctuations in the relative price of their consumption basket, but at odds with the empirical evidence stressed by Backus and Smith [1993] and subsequent work.[1] In recent developments of the literature, a number of contributions have explored mechanisms by which the workhorse model of the international economy can account for the stylized facts — some stressing wealth effects in incomplete market economies, reflecting terms of trade movements; other emphasizing Harrod-Balassa-Samuelson effects driving nontraded goods' prices, or marginal utility shifts (see e.g. Benigno and Thoenissen [2006], Corsetti, Dedola and Leduc [2008], Ghironi and Melitz [2004], Mandelman, Rabanal, Rubio-Ramírez and Vilán, [2010], Nam and Wang [2010], Opazo [2006], Raffo [2010] among others).[2]

In this paper we reconsider the empirical evidence for OECD countries, so to shed light on which of the mechanisms explored by the literature can actually be reconciled with the data. We carry out our analysis using multivariate spectral analysis techniques, rather than focusing only on business cycle frequencies, and distinguish between the real exchange rates for traded and nontraded goods.

Our contribution is twofold. First, we build a simple conceptual and empirical framework to revisit recent developments in open-economy macro that address the international risk sharing puzzle by modelling wealth and income effects (in incomplete market economies) in relation to the equilibrium fluctuations in the relative of tradable or nontradable goods across border. This framework allows us to articulate the empirical analysis as to provide evidence on the different 'channels' identified by this literature as potential explanations of the puzzle.

Second, by distinguishing two components of the real exchange rate depending on goods tradability, we show that an overall negative Backus-Smith statistic tends to be associated with a negative correlation of relative consumption with both the relative price of traded goods across countries, and the relative price of nontraded-goods within countries. In most countries, it is the traded-good component that plays a dominant role in driving the overall Backus-Smith statistics: a rise in domestic consumption relative to the foreign one is associated

[1] See Obstfeld and Rogoff [2001] and references therein for the link between the Backus-Smith statistic and other indicators of lack of of international risk sharing, such as the Feldstein-Horioka puzzle and the consumption correlation puzzle.

[2] An open issue concerns the discount factor in (open economy) macro models, i.e., the extent to which different specifications can be reconciled with asset pricing in the data — see e.g. the discussion in Brandt et al [2006] but also Campbell and Cochrane [1999].

with an appreciation of domestic tradable output and stronger terms of trade. Yet, this is not an exclusive patterns. There are also several cases in which the sign pattern is consistent with a dominant role for the non-traded good price component: an appreciation of nontraded goods coexists with a worsening of the world tradables price of the country, consistent with the Harrod-Balassa-Samuelson model. Spectral analysis further unveils that these patterns are actually starker at business cycle and lower frequencies, arguably the most relevant ones to assess the performance of international business cycle models.

To appreciate the implications of these results recall that, under perfect risk sharing and stable symmetric preferences, the correlation between relative consumption and real exchange rates must be close to one (as stressed by Backus and Smith [1993]) — implying, in the case of stationarity of the real exchange rate, a cointegrating relation between consumption across countries (as pointed out by Kollmann [1995]). This prediction of a perfectly positive correlation is independent of the underlying drivers of real exchange rate fluctuations, including Harrod-Balassa-Samuelson effects affecting the relative price of nontraded goods within countries. Namely, even when positive productivity gains in tradable production drive up the domestic price of nontradables in terms of tradables, perfect risk sharing dictates that overall domestic consumption can rise more than consumption abroad only if the overall real exchange rate depreciates. This in turn is possible only if the international price of the country's traded goods weakens, more than offsetting the pressure toward real appreciation exerted by the classic Harrod-Balassa-Samuelson effect. In other words, under perfect risk sharing, productivity shocks to tradables raising relative consumption should cause the real exchange rates for traded and non-traded goods to move in opposite directions.

With asset-market imperfections, instead, deviations from the perfect correlation prediction may arise corresponding to different mechanisms affecting the patterns of correlation between relative consumption and key international relative prices. One mechanism features a dominant role of the relative price of nontraded goods in driving real exchange rate movements and thus, when productivity shocks in the traded goods sector are also the prevailing source of fluctuations, Harrod-Balassa-Samuelson effects. According to this mechanism, positive output gains in domestic tradables simultaneously drive up relative consumption and nontradable relative prices, while international tradable prices barely move or even fall (as in Benigno and Thoenisson [2006]). Note that the presence of output (productivity) disturbances in nontradables would tend to mute the effects of this mechanism since, other things equal, these disturbances would drive relative consumption and nontradable prices in opposite directions: the unconditional Backus-Smith correlation could then have either sign. A different mechanism features endogenous income effects from output shocks to both tradables and nontradables, whereas, irrespective of the sectoral origin of the shock, output (productivity) increases cause all international relative prices of a country to strengthen, together with a rise in relative consumption (as in Corsetti Dedola and Leduc [2008] or Ghironi and Melitz [2004]).

Our findings suggest that, to a different extent, there is empirical evidence

consistent with either mechanism. The fact that such evidence is sharper at business cycle and lower frequencies strengthens the notion that the stylized facts on risk sharing do provide a meaningful hurdle for open economy models. At the same time, the coexistence of patterns consistent with different models of the international transmission mechanism raises intriguing questions, as of whether different patterns could be ascribed to specific structural or policy-related features of the economy — such as trade openness, capital market liberalization, or the exchange rate regime.

The paper is organized as follows. Section 2 reconsiders recent open-economy literature addressing the Backus Smith puzzle. Section 3 discusses a stylized theoretical model shedding light on possible transmission channels underlying the evidence, using the decomposition of the real exchange rate into two components, the relative price of tradables and non tradables across countries. Results are generalized in Section 4, based on a quantitative model. Section 5 lays out our empirical framework, and presents and discusses our empirical findings. Section 6 concludes. Details on the data, spectral analysis and additional results and figures are presented in the Appendix.

2 The risk-sharing puzzle reconsidered: recent developments in the open-economy literature

With the development of modern international (real and monetary) business cycle models, the open economy literature has been increasingly concerned with understanding the role of frictions and distortions in financial markets in shaping the international transmission mechanism and thus the real allocation within and across borders. Specifically, the literature has faced key questions in the extent to which the workhorse open-economy model can account for stylized facts apparently at odds with well-integrated financial markets. A key instance concerns the degree of cross-border insurance characterizing the world market allocation, reflecting not only the limited cross-border portfolio diversification observed in the data, or the often counterintuitive direction of capital flows, but also, and especially so, the equilibrium comovement of marginal utility, proxied by consumption, in relation to the international relative price of the baskets of consumption goods — in violation of the welfare-based condition of efficient risk-sharing. Ever since the contribution of Backus and Smith [1993], indeed, cross country comovements in consumption and the real exchange rate has become the subject of an intense empirical and theoretical debate (see e.g. Obstfeld and Rogoff [2001] and Chari Kehoe and McGrattan [2002]).

In this section, we reconsider recent theoretical developments in the literature, that explicitly address the 'puzzle' posited by the Backus-Smith analysis and related work, by modelling wealth and income effects of fundamental shocks, in relation to the equilibrium fluctuations in the relative prices of tradables and non tradables across borders. This review of the literature will provide us with the conceptual framework to articulate our empirical analysis below, aiming at

providing direct evidence on the different price and wealth channels identified by the literature as potential explanations of the puzzle.

The natural starting point of our inquiry is the general condition characterizing an allocation with complete risk sharing. Under complete markets, by the law of one price the equations pricing Arrow-Debreu bonds imply that the growth of marginal utility of consumption, expressed in the same currency units, is equalized across agents/countries state by state:

$$\beta \frac{U_C\left(C_t\right)}{U_C\left(C_{t-1}\right)} \frac{P_{t-1}}{P_t} = \beta \frac{U_C^*\left(C_t^*\right)}{U_C^*\left(C_{t-1}^*\right)} \frac{P_{t-1}^*}{P_t^*} \tag{1}$$

where β denotes the discount rate (for simplicity assumed to be identical across borders), U_C and U_C^* denote the marginal utility of domestic and foreign consumption, C and C^* denote domestic and foreign consumption, respectively; P_t and P_t^* denote the domestic and the foreign price level, expressed in the same currency units (via the nominal exchange rate). From the above expression, it is easy to derive a more intuitive condition stating that, under complete markets, the marginal utility of one unit of currency must be equalized across countries in each state of nature up to a constant Ξ, accounting for differences in wealth:

$$\frac{1}{P_t} U_{c,t} = \Xi \frac{1}{P_t^*} U_{c^*,t}^*, \tag{2}$$

In either version, the perfect risk sharing condition above holds in equilibrium exclusively as an implications of the optimal portfolio plans of agents trading a complete set of state-contingent securities among them. It is therefore independent of possible frictions and imperfections in the goods markets (including shipping and trade costs, as well as sticky prices or wages), even when these cause large deviations from the law of one price and purchasing power parity (PPP).

Define the real exchange rate (RER) as the ratio of foreign (P_t^*) to domestic (P_t) price level, expressed in the same currency units

$$RER_t = \frac{P_t^\star}{P_t}. \tag{3}$$

Under the additional assumption that agents have preferences represented by a time-separable, constant-relative-risk-aversion utility function of the form $\frac{C^{1-\sigma}-1}{1-\sigma}$, with $\sigma > 0$, (2) becomes

$$\frac{P_t^*}{P_t} U_{c,t} = RER_t \left(C_t\right)^{-\sigma} = \left(C_t^*\right)^{-\sigma} \tag{4}$$

which in turn translates into the condition of a perfect correlation between the (logarithm of the) ratio of domestic to foreign consumption and the (logarithm of the) real exchange rate.[3] At odds with the hypothesis of perfect risk sharing,

[3] Lewis [1996] rejects nonseparability of preferences between consumption and leisure as an empirical explanation of the low correlation of consumption across countries.

many empirical studies have found this correlation to be significantly below one, or even negative (in addition to Backus and Smith [1993], see for instance Kollmann [1995], Kocherlakota and Pistaferri [2007] and Hess and Shin [2010] among others). Results at odds with perfect risk sharing are typically found also by studies imposing the further assumption that purchasing power parity, or PPP, holds (so that $RER = 1$ or equal to a constant), and thus testing its stronger version implying perfect correlation of consumption across countries.

As is well known, the evidence from this body of literature is a challenge for the open economy literature. Not only it is hard to match using models assuming a complete set of state-contingent securities; it is also hard to match using models featuring imperfect capital markets, but adopting model parameterizations translating into the prediction of an arbitrarily high degree of risk sharing in equilibrium.

Early on, Baxter and Crucini [1995] emphasize that in international business cycle models where domestic and foreign outputs are perfect substitute ($RER = 1$), international borrowing and lending provides efficient means to smooth consumption risk against temporary productivity shocks, with statistical properties of the kind typically found in empirical studies of aggregate TFP. When international trade is restricted to a bond, the model still predicts that, in response to temporary productivity shocks in one country, both domestic and foreign consumption optimally move in the same direction, and are more correlated than output — as is the case in the complete market allocation. However, significant deviations from this allocation can be predicted when productivity shocks are assumed to be near unit-root — in which case trade in one bond does not provide any means for smoothing consumption.

Modelling imperfect substitution between domestic and foreign output clearly opens up new perspectives on risk sharing. In their celebrated contribution, Cole and Obstfeld [1991] (henceforth CO) point out a key property of the model in the limiting case of a unit-elasticity of substitution between goods: with symmetric preferences, relative price adjustment is sufficient to provide perfect production risk insurance. This is so by virtue of the fact that prices and movements move proportionally in opposite directions, keeping the value of national production constant in relative terms independently of whether shocks are temporary or permanent.[4] On the one hand, the CO case appears to exacerbate the problem discussed by Baxter and Crucini [1995]: indeed, it suggests that near unit root shocks per se cannot explain significant departure from perfect risk sharing in models with incomplete markets. On the other hand, the CO contribution also points to the need for a thorough analysis of the contribution of relative price movements to risk sharing — especially when the elasticity of substitution among national goods (or more in general, the trade elasticity) is sufficiently away from unity. In fact, the Cole and Obstfeld example is sometimes (mistakenly) interpreted as suggesting that international relative adjustment necessarily complements asset diversification in raising the level of cross-border insurance;

[4] This result generalizes to environments with sticky prices (see Chari Kehoe and McGrattan [] and Corsetti and Pesenti [2001, 2005] among others). With a unit elasticity of substitution, a similar result can be also derived for preference shocks (Corsetti Dedola and Leduc [2010]).

or, even worse, that the 'relative price channel' and the 'asset diversification channels' of risk sharing can be studied and characterized independently of each other.

As shown by Corsetti Dedola and Leduc [2008a, 2008b and 2010], as well as Viani [2010], under reasonable parameterizations of the model, the joint determination of prices and portfolio allocations in general equilibrium can correspond to cases in which price movements magnify wealth effects of shocks, widening, rather than reducing, the distance between the complete and the incomplete market allocation. In the workhorse model, this is the case under a number of parameters configurations.

Two parameters configurations are analyzed by Corsetti Dedola and Leduc [2008a]. The first one assumes a low short-run trade elasticity — around 1/2 — within the range of the estimates considered in the macro literature. Because of the implied strong income effects from price movements, the terms of trade and the real exchange rate are quite volatile, and wealth divergences significant in response to shocks. The second one assumes persistent shocks (as in Baxter and Crucini) *and* a relatively high trade elasticity — within the range estimated by the trade literature. With high substitutability between domestic and foreign output, expectations of a persistently higher stream of output in the future do not correspond to expectations of a significant deterioration of the terms of trade of the country — which would in part offset the income gains from the increased production. When markets are incomplete, thus, the present value of the income accruing to domestic agents rises relative to foreign agents, generating possibly large cross-country wedges in wealth (see also Nam and Wang [2010] and Opazo [2006], discussing 'news shocks').

In either configuration, the notable common feature is that, with some reasonable home bias in demand, the rise in domestic wealth and consumption driven by a positive shocks to domestic supply is strong enough to translate into an appreciation of both the real exchange rate and the terms of trade of the country. Since in equilibrium the real appreciation exacerbates the cross-border differences in wealth by increasing the purchasing power of domestic agents, the contribution of international relative prices to risk sharing is actually negative — the opposite of the Cole and Obstfeld [1991] case. A generalization of this result in models with firm dynamics is provided by Ghironi and Melitz [2004].[5]

Imperfect substitution between domestic traded and nontraded goods brings yet another relative price into the picture, potentially shaping a different mechanism by which shocks can create wealth divergences consistent with the empirical evidence after Backus and Smith [1993]. The additional mechanism features a dominant role of Harrod-Balassa-Samuelson effects, i.e. of the relative price of nontraded goods, in driving real exchange rate appreciations. According to this mechanism, output gains in domestic tradables simultaneously drive up nontradable prices and relative consumption, while international tradable prices barely

[5] Recent literature discusses a possible reconciliation of the BS evidence with the prediction of complete-market economies, emphasizing the role of demand shocks driven by investment-specific technological gains, and non-separability between consumption and leisure in preference (see Mandelman, Rabanal, Rubio-Ramírez and Vilán, [2010], and Raffo [2010]).

move or even fall (as in Benigno and Thoenisson [2006]). Hence, a violation of the perfect risk sharing condition discussed above does not necessarily imply that domestic consumption (relative to Foreign) is associated with an improvement in the terms of trade. As discussed below, however, for this mechanism to work, productivity shocks in the traded goods sector must be the prevailing source of fluctuations, and the trade elasticity cannot be too high.

The main conclusion from this brief account of the literature is straightforward. Under the incomplete market assumption, there are different possible transmission mechanisms that help reconcile the predictions of open-economy models with the evidence of a low or even negative correlation between relative consumption and real depreciation — envisioning a different behavior of relative prices of tradables and non tradable goods. Specifically, a set of explanation emphasize wealth effects, causing the terms of trade, or the relative price of tradables, to be the main driver of the real appreciation associated with expansions in relative domestic consumption. A second set of explanation downplays the role of the relative price of tradables, in favor of that of nontradables.

3 International relative prices and risk sharing: a simple conceptual and empirical framework

In the light of the recent literature, we now specify a simple framework to study theoretically and empirically the links between relative consumption and the different price components of the real exchange rate, emphasized by different contributions. Throughout our analysis, we will make use of a decomposition of the CPI-based real exchange rate between any two countries (or country aggregates), capturing, respectively. fluctuations in the relative price of traded and nontraded goods. Denoting logs with lower case letters, this decomposition reads:

$$rer = p_T + p_{NT},$$

where

$$p_T = \ln\left(\frac{P_t^{T\star}}{P_t^T}\right)$$

and

$$p_{NT} = \eta^\star \cdot \ln\left(\frac{P_t^{N\star}}{P_t^{T\star}}\right) - \eta \cdot \ln\left(\frac{P_t^N}{P_t^T}\right),$$

and P^T and P^N denote the price of traded and nontraded goods within a country, while η is the average consumption share of non-traded goods, $P^N C^N / PC$.[6] Note that fluctuations in p_T encompass both fluctuations in the terms of trade due to differences in consumption baskets of traded goods, and deviations from the law of one price across borders. This decomposition is exact if, as in Burstein

[6] See Crucini and Landry [2010] for a different decomposition of the real exchange rate emphasizing the cross-country relative price of nontradables.

et al. [2006] and Engel [1999], the CPI in the home and foreign country are assumed to be Cobb-Douglas aggregators

$$\begin{aligned} P_t &= \left(P_t^T\right)^{1-\eta}\left(P_t^N\right)^{\eta} \\ P_t^\star &= \left(P_t^{T\star}\right)^{1-\eta^\star}\left(P_t^{N\star}\right)^{\eta^\star}, \end{aligned}$$

while it is an approximation when the CPI is a generic CES aggregator.

Denoting by σ standard deviations and by rc (the log of) relative consumption C/C^*, the Backus-Smith statistics can be decomposed as the sum of correlations between relative consumption, on the one hand, and the relative price of traded and non traded goods on the other:

$$Corr\left(rc, rer\right) = Corr\left(rc, p_T\right)\frac{\sigma(p_T)}{\sigma(rer)} + Corr\left(rc, p_{NT}\right)\frac{\sigma(p_{NT})}{\sigma(rer)}. \qquad (5)$$

The core of our analysis is that theory actually imposes stark restrictions on the sign of the two terms on the right hand side of the above expression, whose analysis can help shed light on specific risk-sharing channels at work across borders. To provide insight on these restrictions, in the rest of this section we proceed in the spirit of Cole and Obstfeld [1991], by specifying a simple analytical framework to analyze the transmission of sectoral and aggregate shocks, under different assumptions regarding the structure of international asset markets. In a later section, we will extend our analysis to richer models, using quantitative methods. Namely we will build on the model specified in Corsetti, Dedola and Leduc [2008b], featuring international trade in uncontingent bonds and capital accumulation — details on this richer model are presented in the appendix.

Consider a stylized two-country world, in which each country has an endowment of traded and nontraded goods. We refer to the two countries as 'Home' and 'Foreign'. For the Home representative consumer, consumption is given by the following CES aggregator

$$\begin{aligned} C &= \left[a_{\mathrm{T}}^{1/\phi} C_{\mathrm{T}}^{\frac{\phi-1}{\phi}} + (1-a_{\mathrm{T}})^{1/\phi} C_{\mathrm{N}}^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \qquad \phi > 0 \\ C_{\mathrm{T}} &= \left[a_{\mathrm{H}}^{1/\omega} C_{\mathrm{H}}^{\frac{\omega-1}{\omega}} + a_{\mathrm{F}}^{1/\omega} C_{\mathrm{F}}^{\frac{\omega-1}{\omega}}\right]^{\frac{\omega}{\omega-1}}, \qquad \omega > 0, \end{aligned}$$

where $C_{\mathrm{H},t}$ ($C_{\mathrm{F},t}$) is the domestic consumption of Home (Foreign) produced good, a_{H} is the share of the domestically produced good in the Home consumption expenditure, a_{F} is the corresponding share of imported goods, with $a_{\mathrm{F}} = 1 - a_{\mathrm{H}}$. Similarly, $C_{\mathrm{T},t}$ ($C_{\mathrm{N},t}$) denotes consumption of traded goods, and a_{T} is their share in the overall basket. Define $P_{\mathrm{H},t}$ ($P_{\mathrm{F},t}$) as the price of the Home (Foreign) good, and $\tau = \dfrac{P_{\mathrm{F}}}{P_{\mathrm{H}}}$ the terms of trade, i.e., the relative price of Foreign goods in terms of Home goods. Note that according to this definition an

increase in τ implies a *deterioration* of the terms of trade. The relative demand for tradables and nontradables is:

$$\frac{C_{\mathrm{T}}}{C_{\mathrm{N}}} = \frac{a_{\mathrm{T}}}{1-a_{\mathrm{T}}}\left(\frac{P_{\mathrm{T}}}{P_{\mathrm{N}}}\right)^{-\phi}, \quad \frac{C^*_{\mathrm{T}}}{C^*_{\mathrm{N}}} = \frac{a^*_{\mathrm{T}}}{1-a^*_{\mathrm{T}}}\left(\frac{P^*_{\mathrm{T}}}{P^*_{\mathrm{N}}}\right)^{-\phi},$$

while demand for Home traded goods can be written as:

$$\begin{aligned} C_{\mathrm{H}} &= a_{\mathrm{H}}\left(\frac{P_{\mathrm{H}}}{P_{\mathrm{T}}}\right)^{-\omega} C_{\mathrm{T}}, \\ C^*_{\mathrm{H}} &= a^*_{\mathrm{H}}\left(\frac{P_{\mathrm{H}}}{P^*_{\mathrm{T}}}\right)^{-\omega} C^*_{\mathrm{T}}, \end{aligned}$$

where demand's price elasticities coincide with the elasticity of substitution across traded and nontraded goods, ϕ, and the two traded goods, ω, respectively. The welfare-based consumption price indexes are customarily defined as follows

$$\begin{aligned} P_{\mathrm{T}} &= \left[a_{\mathrm{H}} P_{\mathrm{H}}^{1-\omega} + (1-a_{\mathrm{H}})\, P_{\mathrm{F}}^{1-\omega}\right]^{\frac{1}{1-\omega}} \\ P &= \left[a_{\mathrm{T}} P_{\mathrm{T}}^{1-\phi} + (1-a_{\mathrm{T}})\, P_{\mathrm{N}}^{1-\phi}\right]^{\frac{1}{1-\phi}}. \end{aligned}$$

Finally, letting Y_{H} denote Home (tradable) output and Y_{F} Foreign output, the resource constraint for both domestic and foreign tradables is $Y_{\mathrm{H}} = C_{\mathrm{H}} + C^*_{\mathrm{H}}$, and $Y_{\mathrm{F}} = C_{\mathrm{F}} + C^*_{\mathrm{F}}$, while for nontradables obviously we have $C_{\mathrm{N}} = Y_{\mathrm{N}}$ and $C^*_{\mathrm{N}} = Y^*_{\mathrm{N}}$.

Assuming the law of one price holds, the real exchange rate can be written as:

$$\begin{aligned} \ln RER \equiv rer &= \ln\frac{P^*_{\mathrm{T}}}{P_{\mathrm{T}}} + \frac{1}{1-\phi}\ln\frac{a^*_{\mathrm{T}} + (1-a^*_{\mathrm{T}})\left(\frac{P^*_{\mathrm{N}}}{P^*_{\mathrm{T}}}\right)^{1-\phi}}{a_{\mathrm{T}} + (1-a_{\mathrm{T}})\left(\frac{P_{\mathrm{N}}}{P_{\mathrm{T}}}\right)^{1-\phi}} = \\ &= \ln\left[\frac{a^*_{\mathrm{H}} + (1-a^*_{\mathrm{H}})\,\tau^{1-\omega}}{a_{\mathrm{H}} + (1-a_{\mathrm{H}})\,\tau^{1-\omega}}\right]^{\frac{1}{1-\omega}} + \frac{1}{1-\phi}\ln\frac{a^*_{\mathrm{T}} + (1-a^*_{\mathrm{T}})\left(\frac{P^*_{\mathrm{N}}}{P^*_{\mathrm{T}}}\right)^{1-\phi}}{a_{\mathrm{T}} + (1-a_{\mathrm{T}})\left(\frac{P_{\mathrm{N}}}{P_{\mathrm{T}}}\right)^{1-\phi}}. \end{aligned}$$

After taking a log-linear approximation around a steady state normalized so that relative prices are equalized in the long run, we obtain the model-counterpart of the expression $rer = p_T + p_{NT}$ discussed at the beginning of the section:

$$\widehat{rer} = \underbrace{(a_{\mathrm{H}} - a^*_{\mathrm{H}})\,\widehat{\tau}}_{p_T} + \underbrace{\left[(1-a^*_{\mathrm{T}})\,\frac{\widehat{p^*_{\mathrm{N}}}}{p^*_{\mathrm{T}}} - (1-a_{\mathrm{T}})\,\frac{\widehat{p_{\mathrm{N}}}}{p_{\mathrm{T}}}\right]}_{p_{NT}}.$$

In loglinearized form, the decomposition of the Backus-Smith correlation (5) can finally be written as follows:

$$Corr\left(\widehat{rc},\widehat{rer}\right) = Corr\left(\widehat{rc},\left(a_{\mathrm{H}}-a_{\mathrm{H}}^{*}\right)\widehat{\tau}\right)\frac{\left(a_{\mathrm{H}}-a_{\mathrm{H}}^{*}\right)\sigma(\widehat{\tau})}{\sigma(\widehat{rer})}+ \tag{6}$$

$$Corr\left(\widehat{rc},\left(1-a_{\mathrm{T}}^{*}\right)\frac{\widehat{p_{\mathrm{N}}^{*}}}{p_{\mathrm{T}}^{*}}-\left(1-a_{\mathrm{T}}\right)\frac{\widehat{p_{\mathrm{N}}}}{p_{\mathrm{T}}}\right)\frac{\sigma((1-a_{\mathrm{T}}^{*})\frac{\widehat{p_{\mathrm{N}}^{*}}}{p_{\mathrm{T}}^{*}}-(1-a_{\mathrm{T}})\frac{\widehat{p_{\mathrm{N}}}}{p_{\mathrm{T}}})}{\sigma(\widehat{rer})}.$$

Using the above framework, as in Cole and Obstfeld [1991], we will focus our inquiry on the two natural benchmarks of complete markets and financial autarky, for which we can obtain tractable analytical results.

3.1 Relative prices and consumption under complete markets

Under complete markets and standard preferences, the Backus-Smith correlation $Corr\left(\widehat{rc},\widehat{rer}\right)$ must be close to 1. The same is not true, however, for the correlation of relative consumption with single components of the real exchange rate. Consider the two terms on the right hand side of the expression (6). The sign of the second term is determined by the correlation between relative consumption and the ratio of the relative price of non-traded goods, $Corr(\widehat{rc},\widehat{p_{NT}})$. Under standard assumptions consistent with the classic Harrod-Balassa-Samuelson (or Baumol) effects, the terms in $\widehat{p_{NT}}$ will decrease in response to supply shocks concentrated in the Home traded goods sector, particularly to productivity shocks, and will increase in response to Home nontradable supply shocks. However, positive output shocks (in either sector) are very likely to be associated with an increase in relative (Home to Foreign) consumption, at least under home bias (i.e. $a_{\mathrm{H}} > a_{\mathrm{H}}^{*} = 1 - a_{\mathrm{F}}^{*}$). This implies that, if supply shocks to tradables are the main driver of economic fluctuations, $Corr(\widehat{rc},\widehat{p_{NT}}) < 0$ and the second term is negative even under complete markets.

Under complete markets, however, $Corr\left(\widehat{rc},\widehat{rer}\right)$ must be positive and large. Hence, as long as $Corr(\widehat{rc},\widehat{p_{NT}}) < 0$, whatever the shock hitting the economy, it must be the case that both (a) $Corr\left(\widehat{rc},\widehat{p_{T}}\right)$ is large and positive, and (b) $\frac{\sigma(\widehat{p_{T}})}{\sigma(\widehat{rer})}$ is large enough relative to $\frac{\sigma(\widehat{p_{NT}})}{\sigma(\widehat{rer})}$, to insure that the first term in (5) dominates. Under complete markets, indeed, it easy to show that, in response to supply shocks to tradables, relative consumption and the terms of trade move in the same direction in the case of home bias, and in opposite directions in the case of foreign bias in demand. The fact that, with complete markets, perfect consumption insurance optimally insulates relative wealth from price movements, shapes the equilibrium response of relative prices to output shocks. Specifically, with home bias, any gain in domestic tradable output is necessarily associated with a terms of trade depreciation: international consumption spillovers of productivity shocks are unambiguously positive.

3.2 Wealth effects and the international transmission mechanism through relative prices under financial autarky

When markets are incomplete, the interplay of substitution and wealth effects leads to a different array of results relative to the case of perfect risk sharing. At the core of these results is the notion that strong wealth effects in response to a positive shock to Home output can drive aggregate demand for domestic goods up to the point of almost matching or even exceeding the increased supply — thus containing the fall in its relative price or even causing an appreciation. In this subsection we analyze this possibility under the assumption of financial autarky, postponing to a later subsection the analysis of a full-fledged model.

Under financial autarky we can combine the market clearing conditions for tradables and nontradables :

$$\begin{aligned}\frac{C_{\mathrm{T}}}{C_{\mathrm{N}}} &= \frac{Y_{\mathrm{H}}}{Y_{\mathrm{N}}}\frac{P_{\mathrm{H}}}{P_{\mathrm{T}}} = \frac{a_{\mathrm{T}}}{1-a_{\mathrm{T}}}\left(\frac{P_{\mathrm{T}}}{P_{\mathrm{N}}}\right)^{-\phi},\\ \frac{C^*_{\mathrm{T}}}{C^*_{\mathrm{N}}} &= \frac{Y_{\mathrm{F}}}{Y^*_{\mathrm{N}}}\frac{P^*_{\mathrm{F}}}{P^*_{\mathrm{T}}} = \frac{a^*_{\mathrm{T}}}{1-a^*_{\mathrm{T}}}\left(\frac{P^*_{\mathrm{T}}}{P^*_{\mathrm{N}}}\right)^{-\phi},\end{aligned}$$

so to obtain the following (log-linearized) relative price of domestic nontradables in terms of tradables:

$$\begin{aligned}\phi\widehat{\frac{p_{\mathrm{N}}}{p_{\mathrm{T}}}} &= (\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{N}}) - (1-a_{\mathrm{H}})\,\widehat{\tau},\\ \phi\widehat{\frac{p^*_{\mathrm{N}}}{p^*_{\mathrm{T}}}} &= (\widehat{y}_{\mathrm{F}}-\widehat{y}^*_{\mathrm{N}}) + (1-a^*_{\mathrm{H}})\,\widehat{\tau}.\end{aligned}$$

Moreover, since by the balanced trade condition the terms of trade are proportional to relative tradable output

$$\widehat{\tau} = \frac{(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}})}{1-(a_{\mathrm{H}}+(1-a^*_{\mathrm{H}}))\,(1-\omega)},$$

we can write the following decomposition of the real exchange rate:

$$\begin{aligned}\widehat{rer} &= \underbrace{(a_{\mathrm{H}}-a^*_{\mathrm{H}})\,\frac{(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}})}{1-(a_{\mathrm{H}}+(1-a^*_{\mathrm{H}}))\,(1-\omega)}}_{p_T} +\\ &\underbrace{\phi^{-1}\left[\frac{(1-a^*_{\mathrm{T}})\,(\widehat{y}_{\mathrm{F}}-\widehat{y}^*_{\mathrm{N}}) - (1-a_{\mathrm{T}})\,(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{N}}) + \frac{(1-a_{\mathrm{T}})\,(1-a_{\mathrm{H}})+(1-a^*_{\mathrm{T}})\,(1-a^*_{\mathrm{H}})}{1-(a_{\mathrm{H}}+(1-a^*_{\mathrm{H}}))\,(1-\omega)}\,(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}})\right]}_{p_{NT}},\end{aligned}$$

and relative consumption:

$$\begin{aligned}\widehat{rc} &= \left[1+\frac{a_{\mathrm{T}}\left(1-a_{\mathrm{H}}\right)+a_{\mathrm{T}}^{*}\left(1-a_{\mathrm{H}}^{*}\right)}{1-\left(a_{\mathrm{H}}+\left(1-a_{\mathrm{H}}^{*}\right)\right)\left(1-\omega\right)}\right]\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)\\ &\quad+\left[\left(1-a_{\mathrm{T}}^{*}\right)\left(\widehat{y}_{\mathrm{F}}-\widehat{y}_{\mathrm{N}}^{*}\right)-\left(1-a_{\mathrm{T}}\right)\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{N}}\right)\right]\\ &= \left[\frac{1-\left(a_{\mathrm{H}}+\left(1-a_{\mathrm{H}}^{*}\right)\right)\left(1-\omega\right)+\left(2a_{\mathrm{T}}-1\right)\left(1-a_{\mathrm{H}}\right)+\left(2a_{\mathrm{T}}^{*}-1\right)\left(1-a_{\mathrm{H}}^{*}\right)}{\left(a_{\mathrm{H}}-a_{\mathrm{H}}^{*}\right)}\right]p_{T}+\phi p_{NT}.\end{aligned}$$

Consider the case of symmetry for simplicity. Using the expressions for $\widehat{p}_{T}$ and $\widehat{p}_{NT}$, the tradable and nontradable components of the Backus-Smith statistics now read, respectively:[7]

$$Corr\left(\widehat{rc},\widehat{p}_{T}\right)=\left(2a_{\mathrm{H}}-1\right)\left[\phi Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)+\left(2a_{\mathrm{H}}\omega-1\right)\frac{\sigma\left(\widehat{\tau}\right)}{\sigma\left(\widehat{p}_{NT}\right)}\right]\frac{\sigma\left(\widehat{\tau}\right)\sigma\left(\widehat{p}_{NT}\right)}{\sigma\left(\widehat{rc}\right)},$$

and

$$Corr\left(\widehat{rc},\widehat{p}_{NT}\right)=\left[\left(2a_{\mathrm{H}}\omega-1\right)Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)+\phi\frac{\sigma\left(\widehat{p}_{NT}\right)}{\sigma\left(\widehat{\tau}\right)}\right]\frac{\sigma\left(\widehat{\tau}\right)}{\sigma\left(\widehat{rc}\right)},$$

As before, let's focus first on the latter expression, i.e., the correlation between relative consumption and the ratio of nontraded good prices. Since $\phi\frac{\sigma\left(\widehat{p}_{NT}\right)}{\sigma\left(\widehat{\tau}\right)}>0$, it is apparent that for this correlation $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ to be negative, (a) the elasticity ϕ need to be small (implying e.g. strong complementarity between traded and nontraded goods), and (b) $\left(2a_{\mathrm{H}}\omega-1\right)Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)<0$. Using the fact that $\widehat{\tau}=\frac{\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}}{1+2a_{\mathrm{H}}\left(\omega-1\right)}$, it is possible to show that the latter

[7] For the general case, the decomposition of the Backus-Smith statistic can be written as:

$$\begin{aligned}Corr\left(\widehat{rc},\widehat{p}_{T}\right) &= Corr\left(\widehat{rc},\frac{\left(a_{\mathrm{H}}-a_{\mathrm{H}}^{*}\right)}{1-\left(a_{\mathrm{H}}+\left(1-a_{\mathrm{H}}^{*}\right)\right)\left(1-\omega\right)}\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)\right)\\ &= Corr\left(\begin{array}{c}\left(1-a_{\mathrm{T}}^{*}\right)\left(\widehat{y}_{\mathrm{F}}-\widehat{y}_{\mathrm{N}}^{*}\right)-\left(1-a_{\mathrm{T}}\right)\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{N}}\right),\\ \frac{\left(a_{\mathrm{H}}-a_{\mathrm{H}}^{*}\right)}{1-\left(a_{\mathrm{H}}+\left(1-a_{\mathrm{H}}^{*}\right)\right)\left(1-\omega\right)}\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)\end{array}\right).\\ &\quad\frac{\sigma\left(\left(1-a_{\mathrm{T}}^{*}\right)\left(\widehat{y}_{\mathrm{F}}-\widehat{y}_{\mathrm{N}}^{*}\right)-\left(1-a_{\mathrm{T}}\right)\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{N}}\right)\right)}{\sigma\left(\widehat{rc}\right)}+\\ &\quad\left[1+\frac{a_{\mathrm{T}}\left(1-a_{\mathrm{H}}\right)+a_{\mathrm{T}}^{*}\left(1-a_{\mathrm{H}}^{*}\right)}{1-\left(a_{\mathrm{H}}+\left(1-a_{\mathrm{H}}^{*}\right)\right)\left(1-\omega\right)}\right]\frac{\left(a_{\mathrm{H}}-a_{\mathrm{H}}^{*}\right)}{1-\left(a_{\mathrm{H}}+\left(1-a_{\mathrm{H}}^{*}\right)\right)\left(1-\omega\right)}\frac{\sigma\left(\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)\right)}{\sigma\left(\widehat{rc}\right)}\end{aligned}$$

and

$$Corr\left(\widehat{rc},\widehat{p}_{NT}\right)=Corr\left(\widehat{rc},\phi^{-1}\left[\begin{array}{c}\left(1-a_{\mathrm{T}}^{*}\right)\left(\widehat{y}_{\mathrm{F}}-\widehat{y}_{\mathrm{N}}^{*}\right)-\left(1-a_{\mathrm{T}}\right)\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{N}}\right)+\\ \frac{\left(1-a_{\mathrm{T}}\right)\left(1-a_{\mathrm{H}}\right)+\left(1-a_{\mathrm{T}}^{*}\right)\left(1-a_{\mathrm{H}}^{*}\right)}{1-\left(a_{\mathrm{H}}+\left(1-a_{\mathrm{H}}^{*}\right)\right)\left(1-\omega\right)}\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)\end{array}\right]\right).$$

condition is satisfied for:

$$(2a_{\mathrm{H}}\omega-1)\,Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)<0\Longleftrightarrow(1-a_{\mathrm{T}})\,\frac{(2a_{\mathrm{H}}\omega-1)^{2}}{\phi\sqrt{(1+2a_{\mathrm{H}}(\omega-1))^{2}}}\frac{\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)}{\sigma\left(\widehat{p}_{NT}\right)}\cdot$$
$$\left\{\frac{1+2a_{\mathrm{H}}(\omega-1)}{2a_{\mathrm{H}}\omega-1}Corr\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}},\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)\frac{\sigma\left(\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)}{\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)}-1\right\}<0,$$

Given that, for positive shocks to home output, the terms outside the curly bracket are obviously always positive, a necessary condition for $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ to be negative is that the expression inside the curly brackets be also negative. This will be the case when the term

$$\frac{1+2a_{\mathrm{H}}(\omega-1)}{2a_{\mathrm{H}}\omega-1}Corr\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}},\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)\frac{\sigma\left(\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)}{\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)}$$

is close to zero or itself negative. This term will be close to zero when the volatility of (relative) nontraded output is much lower than the volatility of (relative) traded output, or their correlation is low; it will be negative when the correlation and the coefficient $\dfrac{1+2a_{\mathrm{H}}(\omega-1)}{2a_{\mathrm{H}}\omega-1}$ have opposite sign. Note that a sufficient condition for $\dfrac{1+2a_{\mathrm{H}}(\omega-1)}{2a_{\mathrm{H}}\omega-1}>0$ is that the trade elasticity ω be large enough (i.e. $\omega>\max\left\{\dfrac{1}{2a_{\mathrm{H}}},1-\dfrac{1}{2a_{\mathrm{H}}}\right\}$).

The key conclusion to be drawn from the analysis above is that, for Harrod-Balassa-Samuelson effects to be the main determinant of a negative unconditional Backus-Smith correlation $Corr\left(\widehat{rc},\widehat{rer}\right)$, a number of specific conditions must be satisfied. Under the assumption that ω is sufficiently high, for the real exchange rate appreciation to be brought about by an increase in the domestic relative price of nontradables (with the tradable component $\widehat{p}_{T}$ playing a minor role), output fluctuations need to be predominantly sectoral, with a low or negative cross-industry correlation, or mostly driven by tradables. These conditions are indeed imposed in the analysis by Benigno and Thoenissen [2006], in which a negative value of $Corr\left(\widehat{rc},\widehat{rer}\right)$ is obtained through a negative $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ in an economy with a low elasticity ϕ between traded and nontraded goods, and a trade elasticity ω larger than 1, where shocks to tradable productivity are the main driver of macroeconomic fluctuations.

Turning to the other component, $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$, we note that using the expression derived above for $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)$, we can derive the following condition:

$$Corr\left(\widehat{rc},\widehat{p}_{T}\right)<0\Longleftrightarrow(2a_{\mathrm{H}}-1)\left[\phi Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)+(2a_{\mathrm{H}}\omega-1)\,\frac{\sigma\left(\widehat{\tau}\right)}{\sigma\left(\widehat{p}_{NT}\right)}\right]<0$$
$$\Longleftrightarrow(2a_{\mathrm{H}}-1)\left[\begin{array}{c}(2a_{\mathrm{H}}\omega-1)\,\dfrac{\sigma\left(\widehat{\tau}\right)}{\sigma\left(\widehat{p}_{NT}\right)}+(1-a_{\mathrm{T}})\,\dfrac{(2a_{\mathrm{H}}\omega-1)^{2}}{\sqrt{(1+2a_{\mathrm{H}}(\omega-1))^{2}}}\dfrac{\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)}{\sigma\left(\widehat{p}_{NT}\right)}\cdot\\ \left\{\dfrac{1+2a_{\mathrm{H}}(\omega-1)}{2a_{\mathrm{H}}\omega-1}Corr\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}},\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)\dfrac{\sigma\left(\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)}{\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)}-1\right\}\end{array}\right]<0.$$

A number of considerations are in order. First, a negative sign for the $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ does not necessarily imply a negative sign for $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$. While they both fall with $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)<0$, a negative $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ also requires $\phi\frac{\sigma\left(\widehat{p}_{NT}\right)}{\sigma\left(\widehat{\tau}\right)}$ to be small (i.e. a low elasticity of substitution across sectors and/or a low volatility of nontradable prices relative to tradables). But, from the above expression, it is apparent that a low ϕ reduces the weight of $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)$ relative to $\frac{\sigma\left(\widehat{\tau}\right)}{\sigma\left(\widehat{p}_{NT}\right)}$ as a determinant of $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$. Therefore, it may well be possible that $Corr\left(\widehat{rc},\widehat{p}_{T}\right)>0$ when $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)<0$.

Second, contrary to $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$, $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$ can be negative even when $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)\geq 0$. Trivially, this is true when there are only tradables ($a_{\mathrm{T}}=1$) or there are only country-specific aggregate shocks, symmetric across sectors (so that $Corr\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}},\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)\frac{\sigma\left(\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)}{\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)}=1$). A necessary condition is that $(2a_{\mathrm{H}}-1)$ and $(2a_{\mathrm{H}}\omega-1)$ have opposite signs, namely that there is home bias ($\frac{1}{2a_{\mathrm{H}}}<1$) but the trade elasticity is low enough $\omega<\frac{1}{2a_{\mathrm{H}}}$, or viceversa, there is foreign bias and the elasticity is high ($\frac{1}{2a_{\mathrm{H}}}>1,\omega>\frac{1}{2a_{\mathrm{H}}}$). Observe that, with home bias, if the trade elasticity ω is low enough, the $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)$ can be negative even when sectoral output within countries is positively correlated, implying that both components of the Backus-Smith statistic can be negative. As discussed below, this is indeed what happens in the bond economies with a low trade elasticity ω analyzed by Corsetti, Dedola and Leduc [2008a,b], in which Harrod-Balassa-Samuelson effects combine with other mechanisms in generating a negative BS statistics.

In general, however, with incomplete markets, the two components of $Corr\left(\widehat{rc},\widehat{rer}\right)$ can have opposite signs. Thus, the sign and magnitude of the overall Backus-Smith statistic will generally depend on their relative strengths and the relative contributions of $\sigma\left(\widehat{p}_{T}\right)$ and $\sigma\left(\widehat{p}_{NT}\right)$ to real exchange rate fluctuations, and the relative weights of the two terms. Indeed, it is clear that $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$ can have either sign, irrespective of the sign of $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$. If the transmission via international traded-goods prices is negative (high relative consumption is associated with an improvement in the international price of domestic tradables), $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$ is negative: e.g., conditional on productivity shocks to tradables, both terms in the decomposition of the Backus Smith statistics above will have the same sign. If instead the international price of domestic tradables falls with a domestic boom, the two terms have the opposite sign, since $Corr\left(\widehat{rc},\widehat{p}_{T}\right)>0$.

We should note, nonetheless, that different channels have different implications for the possible combinations of sign of $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ and $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$. The channels working through the relative price of nontradables *within* countries (implying a negative $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$), are likely to be associated with a positive $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$. The channels working through the relative price of tradables *across* countries (implying a negative $Corr\left(\widehat{rc},\widehat{p}_{T}\right)$), instead, could be associated with a positive or a negative $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$. In short, we will refer

to these as the relative price of nontradables channel, and the tradable wealth transmission channel.

4 A generalization to the case of international trade in bonds

In this section we use a medium scale two-country model to shed further light on the different channels that can lead to a negative Backus-Smith correlation analyzed above, for more general specifications of the economy. Specifically, we build on the model with traded and nontraded goods in Corsetti, Dedola and Leduc [2008b], which, in addition to endogenous capital accumulation, features trade in a noncontingent bond instead of financial autarky and deviations from the law of one price even under perfect price flexibility, due to the presence of a distribution sector (see Corsetti and Dedola 2005). We focus our analysis on the two main channels discussed above — the relative price of nontradables and the tradable wealth transmission channels —, reporting impulse responses for a version of the model without nominal rigidities, significant home bias (the import share is 15%), a share of tradables of 40%, an elasticity of substitution between tradables and nontradables equal to 0.74, and a distribution margin of 50%.

Panels A through C of Figure 2 show our main results. In each panel, we report impulse responses for a positive productivity shock to Home tradable goods only which is temporary (continuos line) or permanent (dash-dotted line); and a temporary positive aggregate shock to productivity, hitting the two Home sectors symmetrically (dashed line).[8]

In Panel A, we set a low trade elasticity between domestic and foreign tradables — i.e. we set the preference parameter ω equal to 0.5. Observe that all the shocks under consideration result in an appreciation of the relative price of nontradables relative to tradables within the Home country. However, because of the strong effects on tradable wealth associated with a low trade elasticity, also the international price of Home tradable moves in the same direction: the Home terms of trade improve while domestic consumption increases relative to the rest of the world. In other words, strong wealth effects are generated by both aggregate productivity shocks and shocks to tradables — which are also associated with Harrod-Balassa-Samuelson effects in the Home country. This exercise shows that the same mechanism studied analytically under financial autarky is also active when markets are incomplete, but agents can trade a bond across border, hence can engage in intertemporal trade.

[8] The autocorrelation of the temporary shock is set to 0.95 for both the sectoral and macro shocks.

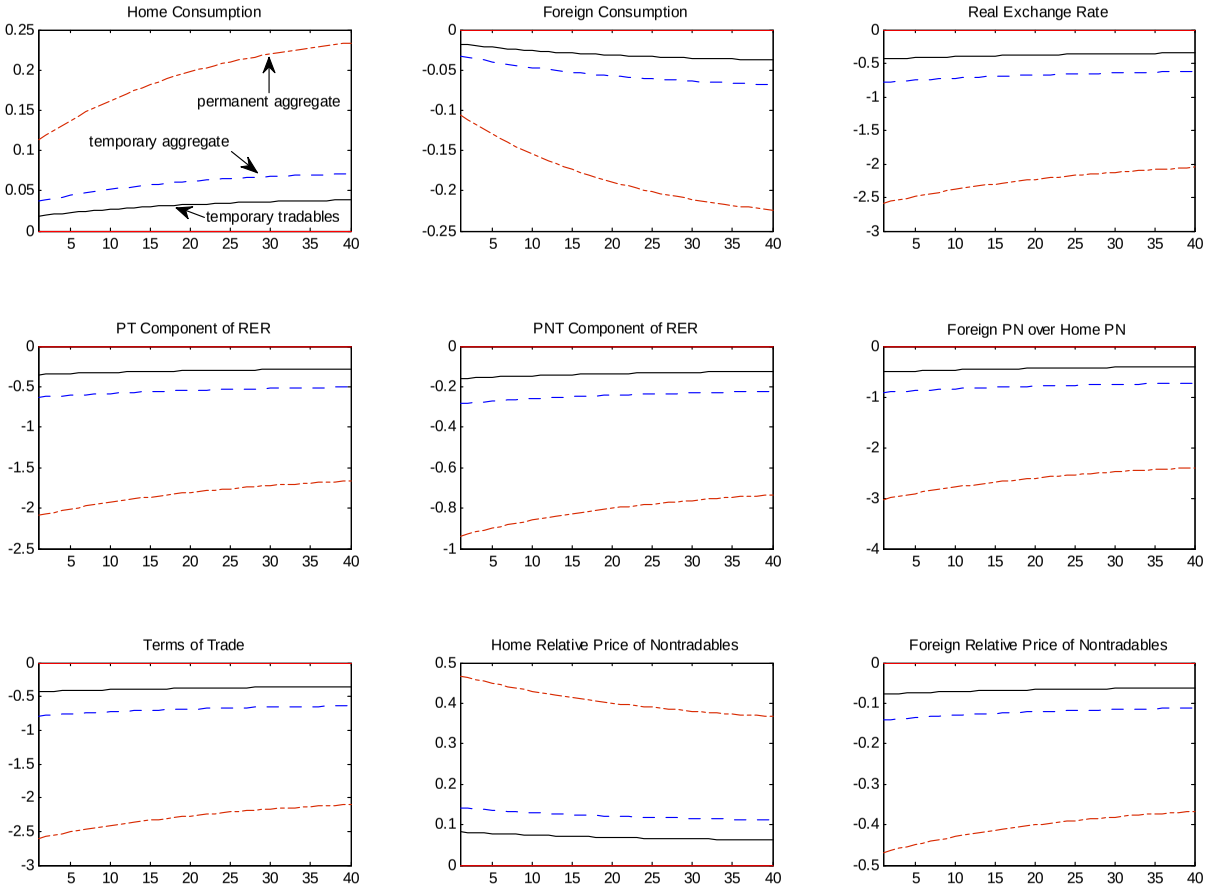


Figure 1: FIGURE 2A

In Panel B we instead explore more closely the relative price of non-tradable channel, stressing substitution effects triggered by the within-country relative price implications of sectoral shocks. In light of the analytical results in the previous section, we obtain a predominant role for this channel in the model, by setting the trade elasticity equal to a value larger than 1. Specifically, we set ω equal to 2, while keeping all the other parameters unchanged. By the Harrod-Balassa-Samuelson effect, then, with a relatively low value of ϕ, the within-country relative price of nontradables must rise significantly in response to a temporary shock to tradables, in order to shift domestic demand towards tradables while increasing relative consumption overall. This is clearly illustrated by the corresponding impulse response in the Figure. However, note that the international relative price of tradables worsens only slightly. Conversely, as expected, this channel is not operative in response to aggregate shocks, either temporary or permanent. This is because aggregate shocks end up reducing, rather than increasing, the domestic relative price of nontradables, reflecting the increased supply of these goods, while still worsening the international relative price of tradables and the terms of trade. Independently of the persistency of the shocks, the real exchange rate depreciates while relative consumption increases. Once again, the main results derived under financial autarky readily extend to the case of a bond economy.

As a final experiment, in panel C we raise ω, up to setting it equal to 4. This parameterization allows us to emphasize two results which are specific to models in which agents can borrow and lend internationally, and thus are not comprised in our discussion of the economy under financial autarky. We first observe that, as the trade elasticity is larger than one, a temporary aggregate shock leads to results similar to those in panel B, but for one important difference: when ω is raised from 2 to 4, the model fails to deliver a negative association between relative consumption and the real exchange rate. In response to positive shocks to tradables, the real appreciation driven by the increase in the within-country relative price of nontradables is now associated with a *fall* in domestic consumption relative to the foreign one, a result that is not present in economies under financial autarky. A second result, already discussed by Corsetti, Dedola and Leduc [2008a], emerges as persistent gains to either sectoral or aggregate productivity in one country translate into an increase in expected income by domestic residents, who can then raise current demand via external borrowing. In the presence of home bias the boom in domestic demand temporarily appreciates international tradable prices and the real exchange rate. This is shown in the figure for the case of aggregate persistent shocks.[9]

[9] Although not reported here, similar results would obtain with a unit root shock to tradable productivity. Interestingly, such a shock would not bring about a negative association of relative consumption and the real exchange rate for $\omega = 2$, contrary to the case of the less persistent shock depicted in panel B.

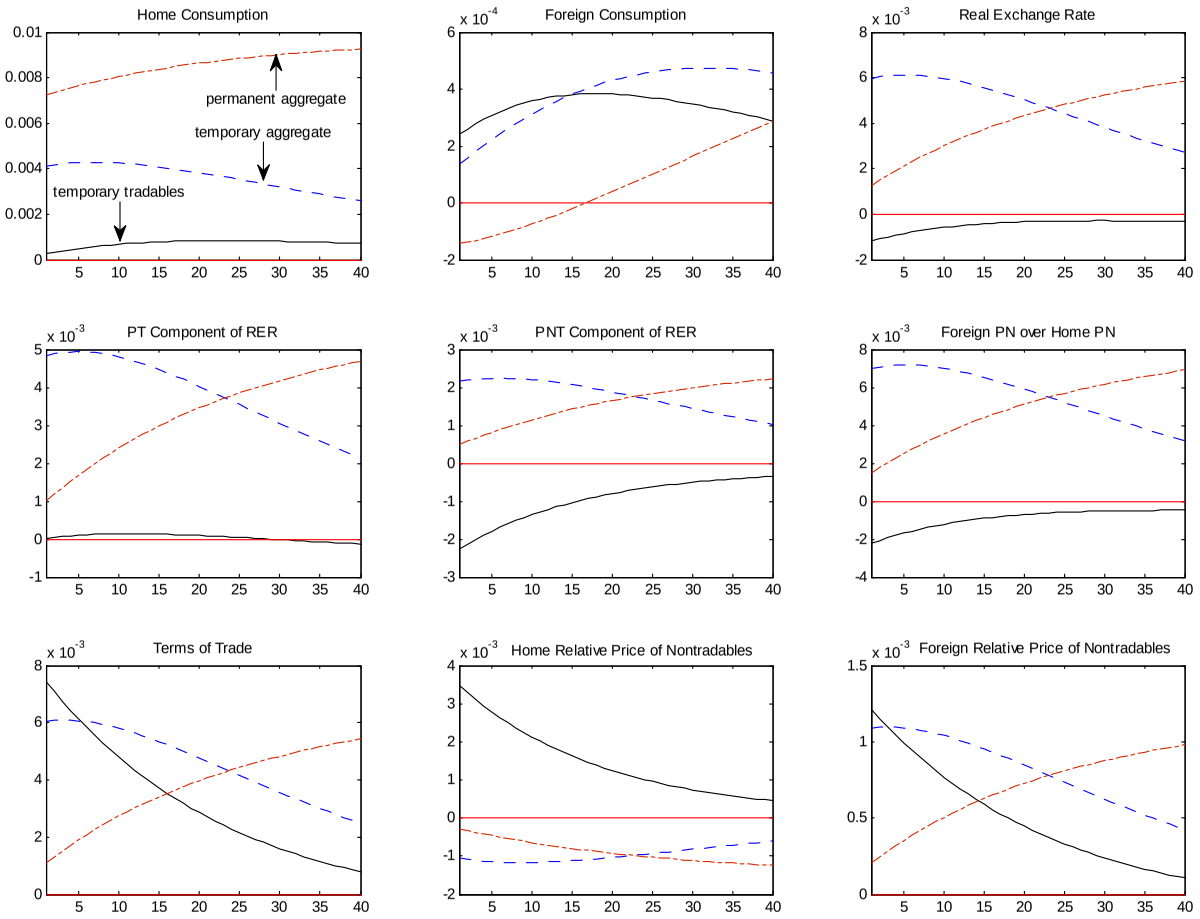


Figure 2: FIGURE 2B

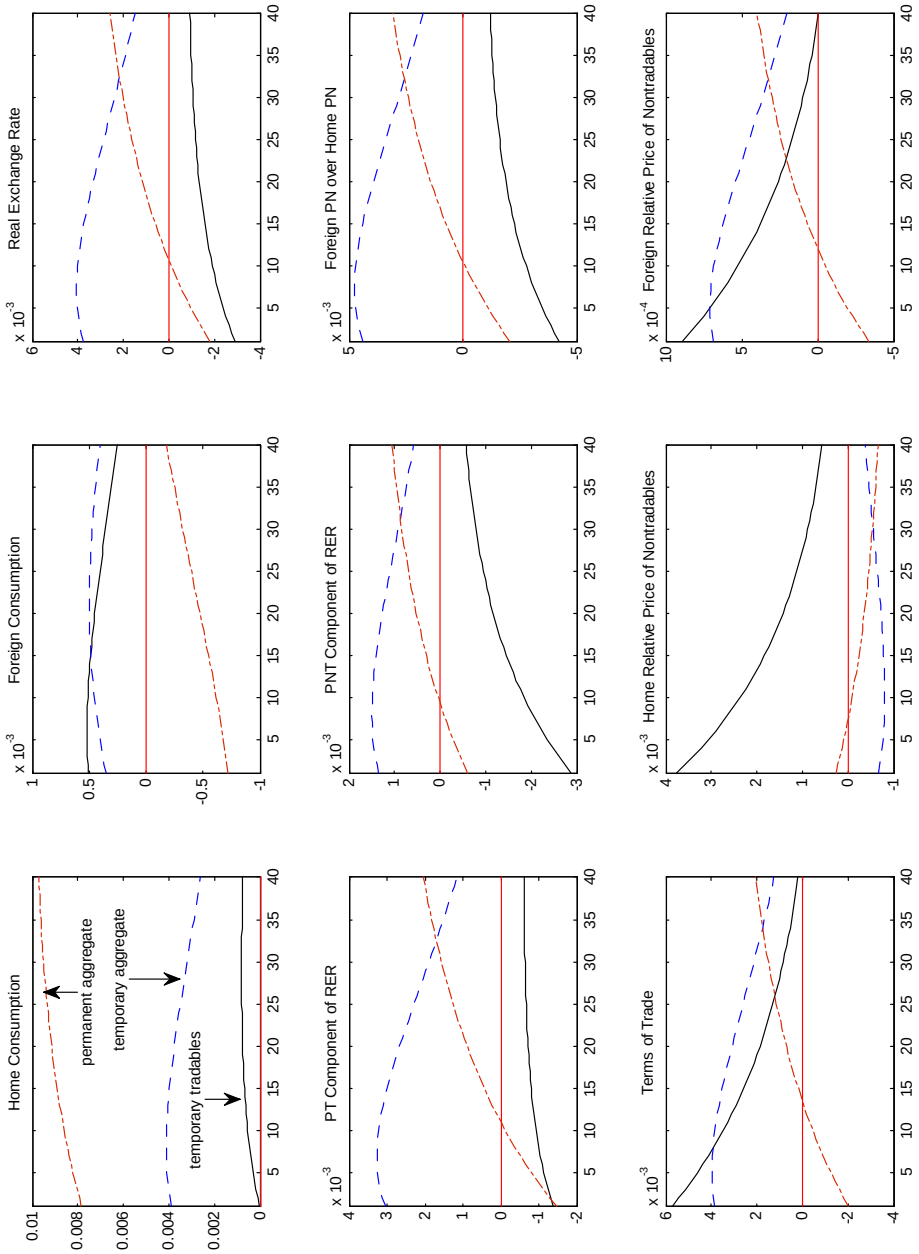


Figure 3: FIGURE 2C

5 An empirical analysis of the relative-price decomposition of the Backus-Smith correlation

The theoretical analysis in the previous Section suggests that deconstructing the Backus-Smith correlation into a tradable and a nontradable price component can substantially refine our understanding of the international risk sharing puzzle, by unveiling different possible transmission mechanisms underlying the empirical evidence presented in Table 1.[10] To carry out our empirical analysis, we reconsider the decomposition of the Backus-Smith statistic in (5):

$$Corr\left(rc, rer\right) = \frac{Cov\left(rc, rer\right)}{\sigma\left(rc\right) \cdot \sigma\left(rer\right)} = \frac{Cov\left(rc, p_T\right)}{\sigma\left(rc\right) \cdot \sigma\left(rer\right)} + \frac{Cov\left(rc, p_{NT}\right)}{\sigma\left(rc\right) \cdot \sigma\left(rer\right)} \quad (7)$$

by which the correlation between relative consumption and the real exchange rate is the sum of two terms, reflecting respectively the contribution of fluctuations in the price of traded and nontraded goods. An alternative decomposition can be written, as to highlight the role of terms of trade movements

$$\begin{aligned} Corr\left(rc, rer\right) &= \frac{Cov\left(rc, p_T\right)}{\sigma\left(rc\right) \cdot \sigma\left(rer\right)} + \frac{Cov\left(rc, p_{NT}\right)}{\sigma\left(rc\right) \cdot \sigma\left(rer\right)} = \\ &= \frac{Cov\left(rc, p_{TOT}\right)}{\sigma\left(rc\right) \cdot \sigma\left(rer\right)} + \frac{Cov\left(rc, \Delta\right)}{\sigma\left(rc\right) \cdot \sigma\left(rer\right)} + \frac{Cov\left(rc, p_{NT}\right)}{\sigma\left(rc\right) \cdot \sigma\left(rer\right)}, \quad (8) \end{aligned}$$

where $p_{TOT} = \log\left(\frac{P_{F,t}}{P^{\star}_{H,t} \cdot S_t}\right)$ denotes the terms of trade and we introduce a term Δ to account for possible deviations from the law of one price. In the rest of this section we will show results from implementing the former decomposition — (7) and (8) — on first-differenced data.

Moreover, since different channels can in principle be active at different frequencies in the data, we will use spectral analysis techniques to estimate the contribution of cycles of different frequency to the different components of (7) and (8). To wit: the dynamic correlation between relative consumption and real exchange rate at frequency λ can be decomposed into comovements of relative consumption and, respectively, traded- and nontraded-goods prices as follows

$$\begin{aligned} \rho_{C,RER}\left(\lambda\right) &= \frac{C_{C,RER}\left(\lambda\right)}{\sqrt{S_C\left(\lambda\right) \cdot S_{RER}\left(\lambda\right)}} = \\ &= \frac{C_{C,PT}\left(\lambda\right)}{\sqrt{S_C\left(\lambda\right) \cdot S_{RER}\left(\lambda\right)}} + \frac{C_{C,PN}\left(\lambda\right)}{\sqrt{S_C\left(\lambda\right) \cdot S_{RER}\left(\lambda\right)}}, \end{aligned}$$

where $C_{C,RER}\left(\lambda\right)$, $C_{C,PT}\left(\lambda\right)$ and $C_{C,PN}\left(\lambda\right)$ are the cospectra of relative consumption and, respectively, the real exchange rate, the traded- and the nontraded-goods prices at frequency λ, and S_C and S_{RER} denote spectra. Similarly, the equivalent of (8) over the frequency domain is

$$\rho_{C,RER}\left(\lambda\right) = \frac{C_{C,PTOT}\left(\lambda\right)}{\sqrt{S_C\left(\lambda\right) \cdot S_{RER}\left(\lambda\right)}} + \frac{C_{C,PN}\left(\lambda\right)}{\sqrt{S_C\left(\lambda\right) \cdot S_{RER}\left(\lambda\right)}} + \frac{C_{C,\Delta}\left(\lambda\right)}{\sqrt{S_C\left(\lambda\right) \cdot S_{RER}\left(\lambda\right)}},$$

[10] For other decompositions in the literature see e.g. Hess and Shin [2010)].

where $C_{C,PTOT}$ is the cospectrum between relative consumption and the terms of trade.

5.1 Implementation

To implement the decomposition of the real exchange rate at the heart of our theoretical discussion

$$rer = p_T + p_{NT},$$

we need to define empirical measures of the real exchange rate (rer), the cross-country relative price of tradables (p_T) and the ratio of the relative price of nontradables within countries (p_{NT}). Data on the latter are especially problematic, as there are no readily available series. Following Engel [1999] and Burstein et al. [2006], we rely on empirical measures of rer and p_T, to compute p_{NT} as a residual.

As regards the tradable-good prices p_T, we use three alternative measures. Our first two measures are based on either retail prices of goods and services, or producer price indexes, as in Engel [1999]. Observe that the former measure includes distribution costs and thus reflects in part prices of nontraded goods; the latter is immune from distribution costs, but generally excludes imports and, in certain cases, export prices (see the discussion in Burstein et al. 2006). We thus based a third measure on prices of imports and exports at the dock, following Burstein et al. [2006].

The terms of trade are constructed using export prices at the dock.[11] Since these series are not available on a bilateral basis, decomposition (8) is carried out only vis-à-vis the rest-of-the-world.

Our sample consists of 20 OECD countries, for which we have quarterly data over the period 1971:1 and 2009:2. For each country, we analyze the correlation between the ratio of domestic to foreign consumption and the real exchange rate both vis-à-vis the US, as well as vis-à-vis a trade-weigthed aggregate of the other countries in the sample — an aggregate which is dubbed 'Rest of the World', or ROW. In each table and figure, results for the two cases (bilateral relative to the US, or relative to the ROW) are shown in the panels A and B, respectively.

5.2 Results

It is well known that the BS correlation for the OECD countries, either against the US or the ROW, is low or negative, whether this is measured using differenced data or HP-filtered data. To set the stage of our contribution it is appropriate to start from the evidence emphasized by the literature. Drawing on related work of ours (Corsetti, Dedola and Viani 2011), we include in Tables 1A and 1B the contemporaneous correlation between relative consumption and

[11] Results derived by proxying the terms of trade with export deflators are not significantly different and are available upon request.

the overall real exchange rate, and its spectral decomposition — as already mentioned, Panel A refers to each country against the US, Panel B to each country against an aggregate of the rest of the world.

Looking at the BS statistics in the first column of Table 1, it is apparent that the evidence from our sample is clearly in line with earlier results from the literature. In the panel A of the Table, nearly all entries in the first column have a negative sign — 17 out of 19 cases; even when positive, the correlation is typically close to zero. In panel B, where correlation are measured for each country relative to an aggregate of other OECD countries, the number of negative entry in the first column is somewhat lower. But the correlation, even when positive, never exceeds .2.

Against this background, the key question we ask in our paper is whether it is possible to detect clear patterns of correlation, once the BS statistics is decomposed distinguishing the contribution of fluctuations in tradable and non tradable prices. The theory section of this paper suggests that the result of a low or negative overall BS correlation can in principle correspond to different correlation patterns in its components, in turn reflecting different international transmission mechanisms.

In this respect, a first key result from our price decomposition analysis is that the sign of the overall BS correlation tend to be the same as the sign of the correlation of relative consumption with the relative price of tradables (compare the first and the second column of Table 1). A large majority of countries indeed display a negative correlation of relative consumption with the relative price of tradables: when domestic consumption is high relative to consumption abroad, the international price of domestic tradable output is also high, and the terms of trade of the country appreciate — looking at the second column of Table 1, this is the case for 15 and 13 countries, in panels A and B, respectively.

In many countries, of course, the correlations of relative consumption with both tradable and nontradable prices have the same sign (9 cases in Panel A and 4 cases in panel B). This means that both components in our decomposition appear to contribute to the BS result — although, quantitatively, the component in the tradable price tend to play the dominant role in the majority of cases.

However, in some cases (in panel A: Australia, Ireland, Japan and New Zealand) a different pattern emerges. The international price of output falls (the entry in the second column is positive), while the nontradable price component appreciates (the entry in the third column is negative). In these cases, the sign of the overall BS correlation appears to be determined by fluctuations in nontradable prices.

Based on contemporaneous correlation, therefore, our empirical evidence suggests that in most OECD countries the correlation pattern by price components tends to support models of the international transmission mechanism featuring a strong role for wealth and demand effects — whereas shocks associated with a rising domestic demand tends to strengthen the international price of domestic tradable goods. Yet, there is also evidence that the contribution of the price of nontradables is not negligible. In some countries, indeed, the correlation pattern across components is consistent with the alternative model

featuring a strong role for Harrod-Balassa-Samuleson effects.

As discussed in our previous work, spectral analysis unveils new important dimensions of the evidence. Using a standard incomplete market open-economy model, in Corsetti, Dedola and Viani [2011] we show that an overall negative covariance between relative consumption and the real exchange rate does not necessarily imply a negative cospectrum at all frequencies. In standard incomplete-market models, in fact, differences across frequencies in the cospectrum of the BS correlation are driven by the insurable component driving the consumption differential and international relative prices. This component reflects the endogenous dynamics of the state variables and thus the specific features of the propagation mechanism embedded in each model. By way of example: if in equilibrium the real exchange rate follows a random walk then in a bond economy the dynamic correlation should be expected to be constant across all frequencies. On the one hand, the contemporaneous covariance between the real exchange rate and the cross-country differential in the growth rate of consumption will generally be non-zero, even in the case of a bond economy, because of uninsured risk. On the other hand, the fact that the model predicts no forecastability for the rate of depreciation has strong implications for the amount of insurance provided by trade in bonds. Indeed, it can be shown that in the random walk case the bond will not be used in equilibrium. For more general stochastic processes, implying that the exchange is not a random walk, it may well be possible that one-bond (incomplete-market) models addressing the BS puzzle would nonetheless predict positive dynamic correlation at some frequency. A sign switch would of course raise interesting empirical question: would it be consistent with the data? More fundamentally, however, what is at stake is whether the amount of insurance can change so much at some frequency, as to result in such a switch in the BS correlation over the spectrum.

Results from the spectral analysis of the BS statistics are also reproduced in Table 1 (columns 4, 7 and 10 in Panel A, 5, 9 and 13 in Panel B). Note that, consistent with the considerations above, the dynamic correlation is not constant: at low and business-cycle frequencies, the inverse BS correlation tends to be stronger. As shown in the Table, more countries display a negative correlation at low and business-cycle frequencies, than at higher frequencies. Not only the intensity of the inverse correlation is correspondingly higher at low and business cycle frequencies (the sample average is -.04 at high frequencies, but -.18 and -.22 at business-cycle and low frequencies, respectively). Also, for some of the countries exhibiting an overall positive correlation (such as Austria), the correlation at business-cycle and/or low frequencies is actually negative. This is likely to reflect the well known fact that, with differenced data, standard correlations in the time domain tend to boost the high frequency components of time series (see e.g. Croux et al. [2001]).

The evidence from spectral analysis is equally instructive when applied to our decomposition of the Backus-Smith statistics. Results at different frequencies are shown in Tables 1 through 3, as well as in Figure 1 through 3 in the appendix. The three tables differ in the way tradable prices are computed: import and export prices are used in Table 1, producer prices in Table 2 and consumer prices

of goods in Table 3. They therefore differ in the extent to which tradable price indexes include a component in the price of nontradables goods and services. Since the relevant price indexes are not necessarily available for all countries over the same time spans, the tables differ in the underlying sample (see the appendix for details). The same information of the Table is further detailed in the Figures, which plot the dynamic correlation by frequency.

As a first finding, note that our results are consistent with the notion that the Harrod-Balassa-Samuelson mechanism is operative at low frequencies, rather than at high frequencies. In Table 1 and 2 (and the corresponding Figures), the correlation between relative consumption and nontradable good prices tends to be negative for more countries at business cycle and lower frequencies. Results in Table 3 are less stark, since the use of retail prices to proxy for tradables arguably blurs a clear distinction between tradables and nontradable prices across the two components of the real exchange rate. In interpreting this finding, it is natural to conjecture that HBS effects should be forecastable — especially in the medium and long run. Our theoretical analysis in Sections 3 and 4 then suggests that, to the extent that agents have access to enough financial instruments to share risk, the negative correlation of the nontradable price component of the BS statistics should be (more than) compensated by a positive and large value for the other component, in the tradable prices.

Concerning the component in tradable prices, however, we find that its contribution to the BS correlation also varies across frequencies, but different patterns emerge. In Table 1, about half the countries in the sample display a large negative entry at lower frequencies. This is strong evidence against risk sharing. However, there are also several cases of countries in which the correlation between relative consumption and the real exchange rate for tradables is actually positive at lower frequencies — consistent with the view that supply shocks driving up relative consumption also translate into a weakening of the international price of a country's output. Observe that, whether the evidence is referred to the real exchange rate, or its relative price components, spectral analysis underscores the notion that contemporaneous correlations computed with first differenced data would give a distorted picture of most relations at the frequencies more relevant for models.

Focusing on Tables 1 (and the corresponding Figure 1), we can further detail the evidence in relation to the different channels of transmission highlighted by the literature. Namely, while negative signs occur for both terms in our decomposition, in the majority of cases a negative sign of the overall BS correlation at low and business cycle frequencies coincides with a negative entry for the component in the relative price of tradables. Looking at the columns referred to business cycle frequencies, for instance, this is the case for 13 countries out of 17 in Table 1A, for 9 countries out of 13 in Table 1B.[12] Moreover, virtually all countries for which the overall BS statistic is positive tend to display a positive association between the relative price of tradables and relative consumption.

[12] At a low frequency, the corresponding figures are 15 out of 19, and 11 out of 15, respectively.

Yet, once again, this is not an exclusive pattern. In some countries, a negative BS statistic at low or business cycle frequencies can actually be attributed to the non-traded good price component, as the corresponding correlation for tradables is actually positive — see for instance Australia and Canada, for which this is the case in both panels of Table 1.

Observe further that BS correlations computed using tradable and nontradable prices tend to be more negative at lower frequencies in the case of Finland, Sweden, New Zealand and the UK, as shown in Figure 1A and 1B, suggesting that for these countries both the Balassa-Samuelson effect and the endogenous wealth effects are effective in the medium to long run.

Since our measure of the nontradables real exchange rate does not depend on the nominal currency rates, a large negative correlation with the nontradables real exchange rate — and a significant contribution of this component to the overall BS statistics especially at business cycle and lower frequencies — suggest that the puzzle cannot be exclusively ascribed to nominal exchange rate fluctuations. By the same token, the fact that the BS puzzle is more pronounced at low frequencies arguably points to a contained role of possible explanations emphasizing nominal rigidities.

We conclude by stressing that our conclusions are substantially unchanged when using the terms of trade, instead of the price of tradables. But when we use our measure of the relative price of tradables built using the PPI or the CPI-good indexes, perhaps not surprisingly, the role of the tradable relative price component as a driver of negative correlations appears even stronger.

TABLE 1A

Correlation of relative consumption and relative prices vis-á-vis the US

Prices of tradables are import and export prices at the dock

COUNTRY	Differenced series			Dynamic Correlation								
				Low frequency			BC frequency			High frequency		
	RER	P_T	P_{NT}	RER	P_T	P_{NT}	RER	P_T	P_{NT}	RER	P_T	P_{NT}
Australia	-0,07	0,00	-0,07	-0,33	-0,11	-0,23	-0,10	0,06	-0,16	-0,01	0,00	-0,01
Austria	0,00	-0,02	0,02	-0,16	0,02	-0,17	-0,11	-0,04	-0,06	0,04	-0,02	0,06
Belgium	-0,08	-0,01	-0,07	-0,20	0,05	-0,25	-0,09	0,03	-0,12	-0,04	-0,05	0,01
Canada	-0,16	-0,06	-0,10	-0,21	0,12	-0,33	-0,24	0,02	-0,26	-0,12	-0,12	0,01
Switzerland	-0,06	-0,04	-0,02	-0,12	-0,05	-0,07	0,02	0,08	-0,06	-0,09	-0,10	0,01
Denmark	-0,20	-0,19	-0,02	-0,30	-0,21	-0,09	-0,25	-0,22	-0,03	-0,16	-0,17	0,00
Spain	-0,21	-0,18	-0,03	-0,53	-0,29	-0,24	-0,37	-0,22	-0,15	0,01	-0,11	0,13
Finland	-0,10	-0,10	0,00	-0,47	-0,31	-0,15	-0,33	-0,23	-0,10	0,05	-0,02	0,06
France	-0,07	-0,17	-0,03	-0,22	-0,23	-0,04	-0,06	-0,12	-0,04	-0,04	-0,17	-0,03
Germany	-0,12	-0,06	-0,06	-0,21	-0,04	-0,17	-0,18	-0,12	-0,06	-0,10	-0,04	-0,05
Ireland	-0,05	0,03	-0,07	-0,16	-0,03	-0,12	-0,01	0,12	-0,13	-0,04	-0,01	-0,04
Italy	-0,01	-0,21	0,20	-0,25	-0,34	0,09	-0,10	-0,21	0,11	0,10	-0,18	0,28
Japan	0,02	0,04	-0,01	-0,14	0,01	-0,16	0,01	0,06	-0,05	0,05	0,03	0,02
Korea	-0,46	-0,34	-0,12	-0,47	-0,21	-0,26	-0,55	-0,33	-0,22	-0,44	-0,36	-0,08
Netherlands	-0,12	-0,07	-0,05	-0,22	-0,12	-0,10	-0,22	-0,14	-0,08	-0,08	-0,04	-0,04
Norway	-0,06	-0,17	0,11	-0,13	-0,48	0,35	-0,13	-0,33	0,20	-0,03	-0,09	0,05
New Zealand	-0,04	0,03	-0,07	-0,44	-0,14	-0,30	-0,27	-0,03	-0,24	0,10	0,07	0,03
Sweden	-0,17	-0,13	-0,03	-0,45	-0,29	-0,16	-0,20	-0,15	-0,04	-0,10	-0,09	0,00
UK	-0,08	-0,11	0,03	-0,42	-0,20	-0,23	-0,34	-0,16	-0,18	0,02	-0,09	0,11
US	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Median	-0,08	-0,07	-0,03	-0,22	-0,14	-0,16	-0,18	-0,12	-0,08	-0,04	-0,09	0,01

NOTE: Correlations of relative consumption and tradable and nontradable prices are normalized using real exchange rate standard deviations

TABLE 1B

Correlation of relative consumption and relative prices vis-á-vis the rest-of-the-world
Prices of tradables are import and export prices at the dock

COUNTRY	Differenced series				Dynamic Correlation Low frequency				BC frequency				High frequency			
	RER	P_T	P_{NT}	P_{TOT}	RER	P_T	P_{NT}	P_{TOT}	RER	P_T	P_{NT}	P_{TOT}	RER	P_T	P_{NT}	P_{TOT}
Australia	-0,05	0,02	-0,07	-0,01	-0,32	-0,05	-0,27	-0,09	-0,01	0,12	-0,13	0,07	-0,03	0,00	-0,02	-0,02
Austria	0,07	-0,05	0,10	-0,17	-0,27	0,08	-0,32	-0,06	-0,14	0,00	-0,13	-0,04	0,12	-0,06	0,17	-0,10
Belgium	0,12	0,41	-0,27	0,51	0,21	0,77	-0,54	0,49	0,25	0,46	-0,18	0,31	0,04	0,32	-0,26	0,18
Canada	-0,13	-0,04	-0,09	-0,25	-0,12	0,14	-0,28	-0,07	-0,21	0,02	-0,22	-0,14	-0,10	-0,10	0,00	-0,13
Switzerland	0,19	0,21	-0,02	0,22	0,29	0,00	0,27	0,02	0,26	0,21	0,04	0,13	0,15	0,24	-0,09	0,11
Denmark	-0,06	-0,11	0,05	-0,08	-0,15	-0,06	-0,10	0,06	-0,05	-0,30	0,24	-0,17	-0,05	-0,04	-0,01	0,00
Spain	-0,05	-0,08	0,05	-0,08	-0,35	-0,34	0,02	-0,22	-0,21	-0,22	0,01	-0,12	0,11	0,05	0,07	0,04
Finland	-0,07	-0,10	0,02	-0,15	-0,55	-0,51	-0,05	-0,37	-0,36	-0,36	-0,02	-0,25	0,14	0,08	0,05	0,06
Germany	-0,02	-0,05	0,01	-0,03	-0,07	-0,16	0,08	-0,16	0,10	-0,12	0,16	-0,16	-0,05	-0,04	-0,03	0,02
Ireland	0,19	0,11	0,09	0,12	0,32	0,09	0,23	0,07	0,32	0,29	0,04	0,19	0,12	0,03	0,10	0,00
Italy	-0,08	-0,37	0,33	-0,57	-0,32	-0,76	0,44	-0,64	-0,12	-0,46	0,40	-0,37	-0,03	0,28	0,28	-0,20
Japan	0,09	0,03	0,05	0,00	-0,07	0,03	-0,10	0,05	0,12	0,09	0,02	0,08	0,10	0,02	0,07	-0,03
Korea	-0,41	-0,38	-0,04	-0,62	-0,49	-0,34	-0,15	-0,30	-0,53	-0,44	-0,09	-0,38	-0,38	-0,36	-0,02	-0,30
Netherlands	-0,04	-0,03	-0,01	-0,20	-0,17	0,00	-0,17	0,02	-0,18	0,00	-0,19	0,04	0,01	-0,05	0,05	-0,16
Norway	0,03	-0,30	0,32	-0,54	-0,01	-1,03	1,00	-0,94	-0,04	-0,55	0,51	-0,48	0,05	-0,17	0,21	-0,14
New Zealand	0,05	0,07	-0,02	-0,01	-0,44	-0,22	-0,22	-0,21	-0,17	-0,03	-0,13	-0,07	0,16	0,13	0,03	0,04
Sweden	-0,15	-0,13	0,00	-0,20	-0,28	-0,35	0,09	-0,25	-0,24	-0,25	0,03	-0,17	-0,10	-0,07	-0,03	-0,05
UK	0,06	-0,04	0,12	-0,07	0,02	0,10	-0,05	0,05	0,02	0,10	-0,06	0,03	0,09	-0,10	0,20	-0,06
US	-0,20	-0,10	-0,11	-0,15	-0,36	-0,04	-0,32	-0,04	-0,26	-0,03	-0,24	-0,05	-0,14	-0,14	0,00	-0,09
Median	-0,03	-0,05	0,01	-0,08	-0,16	-0,05	-0,10	-0,07	-0,09	-0,03	-0,02	-0,07	0,05	-0,04	0,03	-0,03

NOTE: See note to Table 1A. The rest-of-the-world is a trade-weighted aggregate of all the countries in the same table. See the data appendix for a description of the weights

TABLE 2A

Correlation of relative consumption and relative prices vis-á-vis the US

Prices of tradables are producer price indexes

COUNTRY	Differenced series		Dynamic Correlation					
			Low frequency		BC frequency		High frequency	
	P_T	P_{NT}	P_T	P_{NT}	P_T	P_{NT}	P_T	P_{NT}
Australia	-0,03	-0,04	-0,21	-0,12	-0,02	-0,07	0,00	-0,01
Austria	-0,05	0,05	-0,11	-0,05	-0,11	0,01	-0,03	0,07
Canada	-0,10	-0,06	-0,11	-0,10	-0,16	-0,08	-0,07	-0,05
Switzerland	-0,07	0,00	-0,14	0,03	-0,03	0,04	-0,07	-0,02
Denmark	-0,21	0,00	-0,28	-0,03	-0,25	-0,01	-0,18	0,01
Spain	-0,14	-0,07	-0,37	-0,16	-0,28	-0,09	0,04	-0,03
Finland	-0,11	0,01	-0,46	0,00	-0,32	-0,01	0,03	0,02
Germany	-0,14	0,02	-0,21	0,00	-0,21	0,03	-0,12	0,02
Ireland	0,03	-0,08	-0,04	-0,12	0,11	-0,13	0,00	-0,04
Italy	-0,06	0,01	-0,36	0,01	-0,23	0,00	0,08	0,02
Japan	0,02	0,00	-0,11	-0,03	0,05	-0,03	0,03	0,02
Korea	-0,40	-0,06	-0,35	-0,12	-0,46	-0,09	-0,39	-0,05
Netherlands	-0,10	-0,03	-0,12	-0,10	-0,16	-0,06	-0,08	0,00
Norway	-0,15	0,08	-0,36	0,18	-0,25	0,12	-0,10	0,06
New Zealand	-0,06	0,02	-0,26	-0,18	-0,18	-0,09	0,01	0,09
Sweden	-0,18	0,01	-0,41	-0,05	-0,24	0,04	-0,11	0,01
UK	-0,08	0,00	-0,34	-0,09	-0,27	-0,07	0,00	0,02
US	NA	NA	NA	NA	NA	NA	NA	NA
Median	-0,10	0,00	-0,26	-0,05	-0,21	-0,03	-0,03	0,01

NOTE: See note to Table 1A

TABLE 2B

Correlation of relative consumption and relative prices vis-á-vis the rest-of-the-world
Prices of tradables are producer price indexes

COUNTRY	Differenced series			Dynamic Correlation								
				Low frequency			BC frequency			High frequency		
	P_T	P_{NT}	P_{TOT}	P_T	P_{NT}	P_{TOT}	P_T	P_{NT}	P_{TOT}	P_T	P_{NT}	P_{TOT}
Australia	0,04	-0,05	0,03	-0,05	-0,13	-0,06	0,04	-0,09	0,02	0,05	-0,01	0,03
Austria	-0,02	0,07	0,06	0,08	-0,09	-0,02	0,09	-0,01	0,11	-0,06	0,12	0,01
Canada	-0,04	-0,08	-0,22	-0,02	-0,13	-0,10	-0,08	-0,11	-0,10	-0,02	-0,06	-0,11
Switzerland	0,11	0,01	0,20	-0,23	0,06	-0,08	-0,01	0,06	0,05	0,19	-0,01	0,14
Denmark	0,01	0,03	0,19	-0,02	-0,02	0,25	0,05	0,03	0,13	0,00	0,03	0,06
Spain	-0,06	-0,07	-0,07	-0,24	-0,14	-0,19	-0,17	-0,12	-0,13	0,05	-0,02	0,06
Finland	-0,21	0,02	-0,29	-0,52	-0,07	-0,37	-0,43	-0,06	-0,30	0,07	0,11	0,05
Germany	-0,20	0,08	-0,08	-0,20	0,02	-0,29	-0,30	0,09	-0,18	-0,19	0,09	0,01
Ireland	0,25	-0,02	0,08	0,39	0,01	0,12	0,31	0,01	0,15	0,18	-0,05	-0,04
Italy	-0,09	0,01	-0,78	-0,28	-0,07	-1,02	-0,15	-0,02	-0,65	-0,06	0,03	-0,26
Japan	0,11	0,01	-0,06	0,13	0,02	0,09	0,23	0,00	0,08	0,07	0,01	-0,07
Korea	-0,41	-0,08	-0,76	-0,39	-0,14	-0,39	-0,42	-0,12	-0,40	-0,43	-0,07	-0,38
Netherlands	-0,03	0,05	-0,18	0,10	0,01	0,08	0,00	0,02	0,05	-0,05	0,07	-0,14
Norway	-0,12	0,13	-0,52	-0,33	0,46	-1,03	-0,18	0,19	-0,58	-0,09	0,09	-0,12
New Zealand	0,01	0,07	-0,08	-0,34	-0,12	-0,40	-0,11	-0,05	-0,21	0,07	0,11	0,03
Sweden	-0,17	-0,01	-0,20	-0,13	-0,03	-0,16	-0,21	-0,02	-0,14	-0,16	0,00	-0,08
UK	-0,01	0,01	-0,17	-0,03	0,00	-0,12	-0,05	0,01	-0,09	0,01	0,02	-0,08
US	-0,16	-0,10	-0,16	-0,29	-0,07	-0,04	-0,22	-0,10	-0,06	-0,11	-0,10	-0,10
Median	-0,03	0,01	-0,12	-0,17	-0,05	-0,11	-0,09	-0,01	-0,10	-0,01	0,01	-0,06

NOTE: See note to Table 1A

TABLE 3A

Correlation of relative consumption and relative prices vis-á-vis the US

Prices of tradables are goods' retail prices

COUNTRY	Differenced series		Dynamic Correlation					
			Low frequency		BC frequency		High frequency	
	P_T	P_{NT}	P_T	P_{NT}	P_T	P_{NT}	P_T	P_{NT}
Australia	-0,04	-0,01	-0,25	-0,07	-0,03	-0,05	-0,01	0,01
Belgium	-0,12	0,00	-0,25	-0,01	-0,08	-0,01	-0,11	0,02
Canada	-0,31	0,02	-0,36	0,02	-0,36	0,02	-0,27	0,02
Switzerland	-0,11	-0,01	-0,31	0,00	-0,08	-0,01	-0,07	-0,01
Denmark	-0,25	0,02	-0,39	0,03	-0,32	0,03	-0,19	0,01
Spain	-0,26	0,02	-0,54	0,05	-0,46	0,05	-0,06	-0,01
Finland	-0,25	-0,02	-0,53	-0,07	-0,46	-0,03	-0,02	0,00
France	-0,20	0,00	-0,25	-0,02	-0,16	0,00	-0,20	0,01
Germany	-0,08	0,01	-0,21	0,03	-0,15	0,03	-0,05	0,01
Ireland	0,00	0,03	-0,01	0,06	-0,02	0,05	0,02	0,01
Italy	-0,12	0,02	-0,50	0,03	-0,24	0,01	0,03	0,02
Japan	0,03	0,01	-0,16	0,04	-0,11	0,04	0,09	0,00
Netherlands	-0,06	0,01	-0,06	0,06	0,04	0,06	-0,08	-0,01
Norway	-0,22	0,00	-0,51	0,05	-0,38	0,04	-0,17	-0,01
New Zealand	-0,25	-0,01	-0,71	-0,06	-0,61	-0,04	-0,05	0,01
Sweden	-0,22	-0,01	-0,63	0,03	-0,32	0,04	-0,11	-0,04
UK	-0,11	0,02	-0,18	0,01	-0,23	0,03	-0,08	0,01
US	NA	NA	NA	NA	NA	NA	NA	NA
Median	-0,12	0,01	-0,31	0,03	-0,23	0,03	-0,07	0,01

NOTE: See note to Table 1A

TABLE 3B

Correlation of relative consumption and relative prices vis-á-vis the rest-of-the-world

Prices of tradables are goods' retail prices

COUNTRY	Differenced series			Dynamic Correlation Low frequency			BC frequency			High frequency		
	P_T	P_{NT}	P_{TOT}	P_T	P_{NT}	P_{TOT}	P_T	P_{NT}	P_{TOT}	P_T	P_{NT}	P_{TOT}
Australia	0,05	0,01	0,13	0,23	-0,02	0,16	0,13	0,00	0,15	0,01	0,01	0,03
Belgium	0,40	-0,31	0,44	0,19	-0,43	0,02	0,21	-0,37	0,21	0,51	-0,29	0,25
Canada	-0,22	-0,04	-0,24	-0,25	-0,04	-0,08	-0,19	-0,03	-0,04	-0,23	-0,04	-0,16
Switzerland	0,10	-0,04	0,17	-0,28	-0,05	-0,09	-0,15	-0,07	-0,09	0,22	-0,04	0,16
Denmark	-0,08	0,01	0,03	0,10	0,05	0,16	0,02	0,04	0,11	-0,12	0,00	-0,02
Spain	-0,16	0,13	-0,32	-0,26	0,16	-0,19	-0,28	0,15	-0,19	-0,10	0,11	-0,14
Finland	-0,14	0,01	-0,12	-0,35	0,04	-0,25	-0,42	0,06	-0,21	-0,01	-0,01	0,02
France	-0,19	-0,01	-0,73	-0,48	-0,07	-0,22	-0,35	-0,08	-0,30	-0,08	0,03	-0,43
Germany	0,01	0,00	0,50	0,22	-0,02	0,45	0,13	-0,03	0,41	-0,05	0,02	0,18
Ireland	0,25	-0,03	0,18	0,40	-0,01	0,14	0,30	-0,02	0,14	0,20	-0,04	0,06
Italy	0,17	-0,02	-0,30	0,07	0,05	-0,41	0,19	0,07	-0,16	0,17	-0,05	-0,12
Japan	0,18	-0,02	0,26	0,05	0,02	0,24	0,16	0,01	0,19	0,20	-0,03	0,11
Netherlands	0,30	-0,03	-0,42	0,18	0,01	-0,31	0,33	-0,02	-0,28	0,30	-0,04	-0,17
Norway	-0,02	0,03	0,17	0,00	0,05	0,19	-0,08	0,05	0,08	-0,01	0,02	0,08
New Zealand	-0,30	-0,01	-0,35	-0,74	-0,02	-0,37	-0,65	-0,02	-0,27	-0,09	-0,01	-0,11
Sweden	-0,05	0,01	-0,12	-0,65	0,03	-0,38	-0,28	0,07	-0,22	0,10	-0,02	0,02
UK	0,01	-0,04	-0,04	-0,09	-0,10	-0,04	-0,10	-0,10	-0,04	0,07	-0,01	-0,01
US	-0,04	-0,04	-0,13	-0,19	-0,01	-0,07	-0,14	-0,01	-0,07	0,03	-0,05	-0,06
Median	-0,01	-0,01	-0,08	-0,05	-0,01	-0,07	-0,09	-0,01	-0,06	0,02	-0,01	0,01

NOTE: See note to Table 1A

6 Conclusion

For more than two decades, a large body of evidence consistent with the limited degree of cross border risk sharing, especially the "Backus-Smith puzzle", has provided a key hurdle for models of the international transmission. In this paper we have reconsidered this puzzle, by deconstructing it according to the traditional decomposition of the real exchange rate, in its tradable and nontradable goods price components, and by exploring its validity at different frequencies. We have shown that, especially at business cycle and lower frequencies, the correlation between relative consumption and the overall real exchange rate for tradable goods is negative for most countries. Tradable prices tend to appreciate when domestic consumption demand rises relative to the rest of the world, and tend to play a dominant role in driving the BS correlation. Nonetheless, there are also cases in which the real appreciation is driven by the price of nontradables, with limited variations in the terms of trade. Our evidence thus suggests that the data are consistent with a plurality of transmission mechanisms, raising interesting issues in the structural and policy determinants of the differences detected in the data.

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A Appendix. Data sources

We collected quarterly data on real consumption from the OECD Economic Outlook for Australia, Austria, Belgium, Canada, Switzerland, Denmark, Spain, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, New Zealand, Sweden, the UK and the US. Consumer price indexes, nominal exchange rates, producer price indexes, import and export prices at the dock are quarterly data from the IMF International Financial Statistics database for the period 1971:1-2009:2.[13] Due to data availability, for Canada, Ireland, Italy, the Netherlands, Norway, and Spain we use unit value indices as import and export prices at the dock. It should be noted that these might be affected by changes in the composition of imports and exports. Export deflators are from the OECD Economic Outlook. Goods in CPI series were obtained either from the BIS, Eurostat, or national sources. Monthly data were transformed into quarterly by averaging. The seasonal component of the series was removed using Census X12 filter with multiplicative specification. The sources and sample

[13] Import and export prices at the dock are available for France only for the period 1990:1–2009:2. PPI series for Italy and Norway start respectively in 1981:1 and 1977:1. PPI data are not available for Belgium and France.

lengths of goods in CPI data are summarized in Table 6. For the US an alternative series for goods in CPI was constructed, based on consumer prices on different items. We collected data on CPI all items (ai), all commodities less food and beverages (aclfb), food and beverages (fb), services less rent (slr), and rent (r), from the Bureau of Labor Statistics. Following Engel [1999] we run the regression

$$\begin{aligned}\Delta\left(\log ai_t - \log r_t\right) &= \phi_1 \Delta\left(\log aclfb_t - \log r_t\right) + \phi_2 \Delta\left(\log fb_t - \log r_t\right) + \\ &+ \phi_3 \Delta\left(\log slr_t - \log r_t\right) + \varepsilon_t\end{aligned}$$

The US series for goods in CPI was constructed as

$$CPIg_t^{US} = \left(\frac{\phi_1}{\phi_1 + \phi_2}\right) \cdot aglf_t + \left(\frac{\phi_2}{\phi_1 + \phi_2}\right) \cdot fb_t$$

For each country in our dataset, the Foreign counterpart is either the US or a trade-weighted aggregate of all the other countries in the sample. In the latter case, S_t, $P_t^\star$, $P_t^{T\star}$, and the price of Foreign exports are trade-weighted averages of all the other countries in the dataset. Trade weights were built computing bilateral trade shares. Namely, we computed the trade share of country i from country j as

$$0.5 \cdot \frac{\exp_j^i}{\exp^i} + 0.5 \cdot \frac{\text{imp}_j^i}{\text{imp}^i}$$

where $\exp_j^i$ and imp_j^i are exports and imports from country j, and $\exp^i$ and imp^i denote total exports and imports of country i. Exports and imports are averages of annual data over the period 1980-2008, collected from the IMF Direction of Trade Statistics. For the median country trade weights account for roughly 73% of total imports and exports.

B Appendix. Spectral analysis

Spectra and cospectra are estimated non-parametrically using a smoothing window of length $m = (T)^{1/2}$, where T is the sample size. In particular, we use a Tukey window, which associates any linearly-spaced vector x to

$$w(x) = \left\{ \begin{array}{cc} \frac{1}{2} \cdot \left\{1 + \cos\left(\frac{2\pi}{r}\left[x - r/2\right]\right)\right\}, & 0 \leq x \leq r/2 \\ 1, & r/2 \leq x \leq 1 - r/2 \\ \frac{1}{2} \cdot \left\{1 + \cos\left(\frac{2\pi}{r}\left[x - 1 + r/2\right]\right)\right\}, & 1 - r/2 \leq x \leq 1 \end{array} \right\},$$

where r is the smoothing parameter indicating the ratio of taper to constant section in the window, and is assumed to be equal to 0.5.[14]

[14] The Tukey window collapses to a rectangular window for $r = 0$ and to a Hanning window for $r = 1$. Results obtained with these two alternative parametrizations are available upon request.

TABLE 6
Goods in CPI data

COUNTRY	Source	Data Start	Notes
Australia	BIS	1974Q3	
Austria	NA		
Belgium	BIS	1977Q1	
Canada	BIS	1992Q1	Seasonally adjusted at the source
Switzerland	BIS	1983Q1	
Denmark	BIS	1980Q1	
Spain	Eurostat	1992Q1	
Finland	Eurostat	1987Q1	
France	Eurostat	1990Q1	
Germany	Eurostat	1985Q1	Seasonally adjusted at the source
Ireland	Eurostat	1995Q1	
Italy	Eurostat	1987Q1	
Japan	Statistics Bureau	1971Q1	Seasonally adjusted at the source
Korea	NA		
Netherlands	Eurostat	1988Q1	
Norway	Eurostat	1995Q1	
New Zealand	BIS	1988Q4	
Sweden	BIS	1971Q1	
UK	Eurostat	1996Q2	
US	BIS/BSL	1971Q1/1983Q1	

C Appendix. Figures and Tables

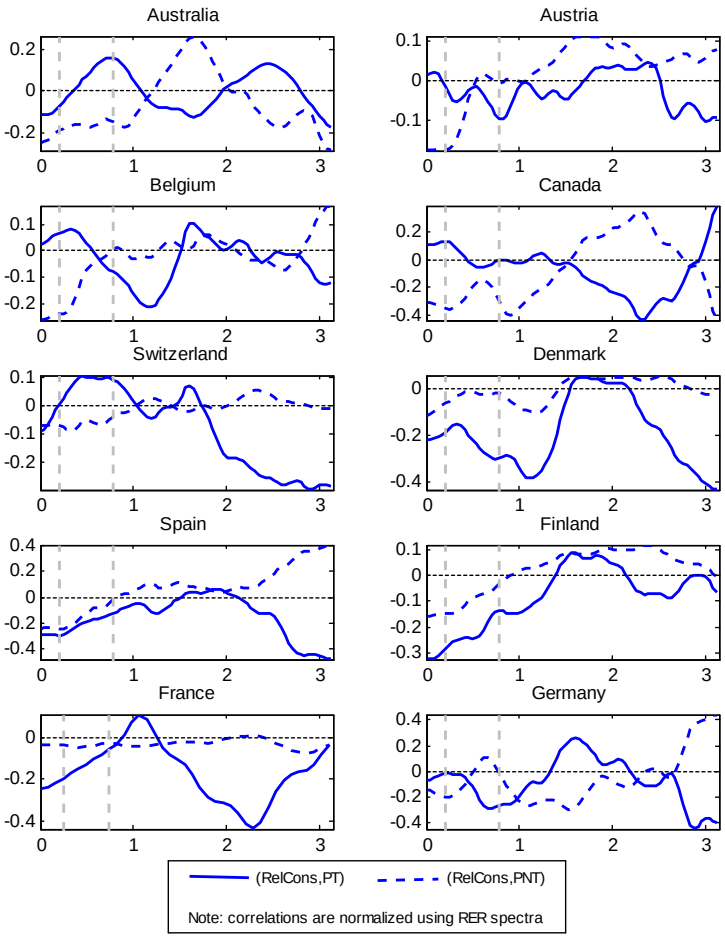


FIGURE 1A

Dynamic correlations of relative consumption and relative prices vis-à-vis the US. Tradable prices are import and export prices at the dock.

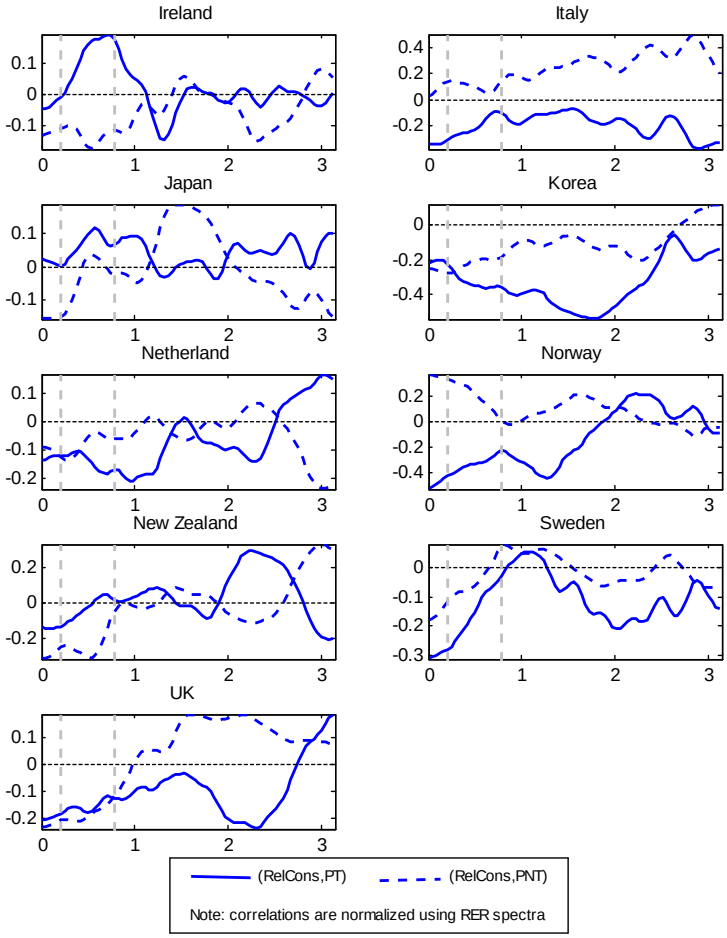


FIGURE 1B

Dynamic correlations of relative consumption and relative prices vis-à-vis the US. Tradable prices are import and export prices at the dock.

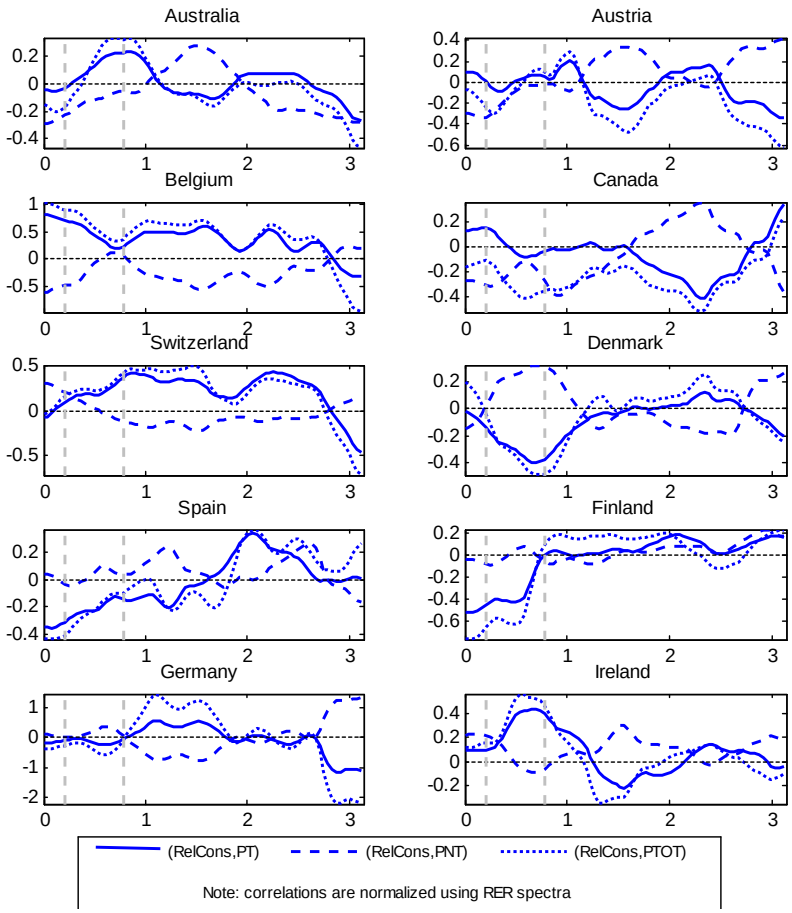


FIGURE 1C

Dynamic correlations of relative consumption and relative prices vis-à-vis the ROW. Tradable prices are import and export prices at the dock.

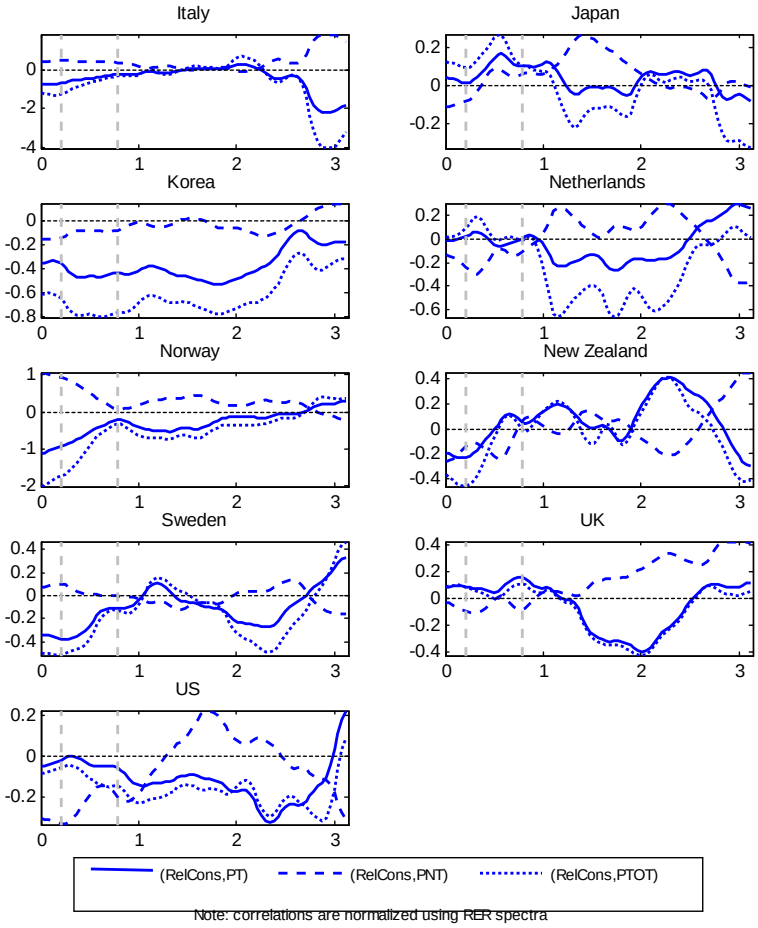


FIGURE 1D

Dynamic correlations of relative consumption and relative prices vis-à-vis the ROW. Tradable prices are import and export prices at the dock.

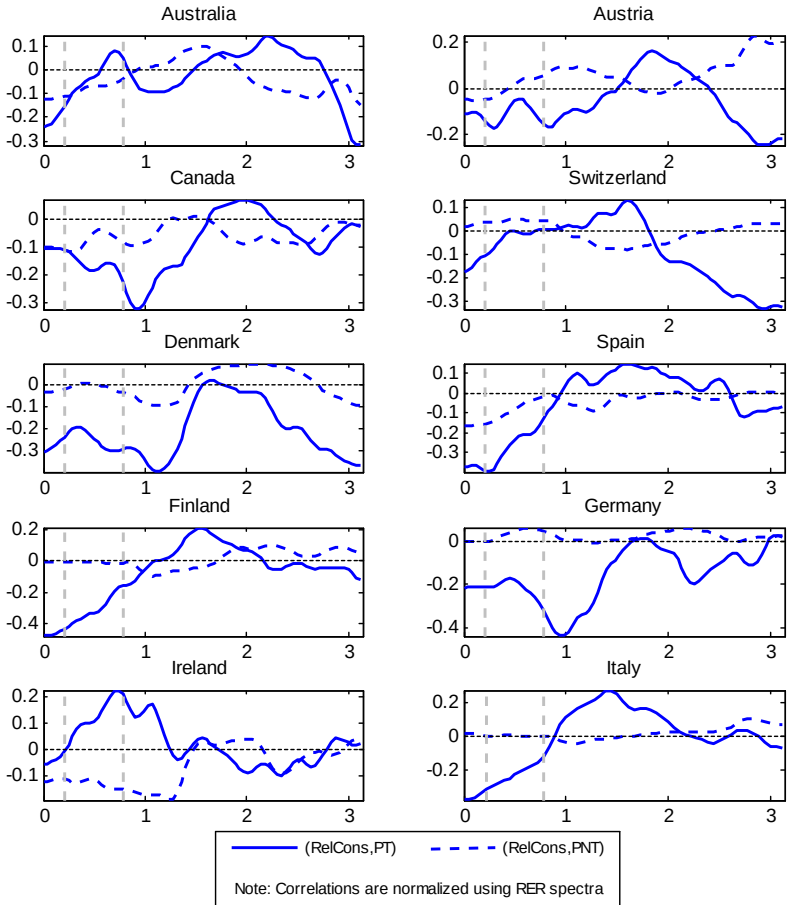


FIGURE 2A

Dynamic correlations of relative consumption and relative prices vis-à-vis the US. Tradable prices are producer price indexes.

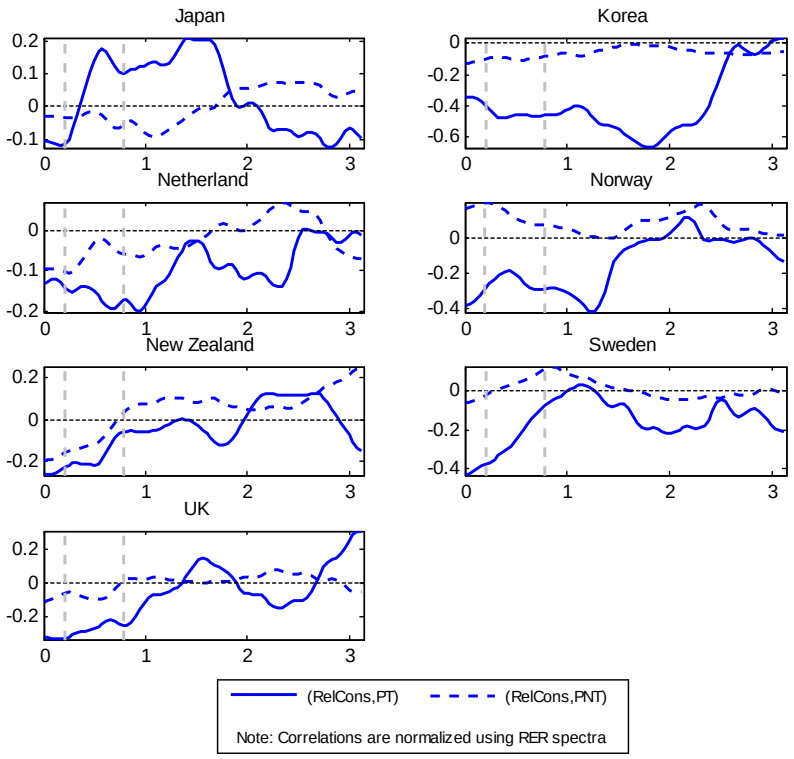


FIGURE 2B

Dynamic correlations of relative consumption and relative prices vis-à-vis the US. Tradable prices are producer price indexes.

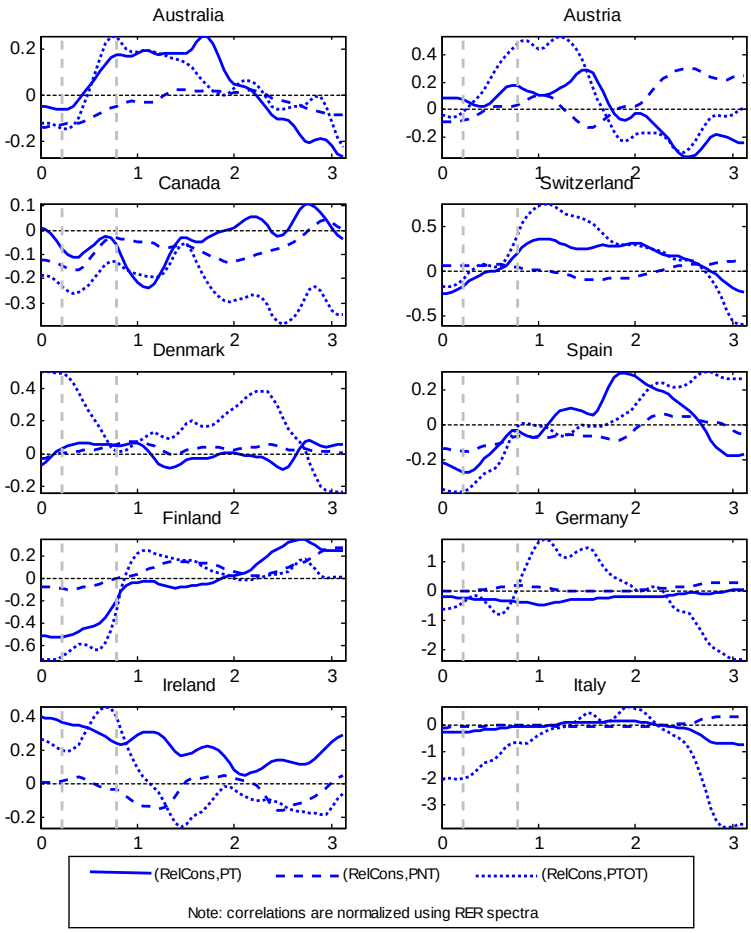


FIGURE 2C

Dynamic correlations of relative consumption and relative prices vis-à-vis the ROW. Tradable prices are producer price indexes.

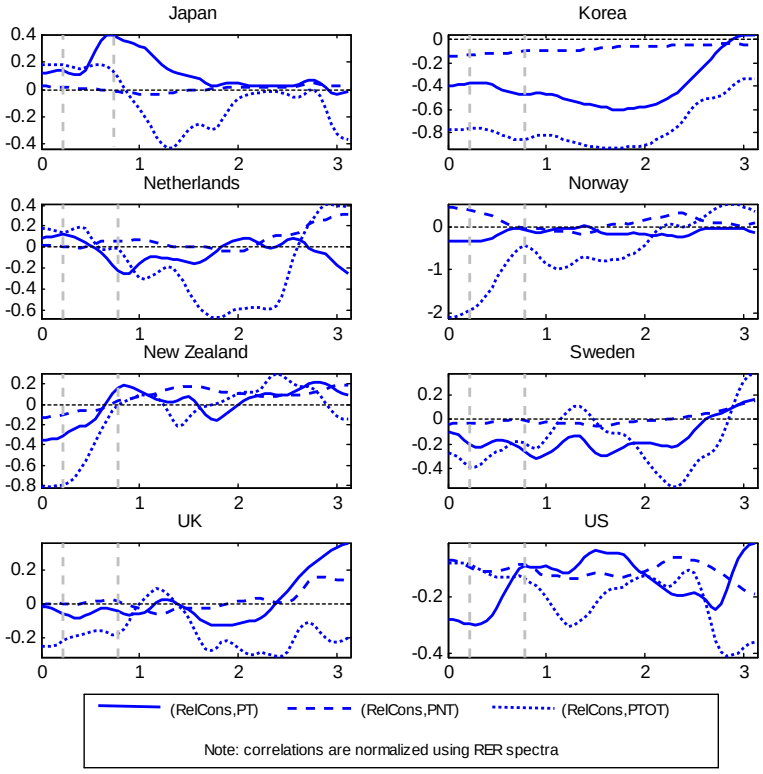


FIGURE 2D

Dynamic correlations of relative consumption and relative prices vis-à-vis the ROW. Tradable prices are producer price indexes.

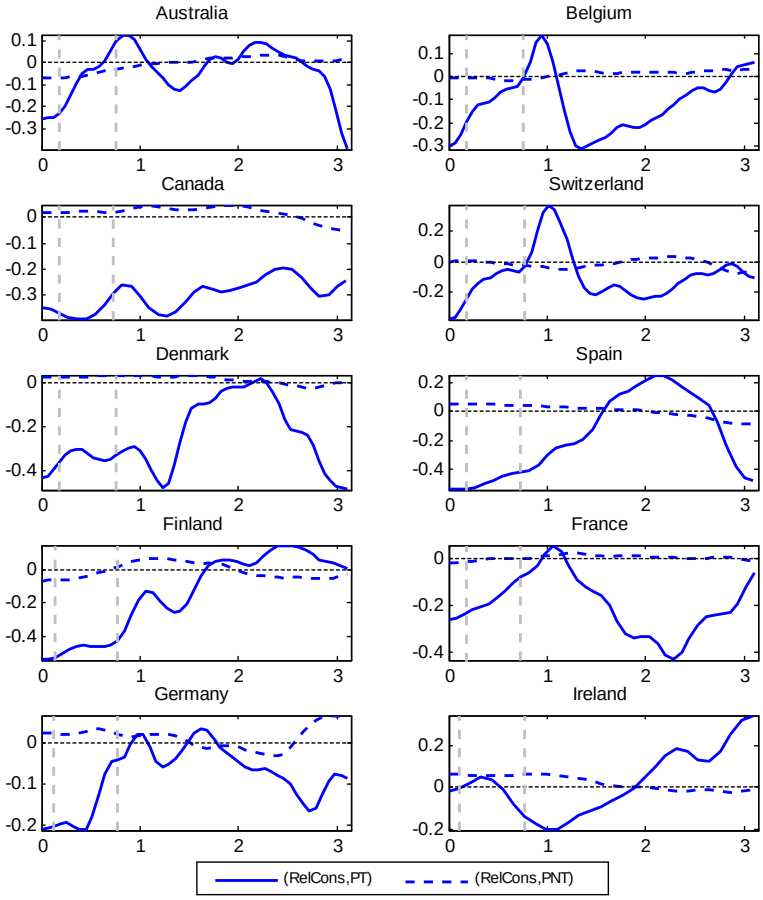


FIGURE 3A
Dynamic correlations of relative consumption and relative prices vis-à-vis the US. Tradable prices are goods in CPI.

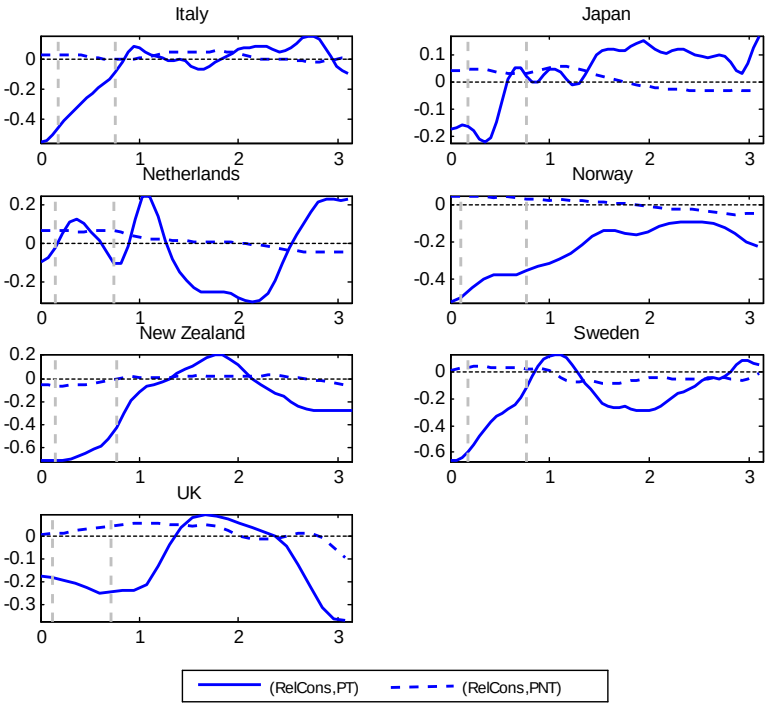


FIGURE 3B
Dynamic correlations of relative consumption and relative prices vis-à-vis the US. Tradable prices are goods in CPI.

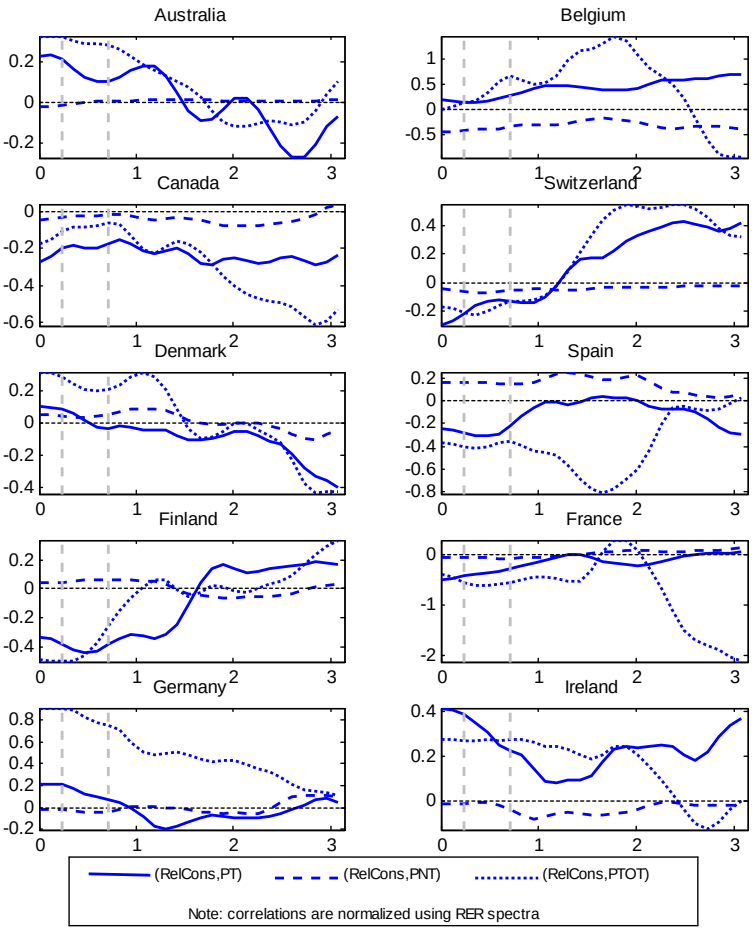


FIGURE 3C

Dynamic correlations of relative consumption and relative prices vis-à-vis the ROW. Tradable prices are goods in CPI.

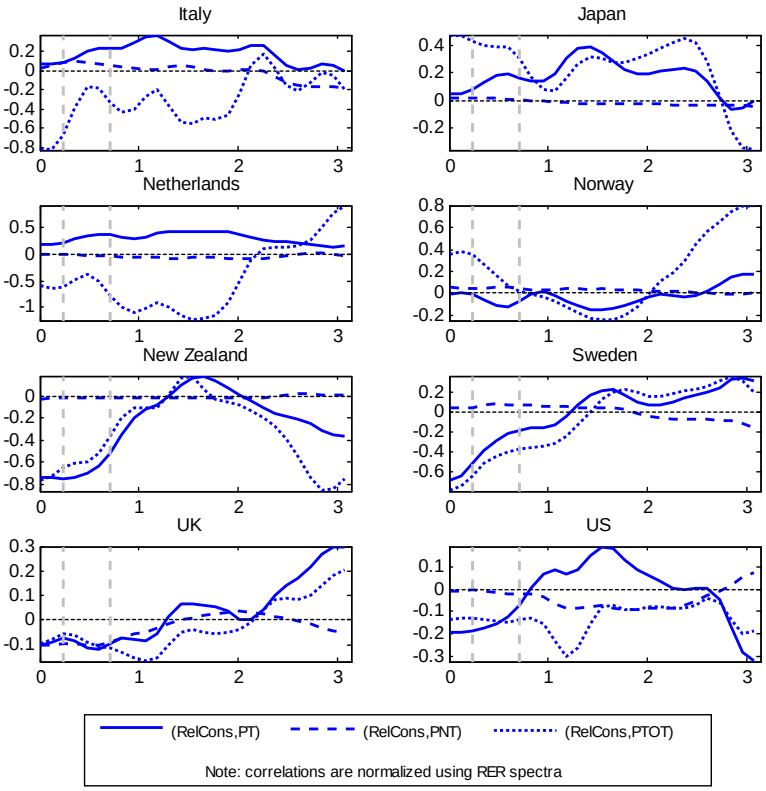


FIGURE 3D
Dynamic correlations of relative consumption and relative prices vis-à-vis the ROW.
Tradable prices are goods in CPI.

TABLE 5A
Dynamic correlations of differenced series at frequency zero
(cointegration test for variables in levels)

COUNTRY	Dynamic correlation (Rc,RER)	
	vs US	vs ROW
Australia	-0,36	-0,34
Austria	-0,16	-0,23
Belgium	-0,24	0,20
Canada	-0,20	-0,12
Switzerland	-0,16	0,27
Denmark	-0,33	-0,17
Spain	-0,53	-0,35
Finland	-0,48	-0,55
France	-0,26	0,15
Germany	-0,21	-0,07
Ireland	-0,18	0,31
Italy	-0,31	-0,37
Japan	-0,13	-0,07
Korea	-0,47	-0,49
Netherlands	-0,22	-0,14
Norway	-0,16	-0,02
New Zealand	-0,46	-0,46
Sweden	-0,49	-0,28
UK	-0,44	0,04
US	NA	-0,37

NOTE: Correlations equal to 1 or -1 signal cointegration of the series in levels

TABLE 5B

Dynamic correlations of differenced series at frequency zero
(cointegration test for variables in levels)

COUNTRY	**Dynamic correlation (Rc,P_T)**						**Dynamic correlation (Rc,P_{NT})**					
	P_T = IE prices		P_T = PPI		P_T = CPI goods		P_T = IE prices		P_T = PPI		P_T = CPI goods	
	vs US	vs ROW	vs US	vs ROW	vs US	vs ROW	vs US	vs ROW	vs US	vs ROW	vs US	vs ROW
Australia	-0,21	-0,07	-0,29	-0,05	-0,26	0,23	-0,41	-0,44	-0,43	-0,68	-0,50	-0,32
Austria	0,02	0,08	-0,13	0,08	NA	NA	-0,40	-0,31	-0,20	-0,16	NA	NA
Belgium	0,03	0,51	NA	NA	-0,29	0,18	-0,44	-0,41	NA	NA	-0,03	-0,61
Canada	0,17	0,18	-0,17	0,01	-0,33	-0,30	-0,35	-0,32	-0,19	-0,22	0,14	-0,34
Switzerland	-0,10	-0,06	-0,19	-0,23	-0,40	-0,31	-0,14	0,35	0,08	0,21	0,00	-0,19
Denmark	-0,26	-0,01	-0,36	-0,11	-0,43	0,10	-0,22	-0,10	-0,14	-0,04	0,26	0,19
Spain	-0,50	-0,36	-0,43	-0,24	-0,53	-0,22	-0,42	0,04	-0,68	-0,46	0,47	0,61
Finland	-0,43	-0,61	-0,53	-0,57	-0,57	-0,31	-0,38	-0,05	-0,02	-0,23	-0,67	0,14
France	-0,28	NA	NA	-0,18	-0,27	-0,50	-0,10	NA	NA	0,05	-0,14	-0,23
Germany	-0,07	-0,09	-0,24	NA	-0,22	0,19	-0,23	0,06	0,00	NA	0,21	-0,09
Ireland	-0,05	0,08	-0,06	0,53	-0,02	0,45	-0,21	0,20	-0,24	0,01	0,44	-0,05
Italy	-0,37	-0,35	-0,41	-0,28	-0,56	0,06	0,04	0,18	0,13	-0,31	0,29	0,08
Japan	0,04	0,06	-0,11	0,13	-0,18	0,05	-0,22	-0,16	-0,14	0,24	0,36	0,32
Korea	-0,28	-0,40	-0,43	-0,46	NA	0,17	-0,45	-0,27	-0,42	-0,66	NA	0,02
Netherlands	-0,25	-0,01	-0,14	0,09	-0,10	NA	-0,16	-0,09	-0,34	0,03	0,40	NA
Norway	-0,60	-0,69	-0,40	-0,19	-0,52	-0,01	0,42	0,58	0,37	0,28	0,36	0,37
New Zealand	-0,20	-0,21	-0,33	-0,46	-0,73	-0,76	-0,44	-0,27	-0,65	-0,38	-0,64	-0,34
Sweden	-0,45	-0,46	-0,50	-0,12	-0,68	-0,68	-0,46	0,11	-0,25	-0,08	0,10	0,09
UK	-0,33	0,15	-0,35	-0,02	-0,19	-0,11	-0,46	-0,04	-0,21	-0,01	0,05	-0,48
US	NA	-0,10	NA	-0,33	NA	-0,20	NA	-0,45	NA	-0,19	NA	-0,05

NOTE: See note to Table 5A