Traded and nontraded goods prices, 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, especially when these are adopted in the analysis of policy trade-offs likely to be affected by imperfections in financial markets. Key to the literature is the evidence, at odds with efficiency, that consumption is relatively high in countries where its international relative price (the real exchange rate) is also high. We reconsider the relation between cross-country consumption differentials and real exchange rates, by decomposing it into two components, reflecting the prices of tradable and nontradable goods, respectively. We document that, as a common pattern among OECD countries, both components tend to contribute to the overall lack of risk sharing, with the tradable price component playing the dominant role in accounting for efficiency deviations. We relate these findings to two mechanisms proposed by the literature to reconcile open economy models with the data. One features strong Balassa-Samuelson effects on nontradable prices due to productivity gains in the tradable sector, with a muted offsetting response of tradable prices. The other, endogenous income effects causing nontradable but especially tradable prices to appreciate with a rise in domestic consumption demand.

JEL classification: F41 and F42

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1 Introduction

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 been facing key questions regarding the extent to which workhorse open-economy models can account for the stylized facts ostensibly at odds with the maintained assumption that financial markets are efficiently integrated — from the limited cross-border portfolio diversification observed in the data, to the apparent violation of the most basic condition of efficient risk sharing, requiring consumption to be rising in countries where its price falls relative to other countries. Ever since the contribution of Backus and Smith (1993), indeed, cross-country correlation between relative consumption (as a proxy for relative marginal utility) and its relative price (i.e., the real exchange rate) have become the subject of an intense empirical and theoretical debate, emerging as a crucial dimension in assessing the performance of alternative models —— a point forcefully made by Obstfeld and Rogoff (2001) and Chari Kehoe and McGrattan (2002). The importance of this debate cannot be over-emphasized. As international models are widely adopted by national and international institutions for policy assessment and design, it stands to reason that they should be consistent with evidence directly related to key distortions (i.e., financial market imperfections) which motivate government interventions in the first place — especially when this evidence is about the comovements of key macro quantities (consumption demand) and prices (the real exchange rate).

As is well known, standard international business cycle models have a hard time to match the data in this dimension, also when they explicitly eschew the assumption of complete markets — a problem dubbed Backus-Smith 'puzzle' or 'anomaly'.[1] In recent years, a number of contributions have taken on the challenge to explore mechanisms by which the workhorse model of the international economy can be brought in line with the stylized facts. Some contributions emphasize real appreciation driven by nontraded goods' prices. In Benigno and Thoenissen (2006), for instance, nontradable price appreciation is driven by positive output gains in the tradable sector, whereas a low elasticity of substitution between the goods produced in the two sectors magnifies the working of the mechanism early on discussed by Baumol (see Baumol and Bowen 1996) and underlying the Harrod-Balassa-Samuleson effect, more than offsetting the deterioration of the relative price of tradable output.

Other contributions, while still consistent with the Harrod-Balassa-Samuleson effect, stress instead the role of endogenous wealth fluctuations in incomplete market economies, causing the international price of a country tradables to appreciate with an expansion in consumption (relative to foreign demand) — see

[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.

e.g. Corsetti, Dedola and Leduc (2008a) and Ghironi and Melitz (2004).[2]

In this paper, we reconsider the evidence in relation to the literature adopting an incomplete-market framework. In light of the importance of different relative prices placed at the heart of the international transmission mechanism by competing models, we redo the analysis in Backus and Smith (1993) by decomposing the correlation between relative consumption and the real exchange rate into two terms, reflecting the prices of tradable and nontradable goods, respectively. At the same time, since we will relate our empirical results to models expressively designed to perform at business cycle frequencies, we adopt multivariate spectral analysis techniques, as to highlight correlations at business cycle and lower frequencies, as opposed to higher frequencies.

Our contribution is both theoretical and empirical. Theoretically, in the spirit of Cole and Obstfeld (1991), we propose a tractable analytical framework to revisit the equilibrium links between wealth and income effects of shocks, on the one hand, and the equilibrium fluctuations in the relative price of tradable and nontradable goods, on the other. Based on this framework, we identify theoretical restrictions placed by recent models proposing potential explanations of the Backus Smith anomaly, on the two components of our decomposition of the Backus-Smith statistic — to guide our empirical analysis of the different 'price channels' identified by the literature. In particular, as a novel contribution to the literature, we derive a necessary condition for perfect risk sharing in models with nontraded goods and Harrod-Balassa-Samuelson effects. In such models, a rise in relative consumption must be associated with a tradable depreciation that is large enough to more than offset the rise in the price of nontradables.

In light of this necessary condition, we show empirically that the Backus Smith anomaly is actually starker, when reconsidered using our decomposition of the real exchange rate by goods tradability. For most countries in our sample, in fact, both the tradable and the nontradable price components of the BS statistics contribute to the BS result. In other words, a rise in domestic consumption relative to the foreign one is systematically associated not only with a rise in the domestic relative price of nontradables (in excess of the corresponding rise abroad), but also with an appreciation of domestic tradable prices, and stronger terms of trade. Since in our sample the traded-good component typically plays the dominant role in determining the size and the intensity of the overall Backus-Smith correlation, this is novel evidence at odds with the presumption that tradable price adjustment to shocks could compensate and make up for financial market imperfections and lack of diversification opportunities.

In a few countries, nonetheless, a different adjustment pattern emerges. An appreciation of the nontraded goods coexists with a fall in the international price of the country's tradable output — the real appreciation underlying the BS re-

[2] Conversely, the contributions maintaining a complete-market framework emphasize marginal utility shifts and demand shocks — see Stockman and Tesar (1995), Raffo (2010) and Mandelman, Rabanal, Rubio-Ramírez and Vilán, (2011). An open issue in the literature 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, Cochrane, and Santa Clara (2006) but also Campbell and Cochrane (1999).

sult therefore reflects the non-traded good price component of the real exchange rate. In these cases, the tradables price adjustment does reduce the amount of uninsurable macroeconomic risk from country-specific shocks. However, its positive role in contributing to global risk sharing is relatively negligible. In this sense, the BS 'anomaly' is still most accurately defined in terms of tradable price behavior.

In carrying out our analysis, we build upon the results from a companion paper (Corsetti Dedola and Viani 2011), in which we have shown that using spectral analysis allows us to distinguish (in models and data) the amount of insurable and uninsurable risk at different frequencies. Specifically, under incomplete markets, any variation in the dynamic Backus-Smith correlation should reflect the changing weight of risks that are insured. In light of the main finding of our earlier paper — that the lack of international risk pooling appears to be most pervasive at business cycle and lower frequencies — in the present paper we take our analysis one step further, and analyze the insurable components of shocks over the spectrum, by different transmission channels identified by the literature.

In this dimension, we find that the contribution of the tradable and nontradable price components to the overall BS correlation are also starker at business cycle and lower frequencies. Note that the fact that the correlation of relative consumption and the domestic relative price of nontraded goods (calculated without using the nominal exchange rate) tends to be negative at low frequencies questions the notion that the BS anomaly can be attributed exclusively to nominal factors. At the same time, it suggests that there may be a substantial quantity of risk financial markets could in principle insure at these frequencies.

Overall, our empirical evidence provides support to both a tradable wealth channel and a nontradable price channel in the international transmission mechanism — although the former appears to be more frequent and robust among OECD countries. As an interesting avenue for future research, the coexistence in the data of patterns consistent with alternative models raises intriguing questions, as of whether these differences across countries could be systematically 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. Based a stylized model economy, Section 3 characterizes analyticaly the restrictions on tradables and nontradable prices implied by alternative transmission channels. Section 4 generalizes them using a full-fledged medium-scale open economy DSGE 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 Cross-border risk sharing reconsidered: recent developments in the open-economy literature

In this section, we briefly discuss recent theoretical developments in the international macro 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.

The natural starting point of our discussion 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 implication 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

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

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

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

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, 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 of purchasing power parity (so that $RER = 1$ or equal to a constant), and thus testing the stronger condition of perfect correlation of consumption across countries. Most importantly, the correlation between relative consumption and the real exchange rate is found to be negative even *conditional* on identified shocks to productivity (see Corsetti, Dedola and Leduc 2008c,2008d). This finding addresses a standard criticism of the empirical literature, stressing that a negative *unconditional* correlation could be simply driven by shocks to marginal utility, even in economies where markets are complete.

This evidence has long posited a challenge to 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 in well-known seminal models featuring imperfect capital markets — the essence of the 'anomaly.' Such 'anomaly' of course would not arise in models assuming a dominant role of demand shocks as driver of business cycle fluctuation. In the Mundell-Fleming model, for instance, positive shocks to the IS naturally raise domestic consumption above the foreign one, and appreciate the exchange rates in nominal and real terms (under flexible rates) or in real terms over time (under fixed rates). Similar results follow from assuming preference shocks (say to the discount rate) in modern international business cycle models, even under the complete market assumption (see e.g. Stockman and Tesar 1994 and Corsetti, Dedola and Leduc 2008). Yet, in general equilibrium, one may expect that models with incomplete markets be able to account for substantial movements in demand and wealth arising endogenously from shocks that affect relative output and thus relative income across countries — such as temporary but persistent shocks to productivity specific to one country.

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 — the incomplete market allocation appears to be arbitrarily close to the complete market one. However, significant differences between these

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

allocations 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 (and assuming zero initial net foreign wealth), relative price adjustment is sufficient to provide perfect production risk insurance. This is so by virtue of the fact that prices and output move proportionally in opposite directions, keeping the value of national production constant in relative terms independently of whether shocks are temporary or permanent.[4] Note that, 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 departures 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; 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), and 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 are significant, in response to shocks. The second one assumes persistent shocks (as in Baxter and Crucini (1995)) and a relatively high trade elasticity — within the range estimated by the trade literature. With high substitutability between domestic and foreign tradable 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

[4] This result generalizes to environments with sticky prices (see Chari Kehoe and McGrattan 2002 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).

present value of the income accruing to domestic agents markedly rises, generating possibly large cross-country wedges in wealth (see also Nam and Wang 2010 and Opazo 2006, discussing a variant of this mechanism focusing on 'news shocks').

In either parameters' 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 shock 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, and of the relative price of nontradables. 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 reconsideration of this result in a model with extensive margins of trade 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 and consumption dynamics consistent with the empirical evidence after Backus and Smith (1993). In the models reviewed above, the relative price of nontraded goods may well rise with domestic consumption demand and real appreciation, but such an increase is neither necessary nor sufficient to determine the overall sign of the BS statistic. In the alternative mechanism, the BS statistic mainly reflects movements in the relative price of nontradables. Namely, the model rests on the idea that output gains in domestic tradables simultaneously drive up nontradable prices and relative consumption, while international tradable prices, contrary to the complete market case, is insufficient to restore efficiency — 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. In the next section we will see, however, that for this mechanism to work, productivity shocks in the traded goods sector must be the prevailing source of fluctuations, and the trade elasticity must be above unity, but 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 tradable and non tradable goods. Specifically, a set of explanations emphasize wealth effects from productivity and endowment shocks, 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 explanations downplays the role of the relative price of trad-

[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 2011; and Raffo 2010).

ables, but at the same time places more importance in output and productivity disturbances in this sector, as the main cause of nontradable relative price appreciation.

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

In the light of the recent developments in the international business cycle literature just discussed, in this section we specify a simple framework shedding light on the equilibrium relation between relative consumption across countries, and the different price components of the real exchange rate emphasized by leading contributions.

Throughout our theoretical and empirical analysis, we will make use of the following 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 (i.e. $rer = \log RER$), this decomposition reads:

$$rer = p_T + p_{NT}, \tag{5}$$

where

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

and

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

with P^T and P^N denoting the price of traded and nontraded goods within a country, while η is the average consumption share of non-traded goods, $P^N C^N/PC$, and all prices are expressed in a common currency. 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. Conversely, p_{NT} is independent of nominal exchange rate fluctuations. The above decomposition is exact if, as in Burstein 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 statistic can be decomposed as the sum of two components in the covariance between relative consumption, on the one hand,

and the relative price of traded and non traded goods on the other:

$$Corr\,(rc, rer) = \frac{Cov\,(rc, rer)}{\sigma\,(rc)\cdot\sigma\,(rer)} = \frac{Cov\,(rc, p_T)}{\sigma\,(rc)\cdot\sigma\,(rer)} + \frac{Cov\,(rc, p_{NT})}{\sigma\,(rc)\cdot\sigma\,(rer)} \qquad (6)$$

This expression can also be redefined in terms of sum of correlations, each term weighted by standard deviation of the corresponding sectoral real exchange rate relative to the standard deviation of the overall real exchange rate:

$$Corr\,(rc, rer) = Corr\,(rc, p_T)\,\frac{\sigma(p_T)}{\sigma(rer)} + Corr\,(rc, p_{NT})\,\frac{\sigma(p_{NT})}{\sigma(rer)}. \qquad (7)$$

The core of our analysis is the notion that theory imposes stark restrictions on the sign of the two terms on the right-hand side of the above expressions, whose analysis can thus 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), and specify 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 using a richer quantitative model. Namely we will build on the model specified in Corsetti, Dedola and Leduc (2008b), featuring international trade in noncontingent bonds and capital accumulation.

The structure of our model is standard. We consider a two-country world economy, in which each country is specialized in the production of a domestic traded good, and domestic nontraded good. We refer to the two countries as 'Home' and 'Foreign'. For the Home representative consumer, consumption is given by the following CES aggregator

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

$$C_{\mathrm{T}} = \left[a_{\mathrm{H}}^{1/\omega} C_{\mathrm{H}}^{\frac{\omega-1}{\omega}} + a_{\mathrm{F}}^{1/\omega} C_{\mathrm{F}}^{\frac{\omega-1}{\omega}}\right]^{\frac{\omega}{\omega-1}}, \qquad \omega > 0,$$

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 (nontraded) 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 $\tau = P_{\mathrm{F}}/P_{\mathrm{H}}$ 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 constraints for both domestic and foreign tradables are $Y_{\mathrm{H}} = C_{\mathrm{H}} + C^*_{\mathrm{H}}$, 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 (7) can then be written as follows:

$$\begin{aligned} Corr\,(\widehat{rc}, \widehat{rer}) &= Corr\,(\widehat{rc}, (a_{\mathrm{H}} - a^*_{\mathrm{H}})\, \widehat{\tau})\, \frac{(a_{\mathrm{H}} - a^*_{\mathrm{H}})\, \sigma(\widehat{\tau})}{\sigma(\widehat{rer})} + \qquad (8) \\ & Corr\left(\widehat{rc}, (1-a^*_{\mathrm{T}})\, \frac{\widehat{p^*_{\mathrm{N}}}}{p^*_{\mathrm{T}}} - (1-a_{\mathrm{T}})\, \frac{\widehat{p_{\mathrm{N}}}}{p_{\mathrm{T}}}\right) \frac{\sigma((1-a^*_{\mathrm{T}})\, \frac{\widehat{p^*_{\mathrm{N}}}}{p^*_{\mathrm{T}}} - (1-a_{\mathrm{T}})\, \frac{\widehat{p_{\mathrm{N}}}}{p_{\mathrm{T}}})}{\sigma(\widehat{rer})}. \end{aligned}$$

As in Cole and Obstfeld (1991), we will first carry out our analysis of competing explanations of the Backus-Smith result assuming a stochastic endowment of traded and non-traded goods, and positing that exogenous supply shocks to these goods are the only source of uncertainty in the model. We will contrast the two natural benchmarks of complete markets and financial autarky — in which cases we can obtain tractable analytical results.

Before proceeding further, it is worthwhile noting that there are alternative ways of decomposing the real exchange rate, differently from (5) — see Crucini and Landry (2010) and Hess and Shin (2010) among others. However, our choice for (6) is not only dictated by constraints on the data (e.g., we do not have price indexes for nontradable goods and services). More importantly, relative to the alternatives, our decomposition best fits the goals of our inquiry on the theoretical insurance channels through relative prices. For instance, for the case of equal expenditure weights $\eta = \eta^*$, the decomposition discussed by Crucini and Landry (2010) reads:

$$
\begin{aligned}
rer &= (1-\eta)\ln\left(\frac{P_t^{T\star}}{P_t^T}\right) + \eta\ln\left(\frac{P_t^{N\star}}{P_t^N}\right) \\
&= (1-\eta)\, q_T + \eta q_{NT}
\end{aligned}
\tag{9}
$$

This decomposition is meant to highlight the role of deviations from the law of one price in both the tradables and nontradables markets, in driving real exchange rate fluctuations. As such, it is a useful counterpart to (5) in relation to the objective of quantifying different sources of real exchange rate volatility. It is less useful, however, with respect to our goal of isolating how different relative prices movements impinge on the Backus-Smith statistic. To see why, note that by definition $q_T = p_T$, while it is straightforward to rewrite the second term in the above expression as follows:

$$\eta q_{NT} = p_{NT} + \eta p_T.$$

Therefore, using (9) instead of (5), the counterpart of our decomposition of the Backus-Smith statistic (6) would be

$$Cov\,(rc, rer) = (1-\eta)\,Cov\,(rc, p_T) + Cov\,(rc, p_{NT} + \eta p_T)$$

The second term, $Cov\,(rc, p_{NT} + \eta p_T) = Cov\,(rc, p_{NT}) + \eta Cov\,(rc, p_T)$, commingles the effects of the different channels operating through p_{NT} and p_T. It may well be that, in the data, the two terms have the same sign when $Cov\,(rc, p_T)$ dominates $Cov\,(rc, p_{NT})$, preventing an independent assessment of the role of the relative price of nontradables in fostering or impeding risk sharing.[6]

[6] By the same token, the decomposition proposed by Hess and Shin (2010), distinguishing between the nominal exchange rate and the ratio of CPIs in different currencies, and designed to analyze the BS correlation across exchange rate regimes, would not allow an analysis of the relative channels on which we focus our paper.

3.1 Perfect risk sharing with traded and nontraded goods: the complete-market benchmark

Under complete markets, it is easy to verify that in our symmetric world economy with supply shocks only it must be the case that $Corr\left(\widehat{rc}, \widehat{rer}\right) = 1$. The same is not true, however, for the correlation of relative consumption with each single component on the right hand side of the expression (8). Now, the sign of the second term depends on the correlation between relative consumption and the ratio of the relative price of non-traded goods, $Corr(\widehat{rc}, \widehat{p_{NT}})$. Consistent with a well-know mechanism (see e.g. Harrod-Balassa-Samuelson effects, or Baumol 'cost disease' model), $\widehat{p_{NT}}$ increases in response to positive supply shocks concentrated in the Home traded goods sector, but decreases in response to positive shocks to Home nontradable supply. At the same time, positive output shocks in either sector are likely to be associated with an increase in relative (Home to Foreign) consumption, at least when demand is biased towards domestic goods (i.e. $a_{\mathrm{H}} > a_{\mathrm{H}}^* = 1 - a_{\mathrm{F}}^*$). It follows 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.

But since with perfect risk sharing, the overall correlation $Corr\left(\widehat{rc}, \widehat{rer}\right)$ must be equal to 1, as long as $Corr(\widehat{rc}, \widehat{p_{NT}}) < 0$ it must be the case that both (a) $Corr\left(\widehat{rc}, \widehat{p_T}\right)$ is large and positive, and (b) $\sigma(\widehat{p_T}) / \ \sigma(\widehat{rer})$is large enough relative to $\sigma(\widehat{p_{NT}})/\sigma(\widehat{rer})$, to insure that the first term in (7) dominates. Under complete markets, indeed, it is easy to show that supply shocks to tradables cause relative consumption and the terms of trade to 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 the international price of tradables to output shocks. Specifically, with home bias, gains in domestic tradable output must be matched by terms of trade depreciation. Moreover, as a necessary condition for perfect risk sharing in the presence of Harrod-Balassa-Samuelson effects, the impact on the real exchange rate of nontradable price appreciation (associated with a rise in relative consumption) must be more than offset by tradable price depreciation.

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. The key difference is 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 containing the fall in their relative price or even causing an appreciation. In this subsection we analyze this possibility in detail under the assumption of financial autarky.

Leaving to the appendix details about the derivation, we write below the relevant decomposition of the correlation between relative consumption and the real exchange rate by tradables and non tradables, derived under the simplifying assumption of symmetry:

$$Corr\left(\widehat{rc},\widehat{p}_T\right)=\left(2a_{\mathrm{H}}-1\right)\left[\phi Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)+\left(2a_{\mathrm{H}}\omega-1\right)\frac{\sigma\left(\widehat{\tau}\right)}{\sigma\left(\widehat{p}_{NT}\right)}\right]\frac{\sigma\left(\widehat{\tau}\right)\sigma\left(\widehat{p}_{NT}\right)}{\sigma\left(\widehat{rc}\right)}, \tag{10}$$

and

$$Corr\left(\widehat{rc},\widehat{p}_{NT}\right)=\left[\left(2a_{\mathrm{H}}\omega-1\right)Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)+\phi\frac{\sigma\left(\widehat{p}_{NT}\right)}{\sigma\left(\widehat{\tau}\right)}\right]\frac{\sigma\left(\widehat{\tau}\right)}{\sigma\left(\widehat{rc}\right)}, \tag{11}$$

As in the previous section, focus first on the latter correlation, between relative consumption and the ratio of nontraded good prices. It is apparent that for this correlation to be negative, the positive term $\phi\sigma\left(\widehat{p}_{NT}\right)/\sigma\left(\widehat{\tau}\right)$ in parenthesis cannot be too large — a condition which is satisfied for a small enough elasticity ϕ (implying strong complementarity between traded and nontraded goods), associated to a contained volatility of nontradables prices. In addition, it must be the case that the first term in parenthesis is negative:

$$\left(2a_{\mathrm{H}}\omega-1\right)Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)<0$$

In the appendix, we show that the above condition is satisfied when:

$$\frac{1+2a_{\mathrm{H}}\left(\omega-1\right)}{2a_{\mathrm{H}}\omega-1}Corr\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}},\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)\frac{\sigma\left(\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)}{\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)}\simeq 0 \text{ or negative}$$

The above expression is close to zero when either the volatility of (relative) traded output is much higher than the volatility of (relative) nontraded output, or the correlation between relative tradable and nontradable output is low. It is negative when the first two terms have opposite sign. Note that a sufficient condition for the coefficient multiplying the correlation term to be positive is that the trade elasticity ω is sufficiently large, i.e.,

$$\omega>\max\left\{\frac{1}{2a_{\mathrm{H}}},1-\frac{1}{2a_{\mathrm{H}}}\right\}\Longrightarrow\frac{1+2a_{\mathrm{H}}\left(\omega-1\right)}{2a_{\mathrm{H}}\omega-1}>0$$

Taking stock: for explanations hinging on the relative price of nontradables as the main determinant of a negative unconditional Backus-Smith correlation to be true, specific conditions must be met. Namely, 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, (a) output fluctuations need to be predominantly sectoral, with a low or negative cross-industry correlation, and mostly driven by tradables; (b) the elasticity of substitution ϕ (between traded and nontraded goods) must be sufficiently low and (c) the elasticity of substitution ω (between domestic and foreign tradables) must be relatively high. These conditions are indeed imposed in the analysis by Benigno and Thoenissen (2006) — these authors assume an elasticity ϕ between traded and nontraded goods below 1, a trade elasticity ω larger than 1, and an estimate of the TFP process in which shocks to tradable productivity are the main driver of macroeconomic fluctuations.

Turning to the analysis of the other component $Corr\left(\widehat{rc},\widehat{p}_T\right)$, the relevant condition is now:

$$Corr\left(\widehat{rc},\widehat{p}_T\right)<0\Longleftrightarrow\left(2a_{\mathrm{H}}-1\right)\left[\phi Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)+\left(2a_{\mathrm{H}}\omega-1\right)\frac{\sigma\left(\widehat{\tau}\right)}{\sigma\left(\widehat{p}_{NT}\right)}\right]<0 \tag{12}$$

Comparing this expression with (11), observe first that a negative correlation of relative consumption with relative nontradable prices does not imply a negative sign for its correlation with relative tradable prices. Both correlations — $Corr\left(\widehat{rc},\widehat{p}_T\right)$ and $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ — clearly fall with a negative covariance between relative prices, i.e. with $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)<0$. However, for the nontradable component in $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ to be negative, we have seen above that the term $\phi\sigma\left(\widehat{p}_{NT}\right)/\sigma\left(\widehat{\tau}\right)$ needs to be to be small — i.e. the elasticity of substitution across sectors needs to be small. But by the condition (12) above, it is apparent that a low intra-sectoral elasticity ϕ would tend to reduce the weight of the negative term in $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)$ (relative to $\sigma\left(\widehat{\tau}\right)/\sigma\left(\widehat{p}_{NT}\right)$). Therefore, it may well be possible that $Corr\left(\widehat{rc},\widehat{p}_{NT}\right)$ and $Corr\left(\widehat{rc},\widehat{p}_T\right)$ have opposite sign.

A second result is that, different from the case of nontradable prices, the sign of the tradable component in $Corr\left(\widehat{rc},\widehat{p}_T\right)$ can be negative even when relative prices are negatively correlated, i.e., $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)\geq 0$. To show this, it is useful to develop (12) a step further, as follows:

$$Corr\left(\widehat{rc},\widehat{p}_T\right)<0$$

$$\Longleftrightarrow$$

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

A negative tradable correlation follows when there are only tradables ($a_{\mathrm{T}}=1$) or there are only country-specific aggregate shocks, symmetric across sectors (so that $Corr\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}},\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)\sigma\left(\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)/\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)=1$). Under either case, a necessary condition is that the two term $\left(2a_{\mathrm{H}}-1\right)$ and $\left(2a_{\mathrm{H}}\omega-1\right)$ have opposite signs. This means that either there is home bias in demand (so that $1/2a_{\mathrm{H}}<1$) and the trade elasticity is low enough $\omega<1/2a_{\mathrm{H}}$, or, viceversa, there is foreign bias in demand ($1/2a_{\mathrm{H}}>1$), and the elasticity is high ($\omega>1/2a_{\mathrm{H}}$).

Note that, provided that there is home bias in consumption and the trade elasticity ω is low enough, the nontradable BS correlation $Corr\left(\widehat{\tau},\widehat{p}_{NT}\right)$ can be negative even when sectoral outputs within countries are positively correlated, i.e. supply shocks are economy wide, rather than sector specific. In response to macro shocks, both components of the Backus-Smith statistic can be simultaneously negative — this is indeed what happens in the bond economies with a low trade elasticity ω analyzed by Corsetti, Dedola and Leduc (2008a,b).

So, the channel working through the relative price of nontradables within countries — emphasizing shocks to tradable output, complementarity between tradables and nontradables, a relatively high trade elasticity — implies that a negative $Corr(\widehat{rc}, \widehat{p}_{NT})$ is likely to be associated with a positive $Corr(\widehat{rc}, \widehat{p}_T)$. Conversely, the channel working through the relative price of tradables across countries — emphasizing wealth and demand effects from supply shocks causing a tradable appreciation — is likely to be associated with a negative sign of both $Corr(\widehat{rc}, \widehat{p}_{NT})$ and $Corr(\widehat{rc}, \widehat{p}_T)$. For this channel to work, home bias in consumption needs to be associated with a relatively low trade elasticity.

4 A generalization to the case of international trade in bonds

To shed further light on the different channels that can lead to a negative Backus-Smith correlation, in this section we use a medium scale two-country model, accounting for more general specifications of our model economy. We build on the model with traded and nontraded goods developed in Corsetti, Dedola and Leduc (2008b), which, in addition to endogenous capital accumulation, features trade in a noncontingent bond instead of financial autarky and allows for 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) — analytical details on the model are given in the appendix. We keep our focus on the two main channels discussed above — in short, the relative price of nontradables and the tradable wealth transmission channels.

Since we are primarily interested in the transmission mechanism, we report impulse responses — shown in Figure 1 through 3. In each Figure, the impulse responses are drawn for both a positive productivity shock to Home tradable goods, which is temporary (continuos line); and a positive aggregate shock to productivity, hitting the two Home sectors symmetrically, which is either temporary (dashed line) or permanent (dash-dotted line). The specification of the model underlying our experiment features no 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%.[7]

In Figure 1, 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 (sectoral or macro, more or less persistent) result in an appreciation of the relative price of both nontradables relative to tradables within the Home country, and relative Home tradable — the Home terms of trade improve while domestic consumption increases relative to the rest of the world. This is because the strong effects on tradable wealth associated with a low trade elasticity cause a marked rise in domestic demand, driving

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

up all prices. The results from this exercise essentially show that the same mechanism studied analytically under financial autarky is active when markets are incomplete, but agents can trade a bond across border, hence can engage in intertemporal trade.

The non-tradable price channel is explored in Figure 2 — a channel emphasizing substitution effects of sectoral shocks, triggering strong within-country relative price adjustment. The analysis in the previous section defines the conditions for boosting the role of this channel in the international transmission mechanism. In addition to a low elasticity of substitution ϕ between tradables and nontradables (which we assume in our baseline specification), the trade elasticity needs to be larger than 1. Consistently, in the exercise shown the Figure, we set ω equal to 2, while keeping all the other parameters unchanged. The transmission mechanism is essentially the same as the one emphasized in the textbook treatment of the Harrod-Balassa-Samuelson effects, or the Baumol model. In response to a temporary shock to tradables, the within-country relative price of nontradables must rise (with a low ϕ, significantly so), in order to shift domestic demand towards tradables while increasing relative consumption overall. This pattern of adjustment to a productivity shock to tradables is clearly illustrated by the corresponding impulse response in the Figure. Observe that, because of the relatively high value of the trade elasticity, the international relative price of tradables worsens only slightly.

As discussed in the previous section, however, the nontradable price channel is not necessarily operative in response to aggregate shocks, hitting both sectors symmetrically, either temporary or permanent. This is because, by increasing the relative supply of nontradables, aggregate shocks end up reducing, rather than increasing, their domestic relative price — while still worsening the international relative price of tradables and the terms of trade. This result is clearly illustrated in Figure 2. Independently of their persistence, aggregate shocks cause the real exchange rate to depreciate with the rise in relative consumption. Also in this case, the main analytical results derived under financial autarky provide an accurate guide to interpret macroeconomic adjustment in a bond economy.

As a final experiment, we explore a set of predictions of the model which are specific to an economy where agents can borrow and lend internationally — hence deriving results which are not comprised in our discussion of the economy under financial autarky. The relevant experiments are reported in Figure 3, where we raise ω up to setting it equal to 4. To start with, observe that, as the trade elasticity is larger than one, a temporary shock increasing tradable productivity leads to results similar to those in panel B, but for one important difference: when ω is 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 smaller increase in domestic consumption than in the foreign one, and thus a *fall* in relative consumption — a result that is not present in economies under financial autarky.

A second finding, already discussed by Corsetti, Dedola and Leduc (2008a), is driven by the fact that 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 by borrowing from foreign residents. In the presence of home bias in consumption, the boom in domestic demand temporarily appreciates international tradable prices and the real exchange rate. In the figure, this mechanism is apparent for the case of aggregate persistent shocks.[8]

So, our quantitative exercises suggest that the two channels discussed under financial autarky are broadly operative in more general model specifications, where agents can engage in intertemporal trade. However, models with intertemporal trade also highlight a new variant of the wealth channel analyzed under financial autarky. For an elasticity ω larger than the the values usually adopted in macro literature but closer to those in the trade literature, persistent shocks can bring about deviations from risk sharing through movements in the international price of tradables.

In conclusion, observe that, from the discussion in this and previous section, the nontradable component of the BS statistic can be negative even under complete markets, and is actually likely to be negative also in models emphasizing the tradable wealth channel. This consideration suggests that, to discriminate among possible mechanisms, one should focus mainly on the sign and the intensity of the tradable component.

Indeed, we have seen that, under complete markets, negative values of the nontradable component of the BS statistic need to be more than offset by large movements in the opposite direction of the international price of tradables (nontradable appreciation can only materialize together with large terms of trade depreciation). In incomplete market models emphasizing the role of nontradable prices in driving the BS result, instead, the predicted movement in the terms of trade is quite contained — although these are still likely to depreciate with a rise in domestic consumption (in response to sectoral productivity shocks). Conversely, in incomplete market models stressing the tradable wealth channel, the international prices for domestic tradables unambiguously appreciate when relative consumption rises in response to productivity shocks (either to tradables, or economy wide). As shown in the above examples, the wealth effects in these models are typically strong enough to cause a nontradable price appreciation as well.

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

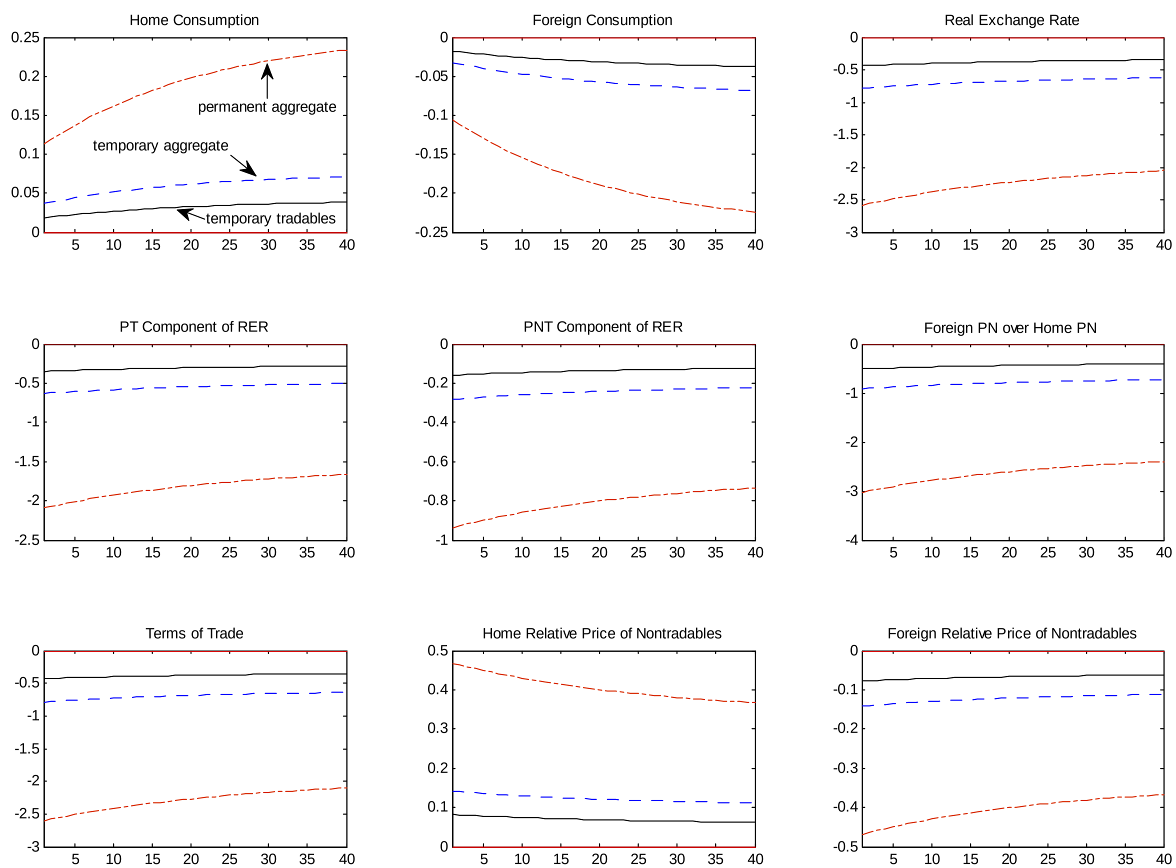

Figure 1: The Wealth Channel with a Low Trade Elasticity

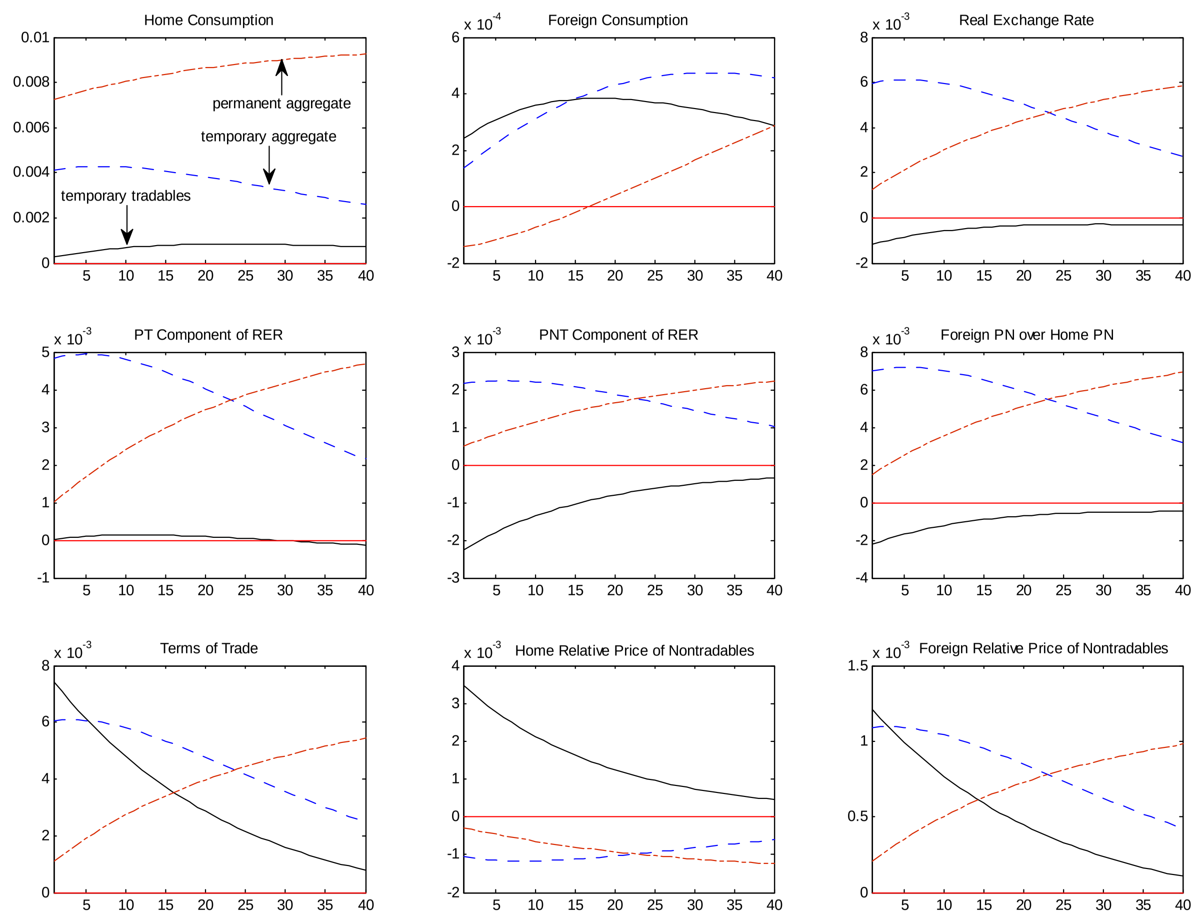

Figure 2: The Nontradable Price Channel

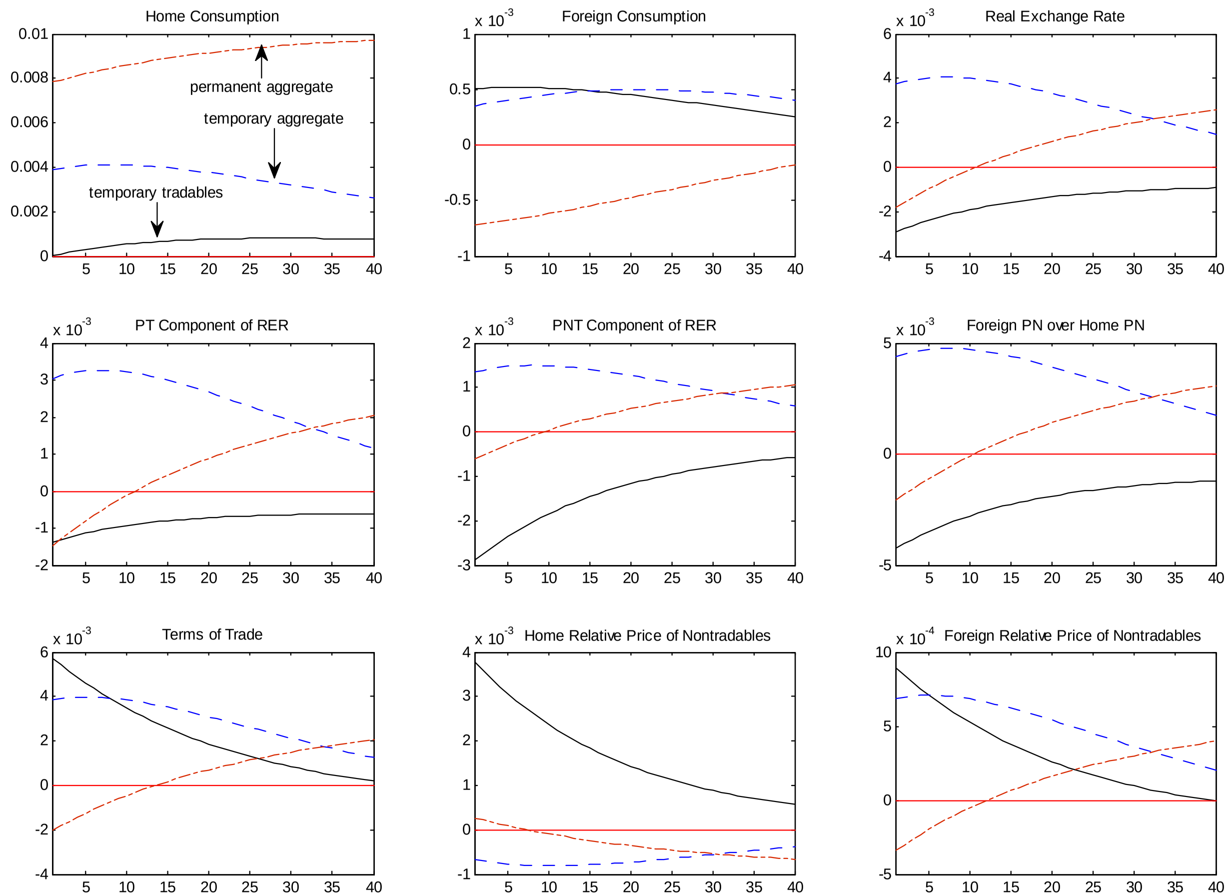

Figure 3: The Wealth Channel with a High Trade Elasticity

5 The relative-price decomposition of the Backus-Smith correlation: empirical evidence

Theory 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 that the empirical evidence on the BS statistic can in principle correspond to different transmission channels. We now turn our attention to the data.

To carry out our empirical analysis, we rely on the decomposition of the Backus-Smith statistic (6), that we rewrite here for convenience:

$$Corr\left(rc,rer\right)=\frac{Cov\left(rc,rer\right)}{\sigma\left(rc\right)\cdot\sigma\left(rer\right)}=\frac{Cov\left(rc,p_{T}\right)}{\sigma\left(rc\right)\cdot\sigma\left(rer\right)}+\frac{Cov\left(rc,p_{NT}\right)}{\sigma\left(rc\right)\cdot\sigma\left(rer\right)} \quad (13)$$

Note that to highlight the role of terms of trade movements and possible deviations from the law of one price we can further transform this expression into the following:

$$\begin{aligned} Corr\left(rc,rer\right) &= \frac{Cov\left(rc,p_{T}\right)}{\sigma\left(rc\right)\cdot\sigma\left(rer\right)}+\frac{Cov\left(rc,p_{NT}\right)}{\sigma\left(rc\right)\cdot\sigma\left(rer\right)}= \\ &= \frac{Cov\left(rc,p_{TOT}\right)}{\sigma\left(rc\right)\cdot\sigma\left(rer\right)}+\frac{Cov\left(rc,\Delta\right)}{\sigma\left(rc\right)\cdot\sigma\left(rer\right)}+\frac{Cov\left(rc,p_{NT}\right)}{\sigma\left(rc\right)\cdot\sigma\left(rer\right)}, \quad (14)\end{aligned}$$

where $p_{TOT}=\log\left(\frac{P_{F,t}}{P^{*}_{H,t}\cdot S_{t}}\right)$ denotes the terms of trade and Δ denotes deviations from the law of one price. In the rest of this section we will show results from implementing the former decomposition — (13) and (14) — 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 each component on the right-hand side of (13) and (14). 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

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

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-good prices and the nontraded-good prices at frequency λ, and S_{C} and S_{RER} denote spectra. Similarly, the equivalent of (14) in the frequency domain is

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

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. 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, Eichenbaum and Rebelo 2006. Following the latter contribution, we thus also consider a third measure, based on prices of imports and exports at the dock.

The terms of trade are constructed using export prices at the dock.[9] Since these series are not available on a bilateral basis, decomposition (14) 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 to follow, results for the two cases (bilateral relative to the US, or relative to the ROW) are shown in the panels A and B, respectively. For the bilateral analysis relative to the US, we decompose real exchange rate fluctuations into the traded and the nontraded good component as in (13). Instead, for the analysis relative to the ROW, we implement the decomposition (14).

5.2 Results

The literature has long established 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 reproducing these basic results. Drawing

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

on related work of ours (Corsetti, Dedola and Viani 2011), we include in Tables 1A and 1B the overall correlation between relative consumption and the real exchange rate (for differenced series) — 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.

The evidence from our sample is clearly in line with results from earlier contributions. 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 never exceeds .2. The 10 percent two-sided confidence intervals, shown in Table 5A and B in the appendix, confirm the main message. In the worst case, the correlation coefficient is significantly lower than .33.

Against this background, the novel question we ask in our paper is whether it is possible to detect clear patterns of correlation for different components of the real exchange rate, 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 these components, reflecting different channels of international transmission.

Decomposition by tradables and nontradables prices A first key result from our decomposition of the BS statistic is that, for most countries, when domestic consumption is high relative to consumption abroad, the international price of domestic tradable output is also high. In the second column of Table 1, where tradable prices are measured using import and export prices at the dock, this is the case for 15 and 13 countries, in panels A and B, respectively. Moreover, our estimates of the overall correlation tend to have the same sign as its tradable price component — compare the first and the second column of Table 1.

In a number of countries (10 cases in Panel A and 4 cases in panel B), both the tradable and nontradable price components of the decompositions (13) and (14) contribute to the BS result, i.e. both have the same sign — although, quantitatively, the component in the tradable price tends to play the dominant role.

There are nonetheless countries for which a different pattern emerges. In Panel A of Table 1, for instance, 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 the case of Australia, Ireland, Japan and New Zealand. For these countries, a low or negative overall BS correlation appears to be determined by fluctuations in nontradable prices.

In this respect, a comment is in order regarding the evidence for the US. In the US, both the tradable and the nontradable components of our decomposition are negative and significantly different from zero (see Tables 6 through 8 in the appendix), but the latter component is quite strong. On the one hand, the evidence for the US seems to square well with the notion that wealth effects from shocks driving relative demand movements may be stronger for large, relatively closed economies. The wealth channel appears to compound with, and thus magnify, the nontradable price channel. On the other hand, the evidence for the other countries calculated vis-à-vis the US is likely to reflect this specific US feature. Indeed, the role of nontradable prices tends to be stronger in the Panel A than in the Panel B of the tables, where the real exchange rate is measured on a multilateral basis.

The confidence intervals reported in Tables 6 and 8 for the tradable component, and in Table 7 for the nontradable component of the BS correlation suggest a pattern similar as in Table 5, for the overall correlation. However, note that in Table 7 most of our estimates are not significantly different from zero (with the notable exception of the US). On this finding, the combination of our price decomposition with spectral analysis below will actually bring some useful insight.

Spectral decomposition of the relative price components In related work (see Corsetti, Dedola and Viani 2011), we have shown that spectral analysis unveils important novel properties of the correlation between relative consumption and the real exchange rate. First, from a theoretical point of view, we have made it clear that in standard incomplete market open-economy models, the cospectrum needs not be constant across frequencies — in general it will vary as a function of the endogenous dynamics of the state variables, i.e. as a function of the propagation mechanism embedded in the model. The key point here is that, in response to a shock, the endogenous dynamic of the economy determines which component of the disturbance is insurable using the assets available to agents in the economy. To wit: in symmetric model economies without capital where agents can borrow and lend internationally, if in equilibrium the real exchange rate follows a random walk, it can be shown that the international bond will not be traded at all. In response to shocks, then, the overall correlation of relative consumption and the real exchange rate may well be negative, depending on the strength of wealth effects in response to uninsured risk. But as long as there is no trade in bonds, the dynamic correlation between relative consumption and the real exchange rate will be constant across frequencies. Conversely, in more general model specifications, in which the exchange rate does not follow a random walk, a component of the shocks hitting the economy will be insurable via trade in bond, implying that the dynamic correlation will be fluctuating across frequencies.

Second, on empirical grounds, we have shown that the correlation between relative consumption and the real exchange rate is lower, and more negative, at business cycle and lower frequencies. Since open economy models are explicitly designed to match the evidence at business cycle frequencies, a specific contribution of spectral analysis consists of strengthening the notion that the 'BS anomaly' discussed in the literature provides a meaningful hurdle for them. Furthermore, in light of the well-known result that, with differenced data, standard correlations in the time domain tend to boost the high frequency components of time series (see e.g. Croux, Forni and Reichlin 2001), our empirical evidence cautions against the reliance on BS correlations calculated on first-differenced data — as these tend to dilute the extent of the deviations from the perfect risk-sharing condition.

These empirical results are reproduced in Table 1 (columns 4, 7 and 10 in Panel A, 5, 9 and 13 in Panel B). Note that, as discussed above, the dynamic BS 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 (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 correlation with a positive sign (such as Austria), the correlation at business-cycle and/or low frequencies is actually negative. The confidence bands shown in table 5A and 5B in the appendix confirm the overall picture: the number of countries with a correlation significantly different from zero more than double when the correlation is measured at business cycle and low frequencies (10 cases), relative to high frequencies (4 cases).

The evidence from spectral analysis is equally instructive when applied to our decomposition of the Backus-Smith statistic. Results are shown in Tables 1 through 3, as well as in Figure 4 through 6 in the appendix. Recall that the three tables and figures differ in the way tradable prices are computed: import and export prices are used in Table 1 and Figure 4, producer prices in Table 2 and Figure 5, and consumer prices of goods in Table 3 and Figure 6. They therefore differ in the extent to which tradable price indexes include a component in the price of nontradables goods and services. As a caveat, it should be kept in mind that, unfortunately, the relevant price indexes are not necessarily available for all countries over the same time spans, hence tables and figures differ in the underlying sample (see the appendix for details), suggesting caution in comparing results across them.

A first finding is that the nontradable price channel (a rise in relative consumption is associated with a rise in the domestic relative price of nontradables) appears to be operative at low frequencies, more than at high frequencies. For instance, in Tables 1 through 3 (and the corresponding Figures), the nontradable price component of the correlation tends to be negative for more countries at business cycle and lower frequencies — although the confidence bands reported in Table 7 still tend to include zeros for most countries. Note the results are slightly less stark in Table 3, as 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.

Since Harrod-Balassa-Samuelson or Baumol effects are likely to be part of this channel, our empirical evidence squares well with the notion that these forces driving domestic sectoral price changes tend to be more effective in the medium and long run — for instance, it would be natural to conjecture that

HBS effects should be forecastable over medium and long horizon. Our theoretical analysis in Sections 3 and 4 then suggests that, to the extent that agents have access to some financial instrument to share risk, a negative sign for 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 latter, however, we find that its contribution to the BS correlation also varies across frequencies, but without compensating for the nontradable price behavior. In Table 1, at business cycle or lower frequencies, about 2/3 of the countries in the sample display a large negative entry consistent with a strong tradable wealth channel; for the remaining countries, results are 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, but the numerical results are close to zero (confidence bands are reported in Tables 6 and 8).

Keeping our focus on Table 1 (and the corresponding Figure 2), we can further detail the evidence in relation to the different channels of transmission highlighted by the literature. Namely, 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.[10] 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.

Yet, 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. As further illustrated by Figure 2A and 2B, the nontradable price components of the BS correlation become more negative at lower frequencies in the case of Finland, Sweden, New Zealand and the UK. For these countries both the nontradable price and the wealth channels are effective at these frequencies.

Since our measure of the nontradables real exchange rate does not depend on nominal currency rates, a large negative entry for the nontradables price component — thus a significant contribution of this component to the overall BS statistic especially at business cycle and lower frequencies — suggests that the BS anomaly cannot be exclusively ascribed to nominal exchange rate fluctuations. By the same token, the fact that the anomaly is more pronounced at low frequencies arguably points to a natural weakness of possible explanations emphasizing nominal rigidities.

These conclusions are substantially unchanged when using the terms of trade,

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

instead of the price of tradables. But when we rely on measures 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.

We conclude by observing that, whether the evidence is referred to the real exchange rate, or its relative price components, spectral analysis clearly warns against relying on standard correlations computed with first differenced data — as these would give a clearly distorted picture of the evidence at the frequencies more relevant for open economy models.

6 Conclusion

In international economics, there is a long-standing tradition of adopting different decompositions of the exchange rate distinguishing price indexes by goods tradability, to shed light on different dimensions of the international transmission mechanisms — from issues raised by the transfer problem and current account adjustment, to the analysis of purchasing power parity in the short and long run. In this paper, we have shown that a standard decomposition is particularly meaningful in assessing recent theoretical literature, pursuing the goal of accounting for the strong evidence of a large role of uninsured risk in shaping the international transmission of shocks. The different channels envisioned by leading models have in fact distinct implications for the behavior of tradable and non tradable prices.

For many OECD countries, we have shown that, especially at business cycle and lower frequencies, tradable prices tend to appreciate when domestic consumption demand rises relative to the rest of the world, arguably reflecting strong consequences on cross-country wealth of business cycle disturbances. For a smaller number of countries, real appreciation associated with demand boom is driven by the price of nontradables, with limited variations in the terms of trade.

In light of our theoretical analysis, these results are consistent, although to a different extent, with a plurality of transmission mechanisms. Yet, the most common pattern found in the data points not only to the presence of sizeable country-specific macreconomic risk associated with nontradable price adjustment, but also to a negative contribution of tradable prices to global pooling of such risk, especially at business cycle and lower frequencies. Distinguishing price indexes by goods tradability thus provides new, more detailed evidence on the pervasiveness of the 'anomaly' already identified by the literature.

TABLE 1A

Decomposition of the 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			Spectral Decomposition: 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	-0,20	-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: The covariances of relative consumption and tradable and nontradable prices are normalized using the standard deviations of the real exchange rate and relative consumption. See text for details.

TABLE 1B

Decomposition of the 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				Spectral Decomposition: Low frequency				Spectral Decomposition: BC frequency				Spectral Decomposition: 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	-0,04	0,02	-0,07	-0,01	-0,32	-0,05	-0,27	-0,19	-0,01	0,12	-0,13	0,13	-0,03	0,00	-0,02	-0,04
Austria	0,06	-0,05	0,10	-0,17	-0,27	0,08	-0,32	-0,13	-0,14	0,00	-0,13	-0,08	0,12	-0,06	0,17	-0,21
Belgium	0,14	0,41	-0,27	0,51	0,21	0,77	-0,54	0,97	0,25	0,46	-0,18	0,63	0,04	0,32	-0,26	0,37
Canada	-0,13	-0,04	-0,09	-0,25	-0,12	0,14	-0,28	-0,13	-0,21	0,02	-0,22	-0,29	-0,10	-0,10	0,00	-0,25
Switzerland	0,19	0,21	-0,02	0,22	0,29	0,00	0,27	0,05	0,26	0,21	0,04	0,26	0,15	0,24	-0,09	0,23
Denmark	-0,06	-0,11	0,05	-0,08	-0,15	-0,06	-0,10	0,12	-0,05	-0,30	0,24	-0,34	-0,05	-0,04	-0,01	-0,01
Spain	-0,04	-0,08	0,05	-0,08	-0,35	-0,34	0,02	-0,43	-0,21	-0,22	0,01	-0,24	0,11	0,05	0,07	0,08
Finland	-0,08	-0,10	0,02	-0,15	-0,55	-0,51	-0,05	-0,75	-0,36	-0,36	-0,02	-0,50	0,14	0,08	0,05	0,12
Germany	-0,05	-0,05	0,01	-0,03	-0,07	-0,16	0,08	-0,33	0,10	-0,12	0,16	-0,31	-0,05	-0,04	-0,03	0,05
Ireland	0,20	0,11	0,09	0,12	0,32	0,09	0,23	0,13	0,32	0,29	0,04	0,37	0,12	0,03	0,10	0,00
Italy	-0,04	-0,37	0,33	-0,57	-0,32	-0,76	0,44	-1,28	-0,12	-0,46	0,40	-0,74	-0,03	0,28	0,28	-0,41
Japan	0,08	0,03	0,05	0,00	-0,07	0,03	-0,10	0,11	0,12	0,09	0,02	0,17	0,10	0,02	0,07	-0,06
Korea	-0,41	-0,38	-0,04	-0,62	-0,49	-0,34	-0,15	-0,61	-0,53	-0,44	-0,09	-0,76	-0,38	-0,36	-0,02	-0,59
Netherlands	-0,05	-0,03	-0,01	-0,20	-0,17	0,00	-0,17	0,03	-0,18	0,00	-0,19	0,08	0,01	-0,05	0,05	-0,31
Norway	0,02	-0,30	0,32	-0,54	-0,01	-1,03	1,00	-1,87	-0,04	-0,55	0,51	-0,96	0,05	-0,17	0,21	-0,29
New Zealand	0,05	0,07	-0,02	-0,01	-0,44	-0,22	-0,22	-0,42	-0,17	-0,03	-0,13	-0,14	0,16	0,13	0,03	0,07
Sweden	-0,14	-0,13	0,00	-0,20	-0,28	-0,35	0,09	-0,51	-0,24	-0,25	0,03	-0,33	-0,10	-0,07	-0,03	-0,11
UK	0,06	-0,08	0,12	-0,07	0,02	0,10	-0,05	0,10	0,02	0,10	-0,06	0,06	0,09	-0,10	0,20	-0,13
US	-0,21	-0,10	-0,11	-0,15	-0,36	-0,04	-0,32	-0,07	-0,26	-0,03	-0,24	-0,09	-0,14	-0,14	0,00	-0,18
Median	-0,04	-0,05	0,01	-0,08	-0,16	-0,05	-0,10	-0,13	-0,09	-0,03	-0,02	-0,14	0,05	-0,04	0,03	-0,06

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

Decomposition of the correlation of relative consumption and relative prices vis-á-vis the US

Prices of tradables are producer price indexes

COUNTRY	Differenced series		Spectral Decomposition					
			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

Decomposition of the 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			Spectral Decomposition								
				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

Decomposition of the correlation of relative consumption and relative prices vis-á-vis the US

Prices of tradables are goods' retail prices

COUNTRY	Differenced series		Spectral Decomposition					
			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

Decomposition of the 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			Spectral Decomposition: 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

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A Appendix. Derivation of the financial autarky equilibrium

With a balanced trade period by period, 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

$$\widehat{\tau} = \frac{(\widehat{y}_{\mathrm{H}} - \widehat{y}_{\mathrm{F}})}{1 - (a_{\mathrm{H}} + (1-a^*_{\mathrm{H}}))\,(1-\omega)}, \tag{15}$$

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

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

and relative consumption:

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

The expressions for the tradable and nontradable components of the Backus-Smith statistic in the text are derived using the expressions for $\widehat{p}_T$ and $\widehat{p}_{NT}$, under the simplifying assumption of symmetry for simplicity. For the general case (without imposing symmetry), the decomposition of the Backus-Smith statistic can be written as:

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

and

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

To show that

$$
\begin{aligned}
\left(2a_{\mathrm{H}}\omega-1\right)Corr\left(\widehat{\tau},\widehat{p}_{NT}\right) &< 0 \\
&\Longleftrightarrow \\
\frac{1+2a_{\mathrm{H}}\left(\omega-1\right)}{2a_{\mathrm{H}}\omega-1}Corr\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}},\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)\frac{\sigma\left(\widehat{y}_{\mathrm{N}}-\widehat{y}_{\mathrm{N}}^{*}\right)}{\sigma\left(\widehat{y}_{\mathrm{H}}-\widehat{y}_{\mathrm{F}}\right)} &\simeq 0 \text{ or negative}
\end{aligned}
$$

we use (15) to write:

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

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 condition in the text is satisfied.

B 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.[11] 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 lengths of goods in CPI data are summarized in Table 4. 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

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

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.

C 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

[11] 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.

TABLE 4
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	

Tukey window, which associates any linearly-spaced vector x to

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

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.[12]

We build confidence intervals from 500 bootstrap replicates. For the dynamic correlation between relative consumption and real exchange rates, we use sigma-confidence intervals. More specifically, we apply the Fisher-z transformation to the simulated dynamic correlations in order for their distribution to get closer to a normal, compute sigma-intervals on the transformed series, and finally convert them into bands for the dynamic correlation.[13] For the measures of comovement between relative consumption and tradable/non-tradable prices

$$\frac{C_{C,PT}(\lambda)}{\sqrt{S_C(\lambda) \cdot S_{RER}(\lambda)}} \quad \text{and} \quad \frac{C_{C,PN}(\lambda)}{\sqrt{S_C(\lambda) \cdot S_{RER}(\lambda)}}$$

we use percentile confidence intervals.[14]

As for unconditional correlations, we compute confidence intervals for $C_{C,RER}$ by applying the Fisher-z transformation to the original statistics, derive confidence bands for this series and convert them into bounds for the original correlation. For the comovement of relative consumption and tradable/non-tradable prices, instead, we employ the bootstrap technique described above, integrating the confidence bounds over all frequencies.

[12] 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.

[13] See Croux et al. [2001].

[14] These last two measures are not bounded between -1 and 1, so we cannot apply to them the Fisher transformation. Sigma-confidence intervals may then be misleading as the distribution of the replicates might not resemble closely a normal distribution.

D Appendix. Figures and Tables

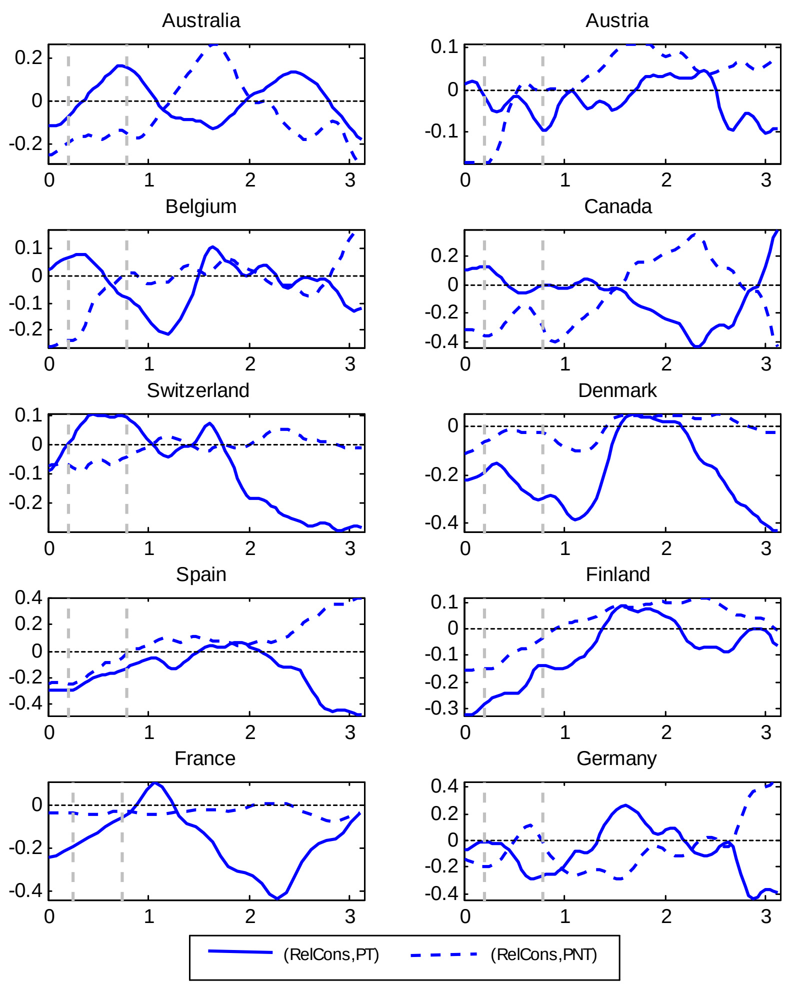

FIGURE 4A

Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the US. Tradable prices are import and export prices at the dock.

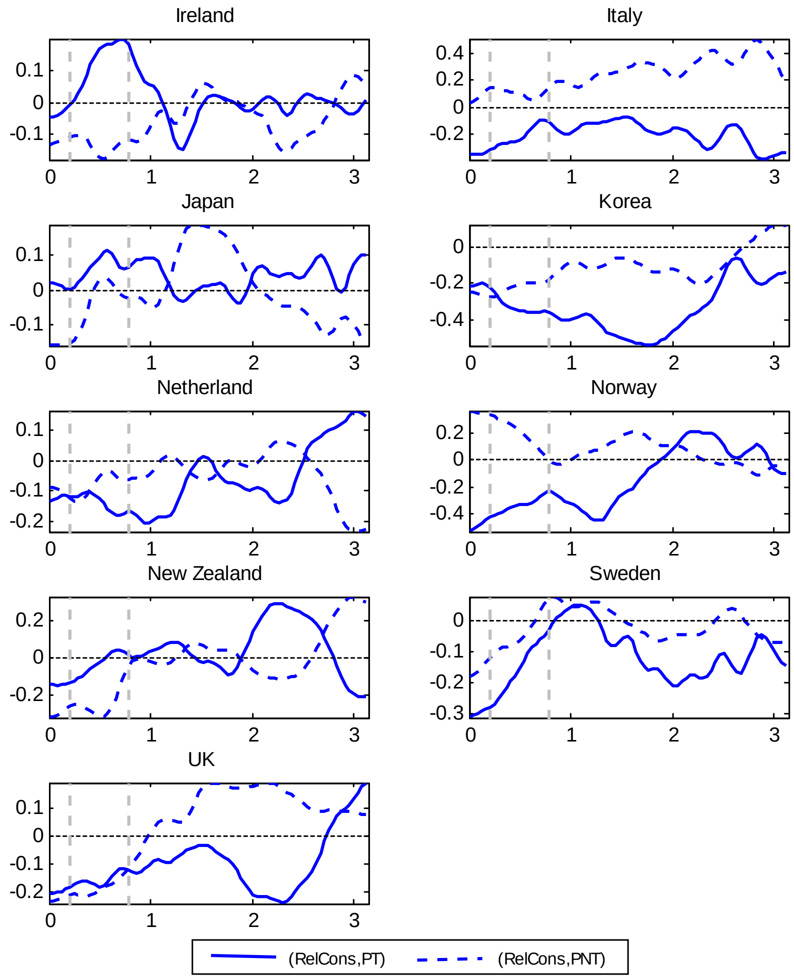

FIGURE 4A (continued)
Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the US. Tradable prices are import and export prices at the dock.

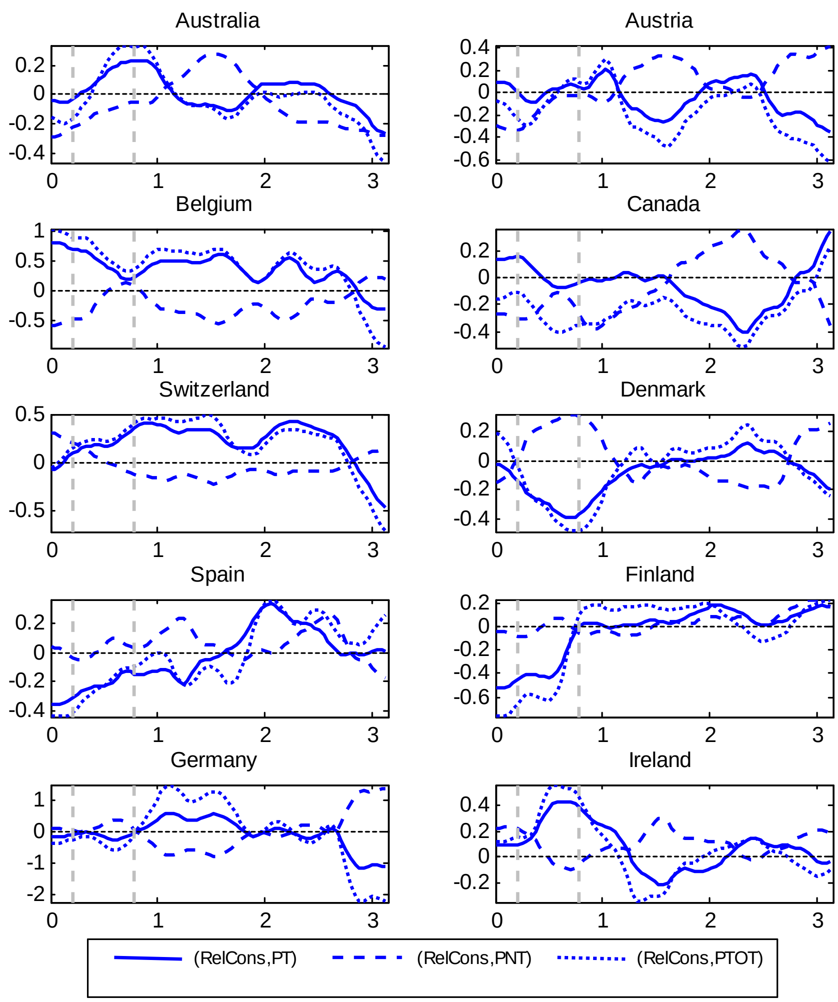

FIGURE 4B

Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the ROW. Tradable prices are import and export prices at the dock.

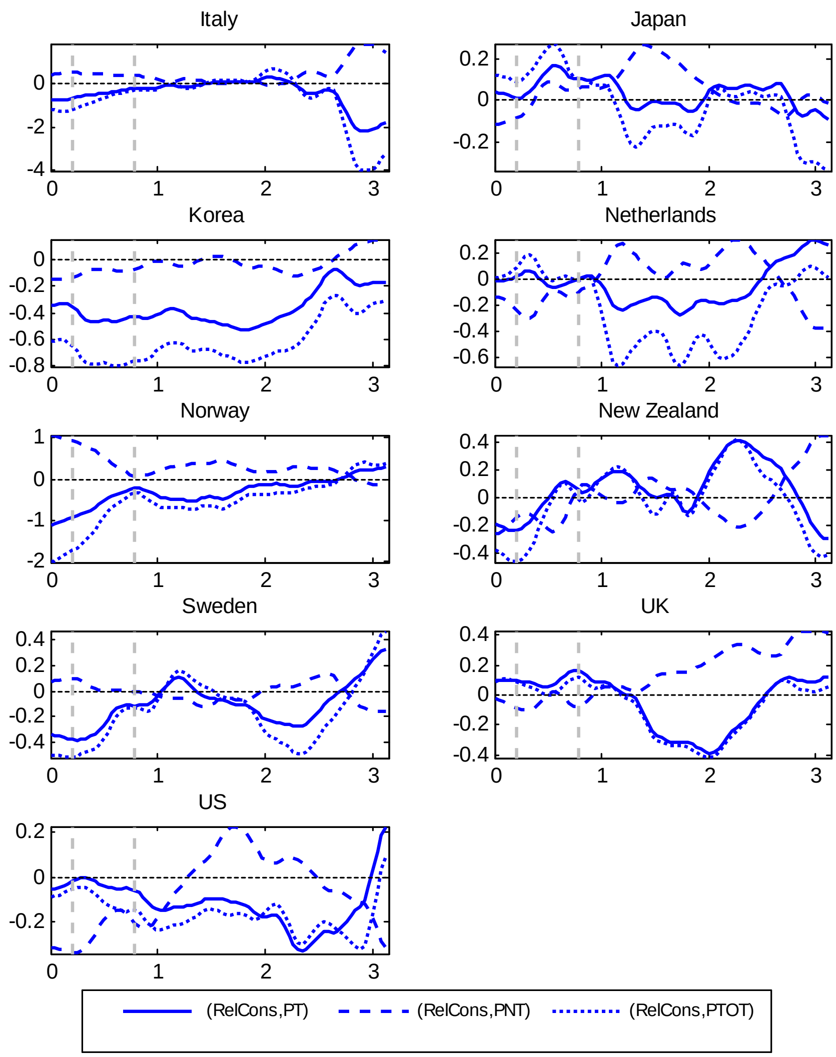

FIGURE 4B (continued)
Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the ROW. Tradable prices are import and export prices at the dock.

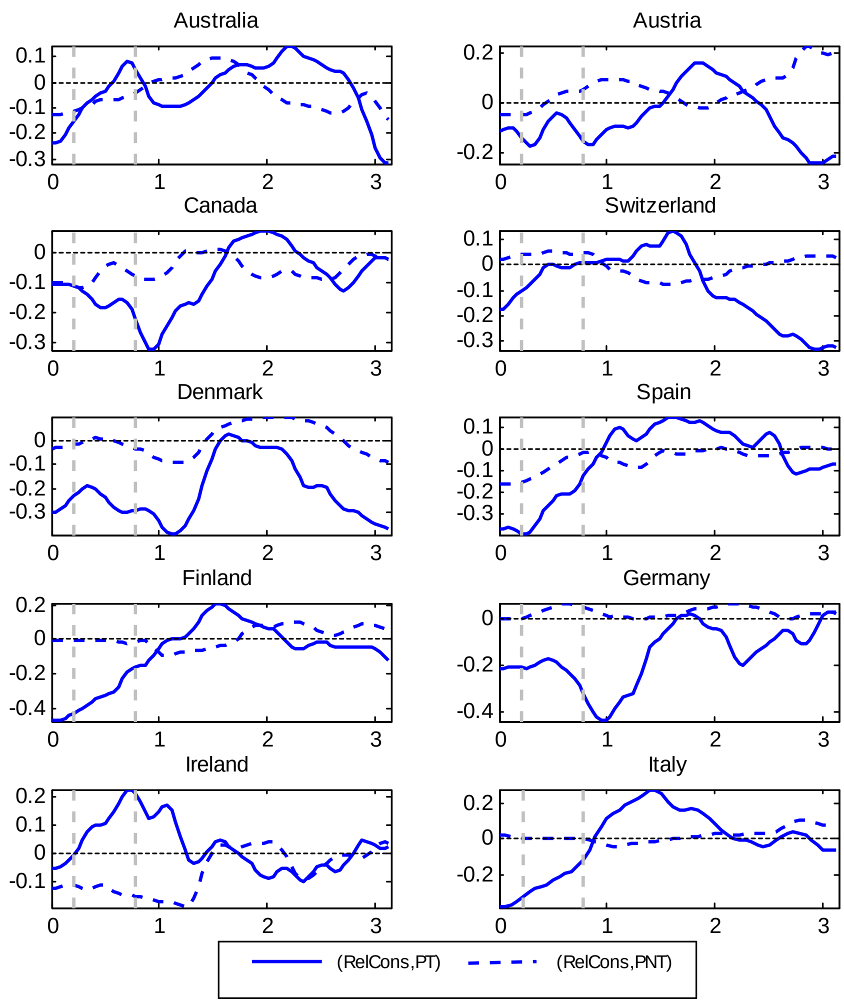

FIGURE 5A

Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the US. Tradable prices are producer price indexes.

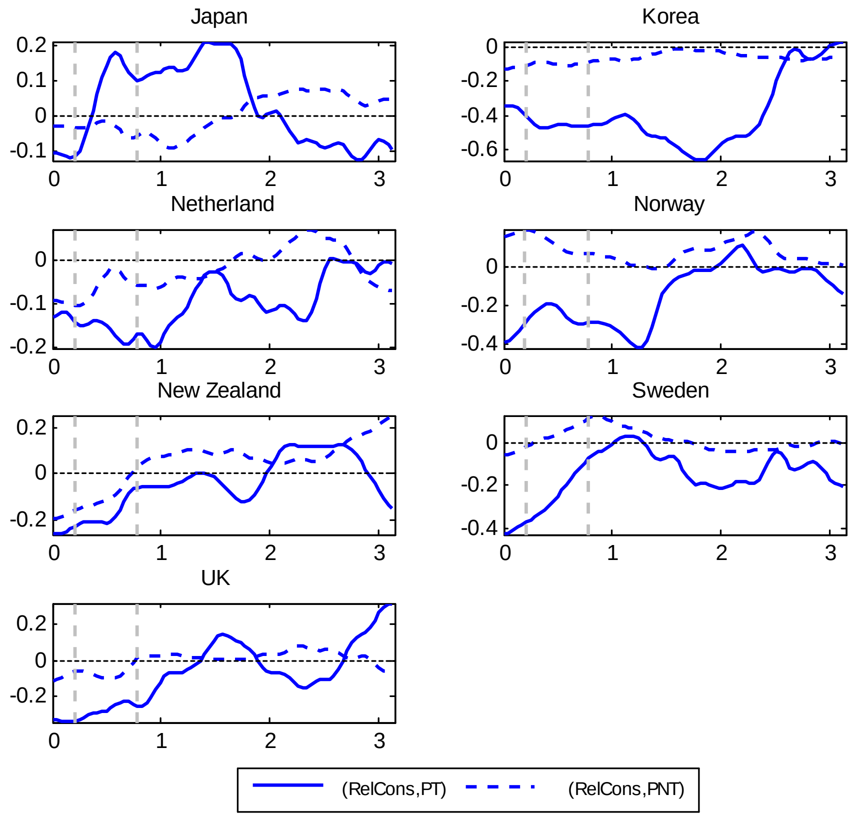

FIGURE 5A (continued)
Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the US. Tradable prices are producer price indexes.

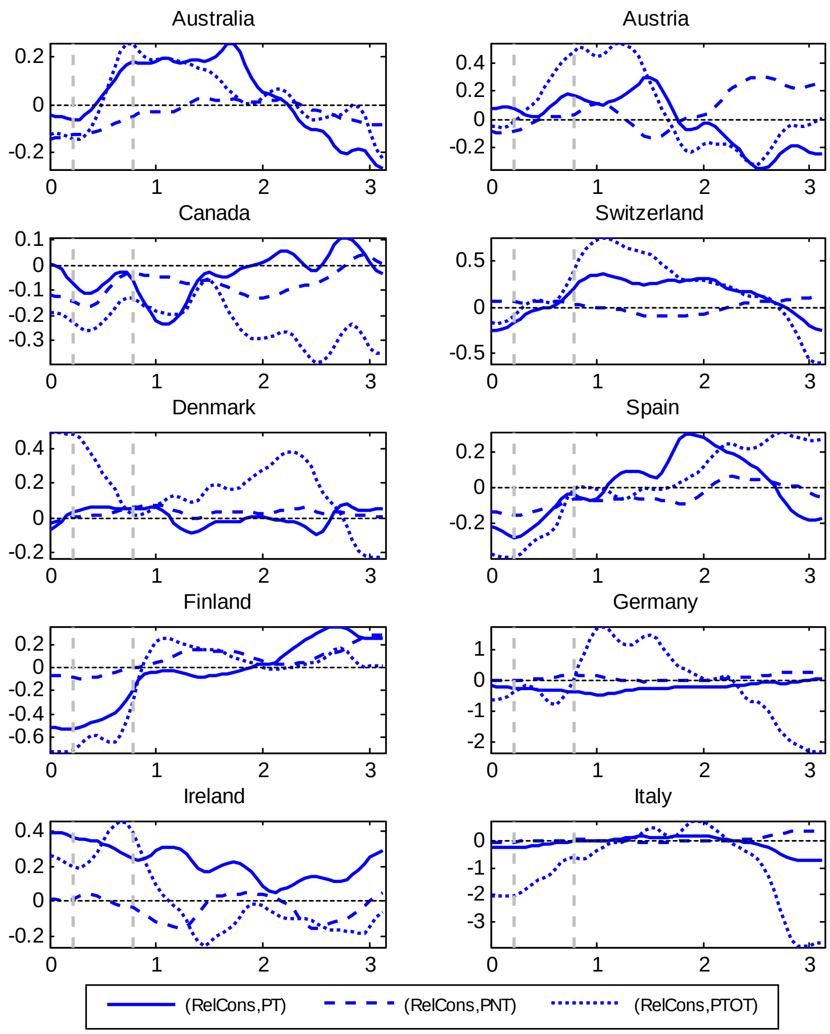

FIGURE 5B
Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the US. Tradable prices are producer price indexes.

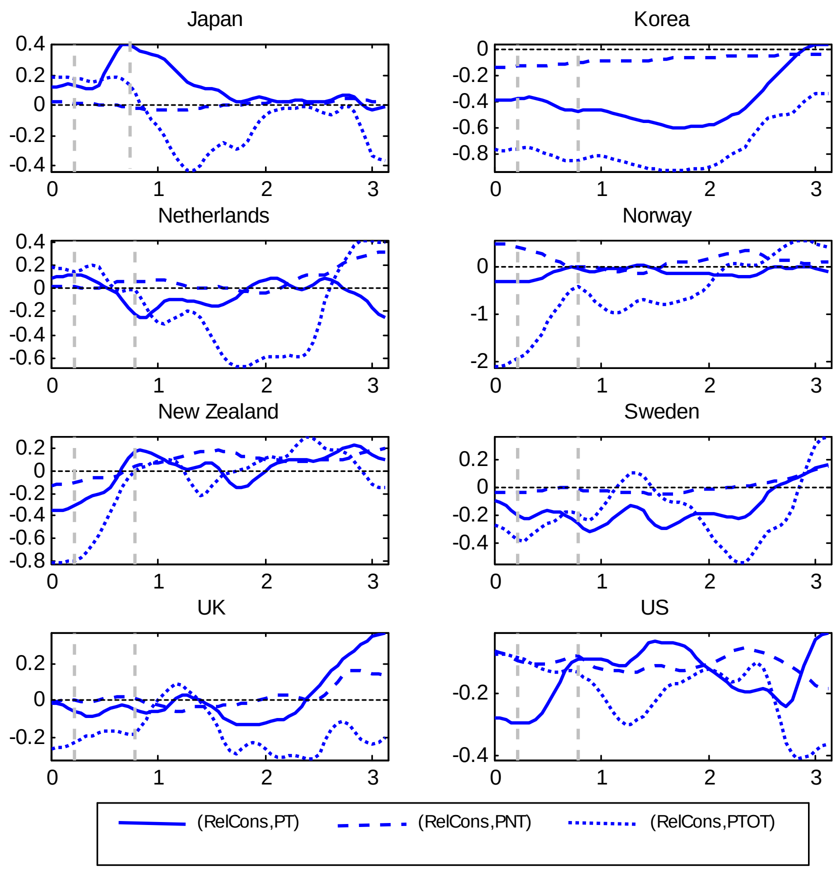

FIGURE 5B (continued)
Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the US. Tradable prices are producer price indexes.

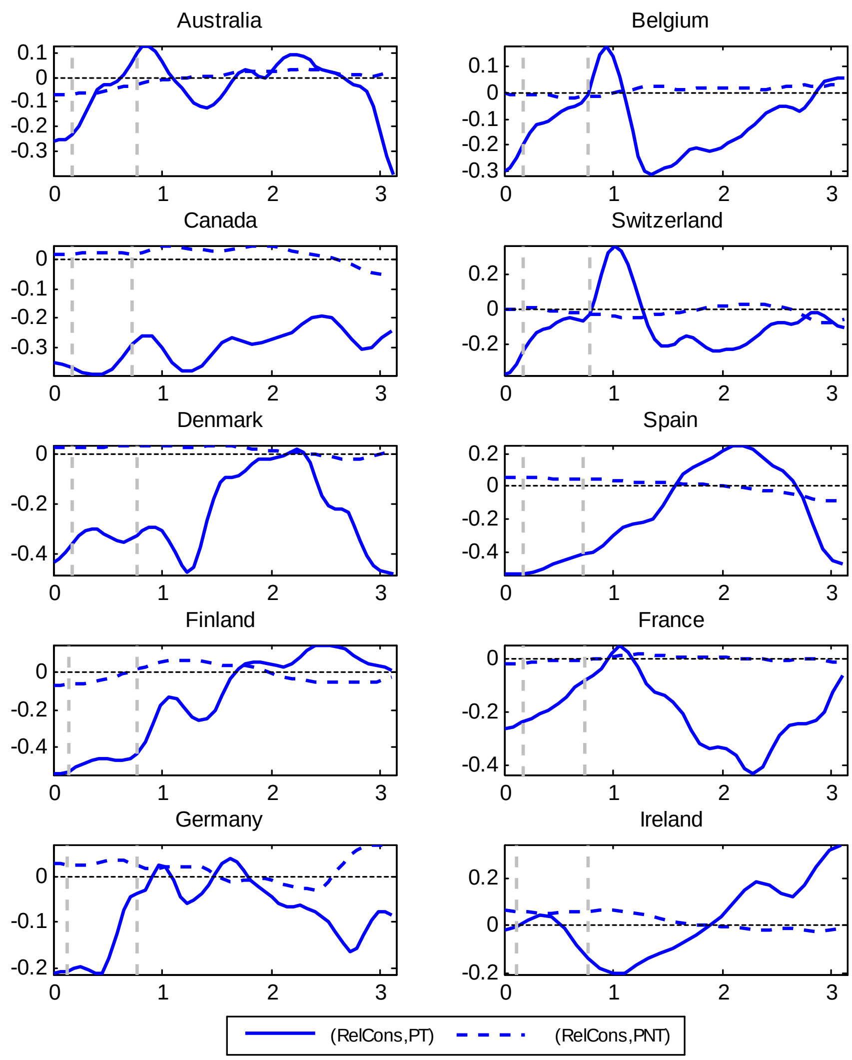

FIGURE 6A

Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the US. Tradable prices are goods in CPI.

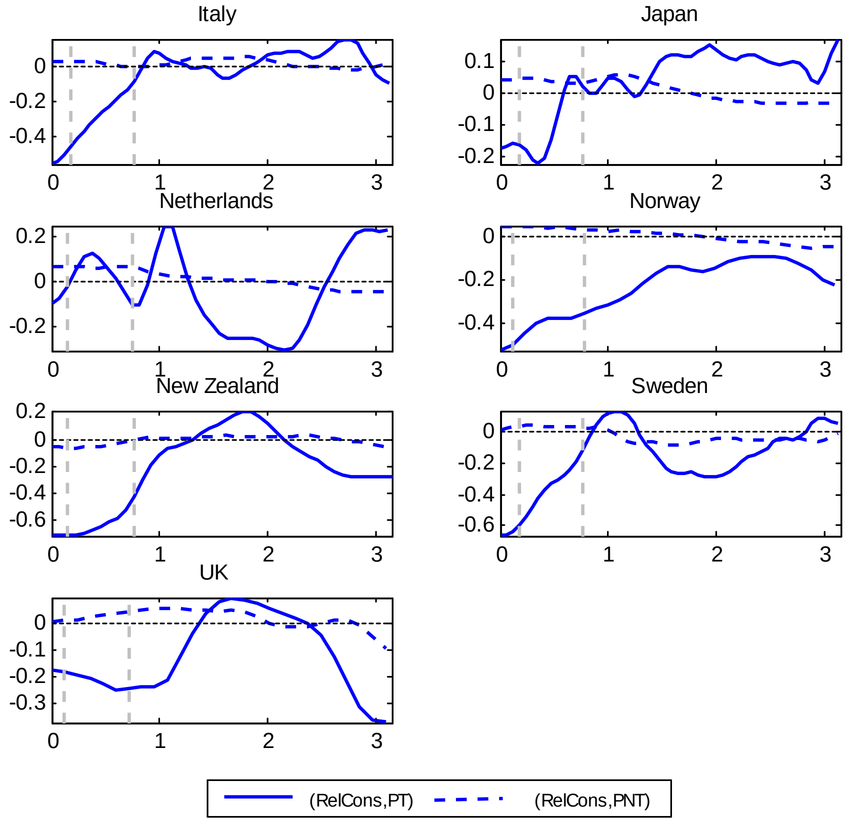

FIGURE 6A (continued)
Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the US. Tradable prices are goods in CPI.

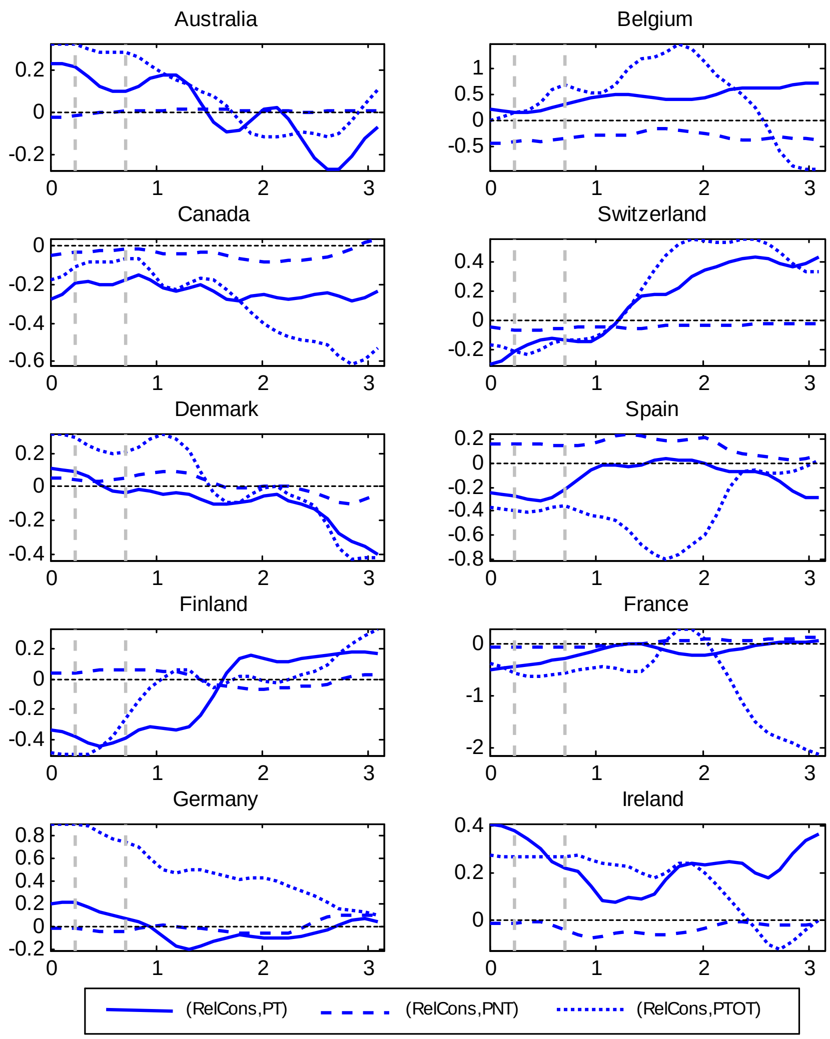

FIGURE 6B
Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the ROW. Tradable prices are goods in CPI.

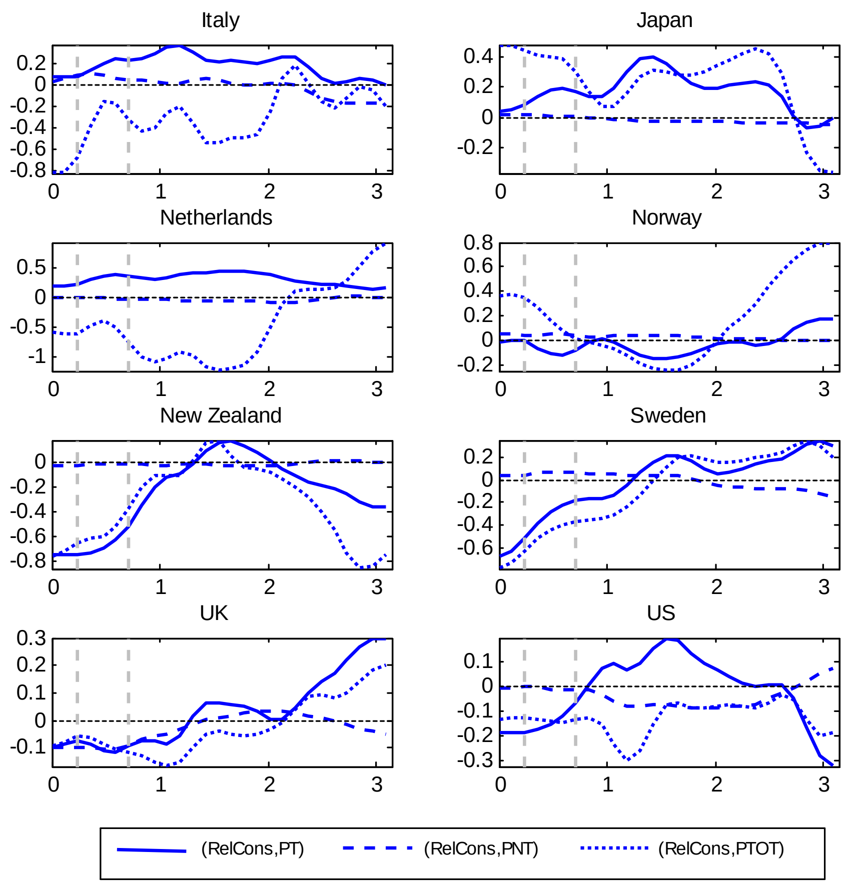

FIGURE 6B (continued)
Spectral decomposition of the two relative price components of the BS statistic vis-à-vis the ROW. Tradable prices are goods in CPI.

TABLE 5A

Correlation of relative consumption and the real exchange rate vis-á-vis the US

Point estimates and 10 percent confidence intervals

COUNTRY	Differenced series			Spectral Decomposition								
				Low frequency			BC frequency			High frequency		
	LB	est	UB	LB	est	UB	LB	est	UB	LB	est	UB
Australia	-0,20	-0,07	0,07	-0,45	-0,33	-0,05	-0,29	-0,10	0,01	-0,11	-0,01	0,08
Austria	-0,14	0,00	0,13	-0,36	-0,16	0,06	-0,24	-0,11	0,04	-0,05	0,04	0,13
Belgium	-0,21	-0,08	0,05	-0,39	-0,20	-0,05	-0,27	-0,09	0,03	-0,13	-0,04	0,05
Canada	-0,29	-0,16	-0,02	-0,44	-0,21	0,00	-0,38	-0,24	-0,10	-0,20	-0,12	-0,03
Switzerland	-0,19	-0,06	0,07	-0,26	-0,12	0,17	-0,15	0,02	0,16	-0,18	-0,09	0,00
Denmark	-0,33	-0,20	-0,07	-0,46	-0,30	-0,05	-0,41	-0,25	-0,14	-0,26	-0,16	-0,07
Spain	-0,33	-0,21	-0,08	-0,66	-0,53	-0,33	-0,51	-0,37	-0,23	-0,09	0,01	0,09
Finland	-0,23	-0,10	0,04	-0,60	-0,47	-0,23	-0,46	-0,33	-0,21	-0,05	0,05	0,14
France	-0,37	-0,20	-0,01	-0,36	-0,22	0,05	-0,22	-0,06	0,07	-0,12	-0,04	0,05
Germany	-0,25	-0,12	0,01	-0,41	-0,21	0,03	-0,35	-0,18	-0,07	-0,18	-0,10	0,00
Ireland	-0,18	-0,05	0,09	-0,31	-0,16	-0,10	-0,18	-0,01	0,10	-0,13	-0,04	0,06
Italy	-0,14	-0,01	0,12	-0,41	-0,25	0,01	-0,28	-0,10	0,01	0,01	0,10	0,19
Japan	-0,11	0,02	0,16	-0,31	-0,14	0,13	-0,16	0,01	0,15	-0,04	0,05	0,15
Korea	-0,56	-0,46	-0,35	-0,65	-0,47	-0,34	-0,62	-0,55	-0,43	-0,51	-0,44	-0,36
Netherlands	-0,25	-0,12	0,01	-0,44	-0,22	0,03	-0,37	-0,22	-0,09	-0,17	-0,08	0,01
Norway	-0,20	-0,06	0,07	-0,31	-0,13	0,13	-0,30	-0,13	0,00	-0,12	-0,03	0,06
New Zealand	-0,17	-0,04	0,09	-0,56	-0,44	-0,19	-0,38	-0,27	-0,12	0,00	0,10	0,17
Sweden	-0,29	-0,17	-0,03	-0,56	-0,45	-0,17	-0,36	-0,20	-0,06	-0,19	-0,10	-0,01
UK	-0,21	-0,08	0,05	-0,57	-0,42	-0,20	-0,45	-0,34	-0,19	-0,07	0,02	0,10
US	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTE: See note to Table 1A. Est denotes point estimates, LB and UB, respectively, lower and upper bound. See Appendix B for details on intervals computation

TABLE 5B

Correlation of relative consumption and the real exchange rate vis-á-vis the rest-of-the-world

Point estimates and 10 percent confidence intervals

COUNTRY	Differenced series			Spectral Decomposition Low frequency			BC frequency			High frequency		
	LB	est	UB	LB	est	UB	LB	est	UB	LB	est	UB
Australia	-0,18	-0,04	0,09	-0,42	-0,32	-0,03	-0,19	-0,01	0,08	-0,11	-0,03	0,07
Austria	-0,08	0,06	0,19	-0,48	-0,27	-0,10	-0,26	-0,14	0,02	0,02	0,12	0,21
Belgium	0,01	0,14	0,27	0,01	0,21	0,42	0,10	0,25	0,38	-0,04	0,04	0,14
Canada	-0,26	-0,13	0,00	-0,37	-0,12	0,05	-0,35	-0,21	-0,07	-0,18	-0,10	-0,01
Switzerland	0,06	0,19	0,32	0,08	0,29	0,49	0,12	0,26	0,39	0,06	0,15	0,23
Denmark	-0,20	-0,06	0,07	-0,30	-0,15	0,10	-0,21	-0,05	0,07	-0,14	-0,05	0,04
Spain	-0,17	-0,04	0,10	-0,52	-0,35	-0,10	-0,37	-0,21	-0,06	0,01	0,11	0,18
Finland	-0,21	-0,08	0,06	-0,66	-0,55	-0,34	-0,51	-0,36	-0,24	0,03	0,14	0,21
Germany	-0,18	-0,05	0,09	-0,24	-0,07	0,19	-0,12	0,10	0,18	-0,13	-0,05	0,05
Ireland	0,07	0,20	0,33	0,12	0,22	0,49	0,18	0,32	0,43	0,04	0,12	0,21
Italy	-0,18	-0,04	0,09	-0,45	-0,32	-0,03	-0,30	-0,12	0,00	-0,11	-0,03	0,06
Japan	-0,05	0,08	0,21	-0,25	-0,07	0,18	-0,05	0,12	0,23	0,01	0,10	0,20
Korea	-0,52	-0,41	-0,30	-0,65	-0,49	-0,36	-0,60	-0,53	-0,41	-0,46	-0,38	-0,21
Netherlands	-0,18	-0,05	0,09	-0,39	-0,17	0,03	-0,29	-0,18	0,00	-0,08	0,01	0,09
Norway	-0,11	0,02	0,15	-0,22	-0,01	0,20	-0,20	-0,04	0,08	-0,05	0,05	0,14
New Zealand	-0,09	0,05	0,18	-0,54	-0,44	-0,18	-0,30	-0,17	-0,03	0,06	0,16	0,24
Sweden	-0,27	-0,14	0,00	-0,50	-0,28	-0,11	-0,38	-0,24	-0,10	-0,20	-0,10	-0,02
UK	-0,06	0,08	0,21	-0,22	0,02	0,23	-0,12	0,02	0,18	0,00	0,09	0,17
US	-0,33	-0,21	-0,07	-0,51	-0,36	-0,12	-0,40	-0,26	-0,14	-0,22	-0,14	-0,05

NOTE: See note to Table 1B and 5A

TABLE 6A

Correlation of relative consumption and the relative price of tradables vis-á-vis the US

Point estimates and 10 percent confidence intervals

COUNTRY	Differenced series			Spectral Decomposition: Low frequency			BC frequency			High frequency		
	LB	est	UB	LB	est	UB	LB	est	UB	LB	est	UB
Australia	-0,07	0,00	0,08	-0,22	-0,11	0,12	-0,07	0,06	0,15	-0,09	0,00	0,09
Austria	-0,15	-0,02	0,10	-0,30	0,02	0,27	-0,23	-0,04	0,18	-0,18	-0,02	0,15
Belgium	-0,13	-0,01	0,12	-0,25	-0,05	0,36	-0,19	0,03	0,24	-0,18	0,05	0,09
Canada	-0,19	-0,06	0,04	-0,13	0,12	0,31	-0,11	0,02	0,19	-0,28	-0,12	0,01
Switzerland	-0,17	-0,04	0,09	-0,28	-0,05	0,33	-0,17	0,08	0,26	-0,24	-0,10	0,04
Denmark	-0,30	-0,19	-0,08	-0,47	-0,21	0,11	-0,42	-0,22	-0,06	-0,28	-0,17	-0,05
Spain	-0,27	-0,18	-0,07	-0,45	-0,29	-0,10	-0,36	-0,22	-0,08	-0,25	-0,11	0,02
Finland	-0,20	-0,10	0,01	-0,52	-0,31	0,02	-0,41	-0,23	-0,04	-0,15	-0,02	0,10
France	-0,17	-0,17	0,05	-0,50	-0,23	0,18	-0,39	-0,12	0,16	-0,17	-0,17	0,06
Germany	-0,20	-0,06	0,10	-0,37	-0,04	0,32	-0,36	-0,12	0,14	-0,22	-0,04	0,12
Ireland	-0,10	0,03	0,17	-0,29	-0,03	0,30	-0,12	0,12	0,30	-0,15	-0,01	0,15
Italy	-0,35	-0,21	-0,07	-0,62	-0,34	0,02	-0,44	-0,21	-0,01	-0,34	-0,18	0,01
Japan	-0,07	0,04	0,14	-0,19	0,01	0,26	-0,09	0,06	0,21	-0,10	0,03	0,15
Korea	-0,42	-0,34	-0,24	-0,46	-0,21	0,00	-0,46	-0,33	-0,17	-0,46	-0,36	-0,25
Netherlands	-0,19	-0,07	0,03	-0,31	-0,12	0,09	-0,29	-0,14	0,02	-0,17	-0,04	0,09
Norway	-0,31	-0,17	-0,03	-0,75	-0,48	-0,15	-0,21	-0,03	0,15	-0,08	0,07	0,24
New Zealand	-0,10	0,03	0,15	-0,33	-0,14	0,15	-0,21	-0,03	0,15	-0,08	0,07	0,24
Sweden	-0,23	-0,13	-0,03	-0,45	-0,29	-0,03	-0,31	-0,15	0,02	-0,22	-0,09	0,02
UK	-0,20	-0,11	-0,02	-0,36	-0,20	0,01	-0,29	-0,16	-0,02	-0,21	-0,09	0,03
US	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTE: See note to Table 5A. Prices of tradables are import and export prices at the dock

TABLE 6B

Correlation of relative consumption and the relative price of tradables vis-á-vis the rest-of-the-world

Point estimates and 10 percent confidence intervals

COUNTRY	Differenced series			Spectral Decomposition								
				Low frequency			BC frequency			High frequency		
	LB	est	UB	LB	est	UB	LB	est	UB	LB	est	UB
Australia	-0,05	0,02	0,10	-0,20	-0,05	0,17	-0,03	0,12	0,21	-0,08	0,00	0,09
Austria	-0,32	-0,05	0,27	-0,39	0,08	0,44	-0,26	0,00	0,31	-0,41	-0,06	0,26
Belgium	0,16	0,41	0,66	0,22	0,77	1,27	0,13	0,46	0,86	-0,02	0,32	0,61
Canada	-0,16	-0,04	0,06	-0,11	0,14	0,40	-0,11	0,02	0,20	-0,24	-0,10	0,04
Switzerland	0,07	0,21	0,36	-0,32	0,00	0,42	-0,05	0,21	0,42	0,07	0,24	0,41
Denmark	-0,29	-0,11	0,06	-0,67	-0,06	0,44	-0,55	-0,30	0,10	-0,22	-0,04	0,10
Spain	-0,21	-0,08	0,06	-0,62	-0,34	-0,02	-0,43	-0,22	-0,04	-0,12	0,05	0,19
Finland	-0,20	-0,10	0,04	-0,72	-0,51	-0,23	-0,55	-0,36	-0,15	-0,08	0,08	0,19
Germany	-0,35	-0,05	0,27	-0,80	-0,16	0,61	-0,59	-0,12	0,45	-0,46	-0,04	0,34
Ireland	-0,05	0,11	0,26	-0,32	0,09	0,53	-0,03	0,29	0,50	-0,14	0,03	0,22
Italy	-0,64	-0,27	-0,03	-1,37	-0,76	-0,02	-0,96	-0,46	-0,05	-0,69	-0,28	0,09
Japan	-0,08	0,03	0,14	-0,18	0,03	0,27	-0,07	0,09	0,24	-0,12	0,02	0,14
Korea	-0,49	-0,38	-0,28	-0,62	-0,34	-0,12	-0,57	-0,44	-0,25	-0,47	-0,36	-0,26
Netherlands	-0,21	-0,03	0,14	-0,37	0,00	0,37	-0,29	0,00	0,26	-0,24	-0,05	0,15
Norway	-0,51	-0,30	-0,09	-1,51	-1,03	-0,41	-0,95	-0,55	-0,25	-0,42	-0,17	0,07
New Zealand	-0,07	0,07	0,23	-0,55	-0,22	0,12	-0,28	-0,03	0,16	-0,04	0,13	0,28
Sweden	-0,22	-0,13	-0,02	-0,59	-0,35	-0,12	-0,41	-0,25	-0,07	-0,18	-0,07	0,03
UK	-0,14	-0,04	0,07	-0,14	0,10	0,33	-0,07	0,10	0,26	-0,25	-0,10	0,01
US	-0,19	-0,10	-0,004	-0,21	-0,04	0,17	-0,17	-0,03	-0,09	-0,25	-0,14	-0,02

NOTE: See note to Table 5B. Prices of tradables are import and export prices at the dock

TABLE 7A

Correlation of relative consumption and the relative price of nontradables vis-á-vis the US

Point estimates and 10 percent confidence intervals

COUNTRY	Differenced series			Spectral Decomposition: Low frequency			BC frequency			High frequency		
	LB	est	UB	LB	est	UB	LB	est	UB	LB	est	UB
Australia	-0,18	-0,07	0,04	-0,41	-0,23	0,02	-0,35	-0,16	0,01	-0,13	-0,01	0,13
Austria	-0,05	0,02	0,09	-0,33	-0,17	-0,01	-0,17	-0,06	0,01	-0,05	0,06	0,17
Belgium	-0,16	-0,07	0,02	-0,43	-0,25	-0,03	-0,27	-0,12	0,00	-0,08	0,01	0,09
Canada	-0,22	-0,10	0,05	-0,63	-0,33	0,01	-0,48	-0,26	-0,07	-0,15	0,01	0,17
Switzerland	-0,08	-0,02	0,03	-0,22	-0,07	0,08	-0,16	-0,06	0,04	-0,04	-0,01	0,04
Denmark	-0,07	-0,02	0,04	-0,24	-0,09	0,11	-0,16	-0,03	0,07	-0,04	0,00	0,05
Spain	-0,12	-0,03	0,07	-0,38	-0,24	-0,03	-0,28	-0,15	-0,01	0,01	0,13	0,21
Finland	-0,05	0,00	0,05	-0,25	-0,15	0,00	-0,18	-0,10	-0,01	0,01	0,06	0,12
France	-0,01	-0,03	0,08	-0,17	-0,04	0,11	-0,15	-0,04	0,08	0,00	-0,03	0,09
Germany	-0,18	-0,06	0,03	-0,39	-0,17	0,07	-0,25	-0,06	0,07	-0,17	-0,05	0,08
Ireland	-0,17	-0,07	0,02	-0,34	-0,12	0,10	-0,28	-0,13	0,01	-0,14	-0,04	0,06
Italy	0,07	0,20	0,32	-0,38	-0,16	0,15	-0,06	0,11	0,30	0,11	0,28	0,44
Japan	-0,10	-0,01	0,08	-0,38	-0,16	0,15	-0,24	-0,05	0,15	-0,08	0,02	0,11
Korea	-0,18	-0,12	-0,05	-0,45	-0,26	-0,06	-0,32	-0,22	-0,08	-0,14	-0,08	-0,01
Netherlands	-0,11	-0,05	0,01	-0,26	-0,10	0,09	-0,20	-0,08	0,05	-0,10	-0,04	0,03
Norway	0,00	0,11	0,21	0,01	0,35	0,62	0,00	0,20	0,40	-0,06	0,05	0,18
New Zealand	-0,16	-0,07	0,04	-0,50	-0,30	-0,03	-0,39	-0,24	-0,05	-0,11	0,03	0,14
Sweden	-0,08	-0,03	0,02	-0,15	-0,04	0,06	-0,06	0,00	0,05	-0,22	-0,09	0,02
UK	-0,03	0,03	0,10	-0,34	-0,23	-0,05	-0,27	-0,11	-0,06	0,02	0,11	0,18
US	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTE: See note to Table 5A. Prices of tradables are import and export prices at the dock

TABLE 7B

Correlation of relative consumption and the relative price of nontradables vis-á-vis the rest-of-the-world

Point estimates and 10 percent confidence intervals

COUNTRY	Differenced series			Spectral Decomposition: Low frequency			Spectral Decomposition: BC frequency			Spectral Decomposition: High frequency		
	LB	est	UB	LB	est	UB	LB	est	UB	LB	est	UB
Australia	-0,16	-0,07	0,05	-0,43	-0,27	0,04	-0,31	-0,13	0,06	-0,14	-0,02	0,10
Austria	-0,18	0,10	0,36	-0,64	-0,32	0,03	-0,40	-0,13	0,10	-0,15	0,17	0,48
Belgium	-0,53	-0,27	0,00	-0,95	-0,54	0,03	-0,62	-0,18	0,14	-0,57	-0,26	0,06
Canada	-0,20	-0,09	0,04	-0,59	-0,28	-0,01	-0,43	-0,22	-0,05	-0,15	0,00	0,18
Switzerland	-0,11	-0,02	0,07	-0,08	0,27	0,46	-0,12	0,04	0,23	-0,17	-0,09	0,01
Denmark	-0,10	0,05	0,19	-0,44	-0,10	0,54	-0,10	0,24	0,49	-0,13	-0,01	0,12
Spain	-0,09	0,05	0,17	-0,31	0,02	0,37	-0,19	0,01	0,25	-0,10	0,07	0,23
Finland	-0,07	0,02	0,12	-0,28	-0,05	0,22	-0,20	-0,02	0,17	-0,07	0,05	0,18
Germany	-0,31	0,01	0,30	-0,46	0,08	0,60	-0,34	0,16	0,45	-0,39	-0,03	0,34
Ireland	-0,05	0,09	0,24	-0,19	0,23	0,57	-0,16	0,04	0,29	-0,09	0,10	0,28
Italy	0,01	0,33	0,58	-0,20	0,44	1,15	0,21	0,40	0,85	-0,11	0,28	0,64
Japan	-0,09	-0,04	0,02	-0,33	-0,10	0,18	-0,17	0,02	0,19	-0,02	0,07	0,17
Korea	-0,09	-0,04	0,02	-0,29	-0,15	0,06	-0,20	-0,09	0,05	-0,08	-0,02	0,05
Netherlands	-0,18	-0,01	0,16	-0,75	-0,17	0,31	-0,54	-0,19	0,23	-0,15	0,05	0,24
Norway	0,11	0,32	0,50	0,28	1,00	1,51	0,21	0,51	0,89	0,00	0,21	0,41
New Zealand	-0,17	-0,02	0,11	-0,50	-0,22	0,21	-0,32	-0,13	0,09	-0,13	0,03	0,18
Sweden	-0,10	0,00	0,09	-0,16	0,09	0,33	-0,14	0,03	0,20	-0,12	-0,03	0,07
UK	0,02	0,12	0,23	-0,32	-0,05	0,15	-0,21	-0,06	0,12	0,08	0,20	0,31
US	-0,20	-0,11	-0,004	-0,50	-0,32	-0,09	-0,40	-0,24	-0,10	-0,10	0,00	0,09

NOTE: See note to Table 5B. Prices of tradables are import and export prices at the dock

TABLE 8

Correlation of relative consumption and terms-of-trade vis-á-vis the rest-of-the-world

Point estimates and 10 percent confidence intervals

COUNTRY	Differenced series			Spectral Decomposition								
				Low frequency			BC frequency			High frequency		
	LB	est	UB	LB	est	UB	LB	est	UB	LB	est	UB
Australia	-0,15	-0,01	0,11	-0,49	-0,19	0,34	-0,15	0,13	0,37	-0,17	-0,04	0,10
Austria	-0,47	-0,17	0,15	-0,51	-0,13	0,22	-0,32	-0,08	0,25	-0,63	-0,21	0,13
Belgium	0,17	0,51	0,81	0,23	0,97	1,63	0,25	0,63	1,17	-0,05	0,37	0,70
Canada	-0,40	-0,25	-0,11	-0,49	-0,13	0,14	-0,50	-0,29	-0,05	-0,47	-0,25	-0,08
Switzerland	0,04	0,22	0,39	-0,30	0,05	0,55	-0,08	0,26	0,53	0,04	0,23	0,43
Denmark	-0,35	-0,08	0,20	-0,95	0,12	0,85	-0,82	-0,34	0,23	-0,29	-0,01	0,22
Spain	-0,23	-0,08	0,09	-0,69	-0,43	-0,07	-0,47	-0,24	-0,04	-0,11	0,08	0,26
Finland	-0,30	-0,15	0,10	-1,08	-0,75	-0,30	-0,81	-0,50	-0,18	-0,12	0,12	0,30
Germany	-0,61	-0,03	0,57	-1,53	-0,33	1,00	-1,03	-0,31	0,80	-0,77	0,05	0,72
Ireland	-0,16	0,12	0,37	-0,46	0,13	0,88	-0,13	0,37	0,76	-0,29	0,00	0,33
Italy	-1,09	-0,57	0,09	-2,44	-1,28	0,14	-1,63	-0,74	0,13	-1,17	0,41	0,36
Japan	-0,20	0,00	0,21	-0,27	0,11	0,54	-0,10	0,17	0,41	-0,26	-0,06	0,17
Korea	-0,76	-0,42	-0,50	-1,02	-0,61	-0,29	-0,94	-0,76	-0,50	-0,72	-0,59	-0,45
Netherlands	-0,48	-0,20	0,08	-0,66	0,03	0,87	-0,50	0,08	0,55	-0,63	-0,31	-0,02
Norway	-0,90	-0,54	-0,14	-2,77	-1,87	-0,57	-1,72	-0,96	-0,39	-0,68	-0,29	0,11
New Zealand	-0,24	-0,01	0,27	-1,01	-0,42	0,24	-0,60	-0,14	0,31	-0,21	0,07	0,36
Sweden	-0,33	-0,20	-0,04	-0,84	-0,51	-0,08	-0,56	-0,33	-0,06	-0,27	-0,11	0,04
UK	-0,21	-0,07	0,08	-0,30	0,10	0,42	-0,20	0,06	0,30	-0,29	-0,13	0,02
US	-0,28	-0,15	-0,02	-0,32	-0,07	0,22	-0,30	-0,09	0,08	-0,35	-0,18	-0,01

NOTE: See note to Table 5B