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Discussion Paper Series nr: 07-32

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Does the Nominal Exchange Rate Explain the Backus-Smith Puzzle? Evidence from the Eurozone

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March 2008

Abstract

The negative correlation between relative consumption growth and real exchange rate changes is a recurrent puzzle in international macroeconomics (Backus and Smith, 1993). Using panel dataset with quarterly observations for all 12 countries from the Eurozone after the introduction of the common currency (1999-2006), this paper demonstrates that the nominal exchange rate is the main source of the puzzle. When nominal exchange rates fluctuations are eliminated, relative consumption growth is positively correlated with the change in the real exchange rate. Moreover, this result is contrasted with alternative samples of (relatively) flexible exchange rate: while the inflation differential is still positively correlated, the nominal exchange rate is negatively correlated with the relative consumption growth. These findings are robust to alternative regression specifications, estimation methods, and data samples.

Keywords: International Risk-Sharing, Exchange Rates, Backus-Smith Puzzle

JEL classification: F31, F33, F41

1 Introduction

Efficient international risk-sharing implies equalization of marginal utility growth rates across countries at any point in time. Moreover, using standard utility function of the constant relative risk aversion (CRRA) form, this condition implies equalization of consumption growth rates across countries. Then, relative differences in consumption growth between two countries should be unpredictable and totally independent of their bilateral real exchange rate. In fact, the real exchange rate does not play any role in this stylized world: since purchasing power parity is assumed to hold at any point in time, real exchange rates do not move at all.

Backus and Smith (1993) extend the basic real business cycle model by introducing non-traded goods, and therefore, the possibility that purchasing power parity does not hold. In turn, this extension modifies the general international risk-sharing condition: instead of having complete equalization of real marginal rates of intertemporal substitution (marginal utility growth rates), real exchange rate fluctuations act as a wedge between marginal utility growth rates in the latter model. Therefore, the marginal utility growth difference should be equal to the changes in the bilateral real exchange rate for the corresponding countries[1]. Furthermore, this condition suggests that countries with an appreciating currency (in real terms) should also experience relatively higher marginal utility growth. Finally, if consumer preferences in both countries can be represented by the power utility function of the constant relative risk-aversion (CRRA) class, then this condition has very clear, intuitive implications for consumption streams in both countries: consumption growth should be higher in countries that experience a relative

[1]For derivation of this condition using an asset pricing framework, see Brandt et al. (2006), for example.

drop in relative price of their goods, i.e. a real depreciation of their currency.

While the framework presented in Backus and Smith (1993) provides a plausible theoretical reason why consumption growth rates across countries are not very strongly correlated, it generates an additional empirical puzzle. In the same article, they show that data for OECD countries clearly reject their proposition: the relationship between real exchange rates and relative consumption growth is either insignificant, or more often, significantly negative. Actually, this implies an anomaly: consumption growth is relatively higher for those OECD countries that experience a relative increase in the overall price level. This finding is known in the literature as the *Backus-Smith puzzle* or the *consumption-real exchange rate correlation puzzle*.

The existence of the Backus-Smith puzzle in data for OECD countries has become an established finding in the international macroeconomics literature (Backus and Smith, 1993; Kollmann, 1995; Ravn, 2001). Not surprisingly then, most recent studies take it as given and try to develop theoretical models that produce outcomes matching the data, i.e. implying a negative correlation between real exchange rates and relative consumption growth. These models introduce various frictions into the canonical model(s) ranging from incomplete financial markets with non-traded goods sector (Benigno and Thoenissen, 2005), incomplete capital markets and distribution services that are intensive in local (domestic) inputs (Corsetti, Dedola and Leduc, 2004, 2007), economies with limited commitment (Kang, 2006), or private information (Kang, 2007).

One of the rare recent empirical explanations for the Backus-Smith puzzle is presented by Hess and Shin (2006). Using data for all OECD countries, they separate real exchange rate movements into their underlying components: nominal exchange rate and inflation differential changes. They find that the nominal exchange rate is the main source of the Backus-Smith puzzle: while the correlation between the negative of the inflation differential and relative consumption growth is generally positive (as expected by theory), it is typically negative between the nominal exchange rate and relative consumption growth. Furthermore, this anomaly (negative consumption-real exchange rate correlation) is present primarily for episodes of very large nominal exchange rate fluctuations. Finally, using inter-state data for the USA, where the nominal exchange rate is constant, they show that the Backus-Smith puzzle disappears. In this way, the current paper is very closely related to Hess and Shin (2006). Focusing on the Eurozone after the introduction of the Euro, it investigates the importance of (the elimination) of nominal exchange rate changes for the Backus-Smith anomaly.

Using data for the Eurozone countries, this study tries to give answers to the following questions: Is the nominal exchange rate the main reason for the consumption-real exchange rate (Backus-Smith) anomaly? Does the elimination of the nominal exchange rate solve the Backus-Smith puzzle?

The main findings in this study suggest that the nominal exchange rate is indeed the main reason for the anomalous correlation between relative consumption growth and real exchange rate changes. First, the puzzle disappears for the countries from the Eurozone after the introduction of the common currency. Second, the evidence from alternative floating (nominal) exchange rate periods suggests that only the nominal exchange rate displays anomalous behavior, while the inflation differential behaves in line with theory.

The rest of this paper is organized as follows. Section 2 presents the theoretical framework and derives empirically testable versions of the main conditions. Section 3 describes the dataset and presents the empirical strategy. The results from the empirical analysis are presented in section 4, and finally, section 5 gives some concluding remarks.

2 Theoretical Framework

2.1 Backus-Smith Puzzle

Efficient resource allocation in an international context implies equalization of all marginal utility growth rates at each point in time[2]. Translated in a two-country framework, this condition suggests the following relation[3]:

$$\frac{u'(c_{t+1})}{u'(c_t)} = \frac{u'(c^*_{t+1})}{u'(c^*_t)}, \forall t \tag{1}$$

In fact, this condition holds as long as all relative international prices stay constant, i.e. as long as the purchasing power parity (PPP) condition holds. As first pointed out by Backus and Smith (1993), deviations from PPP (due to the presence of non-tradeable goods, high transport costs or tariff barriers for example) drive a wedge between the marginal utility growth rates across countries[4]. In that case, Backus and Smith (1993) demonstrate that marginal utility growth rates have to be corrected for changes in relative prices, i.e. movements of the real exchange rate. Accordingly, the internationally efficient allocation will then be given by the following condition[5]:

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[2]In general, the utility function depends on many arguments and not only on the consumption level. The simplification made here emphasizes only the argument that takes central place in the empirical investigation.

[3]In the rest of the paper, foreign variables are always denoted with a star (*).

[4]About evidence on the deviations from the purchasing power parity (PPP) condition see Engel (2000), Engel and Rogers (1996), Froot and Rogoff (1995), or Rogoff (1996), for example.

[5]For a formal, theoretical underpinning of this condition, see Backus and Smith (1993),

$$\frac{e_{t+1}}{e_t}\frac{u'(c_{t+1})}{u'(c_t)} = \frac{u'(c^*_{t+1})}{u'(c^*_t)} \tag{2}$$

where e_t, the real exchange rate at time t, is defined as the price of foreign in terms of domestic goods:

$$e_t = s_t \frac{P^*_t}{P_t} \tag{3}$$

This equation clearly shows that the real exchange rate contains two components: the nominal exchange rate s_t which gives the price of foreign in terms of domestic currency (units of domestic currency per one unit of foreign currency) and the relative price component defined as the ratio of the CPIs for the two countries (foreign over domestic price level). Using this definition for the real exchange rate, condition 2 can be rewritten as follows:

$$\frac{s_{t+1}}{s_t}\frac{P^*_{t+1}}{P^*_t}\frac{P_t}{P_{t+1}}\frac{u'(c_{t+1})}{u'(c_t)} = \frac{u'(c^*_{t+1})}{u'(c^*_t)} \tag{4}$$

after a slight rearrangement this condition can be given in terms of rates of change:

$$\Delta u'(c^*_{t+1}) - \Delta u'(c_{t+1}) = \Delta s_{t+1} + \Delta p^*_{t+1} - \Delta p_{t+1} \tag{5}$$

where Δx_{t+1} denotes the rate of change of variable x between time $t+1$ and t, and Δp_{t+1} and Δp^*_{t+1} denote domestic and foreign inflation rates over the same time period. Equation 5 is of central importance for this study. It summarizes the Backus-Smith condition for efficient international risk-sharing in the presence of real exchange rate changes: the difference between marginal utility growth rates for two countries should equal changes in their bilateral real exchange rate. In turn, it suggests that countries with

Kollmann (1995), Ravn (2001), Hess and Shin (2006), or Corsetti et al. (2007), among others.

appreciating currency (in real terms) should also experience relatively higher marginal utility growth.

2.1.1 Empirical Implementation: CRRA Utility

Equation 5 connects the movements of the bilateral real exchange rate with the difference between marginal utility growth rates for the corresponding countries. However, the latter are expressed through the general form of the utility function, which does not allow for direct empirical testing. Therefore, in order to empirically test this condition, a specific form has to be assigned to the utility function. For example, the utility function can belong to the general class of constant relative risk aversion (CRRA) functions, given by the following equation:

$$u(c_t) = \frac{(c_t)^{1-\gamma}}{1-\gamma} \tag{6}$$

where γ is the coefficient of risk aversion[6]. Using this form for the utility function, condition 4 can be rewritten as follows:

$$\frac{s_{t+1}}{s_t}\frac{P^*_{t+1}}{P^*_t}\frac{P_t}{P_{t+1}}\frac{(c_{t+1}^{-\gamma})}{(c_t^{-\gamma})} = \frac{(c_{t+1}^{*-\gamma})}{(c_t^{*-\gamma})} \tag{7}$$

or, in terms of rates of change:

$$\Delta(c_{t+1}) - \Delta(c^*_{t+1}) = \frac{1}{\gamma}(\Delta s_{t+1} + \Delta p^*_{t+1} - \Delta p_{t+1}) \tag{8}$$

Now, we define the difference between domestic and foreign levels of variable x by a tilde ($\tilde{x}$). Therefore, we get the following definitions $\Delta\tilde{c}_{t+1} \equiv \Delta(c_{t+1}) - \Delta(c^*_{t+1})$ and $\Delta\tilde{p}_{t+1} \equiv \Delta(p_{t+1}) - \Delta(p^*_{t+1})$.

[6] For the purpose of simplicity and tractability in the rest of the analysis, we assume that both countries have the same coefficient of risk aversion.

Throughout subsequent empirical analysis, I use $\Delta\hat{p}_{t+1} \equiv \Delta(p^*_{t+1}) - \Delta(p_{t+1}) = -\Delta\tilde{p}_{t+1}$ rather than $\Delta\tilde{p}_{t+1}$. Using this notation, both components of the real exchange rate are positively related to relative consumption growth. As a result, we can simplify condition 8 as follows:

$$\Delta\tilde{c}_{t+1} = \frac{1}{\gamma}(\Delta s_{t+1} + \Delta\hat{p}_{t+1}) \tag{9}$$

In this way, equation 9 relates the relative consumption growth with the two components of the real exchange rate changes: the nominal exchange rate changes Δs_{t+1} and the negative of the inflation differential $\Delta\hat{p}_{t+1}$. Furthermore, the sum of the right hand side terms equals the change in the real exchange rate, so that the following equation holds:

$$\Delta\tilde{c}_{t+1} = \frac{1}{\gamma}(\Delta e_{t+1}) \tag{10}$$

Condition 10 implies a direct, testable relation between relative consumption growth and total real exchange rate changes. In fact, it gives a testable equation of the Backus-Smith condition: in the presence of real exchange rate fluctuations, efficient international risk-sharing implies that consumption growth should be higher in countries that experience relative drop in the price of consumption. Therefore, the major part of the empirical analysis in this paper is based on (modified versions of) this equation.

2.1.2 Empirical Specification(s)

Condition 10 implies the following general form of the regression equation to be estimated:

$$\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta e_{it} + u_{it} \tag{11}$$

where $\Delta\tilde{c}_{it}$ refers to the relative consumption growth (difference between domestic and foreign consumption growth rates) for country-pair i at time t, Δe_{it} refers to the real exchange real (price of foreign in terms of domestic goods) for country pair i at time t, and u_{it} is the error term (it is assumed that $u_{it} \sim iid(0, \sigma^2_{u_{it}})$)[7].

Hence, this general form of the regression equation gives two coefficients to be estimated: β_0 and β_1. The former gives the regression intercept[8], while the latter gives the slope coefficient estimate. In turn, this slope coefficient is the main object of interest for this study because it measures the co-movement between real exchange rate changes and relative consumption growth. According to the theoretical framework with CRRA utility function elaborated above, this slope coefficient corresponds to the reciprocal value of the coefficient of relative risk-aversion. Therefore, β_1 is expected to be positive, significantly different from zero and equal to $1/\gamma$.

As mentioned above, equation 11 gives the very general empirical specification for testing the Backus-Smith condition. In fact, several modified versions of this general equation are used in the empirical analysis. Moreover, these modifications are based on three dimensions: first, with respect to the exchange rate regime (fixed vs. floating/flexible); second, with respect to different decompositions of the real exchange rate changes; and third, allowing for the possibility of partial or incomplete international risk-sharing.

The first distinction concerns the differences that exist among regression

[7]In general, this term should capture all non-consumption preference shocks, measurement errors, and relevant idiosyncratic characteristics of country-pair i not captured by the real exchange rate changes.

[8]Strictly speaking, the general form of the regression equation does not include a constant term or intercept (see also Hess and Shin, 2006). However, I include it here in order to avoid possible technical problems. The estimation results are robust to the inclusion/exclusion of this constant term.

equations estimated for alternative samples. For example, sample (1) refers to the Eurozone 12 countries after the introduction of the Euro. Since nominal exchange rates are constant for all countries in this sample, I estimate the following modified version of equation 11:

$$\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta\hat{p}_{it} + u_{it} \tag{12}$$

Second, for the other four samples characterized by flexible/floating nominal exchange rates, I use several alternative decompositions of the real exchange rate term. Initially, I include each component of the real exchange rate separately. Hence, I estimate the following two specifications:

$$\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta s_{it} + u_{it} \tag{13}$$

and

$$\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta\hat{p}_{it} + u_{it} \tag{14}$$

In this way, I investigate the individual effect of each real exchange rate component on the consumption growth differential. Furthermore, I include the total real exchange rate movement as the sole explanatory variable. Then, I estimate an equation similar to 11. Finally, I decompose the real exchange rate change into its two components: the nominal exchange rate change and the inflation rate differential. In this case, I investigate the individual contribution of each real exchange rate component by estimating the following type of regressions:

$$\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta s_{it} + \beta_2\Delta\hat{p}_{it} + u_{it} \tag{15}$$

It is important to note that the efficient risk-sharing condition gives very clear implications for all slope coefficients in the alternative specifications (see equations 9 and 10). According to the theoretical condition, the slope coefficient estimates in front of the inflation differential and the nominal exchange rate change should be very similar to the one in front of the total real exchange rate change term. Hence, they should be all positive and significantly different from zero.

Finally, the third modification of the general empirical specification concerns the possibility for partial risk-sharing. Various frictions in goods markets (non-tradeable goods, transportation costs, tariff and quota barriers,etc.) or asset markets (capital account restrictions, capital market imperfections, etc.) constrain the portion of aggregate, macroeconomic risks that can be potentially shared across borders. Therefore, I allow for incomplete or partial international risk-sharing in the general framework by including a relative output growth term as an additional explanatory variable. In fact, this term represents difference between the output growth rates for the corresponding countries and is defined in a similar way as the consumption growth differential:

$$\Delta\tilde{g}_{t+1} \equiv \Delta g_{t+1} - \Delta g^*_{t+1} \tag{16}$$

where $\Delta(g_{t+1})$ and $\Delta(g^*_{t+1})$ refer to domestic and foreign output growth rates, respectively. In this case, the general form of the regression equation testing the Backus-Smith condition looks as follows:

$$\Delta\tilde{c}_{it} = \beta_0 + \beta_1 \Delta e_{it} + \beta_2 \Delta\tilde{g}_{it} + u_{it} \tag{17}$$

If complete risk sharing takes place across countries, then the relative consumption growth should be unpredictable, and therefore uncorrelated with relative output growth. Therefore, in this case, the coefficient in front of the relative output growth term should not be significantly different from zero. On the other hand, a significantly positive estimate for this slope coefficient means that relative consumption responds and closely follows relative output growth. In turn, a significantly positive estimate for β_2 implies a deviation from complete international risk-sharing. The interpretation of the other slope coefficients in this regression equation is similar to the one given for the case of complete risk-sharing.

3 Data and Empirical Strategy

3.1 Data Sources

The dataset consists of quarterly observations for all 12 Eurozone countries as well as six major industrial countries outside the Eurozone: Australia, Japan, Sweden, Switzerland, UK, and USA. It includes data series on four different economic categories: real per capita consumption, real per capita gross domestic product, nominal exchange rates and inflation rates. Data on consumption and gross domestic product comes from the OECD Main Economic Indicators database. For consumption, I use the growth rate of real per capita final private consumption expenditure or the growth rate of real per capita personal expenditure, depending on the exact definition for the corresponding country. I calculate it as the quarterly rate of change in real (aggregate) final consumption expenditure deflated by the population growth rate. The growth rate of real per capital gross domestic product is calculated in a similar way. Data on nominal exchange rates comes from the GTIS database. For all countries in the dataset, I calculate quarterly changes in the nominal exchange rates (calculated through the US/domestic currency GTIS exchange rate series). The inflation rate series are calculated as quarterly changes in the general CPIs (alternatively NADJ). All data is retrieved from Datastream.

3.2 Data Samples

This study is primarily interested in empirically testing several relations for the 12 countries of the Eurozone during the Euro period. Nonetheless, in order to captire the specific nature of these relationships for the Eurozone, I compare it with four other samples (groups of countries/time periods). All of these samples are shown in Table 1. Sample (1) refers to the sample of primary interest, i.e. the countries of the Eurozone during the Euro period (1999-2006). First, the results for this sample are compared with the results for the same group of countries in different time periods. Thus, sample (2) covers a long period (1986-1998) and sample (3) covers a shorter period before the introduction of the Euro (1995-1998). This specific division of the entire time period was dictated by data availability issues. The former sample covers the longest period for which data was available, but this panel dataset is strongly unbalanced. The latter sample covers a much shorter period with a strongly balanced panel dataset. Second, the results from sample (1) are compared with two samples for a group of (major) industrial countries: sample (4) covering the entire time period (1986-2006), and sample (5) covering the Euro period only (1999-2006). Both data samples for the group of industrial countries are strongly balanced[9].

3.3 Summary Statistics

The summary statistics are presented in Tables 2-4. Table 2 displays (annualized) means and (annualized) standard deviations of the three data series used in the estimations for the Eurozone countries after the introduction

[9]There are only several missing observations in the consumption/output series for Japan and Sweden.

Table 1: Samples and Time Periods

Sample	Countries	Time period
(1)	Eurozone	1999:Q1-2006:Q1
(2)	Eurozone countries	1986:Q1-1998:Q4
(3)	Eurozone countries	1995:Q1-1998:Q4
(4)	Industrial countries	1986:Q1-2006:Q1
(5)	Industrial countries	1999:Q1-2006:Q1

of the Euro (sample 1)[10]. There are several interesting findings in Table 2. First, and in sharp contrast to macroeconomic models that assume (perfect) international capital market integration, the figures in this table suggest that the countries from the Eurozone do not exploit risk-sharing opportunities. In fact, consumption per capita growth is much more variable than GDP per capita growth for each sample in this table, just opposite of what theory would suggest. Second, the annualized growth rates for consumption and GDP per capita are of very similar magnitude and typically equal about 3 percent per annum.

Table 2 contains summary statistics for the Eurozone before the introduction of the Euro. It is divided into 2 panels: the upper one corresponds to sample (2), while the lower one corresponds to sample (3) from Table 1. There are broad similarities with the figures in Table 2: consumption per capita growth was similar in magnitude, but much more variable than GDP per capita growth. Moreover, inflation rates were much higher and more variable in the more distant past (upper panel) compared to the last decade (lower panel of Table 3 and Table 2). This observation at least partially reflects the general improvement in macroeconomic policy management in

[10] The last row contains the cross-country average values for the summary statistics.

Table 2: Summary Statistics: Eurozone Countries (1999 : Q1-2006 : Q1)

Country	**C**		**Y**		**P**	
	Sample 1: 1999:Q1-2006:Q1					
	mean	st.dev	mean	st.dev	mean	st.dev
AUS	1.57	1.21	1.87	1.44	1.91	1.06
BEL	1.71	2.13	2.10	2.13	2.08	1.62
FIN	3.23	1.74	3.27	2.95	1.47	1.76
FRA	2.62	1.32	1.97	1.76	1.79	1.29
GER	0.66	2.87	1.24	1.99	1.58	1.34
GRE	7.72	17.49	4.56	5.41	3.34	5.81
ITA	0.99	2.03	1.34	1.84	3.72	2.50
IRE	5.33	5.05	5.83	7.23	2.37	0.71
LUX	3.91	10.14	4.45	4.79	2.52	1.99
NL	1.06	3.37	1.81	1.92	2.28	1.73
POR	1.74	2.82	3.71	1.64	3.18	3.13
SPA	7.23	3.25	1.33	3.05	3.04	2.19
MEAN	3.15	4.45	2.79	3.01	2.44	2.09

Note: The table presents summary statistics (means and standard deviations) for the following series: real per capital consumption growth rate (C), real per capita GDP growth (Y), and inflation rate (measures as percentage change in the CPI (P) for each of the 12 countries from the Eurozone. The sample period is 1999 : Q1-2006 : Q1 (Sample 1). All statistics are calculated using quarterly observations. The last row contains average values for the corresponding statistic across all countries. Quarterly data on real per capita GDP growth for Greece was not available over the entire time-period (they start only in 2000:Q1). All figures presented in the table are annualized and expressed in percentage terms (rounded to two decimal places).

more recent past. Finally, although average changes in nominal exchange rates across the countries in this dataset were close to zero, they were also by far the most variable of all data series[11]. In fact, the average (annualized) standard deviation of the nominal exchange rate changes was about 24 percent for the entire time period, much higher than any other economic series.

Summary statistics for the group of industrial countries are reported in Table 4. Panel A contains figures for sample (4) covering the long period (1986 : Q1-2006 : Q1), while panel B contains figures for sample (5), covering the period after the introduction of the Euro (1999 : Q1-2006 : Q1).

In contrast to the previous table, per capita consumption growth shows similar levels of variability compared to per capita GDP growth. Moreover,

[11] All nominal exchange rate changes are calculated against the US dollar.

Table 3: Summary Statistics: Eurozone Countries

Country	C		Y		P		S	
Sample 2: 1986:Q1-1998:Q4								
	mean	st.dev	mean	st.dev	mean	st.dev	mean	st.dev
AUS	2.37	1.37	2.80	1.34	2.34	2.97	3.43	25.74
BEL	2.00	1.74	2.20	1.77	2.08	1.59	3.29	24.91
FIN	1.86	3.91	2.26	5.16	2.85	2.71	0.80	22.70
FRA	1.67	2.33	2.06	1.85	2.19	1.30	2.66	23.86
GER	1.85	4.86	1.38	2.96	2.29	2.44	3.48	25.76
GRE	2.40	5.95			11.56	8.55	-4.94	20.96
ITA	2.16	2.94	10.04	11.73	2.41	1.78	1.69	22.85
IRE	8.12	8.58	1.88	2.25	4.40	1.92	0.42	24.40
LUX	4.08	10.53	4.77	5.74	0.89	0.99	3.29	24.91
NL	4.43	1.92	3.92	1.80	1.90	1.89	3.42	25.52
POR	4.23	3.78	3.31	1.95	4.56	2.46	0.92	23.88
SPA	5.96	3.87	4.00	1.87	6.93	4.65	-0.42	21.87
MEAN	3.43	4.32	3.51	3.49	3.70	2.77	1.50	23.95
Sample 3: 1995:Q1-1998:Q4								
	mean	st.dev	mean	st.dev	mean	st.dev	mean	st.dev
AUS	1.58	1.12	2.79	1.01	1.47	2.16	-1.19	19.74
BEL	1.99	1.74	2.20	1.77	1.46	1.65	-1.39	19.95
FIN	3.70	1.17	4.69	2.04	0.82	1.14	-0.91	18.34
FRA	1.86	3.02	1.99	1.33	1.19	1.21	-0.90	18.32
GER	1.70	2.47	1.54	2.58	1.31	1.66	-1.22	19.99
GRE	2.40	5.95			5.61	6.50	-4.05	16.98
ITA	2.23	2.67	1.43	2.17	1.80	1.77	-0.82	15.19
IRE	8.12	8.58	10.04	11.73	2.93	1.93	-0.92	17.31
LUX	4.098	10.53	4.77	5.74	0.89	0.99	-1.39	19.95
NL	4.43	1.92	3.91	1.79	1.98	0.92	-1.38	19.89
POR	4.23	3.78	3.30	1.95	2.76	1.79	-1.99	16.62
SPA	5.96	3.87	4.01	1.87	2.94	2.27	-1.46	17.79
MEAN	3.52	3.90	3.39	2.83	2.10	2.01	-1.47	18.34

Note: The table presents summary statistics (means and standard deviations) for the following series: real per capital consumption growth rate (C), real per capita GDP growth (Y), inflation rate (measures as percentage change in the CPI (P), and nominal exchange rate changes (S) for each of the 12 countries from the Eurozone. All statistics are calculated using quarterly observations. The nominal exchange rate changes are calculated with respect to the US dollar (units of currency per US dollar). Each panel refers to a different sample period: the upper panel refers to period $1986:Q1$-$1998:Q4$ (Sample 2), while the lower panel refer to period $1995:Q1$-$1998:Q4$ (Sample 3). Consumption and GDP growth series for most countries start only in 1995. Therefore, most of the summary statistics for these series are same in both panels. The last row in each panel contains average values for the corresponding statistic across all countries. Quarterly data on real per capita GDP growth for Greece was not available over the entire time-period (they start only in 2000:Q1), hence the empty spaces in panels B and C. All figures presented in the table are annualized and expressed in percentage terms (rounded to two decimal places).

Table 4: Summary Statistics: Industrial Countries

Country	**C**		**Y**		**P**		**S**	
				Panel A: 1986:Q1-2006:Q1				
	mean	st.dev	mean	st.dev	mean	st.dev	mean	st.dev
AUT	3.28	2.36	3.38	2.71	3.56	3.15	0.58	20.09
JAP	1.14	3.35	1.28	2.96	0.60	2.54	2.94	26.47
SWE	2.26	2.64	2.99	1.73	2.89	3.91	0.26	22.81
SWI	1.39	2.14	1.54	2.70	1.81	2.35	2.87	26.55
UK	2.97	2.74	2.55	1.98	3.50	3.31	1.28	20.06
USA	3.29	1.89	3.04	2.03	3.07	1.37		
MEAN	2.39	2.52	2.46	2.35	2.57	2.77	1.59	23.19
				Panel B: 1999:Q1-2006:Q1				
	mean	st.dev	mean	st.dev	mean	st.dev	mean	st.dev
AUT	3.71	1.83	3.17	2.14	3.17	2.53	3.29	23.89
JAP	1.18	1.84	1.63	2.57	-0.42	1.28	0.06	22.62
SWE	2.39	2.74	2.89	1.81	1.31	2.10	0.85	22.05
SWI	1.48	1.51	1.81	2.63	0.98	2.13	1.21	22.47
UK	3.01	1.99	2.71	1.11	2.45	1.99	0.77	14.84
USA	3.41	1.67	2.79	2.15	2.74	1.22		
MEAN	2.53	1.93	2.50	2.07	1.70	1.87	1.24	21.17

Note: The table presents summary statistics (means and standard deviations) for the following series: real per capital consumption growth rate (C), real per capita GDP growth (Y), inflation rate (measures as percentage change in the CPI (P), and nominal exchange rate changes (S) for 6 industrial countries. All statistics are calculated using quarterly observations. The nominal exchange rate changes are calculated with respect to the US dollar (units of currency per US dollar). Panel A refers to the long time period 1986 : $Q1$-2006 : $Q1$, while Panel B refers to the period after the introduction of the Euro: 1999 : $Q1$-2006 : $Q1$. Complete consumption and GDP growth series over the entire time period are available for the following countries: Australia, Switzerland, UK, and USA. The corresponding series for Japan and Sweden start in 1994 : $Q1$ and 1993 : $Q1$, respectively. All figures presented in the table are annualized and expressed in percentage terms (rounded to two decimal places).

per capita consumption growth variability is slightly lower than per capita GDP growth variability in the latter period. In turn, this suggest better risk-sharing for the countries in this group. The other figures are comparable to those for the Eurozone. For example, inflation strongly decreased and became considerably less variable in the more recent past: the average inflation rate decreased from 2.57 to 1.7, and its standard deviation fell from 2.77 to 1.87 percent. Moreover, as in the case of the Eurozone, nominal exchange rates were by far the most variable of all time series.

4 Results

This section presents the main findings from the empirical analysis. It is divided into two parts: the first one presents regression results about the Eurozone countries in the Euro-period, and the second one presents results from similar empirical specifications for alternative data samples (Eurozone countries in the pre-Euro-period, and several other industrial countries).

4.1 Eurozone Countries in the Euro-Period

4.1.1 Bilateral Estimations

In order to investigate the relation between relative consumption growth and real exchange rate changes, I estimate bilateral regressions for each country of the Eurozone against all other 11 partner countries. The results from these estimations are presented in Table 5. For each pair of countries, given by the column-row intersection, I present the slope coefficient estimates and its corresponding t-statistic (in brackets). Therefore, these figures show the severity of the Backus-Smith puzzle for the Eurozone countries: significantly negative coefficients indicate presence of the Backus-Smith puzzle, while significantly positive ones support the theory.

There are mixed results in this table. In fact, the coefficient estimates are still (significantly) negative or insignificantly different from zero for several bilateral country pairs, as suggested by the large literature on the Backus-Smith puzzle. Nonetheless, the majority of coefficient estimates are positive, and many of them are significantly different from zero, just in accordance with theory. In fact, most of the significantly negative results refer to the bilateral pairs that include Luxembourg. If this country is taken aside, then there is only one significantly negative coefficient estimate in the entire dataset: the one corresponding to the country pair Spain-Portugal. Con-

Table 5: Results from Bilateral Estimations: Eurozone 1999:Q1-2006:Q1

	AUS	**BEL**	**FIN**	**FRA**	**GER**	**GRE**	**IRE**	**ITA**	**LUX**	**NL**	**POR**	**SPA**
AUS												
BEL	0.46											
	(2.09)**											
FIN	0.346	0.391										
	(1.33)	(1.26)										
FRA	0.316	0.347	0.378									
	(1.33)	(1.00)	(1.33)									
GER	0.732	1.296	0.5	0.312								
	(1.74)*	(2.60)**	(1.76)*	(0.93)								
GRE	1.036	0.969	1.369	1.017	0.861							
	(1.83)*	(1.82)*	(2.16)**	(1.65)	(1.62)							
IRE	0.445	0.714	0.258	-0.697	1.328	0.683						
	(0.46)	(1.05)	(0.38)	(-0.80)	(1.64)	(1.25)						
ITA	-0.183	0.03	-0.14	-0.219	0.172	1.224	-0.275					
	(-1.09)	(0.15)	(-0.42)	(-1.02)	(0.70)	(1.99)*	(-0.66)					
LUX	-3.633	-3.277	-2.489	-4.028	-2.826	2.928	-4.209	-1.082				
	(-5.08)***	(-5.93)***	(-2.32)**	(-4.18)***	(-5.26)***	(3.32)***	(-5.04)***	(-1.03)				
NL	-0.272	-0.062	0.456	-0.165	0.42	0.758	-0.885	-0.184	-2.439			
	(-0.69)	(-0.15)	(0.91)	(-0.39)	(0.80)	(1.34)	(-1.06)	(-0.57)	(-3.04)***			
POR	0.016	0.042	0.086	-0.092	0.086	0.76	-0.382	-0.265	0.225	-0.086		
	(0.09)	(0.24)	(0.36)	(-0.42)	(0.36)	(1.19)	(-1.11)	(-1.19)	(0.27)	(-0.33)		
SPA	0.625	0.424	0.928	0.586	0.825	0.539	0.253	-0.467	0.171	0.376	-0.776	
	(2.66)***	(1.93)*	(2.87)***	(1.90)*	(3.15)***	(0.72)	(0.46)	(-1.21)	(0.11)	(0.78)	(-2.15)**	

Note: The table presents results from bilateral time-series estimations given by the following regression equation $\Delta\tilde{c}_t = \beta_0 + \beta_1 \Delta\hat{p}_t + u_t$ among all 12 Eurozone countries. All results are based on 28 quarterly observations over the period 1999:Q1-2006:Q1. For each pair of countries, given by the column-row intersection, I present the slope coefficient estimates and its corresponding t-statistic (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution with 27 degrees of freedom are 1.703 (10%), 2.052 (5%), and 2.771 (1%).

trary to this, there are over a dozen of positive coefficient estimates significantly different from zero. These results clearly give support for the theory and suggest that the Backus-Smith anomaly has largely disappeared for the Eurozone countries after the introduction of the common currency. In order to further investigate this suggestive finding, I present pooled and panel estimates.

4.1.2 Pooled-OLS and Panel Evidence

Table 6 presents results from pooled-OLS and panel estimations for the Eurozone countries in the period after the introduction of the Euro. It is divided into three panels, each corresponding to a different set of countries. The columns contain results for different estimation procedures: pooled-OLS, panel estimation with random effects and panel estimation with fixed effects. Moreover, for each of these specifications, I allow for partial (incomplete) risk-sharing (columns marked by (g)).

Panel A refers to the complete dataset - all 12 Eurozone countries. The first row in this panel gives coefficient estimates for the real exchange rate, i.e. the inflation differential in this time period. They are positive and significantly different from zero for each specification that does not allow for partial risk-sharing. In fact, the t-statistics (given in brackets) are far above the usual critical values, suggesting that this relation is statistically significant at any conventional level (1 percent, for example). When we allow for incomplete risk-sharing, the slope coefficient estimates for the output term are significantly positive in each of the three specifications, suggesting that international risk-sharing in this country set is far from perfect. Simultaneously, the slope coefficient in front of the real exchange rate (the negative of the inflation differential) remains positive and statistically significant for all but one specification (pooled-OLS). This is the most important result in this study: when nominal exchange rates are fixed, relative consumption co-moves positively with the real exchange rate, i.e. the Backus-Smith puzzle disappears.

The lower two panels restrict the complete dataset: the results in Panel B exclude Luxembourg, while those in Panel C exclude Luxembourg and Greece. These exclusions are based on several arguments about the countries concerned. First, the results from the bilateral estimations presented in Table 5 already suggested that Luxembourg behaves very differently from the rest of the Eurozone countries. Furthermore, there are several reasons that might justify the exclusion of Luxembourg from this (pooled) analysis: it is much smaller (geographically and economically) than the other countries, has a very high concentration of international institutions and international banks, and employs a very mobile workforce[12]. Second, there are several limitations in the quarterly data series for Greece used in the analysis, motivating its exclusion in panel C[13]. Moreover, Table 3 suggests that most of these macroeconomic series display persistently higher levels and/or inflation compared to most other countries even into the Euro-period.

Several findings in these lower panels deserve attention. First, the main result from Panel A does not vanish. In fact, the slope coefficient estimate in front of the real exchange rate retains its positive sign and statistical significance in all specifications. Moreover, its economic and statistical significance increases in the second panel, while it drops only marginally in the

[12]Many of these aspects can help in explaining why the macroeconomic variables for Luxembourg might not correctly reflect the changes in purchasing power of its inhabitants as well as the correlation between relative purchasing power changes and relative consumption growth.

[13]The quarterly consumption growth series for Greece are available only from 1995:Q1, while the quarterly real GDP growth series are available only from 2000:Q1.

third panel. This indicates that the main finding from Panel A is not due to the inclusion of one of these countries. Second, the coefficient on the relative output drops marginally in the second panel, while it completely loses its significance in the last panel. Therefore, this finding suggests that once the effect of the real exchange rate is taken into account, the hypothesis of perfect risk-sharing for this restricted dataset cannot be rejected.

In order to deal with possible endogeneity issues, I instrument the independent variables with the lagged value of the dependent variable ($\Delta\tilde{c}_{i,t-1}$) and the lagged values of all independent variables ($\Delta\hat{p}_{i,t-1}$ and $\Delta\tilde{g}_{i,t-1}$ in this case)[14].

Table 7 presents results from the instrumental variables panel estimations. In accordance with the set-up of Table 6, it is divided into three panels: complete set of Eurozone countries (Panel A), excluding Luxembourg (Panel B), and excluding Greece and Luxembourg (Panel C). The main conclusions from Table 6 stay unchanged: relative consumption growth is positively related to the real exchange rate, and there is a significant departure from perfect risk-sharing for all but the last set of countries (Panel C).

4.2 Comparison with Alternative Samples

The last section presented results for the countries of the Eurozone after the introduction of the Euro. They clearly indicated that the Backus-Smith puzzle disappears in this sample. In order to see whether this result is due to

[14]For similar choice of instruments see Hess and Shin (2006). The results from the first-stage regression suggest strong correlation between the variables chosen as instruments and the original explanatory variables. For example, the value for the F-statistic from the first-stage regression of $\Delta\hat{p}_{it}$ on the three instruments is 327.85, while the corresponding value for the first-stage regression of $\Delta\tilde{g}_{it}$ on the same three instruments is 181.62. Both values are much higher than 10, a threshold value required for strong instruments. All results are available upon request.

Table 6: Pooled OLS and Panel Estimations: Eurozone 1999:Q1-2006:Q1

	pooled	pooled (g)	panel re	panel fe	panel re (g)	panel fe (g)
			Panel A: All country pairs			
$\hat{p}$	0.251	0.062	0.385	0.437	0.115	0.126
	(4.93)***	(1.71)*	(7.65)***	(8.59)***	(3.28)***	(3.54)***
$\tilde{g}$		0.107			0.145	0.153
		(5.02)***			(6.78)***	(6.97)***
Obs	3674	3586	3674	3674	3586	3586
R^2	0.01	0.01		0.02		0.02
Stacks			132	132	132	132
			Panel B: Excluding Luxembourg			
$\hat{p}$	0.382	0.21	0.548	0.592	0.306	0.315
	(7.73)***	(7.07)***	(11.47)***	(12.30)***	(11.82)***	(12.16)***
$\tilde{g}$		0.037			0.071	0.073
		(1.98)**			(4.24)***	(4.34)***
Obs	3080	3000	3080	3080	3000	3000
R^2	0.02	0.02		0.05		0.07
Stacks			110	110	110	110
			Panel C: Excluding Luxembourg and Greece			
$\hat{p}$	0.151	0.083	0.263	0.277	0.18	0.188
	(3.26)***	(2.23)**	(6.05)***	(6.34)***	(5.49)***	(5.72)***
$\tilde{g}$		0.079			0.004	0.013
		(3.88)***			(0.24)	(0.70)
Obs	2660	2640	2660	2660	2640	2640
R^2	0	0.01		0.02		0.01
Stacks			95	95	95	95

Note: The table presents results from pooled-OLS and panel data estimations (with random-effects and fixed-effects) for the Eurozone countries in the period after the introduction of the Euro: 1999:Q1-2006:Q1. The general regression specification is given by the following equation: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta\hat{p}_{it} + u_{it}$, while the specification that allows for partial risk-sharing in consumption is given by:
$\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta\hat{p}_{it} + \beta_2\Delta\tilde{g}_{it} + u_{it}$. Panel A contains results for all 12 countries, Panel B excludes Luxembourg, and Panel C excludes Luxembourg and Greece. The number of stacks refers to the number of bilateral country-pairs included in the panel. For each specification, the table displays the slope coefficient estimates with the corresponding t-statistics (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution are 1.645 (10%), 1.960 (5%), and 2.576 (1%).

Table 7: Instrumental Variables (IV) Panel Estimations: Eurozone 1999:Q1-2006:Q1

	panel re	panel fe	panel re (g)	panel fe (g)
		Panel A: All country pairs		
$\hat{p}$	0.39	0.442	0.122	0.133
	(7.72)***	(8.64)***	(3.44)***	(3.68)***
$\tilde{g}$			0.141	0.148
			(6.51)***	(6.71)***
Obs	3651	3651	3586	3586
R^2		0.02		0.02
Stacks	132	132	132	132
		Panel B: Excluding Luxembourg		
$\hat{p}$	0.549	0.593	0.312	0.321
	(11.47)***	(12.29)***	(11.98)***	(12.29)***
$\tilde{g}$			0.069	0.071
			(4.09)***	(4.19)***
Obs	3067	3067	2968	2968
R^2		0.05		0.07
Stacks	110	110	110	110
		Panel C: Excluding Luxembourg and Greece		
$\hat{p}$	0.265	0.28	0.185	0.193
	(6.11)***	(6.39)***	(5.64)***	(5.87)***
$\tilde{g}$			0.003	0.011
			(0.16)	(0.61)
Obs	2648	2648	2623	2623
R^2		0.02		0.01
Stacks	95	95	95	95

Note: The table presents results from instrumental variables panel data estimations (with random-effects and fixed-effects) for the Eurozone countries in the period after the introduction of the Euro: 1999:Q1-2006:Q1. The lagged values of the dependent variable $\Delta\tilde{c}_{i,t-1}$ and/or the lagged values of the independent variables $\Delta\hat{p}_{i,t-1}$ and $\Delta\tilde{g}_{i,t-1}$ are used as instruments for the original independent variables. The general regression specification is given by the following equation: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta\hat{p}_{it} + u_{it}$, while the specification that allows for partial risk-sharing in consumption is given by: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta\hat{p}_{it} + \beta_2\Delta\tilde{g}_{it} + u_{it}$. Panel A contains results for all 12 countries, Panel B excludes Luxembourg, and Panel C excludes Luxembourg and Greece. The number of stacks refers to the number of bilateral country-pairs included in the panel. For each specification, the table displays the slope coefficient estimates with the corresponding t-statistics (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution are 1.645 (10%), 1.960 (5%), and 2.576 (1%).

the elimination of the nominal exchange rate, I contrast the findings for the Eurozone in the period 1999:Q1-2006:Q1 with four alternative samples given in Table 1. First, I present results for the same set of countries (Eurozone 12) during alternative time periods (samples (2) and (3)), and second, I present evidence on a different set of industrial countries during the same time period (samples (4) and (5)).

4.2.1 Eurozone (1986:Q1-1998:Q4)

Tables 8 and 9 present results for the same Eurozone countries during the entire time period before the introduction of the Euro (1986:Q1-1998:Q4)[15]. Table 8 contains results for pooled-OLS estimations, while Table 9 contains results from panel estimations[16]. In accordance with the set-up above, both tables are divided into three panels.

Each column of Table 8 corresponds to a different specification. I regress the relative (bilateral) consumption growth on four sets of explanatory variables: i) (negative of the)inflation differential, ii) nominal exchange rate changes, iii) real exchange rate changes, and iv) joint inclusion of both components of real exchange rate changes - the inflation differential and the nominal exchange rate changes. Moreover, I estimate each of these four spec-

[15] The specification(s) that exclude the nominal exchange rate have been estimated over the period 1970:Q1-1998:Q4 as well. There are no significant differences in the estimation results with respect to the exact starting date (1970:Q1 or 1986:Q1).

[16] I only report results from fixed-effects panel estimations. In most specifications, the Hausman test suggests rejection of the null hypothesis of no systematic difference between estimates obtained with fixed-effects and estimates obtained with random-effects. Therefore, only fixed-effects estimations yield consistent estimates in this case. In some specifications, the Hausman test is (marginally) not rejected, but then the results from the two estimation procedures do not differ significantly and do not lead to qualitatively different conclusion(s).

ifications by assuming perfect risk-sharing as well as by allowing for partial risk-sharing through the inclusion of the relative output growth term[17].

There are several interesting results in the first panel of Table 8. First, the sign of the inflation differential term changes from one specification to other. In fact, it changes from positive and significant in the first column, to negative and insignificant in the second and the last column. Second, the nominal exchange rate always enters the estimations with a significantly negative sign. Third, the results for the nominal exchange rate are very similar to the results for the real exchange rate. And finally, the significantly positive sign in front of the relative output growth suggests that risk-sharing among these countries is far from perfect[18].

The first three of these observations are especially important for understanding the relative consumption - real exchange rate correlation (Backus-Smith) puzzle. In fact, these results indicate that the inflation differential is not the main source of the puzzle: it has the theoretically expected sign (positive) at least as often as the anomalous one (negative). Instead, the results suggest that the main source of the anomaly is the behavior of the nominal exchange rate: both nominal and real exchange rate changes enter the relation with negative coefficients, very similar in magnitude and significantly different from zero. The lower two panels in this table report results for the group of Eurozone countries excluding Luxembourg (Panel B) and excluding Luxembourg and Greece (Panel C). The results in these panels are very similar and convey the same message as Panel A[19]. In fact, the most important difference concerns the coefficient in front of the infla-

[17] The specifications that include the relative output term are marked with (g) as before.

[18] A comparison between the slope coefficient estimates in front of the relative output growth term (g) (panels B and C in tables 6 and 8) suggests that, as expected, risk-sharing across Eurozone countries increases in the latter, Euro-period.

[19] This comes (partly) as a result of the data limitations for these countries.

tion differential, which becomes negative and marginally significant in some of the specifications, and the coefficient in front of the nominal (and real) exchange rate changes in Panel B, which gains more significance.

Table 9 contains results from fixed-effects panel estimations[20]. It is structured in a similar way as Table 8 and follows the same order in presenting different specifications. The results in this table just strengthen the evidence about the "dichotomy" that exists between the two components of the real exchange rate. In fact, the coefficient for the inflation differential is positive and significantly different from zero in all specifications in Panel A. Clearly, this "macroeconomic" part of the real exchange rate behaves in line with theory. On the other hand, the coefficient for the nominal (and real) exchange rate is negative and significantly different from zero in each specification. Therefore, these two findings clearly suggest that the anomalous negative correlation between relative consumption growth and real exchange rate changes (Backus-Smith puzzle) comes from the nominal exchange rate behavior.

The lower two panels in this table broadly support the evidence from Panel A. In fact, the coefficient in front of the inflation differential stays positive in all specifications. Moreover, it is statistically significant (at 5 percent level) in all but one specification. The results about the nominal exchange rate stay literally unchanged: its slope coefficient is negative and statistically significant at any conventional level (1 percent significance).

A final note can be addressed about the difference between the results from pooled-OLS and panel estimations. In fact, they produce somewhat different estimates for the slope coefficient in front of the inflation differential

[20] I do not report results from the instrumental variables estimations here since they do not differ significantly from the standard panel estimates. They are available upon request.

Table 8: Pooled OLS Estimations: Eurozone countries 1986:Q1-1998:Q4

	pooled	pooled (g)	pooled	pooled (g)	pooled	pooled (g)	pooled	pooled (g)
				Panel A: All countries				
$\hat{p}$	0.066	-0.05					0.037	-0.073
	(1.82)*	(-0.75)					(1.02)	(-1.08)
$\tilde{g}$		0.241		0.24		0.24		0.24
		(8.33)***		(8.28)***		(8.30)***		(8.30)***
s			-0.065	-0.052			-0.063	-0.055
			(-5.72)***	(-2.96)***			(-5.51)***	(-3.06)***
e					-0.058	-0.055		
					(-5.12)***	(-3.14)***		
Obs	2442	1734	2442	1734	2442	1734	2442	1734
R^2	0.01	0.03	0.01	0.04	0.01	0.04	0.01	0.04
Stacks								
				Panel B: Excluding Luxembourg				
$\hat{p}$	0.001	-0.112					-0.033	-0.142
	(0.02)	(-2.00)**					(-1.05)	(-2.53)**
$\tilde{g}$		0.22		0.209		0.208		0.209
		(8.25)***		(8.03)***		(8.05)***		(8.07)***
s			-0.074	-0.064			-0.076	-0.068
			(-7.61)***	(-4.47)***			(-7.68)***	(-4.73)***
e					-0.073	-0.071		
					(-7.57)***	(-4.97)***		
Obs	2106	1446	2106	1446	2106	1446	2106	1446
R^2	0	0.05	0.03	0.06	0.03	0.06	0.03	0.06
Stacks								
				Panel C: Excluding Luxembourg and Greece				
$\hat{p}$	-0.038	-0.112					-0.068	-0.142
	(-0.87)	(-2.00)**					(-1.57)	(-2.53)**
$\tilde{g}$		0.22		0.209		0.208		0.209
		(8.25)***		(8.03)***		(8.05)***		(8.07)***
s			-0.063	-0.064			-0.065	-0.068
			(-5.61)***	(-4.47)***			(-5.76)***	(-4.73)***
e					-0.065	-0.071		
					(-5.83)***	(-4.97)***		
Obs	1874	1446	1874	1446	1874	1446	1874	1446
R^2	0	0.05	0.02	0.06	0.02	0.06	0.02	0.06
Stacks								

Note: The table presents results from pooled-OLS estimations for the Eurozone countries over the sample period 1986:Q1-1998:Q4. The general specification is given by the following regression equation: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1 \Delta x_{it} + u_{it}$, while the specification that allows for partial risk-sharing in consumption is given by: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1 \Delta x_{it} + \beta_2 \Delta\tilde{g}_{it} + u_{it}$. Moreover, each of these specifications is estimated using alternative variables in place of Δx_{it}: the negative of the inflation differential $\Delta\hat{p}_{it}$ (first two columns), the change in the nominal exchange rate Δs_{it} (third and fourth column), the change in the real exchange rate Δe_{it} (fifth and sixth column), and its both components $\Delta\hat{p}_{it}$ and Δs_{it} together (last two columns). Panel A contains results for all 12 countries, Panel B excludes Luxembourg, and Panel C excludes Luxembourg and Greece. The number of stacks refers to the number of bilateral country-pairs included in the panel. For each specification, the table displays the slope coefficient estimates with the corresponding t-statistics (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution are 1.645 (10%), 1.960 (5%), and 2.576 (1%).

term. While these estimates are inconclusive from the pooled-OLS estimations, they are positive and (almost) always statistically different from zero in the panel estimations. These two estimations differ with respect to the way they treat the error term: the fixed-effects panel specification explicitly accounts for the country pair-specific (unit-specific) part of the error term, while the pooled-OLS does not make this distinction[21]. Therefore, the results suggest that accounting for these unobserved, country-pair specific characteristics, just strengthens the evidence about the "dichotomous" effects of the two real exchange rate components on relative consumption.

4.2.2 Eurozone(1995:Q1-1998:Q4)

Tables 8 and 9 presented results for the Eurozone countries during the entire period 1986:Q1-1998:Q4. However, the panel dataset used in these estimations is strongly unbalanced, since the data series do not have equal length for each country. Therefore, I turn to a shorter time period for which a balanced panel can be constructed[22]. Tables 10 and 11 present results for this period, which refers to the four years before the introduction of the Euro (1995:Q1-1998:Q4). Both tables follow a very similar set-up with the previous tables.

The first table (Table 10) contains results from the pooled-OLS estimations. For the specifications that do not include a relative output growth term (do not allow for partial risk-sharing), the results are very similar to those for the entire sample (sample (2)): the inflation differential enters

[21] If the country pair-specific, time-invariant components of the error term are correlated with any of the independent variables in the regression equation, then the strict exogeneity assumption will not be satisfied and the OLS-estimates will not be valid.

[22] There is a necessary trade-off between the time length of the dataset and data availability. Hence, the time dimension of the balanced panel dataset analyzed in these tables is 16 quarters.

Table 9: Panel Estimations: Eurozone countries 1986:Q1-1998:Q4

				Panel A: All countries				
$\hat{p}$	0.127	0.199					0.107	0.178
	(3.18)***	(2.85)***					(2.68)***	(2.54)**
$\tilde{g}$		0.270		0.271		0.272		0.267
		(8.56)***		(8.57)***		(8.62)***		(8.47)***
s			-0.063	-0.05			-0.061	-0.045
			(-5.71)***	(-2.92)***			(-5.44)***	(-2.61)***
e					-0.052	-0.038		
					(-4.75)***	(-2.21)**		
Obs	2442	1734	2442	1734	2442	1734	2442	1734
R^2	0.01	0.05	0.01	0.05	0.01	0.05	0.02	0.05
Stacks	132	110	132	110	132	110	132	110
				Panel B: Excluding Luxembourg				
$\hat{p}$	0.058	0.148					0.036	0.121
	(1.73)*	(2.71)***					(1.07)	(2.22)**
$\tilde{g}$		0.246		0.241		0.244		0.237
		(9.04)***		(8.91)***		(9.03)***		(8.75)***
s			-0.073	-0.061			-0.073	-0.058
			(-7.93)***	(-4.71)***			(-7.81)***	(-4.44)***
e					-0.067	-0.053		
					(-7.32)***	(-4.04)***		
Obs	2106	1446	2106	1446	2106	1446	2106	1446
R^2	0	0.06	0.03	0.07	0.03	0.07	0.03	0.08
Stacks	110	90	110	90	110	90	110	90
				Panel C: Excluding Luxembourg and Greece				
$\hat{p}$	0.099	0.148					0.072	0.121
	(2.28)**	(2.71)***					(1.68)*	(2.22)**
$\tilde{g}$		0.246		0.241		0.244		0.237
		(9.04)***		(8.91)***		(9.03)***		(8.75)***
s			-0.062	-0.061			-0.06	-0.058
			(-5.94)***	(-4.71)***			(-5.73)***	(-4.44)***
e					-0.055	-0.053		
					(-5.35)***	(-4.04)***		
Obs	1874	1446	1874	1446	1874	1446	1874	1446
R^2	0	0.06	0.02	0.07	0.02	0.07	0.02	0.08
Stacks	95	90	95	90	95	90	95	90

Note: The table presents results from fixed-effects panel data estimations for the Eurozone countries over the sample period 1986:Q1-1998:Q4. The general specification is given by the following regression equation: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta x_{it} + u_{it}$, while the specification that allows for partial risk-sharing in consumption is given by: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta x_{it} + \beta_2\Delta\tilde{g}_{it} + u_{it}$. Moreover, each of these specifications is estimated using alternative variables in place of Δx_{it}: the negative of the inflation differential $\Delta\hat{p}_{it}$ (first two columns), the change in the nominal exchange rate Δs_{it} (third and fourth column), the change in the real exchange rate Δe_{it} (fifth and sixth column), and its both components $\Delta\hat{p}_{it}$ and Δs_{it} together (last two columns). Panel A contains results for all 12 countries, Panel B excludes Luxembourg, and Panel C excludes Luxembourg and Greece. The number of stacks refers to the number of bilateral country-pairs included in the panel. For each specification, the table displays the slope coefficient estimates with the corresponding t-statistics (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution are 1.645 (10%), 1.960 (5%), and 2.576 (1%).

with the "correct" positive sign, nominal and real exchange rate changes with the anomalous negative sign. Moreover, all these effects are typically significantly different from zero. However, when the relative output growth term is included in the regression equation (it is always significant with the correct, positive sign), most of these results lose significance and even change sign. Actually, a similar pattern can be observed for all three panels in this table: most variables (real exchange rate components) lose significance when the relative output growth terms is included in the estimations. In order to investigate the importance of the specific estimation procedure for these findings, I present results from fixed-effects panel estimations in Table 11.

The panel estimation results in Table 11 strengthen the evidence about the "dichotomy" that exists between the two components of the real exchange rate. In fact, the inflation differential enters with a significantly positive sign in all specifications (always significantly different from zero at least at 10 percent level), while the nominal exchange rate enters with a significantly negative sign in all specifications that do not allow for partial risk-sharing (i.e. do not include the relative output growth term). Moreover, the coefficient estimates for the real exchange rate are very similar to those for the nominal exchange rate, supporting the proposition that the consumption real exchange rate anomaly is primarily due to the nominal exchange rate.

There are two main conclusions that can be drawn from Tables 10 and 11. First, the results support the proposition that the nominal exchange rate is the main source of the consumption real exchange rate correlation (Backus-Smith) puzzle. Similar to the results for the Eurozone countries over the entire time period (sample 2), the results from the panel estimations suggest that the negative of the inflation differential exhibited positive correlation

Table 10: Pooled OLS Estimations: Eurozone countries 1995:Q1-1998:Q4

	pooled	pooled (g)	pooled	pooled (g)	pooled	pooled (g)	pooled	pooled (g)
				Panel A: All countries				
$\hat{p}$	0.091	-0.045					0.072	-0.039
	(2.18)**	(-0.53)					(1.72)*	(-0.45)
$\tilde{g}$		0.191		0.19		0.19		0.19
		(5.97)***		(5.94)***		(5.94)***		(5.95)***
s			-0.045	0.024			-0.041	0.023
			(-3.07)***	(0.83)			(-2.76)***	(0.78)
e					-0.033	0.018		
					(-2.27)**	(0.63)		
Obs	1956	1468	1956	1468	1956	1468	1956	1468
R^2	0	0.02	0	0.02	0	0.02	0.01	0.02
				Panel B: Excluding Luxembourg				
$\hat{p}$	0.015	-0.144					-0.01	-0.144
	(0.43)	(-1.99)**					(-0.27)	(-1.98)**
$\tilde{g}$		0.143		0.141		0.141		0.143
		(5.03)***		(4.96)***		(4.95)***		(5.02)***
s			-0.058	0.004			-0.059	-0.001
			(-4.53)***	(0.18)			(-4.52)***	(-0.00)
e					-0.055	-0.011		
					(-4.34)***	(-0.47)		
Obs	1620	1180	1620	1180	1620	1180	1620	1180
R^2	0	0.02	0.01	0.02	0.01	0.02	0.01	0.02
				Panel C: Excluding Luxembourg and Greece				
$\hat{p}$	-0.02	-0.144					-0.028	-0.144
	(-0.36)	(-1.99)**					(-0.51)	(-1.98)**
$\tilde{g}$		0.143		0.141		0.141		0.143
		(5.03)***		(4.96)***		(4.95)***		(5.02)***
s			-0.018	0.004			-0.019	-0.001
			(-1.06)	(0.18)			(-1.12)	(-0.00)
e					-0.02	-0.011		
					(-1.16)	(-0.47)		
Obs	1388	1180	1388	1180	1388	1180	1388	1180
R^2	0	0.02	0	0.02	0	0.02	0	0.02

Note: The table presents results from pooled-OLS estimations for the Eurozone countries using quarterly observations over the sample period 1995:Q1-1998:Q4. The very short time period (16 observations per country) is chosen in order to have a strongly balanced pre-Euro dataset. The general specification is given by the following regression equation: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta x_{it} + u_{it}$, while the specification that allows for partial risk-sharing in consumption is given by: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta x_{it} + \beta_2\Delta\tilde{g}_{it} + u_{it}$. Moreover, each of these specifications is estimated using alternative variables in place of Δx_{it}: the negative of the inflation differential $\Delta\hat{p}_{it}$ (first two columns), the change in the nominal exchange rate Δs_{it} (third and fourth column), the change in the real exchange rate Δe_{it} (fifth and sixth column), and its both components $\Delta\hat{p}_{it}$ and Δs_{it} together (last two columns). Panel A contains results for all 12 countries, Panel B excludes Luxembourg, and Panel C excludes Luxembourg and Greece. For each specification, the table displays the slope coefficient estimates with the corresponding t-statistics (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution are 1.645 (10%), 1.960 (5%), and 2.576 (1%).

Table 11: Panel Estimations: Eurozone countries 1995:Q1-1998:Q4

Panel A: All countries								
$\hat{p}$	0.162	0.33					0.151	0.34
	(3.48)***	(3.59)***					(3.23)***	(3.68)***
$\tilde{g}$		0.195		0.204		0.203		0.195
		(5.45)***		(5.72)***		(5.69)***		(5.46)***
s			-0.043	0.025			-0.039	0.035
			(-2.97)***	(0.89)			(-2.68)***	(1.23)
e					-0.026	0.055		
					(-1.85)*	(1.96)*		
Obs	1956	1468	1956	1468	1956	1468	1956	1468
R^2	0.01	0.03	0	0.02	0	0.03	0.01	0.03
Stacks	132	110	132	110	132	110	132	110
Panel B: Excluding Luxembourg								
$\hat{p}$	0.08	0.285					0.066	0.287
	(2.08)**	(4.00)***					(1.72)*	(4.02)***
$\tilde{g}$		0.129		0.144		0.145		0.13
		(4.29)***		(4.78)***		(4.82)***		(4.31)***
s			-0.057	0.004			-0.055	0.01
			(-4.72)***	(0.17)			(-4.57)***	(0.48)
e					-0.046	0.028		
					(-3.96)***	(1.34)		
Obs	1620	1180	1620	1180	1620	1180	1620	1180
R^2	0	0.03	0.01	0.02	0.01	0.02	0.02	0.03
Stacks	110	90	110	90	110	90	110	90
Panel C: Excluding Luxembourg and Greece								
$\hat{p}$	0.176	0.285					0.172	0.287
	(3.22)***	(4.00)***					(3.12)***	(4.02)***
$\tilde{g}$		0.129		0.144		0.145		0.13
		(4.29)***		(4.78)***		(4.82)***		(4.31)***
s			-0.016	0.004			-0.011	0.01
			(-1.06)	(0.17)			(-0.73)	(0.48)
e					-0.002	0.028		
					(-0.16)	(1.34)		
Obs	1388	1180	1388	1180	1388	1180	1388	1180
R^2	0.01	0.03	0	0.02	0	0.02	0.01	0.03
Stacks	95	90	95	90	95	90	95	90

Note: The table presents results from fixed-effects panel data estimations for the Eurozone countries over the sample period 1995:Q1-1998:Q4. The very short time period (16 observations per country) is chosen in order to have a strongly balanced pre-Euro dataset. The general specification is given by the following regression equation: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1 \Delta x_{it} + u_{it}$, while the specification that allows for partial risk-sharing in consumption is given by: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1 \Delta x_{it} + \beta_2 \Delta\tilde{g}_{it} + u_{it}$. Moreover, each of these specifications is estimated using alternative variables in place of Δx_{it}: the negative of the inflation differential $\Delta\hat{p}_{it}$ (first two columns), the change in the nominal exchange rate Δs_{it} (third and fourth column), the change in the real exchange rate Δe_{it} (fifth and sixth column), and its both components $\Delta\hat{p}_{it}$ and Δs_{it} together (last two columns). Panel A contains results for all 12 countries, Panel B excludes Luxembourg, and Panel C excludes Luxembourg and Greece. The number of stacks refers to the number of bilateral country-pairs included in the panel. For each specification, the table displays the slope coefficient estimates with the corresponding t-statistics (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution are 1.645 (10%), 1.960 (5%), and 2.576 (1%).

with the relative consumption growth term, just as expected by theory.

4.2.3 Industrial Countries

The results so far concerned only one group of countries (Eurozone 12) over three different time periods. The purpose was to show the importance of the nominal exchange rate changes for the consumption-real exchange rate (Backus-Smith) puzzle. Therefore, it was natural to start with a comparison of different episodes for the same group of countries: the Euro-period (sample (1)) was compared with two pre-Euro periods (samples (2) and (3)). Now, I do a similar exercise and compare the results for the Eurozone after the introduction of the Euro (sample (1)) with results for a group of advanced industrial countries during the same time period. I include six industrial countries that generally had flexible nominal exchange rates over the concerned time period: Australia, Japan, Sweden, Switzerland, UK and USA.

First, I start with an analysis of the entire time period over which data for this set of countries is available (1986:Q1-2006:Q1)[23]. Table 12 presents the results from these estimations. Panel A contains results from the pooled-OLS, while Panel B contains results from fixed-effects panel estimations[24]. Each column in these panels contains results for a different specification. The figures in the first panel suggest that there is only one consistent effect: the relative output term enters with a significantly positive sign in all

[23]Similar as in the case of the Eurozone countries, all specifications that exclude the nominal exchange rate were estimated for a longer period as well (1970:Q1-2006:Q1). The results differ marginally however, and we do not report them here.

[24]In most specifications for the industrial countries, the Hausman specification test suggests rejection of the null hypothesis of no systematic difference between estimates obtained with fixed-effects and estimates obtained with random-effects. Therefore, only fixed-effects estimations yield consistent estimates in this case.

specifications, indicating that risk-sharing among these countries is far from perfect. Moreover, the negative of the inflation differential has a significantly positive sign when included without the nominal exchange rate. When the latter is included in the regression equation, the coefficient in front of the inflation differential term changed from positive into negative. Finally, both the nominal and the real exchange rate changes enter the equation with negative coefficients. However, none of them is significant at any conventional significance level.

The lower panel (Panel B) of this table presents results from fixed-effects panel estimations. There are at least three points worth mentioning for the panel estimation results. First, similar as in the pooled-OLS estimations, the relative output term enters with a significantly positive sign in each specification, suggesting a strong departure from perfect risk-sharing. Second, the negative of the inflation differential enters with a significantly positive sign in all panel estimations. Besides being statistically significant at 1 percent significance level, this effect has an economic meaning as well: it implies values for the relative risk-aversion coefficient in the range 4-9[25]. Third, both nominal and real exchange rate changes enter most panel specifications with a negative sign, though their effect is not statistically significant. In sum, this table suggests that the nominal exchange rate is unrelated to relative consumption growth, while (the negative of) the inflation differential is strongly positively related to the relative consumption growth.

Table 13 contains results for the last sample (5): the same group of advanced industrial countries over the Euro-period (1999:Q1-2006:Q1). The structure of the table is similar to that of Table 12: Panel A contains results from the pooled-OLS estimations, while Panel B contains results from panel

[25] The figures can be calculated as the reciprocal values of the slope coefficient estimates in front of the inflation differential term ($1/0.23 = 4.34$, $1/0.113 = 8.85$).

Table 12: Industrial Countries 1986:Q1-2006:Q1

Panel A: Pooled OLS Estimates								
$\hat{p}$	0.085	0.038					-0.085	-0.04
	(3.30)***	(1.65)*					(-3.29)***	(-1.74)*
$\tilde{g}$		0.526		0.531		0.531		0.527
		(21.92)***		(22.19)***		(22.21)***		(21.96)***
s			-0.001	-0.003			0	-0.004
			(-0.30)	(-1.11)			(-0.03)	(-1.24)
e					-0.001	-0.004		
					(-0.15)	(-1.33)		
Obs	1844	1844	1844	1844	1844	1844	1844	1844
R^2	0.01	0.21	0	0.21	0	0.21	0.01	0.21
Panel B: Panel Estimates (Fixed Effects)								
$\hat{p}$	0.149	0.114					0.15	0.113
	(5.60)***	(4.61)***					(5.62)***	(4.52)***
$\tilde{g}$		0.411		0.422		0.422		0.412
		(16.35)***		(16.74)***		(16.70)***		(16.36)***
s			0.001	-0.003			-0.001	-0.002
			(0.09)	(-1.07)			(-0.42)	(-0.64)
e					0.002	-0.002		
					(0.59)	(-0.52)		
Obs	1844	1844	1844	1844	1844	1844	1844	1844
R^2	0.02	0.14	0	0.13	0	0.13	0.02	0.14
Stacks	30	30	30	30	30	30	30	30

Note: The table presents results from pooled-OLS and fixed-effects panel data estimations for 6 industrial countries over the sample period 1986:Q1-2006:Q1. The dataset is strongly unbalanced. Observations over the entire time period (1986:Q1-2006:Q1) are available for the following countries only: Australia, Switzerland, UK and USA, while for Japan and Sweden observations are available over the period 1994 : Q1-2006:Q1 and 1993 : Q1-2006:Q1, respectively. The general specification is given by the following regression equation: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta x_{it} + u_{it}$, while the specification that allows for partial risk-sharing in consumption is given by: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1\Delta x_{it} + \beta_2\Delta\tilde{g}_{it} + u_{it}$. Moreover, each of these specifications is estimated using alternative variables in place of Δx_{it}: the negative of the inflation differential $\Delta\hat{p}_{it}$ (first two columns), the change in the nominal exchange rate Δs_{it} (third and fourth column), the change in the real exchange rate Δe_{it} (fifth and sixth column), and its both components $\Delta\hat{p}_{it}$ and Δs_{it} together (last two columns). Panel A contains results from the pooled-OLS estimations, while Panel B contains results from fixed-effects panel estimations. The number of stacks refers to the number of bilateral country-pairs included in the panel. For each specification, the table displays the slope coefficient estimates with the corresponding t-statistics (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution are 1.645 (10%), 1.960 (5%), and 2.576 (1%).

estimations. Several findings in the first panel deserve attention. First, as was the case with the previous samples, the coefficient in front of the relative output term is positive and significantly different from zero. Second, both nominal and real exchange rate changes have negative signs in all specifications, and their effect is significant in most cases. Third, in contrast to the evidence found in previous samples, the inflation differential has a significantly negative sign in each specification. In fact, this effect is especially robust, as the coefficient in front of the inflation differential term stays almost literally unchanged in all alternative specifications.

The lower panel in Table 13 presents results from fixed-effects panel estimations. Although most results are broadly similar to those from the pooled regressions, the most important difference concerns the coefficient estimate in front of the inflation differential term. It loses significance in all specifications and even changes sign once. The nominal exchange rate (and in the turn, the real exchange rate) enters with a negative sign, which is often statistically significant as well. Therefore, these findings demonstrate once again that the nominal exchange rate is the main source of Backus-Smith anomaly.

4.3 Discussion of the Results

The estimations presented in this section suggested that relative consumption growth is positively related to (the negative of) the inflation component of the real exchange rate.

In turn, this finding has important implications about international risk-sharing: it suggests that consumers exploit international relative price changes and increase consumption in situations when their purchasing power is relatively higher (prices they face are relatively lower). This is in line with

Table 13: Industrial Countries during the Euro Period 1999:Q1-2006:Q1

Panel A: Pooled OLS Estimates								
$\hat{p}$	-0.279	-0.239					-0.281	-0.241
	(-9.01)***	(-8.32)***					(-9.09)***	(-8.42)***
$\tilde{g}$		0.423		0.458		0.457		0.425
		(12.30)***		(12.92)***		(12.95)***		(12.41)***
s			-0.009	-0.011			-0.01	-0.012
			(-1.84)*	(-2.39)**			(-2.19)**	(-2.71)***
e					-0.015	-0.016		
					(-3.15)***	(-3.60)***		
Obs	840	840	840	840	840	840	840	840
R^2	0.09	0.23	0	0.17	0.01	0.18	0.09	0.23
Panel B: Panel Estimates (Fixed Effects)								
$\hat{p}$	0.007	-0.023					-0.003	-0.028
	(0.19)	(-0.67)					(-0.09)	(-0.82)
$\tilde{g}$		0.312		0.313		0.314		0.316
		(8.96)***		(9.04)***		(9.06)***		(9.07)***
s			-0.006	-0.008			-0.006	-0.008
			(-1.46)	(-1.95)*			(-1.45)	(-2.00)**
e					-0.006	-0.009		
					(-1.44)	(-2.03)**		
Obs	840	840	840	840	840	840	840	840
R^2	0	0.09	0	0.09	0	0.09	0	0.09
Stacks	30	30	30	30	30	30	30	30

Note: The table presents results from pooled-OLS and fixed-effects panel data estimations for 6 industrial countries over the Euro period 1999:Q1-2006:Q1. The general specification is given by the following regression equation: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1 \Delta x_{it} + u_{it}$, while the specification that allows for partial risk-sharing in consumption is given by: $\Delta\tilde{c}_{it} = \beta_0 + \beta_1 \Delta x_{it} + \beta_2 \Delta\tilde{g}_{it} + u_{it}$. Moreover, each of these specifications is estimated using alternative variables in place of Δx_{it}: the negative of the inflation differential $\Delta\hat{p}_{it}$ (first two columns), the change in the nominal exchange rate Δs_{it} (third and fourth column), the change in the real exchange rate Δe_{it} (fifth and sixth column), and its both components $\Delta\hat{p}_{it}$ and Δs_{it} together (last two columns). Panel A contains results from the pooled-OLS estimations, while Panel B contains results from fixed-effects panel estimations. The number of stacks refers to the number of bilateral country-pairs included in the panel. For each specification, the table displays the slope coefficient estimates with the corresponding t-statistics (in brackets). Significance at 10%, 5%, and 1% is indicated by *, **, and ***, respectively. The critical values for the t-distribution are 1.645 (10%), 1.960 (5%), and 2.576 (1%).

macroeconomic theory and gives support to the basic condition for efficient risk-sharing in consumption. Moreover, this relation was shown to be surprisingly robust to alternative regression specifications, estimation methods, country samples, and nominal exchange rate regimes. In the case of flexible (floating) nominal exchange rates, the results imply a clear "dichotomy" in the behavior of the two components of the real exchange rate. The inflation differential is positively related, while the nominal exchange rate is generally negatively related to relative consumption growth. In turn, this finding suggests that the asset component of the real exchange rate is "disconnected" from the underlying macroeconomic fundamentals (relative consumption), and thereby, generates the consumption-real exchange rate puzzle. Furthermore, most of these results gain statistical significance when one explicitly accounts for country-pair-specific characteristics (fixed-effects) in the panel regressions[26].

Finally, it is worth making a note on the values for R^2 presented in most of the estimations. First, the values for R^2 are typically very low and fall in the range 0-3% (and never above 10%) for specifications that do not allow for partial international risk-sharing. In fact, this is not surprising and closely corresponds with optimal (full) consumption insurance condition in the international context: movements in relative consumption growth, like movements in (real) exchange rates, should be unpredictable ex-ante [27]. Second, once the relative output growth term is included in the specification, the values for R^2 increase significantly and in some cases fall in the range 20-30%. This finding supports the argument that international risk-sharing

[26] In general, the specification tests also suggest that this is the only consistent estimation procedure.

[27] For the implications of the optimal insurance condition see Cochrane (1991), for example.

is far from perfect: idiosyncratic output changes explain a large portion of the variation in idiosyncratic consumption changes.

5 Conclusion

This study provides some new empirical evidence about the importance of nominal exchange rate fluctuations for one of the most important anomalies in international macroeconomics: the negative correlation between relative consumption growth and real exchange rate changes (Backus-Smith puzzle). Its main findings can be summarized as follows. First, in accordance with theory and in stark contrast to the anomalous behavior first documented by Backus and Smith (1993), the real exchange rate is positively related to relative consumption growth for Eurozone 12 countries after the introduction of the Euro. This is true for the majority of bilateral-pair estimations, but also for the pooled dataset (using pooled-OLS and various panel estimation procedures). Second, this finding only applies to the period of fixed nominal exchange rates - the Eurozone countries in the Euro-period, and stays in contrast to all alternative/controlling samples with (relatively) flexible nominal exchange rates. Third, when real exchange rate changes for the latter samples are separated into their two components, the regressions results suggest that the Backus-Smith anomaly stems primarily from the nominal exchange rate changes. In fact, there is a clear "dichotomy" between the results for (the negative of) the inflation differential and nominal exchange rate changes. While the first relation is generally positive, and hence, in accordance with theory, the second one is generally negative and implies a clear violation of the basic condition for risk-sharing across countries. Several alternative samples, empirical specifications and empirical procedures support this result. Inevitably, nominal exchange rate behavior appears crucial for understanding the relative consumption-real exchange rate puzzle investigated in this study. Our finding therefore raises an additional puzzle: why is the nominal exchange rate negatively correlated to relative consumption and why does it behave so differently from the inflation differential?

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