Analysing aggregate real exchange rate persistence through the lens of sectoral data.

By Laura Mayoral[a] and Maria Dolores Gadea[b]

[a]Institute for Economic Analysis, (CSIC)

[b]Dept. of Applied Economics, University of Zaragoza

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Abstract

In this paper we analyze the persistence of aggregate real exchange rates (RERs) for EU-15 countries by using sectoral data. We employ the results recently developed in Mayoral (2008) that establish a link between aggregate and sectoral persistence. They allow us to decompose aggregate RER persistence into the persistence of its different subcomponents. We show that a limited number of sectors are responsible of the high levels of persistence observed at the aggregate level. We use quantile regression to investigate whether the traditional theories proposed to account for the slow reversion to parity (lack of arbitrage due to nontradibilities or imperfect competition) are able to explain the behavior of the upper quantiles of sectoral persistence. We conclude that factors related to imperfect competition and market structure have more explanatory power than variables related to the tradability of the goods or its inputs.

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1. INTRODUCTION

During the last few years there has been a remarkable transformation on the beliefs about the holding of the PPP and, in contrast to the view prevailing some decades ago, there is a general consensus about the long-run holding of the PPP. This change in beliefs was made possible by a number of studies that, either using longer spans of data (Abuaf and Jorion, 1990, Lothian and Taylor, 1996) or panel data sets (Frankel and Rose, 1996, Engel et al., 1997) have been able to improve the power of unit root tests.

Much of what we have learned about real exchange rate persistence comes from studies that use aggregate price indices to build aggregate real exchange rate (RER) data. A recent literature, however, has focused on disaggregate real exchange rates. Imbs et al. (2005) argue that sectoral RER persistence is considerable lower than that of aggregate RER. Using Eurostat dataset, they report standard HL estimates, in the range of 3-5 years, while when sectoral data is employed, HL estimates drop considerably and are around 1 year. They claim that this divergence is due to an aggregation bias that arises as a consequence of the high degree of heterogeneity in sectoral RERs, that neither standard time series nor panel data techniques are able to control. Crucini and Shintani (2008) analyze a micro-panel of local currency prices of individual retail goods and services in major cities and also find moderate HL values for the median good: around 12-19 months. However, they claim that the aggregation bias appears not to be a robust feature of the data. They find some aggregation bias when U.S. city level data is employed but when cross-border pairs are analyzed, the bias seems to disappear. In these cases, they find aggregate estimates very much in line with those obtained at the disaggregate level.

These contradictory results suggest that the relation between aggregate and sectoral RER persistence is not well-understood. This paper has as starting point the results developed in Mayoral (2008), that established a direct link between aggregate and sectoral persistence. They show that in a linear setting, similar to that employed in Imbs et al. (2005) or Crucini and Shintani (2008), the standard IRF computed with aggregate data equals the average of the individual IRFs. This result is very interesting for different reasons: firstly, aggregate persistence, as measured by the IRF or the associated scalar tools, is completely determined by the behavior of the sectors. Therefore, the standard HL can be estimated by using either aggregate or sectoral data. Secondly, since the aggregate IRF is the average of sectoral IRFs, it is possible to investigate the sources of aggregate persistence by analyzing the characteristics of the individual IRFs. As is well-known, averages are very non-robust measures. Thus, it is possible that, although most sectors have moderate values of persistence, the existence of a few highly persistent ones give rise to an average IRF that is highly persistent too.

The goal of this paper is twofold. Firstly, we decompose aggregate persistence into the persistence of its different components. As has been reported in the literature, we document a high degree of heterogeneity in RER persistence at the sectoral level. This analysis allows us to identify the sectors that, to a large extent, are responsible of the high degree of persistence observed at the aggregate level. We show that if the top 30% most persistent sectors are excluded, the resulting HL is below 2 years for most countries. Thus, the persistence implied by 70% of the sectors is compatible with models based on nominal rigidities. We also show that most of these sectors belong to the durable category, characterized by high tradability but a high degree of product differentiation. We are also able to quantify the contribution to total persistence of each of the sectors in our dataset. It turns out that, in the long run around 50% of the remaining effect of a shock is driven by durable goods.

Secondly, we investigate the factors that account for the slow reversion to parity. Several theories have been proposed to explain the slow speed of convergence of RERs. Among these theories, the lack of arbitrage in nontradable goods, and the existence of imperfect competition due to pricing-to-market have prominent roles. Using data on market structure and international trade we test for these theories.

A remarkable difference of our approach with respect to previous studies, such as Cheung et al. (2001) and Crucini et al. (2005), is that we put special emphasis on explaining the behavior of the upper quantiles of the distribution of sectoral persistence, since they determine to a large degree the persistence observed at the aggregate level. It is well known that the resulting estimates of various effects on the conditional mean of sectoral persistence are not necessarily indicative of the size and nature of these effects on the upper tail of the distribution. Thus, a more complete picture of covariate effects can be provided by estimating a family of conditional quantile functions. Our results suggest that variables related to market structure and the degree of competition have more explanatory power to account for the behavior of the upper tails of the distribution than those associated with tradability of the final good or its inputs. These conclusions are in good agreement with modern trade theories.

The outline of the paper is as follows. Section 2 summarizes the theoretical results about the relation between aggregate and sectoral IRFs. Section 3 presents the different datasets used in this paper and examines whether IRFs estimated with data at different levels of aggregation behave as the theory predicts. Section 4 analyses the characteristics of the sectors by their contribution to overall persistence. Section 5 explores whether the traditional theories (lack of arbitrage due to nontradability or imperfect competition) are able to explain the distribution of sectoral persistence while Section 6 puts forward some concluding remarks.

2. ANALYZING AGGREGATE REAL EXCHANGE RATE PERSISTENCE USING DISAGGREGATE DATA: THEORETICAL BACKGROUND

In this section we present the theoretical background that motivates our empirical exercise. We assume a linear specification for the sectoral RERs that allows for heterogeneous dynamics and, under these assumptions, derive the corresponding aggregate model. Next, we describe the relation between measures of persistence derived from aggregate and sectoral data. As shown in Mayoral (2008), the IRF associated to the aggregate process equals the average of the sectoral IRFs. This implies that, firstly, the IRF (and related measures such as the HL) can be estimated using either sectoral or aggregate data. Secondly, the fact that the IRF is the average of the sectoral IRFs allows us to decompose aggregate persistente into the persistence of its different subcomponents.

Finally, we also present definitions of other persistence measures that will be used throughout the paper.

2.1. Sectoral and aggregate RERs

Impediments to arbitrage, nominal rigidities and market structure vary considerably across sectors. Since these impediments are usually believed to be behind cross-country price differences, they could bring about important heterogeneity in the speeds of reversion to parity across sectors and countries.

In this paper we adopt a linear specification for sectoral RERs that can account for different sources of heterogeneity: in addition to country and sector fixed effects (captured by the parameter $\gamma_{c,i}$), it also allows for different speeds of shock adjustment by letting the autoregressive coefficients be heterogeneous. More specifically, we assume that for each country c, each sector can be represented as

$$q_{c,i,t} = \gamma_{c,i} + \sum_{k=1}^{K} \rho_{c,i,k} q_{c,i,t-k} + \nu_{c,i,t}, \qquad i = 1, ..., N, \; c = 1, ..., C; \; t = 1, ..., T, \tag{1}$$

where i, c and t denote sector, country and period, respectively, $q_{c,i,t}$ is the real exchange rate for country c, sector i at time t. To simplify the exposition, for now we suppose that $K = 1$ (this hypothesis will be relaxed shortly). We further assume that $\gamma_{c,i} = \bar{\gamma} + \eta^{\gamma}_{c,i}$, $\rho_{c,i} = \bar{\rho} + \eta^{\rho}_{c,i}$, $\bar{\gamma}$ and $\bar{\rho}$ are constants, and $\rho_{c,i}$ has support on the interval (-1, 1]; $E_s\left(\rho^h_c\right)$ exists for all h, where $E_s\left(.\right)$ denotes the expectation over the cross-sectional distribution of sectors of country c, and that the innovation $\nu_{c,i,t} = u_{c,t} + \varepsilon_{c,i,t}$ is the sum of two orthogonal, zero-mean martingale difference sequences, one common to all sectors and one idiosyncratic, with variances $\sigma^2_{u_c} > 0$ and $\sigma^2_{\varepsilon_{c,i}}$, respectively. Finally, it is assumed that $\eta^{\gamma}_{c,i}$ and $\eta^{\rho}_{c,i}$ are *i.i.d.* zero-mean random variables, mutually independent of $\nu_{c,i,t}$.

To derive the corresponding aggregate RER for country c, we follow the approach of Stoker (1984), who defines an aggregate process as one given by the expected value across individuals of the disaggregate relations. Thus, the aggregate real exchange rate for country c is given by $Q_{c,t} = E_s\left(q_{c,t}\right)$. This implies that

$$Q_{c,t} = E_s(\gamma_c) + E_s(\rho_c q_{c,t-1}) + E_s(\nu_{c,t}), \tag{2}$$

Under the assumptions above and assuming further that the number of micro-processes is (countably or uncountably) infinite, Lewbel (1994) showed that expression (2) is equivalent to,

$$Q_{c,t} = \sum_{s=1}^{\infty} A_s Q_{c,t-s} + u_{c,t}, \tag{3}$$

for constants A_1, $A_2, ...$ that satisfy $A_j = m_j - \sum_{r=1}^{j-1} m_{j-r} A_r$, where $m_j = E\left(\rho^j_c\right)$ is the moment of order j of ρ_c.

Thus, under sectoral heterogeneity, the aggregate model might display very complicated dynamics, as shown in (3), even when the behavior of the micro units is very simple, as is in this case.

2.2. Aggregate and sectoral IRFs

In order to evaluate the persistence of aggregate and sectoral data, it is customary to compute the IRF and then, to derive scalar measures, such as the half life (HL) or the cumulative impulse response (CIR).

The IRF is defined as the effect of a change in the aggregate shock by a unit quantity ocurring at time t on the current and subsequent values of the variable of interest. Following Koop et al. (1997), for each country c and sector i, it can be computed as the difference between two forecasts as follows

$$IRF_{c,i}(t,h) = E\left(q_{c,i,t+h} | u_{c,t} = 1; z_{c,i,t-1}\right) - E\left(q_{c,i,t+h} | u_{c,t} = 0; z_{c,i,t-1}\right), \tag{4}$$

where the operator $E(.|.)$ denotes the best mean squared error predictor and $z_{i,t-1} = \begin{pmatrix} q_{c,i,t-1}, & q_{c,i,t-2} & ... \end{pmatrix}'$; Applied to the simple model in (1) with $K = 1$, it yields that the response of sector i in country c to a unitary aggregate shock in t, h periods ahead is

$$IRF_{c,i}(t,h) = \rho_{c,i}^{h}, \text{ for } h \geq 0. \tag{5}$$

If one is interested in the average response to this shock across sectors, a natural measure of average persistence would be to consider the expected value of (5) over the distribution of units. The expected impulse response in country c to a unitary shock h periods ahead, denoted as $IRF_{c,\text{sect.}}$, is then given by

$$IRF_{c,\text{sect.}}(t,h) = E_s\left(IRF^c(t,h)\right) = E_s\left(\rho_c^h\right), \text{ for } h \geq 0, \tag{6}$$

Then, the expected IRF associated with (1) is given by the $h^{th} - moment$ of the distribution of ρ.

Since our goal in this paper is to learn more about aggregate persistence by using disaggregate data, we now turn to examine the relation between aggregate and sectoral IRFs. This question has been addressed in Mayoral (2008) and we only summarize those results briefly here.

The standard aggregate IRF associated with model (3) can be computed as

$$IRF_{c,\text{aggr.}}(t,h) = E\left(Q_{c,t+h}|u_{c,t}=1;Z_{t-1}\right) - E\left(Q_{c,t+h}|u_{c,t}=0;Z_{t-1}\right), \tag{7}$$

where $\text{IRF}_{\text{aggr.}}$ denotes the standard IRF computed with aggregate data and $Z_{t-1} = (Q_{c,t-1},\ Q_{c,t-2}, ...)$. Application of this definition to (3) yields,

$$\begin{aligned} IRF_{c,\text{aggr.}}(t,\ 1) &= A_1;\ IRF_{c,\text{aggr.}}(t,\ 2) = A_1^2 + A_2 \\ IRF_{c,\text{aggr.}}(t,\ 3) &= A_1\left(A_1^2 + A_2\right) + A_2A_1 + A_3, \end{aligned}$$

and in general,

$$IRF_{c,\text{aggr.}}(t,h) = \sum_{j=1}^{h} A_j IRF_{c,\text{aggr.}}(h-j). \tag{8}$$

Using the fact that $m_j = \sum_{r=0}^{j-1} m_r A_{j-r}$, Mayoral (2008) has shown that $IRF_{c,\text{aggr.}}(t,1) = A_1 = m_1$, $IRF_{c,\text{aggr.}}(t,2) = A_1^2 + A_2 = m_0A_2 + m_1^2 = m_2$, and that, in general,

$$IRF_{c,\text{aggr.}}(t,\ h) = m_h = E_s\left(\rho_c^h\right),\ \text{for all } h. \tag{9}$$

It follows that

$$IRF_{c,\text{aggr.}}(t,\ h) = IRF_{c,\text{sect.}}(t,\ h),\ \text{for all } h \tag{10}$$

that is, the population values of the IRF across aggregation levels coincide. Furthermore, the relationship between IRFs also holds for values of K larger than 1. To simplify the notation, these functions will be simply denoted as IRF_c in the following.

This result is very interesting since it clarifies the relation between aggregate and sectoral persistence. It implies that the IRF associated to aggregate RERs can also be estimated using sectoral data. Moreover, the fact that the former can be computed as the average of the sectoral IRFs allows us to decompose aggregate RER persistence into the persistence of its different subcomponents.

2.3. Other measures of persistence

Since the IRF is a vector of numbers, it is customary to use other scalar measures of persistence. In this paper we employ two of these measures: the half-life (HL), defined as the number of periods it takes until half of the effect of a shock dissipates, and the cumulated impulse response

CIR(h), which measures the total cumulative effect of a shock h periods after it took place. For each country c, the HL is defined as the value of the IRF that satisfies

$$IRF_c(t, h = HL_c) = 0.5, \tag{11}$$

We follow Kilian and Zha (2002) and define the half-life as the largest value of HL_c such that $\text{IRF}_c(t, HL_c - 1) \geq 0.5$ and $\text{IRF}_c(t, HL_c + 1) < 0.5$.

As for the CIR(h), it is computed as

$$CIR_c(h) = \sum_{l=0}^{h} IRF_c(t, l). \tag{12}$$

The HL is usually the favourite persistence measure in the PPP literature. However, it is important to notice that it has important drawbacks. Among the most important ones is that it cannot be consistently estimated in AR(p) models if $p > 1$. Given this important limitation, in the following we will consider both the HL and the CIR.

3. ANALYZING AGGREGATE RER PERSISTENCE USING SECTORAL DATA: EMPIRICAL RESULTS

This section presents the data used in our analysis. Next, we show that the theoretical results presented in Section 2.2 are a reasonable prediction of the relation between aggregate and disaggregate persistence measures in our data set.

3.1. The data

To construct the RERs, we use the Eurostat Harmonized Index of Consumer Prices (HICP) for the EU-15 countries from 1996:1 to 2007:12. These countries and their corresponding abbreviations are Austria (AU), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (GE), Greece (GR), Ireland (IR), Italy (IT), Luxembourg (LU), Netherlands (NL), Portugal (PO), Spain (SP), Sweden (SW) and United Kingdom (UK). Eurostat provides data corresponding to four levels of aggregation. The most disaggregate level (that we will refer to as Level 3) contains 94 disaggregate prices. Level 2 and Level 1 aggregate these 94 series into 49 and 12 categories, respectively. Finally, Level 0 denotes aggregate HICP. In this paper, we mainly focus on Level 3 HICP sub-indices. Due to data unavailability, some of the sectors had to be excluded from the analysis. Appendix 1 contains a detailed list of the sectors in Level 3 (Table A.1) as well as lists of the sectors of which data was missing (Table A.2).

Nominal exchange rates are obtained from the Main Economic Indicators of the OECD. RERs are defined against the U.K. pound. For level of aggregation $L = \{0, 1, 2, 3\}$, the RER of sector i in country c is defined as

$$q^L_{c,i,t} = \log(P^L_{c,i,t}/S_{c,t}P^L_{UK,i,t}),$$

where $S_{c,t}$ denotes the nominal bilateral exchange rate defined as the number of domestic units per pound at time t, $P^L_{c,i,t}$ is the price of sector i in country c at time t and $P^L_{UK,i,t}$ is the corresponding U.K. price for levels of aggregation $L = \{0, 1, 2, 3\}$.

Figure I depicts the original aggregate RERs for each of the EU-15 countries. This graph also includes plots of the aggregates of sectors at levels of aggregation $L = \{1, 2, 3\}$. These aggregate series have been constructed as a weighted average of the corresponding sectoral data, where the weights employed are the average over the period 1996-2007 of those employed by Eurostat to compute the aggregate index. In spite of the fact that some of the sectors have been eliminated from the analysis, all series are remarkably close, suggesting that the role of the missing sectors is, possibly, fairly small.

(**Figure I about here**)

We also employ three additional datasets: the Comtrade (United Nation Commodity Trade Statistic Database), the OECD Structural Analysis Statistics (STAN, Edition 2008) and the Input-Output Tables (IOT) from the OECD. The first dataset provides information about trade flows for individual countries at six digits of disaggregation and allows us to calculate different indicators that capture the trade features of each sector. The second contains data about value added, gross output, labor costs and other industry indicators that will be employed to analyze the market structure of the sectors. Details on the construction of the databases are provided in Appendix 1.

3.2. Comparing aggregate and sectoral persistence measures

In this section we check whether equation (10) approximately holds for the Eurostat dataset.

To do this, we have obtained estimators of $\mathrm{IRF}_{c,aggr}$ and $IRF_{c,\mathrm{sect}}$, defined in (8) and (6) respectively, for all the countries in our dataset. To estimate $IRF_{c,\mathrm{sect}}$, an AR(p) model has been fitted to each of the sectors in country c, where p was chosen according to the general-to-specific (GTS) approach.[1] Since the data is in general highly persistent, Kilian's (1998) bootstrap after bootstrap method has been employed to correct for small sample bias. Next, $\widehat{IRF_{c,\mathrm{sect.}}}$ is computed as the weighted average of the individual IRFs, where the weights are the average over the period 1996-2007 of those employed by Eurostat to elaborate the aggregate index. With respect to $\mathrm{IRF}_{c,aggr.}$, two different estimates are provided, one computed using the original aggregate data (Level 0) while the other is based on the aggregate of the sectoral data available at Level 3. An AR(p) process has been fitted to both datasets, where p was chosen according to the GTS approach and the estimated models have been used to compute the corresponding IRFs according to expression (8).[2] Figure II present plots of $\widehat{IRF_{c,aggr.}}$ and $\widehat{IRF_{c,\mathrm{sect}}}$ for EU-15 countries.

Table I presents some summary statistics of the estimated IRFs. More specifically, the HL_c and four values of the $\mathrm{CIR}_c(h)$ (for h corresponding to 1, 2, 3 and 5 years) are presented for each country. Ag0 (Ag3) denotes estimates computed with aggregate Level 0 (Level 3) data, while Sec. refers to estimates of persistence measures computed using sectoral data. Table I shows that, in general, measures of persistence computed with aggregate or sectoral data are very similar. The values of the CIR_c show that the pattern of decay of $\widehat{IRF_{c,aggr.}}$ and $\widehat{IRF_{c,\mathrm{sect}}}$ is very similar while the estimates of the HL point to the same direction.

The previous results are important because they motivate our empirical analysis: since the persistence of aggregate RERs is a function of that of sectoral RERs, the use of disaggregate data can provide a lot of information about the sources of aggregate persistence that would not possible

[1] As shown by Kursteiner (2005), if the underlying model is an AR(∞) processes, consistent and asymptotically normally distributed estimators of the coefficients are obtained if an AR(p) model is fitted and p is chosen according to the GTS approach.

[2] The maximum value of p, pmax, was set equal to 36 for both aggregate and sectoral data.

to obtain by only using aggregate information.

(**Figure II about here**)

TABLE I

AGGREGATE VS. SECTORAL PERSISTENCE♠

	HL			CIR(12)			CIR(24)			CIR(36)			CIR(60)		
	Ag0	Ag3	Sec	Ag0	Ag3	Sec	Ag0	Ag3	Sec	Ag0	Ag3	Sec	Ag0	Ag3	Sec.
AU	37.98	37.52	36.57	15.82	16.01	13.90	22.71	22.59	18.99	29.09	27.91	26.76	29.09	27.91	26.76
BE	42.46	40.18	115.29	9.07	9.05	8.63	15.55	15.57	14.41	23.45	23.04	20.07	33.90	31.82	26.21
DK	37.95	44.08	37.33	9.82	10.41	9.10	16.76	18.55	15.28	23.89	27.42	21.24	29.94	37.80	30.61
FI	18.80	36.04	12.02	8.16	8.64	8.03	12.38	13.90	12.54	15.78	18.50	16.56	14.35	18.48	19.75
FR	37.57	37.21	37.61	9.83	10.00	9.03	16.84	17.11	15.52	23.95	23.96	22.04	29.53	28.11	30.23
GE	36.86	31.32	18.33	9.40	9.53	8.29	15.41	15.54	13.24	21.48	21.28	18.04	26.08	24.33	24.66
GR	38.35	42.31	49.40	9.84	10.00	9.60	17.00	17.84	17.35	24.88	26.53	25.81	30.46	34.63	37.72
IR	63.73	46.19	43.38	9.82	9.64	9.09	18.80	17.93	15.91	30.60	28.00	23.72	50.16	39.94	34.12
IT	46.42	60.51	36.99	10.00	10.35	8.61	18.18	19.60	14.68	27.98	31.19	20.96	39.74	48.88	28.38
LU	82.24	79.04	37.49	9.46	9.60	8.31	17.16	18.19	14.14	28.01	29.54	20.57	48.30	50.95	30.15
NL	43.61	44.19	37.32	9.87	9.91	8.93	17.51	17.64	14.80	26.14	26.56	21.02	35.97	37.52	28.88
PO	66.74	55.35	37.61	10.48	9.32	8.88	19.45	16.87	15.01	31.20	26.70	21.73	50.87	41.42	29.93
SP	89.52	118.53	73.14	11.74	10.92	9.04	21.77	21.48	16.43	35.25	35.94	24.79	62.67	67.57	29.65
SW	19.82	22.38	20.06	8.27	8.87	8.15	14.17	15.94	14.28	15.10	17.88	17.48	14.81	15.65	22.39

♠pmax=36 for sectoral and aggregate series. General-to-specific lag selection method.

Aggregate level 0 (Agg0) refers to the real exchange rates built with the original Eurostat price index.

Aggregate level 3 (Agg3) refers to the real exchange rates built as a weighted average of Level 3 data.

4. ANALYZING SECTORAL PERSISTENCE.

We now turn to describe the distribution of persistence across sectoral RER for EU-15 countries. We focus on different aspects, such as documenting the degree of heterogeneity in sectoral RER data, analysing the contribution of the sectors to total persistence and discovering the sectors that drive aggregate persistence upwards.

4.1. Heterogeneity in RER sectoral data

Many studies have documented the existence of a high degree of heterogeneity in sectoral RER data (see Imbs et al., 2005, Crucini and Shintani, 2008, among many others). Table II documents sectoral heterogeneity in our data set. HLs have been computed for each country c and each sector i in Level 3 and Table II reports some descriptive statistics of the obtained values, more specifically, the average, the standard deviation and the rank. It also reports the percentage of sectors in country c whose HL is smaller than 2 years (24 months), lies in the 3-5 year (36-60 month) interval or is larger than 10 years (120 months).

TABLE II

Heterogeneity in Sectoral HLs

	mean	std.	rank	% $HL_{i,c}$<24	% (36< $HL_{i,c}$ <60)	%$HL_{i,c}$ >120
AU	58.80	46.28	118.49	40.85	12.68	25.35
BE	60.24	44.14	119.28	30.12	17.20	23.45
DK	57.11	44.88	117.85	35.62	10.96	21.99
FI	47.44	40.30	118.28	36.00	20.00	16.00
FR	59.25	41.69	119.09	27.63	21.05	18.42
GE	54.28	44.07	118.85	36.36	19.48	23.38
GR	67.16	41.48	117.63	18.42	19.74	22.37
IR	61.70	43.03	119.04	17.81	21.92	24.66
IT	62.00	42.18	110.53	28.77	19.18	21.92
LU	62.60	41.99	119.29	24.32	18.92	25.68
NL	57.09	41.57	118.80	25.35	23.94	18.31
PO	55.26	41.15	112.98	30.00	24.29	20.00
SP	70.60	43.75	118.53	18.92	12.16	36.49
SW	41.29	39.38	118.53	56.94	13.89	13.89

Table II shows that there is a high degree of heterogeneity in sectoral persistence, as the std. and the rank illustrate. Another interesting observation is that, although the average HL lies in the so-called Rogoff's interval (36-60 months), this fact is not longer true when individual sectors are considered. In fact, only 10 to 20% of the sectors display this type of behaviour. A considerable number of sectors show HLs below 2 years that are, in principle, compatible with models based on nominal rigidities. However, there is an important number of sectors whose HL exceeds 10 years.

Is there any pattern in the distribution of sectoral persistence? Table III presents averages of the individual HLs grouped by type of product. Sectors have been classified as food and beverages, energy, non-durables, durables and services (full lists of the sectors included in these categories are provided in Appendix 1).

Table III shows that there is a high degree of heterogeneity both across type of product and across countries. In general, non-durable goods are the least persistent products as opposed to durable goods, which are the most persistent ones. Surprisingly, services that are traditionally considered to be very persistent due to their lack of tradability, display a moderate HL.

TABLE IV

HL MEAN BY SECTORS

	AU	BE	DK	FI	FR	GE	GR	IR	IT	LU	NL	PO	SP	SW
FOOD	40.94	53.66	50.32	44.96	58.67	28.78	80.04	76.11	58.54	67.15	46.64	76.11	78.06	28.39
ENERGY	97.07	75.22	36.65	34.51	61.67	74.69	53.59	45.79	78.42	75.58	62.04	17.96	77.35	39.25
NON-DUR.	49.93	64.57	55.74	37.27	52.40	66.48	59.96	54.23	54.42	48.78	81.35	32.96	61.92	52.82
DUR.	88.34	83.64	93.68	78.79	81.50	85.10	87.98	56.36	89.96	89.38	88.15	60.66	99.12	56.74
SERVICES	57.96	54.64	54.01	45.30	51.84	55.92	53.21	57.56	56.48	57.25	56.95	56.37	57.71	35.42
TOTAL	58.80	60.24	57.11	47.44	59.25	54.28	67.16	61.70	62.00	62.60	57.09	60.75	70.60	41.29

Average HLs by group of product.

Figure III presents plots of the IRFs by type of product. To compute these functions, the IRFs of the sectors belonging to a particular category have been weighted using Eurostat weights. Thus, the sum of these functions equals the sectoral IRF.

(Figure III about here)

4.2. Assessing the contribution of sectors to aggregate RER persistence.

The relation between individual and aggregate IRF allows us to quantify the contribution of each sector to aggregate persistence. This could be done in the following way. Since $IRF_{c,\text{sect}}$ is the weighted average of all sectors, it could be decomposed into the contribution of different sectors in the following way

$$IRF_{c,\text{sect}}\left(t,h\right)=\sum_{k=1}^{K}\sum_{i=1}^{N_k}\omega_i IRF_{c,i}\left(t,h\right)$$

where K denotes the number of groups considered and is such that $\sum_{k=1}^{K} N_k = N$. Next, the percentage contribution of group k, $C_{c,k}$, is computed as

$$C_{c,k}(h) = \frac{\sum_{i=1}^{N_k} \omega_i IRF_{c,i}(t,h)}{IRF_{c,\text{sect}}(t,h) = \sum_{i=1}^{N} \omega_i IRF_{c,i}(t,h)}.$$

Next, to summarize the relative contribution, different persistence measures have been considered, namely the HL and the CIR(h) at different horizons h corresponding to 1, 3, 5 and 7 years. The relative contribution of group k to $\text{CIR}_{c,k}(h)$ is defined as

$$CIR_{c,k}(h) = \sum_{j=1}^{h} C_{c,k}(j),$$

As for the relative contribution of group k in country c to the HL, denoted as $HL_{c,k}$, it has been computed in the following way.

$$HL_{c,k} = \frac{\sum_{i=1}^{N_k} \omega_i IRF_{c,i}(t, HL_c)}{IRF_{c,\text{sect}}(t, HL_c)}$$

Table V presents the corresponding figures. Columns 3 to 7 display the average across EU-15 countries of $HL_{c,k}$ and $CIR_{c,k}(h)$. In addition, the second column in Table V presents the average of the weights corresponding to a particular category. That is, the average Eurostat weight (across the EU-15 countries) of all the products labelled as food is 24%.

Several interesting conclusions can be drawn from this table. Looking at the different horizons of the CIR it is possible to assess the evolution of the persistence of shocks over time across groups of sectors. In the short run (CIR(12)), all groups behave very similarly, as shown by the fact that the contribution to CIR(12) of each group is almost equal to its corresponding initial weight. However, as farther horizons are analyzed, the picture changes dramatically. Durable goods become the group with the highest contribution to long run persistence. Their contribution to CIR(60) and CIR(80) exceeds by 30% and 51% their corresponding initial weight. On the opposite side, the contribution of services and energy sectors to aggregate persistence decreases when longer horizons are considered. Their contribution to $(CIR(60), CIR(84))$ is only (0.55%, 0.44%) and (0.81%, 0.66%) for energy and services, respectively. This result is quite surprinsing because services are usually believed to be the highly persistent. It is also remarkable that the contribution of food and non-durables remains fairly contant over time and very similar to its initial weight (24% and 9%, respectively).

TABLE V

Contribution of group of sectors to agg. persistence

	Weights	HL	CIR(12)	CIR(36)	CIR(60)	CIR(84)
1.FOOD	0.24	0.22	0.26	0.26	0.25	0.24
- Food	0.19	0.17	0.20	0.19	0.19	0.18
- Alcohol and Tobacco	0.06	0.06	0.06	0.07	0.06	0.06
2. ENERGY	0.09	0.09	0.09	0.08	0.05	0.04
3.NON DURABLES	0.06	0.07	0.06	0.07	0.07	0.07
4.DURABLES	0.27	0.38	0.25	0.29	0.35	0.41
- Clothing and personal effects	0.11	0.18	0.10	0.12	0.15	0.17
- Durables for the dweling	0.06	0.07	0.05	0.06	0.07	0.08
- Motor vehicles	0.07	0.09	0.07	0.08	0.09	0.11
- Electronic products	0.02	0.03	0.02	0.02	0.03	0.03
- Recreational and cultural	0.02	0.02	0.01	0.02	0.02	0.02
5.SERVICES	0.33	0.23	0.34	0.30	0.27	0.22
- Services relating to the dweling	0.09	0.06	0.09	0.08	0.07	0.06
- Transport	0.05	0.03	0.04	0.04	0.03	0.03
- Financial services	0.01	0.02	0.02	0.02	0.02	0.02
- Recreational and cultural services	0.16	0.11	0.16	0.15	0.13	0.11
-Other services	0.02	0.02	0.02	0.02	0.02	0.00
TOTAL	1	1	1	1	1	1

Since the previous table can hide important cross-country heterogeneity, Appendix 2 reports a similar analysis for each of the countries in our data set.

4.3. What sectors drive aggregate RER persistence upwards?

It was shown in Section 2 that the aggregate IRF is the average of the sectoral IRFs. However, it is well-known that averages are very non-robust measures in the presence of unusually high observations. Then, it can be the case that the excess persistence that we observe at the aggregate level is driven by a limited number of highly persistent sectors while the rest display moderate values of persistence.

In order to investigate this conjecture, we have ranked all the sectors in country c according to their degree of persistence, as measured by their corresponding HL. More specifically, for each of the countries, sectors have been ranked according to the value of the HL. Next, we have eliminated the top 10% most persistent sectors, we have aggregated the remaining ones, and we have recomputed the IRF in (8) with the remaining 90% sectors. Next, the HL of the latter IRF has been computed. The same exercise has been repeated excluding the 20% and the 30% most persistent sectors. The results are displayed in Table VI. The second column in this table reports the HLs obtained with all sectors in the analysis. Columns 3 to 5 report similar figures computed by excluding the top 10, 20 and 30% most persistent sectors, respectively.

As Table VI shows, when the top 30% most persistent sectors are excluded, the HL falls drastically: 10 out of the 14 countries considered have HLs smaller than 2 years. This implies that for most countries the excess persistence that has been traditionally found in aggregate RER is basically driven by this 30% of highly persistent sectors.

TABLE VII

HL ELIMINATING MORE PERSISTENCE SECTORS

	total sectors	less 10% sectors	less 20% sectors	less 30% sectors
AU	37.52	37.24	20.28	18.73
BE	40.18	37.85	18.94	18.55
DK	44.08	38.13	20.64	19.78
FI	36.04	19.82	11.06	11.01
FR	37.21	36.61	25.11	25.11
GE	31.33	19.96	20.01	11.18
GR	42.31	44.06	44.08	31.84
IR	46.19	44.32	37.87	37.56
IT	60.51	55.07	20.38	20.01
LU	79.04	76.16	60.19	58.05
NL	44.19	41.71	37.64	20.30
PO	55.35	53.58	43.51	38.12
SP	118.53	118.51	99.58	53.11
SW	22.38	22.35	19.29	19.18

The previous analysis suggest that in order to understand why aggregate RERs are so persistent, a careful examination of the sectors in the upper quantiles of the distribution of persistence is needed. In the remaining of this section we provide a description of these sectors. Section 5 in turn will present the results of a more detailed analysis that, by using quantile regression, aims to pin down the variables that can explain the persistence in the upper quantiles.

What are the characteristics of these 30% of excluded sectors? Figure IV presents the proportions of excluded sectors in each of the groups considered above (food, durables, non-durables, energy and services). This figure shows that most of these goods belong to three categories: durables, services and food products. However, durable goods are, by far, the most common group.

(Figure IV about here)

Finally, it is interesting to analyze whether the ranking of sectoral persistence is similar across countries. To do that, we have computed the Spearman's rank correlation coefficient. This coefficient is a non-parametric measure of correlation and it assesses how well an arbitrary monotonic function could describe the relationship between two variables, without making any assumptions about the frequency distribution of the variables. Table VII displays the corresponding correlations. In general, correlations are positive and significant, indicating that the ranking of persistent sectors is similar across countries. A notorious exception is Ireland which has non significant correlations with the remaining countries, suggesting that its trade conditions with the U.K. are quite different from those of other countries.

TABLE VII

Matrix of Sperman Test

	AU	BE	DK	FI	FR	GE	GR	IR	IT	LU	NL	PO	SP	SW
AU	1	0.70 (7.21)	0.67 (6.66)	0.63 (6.02)	0.57 (5.14)	0.57 (5.13)	0.39 (3.13)	0.10 (0.74)	0.68 (6.94)	0.62 (5.81)	0.49 (4.18)	0.35 (2.76)	0.73 (7.93)	0.43 (3.48)
BE		1	0.67 (6.71	0.56 (5.04)	0.61 (5.77)	0.63 (6.07)	0.49 (4.16)	0.02 (0.18)	0.70 (7.25)	0.61 (5.69)	0.54 (4.80)	0.29 (2.28)	0.73 (7.85)	0.42 (3.39)
DK			1	0.67 (6.69)	0.64 (6.15)	0.65 (6.33)	0.55 (4.85)	0.18 (1.36)	0.63 (6.02)	0.70 (7.31)	0.60 (5.54)	0.28 (2.16)	0.70 (7.30)	0.50 (4.23)
FI				1 ()	0.63 (6.09)	0.50 (4.26)	0.46 (3.85)	0.17 (1.26)	0.57 (5.13)	0.59 (5.38)	0.48 (4.05)	0.31 (2.39)	0.67 (6.71)	0.54 (4.79)
FR					1 ()	0.46 (3.80)	0.63 (6.00)	0.13 (0.93)	0.66 (6.47)	0.63 (6.00)	0.56 (5.05)	0.11 (0.85)	0.71 (7.52)	0.49 (4.14)
GE						1 ()	0.37 (2.91)	0.20 (1.52)	0.52 (6.54)	0.51 (4.44)	0.47 (3.93)	0.32 (2.51)	0.47 (3.99)	0.39 (3.10)
GR							1 ()	0.30 (2.32)	0.43 (3.53)	0.46 (3.88)	0.43 (3.53)	0.18 (1.40)	0.53 (4.63)	0.18 (1.33)
IR								1 ()	0.03 (0.22)	0.16 (1.24)	0.16 (1.21)	0.42 (3.45)	0.04 (0.33)	-0.06 (-0.42)
IT									1 ()	0.78 (9.17)	0.55 (4.78)	0.27 (2.04)	0.71 (7.45)	0.38 (3.03)
LU										1 ()	0.47 (3.97)	0.23 (1.75)	0.66 (6.45)	0.36 (2.83)
NL											1 ()	0.17 (1.31)	0.39 (3.16)	0.33 (2.58)
PO												1 ()	0.35 (2.75)	0.15 (1.16)
SP													1 ()	0.55 (4.83)
SW														1 ()

t-student pathentesis.

5. EXPLAINING RER PERSISTENCE

RER persistence has been traditionally explained by the existence of many goods in the consumption basket that are not traded. For this set of goods, arbitrage is, at best, indirect and weak. Therefore, volatile and persistent real exchange rates should be expected. However, actual evidence on the implications of the non-tradability of goods is less conclusive, see Engel (1999), Betts and Kehoe (2006) and Kim, (2004).

In response to this mixed evidence, a new theory has emerged that treats all goods alike. Obstfeld and Rogoff (1995) and Svennssonn and van Wijnergen (1989) have developed the New Open Economy Macroeconomics paradigm in which all goods share a common markup and a similar degree of nominal price stickiness. Betts and Devereux (1996) extend this framework to allow for pricing-to-market (PTM) in order to account for the little effect on prices of traded goods that exchange rate movements have. When markets are segmented, a monopolistically competitive firm's pricing behavior between common currency prices of the same good in different market and then, violate the law of one price which is a building block of PPP. There is substantial evidence of PTM (Knetter, 1993). Faruqee (1995) provides some insight on the relation between PTM and RER persistence. He shows that PTM intensifies the degree of RER exchange persistence under nominal rigidities. Furthermore, his results suggest that persistence increases as the elasticity of substitution between varieties of the same good rises. A link between market structure and RER persistence is also suggested by Bergin and Feenstra (1999).

Hau (2000) introduces factor (labor) markets in a framework similar to that of Obstfeld and Rogoff and relies on the presence of nontradables to account for the volatility of real and nominal exchange rates. Hairault and Sopraseuth (2003) provide an integrated model with PTM and non tradables and show that both effects are deeply intertwined.

In this section we investigate the importance of these theories in determining the sources of persistence of RER. There are several papers that have attempted to do so as, for instance, Cheung et al. (2001) and Crucini et al. (2005). The main difference of our analysis with respect to these papers is the use of quantile regression. We believe that in order to understand the forces that shape aggregate RER persistence, the emphasis should be placed on explaining the upper quantiles of the distribution of persistence, rather than the conditional mean, as traditional regression analysis has done. This is so because, as has been illustrated in Section 4, the PPP puzzle is a consequence of the behavior of sectors in the upper tail of the distribution of persistence.

In the following, we describe the explanatory variables considered in this exercise as well as the different dependent variables that will be employed as proxies for the persistence of sectors. Next, we have carried out two different analysis involving these variables. Firstly, a standard panel has been estimated to explore the ability of the above-mentioned variables in explaining the conditional mean of persistence. Next, a country by country quantile regression analysis has been considered to evaluate to what extent these variables are able to explain the behaviour of the upper quantiles of the sectoral distribution of persistence.

5.1. Dependent and independent variables

We have considered different explanatory variables that aim to capture the degree of tradability as well as the market structure and the degree of competition in each of the sectors. The set of explanatory variables considered in this exercise is as follows.

a) Tradability measures.

- Degree of openness of the final good: measures the extent to which sector j is involved in international trade. Two different definition of openness have been considered:

$$op1_{c,i} = \frac{X_{ci} + M_{ci}}{\sum_{i=1}^{N}(X_{ci} + M_{ci})},$$

where X_{ci} (M_{ci}) represents total exports (imports) of sector i in country c. Thus, op1 measures the contribution of sector i to total trade in country c.

An alternative definition of openness is

$$op2_{c,i} = \frac{X_{ci} + M_{ci}}{GDP_{ci}},$$

where GDP_{ci} is total GDP of sector i in country c.

- Labor factor intensity (lab) : Goods are a combination of tradable and nontradable goods. The share of labor in the production of the good is usually employed as a proxy for the degree of nontradability of the good itself. We use the variable lab to capture this effect. It is defined as

$$LAB_{c,i} = \frac{L_{c,i}}{\sum_{i=1}^{N} L_{c,i}}$$

where $L_{c,i}$ denotes the number of workers in sector i of country c.

- Degree of openness of intermediate inputs (input_trade): measures the degree of tradeability of the intermediate inputs. It is similar to op2 but applied to each of the inputs employed in the production of the goods in sector i.

- Labor factor intensity of intermediate inputs (input_lab) : it is also similar to lab but computed on the inputs employed in the fabrication of the sector i.

b) Variables related to Market structure.

- Intra-industry trade index (iit): as shown by Faruqee (1995) sectors with a higher degree of intra-industry trade exhibit a greater degree of PTM. We utilize the intra-industry trade index (Grubel and Lloyd, 1975):

$$iit_i^c = 1 - \frac{\sum_{i=1}^{I} |X_{ci} - M_{ci}|}{\sum_{i=1}^{I} (X_{ci} + Mc_i)}$$

- Price-cost margin (pcm): this variable approximates the profitability of an industry. We define the pcm index as

$$pcm_i^c = \frac{VA_{ci} - W_{ci}}{VA_{ci} + CM_{ci}},$$

  where VA_{ci} is the value added (that is, the value of total production minus the cost of materials) of sector i in country c, W_{ci} is labor compensation and CM_{ci} denotes the cost of materials.

  In addition, we control for the following variables:

- Sectoral inflation rate (infl): it is usually believed that when inflation is high, prices have to be changed more often and this translates into a decrease in RER persistence. However, the final effect of inflation is not clear: it is also well known that the lack of trade or competition in a sector can lead to inflation, therefore, it is also possible that inflation is positively correlated with persistence

- especialization index (ei): this index is constructed as the ratio of the relative size of exports of sector i in country c over the relative size of sector i to total exports.

$$ei_i^c = \frac{X_{ci} / \sum_{i=1}^{I} X_{ci}}{\sum_{c=1}^{C} X_{ci} / \sum_{c=1}^{C} \left(\sum_{i=1}^{I} X_{ci} \right)}$$

- Relative trade balance (rtb): Measures net exports of sector i over total trade.

$$rtb_i^c = \frac{(X_{ci} - M_{ci})}{\sum_{i=1}^{I}(X_{ci} + M_{ci})}$$

- Productivity, (prod): it accounts for the deviation of the productivity of sector i in country c with respect to the average of the country c,

$$prod_i^c = prod_{ci} - \frac{1}{I}\sum_{i=1}^{I} prod_{ci}$$

where $prod = \frac{VA_{ci}}{L_{ci}}$.

- Labor costs (wag): measures the deviation of labor cost in sector i with respect to the average labor costs of the country.

$$wag_{c,i} = wag_{c,i} - \frac{1}{N}\sum_{i=j}^{N} w_{c,j}$$

- Unitary labor costs (ucl) : computed as total labor compensation in sector i over value added in sector i.

$$ucl_i^c = \frac{W_{ij}}{VA_{ij}}.$$

As for the dependent variables, four different persistence measures have been considered: the individual HLs, and the individual CIR(h), for different values of h corresponding to 1, 3, 5 and 7 years.

5.2. Panel Analysis

The following model has been estimated

$$y_{ci} = \theta_c + X_{ci}\beta + u_{ci},$$

where y_{ic} represents the dependent variable (HL$_{ci}$ or CIR$_{ci}$ (h)) and X_{ci} denotes the above-described set of regressors. The parameters have been estimated using the fixed-effects estimator, as the Hausmann test rejected the hypothesis of consistency of the random effects one.

Table VII displays the estimated coefficients as well as their associated p-values. The main findings can be summarized as follows. The variables associated to the tradability of the inputs, input_op and input_lab, are in general highly significant and have the expected sign: an increase in the openness of the inputs decreases persistence and the effect seems to be more important as longer horizons are considered. Input_lab shows a similar behaviour: it has a positive sign, which implies that goods whose inputs more labor intensive tend to be more persistent. However, it loses its significance for long-run values of the CIR.

Although the tradability of inputs seems to be important in determining the persistence of final goods, the tradability of the latter does not seem to be so. In fact, the variable *lab* is not significant (and, for this reason, it has been omitted from Table VIII), while the variable op1 appears with a positive sign, in contrast to what theory predicts. A positive sign implies that more open sectors are associated with higher levels of persistence. However, this result is not that surprising: from Section 4 we know that durable goods are the most persistent ones. This group is characterized by a high degree of openness. However, other groups traditionally considered to be highly nontradable, as services, are not very persistent in this particular dataset.

The variables in charge of capturing features associated to the market structure and the lack of competition behave as expected. The variable pcm enters all equations with a significant positive sign that increases considerably in the CIR60 and CIR84 equations. iit is also associated to a positive coefficient, indicating that sectors with more intraindustry trade tend to be more persistent.

Among the control variables (wag, prod, and infl) only the latter is significant. It enters the equations with a positive sign and the value of the coefficient tends to increase with the horizon of the CIR. Finally, these variables are able to explain around 50-60% of the total variability and it is remarkable that their explanatory power tends to increase with the horizon of the CIR.

TABLE VIII

RESULTS OF PANEL DATA ANALYSIS

	HL	CIR12	CIR24	CIR60	CIR84	HL*
c	38.08 (0.000)	7.62 (0.000)	16.34 (0.000)	21.48 (0.000)	23.43 (0.000)	49.78 (0.000)
op1	1.94 (0.059)	0.03 (0.560)	0.50 (0.026)	1.25 (0.010)	2.52 (0.001)	1.93 (0.061)
input_op	−0.04 (0.0239)	−0.00 (0.000)	−0.01 (0.003)	−0.02 (0.010)	−0.03 (0.014)	−0.05 (0.026)
input_lab	1.10 (0.060)	0.08 (0.043)	0.21 (0.093)	0.32 (0.247)	0.47 (0.290)	0.39 (0.678)
pcm	25.76 (0.008)	2.12 (0.000)	7.08 (0.000)	9.81 (0.032)	12.17 (0.101)	28.79 (0.013)
iit	0.07 (0.275)	0.01 (0.018)	0.02 (0.238)	0.33 (0.293)	0.06 (0.250)	0.14 (0.078)
wag	0.05 (0.028)	0.00 (0.535)	0.00 (0.559)	0.01 (0.405)	0.02 (0.302)	0.06 (0.035)
prod	−0.04 (0.007)	−0.00 (0.508)	−0.00 (0.417)	−0.01 (0.341)	−0.02 (0.2892)	−0.04 (0.016)
infl	4.22 (0.000)	0.14 (0.000)	1.28 (0.000)	2.91 (0.000)	4.55 (0.000)	4.51 (0.000)
R^2	0.53	0.54	0.58	0.60	0.61	0.53
Hausman_test	94.68 (0.000)	24.45 (0.000)	74.57 (0.000)	102.96 (0.000)	113.21 (0.000)	63.40 (0.000)

p-values in brackets.

Cross-section fix effects.

HL* service sectors has been eliminated in the regression

5.3. Quantile regression analysis (to be completed)

It has been recognized that the resulting estimates of various effects on the conditional mean of sectoral persistence is not necessarily indicative of the size and nature of these effects on the upper tail of the distribution. A more complete picture of covariate effects can be provided by estimating a family of conditional quantile functions. Then, we have estimated quantile regressions for each of the countries of our data set.

Figures V to VIII plot the 19 distinct quantile regression estimates ranging from 0.05 to 0.95 as the solid curve for three of the countries in our sample: Finland, Germany and Italy. These coutries have been chosen because they represent countries where persistence is low, medium and high, respectively. For each covariate, these point estimates may be interpreted as the impact of a one-unit change of the covariate on sectoral persistence holding other covariates fixed. Thus, each of the plots has a horizontal quantile scale, and the vertical scale indicates the covariate effect.

The blue solid line in each figure shows the ordinary least squares estimate of the conditional mean effect. The two dotted lines depicts a 95 percent pointwise confidence band for the quantile regression estimates.

It is remarkable that the behavior of most of the variables change when considered in the upper tail. The absolute value of the coeffients of the variables related to market structure, such as pcm, iit, prod, wag in general increase considerably in the upper quantiles, indicating that their explanatory power is more powerful precisely in these quantiles. On the other hand, the variables related to tradability experience a modest change. This result confirm the results that we have found in the previous section: it seems that the forces that shape persistence are more related with market structure and lack of competition rather than with good tradability.

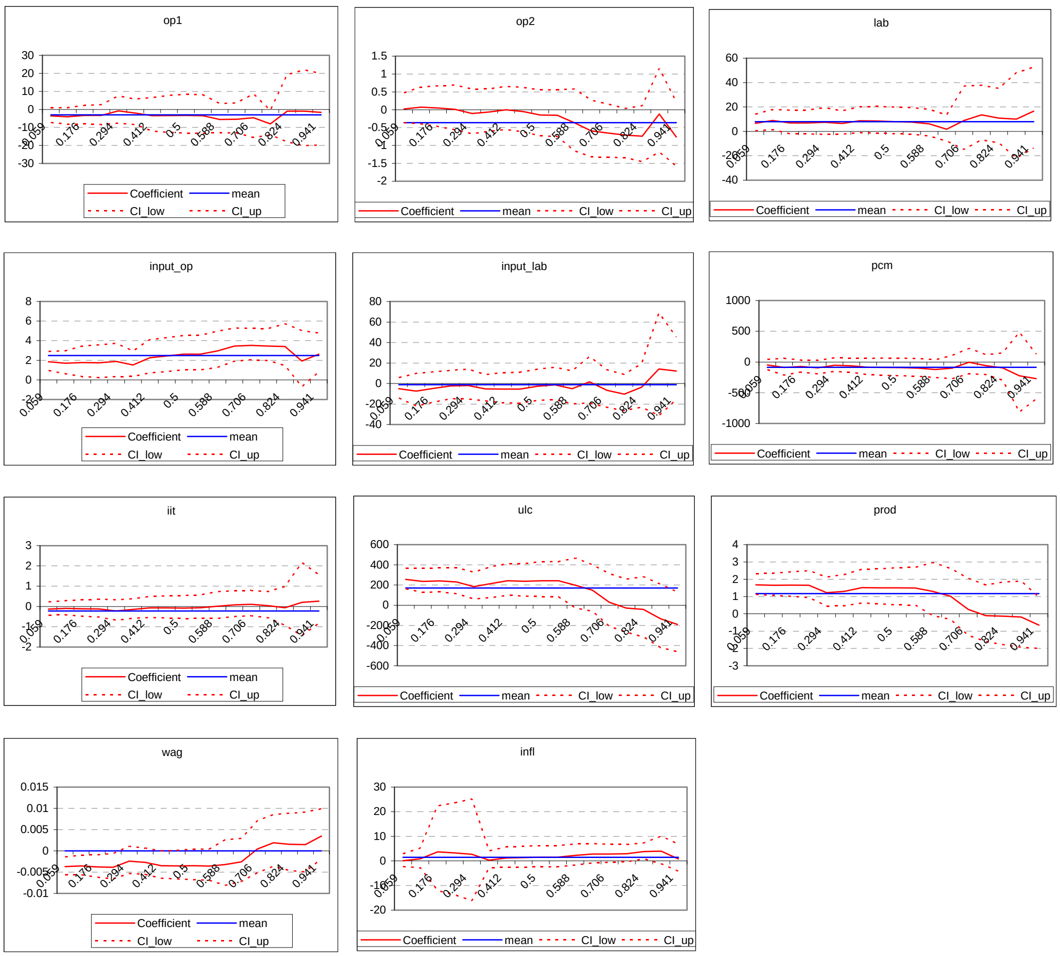

FIG 5. Italy's quantile regression results

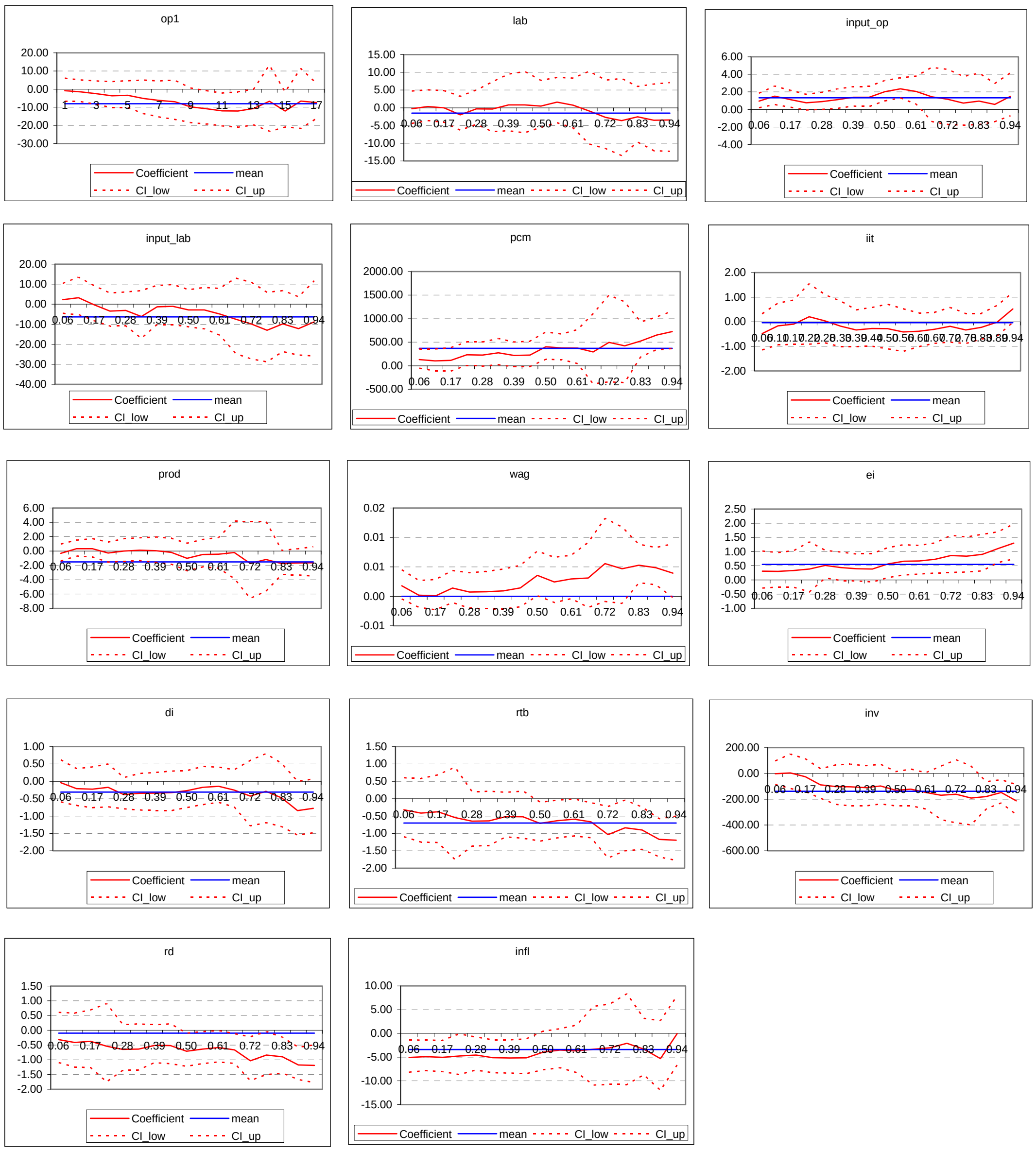

FIG 6. Germany's quantil regression results

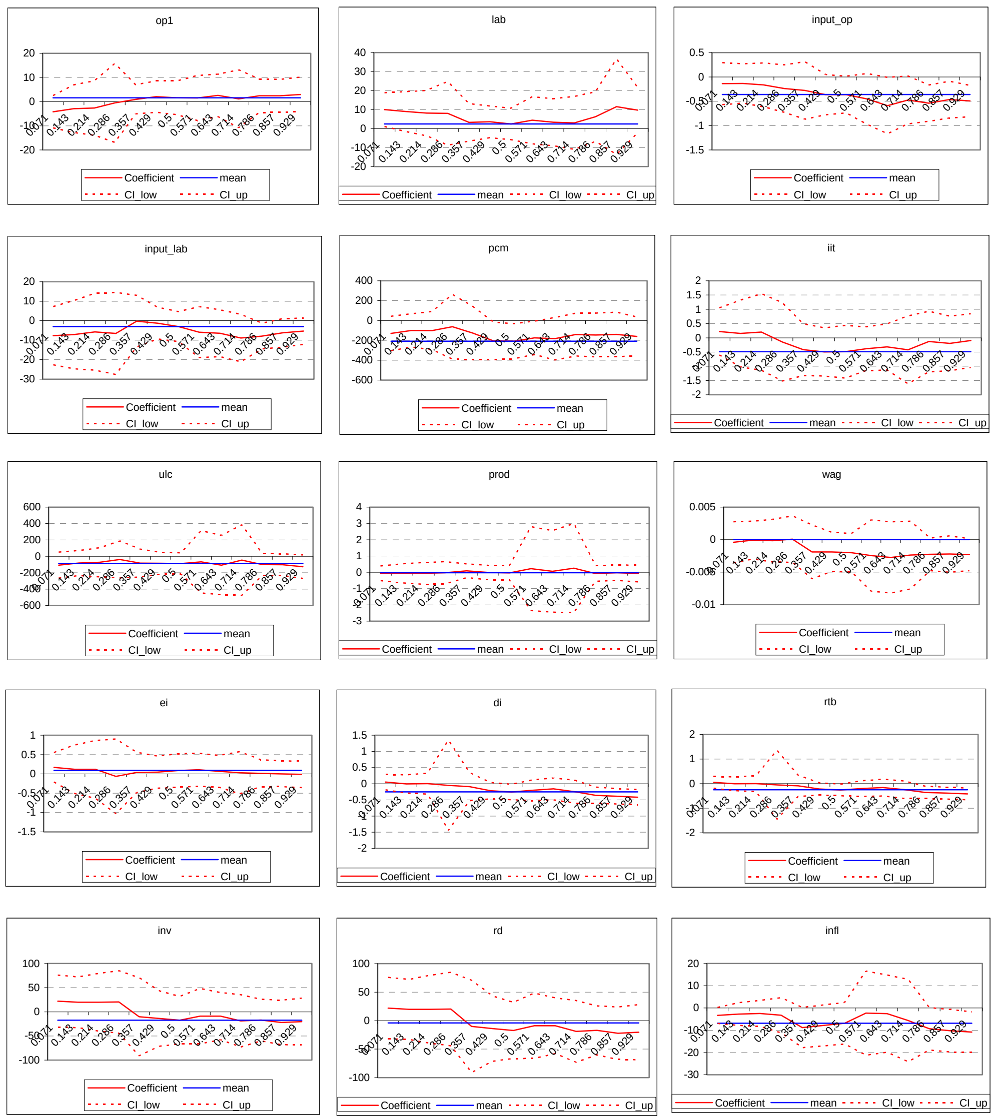

FIG 7. Finland's quantile regression results

6. CONCLUSIONS

This paper analyzes aggregate RER persistence for the EU-15 countries through the lens of sectoral data. We make use of recent theoretical results that establish a link between aggregate and sectoral impulse response functions which allow us to decompose aggregate persistence into its different subcomponents. We explore the forces that shape aggregate persistence by analyzing the characteristics of the sectors in the upper tail of the distribution of persistence. Using trade and industry data, we test whether the traditional theories (non tradibility, lack of competition) are able to account for the pattern of persistence observed in sectoral data.

Our results suggest that persistence in the upper quantiles is explained by factors that have to do with the market structure and the lack of competition in the final goods market. Since the behavior of the upper quantiles determine to a large extend the persistence observed at the aggregate level, we conclude that pricing to market and market power has a lot to do in explaining the slow reversion to PPP.

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FIGURES

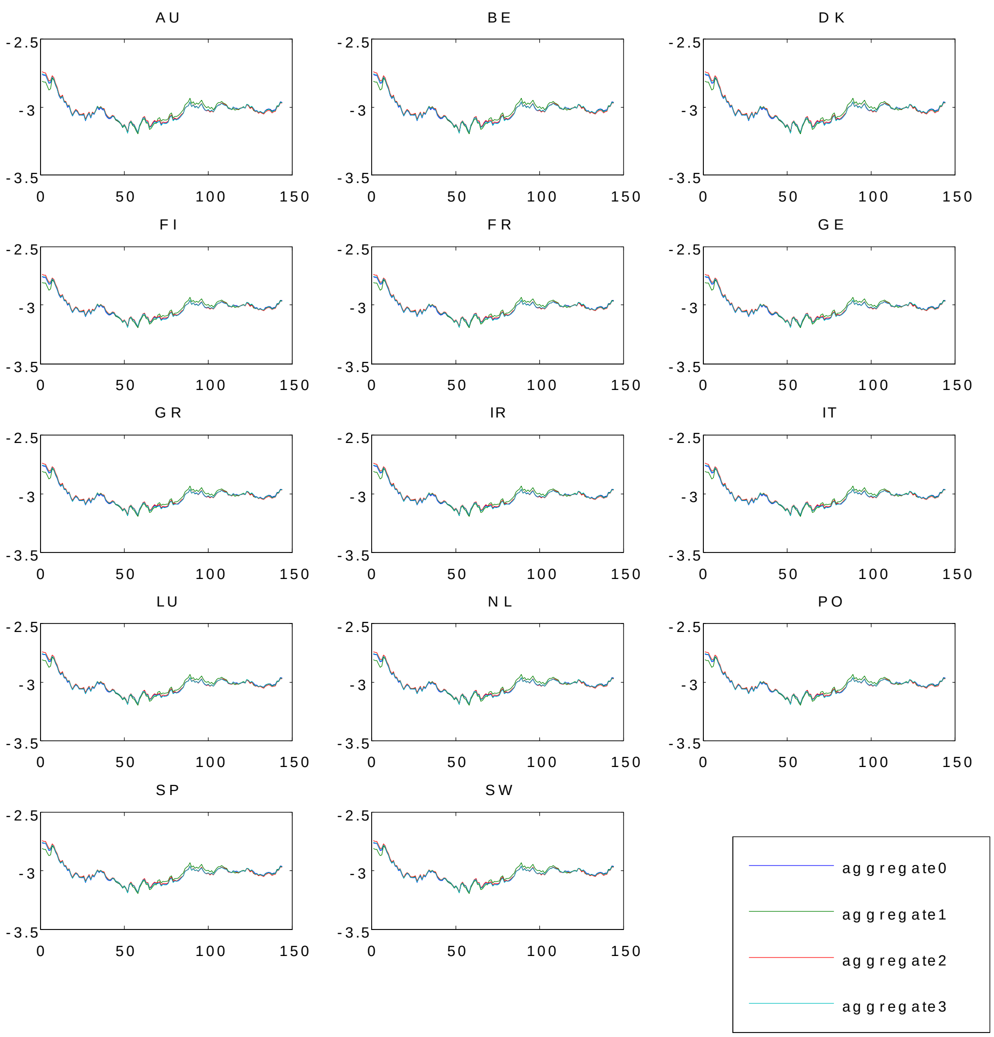

FIG 1. Real Exchange Rates at different aggregation levels

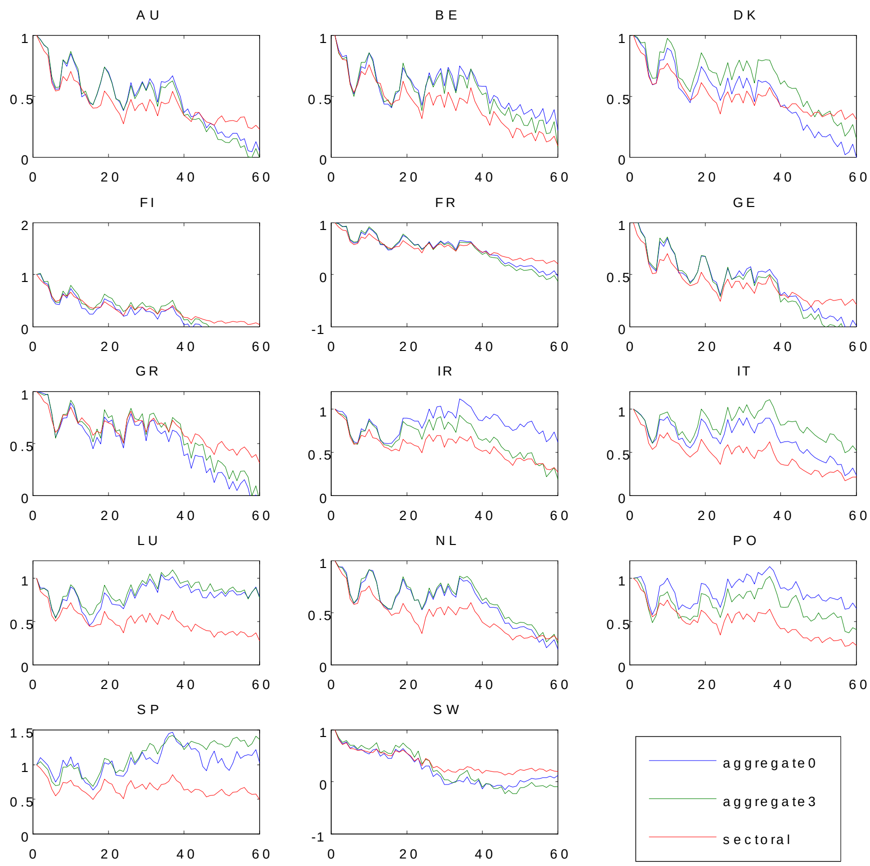

Fig 2. Estimated IRFs obtained with aggregate and disaggregate (Level 3) data.

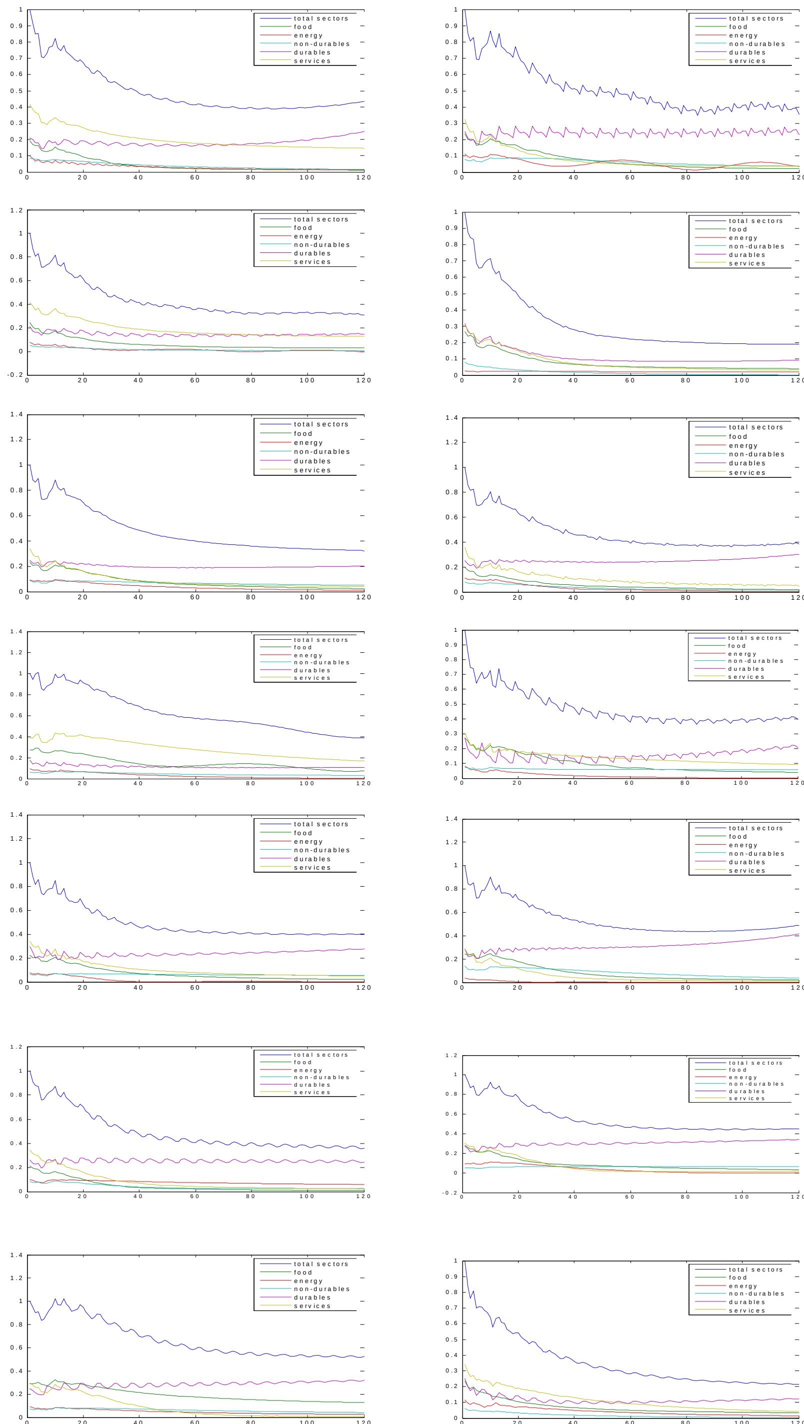

FIG 3. Impulse response functions by groups of sectors

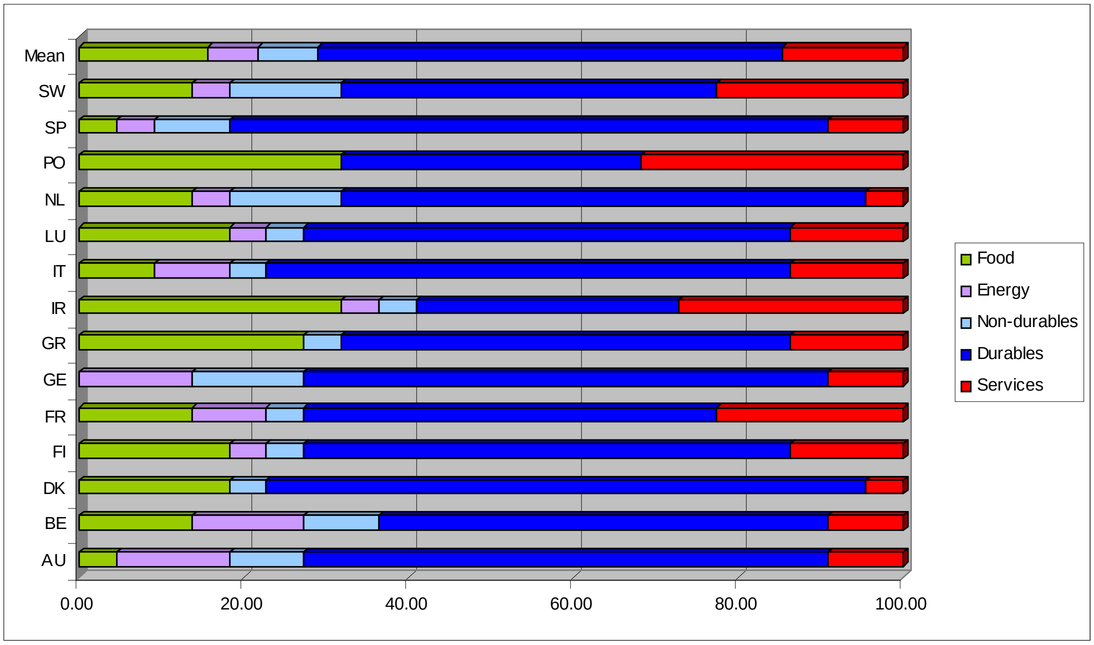

FIG. 1. FIG. 4. Composition of 30% most persistent sectors