

**OIL PRICES AND INFLATION IN THE EURO AREA AND ITS  
MAIN COUNTRIES: GERMANY, FRANCE, ITALY AND SPAIN**

**CÉSAR CASTRO  
PILAR PONCELA  
EVA SENRA**

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# Oil Prices and Inflation in the Euro Area and its Main Countries: Germany, France, Italy and Spain

César Castro\*

Pilar Poncela\*\*

Eva Senra\*\*\*

## Abstract

There is no consensus in the literature about the effects of oil price increases in inflation. Variations in oil prices do not need to hit all the economies in a similar way as some countries and sectors may be more dependent or efficient in the use of oil than others. We propose a disaggregated approach to identify the economic sectors where there is a loss of competitiveness due to oil price shocks. To characterize these effects we use multivariate transfer function models with oil and other commodity prices and measures of the demand pressures as inputs at the highest level of disaggregation in the non-administered harmonized consumer prices indices for the euro area and its four largest economies: Germany, France, Italy and Spain. We also address non linearity issues by taking into account asymmetric effects regarding large positive variations of oil prices.

Key words: Index aggregation, prices, energy, transfer function, non-linearity.

JEL Classification: E31, C32, C5.

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\* Corresponding author. César Castro, Instituto Flores de Lemus, Universidad Carlos III de Madrid, Spain.  
E-mail: [ccastro@inst.uc3m.es](mailto:ccastro@inst.uc3m.es)

\*\* Dept. Análisis Económico: Economía Cuantitativa. Universidad Autónoma de Madrid. Spain

\*\*\* Dept. Estadística, Estructura Económica y O.E.I. Universidad de Alcalá. Spain

## **1. INTRODUCTION**

There are numerous studies that try to analyze how non anticipated fluctuations in international oil prices affect the economy. The nature of these fluctuations and their mechanisms of transmission to economic variables are crucial in understanding their effects. In fact, the effect of oil shocks today is different from those in the 1970s and 1980s. For instance, Hooker (2002) found that there is no causal link between oil prices and the main macroeconomic variables in the United States after 1973. Other authors, such as Hamilton (1996), using a variable of net growth of oil prices, conclude that there is a negative correlation with the economic growth and other macroeconomic variables, although this has been less since 1973.

In general, the literature considers that the episodes of the 1970s oil price fluctuations are characterized by particular features that are not present in later episodes. Blanchard and Galí (2007) cite, among others, the nature of the fluctuations, the smaller share of the oil in the current production nowadays, the existence of more flexible labor markets and improvements in monetary policy. Cologni and Manera (2009) include improvements in energy efficiency and a better understanding of the supply and demand shocks by monetary authorities. Peersman and Van Robays (2009) show that the nature of the shocks and the different reaction of the monetary authorities in the United States and the Euro Area have been crucial for the impact on the economy. Cologni and Manera (2009) believe that the net increases in price and their volatility, rather than the type of shocks, are a better description of the macroeconomic impacts. Ferderer (1996) also shows that increase in price volatility helps to explain the added and asymmetric effect on macroeconomic variables.

As far as inflation is concerned, there is consensus that this variable has been significantly affected by oil price fluctuations (Jimenez-Rodriguez and Sanchez, 2009). Cuñado and Perez de Gracia (2003) found that oil price variations had permanent effects on inflation and they are asymmetric on the growth of industrial production. Kilian (2008a,b) examines again the different causes of the oil price shocks and estimated that they cause a sharp drop on U.S. real gross domestic product (GDP) growth after five quarters rather than an immediate and sustained reduction in economic growth, and a

spike in consumer price index (CPI) inflation after three to four quarters. Cologni and Manera (2008) use a structural co-integrated vector autoregression model to study the effects of oil price shocks on output and prices of the G7 economies noting the existence of an instantaneous, temporary effect of oil price innovations on prices. As can be seen, there is no agreement in the literature about the magnitude and duration of the oil shocks on inflation. Besides that, the different regulatory framework amongst countries might distort the results obtained and does not allow for a homogeneous comparison.

There are various ways in which oil price variations may affect inflation. We can distinguish between first round and second round effects (based on expectations). The first round effects might turn into direct effects (for example, refined oil) or indirect ones (those affecting goods and services that use petroleum as input). But a study on aggregated inflation might not show all these effects.

In fact, previous analyses use only aggregate measures of inflation or very simple disaggregations (energy/non-energy), and conclude that there is mainly a direct impact through the energy component, while indirect and second round effects are commonly less important. Most approaches are based on reduced time series models, structural vector autoregressions and dynamic stochastic general equilibrium models (see, for instance, Peersman and Robays, 2009, Alvarez et al. 2011, and ECB, 2010).

We seek to identify the effects of the fluctuations of international oil price on inflation by analyzing their impact on the harmonized indices of consumer prices (HICP) for the whole Euro Area and its four main economies (Germany, France, Italy and Spain). We analyze it from the lowest to the highest levels of aggregation. We differentiate from other analyses, first by excluding from the HICP the group of administered prices that are ruled out of market fluctuations and might distort the results, and second, by performing a disaggregated approach, as this is the best way to differentiate between direct and indirect effects. Within this setup, we estimate multivariate transfer function models between oil prices and disaggregated inflation, including other inputs that may affect the outcome, such as the price of other commodities and measures of the demand pressures. In this framework we are able to check and quantify our conjecture: the price of oil is an important source of variation in inflation in the euro area with different effects (direct, indirect and

second round effects), that might vary across the economies. This will lead to a loss of competitiveness of certain countries and sectors. Finally, we address the non-linearity issue by including a variable that captures large positive variations of oil prices.

The rest of the paper is structured as follows. Section 2 shows the stylized facts in inflation and a new set of HICP, excluding administered prices, for the Euro Area and its main partners. Section 3 describes the methodology and the main results. In section 4 we take into account the possibility of non-linear effects in the relationship between oil price changes and inflation. Section 5 concludes.

## **2. A DESCRIPTION OF EURO AREA INFLATION BY MAIN COUNTRIES AND COMPONENTS**

To describe the evolution of prices we consider the HICP monthly index from EUROSTAT between January 1996 and March 2012. Table 1 shows a simple descriptive analysis of the accumulated energy and non-energy inflation for the whole sample considered by regions as well as their contributions to total inflation. From the Table, we can first see that the accumulated energy inflation has been more dynamic than the non-energy component, with increases ranging from 82.2% in France to 115.1% in Germany. In fact, in Italy energy inflation was 2 times greater than the non-energy inflation, 2.3 times in Spain, 2.9 in France and 5.4 times in Germany. Second, the relationship between energy and total inflation is not immediate. The total accumulated inflation has ranged between 29% in Germany and 54.2% in Spain, but the energy group contribution was similar with 12.2 percentage points (pp) and 10.2 pp, respectively. In contrast, non-energy inflation contributes with 18.9 pp in Germany and is exceptionally high in Spain (44.1 pp of total inflation), which may be due to indirect or second round effects of oil shocks. As an overall conclusion, the effects of oil shocks on inflation are complex and seem to work through different channels in the various economies.

**Table 1. Accumulated Inflation**  
**December 1996 - March 2012 (%)**

	<b>Total</b>	Energy	Non-energy	Contributions (p.p.)*	
				Energy	Non-energy
Euro area	<b>38.0</b>	106.0	32.1	9.7	29.2
Germany	<b>29.0</b>	115.1	21.1	12.2	18.9
France	<b>32.8</b>	82.2	28.6	7.3	26.0
Italy	<b>45.5</b>	84.7	42.3	6.2	39.3
Spain	<b>54.2</b>	112.5	48.5	10.2	44.1

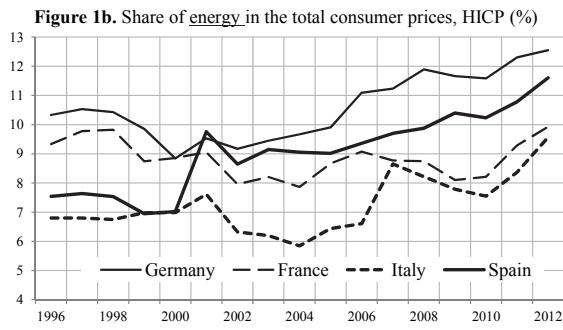
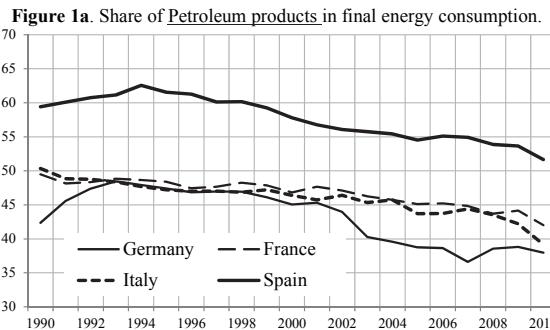
\*There are some differences in total inflation when adding up energy and non-energy contributions due to changing weights

Source: Eurostat

In an attempt to understand these differences between the four countries, we have to take into account the energy consumption structure and taxes and regulatory rules in domestic markets that are different in the four countries. On the one hand, with regard to the energy consumption structure, Figure 1a shows that Spain has the largest share of petroleum products within the final national energy consumption. This share was 51.7% in Spain and 37.9% in Germany in 2010. Nonetheless, this is not the situation faced by households -whose consumption structure determines the HICP weights-, where the biggest share of energy in total HICP is shown by Germany (see Figure 1b). On the other hand, Figure 1c and 1d also show the different taxation structure in two of the most important petroleum products for consumption (euro-super 95 and diesel oil) among countries, with Germany and France showing the highest imposition, as opposed to Spain, with the lowest. These key facts suggest that variations in the price of petroleum products may have greater effects in the Spanish than in the German production structures and, therefore, we may find greater indirect or second round effects in the Spanish case. However, the effects on direct energy consumption may be greater in Germany due to its greater household consumption and total taxation.

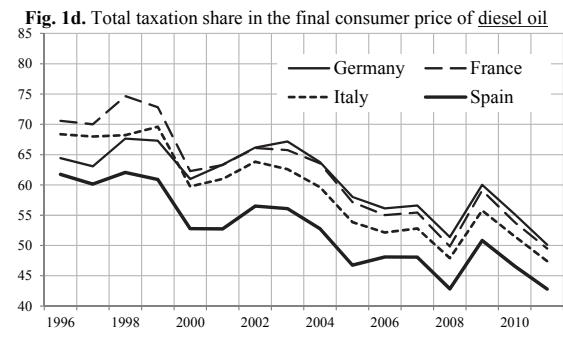
**Figure 1. Key Features of the Energy Sector in the Euro Area and Its Main Partners**

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**Figure 1c.** Total taxation share in the final consumer price of euro-super 95

Year	Germany (%)	France (%)	Italy (%)	Spain (%)
1996	72	80	75	65
1998	75	80	78	68
2000	68	70	65	62
2002	72	68	65	62
2006	65	62	58	55
2010	60	58	55	52



Source European Commission.

Additionally, different regulations apply in the four countries for the price of the remaining energy consumption products and services (mainly gas and electricity), which can be affected by political considerations, amongst others. For a more homogeneous comparison of different geographical areas, we exclude from the analysis all the HICP subclasses classified as administered, and therefore not directly open to market fluctuations.

Table 2 shows the total number of HICP series considered in the analysis. We start with the greater level of disaggregation (93 subclasses) and we exclude the goods and services with totally or partially administered prices according to the Eurostat criterion. When some of them are administered in one region but not in another, we exclude the corresponding series in both to obtain the highest level of comparison. Finally, we work with a set consisting of 59 subclasses and 6 groups (5 special groups and the total HICP) of non-administered price indices for each of the five geographical areas.

**Table 2. Final Number of Series for the Analysis**

Regions	Groups	Subclasses*	Total
5	6	59	325
Euro area	Processed food		
Germany	Non-energy industrial goods		
France	Services		
Italy	Non-processed food		
Spain	Energy		
	Total		

\* A detailed description of the subclasses can be found in the appendix A

As we can see in Table 3, the total weight excluded from HICP ranges from 20.4% in Italy to 27.1% in Germany, and is mainly concentrated in services. The most important services excluded are telephone, waste collection, cultural services, combined passenger transport and education. In energy, we exclude solid fuels and heat energy (these are administered prices only in Germany and France, but we exclude them in the remaining regions for homogenous aggregation), as well as electricity and gas, both fully or mainly administered in all countries although with different weights; for example, in Germany, we exclude energy components, which accounted for 7.2% of total weight in 2012, although in Italy and France they only reached 4.3%.

**Table 3. Weight of Subclasses Excluded from Total HICP, 2012 (%)**

	TOTAL EXCLUDED	Non-energy industrial goods	Services	Energy <sup>1</sup>	Electricity	Gas	Weight of excluded administered HICP subclasses <sup>2</sup>	Weight of HICP subclasses excluded for homogeneous comparison between countries
Euro area	<b>24.1</b>	<b>3.5</b>	<b>15.4</b>	<b>5.2</b>	2.6	1.8	21.2	2.9
Germany	<b>27.1</b>	<b>4.3</b>	<b>15.6</b>	<b>7.2</b>	3.3	1.6	20.0	7.1
France	<b>22.3</b>	<b>3.2</b>	<b>14.9</b>	<b>4.3</b>	2.6	1.4	12.3	10.0
Italy	<b>20.4</b>	<b>3.3</b>	<b>12.8</b>	<b>4.3</b>	1.5	2.8	10.8	9.6
Spain	<b>21.1</b>	<b>3.3</b>	<b>13.2</b>	<b>4.6</b>	3.2	1.4	11.5	9.6

<sup>1</sup> For energy, we present only the main subclasses excluded: electricity and gas

<sup>2</sup> These weights might not fully coincide with those from Eurostat, due to aggregation restrictions

If we now look again at the contribution of the energy HICP component to the new total, excluding the administered prices component, we find a similar but different picture

to that previously presented. Figure 2 shows that the increase in energy HICP seems to be the main determinant for the level and variability of global inflation, especially in Germany and France, (Figure 2, panels 2b and 2c), but it is less important in Spain and Italy (see panels 2d and 2e), where global inflation seems to be dominated by other factors.

**Figure 2. Contributions of Energy and Non-energy Groups to Annual Inflation (excluding administered prices)**

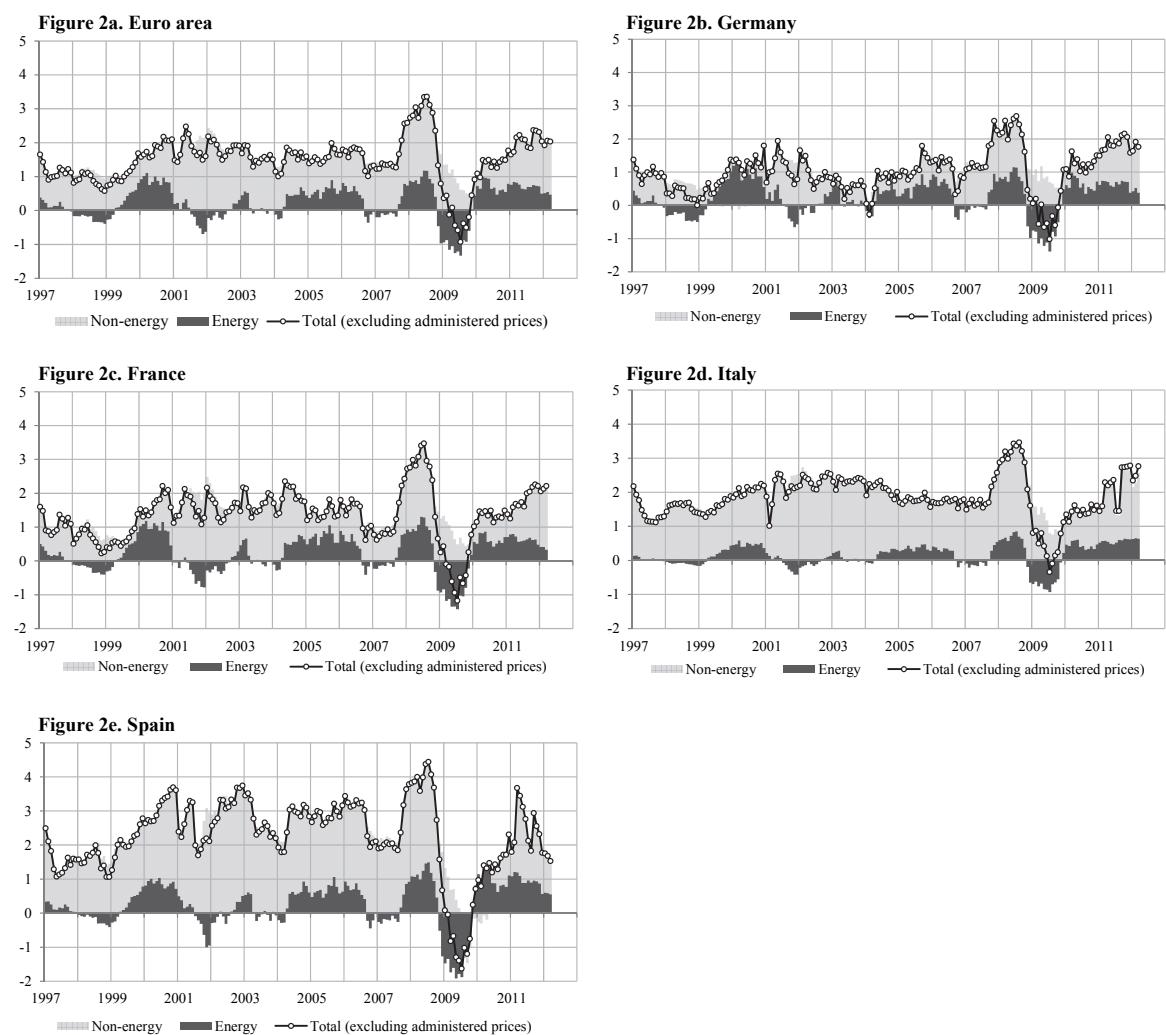


Table 4 shows the behavior of accumulated total, energy and non-energy non-administered inflation. There are some differences when compared to Table 1. First, non-

administered accumulated inflation is smaller than total accumulated inflation in Germany (25.9% versus the previous 29.0%) but it is greater in the rest of the countries. That is, administered prices have helped to contain inflation pressures except in Germany. Second, the energy component is again the most dynamic, and thus it is the component that shows the most important differences between non-administered inflation and total inflation. We can see that in the case of France the energy component increased by 82.2% (see Table 1) and the equivalent non-administered energy component by 121.8% (see Table 4), a difference about 40 pp. In Germany, this difference is about 25 pp, and in Spain about 34 pp. The main reason is that the excluded administered prices of gas and electricity have been less inflationary than the other energy components in all the countries. Third, we can see that the contribution of energy is higher in Spain (9.0 pp), as opposed to Italy (4.6 pp). Again, the non-energy inflation contributes notably high in Spain (47.0 pp) and is especially low in Germany (18.8 pp).

**Table 4. Accumulated Non-administered Inflation  
December 1996 - March 2012 (%)**

	Total	Energy	Non-energy	Contributions (pp)*	
				Energy	Non-energy
Euro area	<b>37.8</b>	135.3	32.5	7.6	30.7
Germany	<b>105.8</b>	43.9	56.4	42.0	56.0
France	<b>146.9</b>	50.1	0.0	47.0	0.0
Italy	<b>0.0</b>	0.0	0.0	0.0	0.0
Spain	<b>0.0</b>	0.0	0.0	0.0	0.0

\* There are some differences in total inflation when adding up energy and non-energy contributions due to changing weights

Source: Eurostat

The descriptive analysis about non-administered inflation shows that both the energy and non-energy groups in Spain (in total and contributing terms) have been the largest, especially when compared to Germany.

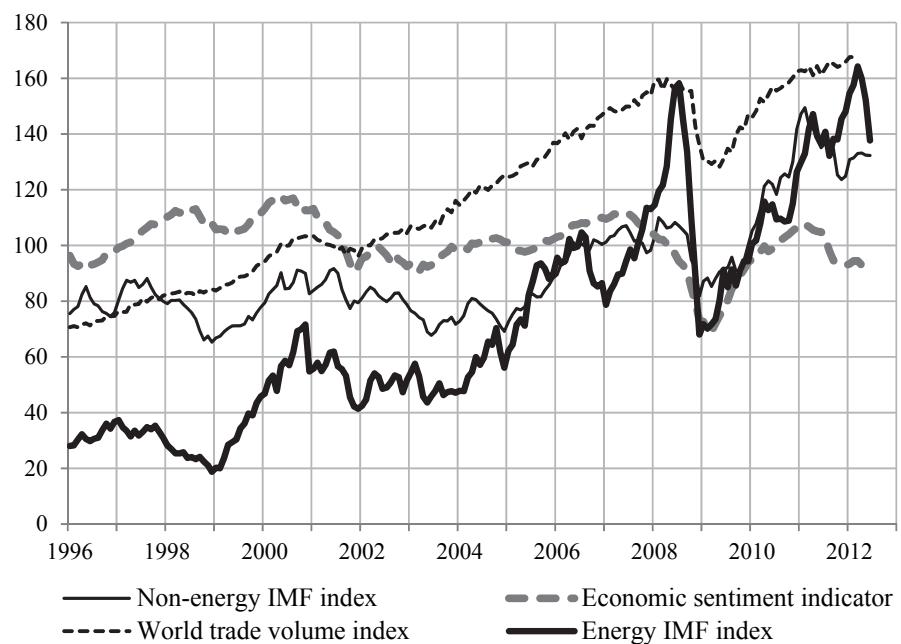
### **3. TRANSMISSION CHANNELS OF ENERGY PRICES INTO INFLATION**

To fully characterize how international energy price increases are translated into inflation, we estimate a set of multivariate transfer function models for the 6 groups and 59

subclasses of HICP between January 1996<sup>1</sup> and March 2012 for all of the five regions considered: Euro Area, Germany, France, Italy and Spain (at the end of this section we summarize the results from the highest level of disaggregation). As our objective is related to the assessment of the effects of oil shocks into inflation and oil prices are exogenous to the European economies considered, we use multivariate transfer function models.

As inputs for the transfer functions we consider as exogenous variables the world price indices of several raw materials, as well as two indicators for internal and external demand pressures. Regarding the commodity prices, we use the monthly International Monetary Fund (IMF) price indices of energy and non-energy goods (base year 2005) taken from the IMF database (<http://www.imf.org/external/np/res/commod/index.asp>) in nominal US\$ and converted to € at the corresponding exchange rate. As Figure 3 shows, there is a different behavior between the energy and non-energy inputs, with the energy index being the most dynamic.

**Figure 3. Input variables in the Transfer Function Model**



<sup>1</sup> We use data since 1996 because is the first year with inflation data available in Eurostat.

To account for global demand pressures on inflation, we consider a monthly index of volume of world trade (TRADE) taken from the CPB Netherlands Bureau for Economic Policy Analysis (<http://www.cpb.nl/en/node/>). For the domestic demand pressure, we use the economic sentiment indicator (ESI) published by the European Commission ([http://ec.europa.eu/economy\\_finance/db\\_indicators/index\\_en.htm](http://ec.europa.eu/economy_finance/db_indicators/index_en.htm)). We have chosen these indicators because of their strong relation with economic growth (measured by the real GDP growth) and the advantage of their monthly periodicity. ESI is important for its influence on price formation (mainly on the demand side and its ability to capture final interest rates effects), especially since the 2008-09 crisis. As regards the world trade indicator, it shows strong growth until the first half of 2008. The purpose of using this indicator is to capture global demand shocks and to measure global competition.

We check how these two commodity prices and the two variables related with the demand side pressure are transmitted dynamically into the HICP inflation by using multivariate transfer function models. We are interested mainly in the effects of shocks on oil commodity prices but the remaining three variables are used as a control in the exercise.

We use the Linear Transfer Function (LTF) identification method, proposed by Liu and Hanssens (1982). As regards the transformations performed, we took logarithms and differentiated the HICP series as needed to ensure stationarity. The input series are stationary taking just first differences, and for the HICP series we have taken a seasonal difference or a seasonal plus a regular difference. All the parameters are significant at the 5% significance level. To get a flavor of the type of results obtained, in appendix A, Table A-2, we can see an example of the final transfer function model estimated for total HICP for the Euro Area and the four main countries considered: Germany, France, Italy and Spain<sup>2</sup>.

To check the robustness of the estimated gains to the sample period considered we performed the same analysis for the period before the subprime crisis, that is from

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<sup>2</sup> Full results are available from the authors upon request.

January 1996 to December 2007. The detailed results are available from the authors upon request, but it is worthwhile to stress that the effects of oil prices remain similar and the only difference is that the level of significance of the variable world trade was higher than in the whole sample.

**Table 5. Transfer Function Gains (%) for Total HICP  
Inflation (excluding administered prices) Derived  
From a Growth of 10% in Energy Prices and an  
Equivalent Shock in the Rest of the Input Variables.**

	Energy	Non-energy	ESI	TRADE
<b>Euro area</b>	0.18	0.10	0.06	-0.04
Germany	0.19	0.06	0.06	-0.05
France	0.12	0.02		-0.06
Italy	0.05	0.09		0.02
Spain	0.27	0.17		-0.12

Note: Non significant variables were excluded from the final estimation and therefore the corresponding cells are empty.

To analyze the effect of a homogenous impact on inflation, Table 5 shows the transfer function gains in total HICP inflation of the euro area and its main partners derived from one shock at the time in the inputs. All the input variables considered have very different standard deviations, ranging from 1.9 and 1.6 in ESI or TRADE to 3.2 and 7.2 in the non-energy and energy indices respectively. As it is common in the literature to consider a 10% increase in energy prices, that is 1.4 times its standard deviation, we have considered a proportional shock for the rest of the input variables.

The results show (see Table 5) that first, energy is a main contributor to inflation in all the areas considered, but in Italy. It is especially relevant in Spain, where it is 5.6 times more intense than in Italy, 2.3 than in France and 1.4 than in Germany. Second, non-energy raw materials also have the expected positive impact. Third, global trade captures increases in world competition and therefore has a negative impact on inflation except in Italy that appears with a very low magnitude, although positive. Finally, domestic demand pressures have a positive effect on inflation in Germany.

To gain further insights in the growth of inflation, Table 6 shows the effects of a 10% increase in oil prices on each of the five special groups of HICP inflation for the five areas considered.

**Table 6. Transfer Function Gains (%) for Groups of HICP Inflation (excluding administered prices) Derived From a Growth of 10% in International Price Index of Energy.**

	TOTAL	Processed food	Non-energy industrial goods	Services	Unprocessed food	Energy
<b>Euro area</b>	<b>0.18</b>			<b>0.03</b>	<b>0.04</b>	<b>3.84</b>
Germany	0.19	0.02		-0.01	0.45	3.57
France	0.12			0.04	0.09	3.90
Italy	0.05		-0.001			2.83
Spain	0.27					3.99

Note: Non significant variables were excluded from the final estimation and therefore the corresponding cells are empty.

There is one direct effect that appears as the most important outcome from this analysis and it is that the increase in international energy prices has an expected and significant impact on the energy inflation in the five regions considered. Nevertheless, it is worth noting the differences among them: one year after an increment of 10% in international energy prices results in a gain in the energy component around 4.0 pp in Spain and France, while in Italy it is 2.83 pp and in Germany it is 3.57 pp (see the last column of Table 6).

Indirect effects (those affecting goods and services that use energy as input), and especially second round effects might be dissipated in the production process. Table 6 shows that oil prices have a positive, but small effect on services in the Euro area and France, which may be related with these indirect and second round effects. In contrast, there are some reasons related to the demand reduction behind the apparently counter intuitive few negative responses found.

Since energy inflation is the most dominant channel in translating oil price into total inflation, we proceed with a more detailed dynamic analysis of the energy subclasses

liquid fuels and fuels and lubricants for personal transport equipment. Table 7 shows the one year accumulated gains derived from a permanent 10% increase in oil prices.

The greatest impact is in the liquid fuels component, with almost 7 pp in Germany and more than 2 pp in Italy (see panel B, row named Total in Table 7), but this component has a small weight (between 0.9% in Germany and 0.4% in Spain of total inflation, see the row named Weights of Table 7). On the other hand, an oil price shock shows a smaller impact in fuels and lubricants for personal transport equipment, but due to its greater weight it has a bigger effect on total inflation. Thus, the growth in oil prices causes an increase mainly in liquid fuels, (with small weight), and to a lesser extent in fuels and lubricants for personal transport equipment (with a greater weight), causing finally that Spain and France suffer the greatest impact as a whole. The smallest effect is found in Italy. The difference in the results among regions may be due to the competitiveness of the energy sector or to the taxation system.

**Table 7. Dynamic Effects on Energy Inflation and Its Subclasses  
(excluding administered prices), Derived From a Growth  
of 10% in International Price Index of Energy**

	A) Energy					B) Liquid fuels					C) Fuels and lubricants for personal transport equipment				
	Euro area	Germany	France	Italy	Spain	Euro area	Germany	France	Italy	Spain	Euro area	Germany	France	Italy	Spain
<b>Weights</b>	<b>4.7</b>	<b>4.8</b>	<b>5.0</b>	<b>3.7</b>	<b>5.5</b>	<b>0.7</b>	<b>0.9</b>	<b>0.7</b>	<b>0.7</b>	<b>0.4</b>	<b>4.0</b>	<b>4.0</b>	<b>4.2</b>	<b>3.0</b>	<b>5.0</b>
0	2.4	3.2	2.1	1.2	2.3	4.5	6.3	4.0	1.2	3.6	2.1	2.7	1.8	1.2	2.3
1	1.4	1.0	1.8	1.6	1.7	1.4	0.5	1.9	1.2	2.9	1.3	0.9	1.8	1.7	1.5
2	-0.5										-0.6				
3															
4															-0.2
5															-0.4
6															
7															0.2
8	-0.3	-0.4													-0.3 -0.5
9															
10		-0.4													-0.4
11	0.4	0.6													0.3 0.5
Total	<b>3.8</b>	<b>3.6</b>	<b>3.9</b>	<b>2.8</b>	<b>4.0</b>	<b>5.9</b>	<b>6.9</b>	<b>5.9</b>	<b>2.4</b>	<b>6.6</b>	<b>3.0</b>	<b>2.6</b>	<b>3.2</b>	<b>2.7</b>	<b>3.6</b>
Lag 0 + 1	3.8	4.2	3.9	2.9	4.0	5.9	6.9	5.9	2.4	6.6	3.3	3.6	3.6	2.9	3.8

Note: Non significant variables were excluded from the final estimation and therefore the corresponding cells are empty.

Additionally, Table 7 shows the dynamics up to one year of the effect of oil price increases on the energy component. We can see that almost all the impact is concentrated contemporaneously and with one lag.

Finally, for a further insight of how oil prices affect the special groups of inflation, we perform a similar disaggregated analysis through the remaining 57 subclasses of HICP: 11 for processed food, 27 for non-energy industrial goods, 15 for services and 4 for unprocessed food. Table 8 shows the number of such goods and services with positive (+) or negative (-) total gains, 12 months after the beginning of an oil price shock. As we can see, France is the country where oil prices are disseminated through the largest number of

goods and services (24). France (10), and especially Germany (12), have the highest number of goods and services with negative gains, that is to say, the oil price shock reduces inflation in a larger number of items due to the demand side reduction related with second round effects. In fact, Germany has the lowest number of goods and services with a positive reaction to an oil price increase (7). France is also the country that has a greater number of items with positive gains (14). In Appendix A, Table A-3 shows detailed information about the gains for each of the disaggregated items.

**Table 8. Subclasses of HICP\* with Positive or Negative Gains Derived From a Growth in Energy Prices**

	TOTAL	Euro area		Germany		France		Italy		Spain	
		+	-	+	-	+	-	+	-	+	-
Processed food	<b>11</b>	1	1	2	2	1	2			1	
Non-energy industrial goods	<b>27</b>	5	4	1	6	6	4	3	4	4	4
Services	<b>15</b>	1	5	2	4	4	3	4		1	4
Unprocessed food	<b>4</b>		1			1	1	1			
Energy	<b>2</b>	2		2		2		2		2	
<b>TOTAL</b>	<b>59</b>	<b>9</b>	<b>11</b>	<b>7</b>	<b>12</b>	<b>14</b>	<b>10</b>	<b>10</b>	<b>4</b>	<b>8</b>	<b>8</b>
			<b>20</b>		<b>19</b>		<b>24</b>		<b>14</b>		<b>16</b>

\*Excluding administered prices

Note: Non significant variables were excluded from the final estimation and therefore the corresponding cells are empty.

The nature of these positive or negative gains is an issue without consensus in the literature. Increase in inflation is normally associated with production costs (indirect and second round effects), although this issue has not been solved in the empirical macroeconomic literature (see Kilian, 2008c). On the other hand, decrease in inflation is related to the reduction in the demand for goods and services triggered by the oil price shock. Hamilton (2008) points out that disruption in consumer's and firm's spending on goods and services other than energy is a way energy price shocks affect the economy. This reduction in the demand has four direct transmission channels: the reduction of discretionary income (less money to spend after paying energy bills); uncertainty about future energy prices; precautionary savings; and operating costs effects (Kilian, 2008c). Hence, the positive gains in inflation shown in Table 8 for some goods and services may be associated with the increase in production costs, and the negative ones with the reduction in the demand. The sign of these gains depends on the particular structure in the production and consumption of each of the five economies, so for the same good or

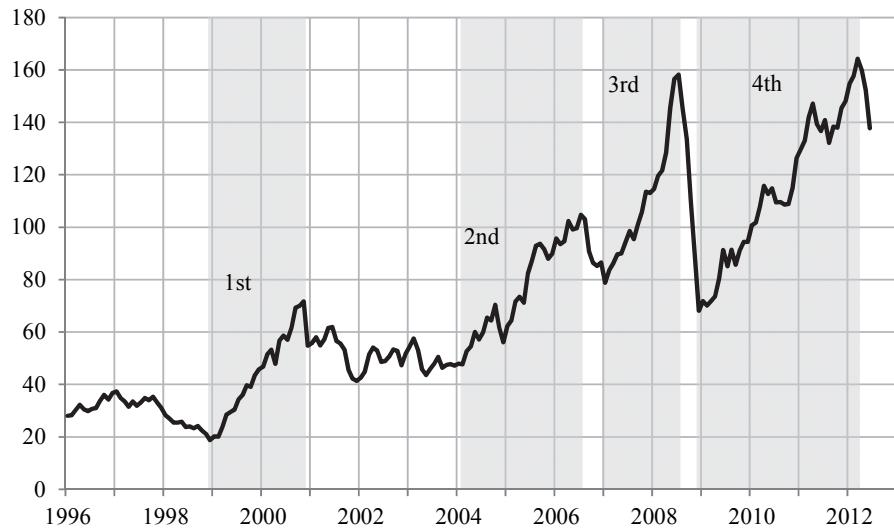
service we can find opposite signs. The consequences of this finding might indicate a further loss of competitiveness due to indirect or second round effects of oil increases.

#### **4. NON-LINEAR TRANSMISSION CHANNELS OF ENERGY PRICES INTO INFLATION**

An important issue related to the transmission of oil shocks into the economy is the possible asymmetric effect on inflation, which could be greater when inflation increases than when it decreases. The treatment of asymmetric effects is recurrent in the literature. In relation to the business cycle, Raymond and Rich (1997) show that while the behavior of oil prices has been a contributing factor to the mean of low-growth phases of output, movements in oil prices have not generally been a principal determinant in the historical incidence of the higher growth phases. Hamilton (2003) also suggests a non-linear causal relationship between economic activity and oil price shocks: increases in oil prices affect the economy but decreases do not, and the increases that occur after a prolonged period of price stability have a greater effect than those which correct previous falls. In the same line, Jimenez-Rodriguez and Sanchez (2005) found that the effects on the macro-economy remain significant, but basically when oil prices rise. This non linearity is observed even before the episodes of the 1970s in the United States economy (Jimenez-Rodriguez, 2009) and in more advanced economies in the 70s and 80s (Jimenez-Rodriguez and Sanchez, 2009). The non-linear nature of the relationship between oil price variations and inflation has been less explored.

To analyze this relation we define, in a similar way to Blanchard and Galí (2007), an oil crisis as an episode involving a cumulative change in the nominal log oil price of above 50% and sustained for more than 12 months. According to this definition, there have been four oil crises between January 1996 and March 2012, shown in the shaded areas in Figure 4: first, from December 1998 to November 2000; second, from February 2004 to July 2006; third, from January 2007 to July 2008; and fourth, from December 2008 to March 2012. The main descriptive statistics for each of the four episodes are shown in Table 9.

**Figure 4. IMF Index of Energy Prices (€)**



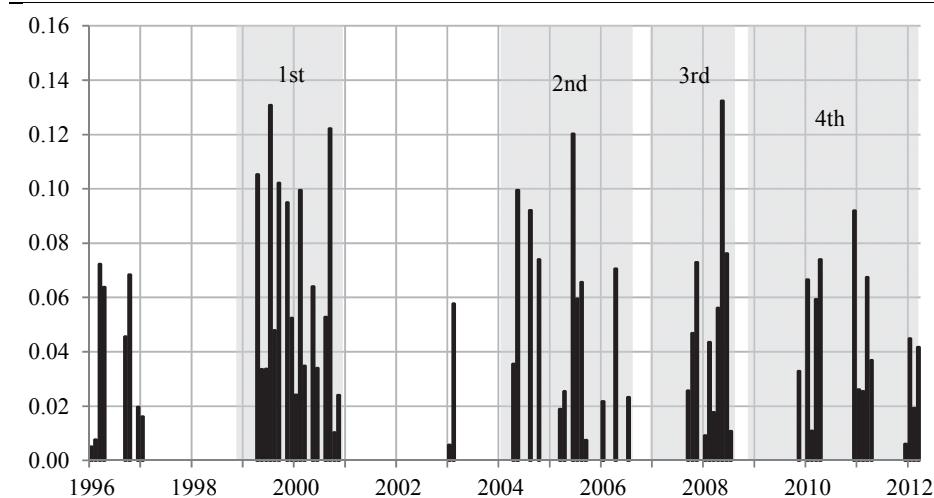
Note: Shaded areas show the 4 episodes considered as oil crises: 1st: Dec 98-Nov 00, 2nd: Feb 04-Jul 06, 3rd: Jan 07-Jul 08, 4th: Dec 08 - Mar 12

**Table 9. Crisis Episodes in the IMF Index of Energy Prices (€)**

Episodes:	1st: Dec98-Nov00	2nd: Feb04-Jul06	3rd: Jan07-Jul08	4th: Dec08-Mar12
Growth, %	133.8	78.6	69.7	88.1
Mean	43.9	76.9	110.2	113.7
Max - Min	52.9	57.0	79.4	96.2
Months	0	0	0	0

To analyze the possible asymmetric relation between oil prices and inflation, we use the net energy price increase proposed by Hamilton (1996). Figure 5 shows this shock on the IMF energy index (€): if the value for the current quarter exceeds the previous year's maximum, the percentage change over the previous year's maximum is plotted. If the price of oil in quarter  $t$  is lower than it had been at some point during the previous four quarters, the series is defined to be zero for date  $t$ .

**Figure 5. Hamilton Energy Shocks**



Note: Shaded areas show the 4 episodes considered as oil crises: 1st: Dec 98-Nov 00, 2nd: Feb 04-Jul 06, 3rd: Jan 07-Jul 08, 4th: Dec 08 - Mar 12

These energy shocks are concentrated in the previously analyzed episodes we have called oil crises: 53 of the 62 identified shocks belong to this group. To know the proportion of these shocks that is responsible for the growth of consumer prices and the differences between countries we repeat the multivariate transfer function analysis replacing the previously IMF energy price index with the Hamilton energy type of shock.

Table 10 shows a comparison between the transfer function gains obtained using the IMF energy price index and those obtained with the Hamilton shock. If the relation is asymmetric (and the effect is larger during the rises), then the transfer function gains should be greater using the Hamilton type of shock (since the average estimated effect should not be mitigated during the drops in oil prices). Nevertheless, we found that the transfer function gains are greater for the original oil price shock than for the Hamilton shock. In particular, we found that the transfer function gains associated to the non-linear oil variable account for almost 90% of the linear effect in the case of France and Germany and only 49% in the case of Spain. Regarding the decomposition of the energy component, the impact of the Hamilton shock is greater than the original oil shock in liquid

fuels in all the countries, except Spain, indicating the possibility of asymmetric effects in this class.

**Table 10. Transfer Function Gains (pp) for HICP Inflation in Energy (excluding administered prices) and Its Subclasses**

A) Derived from a growth of 10% in oil prices (row named Total in table 10)					
	Euro area	Germany	France	Italy	Spain
<b>Energy</b>	<b>3.8</b>	<b>3.6</b>	<b>3.9</b>	<b>2.8</b>	<b>4.0</b>
Liquid fuels	5.9	6.9	5.9	2.4	6.6
Fuels and lubricants for personal transport equipment	3.0	2.6	3.2	2.7	3.6

B) Hamilton shock derived from a growth of 10% in oil prices					
	Euro area	Germany	France	Italy	Spain
<b>Energy</b>	<b>3.1</b>	<b>3.1</b>	<b>3.6</b>	<b>1.7</b>	<b>2.0</b>
Liquid fuels	6.8	8.4	6.2	2.4	5.4
Fuels and lubricants for personal transport equipment	1.8	2.1	1.8	2.3	2.1

C) C=B/A Share of total gains explained by Hamilton shock, %					
	Euro area	Germany	France	Italy	Spain
<b>Energy</b>	<b>82</b>	<b>87</b>	<b>91</b>	<b>60</b>	<b>49</b>
Liquid fuels	115	123	104	102	82
Fuels and lubricants for personal transport equipment	60	83	56	84	59

Table 11 shows the results of the dynamic reaction of energy and its subclasses to a 10% oil shock on international oil prices. As we saw in Table 7, the impact of a Hamilton type of shock is concentrated in the contemporaneous month, although we found some important and negative lagged effects five months after the outset of the oil price shock.

**Table 11. Dynamic Effects on Energy Inflation and Its Subclasses (excluding administered prices), Derived From a Hamilton Shock of Growth of 10% in International Price Index of Energy**

	Energy					Liquid fuels					Fuels and lubricants for personal transport equipment					
	Euro area	Germany	France	Italy	Spain	Euro area	Germany	France	Italy	Spain	Euro area	Germany	France	Italy	Spain	
Weights	4.7	4.8	5.0	3.7	5.5	0.7	0.9	0.7	0.7	0.4	4.0	4.0	4.2	3.0	5.0	
Lags	0	4.0	4.9	3.6	2.0	3.2	6.8	8.4	6.2	3.1	7.3	3.7	3.8	3.3	2.1	2.7
	1			1.3	1.3				1.5	2.8			0.9	1.4	1.6	
	2	-0.8														
	3		-1.8						-0.9	-2.6	-1.9	-1.6	-1.2			-1.2
	4			-1.3										-1.3	-1.2	-0.9
	5			-1.6	-1.3				-1.3	-2.0						
	6															
	7															-1.0
	8															
	9															
	10															
	11															0.9
Total	3.1	3.1	3.6	1.7	2.0	6.8	8.4	6.2	2.4	5.4	1.8	2.1	1.8	2.3	2.1	
Lag 0 + 1	4.0	4.9	3.6	3.3	4.6	6.8	8.4	6.2	4.6	10.1	3.7	3.8	4.3	3.5	4.3	

Note: Non significant variables were excluded from the final estimation and therefore the corresponding cells are empty.

## 5. CONCLUSIONS

Oil prices play a relevant role in inflation dynamics. There is a clear direct impact through the energy component, but the effect on total inflation through the non-energy components is not immediate. In this sense, we have observed that Germany is the most affected country by energy inflation while, in contrast, non-energy inflation helps to contain total inflation notably. But this is not a common picture, and in a country like Spain, although energy inflation contributes notably to total inflation, non-energy inflation is exceptionally high. These differences might be due to other inputs as well as to indirect or second round effects and to the different consumption structure, taxes and regulatory rules in the domestic markets. It has been necessary to perform a more detailed disaggregated analysis on non-administered inflation components to understand oil effects. An initial

analysis shows that administered prices have helped to contain inflation in Spain, Italy and France, but not in Germany.

The disaggregated transfer function modeling has shown the expected positive impact of oil prices on the energy component mainly through fuels and lubricants for personal transport equipment, contemporaneously and after 1 lag. But we have also observed small but significant gains from the oil price impact on the groups of non-energy industrial goods and services. A more disaggregated analysis by subclasses has shown different responses in each of the economic areas considered that can be associated with indirect and second round effects. These differences are partly the consequence of the specific domestic structure of the supply and demand, but also of other competitiveness factors, such as market rigidities.

Finally, non-linearity has been addressed by the Hamilton shock variable. We do not find strong evidence of non-linearity or asymmetric effects of oil price variations in inflation (contrary to what might be found in the relation between oil shocks and GDP growth). Nonetheless, we find some evidence of nonlinearity in the two CPI energy subclasses for France and Germany.

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## Appendix A

**Table A-1. Final HICP Sub-classes Used in the Analysis**

1 Oils and fats	31 Electrical appliances for personal care; other appliances, articles and products for personal care
2 Tobacco	32 Major household appliances whether electric or not and small electric household appliances
3 Bread and cereals	33 Equipment for the reception, recording and reproduction of sound and pictures
4 Milk, cheese and eggs	34 Photographic and cinematographic equipment and optical instruments
5 Sugar, jam, honey, chocolate and confectionery	35 Information processing equipment
6 Food products n.e.c.	36 Jewellery, clocks and watches
7 Coffee, tea and cocoa	37 Household textiles
8 Mineral waters, soft drinks, fruit and vegetable juices	38 Glassware, tableware and household utensils
9 Spirits	39 Maintenance and repair of personal transport equipment
10 Wine	40 Other services in respect of personal transport equipment
11 Beer	41 Passenger transport by air
12 Garments	42 Insurance connected with transport
13 Other articles of clothing and clothing accessories	43 Restaurants, cafés and the like
14 Footwear including repair	44 Canteens
15 Motor cars	45 hotels
16 Motor cycles, bicycles and animal drawn vehicles	46 tourism
17 Spares parts and accessories for personal transport equipment	47 Actual rentals for housing
18 Furniture and furnishings	48 Services for the maintenance and repair of the dwelling
19 Tools and equipment for house and garden	49 culture: Recreational and sporting services
20 Recording media	50 Repair of household appliances
21 Games, toys and hobbies	51 Domestic services and household services
22 Equipment for sport, camping and open-air recreation	52 Hairdressing salons and personal grooming establishments
23 Other personal effects	53 Financial services n.e.c.
24 Materials for the maintenance and repair of the dwelling	54 Meat
25 Non-durable household goods	55 Fish and seafood
26 Gardens, plants and flowers	56 Fruit
27 Pets and related products; veterinary and other services for pets	57 Vegetables
28 Newspapers and periodicals	58 Liquid fuels
29 Carpets and other floor coverings	59 Fuels and lubricants for personal transport equipment
30 Miscellaneous printed matter; stationery and drawing materials	

**Table A-2. Parameters of the Final Transfer Function Model Estimated for  
Total log (HICP)<sup>1</sup>**

Input variable	Lag	Euro area	Germany	France	Italy	Spain
	0	<b>0.0122</b> (7.27)	<b>0.0125</b> (6.90)	<b>0.0062</b> (3.66)		<b>0.0135</b> (4.43)
	1	<b>0.0055</b> (3.15)		<b>0.0056</b> (3.42)		<b>0.0136</b> (4.54)
$\Delta\Delta_{12}\log(ENERGY)$	2				<b>0.0048</b> (2.80)	
	7		<b>0.0083</b> (3.61)			
	1					<b>0.0119</b> (3.00)
	5			<b>-0.0092</b> (-2.79)	<b>-0.0105</b> (-2.64)	
$\Delta\Delta_{12}\log(NON-ENERGY)$	7	<b>0.0221</b> (5.53)		<b>0.0148</b> (4.03)	<b>0.0191</b> (4.72)	<b>0.0396</b> (5.60)
	8		<b>0.0129</b> (2.76)			
	4		<b>0.026</b> (2.68)			
$\Delta\Delta_{12}\log(ESI)$	7	<b>0.0244</b> (3.37)				
	2	<b>0.0369</b> (4.75)	<b>0.0348</b> (3.44)		<b>0.0465</b> (6.07)	
$\Delta\Delta_{12}\log(TRADE)$	11	<b>-0.0548</b> (-7.47)	<b>-0.0569</b> (-6.29)	<b>-0.0286</b> (-3.71)	<b>-0.0393</b> (-5.19)	<b>-0.0543</b> (-4.26)
ARIMA(p,d,q)x(P,D,Q) <sup>2</sup>		(0,1,0)x(0,1,1)	(0,1,1)x(0,1,1)	(0,1,0)x(0,1,1)	(0,1,2)x(0,1,1)	(0,1,1)x(0,1,1)
Intervention analysis <sup>3</sup>		IO, Apr-01	IO, Dec-00	TC, Jan-02	LS, Apr-00	IO, Mar-11
		TC, Jan-02	TC, Jan-01	TC, Feb-03	TC, Feb-01	IO, Jul-11
		TC, Sep-05	TC, Feb-03	IO, Sep-06	IO, Mar-01	TC, Sep-11
		AO, Oct-06	IO, Jan-04	IO, Nov-07	IO, Aug-01	
		LS, Nov-07	TC, Sep-05	LS, Aug-08	LS, Oct-06	
		AO, Apr-08	LS, Sep-07		AO, Apr-08	
		AO, Feb-09	LS, Nov-07		IO, Nov-08	
		IO, Jul-11	AO, Apr-08		AO, Feb-09	
		IO, Sep-11			IO, Mar-11	
					LS, Jul-11	
					IO, Sep-11	
					TC, Jan-12	

<sup>1</sup> The figures in parenthesis are estimated t-values.

<sup>2</sup> Standard ARIMA notation where **d** and **D** stand for the number of regular and seasonal differences, **p** and **P** for the order of the regular and seasonal Autoregressive components and **q** and **Q** for the regular and seasonal Moving Average components. All the roots lie within the unit circle.

<sup>3</sup> AO stands for additive outlier, LS for level shift, TC for transitory change and IO for innovative outlier

**Table A-3. Signs of the Significant Transfer Function Gains for HICP by Sub-classes (excluding administered prices) Derived From a Growth of 10% in Oil Prices**

	Euro area	Germany	France	Italy	Spain
<b>PROCESSED FOOD</b>					
Oils and fats	-				
Tobacco	+	-			
Bread and cereals					
Milk, cheese and eggs	+	+			
Sugar, jam, honey, chocolate and confectionery			+		
Food products n.e.c.					
Coffee, tea and cocoa					
Mineral waters, soft drinks, fruit and vegetable juices				+	
Spirits					
Wine					
Beer	-	-			
<b>NON-ENERGY INDUSTRIAL GOODS</b>					
Garments			-		
Other articles of clothing and clothing accessories					
Footwear including repair					
Motor cars	-				
Motor cycles, bicycles and animal drawn vehicles			+		
Spares parts and accessories for personal transport equipment	-		-		
Furniture and furnishings				+	-
Tools and equipment for house and garden	-			+	
Recording media	+				
Games, toys and hobbies			+		+
Equipment for sport, camping and open-air recreation					+
Other personal effects	-				
Materials for the maintenance and repair of the dwelling	+				
Non-durable household goods	-				+
Gardens, plants and flowers			-	-	
Pets and related products; veterinary and other services for pets			-		-
Newspapers and periodicals			-		
Carpets and other floor coverings	-				+
Miscellaneous printed matter; stationery and drawing materials			-		
Electrical appliances for personal care; other appliances, articles and products for personal care	+	-	-		
Major household appliances whether electric or not and small electric household appliances					
Equipment for the reception, recording and reproduction of sound and pictures	+		+		
Photographic and cinematographic equipment and optical instruments	+		+		
Information processing equipment			+		
Jewellery, clocks and watches	-				
Household textiles	+	-		+	-
Glassware, tableware and household utensils			+	-	
<b>SERVICES</b>					
Maintenance and repair of personal transport equipment			+		-
Other services in respect of personal transport equipment					
Passenger transport by air				+	
Insurance connected with transport			+	+	
Restaurants, cafés and the like	-		+	+	
Canteens			-		
hotels	-				
tourism	+	+			
Actual rentals for housing			-		
Services for the maintenance and repair of the dwelling			-	+	-
culture:Recreational and sporting services	-				
Repair of household appliances	-				
Domestic services and household services	+				+
Hairdressing salons and personal grooming establishments	-				
Financial services n.e.c.			+		-
<b>UNPROCESSED FOOD</b>					
Meat					
Fish and seafood				+	
Fruit			+		
Vegetables	-		-		
<b>ENERGY</b>					
Liquid fuels	+	+	+	+	+
Fuels and lubricants for personal transport equipment	+	+	+	+	+

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