Food Price Pass-Through in the Euro Area: Non-Linearities and the Role of the Common Agricultural Policy*

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In this paper we analyze the pass-through of a commodity price shock along the food price chain in the euro area. Departing from the existing literature, which focuses on food commodity prices as quoted in international markets, we use a novel database that accounts for the role of the Common Agricultural Policy in the European Union. We model several departures from the linear pass-through benchmark and compare alternative specifications with aggregate and disaggregate data. Overall, when the appropriate data set and methodology are used, it is possible to identify a significant and long-lasting pass-through. The results of our regressions are applied to the food price shock in the 2007–08 period; a decomposition exercise shows that commodity prices are the main determinant of the increase in producer and consumer prices, thus solving the puzzle highlighted in the existing literature for the euro area.

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"Rapidly rising prices for globally traded commodities have been the major source of the relatively high rates of inflation we have experienced in recent years, underscoring the importance for policy of both forecasting commodity price changes and understanding the factors that drive those changes."

—Ben Bernanke (2008)[1]

"Annual HICP inflation has remained considerably above the level consistent with price stability since last autumn. . . . This worrying level of inflation is largely the result of both the direct and indirect effects of past surges in energy and food prices at the global level."

—European Central Bank (2008)[2]

"Retail food prices are heading for their biggest annual increase in as much as 30 years, raising fears that the world faces an unprecedented period of food price inflation. Prices have soared as the expanding biofuels industry, climate change and the growing prosperity of nations such as India and China push up the costs of farm commodities including wheat, corn, milk and oils. Food companies have started passing on these increases to consumers, but the prospect of sustained commodity price rises means the industry's profits could be hit as it is forced to absorb the higher costs itself."

—*Financial Times*, May 23, 2007[3]

1. Introduction

The rate of pass-through of commodity price shocks is a crucial issue in forecasting consumer prices and hence in determining the

[1] Ben S. Bernanke, "Outstanding Issues in the Analysis of Inflation," (speech, Federal Reserve Bank of Boston's 53rd Annual Economic Conference, Chatham, Massachusetts, June 9, 2008).

[2] Editorial, European Central Bank *Monthly Bulletin*, September 2008.

[3] Jenny Wiggins, "Fears over Food Price Inflation," *Financial Times* (London), May 23, 2007.

appropriate stance of forward-looking monetary policy.[4] Conventional wisdom holds that the sharp fluctuations in food commodity prices in international markets and their eventual transmission to consumer prices were key drivers of the wide swings in headline inflation observed in many developed and developing economies between 2007 and 2009. Yet, formal empirical analyses struggle to find a robust pass-through in the euro area (e.g., Benalal et al. 2004; Chauvin and Devulder 2008).[5]

What explains this puzzle? One hypothesis is that the existing studies look at the wrong commodity data: the international food commodity prices that are at the heart of most empirical investigations are a poor approximation of the true input cost pressures faced by euro-area producers. This is because international food commodity prices do not account for the distortions induced by the Common Agricultural Policy (CAP) in Europe. A second hypothesis is that these studies generally neglect that the pass-through may be non-linear and may depend on the sign, size, and volatility of the impulse. These effects have been shown to matter for the transmission of oil price shocks to both real and nominal variables (Hamilton 1996; Jiménez-Rodríguez and Sánchez 2005), but so far they have been ignored in the context of food prices.

We investigate the two hypotheses using a novel database of farm-gate and internal market prices of food commodities collected by the European Commission in the European Union (EU). These prices take implicitly into account the presence of the CAP in Europe. We also model several departures from the linear pass-through benchmark, employing various non-linear transformations of the prices of food commodities that have been successfully used to link oil prices and real activity in the past (see, for example, Bernanke, Gertler, and Watson 1997; Hamilton and Herrera 2004; and Jiménez-Rodríguez and Sánchez 2005).

[4] See, for example, Bernanke and Gertler (2001), Blanchard and Galí (2007), and Edelstein (2007).

[5] In Benalal et al. (2004), food commodity prices concur to determine processed food prices in the euro area, but only with a long lag and a small coefficient, implying an economically trivial impact on the dependent variable. In Chauvin and Devulder (2008), processed food prices depend on non-oil import prices with a lag of two quarters and an economically miniscule impact. In both papers, unprocessed food prices do not depend on food commodity prices.

An additional contribution of the paper is that it compares alternative model specifications with aggregate and disaggregate food data. There is a long tradition of assessing the relative merits of the two approaches in economic modeling, going back to the works of Theil (1954) and Grunfeld and Griliches (1960). More recent attempts include Benalal et al. (2004) and Hubrich (2005), which compare the two approaches in the context of forecasting euro-area inflation. This literature highlights several rationales for using disaggregate variables. One is that the disaggregate approach allows a more flexible modeling of the idiosyncratic properties of the data—for example, by using different dynamic structures and information sets for the various food components. A second rationale is that it allows to measure individual pass-through patterns for different commodities and to analyze the food items that are more directly related to commodity prices, while ignoring those that are not obviously exposed to commodity price changes, such as tobacco, alcoholic beverages, fruits, and vegetables. However, the aggregate approach also presents potential advantages, as the noise in the individual food data may average out in the aggregate. Thus, both approaches have potential merits, and a winner can only be chosen empirically—a task that we pursue in this paper.

Drawing on monthly data from January 1997 to June 2009, we examine an aggregate index of food commodity prices and six components of this index—cereal, coffee, dairy, fats, meat, and sugar. We compare pass-through patterns of EU and international food commodity price data. We use vector autoregressive models (VARs) to test whether shocks in these variables are passed on to the food components of both the producer price index (PPI food) and the consumer price index (HICP food) in the euro area, as well as on individual items of these indices.

Our analysis yields some interesting results. Contrary to the existing literature, we find evidence of a statistically and economically significant food price pass-through in the euro area when EU internal food commodity prices are used. We also find that this statistical relationship breaks down when international commodity prices are used. The clear implication of these findings is that the CAP plays a crucial role in the transmission mechanism of food price shocks in the euro area. This conclusion rests on the assumption that

CAP-related trade frictions account for most of the wedge between the two sets of food commodity prices. Moreover, we find that the disaggregate approach performs better than its aggregate counterpart, a result that we attribute to the more flexible modeling of idiosyncratic components in the former approach. Asymmetries and non-linearities also appear to matter in our analysis, suggesting that they should not be overlooked when measuring the pass-through of commodity price shocks.

Finally, a historical decomposition of the factors driving the rise in consumer food prices between 2007 and mid-2008 indicates that commodity price shocks explain the bulk of the observed increase, albeit the reaction in producer and consumer prices seems to have been somewhat over and above the historical norm. While such increases partly offset the previous deterioration in profit margins for producers and retailers, their size suggests that prices may have been raised in excess of what would have been commanded by the mere pass-through of the rising input costs.

The rest of the paper is organized as follows. The next section discusses the link between food commodity prices and inflation and details the database. Section 3 describes the methodology. Section 4 presents the results. Section 5 discusses the implication of the analysis for the commodity price boom in 2007–08. The last section concludes.

2. Link between Food Commodity Prices and Inflation

The dichotomy between flexible commodity prices and sticky industrial and retail prices lies at the heart of most formal accounts of pass-through. Commodity prices, which are set in competitive, flexible markets, respond immediately to general macroeconomic news, whereas intermediate and final consumer prices, which are set contractually by producers and retailers, take more time to react. Because commodity prices are more flexible, they can be expected to lead the adjustment along the price chain, regardless of the source of the initial shock. For example, a cost-push shock that originates in commodity markets and that is transmitted through the production chain will only affect final selling prices with a lag (see Bloch, Dockery, and Sapsford 2004). Likewise, the first signs of a demand-pull shock might be visible in commodity markets and affect final good markets only with a delay (see Blomberg and Harris 1995; and Furlong and Ingenito 1996).

In practice, an empirical link between prices at different stages of the production process may be difficult to detect for a number of reasons (see Edelstein 2007). First, higher input costs in the form of higher commodity prices may not be passed on to consumers if the shock is absorbed in producers' and retailers' margins or through advances in productivity. Second, commodity prices may have little predictive ability for inflation if consumer prices are subject to several offsetting shocks at any given point in time. Third, the increased attention of monetary authorities to commodity prices may have weakened their signaling role for inflation. This occurs, for example, as monetary authorities ease or tighten policy in response to the inflationary signal of commodity prices, which thereby mitigates the actual inflation outcome.[6]

Another reason why a positive correlation may be difficult to detect is the existence of non-linearities in the transmission mechanism. A quick review of the literature reveals that adjustment costs, menu costs, and information asymmetries represent important sources of non-linear pass-through. For example, Ball and Mankiw (1994) show that in the presence of menu costs, firms face a range of inaction in response to input price shocks. That is, firms respond to large shocks but not to small shocks. Furthermore, in the presence of trend inflation, menu costs may lead to more resistance to lower prices than to increase them, as the upper bound of the firms' range of inaction is smaller in real terms than the lower bound, even when menu costs are symmetric. Balke, Brown, and Yücel (1998) argue that the non-linear adjustment to price shocks could also be explained by the inventory behavior of retailers. Gardner (1975) and Kinnucan and Forker (1987) argue that government intervention may lead to non-linear price adjustments if price movements

[6]Fuhrer and Moore (1992), for example, show that if commodity prices enter the monetary policy reaction function, pressures on commodity prices can lead to declines in final goods prices. Although the signal of incipient inflation pressures stemming from commodity prices is correct, little actual inflation occurs because of offsetting monetary policy.

in one direction are more likely to trigger intervention than movements in the opposite direction. Bailey and Brorsen (1989) argue that non-linearities may arise from asymmetric information among competing firms, due to economies of scale in information gathering. Finally, the presence of non-competitive behaviors in the marketplace may be a further cause of non-linear price responses. Owing to market power and oligopolistic behaviors in the production and distribution sectors, price reductions at the farm level may be only slowly and possibly not fully transmitted through the food price chain, whereas price increases are quickly passed on to final consumer prices.[7]

In our empirical investigation, we explicitly model three types of non-linearities: asymmetries, threshold effects, and the scaled pass-through. The asymmetric pass-through occurs when the transmission of a price shock depends on whether its sign is positive or negative. Threshold effects occur when the response depends on the size of the shock. The scaled pass-through occurs when the transmission depends on the volatility affecting commodity prices.

2.1 Empirical Literature

The empirical literature on food price pass-through is fairly abundant. Although methodological differences among the various studies imply that the results are not always directly comparable, a number of regularities may be highlighted. The following seem particularly relevant for the present study.

First, the food price pass-through varies largely depending on the product category. This is one of the main findings in the report by London Economics (2004), which looks at pass-through patterns for a large number of food categories in the EU countries. The result is also confirmed by the analysis in Vavra and Goodwin (2005) for the United States, which compares pass-through elasticities in the beef, chicken, and eggs markets. Variations in pass-through elasticities across industries and product categories in the United States

[7]See the overviews in Meyer and von Cramon-Taubadel (2004) and Vavra and Goodwin (2005).

can also be inferred indirectly by contrasting the results in Kinnucan and Forker (1987) for the dairy industry with those in Boyd and Brorsen (1988) for the pork industry.

Second, the pass-through to producer prices is higher than the pass-through to consumer prices. Several studies make this comparison directly and the common finding is invariably that the food price pass-through gets smaller as one moves along the production chain (see Bukeviciute, Dierx, and Ilzkovit 2009). The intuition is rather straightforward: the pass-through is directly linked to the share of total value added represented by commodity inputs. As the share of value added represented by non-commodity related input costs—such as wages, rents, and packaging—increases when one moves from intermediate to final stages of production, the size of pass-through becomes smaller.

Third, the pass-through is asymmetric. Numerous studies find evidence that intermediate and consumer prices tend to respond more rapidly to input cost increases than to decreases. The finding seems robust to the empirical method used and appears to hold across a variety of products, geographical areas, and time periods. For example, in an extensive study of 282 products and product categories, including 120 agricultural and food items, Peltzmann (2000) shows that asymmetric price transmission is the rule in the majority of producer and consumer markets. A comprehensive review of this literature can be found in Meyer and von Cramon-Taubadel (2004). Vavra and Goodwin (2005) also delve into the various econometric techniques employed to detect and estimate asymmetric pass-through in the food price chain.

Notwithstanding the wealth of results and empirical findings reported in the literature, a number of issues remain unresolved. While the motivation of most existing studies is to analyze the competitive behavior in specific industries and to measure their distance from the perfect competition benchmark, little effort has been devoted so far to the construction of models to assess the inflationary impact of food commodity prices shocks. Moreover, few analyses have been carried out for the euro area, partly reflecting the fact that, with monetary union starting in 1998, only recently have data series become long enough to allow a meaningful econometric treatment. In most cases, the existing studies focus on international commodity prices (see, for example, International Monetary Fund

2008; and OECD 2008), glossing over the presence of the CAP in the EU, which is likely to affect the transmission mechanism in important ways, as we argue below.[8] Finally, while asymmetries have been thoroughly analyzed by the literature, other types of non-linearities, such as threshold effects and the scaled pass-through, have generally been overlooked, despite their theoretical and practical importance.

In this paper, we attempt to fill these gaps in the literature. We estimate a model of pass-through that focuses explicitly on the inflationary impact of food commodity price shocks. The model contributes to the understanding of the pass-through mechanism in the euro area by controlling explicitly for the role of the CAP and by contrasting pass-through patterns in aggregate and disaggregate models, which allows a more detailed account of idiosyncratic behaviors. Finally, the paper incorporates elements of econometric theory aimed at capturing possible non-linearities in the pass-through relationships.

2.2 Data Description

To analyze the patterns of food price pass-through in the euro area, we take a pricing chain approach and focus on how shocks in food commodity prices are transmitted downstream to producer and consumer prices. This approach has been used extensively in the literature (see the overview in Vavra and Goodwin 2005) and is supported by formal statistical tests in our data set for the euro area.[9]

The series used for the empirical investigation are the food price components (and individual food items) of the Harmonised Index of Consumer Prices (HICP) and the producer price index for the euro area, as provided by Eurostat. For food commodity prices, the choice takes into account the fact that, for a number of food crops

[8] As far as we are aware, the report by the National Bank of Belgium (2008) is the only empirical application to take explicitly into account the role of the CAP in Europe. The study uses internal market prices for agricultural products in the EU and adopts a VAR model specification to assess the extent of pass-through to consumer prices in Belgium and in the euro area. Our paper extends this analysis by examining non-linearities and by focusing on the transmission to individual food price components.

[9] Granger causality tests performed on the data provide evidence of one-way causality running from commodity to producer prices and from producer to consumer prices, thereby supporting the chosen modeling strategy.

produced directly in the EU, prices in international markets have been historically somewhat lower and significantly more volatile than those prevailing in the EU (see National Bank of Belgium 2008). To a large extent, the difference can be attributed to the presence of the CAP, which cushions the transmission of global shocks to EU internal prices.

The CAP is a system of agricultural subsidies and programs implemented in the EU by the European Commission. Its key objectives, as enshrined in the EU treaties, are to increase agricultural productivity and to ensure a fair standard of living for agricultural producers, while stabilizing markets and guaranteeing availability of food supplies at reasonable prices to consumers. It consists of several types of interventions affecting prices and quantities of agricultural commodities within the EU, such as direct subsidy payments for crops, price support mechanisms, and guaranteed minimum prices, and is complemented with tariffs and quotas on agricultural products imported from outside the EU. A detailed description of the development of all the measures is hardly possible, as the system is constantly changing. An overview of the mechanisms currently in place and of the changes that will be gradually phased in over the coming decade can be found in European Commission (2010).

Neglecting the influence of the CAP might be a key reason why in the past commodity prices were found to be largely insignificant in explaining consumer food prices in the euro area. To control for the influence of the CAP on the size and speed of the transmission of a global commodity price shock in the euro area, this paper uses a hybrid database that combines EU internal market prices for those commodities that are produced in the EU (namely, meat, cereal, dairy, and fats) and prices quoted in international markets for those commodities that are not subject to CAP intervention prices (coffee and sugar). The former series are drawn from a publicly available database constructed by the Directorate-General for Agriculture and Rural Development (DG AGRI) of the European Commission, putting together series of farm-gate and wholesale market prices collected and transmitted by national Ministries of Agriculture of the various member states of the EU.[10] The data

[10]Prices are monitored weekly and reported monthly. For further details, see the report by the European Commission, available at http://ec.europa.eu/agriculture/markets/prices/monthly_en.pdf.

Table 1. Composition of DG AGRI Data Set

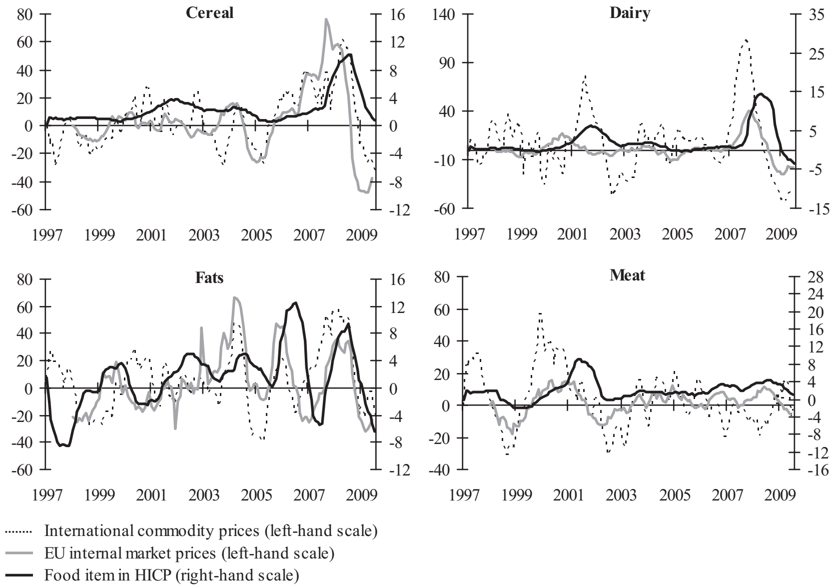
Cereal	Dairy	Fats	Meat
Feed Oats	Skim Milk Powder (SMD)	Oil 2%	Beef
Milling Oats	SMD—Intervention Quality	Extra Virgin Oil 0.5%	Young Beef
Feed Rye	SMD—Animal Feed Quality	Extra Virgin Oil 0.8%	Cow
Breadmaking Rye	Butter	Olive Residue	Young Cow
Durum Wheat	Cheddar	Olive Residue 10%	Pork
Feed Wheat	Edam		Chicken
Breadmaking Wheat	Eggs		
Maize			
Malting Barley			
Feed Barley			

include monthly observations over the period from January 1997 to June 2009. Table 1 shows an overview of the database composition, which includes four product groups (meat, cereal, dairy, and fats) and twenty-eight individual price series.[11] International prices of coffee and sugar are drawn from the Hamburg Institute of International Economics (HWWI) database, which has been widely used in earlier analysis of pass-through.

To illustrate the short-run relationship between commodity prices and inflation, figure 1 plots the annual percentage changes in the price indices of selected food items included in the HICP baskets, together with those of the relevant EU internal commodity prices drawn from the DG AGRI data set. For comparison purposes, we also include the annual growth rate of the comparable commodity prices as quoted in international markets, which are drawn from the HWWI database. Several points can be highlighted from the figure. First, we observe that while international commodity prices are generally more volatile than EU internal market prices, in particular during the period from 1997 to 2005, the two indices have been closely correlated in the wake of the recent food price shock. This fact is consistent with the idea that the CAP provides a price stabilization mechanism mainly against price falls. Second, unsurprisingly, HICP food prices show higher correlation with EU internal

[11]In order to construct aggregate commodity price indices for the four product groups reported in the table, we consider the unweighted, arithmetic mean of the price series (in level) listed in each group.

Figure 1. Consumer and Commodity Prices (annual percentage change)



Sources: Eurostat, European Commission, HWWI, and authors' calculations.

market prices than with international prices, suggesting that the former may be a better gauge of commodity input cost pressures faced by producers and retailers in the euro area.

The individual commodity price series depicted in figure 1 can be used, in combination with the international prices of coffee and sugar, to construct aggregate indices of food commodity prices, which can be directly compared with the corresponding food price components of consumer and producer prices.[12] Figure 2 depicts

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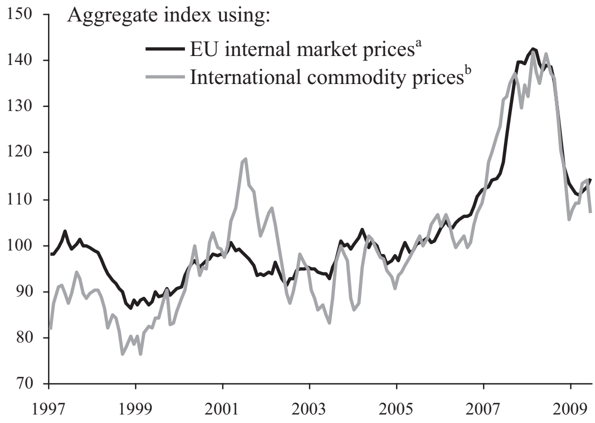
[12]For the construction of aggregate indices of commodity, producer, and consumer prices, the following weighting schemes are used in this paper. Individual food items in the HICP and PPI indices are weighted using the relevant weights in the HICP and PPI baskets, as published by Eurostat. For commodity prices, we adopt "use-based" weights. These derive from the structure of euro-area domestic demand (domestic production plus imports minus exports) in the period 2004–06, and follow an experimental scheme envisaged by the European Central Bank (ECB), which is described in detail in the box entitled "Euro Area Non-Energy Commodity Price Indices Compiled by the ECB" published in the December 2008 issue of the ECB *Monthly Bulletin*.

Figure 2. Food Commodity Indices (index level, 2005 = 100; in euro)



[a]Includes EU internal market prices for meat, cereal, dairy, and fats items and international prices for coffee and sugar items.
[b]Includes international prices for all food items considered (meat, cereal, dairy, fats, coffee, and sugar). All international price series (originally quoted in U.S. dollars) are converted to euros before aggregation using the bilateral exchange rate. Use-based weights are adopted for the aggregation; see footnote 12.

two such food commodity indices, one based on EU internal market prices and another using international commodity prices only. It shows that between 1997 and 2005, international commodity prices were significantly more volatile than EU internal market prices. During that period, commodity prices in international markets were generally below CAP intervention prices, so that the relative tranquility of EU internal market prices might be a by-product of the CAP. However, as commodity prices in international markets progressively crossed EU intervention prices from 2006 onwards, the two series drifted upwards in tandem, consistently with the idea that the CAP, by design, mainly provides a floor against price falls.

3. Methodology

Most studies of pass-through adopt structural models of mark-up pricing, where final consumer prices are a function of various cost factors (unit labor cost, cost of energy, the exchange rate) including commodity prices, as well as indicators of the cyclical position of the economy (see Bloch, Dockery, and Sapsford 2004). This approach allows to model the determinants of retail prices, but the choice of explanatory factors is somewhat arbitrary. An alternative approach used, for example, by Furlong and Ingenito (1996) and Zoli (2009) is to model the pass-through by means of VAR models. This paper follows the latter approach. It considers unrestricted VAR models for the euro area and investigates the interaction between commodity, producer, and consumer prices individually for the six food commodities mentioned in the previous section (cereal, coffee, dairy, fats, meat, and sugar). It also considers an aggregate version of the model, where individual series are aggregated to form price indices.

We separately estimate a pth-order VAR for each food item (cereal, coffee, dairy, fats, meat, sugar), as well as for the aggregate index. The reduced-form VARs may be written as

$$y_t = k + \sum_{i=1}^{p} A_i y_{t-i} + \varepsilon_t, \tag{1}$$

where y_t is a $(n \times 1)$ vector of endogenous variables; k is the $(n \times 1)$ intercept vector; A_i is the ith $(n \times n)$ matrix of autoregressive coefficients for $i = 1, 2, \ldots, p$; and ε_t is the $(n \times 1)$ generalization of a white-noise process.[13] The vector of endogenous variables includes the first log-differences of both producer prices (ppi_t) and consumer prices ($hicp_t$) of specific food items, as well as either the first log-difference of the corresponding commodity price (c_t) in the linear specification or its non-linear transformations, as detailed below.

The non-linear specifications of commodity prices considered in this paper are the following: (i) asymmetric specification, in which increases and decreases in the price of a commodity are considered as separate variables;[14] (ii) scaled specification, which takes

[13]To identify the system, we use the Choleski decomposition, imposing the following order of innovations: commodity prices (and their non-linear transformations, as we will discuss later), followed by producer and consumer prices. This ordering is consistent with the pricing chain assumption.

[14]See Vavra and Goodwin (2005) for an interpretation of the asymmetric specification.

the volatility of commodity prices into account;[15] and (iii) Net24 specification, where the relevant commodity price variable is characterized by the net amount by which these prices have gone up over the last two years.[16]

The asymmetric specification captures the type of non-linearity that occurs when a price shock is transmitted differently depending on the sign. In this specification, positive (c_t^+) and negative (c_t^-) rates of change of commodity price are separated as follows:[17]

$$c_t^+ = \begin{cases} c_t & \textit{if } c_t > 0 \\ 0 & \textit{otherwise} \end{cases}$$

$$c_t^- = \begin{cases} c_t & \textit{if } c_t < 0 \\ 0 & \textit{otherwise.} \end{cases}$$

The scaled specification captures the non-linearity that occurs when the pass-through depends on how surprising the shock to

[15]The scaled specification was developed by Lee, Ni, and Ratti (1995) in the context of the impact of oil price shocks on economic activity. This specification captures the idea that an oil price shock that follows a long period of price stability has more dramatic macroeconomic consequences than one that follows a period of high price volatility. We adapt this specification to our context assuming that an increase in food commodity prices is likely to have a larger impact in a stable price environment than in an environment where price movements are frequent and erratic, given that price changes in a volatile environment are more likely to be quickly reversed. Also, when volatility is high, it is more difficult to disentangle the noise from the signal in the shock.

[16]The net specification was proposed by Hamilton (1996) in the context of oil shocks. The idea behind this specification is that oil price movements must be novel (and thus potentially disturbing to producers and consumers) to have an impact. As such, oil price increases that simply reverse previous decreases have little or no effect. We adapt this specification to our context assuming that increases in food commodity prices cascade along the food price chain only if they are big enough to reverse the decreases observed in the previous periods.

[17]Kilian and Vigfusson (2009) argue that asymmetric specifications such as those used in this paper may be biased and lead to misguided conclusions. They propose an alternative framework, which, however, is itself not immune from criticism (see Hamilton 2010). As a robustness check, we estimate the asymmetric VAR with the Kilian-Vigfusson methodology and find that the responses to positive shocks are virtually the same as in the specification adopted by this paper. Responses to negative shocks are significant, but they are small (on average half of the response to positive shocks; see figure 5 in the appendix), suggesting that the finding of an asymmetric pass-through still stands, at least qualitatively. Moreover, due to extra parameters and a finite sample of initial conditions, the uncertainty around the impulse responses is larger.

commodity prices is. The following *AR(12)-GARCH(1,1)* representation of a specific food commodity price is considered, where the particular lag structure takes into account the persistence of c_t:

$$c_t = \alpha_0 + \alpha_1 c_{t-1} + \ldots + \alpha_{12} c_{t-12} + e_t$$
$$e_t | I_{t-1} \sim N(0, h_t)$$
$$h_t = \gamma_0 + \gamma_1 e_{t-1} + \gamma_2 h_{t-1}$$
$$SCPI_t = \max\left(0, c_t / \sqrt{\hat{h}_t}\right).$$

The Net24 specification considers the variable $NCPI_t$, which is defined as the amount by which the log of a specific commodity price in month t, c_t, exceeds the maximum value over the previous twenty-four months, and 0 otherwise.[18] That is,

$$NCPI_t = \max\{0, c_t - \max(c_{t-1}, \ldots, c_{t-24})\}.$$

This specification captures the threshold effect, which occurs when larger shocks bring about a different response than smaller shocks.[19]

4. Results

On the basis of the Schwarz information criterion, reported in table 2, we conclude that the linear and asymmetric specifications are always dominated by the Net24 and scaled specifications. Looking at individual commodities, the scaled specification is preferred for cereal, coffee, fats, and meat; the Net24 specification is preferred for dairy products and sugar. We recall that the scaled specification captures the idea that a shock in an environment of stable prices is more easily recognized as such and has a larger economic

[18]We construct scaled and Net24 specifications for commodity price decreases (that is, $SCPD_t$ and $NCPD_t$). However, they are never found to have a statistically significant impact on consumer prices, and hence they are excluded from the VARs.

[19]We conduct sensitivity analysis using an alternative twelve-month specification (Net12). The results are essentially the same as those obtained using twenty-four months. They can be found in the working paper version of this article (see ECB Working Paper No. 1160, April 2010).

Table 2. Schwarz Information Criterion

	Linear	Asymmetric	Net24	Scaled
Cereal	−4.70	−5.84	−6.24	**−6.72**
Coffee	1.31	−0.28	−1.60	**−3.61**
Dairy	−3.97	−5.15	**−5.88**	−5.67
Fats	1.56	0.76	−0.02	**−1.69**
Meat	−4.23	−5.03	−5.71	**−6.04**
Sugar	−3.19	−4.18	**−5.47**	−4.37
Index	−6.50	−7.35	**−7.69**	−7.54

Notes: Comparison of information criterion for various VAR specifications including food commodity prices (and their non-linear transformations), and PPI food and HICP food prices. The various VARs are estimated over the sample period from January 1997 to June 2009, using monthly observations. Preferred models are in bold in the table.

pass-through than if the same shock occurred in a more volatile environment. Likewise, the Net24 specification assumes that prices are raised only when commodity prices cross some arbitrarily identified threshold, and are hardly reduced when commodity prices fall—an idea also incorporated in the asymmetric specification. Both specifications allow for the possibility that the pass-through may be different depending on the size and sign of the underlying shock.[20]

At the aggregate level, the Net24 model outperforms the scaled specification. We conjecture that this is because price uncertainty is often market specific and may not be captured properly by aggregate models. Along with other considerations, this result suggests that a disaggregated approach is to be preferred when dealing with non-linearities. These results are quite robust and remain valid when international commodity prices are used (see table 7 in the appendix).

In what follows, we mainly look at pass-through patterns from EU internal market prices for the food commodities under the CAP and international prices for the commodities not subject to

[20]Similar results are found when the Akaike information criterion is used; see table 6 in the appendix.

such intervention (coffee and sugar). When international commodity prices are used, it will be made clear in the text.

4.1 Significance and Speed of Pass-Through

We measure the speed of pass-through as the number of months in which the impulse response functions of producer and consumer prices to a commodity price shock are significantly different from zero, using 95 percent confidence bands.[21]

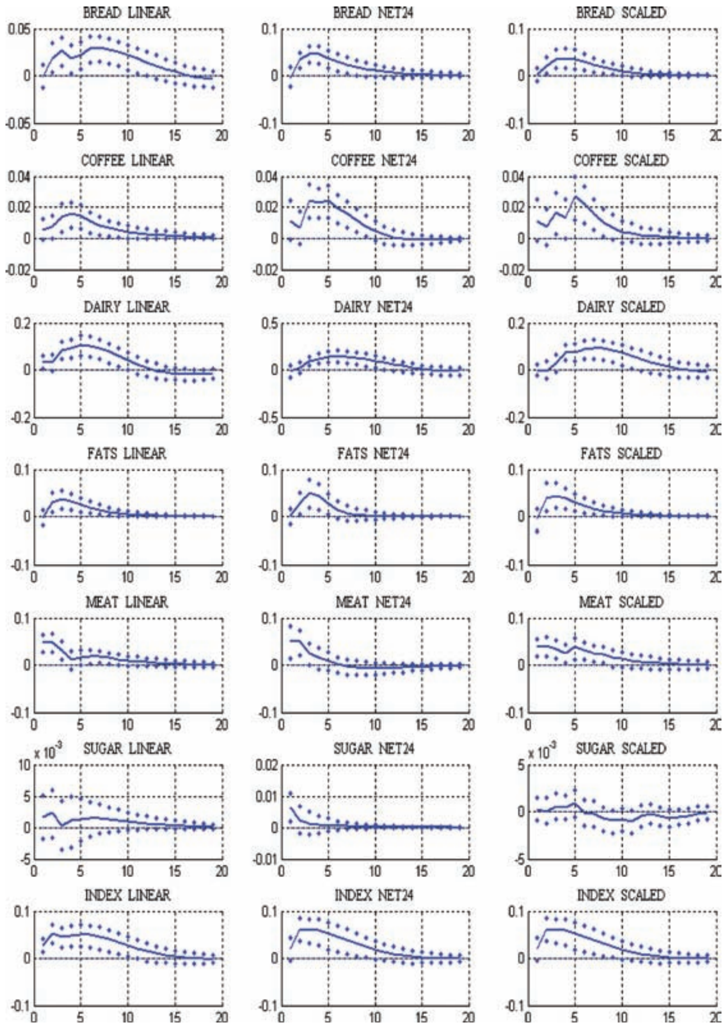
Figure 3 reports the impulse response functions for seven HICP food items (cereal, coffee, dairy, fats, meat, sugar, and the aggregate EU food index) and three model specifications (linear, Net24, and scaled).[22] With few exceptions, commodity price changes are generally found to significantly affect prices further down the food production chain. Beyond the variability across specifications, there are indications that the patterns of pass-through differ significantly across food items.

Focusing on shock persistence, table 3 shows that the fastest pass-through occurs for meat items (two months in the asymmetric and Net24 specifications, where the transformed variable already incorporates some delay, and seven months in the linear and scaled models). Fats products also display a relatively fast pass-through of between four and ten months, depending on the specification. The impulse response function for sugar products decreases quickly and is not significant at the 95 percent confidence level. For this item there is no systematic pass-through from commodity price shocks. Shocks to coffee prices are found to have a protracted impact on retail prices, with persistence ranging between seven and eight months in the various specifications. Cereal and dairy products present the slowest pass-through, possibly as a consequence of their relatively long processing time. Finally, the regression using the aggregate food commodity index indicates that a change in food commodity prices affects retail food prices for around eight or nine months. The long-ranging predictive power of EU internal food commodity prices,

[21] The confidence bands are based on a bootstrapping procedure with 1,000 draws (see Efron and Tibshirani 1993).

[22] Figure 6 in the appendix shows the impulse responses of HICP food prices for the asymmetric and Net12 specifications.

Figure 3. Impulse Response Functions: HICP Food Prices (percentage point)



Notes: The figure shows the impulse responses of HICP food prices (solid lines) to a unit shock in the corresponding commodity price (or its non-linear transformations) and their 95 percent confidence intervals (dotted lines). Each row refers to the response for a specific food item (cereal, coffee, dairy, fats, meat, sugar, and the aggregate index), and each column refers to the response for each of the linear, Net24, and scaled specifications. The impulse responses are based on VAR models including food commodity prices (or their non-linear transformations), and PPI food and HICP food prices, estimated over the sample period from January 1997 to June 2009. Observations are monthly.

Table 3. Persistence of a Commodity Price Shock: HICP Food Prices (number of months)[a]

	Linear	Asymmetric	Net24	Scaled
Cereal	10	7	7	8
Coffee	8	7	8	7
Dairy	8	9	10	10
Fats	9	9	4	10
Meat	7	2	2	7
Sugar	—[c]	—[c]	c[b]	—[c]
Index	9	8	8	9

[a]Measured as the number of months in which the impulse response functions of the various HICP food items to a unit shock in commodity prices is statistically significant, using 95 percent confidence bands. The statistics reported in the table are based on various VAR specifications including food commodity prices (and their non-linear transformations), and PPI food and HICP food prices, estimated over the sample period from January 1997 to June 2009. Observations are monthly.
[b]Only contemporaneous impact is statistically significant.
[c]No statistically significant impact is identified.

together with their extreme timeliness, highlights the importance of this data set for forecasting and policymaking.[23]

These results are in stark contrast to those obtained using international commodity prices. When international commodity prices are used for cereal, dairy, fats, and meat, no significant pass-through to HICP food items is found, except for the case of dairy products (see table 9 in the appendix).

4.2 Size of Pass-Through

The cumulated impulse responses to a unit shock in commodity prices provide a measure of the overall elasticities across model

[23]Compared with HICP food prices, the pass-through to PPI food is more rapid, as one would expect (the impulse responses are significant for up to seven months; see table 8 in the appendix). For PPI food items, the relative speed of pass-through is in line with those observed for HICP food, with meat presenting the fastest pass-through, followed by fats, coffee, cereal, and dairy products. For sugar, the pass-through is instantaneous and not systematically significant across models.

Table 4. Pass-Through to HICP Food Prices (percentage point)[a]

	Cereal	Coffee	Dairy	Fats	Meat	Sugar	Weighted Average[b]
A. Linear							
Contemporaneous	0.00	0.01	0.03	0.00	0.05	0.00	0.02
One Quarter	0.06	0.04	0.24	0.10	0.14	0.01	0.12
Two Quarters	0.14	0.08	0.54	0.15	0.19	0.01	0.23
Four Quarters	0.26	0.10	0.74	0.18	0.25	0.01	0.33
B. Net 24							
Contemporaneous	0.00	0.01	−0.01	0.00	0.05	0.01	0.02
One Quarter	0.12	0.07	0.22	0.12	0.14	0.01	0.14
Two Quarters	0.21	0.12	0.65	0.17	0.15	0.01	0.26
Four Quarters	0.28	0.15	1.17	0.18	0.11	0.01	0.38
C. Scaled							
Contemporaneous	0.00	0.01	0.00	0.00	0.04	0.00	0.01
One Quarter	0.10	0.05	0.10	0.12	0.14	0.00	0.10
Two Quarters	0.18	0.11	0.35	0.19	0.24	0.00	0.22
Four Quarters	0.24	0.14	0.74	0.22	0.31	0.00	0.35

[a]Measured as the cumulated impulse responses over time to a unit shock in commodity prices. The impulse responses are calculated from VAR models including the food commodity prices (and their non-linear transformations), and PPI food and HICP food prices, estimated over the period from January 1997 to June 2009 using monthly observations. For conciseness, only the quarterly aggregations of impulse responses are reported in the table.
[b]Weighted average of the estimated impulse response functions for the individual food items reported in the columns to the left. The following weights, obtained from the relative weight of the item in the HICP basket and rebased to equal 100 over the selected components, have been used for the aggregation: cereal 25.2%; coffee 3.6%; dairy 21.8%; fats 5.2%; meat 35.0%; sugar 9.4%.

specifications and commodities.[24] These are shown in table 4, where each column reports the impact on a particular component of HICP food prices and the last column reports the weighted average of the

[24]To ensure comparability across specifications, we scale the impulse responses as follows: for *SCPI*, they are divided by the sample mean of the standard deviation (h_t); for *NCPI*, they are divided by the ratio between the standard deviation of the growth rate of commodity prices and the *NCPI*.

impacts, using the weights described in the explanatory note of the table. The impact is measured as the cumulated impulse response to the shock over time and is expressed in quarters rather than months, for the sake of conciseness.

Panel A considers the linear case. Several results stand out. First, there is a wide dispersion of elasticities across different food items: the cumulated impact after four quarters ranges from 0.01 for sugar to 0.74 for dairy products. Ample differences in the size of pass-through by component were also reported in the literature (see section 2.1), which confirms that the disaggregate approach is preferable in a pass-through context because it allows a more flexible treatment of idiosyncratic components. Second, in most cases, the contemporaneous impact of the shock is negligible. The pass-through is relatively slow and lasts up to three or four quarters depending on the food item considered. The results for food as a whole obtained through a weighted average of the individual food items show a cumulative impact on consumer prices of 0.33 in the fourth quarter after the shock.[25]

Panels B and C summarize the elasticities for our preferred non-linear models, the Net24 and scaled specifications.[26] Non-linear specifications yield on average higher elasticities than the linear case, indicating that shocks that are exceptionally large by historical standards and shocks that occur in an environment of stable prices lead, on average, to a higher impact on final consumer prices.

Two exceptions are the sugar and coffee components. Unlike the other commodities in our sample, coffee and sugar are not produced in commercial quantities in the EU. Therefore the only available commodity prices are those quoted in international markets, which are also an accurate representation of the prices faced by euro-area producers. Both have a small pass-through, a fact possibly explained by the presence of hedging practices against the short- and medium-term fluctuations in these commodity prices. Moreover, while the pass-through to sugar prices is statistically insignificant, a coffee price shock has a significant effect on consumer prices. Such difference could be explained by the limited weight of sugar in final

[25]The results at the five- and six-quarter horizons are very close to those at four quarters.

[26]Table 10 in the appendix presents the elasticities for the asymmetric and Net12 specifications.

products such as confectionery, while the weight of coffee in the production of packaged coffee and related services may be higher.

A useful check when assessing pass-through patterns is to compare the estimated elasticities in the long run with the commodity content of each food product.[27] Indeed, increases in commodity prices may be expected to lead to increases in final consumer prices that are proportional to the commodity content of the final good, keeping everything else constant. For instance, using data from the input-output tables for the United States, Hobijn (2008) estimates that commodity prices account for 25–30 percent of the overall retail price of food products, and that non-agricultural inputs, such as wages, rents, transport costs, and so on, account for the remaining share. Similarly, Bukeviciute, Dierx, and Ilzkovit (2009) calculate that agricultural products represent, on average, between 15 percent and 30 percent of the final price paid by consumers in the EU. These shares are broadly consistent with the size of the estimated elasticities reported in table 4.[28]

Overall, these results, along with the tests on the different models described in the previous section, show that, when assessing the food price pass-through, non-linearities are relevant and need to be properly accounted for. The non-linear specifications perform consistently better than the linear model and result in a higher effect of changes in commodity prices on producer and consumer prices. This result is consistent with the earlier findings in the literature (see section 2.1).

4.3 Total of Commodity-Dependent Food

The overall effect of commodity prices on the HICP food components can be calculated either by aggregating the estimated impulse responses of the models for the various food items (*bottom up*) or by constructing aggregate indices of commodity, producer, and consumer prices of food items and estimating a single VAR on these data (*top down*). The two approaches do not give necessarily the

[27]The long run is defined as the horizon at which commodity price shocks stop statistically affecting consumer prices.

[28]Table 11 in the appendix reports the corresponding impact on the PPI food items. The general pattern is the same as for HICP food items, but for PPI, the pass-through is generally higher, in line with the stylized facts illustrated in the literature review in section 2.1.

same results, because the aggregate indices may hide the specificities of the pass-through of different items and may only provide approximate results, especially in the presence of non-linear effects or strong cross-effects among different goods.[29] Having noted in table 2 that the non-linear models outperform their linear counterparts, we expect the bias of the aggregate approach to be sizable.

We compare the aggregation of the impulse responses for individual commodities in the last column of table 4 with the measure obtained from the aggregate approach (table 5, panel A). The top-down approach leads to an overestimation of the impact of a shock, as specificities and non-linearities of the pass-through of single commodities are ignored by the aggregate indices.

The results reported in table 5, panel B are based on the same (aggregate) approach as in panel A, but using international food commodity prices for cereal, dairy, fats, and meat, as opposed to EU internal market prices. The impulse responses are negligible and statistically insignificant, a result consistent with the literature based on international commodity prices.

Looking across models, the non-linear specifications consistently show higher pass-through than the linear case when the impulse responses are aggregated in the last column of table 4, but the differences between linear and non-linear models disappear in the aggregate approach, thus further confirming that the latter approach does not correctly capture asymmetries and non-linearities. The two best-performing models, the Net24 and the scaled specifications, provide similar results, with long-run elasticities of about 0.35–0.38 on the food items affected by commodities, corresponding to around 0.18 for

[29] Lütkepohl (2009) points out that it may be difficult to construct a VAR model that takes into account all the possible links among the components, and one may consider forecasting individual components and then aggregating them. While the estimation of a single VAR including all time series is asymptotically more efficient, the author argues that a simple estimation of each subcomponent followed by aggregation may describe the aggregate data better, as a VAR encompassing many subcomponents implies a high number of estimation parameters. Lütkepohl (1984) shows that this problem is particularly acute in small samples, and concludes that when "predictors based on known processes are nearly identical, the estimation part of the mean square error becomes important and generally the predictor based on the smaller model is then to be preferred." This is certainly the case in our paper, as a joint estimation would multiply exponentially the number of estimation parameters. Additionally, it is not obvious that the gains obtained by taking into account the interrelations among some food categories (e.g., coffee and meat) are relevant.

Table 5. Comparing Alternative VAR Specifications: HICP Food Prices (percentage point)[a]

	Linear	Asymmetric	Net24	Scaled
A. Aggregate Index Using EU Internal Market Prices[b]				
Contemporaneous	0.03	0.05	0.02	0.02
One Quarter	0.18	0.32	0.20	0.16
Two Quarters	0.32	0.53	0.34	0.28
Four Quarters	0.47	0.70	0.45	0.40
Six Quarters	0.48	0.72	0.46	0.41
B. Aggregate Index Using International Prices[c]				
Contemporaneous	0.00	0.00	0.00	0.00
One Quarter	0.01	0.01	0.01	0.00
Two Quarters	0.03	0.04	0.05	0.01
Four Quarters	0.06	0.09	0.10	0.02
Six Quarters	0.07	0.11	0.12	0.02

[a]The table reports the cumulated impulse responses over time of HICP food prices to a unit shock in commodity prices. The impulse responses are derived from VAR specifications including food commodity prices (and their various non-linear transformations), and PPI food and HICP food prices, estimated over the sample period from January 1997 to June 2009. Observations are monthly. For conciseness, only the quarterly aggregations of impulse responses are reported in the table.
[b]Impulse responses from the estimation of a single VAR on aggregate indices of commodity, producer, and consumer prices of food items, using a top-down approach (see footnote 12 in the main text for the details of the weights used for the construction of such aggregate indices).
[c]Same as in [b], but using prices quoted in international markets rather than EU internal market prices food commodities.

overall food inflation, given that the modeled components represent around half of the overall food consumption in the HICP.[30]

[30]The results for PPI food are comparable to those for HICP food but the pass-through elasticities are higher, as one would expect given that the PPI is measured at a higher level of the production chain (see table 11 in the appendix). Again, the results using international commodity prices imply low and insignificant pass-through, and the aggregate approach gives high and seemingly upwardly biased estimates (see table 12 in the appendix). However, the non-linear models in table 11, still preferred on the basis of our tests, produce impulse responses of similar magnitude across specifications, possibly implying that the non-linearities are mainly located in the transmission to consumer prices.

5. The Food Price Shock of 2007–08

The sharp increase in retail food prices in the euro area during the 2007–08 period was widely attributed to the pass-through of the rapid acceleration in food commodity prices in international markets.[31] Indeed, the rises in commodity prices in global markets preceded by several months the increases in producer and consumer prices in the euro area. Moreover, within food prices, the items that rose more sharply were those with a relatively high content of commodity inputs, such as cereal, fats, and dairy products, whereas seasonal items such as fruit and vegetables, items with low commodity content, such as soft drinks, and items that are mainly produced domestically, such as fish, did not increase that much. Furthermore, food inflation increased simultaneously in many economies outside the euro area during the period, suggesting a common external force behind such increases.

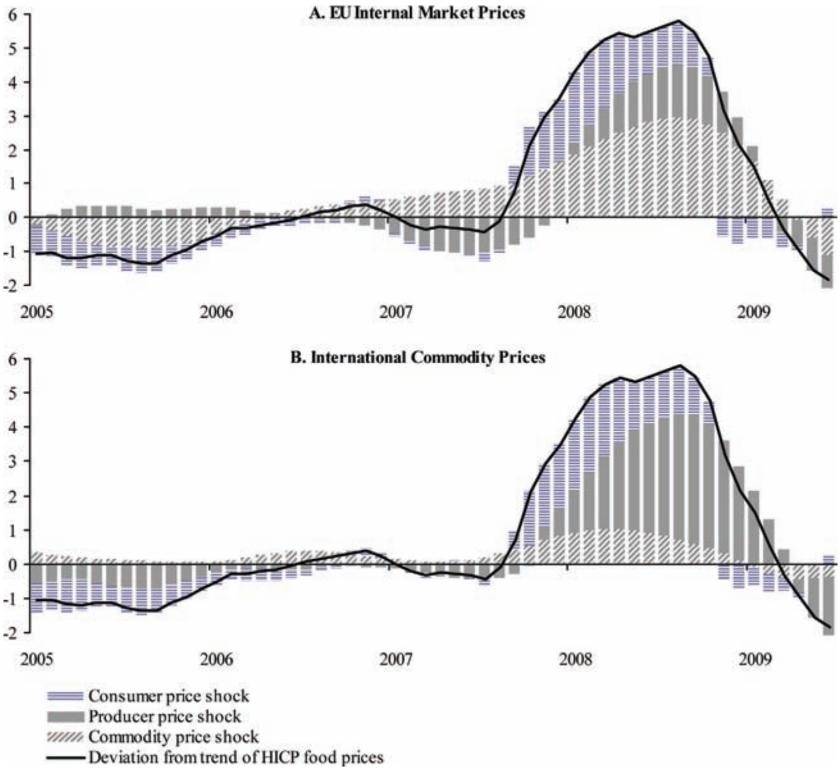
In this section, we perform a shock decomposition analysis to validate this intuitive interpretation. Formally, the decomposition is based on the innovation accounting technique proposed by Sims (1980) using the scaled VAR, which is our preferred model specification for most food items; see table 2.[32] The shocks are identified imposing the Choleski decomposition and assuming the same order as the production chain, so that innovations in commodity prices are not affected by any others in the current period, innovations in producer prices are only affected by those in commodity prices, and innovations in consumer prices are affected by those in both commodity and producer prices. For conciseness, we only consider VARs based on aggregate food price indices, which are easier to handle in practice.

The innovation accounting exercise on the scaled model with EU food commodity prices, reported in figure 4A, provides some tentative evidence that, during the 2007–08 food price shock, producer and consumer prices rose somewhat in excess of their historical norm, albeit this acceleration may have been a partial offset for the deterioration in producers' and distributors' margins observed in the

[31] A comprehensive analysis of the structural factors underpinning the rise in food commodity prices in global markets can be found, for example, in IMF (2008).

[32] As a cross-check, we have performed decompositions based on the linear model. The results are essentially the same as for the scaled model.

Figure 4. Historical Decomposition Using the Scaled VAR (percentage point)



Note: Historical decomposition of the deviation from trend of selected HICP food items, using Sims' (1980) innovation accounting methodology.

course of 2007. During that period, rising commodity prices were not passed on to the consumers, but were absorbed in producers and distributors' margins, as indicated by the below-trend increase in HICP food prices and the negative contributions of producer and consumer price shocks to the overall deviation from trend in HICP food prices in the period.

Interestingly, figure 4A also shows the strong influence of EU food commodity prices on HICP food prices, particularly during the recent food price shock. In mid-2008, around half of the total deviation from trend of HICP food prices was explained by innovations in commodity prices. This finding is in stark contrast with that in figure 4B, obtained from a similar scaled VAR, but using international food commodity prices instead of the EU internal market prices for the food commodities under the CAP. In this case, commodity price shocks account for only a small fraction of the total deviation from trend of HICP food prices. Taken together, the two figures hint that a significant pass-through can only be identified when the CAP is put into the picture. They suggest that commodity prices, when measured correctly, are responsible for a considerable part of the fluctuations in HICP food prices observed in recent years. We can thus reconcile empirical evidence and conventional wisdom.

6. Conclusions

In this paper we analyze the transmission of a commodity price shock through the food price chain in the euro area. Conventional wisdom holds that increases in commodity prices pass through, at least partially, to final consumer prices. However, a robust link between prices at different stages of the food production chain is seemingly hard to detect in formal regression models for the euro area.

We explore the hypothesis that the lack of an empirical link is a statistical artifact, stemming from the fact that the existing studies use wrong commodity data and typically neglect the role of non-linearities. To investigate this hypothesis, we use a novel database of farm-gate and internal market prices for food commodities collected in the EU, which takes implicitly into account the presence of the CAP in Europe. This is an important departure from the existing literature, which mainly focuses on food commodity prices quoted in international markets.

Our analysis highlights a number of interesting conclusions. First, moving from international commodity prices to EU internal food commodity prices allows a significant food price pass-through to be identified. Our interpretation of this finding is that the CAP plays an important role in the transmission mechanism of food price shocks in the euro area.

Second, asymmetries and non-linearities are empirically relevant and have to be accounted for when measuring the impact of a commodity price shock on consumer prices. Differences in the estimated pass-through between linear and non-linear models suggest that putting the CAP into the picture is key to a proper understanding of recent events.

Third, we estimate pass-through patterns using both aggregate and disaggregate models. The latter approach highlights important differences in the structure of pass-through for the various items, which are mostly lost when aggregate indices are used. The clear implication of this finding for modeling and forecasting is that the pass-through should be preferably estimated at a disaggregate level.

Overall, when the appropriate data set and methodology are used, it is possible to identify a significant and long-lasting food price pass-through in Europe. The results of our regressions are applied to the strong increase in food prices in the 2007–08 period. The decomposition exercise shows that commodity prices are the main determinant of the increase in producer and consumer prices, thus solving the pass-through puzzle highlighted in the existing literature for the euro area.

A few implications of our findings for the monitoring, modeling and forecasting of food prices in the euro area are worth mentioning. The CAP plays an important role in the transmission mechanism of food price shocks in the euro area, and the novel database adopted in this paper provides valuable information for the assessment of near-term food price developments. Moreover, models of pass-through for the euro area should be preferably estimated at a disaggregated level and should ideally allow for non-linear pass-through.

Appendix. Additional Tables and Figures

Table 6. Akaike Information Criterion

	Linear	**Asymmetric**	**Net24**	**Scaled**
Cereal	−5.31	−6.26	−6.67	**−6.96**
Coffee	0.89	−0.60	−2.03	**−4.41**
Dairy	−4.39	−5.57	**−6.31**	−5.92
Fats	1.32	0.52	−0.45	**−1.94**
Meat	−4.85	−5.65	−6.32	**−6.85**
Sugar	−3.81	−4.80	**−5.72**	−4.98
Index	−6.93	−7.78	**−8.11**	−7.97

Notes: Information criteria across various VAR specifications including food commodity prices (and their non-linear transformations), and PPI food and HICP food prices. The various VARs are estimated over the sample period from January 1997 to June 2009 using monthly observations. Preferred models are in bold in the table.

Table 7. Information Criteria: Models with International Food Commodity Prices

	Linear	**Asymmetric**	**Net24**	**Scaled**
A. Schwarz Criterion				
Cereal	−2.99	−3.81	**−4.65**	−4.58
Coffee	1.31	−0.28	−1.60	**−3.61**
Dairy	0.04	−1.27	−2.80	**−5.47**
Fats	2.46	1.71	0.42	**−1.44**
Meat	−1.70	−2.80	−4.67	**−5.62**
Sugar	−3.19	−4.18	−5.47	−4.37
Index	−4.02	−5.26	−6.20	**−6.30**
B. Akaike Criterion				
Cereal	−3.23	−4.05	**−4.90**	−4.83
Coffee	0.89	−0.60	−2.03	**−4.41**
Dairy	−0.39	−1.70	−3.22	**−5.89**
Fats	2.21	1.29	0.18	**−1.87**
Meat	−2.50	−3.61	−5.28	**−6.43**
Sugar	−3.81	−4.80	**−5.72**	−4.98
Index	−4.63	−5.69	**−7.00**	−6.72

Notes: Information criteria across various VAR specifications including food commodity prices (and their non-linear transformations), and PPI food and HICP food prices. The various VARs are estimated over the sample period from January 1997 to June 2009 using monthly observations. Preferred models are in bold in the table.

Table 8. Persistence of a Commodity Price Shock: PPI Food Prices (number of months)[a]

	Linear	Asymmetric	Net24	Scaled
Cereal	8	5	5	7
Coffee	7	5	7	5
Dairy	7	7	8	8
Fats	5	4	2	4
Meat	3	1	c[b]	3
Sugar	—[c]	—[c]	—[c]	—[c]
Index	7	6	6	7

[a]Measured as the number of months in which the impulse response functions of the various PPI food items to a unit shock in commodity prices is statistically significant, using 95 percent confidence bands. The statistics reported in the table are based on various VAR specifications including food commodity prices (and their non-linear transformations), and PPI food and HICP food prices, estimated over the sample period from January 1997 to June 2009. Observations are monthly.
[b]Only contemporaneous impact is statistically significant.
[c]No statistically significant impact is detected.

Table 9. Persistence of a Shock in International Commodity Prices: HICP Food Prices (number of months)[a]

	Linear	Asymmetric	Net24	Scaled
Cereal	—[b]	—[b]	—[b]	—[b]
Coffee	8	7	8	7
Dairy	10[c]	9[c]	11[d]	9[c]
Fats	—[b]	—[b]	—[b]	—[b]
Meat	—[b]	—[b]	—[b]	—[b]
Sugar	—[b]	—[b]	c[e]	—[b]
Index	10[f]	12[f]	8[c]	—[b]

[a]Measured as the number of months in which the impulse response functions of the various HICP food items to a unit shock in international commodity prices is statistically significant, using 95 percent confidence bands. The statistics reported in the table are based on various VAR specifications including food commodity prices (and their non-linear transformations), and PPI food and HICP food prices, estimated over the sample period from January 1997 to June 2009. Observations are monthly.
[b]No statistically significant impact is identified.
[c]No statistically significant impact between zero and three months.
[d]No statistically significant impact between zero and five months.
[e]Only contemporaneous impact is statistically significant.
[f]No statistically significant impact between zero and four months.

Table 10. Pass-Through to HICP Food Prices (percentage point)[a]

	Cereal	**Coffee**	**Dairy**	**Fats**	**Meat**	**Sugar**	**Weighted Average**[b]
A. Asymmetric							
Contemporaneous	0.00	0.01	0.03	0.00	0.07	0.01	0.03
One Quarter	0.16	0.05	0.43	0.14	0.20	0.01	0.21
Two Quarters	0.28	0.12	0.98	0.22	0.26	0.01	0.39
Four Quarters	0.36	0.15	1.48	0.26	0.33	0.02	0.55
B. Net12							
Contemporaneous	0.00	0.01	−0.01	0.00	0.05	0.01	0.02
One Quarter	0.12	0.05	0.22	0.09	0.13	0.01	0.13
Two Quarters	0.20	0.10	0.63	0.15	0.15	0.02	0.25
Four Quarters	0.27	0.13	1.14	0.19	0.14	0.02	0.38

[a]Measured as the cumulated impulse responses over time to a unit shock in commodity prices. The impulse responses are calculated from VAR models including the non-linear transformations of the food commodity prices, and PPI food and HICP food prices, estimated over the period from January 1997 to June 2009 using monthly observations. For conciseness, only the quarterly aggregations of impulse responses are reported in the table.

[b]Weighted average of the estimated impulse response functions for the individual food items reported in the columns to the left. The following weights have been used for the aggregations, obtained from the relative weight of the item in the HICP basket, rebased to equal 100 over the selected components: cereal 25.2%; coffee 3.6%; dairy 21.8%; fats 5.2%; meat 35.0%; sugar 9.4%.

Table 11. Pass-Through to PPI Food Prices (percentage point)[a]

	Cereal	Coffee	Dairy	Fats	Meat	Sugar	Weighted Average[b]
A. Linear							
Contemporaneous	0.01	−0.01	0.09	0.15	0.16	0.00	0.10
One Quarter	0.22	0.07	0.50	0.44	0.28	0.00	0.29
Two Quarters	0.42	0.10	0.88	0.52	0.36	0.01	0.45
Four Quarters	0.57	0.13	0.98	0.55	0.41	0.01	0.51
B. Asymmetric							
Contemporaneous	0.03	0.00	0.14	0.19	0.23	0.00	0.14
One Quarter	0.42	0.09	0.77	0.61	0.40	−0.01	0.44
Two Quarters	0.62	0.16	1.40	0.72	0.50	−0.01	0.67
Four Quarters	0.69	0.18	1.81	0.76	0.56	−0.01	0.82
C. Net12							
Contemporaneous	0.02	0.01	0.05	0.14	0.11	0.00	0.07
One Quarter	0.30	0.08	0.45	0.41	0.17	0.01	0.24
Two Quarters	0.44	0.13	0.95	0.49	0.16	0.01	0.40
Four Quarters	0.50	0.17	1.43	0.53	0.14	0.01	0.53
D. Net24							
Contemporaneous	0.02	0.00	0.05	0.11	0.10	0.00	0.06
One Quarter	0.31	0.10	0.46	0.28	0.11	0.01	0.22
Two Quarters	0.46	0.16	0.98	0.28	0.07	0.01	0.36
Four Quarters	0.52	0.18	1.46	0.27	−0.01	0.01	0.47
E. Scaled							
Contemporaneous	0.03	−0.01	0.05	0.16	0.15	0.00	0.08
One Quarter	0.29	0.08	0.25	0.52	0.36	0.00	0.26
Two Quarters	0.44	0.15	0.59	0.61	0.46	−0.01	0.41
Four Quarters	0.51	0.18	0.92	0.65	0.53	−0.02	0.54

[a]Measured as the cumulated impulse responses over time to a unit shock in commodity prices. The impulse responses are calculated from VAR models including the food commodity prices (and their non-linear transformations), and PPI food and HICP food prices, estimated over the period from January 1997 to June 2009 using monthly observations. For conciseness, only the quarterly aggregations of impulse responses are reported in the table.

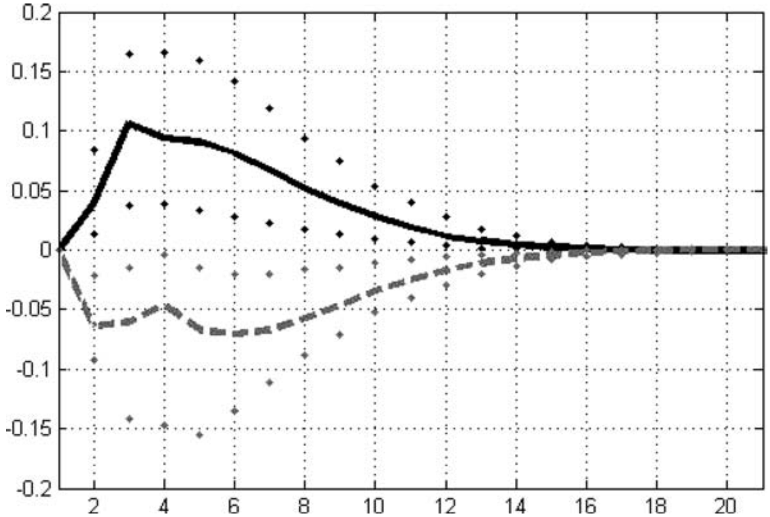
[b]Weighted average of the estimated impulse response functions for the individual food items reported in the columns to the left. The following weights have been used for the aggregations, obtained from the relative weight of the item in the PPI basket, rebased to equal 100 over the selected components: cereal 6.2%; coffee 5.9%; dairy 27.9%; fats 6.7%; meat 37.7%; sugar 15.6%.

Table 12. Comparing Alternative VAR Specifications: PPI Food Prices (percentage point)[a]

	Linear	Asymmetric	Net24	Scaled
A. Aggregate Index Using EU Internal Market Prices[b]				
Contemporaneous	0.10	0.17	0.09	0.09
One Quarter	0.45	0.63	0.34	0.37
Two Quarters	0.69	0.93	0.53	0.56
Four Quarters	0.81	1.09	0.65	0.67
Six Quarters	0.78	1.09	0.64	0.67
B. Aggregate Index Using International Prices[c]				
Contemporaneous	0.01	0.02	0.00	−0.02
One Quarter	0.09	0.13	0.06	0.01
Two Quarters	0.13	0.20	0.12	0.02
Four Quarters	0.16	0.27	0.18	0.04
Six Quarters	0.16	0.29	0.18	0.04

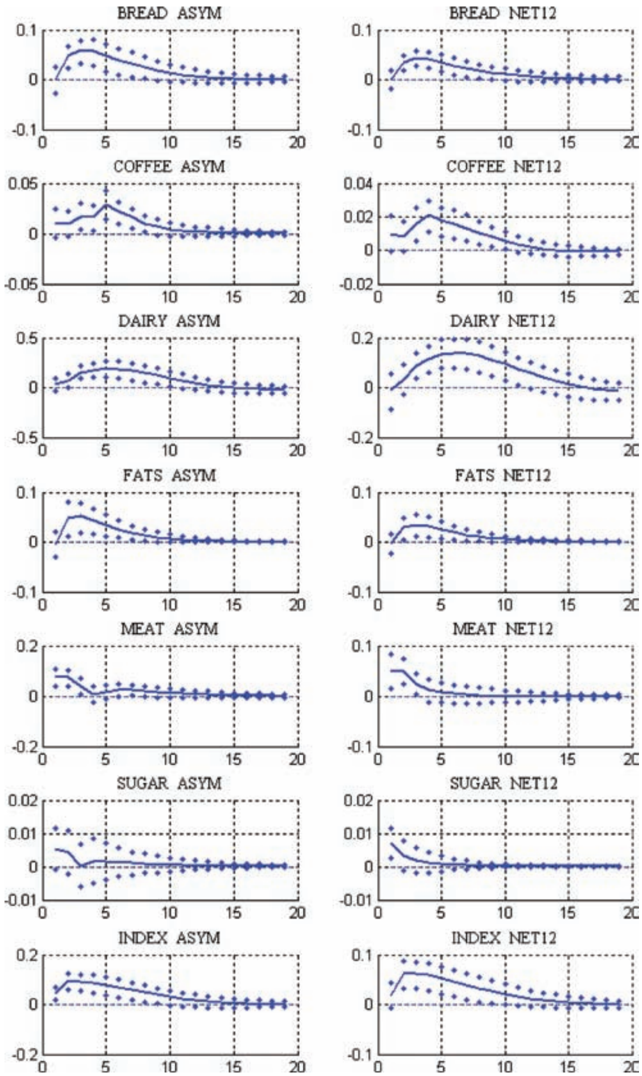
[a]The table reports the cumulated impulse responses over time of PPI food prices to a unit shock in commodity prices. The impulse responses are derived from VAR specifications including food commodity prices (and their various non-linear transformations), and PPI food and HICP food prices, estimated over the sample period from January 1997 to June 2009. Observations are monthly. For conciseness, only the quarterly aggregations of impulse responses are reported in the table.
[b]Impulse responses from the estimation of a single VAR on aggregate indices of commodity, producer, and consumer prices of food items, using a top-down approach (see footnote 12 in the main text for the details of the weights used for the construction of such aggregate indices).
[c]Same as in [b], but using prices quoted in international markets rather than EU internal market prices food commodities.

Figure 5. Impulse Responses of HICP Food Prices to an Asymmetric Shock Using the Kilian-Vigfusson Methodology (percentage point)



Notes: The figure shows the impulse response to a positive (continuous black line) and negative (dashed gray line) food commodity price shock, together with the respective confidence bands (dotted lines) based on the Kilian-Vigfusson methodology. Responses are from a VAR estimated over the aggregate index.

Figure 6. Impulse Response Functions of HICP Food Prices (percentage point)



Notes: The figure shows the impulse responses of HICP food prices (solid lines) to a unit shock in commodity prices, together with the 95 percent confidence interval (dotted lines). The charts in the rows refer to the responses for specific food items (cereal, coffee, dairy, fats, meat, sugar, and the aggregate index), and the columns refer to the responses for the asymmetric and Net12 specification. The impulse responses are based on VAR models including the non-linear transformation of the food commodity price, and PPI food and HICP food prices, estimated over the sample period from January 1997 to June 2009. Observations are monthly.

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