Food price pass-through in the euro area: the role of asymmetries and non-linearities

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Abstract

In this paper we analyse the pass-through of a commodity price shock along the food price chain in the euro area. Unlike the existing literature, which mainly focuses on food commodity prices 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 food data. Overall, when the appropriate dataset and methodology are used, it is possible to identify a significant and long-lasting food price pass-through. The results of our regressions are applied to the strong increase in food prices in the 2007-08 period; a simple 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.

Keywords: food commodity prices; inflation; non-linearities; pass-through.

JEL classification: C32; C53; E3; Q17.

The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank, its Governing Council or the Eurosystem. The authors wish to thank Hans-Joachim Klöckers, Angela Maddaloni, José Marín Arcas, Aidan Meyler, Julian Morgan, an anonymous referee and participants at an internal ECB seminar for their valuable comments, suggestions and discussions. All remaining errors are the sole responsibility of the authors.

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Non-technical summary

This paper analyses the transmission of commodity price shocks along the food price chain in the euro area. Conventional wisdom holds that increases in commodity prices are passed through, at least partially, to retail prices. Yet, formal statistical tests typically struggle to find a robust food price pass-through in the euro area. What explains this puzzle? One hypothesis is that the existing studies look at the wrong food commodity data: the international commodity prices that are at the heart of most empirical investigations are a poor approximation for the commodity cost pressures faced by euro area producers. This is because they do not account for the distortions induced by the Common Agricultural Policy 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, but so far they have been neglected in the context of food prices.

We investigate these hypotheses using a novel database of farm-gate and internal market prices of food commodities collected in the European Union. These prices take implicitly into account the presence of the Common Agricultural Policy in Europe. We also model several departures from the linear pass-through benchmark and compare alternative specifications with aggregate and disaggregate food data.

Our investigation highlights a number of interesting results. Contrary to the existing literature, we find evidence of a statistically and economically significant food price pass-through in the euro area, provided that the Common Agricultural Policy is put into the picture. We also find that asymmetries and non-linearities are statistically and economically significant, and hence have to be accounted for in order to precisely measure the impact of a commodity price shock on consumer prices. A model-based decomposition of the factors driving the rise in food prices at the consumer level between 2006 and mid-2008 shows that commodity prices were a key determinant of the increase in food consumer prices, thus solving the pass-through puzzle highlighted in the literature. Finally, the disaggregate approach highlights important differences in the structure of pass-through for the various food items, which are lost when aggregate indices are used.

A few implications of our findings for the monitoring, modelling and forecasting of food prices in the euro area are worth mentioning. The Common Agricultural Policy plays an important role in the transmission mechanism of food price shocks in the euro area and the novel database adopted in this paper may provide 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.

"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]

"[A]nnual 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, 23 May 2007[3]

1. Introduction

It is widely believed that commodity price shocks pass through, at least partially, to final consumer prices. Policymakers and economic observers, for example, have relied on this argument to explain the surge in retail food prices observed in many developed and developing economies between 2006 and mid-2008, as the opening quotes indicate. However, somewhat in defiance of these accounts, a number of empirical investigations have struggled to find an economically and statistically significant pass-through between international food commodity prices and final consumer prices for the euro area (see IMF, 2008a; Benalal et al, 2004; Chauvin and Devulder, 2008).[4] By contrast, there is evidence of a robust pass-through between the two variables for other major economies outside the euro area (see IMF, 2008b).

What explains the low estimates of food price pass-through in the euro area and why are formal empirical investigations at odds with common sense? This paper attempts to shed some light on the issues. Improving the understanding of the dynamic relationship between commodity prices and the retail prices of food products has clear benefits for inflation forecasting and the implementation of monetary policy, as food represents almost one-fifth of euro area consumption and food prices have been a key driver of the sharp rises and falls in headline inflation in recent years. Energy prices have also been a major influence on overall inflation over the period, but with half the weight of food, they have attracted undoubtedly much more attention, both

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

[2] See the Editorial of the September 2008 issue of the Monthly Bulletin of the European Central Bank.

[3] "Fears over food price inflation" by Jenny Wiggins, Financial Times, London, 23 May, 2007.

[4] In Benalal et al (2004), food commodity prices appear as a determinant in the processed food price equation for the euro area, but only with a long lag of six months and a relatively small coefficient, implying an economically trivial impact on the dependent variable. The equation for unprocessed food prices does not include food commodity prices as a determinant. In Chauvin and Devulder (2008), processed food prices do not depend on food commodity prices. They depend on non-oil import prices, but only with a lag of two quarters and with an economically miniscule impact, relative to unit labour cost, which is the main explanatory factor. As in Benalal et al (2004), the unprocessed food price equation does not depend on food commodity prices, nor does it incorporate import prices.

in the literature and in the economic profession. Furthermore, some of the factors that have underpinned the rises and falls in commodity prices in recent years are still in place (structural shift in food demand due to rising income in developing countries, demographic growth) or can quickly materialize again (bad weather, bad crops) and while the recent peaks may not represent a new norm, the volatility of commodity prices may be expected to remain high in international markets going forward. Looking at the pass-through mechanism in this context comes clearly at a premium.

Two hypotheses may help explain why the empirical literature has been unable to capture the full extent of the food price pass-through in the euro area. One is that the international prices that are typically at the heart of the existing studies of pass-through may not be the right gauge of commodity cost pressures in the euro area. Being quoted in global markets, such prices do not account for the presence of the Common Agricultural Policy (CAP) in the European Union (EU). Certain features of the CAP introduce price distortions for an important range of food agricultural products of which the EU is a large producer, resulting in a disconnection between the prices in the EU and those quoted in international markets. For these products, international prices may provide a poor guide to the true input cost pressures faced by producers and retailers along the food production chain. They may give a wrong signal when tested in formal models of pass-through for the euro area.

A second hypothesis is that the pass-through may be non-linear. It may depend, for example, on the sign, size and volatility of the impulse. Such effects have been shown to matter for the transmission of oil price shocks to both real and nominal variables (see, for example, Hamilton, 1996; and Jiménez-Rodríguez and Sánchez, 2005), but so far they have been neglected in the context of food prices.

In line with these hypotheses, this paper contributes to the literature in two important dimensions. First, it uses a recent database of farm-gate and internal market prices for food commodities collected in the EU, which take implicitly into account the role of the CAP. The database, explained in further detail in Section 2, is produced by the European Commission (EC) and contains detailed price information for several food agricultural commodities produced directly in the EU. In comparison with the prices of internationally traded food commodities normally used in previous studies, the Commission's database collects the prices of food items observed inside the EU, thereby capturing the presence of the CAP, which has the effect of shielding EU agricultural commodity prices from developments abroad.

Second, it employs econometric techniques aimed at capturing possible non-linearities in the transmission of food price shocks. We take this possibility into account by comparing a linear model of pass-through with models including various non-linear transformations of the prices of food commodities, which have been successfully used to link oil prices and real activity in the past (see, for example, Bernanke et al 1997; Hamilton and Herrera, 2004; and Jiménez-Rodríguez and Sánchez, 2005; among others).

An additional contribution of the paper is that it compares alternative model specifications with aggregate and disaggregate food data. There is a long tradition for assessing the relative merits of the two approaches in economic modelling, going back to the works of Theil (1954) and Grunfeld and Griliches (1960). More recent attempts include Hubrich (2005) and Benalal et al (2004), which compare the two approaches in the context of forecasting euro area inflation. This literature highlights several rationales for using aggregate indices of disaggregate variables, instead of the aggregate variable of interest directly. One is that the disaggregate approach allows a more flexible modelling 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 analyse the food items that are more directly related to commodity prices, whereas the overall food price index would include also items that are not obviously exposed to commodity price changes (such as tobacco, fruits and vegetables). However, the aggregate approach also presents potential advantages: the noise in the individual food data may average out in the aggregate. Furthermore, since the models for the disaggregate variables are bound to be misspecified, the accuracy of the aggregate may not necessarily improve, whereas idiosyncratic misspecification errors may cancel out when an aggregate model is used. 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 individual subcomponents of this index – cereals, coffee, dairy, fats, meat, and sugar. We compare pass-through patterns from 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 subcomponents of these indices. These VAR methods allow us to measure the pass-through, while controlling for other determinants of inflation.

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. This is a less stringent assumption than it might at first sight appear, if we consider that food commodities are homogeneous, storable and transportable goods, which, in the absence of trade restrictions, could be easily exchanged internationally, arbitraging away most price differentials. Moreover, we find that the disaggregate approach performs better than its aggregate counterpart, a result that we attribute to the more flexible modelling of idiosyncratic components in the former approach. Asymmetries and non-linearities are also statistically and economically significant, and hence have to be accounted for properly when measuring the impact of a commodity price shock on consumer prices.

Finally, a historical decomposition of the factors driving the rise in food prices at the consumer level between 2006 and mid-2008 indicates that commodity price shocks explain the bulk of the observed increase, albeit the commodity price shock seems to have triggered also a reaction in producer and consumer prices that is somewhat over and above the historical norm. While the increase partly offsets past deterioration in profit margins for producers and distributors, the size of the increase suggests that producers and distributors may have raised prices in excess of what would have been commanded by a simple pass-through mechanism 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 main results. Section 5 discusses the implication of the analysis for the commodity price boom in 2007-2008. 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 generally 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. 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).

Building on this simple intuition, the theoretical literature has described several channels through which movements in commodity prices provide early warning signals about inflation. Models of cost mark-up pricing *á la* Kalecki (1971), for example, emphasise the role of idiosyncratic shocks that originate in the markets for certain commodities, such as a drought that reduces the supply of a crop pushing up prices. To the extent that these commodities are used as intermediate inputs for the production of final consumption goods, such shocks may be eventually transmitted to intermediate and final prices, if they are not absorbed in profit margins or through advances in factor productivity (see Bloch et al, 2004).

Frankel (1986), Boughton and Branson (1991) and Fuhrer and Moore (1992) provide a different account that builds on Dornbusch's (1976) classic exchange-rate model with overshooting. In these models, a surge in aggregate demand (exemplified by an unexpected increase in the money supply) causes commodity prices to jump above their new long-run value, to restore simultaneous equilibrium in the money and goods markets. Notably, the shock originates in the retail sector, but commodity prices are still the first to react as they are more flexible.[5]

Overall, this literature predicts that movements in commodity prices typically anticipate changes further down the price chain and that commodity prices may be expected to correlate positively with intermediate and retail prices. In practice, however, 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, despite the existence of a theoretical link, commodity prices may have little predictive ability for inflation if consumer prices are subject to several offsetting shocks at any one time. Third, the theoretical literature suggests that the increased attention of monetary authorities to commodity prices may have weakened their signalling 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]

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[5] Blomberg and Harris (1995) highlight a third linkage, partly related to the two described above, which works through expectations. Because commodity prices respond quickly to general inflationary pressures, they may be seen as a hedge against inflation. In anticipation of an increase in inflation, investors may turn to commodities, pushing up their prices. In this way, rising commodity prices may harbinger future inflationary pressures along the pricing chain. Traditionally, precious metals provide a useful hedge against inflation, while this channel seems less relevant for other primary commodities (including food agricultural commodities), whose prices have been on a clear secular downward trend when deflated by some price index of manufactured products (see Bloch et al, 2004). Owing to their greater flexibility, the prices of primary commodities can be generally expected to rise faster than overall inflation in response to a macroeconomic impulse. However, they tend to fall behind overall inflation in the long run, as productivity growth in the primary sector outpaces that in the industrial sector.

[6] Fuhrer and Moore (1992), for example, show that if commodity prices are included in the monetary policy reaction function, even mild pressures on commodity prices can lead to perverse outcomes, with increases in commodity prices leading to declines in final goods prices. Although the signal of

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, they 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 et al (1998) argue that the non-linear adjustment to price shocks could also be explained by the inventory behaviour of retailers. Gardner (1975) and Kinnucan and Forker (1987) argue that government intervention may lead to non-linear price adjustments if price movements 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.

However, although menu and adjustment costs, information asymmetries, and government intervention are important sources of non-linear price responses, it is the presence of non-competitive behaviours in the market place that is often identified as the main culprit for such non-linearities. According to this view, abuses of market power and oligopolistic behaviours in the food production and distribution sectors imply that a price reduction at the farm level is only slowly and possibly not fully transmitted through the food price chain, whereas price increases at the farm level are quickly passed on to final consumer prices.[7]

To control for the possible existence of a non-linear relationship between commodity and consumer prices, we consider three types of non-linear specifications in our empirical analysis: asymmetric, threshold and state-dependent. Asymmetric pass-through occurs when a price shock is transmitted differently depending on whether the shock is positive or negative. Threshold effects occur when larger shocks bring about a different response than smaller shocks. State-dependent pass-through occurs when the transmission depends on particular features affecting the state of the economy.

2.1. Empirical literature

The empirical literature on food price pass-through is fairly abundant. Differences in data sources, sample periods (and hence sets of underlying shocks), estimation methodologies, motivations and focus of the various studies imply that the quantitative results are not directly comparable. However, these studies provide a qualitative indication of broad trends and regularities, which can be grouped in five main stylised facts (SF):

SF1: *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 across the main 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

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incipient inflation pressures stemming from commodity prices is correct, little actual inflation occurs because of offsetting monetary policy. Blomberg and Harris (1995) consider this as an example of Goodhart's law, whereby "any statistical regularity will tend to collapse once pressure is placed on it for control purposes".

[7] A rich literature models the impact of market power on price transmission. An overview can be found in Vavra and Goodwin (2005) and Meyer and von Cramon-Taubadel (2004).

and product categories in the United States 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.

SF2: *The food price pass-through differs across countries*. For example, IMF (2008b) estimates that, on average, the pass-through in emerging markets is about three times higher than in advanced economies. While this fact is consistent with the higher share of food consumption and the greater importance of material costs in production in developing economies, composition effects alone cannot explain the totality of the difference. Structural factors, such as the openness to foreign trade and competitive conditions in the internal markets for the various food products are likely to play an equally important role.[8] Underscoring this point, London Economics (2004) details significant variations in pass-through elasticities across individual EU countries, including those at comparable levels of economic development, where compositional effects would not be expected to matter that much.

SF3: The size of the food price pass-through has changed over time. Blomberg and Harris (1995) provide evidence that the relationship between food commodity and consumer prices has weakened since the mid-1980s in the United States. Furlong and Ingenito (1996) also document a shift in the relationship in the same period. Arguably, the weakening of the link reflects the falls in the demand for commodities, which was particularly noticeable at that time, as final demand moved steadily away from goods with high commodity content (such as food) toward sectors with low commodity content (such as IT and services). The reduced role for commodities in the economy means that price pass-through effects are weakened, and also that rises in commodity prices may signal price pressures in a narrow part of final demand rather than in economy-wide demand – i.e. a change in relative prices as opposed to a general inflationary bout. The timing of the change in the mid-1980s also coincides with a period of rapid acceleration in financial innovation, which may have reduced the size of pass-through by allowing access to ever more sophisticated instruments to hedge commodity price volatility.

SF4: *The pass-through to producer prices is higher than to consumer prices*. Only a few studies make this comparison for food prices, directly or indirectly (see Bukeviciute et al, 2009), but a common finding is invariably that the extent of pass-through gets smaller the further one moves along the price chain.[9] The intuition behind this result is rather straightforward: as the share of total value added accounted for by commodity inputs diminishes when one moves from intermediate to final consumption goods, so does the extent of pass-through. A relatively high proportion of the total value added of final consumption goods is represented by non-commodity related input costs, such as wages, rents, and packaging.

SF5: *The food price pass-through is asymmetric*. Numerous studies looking at the transmission of price shocks in agricultural commodity markets find evidence that intermediate and consumer prices tend to respond faster to input cost increases than to decreases. The finding seems robust to the particular 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 prevalent in the majority of producer and consumer markets. He concludes that asymmetric price transmission is the rule rather than the exception. A comprehensive review of this literature can be found in Meyer and von Cramon-

[8] Analysing cross-country patterns in food pass-through in Latin America, Rigobon (2008) finds that while the long-run pass-through elasticities are broadly comparable across countries, the timing of pass-through is different, ranging from 12 months in Chile to 24-30 months in Peru and Colombia.

[9] In contrast, this result is well known in the exchange rate pass-through literature, see for example Frankel et al (2005).

Taubadel (2004). Vavra and Goodwin (2005) dwell also on the various econometric techniques that have been 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 analyse the competitive behaviour 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 consistent analyses have been carried out for the euro area, most likely 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 for the euro area focus on international commodity prices (see, for example, IMF, 2008a; 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.[10] Finally, while asymmetries have been thoroughly analysed by the literature, other types of non-linearities, such as threshold effects and state dependent 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 the pass-through behaviour in aggregate and disaggregate models, which allow a more detailed account of idiosyncratic behaviours. Finally, the paper incorporates elements of econometric theory aimed at accounting for the possible impact of non-linearities in the pass-through relationship.

2.2. Data description

To analyse 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 borne by formal statistical tests in our dataset for the euro area.[11]

The series used for the empirical investigation are the food price components (and individual food sub-components) 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 of a relevant series has to take account of the fact that, for a number of food crops 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 has been attributed to the presence of the CAP, which has cushioned

[10] 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 both Belgium and the euro area. While the dataset and methodology are similar to those employed in the present paper, two important differences need to be highlighted. First, unlike the study by the National Bank of Belgium (2008), which focuses only on the linear case, this paper examines also several non-linear specifications. Second, National Bank of Belgium (2008) focuses on aggregate indices of food price inflation, whereas in our model we analyse the transmission to individual food price sub-components.

[11] 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 modelling strategy. In the interest of brevity, we do not report these results in the paper, but they are available from the authors upon request.

the transmission of global shocks to EU internal prices through its mechanisms of intervention prices, price support, import tariffs and quotas. Neglecting the influence of the CAP might be an important reason why in the past commodity prices were found to be largely insignificant in explaining food prices at the consumer level in the euro area, as we discussed in the previous section.

To control for the influence of the CAP on the size and speed of the transmission of global commodity price shock in the euro area, we use in this paper an hybrid dataset 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.[12] The dataset includes 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 28 individual price series.[13]

[Insert Table 1 about here]

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 dataset. 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.

[Insert Figure 1 about here]

Several points can be highlighted from the Figure. First, we observe that while international commodity prices are generally more volatile that 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 stabilisation mechanism mainly against price falls. Second, unsurprisingly, consumer prices show higher correlation with EU internal 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 described 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 to the corresponding food price components of consumer and producer prices.[14] Figure 2,

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[12] 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.

[13] In order to construct aggregate commodity price indices for the four product groups reported in the Table, as a first approximation and for lack of a better weighting scheme, we consider the un-weighted, arithmetic mean of the price series (in level) listed in each group.

[14] 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

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

[Insert Figure 2 about here]

3. Methodology

Many studies look at the price transmission mechanism in food commodity markets. The vast majority adopts structural models of mark-up pricing, where consumer prices are a function of a number of cost factors (unit labour cost, cost of energy, the exchange rate) including commodity prices, as well as indicators of the cyclical position of the economy (see Bloch et al, 2004). This approach has the benefit of allowing to model the determinants of retail prices, but the choice of explanatory factors is somewhat arbitrary.

An alternative approach used by Furlong and Ingenito (1996), Krichene (2008), and Zoli (2009), among others, is to model the pass-through by means of VAR models.[15]

This paper follows the latter approach. It considers an unrestricted vector autoregression model for the euro area and investigates the interaction between commodity prices, producer prices and consumer prices for the six food commodities mentioned in the previous section (cereal, meat, dairy, fats, coffee and sugar). It also considers an aggregate version of the model, were individual series are aggregated to form price indices.

The reduced form VAR may be written as

$$y_t = k + \sum_{i=1}^{p} A_i y_{t-i} + \varepsilon_t \qquad (1)$$

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 $i = 1, 2, ..., p$, and ε_t is the $(n \times 1)$ generalisation of a white noise process.[16] 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-

commodity prices, by contrast, we adopt "use-based" weights. These are derived 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, 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. See: http://www.ecb.int/pub/pdf/mobu/mb200812en.pdf.

[15] A comprehensive review of the empirical methodologies employed in the literature is in Vavra and Goodwin (2005).

[16] The system is identified using a Choleski decomposition and imposing that commodity prices (and their non-linear transformation, as we will discuss later) come first in the ordering of innovations, followed by producer and consumer prices. This ordering corresponds to the pricing chain assumption.

differences 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: a) asymmetric specification, in which increases and decreases in the price of a commodity are considered as separate variables;[17] b) scaled specification, which takes the volatility of commodity prices into account;[18] c) net1 specification, where the relevant commodity price variable is characterized by the net amount by which these prices have gone up over the last year;[19] and d) net2 specification, which is a modification of the latter and considers two years instead of one.

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:

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

The scaled specification captures the threshold effects, which occur when larger shocks bring about a different response than smaller shocks. The following *AR(12)-GARCH(1,1)* representation of a specific food commodity price is considered:

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

The net1 specification considers the variable $NCPI_t$, which is defined as the amount by which the log of a specific commodity price in month t, cp_t, exceeds the maximum value over the previous twelve months; and 0 otherwise. That is:

$$NCPI_t = \max(0, cp_t - \max\{cp_{t-1}, \ldots, p_{t-12}\})$$

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

[18] The scaled specification was developed by Lee *et al* (1995) in the context of the analysis of oil price impact on economic activity. The idea behind this specification is that oil price increases after a long period of price stability have more dramatic macroeconomic consequences than those that are mere corrections of oil price decreases during the previous quarter. We adapt this specification to our context considering 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.

[19] The net specification was proposed by Hamilton (1996) in the context of oil shock impacts. 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 any decrease observed in the previous quarters.

The net2 specification considers the variable $NCPI2_t$, which is defined as $NCPI_t$, considering 24 months instead of 12 months.[20] The net1 and the net2 specifications are slightly different ways to capture the state-dependent pass-through, which occurs when the transmission of a shock depends on particular features affecting the state of the economy.

4. Results

This section reports the main findings of the paper. On the basis of the Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (SC), reported in Table 2, we conclude that non-linearities matter for all food items, irrespective of the (international or EU internal) measure of commodity prices.

[Insert Table 2 about here]

Looking at the models with EU internal commodity prices in Panel A, the scaled specification is preferred for cereal, coffee, fats and meat; the net2 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 pass-through than if the same shock occurred in a more volatile environment. Likewise, the net2 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 of commodity price shocks may be different depending on the size and sign of the underlying shock.

At the aggregate level, the net1 and net2 models outperform the scaled specification. We conjecture that this is because price uncertainty is often market-specific and, therefore, aggregate models may find it more difficult to capture this uncertainty properly. Along with other considerations, this result indicates 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 introduced (see Panel B in Table 2).

In what follows, we will 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 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 function of producer and consumer prices to a commodity price shock is significantly different from zero, using 95% confidence bands. With only few exceptions (mostly in the transmission to producer prices) commodity price changes are generally found to significantly affect prices further down the food production chain.

Table 3 reports the persistence (in number of months) of a commodity price shock on food producer prices. Beyond the variability across specifications, there are indications of different speeds of pass-through for different commodity shocks. The fastest pass-through is found on meat items, where the significant lags vary from a

[20] We construct scaled, net1 and net2 specifications also for commodity price decreases (that is, $SCPD_t$, $NCPD_t$, and $NCPD2_t$). However, in no case these are found to have a statistically significant impact on consumer prices, and hence they have been eliminated from the VAR models.

contemporaneous effect to three months in the net1 and net2 models, where the transformed variable already incorporates some delay. Fats products have also a relatively fast pass-through, with significant lags of between 2 and 5 months, depending on the specification. The impulse response function for sugar products decreases quickly and is not significant at the 95% confidence level. For this item there is no systematic pass-through from commodity price shocks to producer prices. Shocks in cereal and coffee prices are found to have a protracted impact on food producer prices, with persistence ranging from 5 to 8 months in the various specifications. Finally, dairy products present the slowest pass-through, possibly as a consequence of the relatively long processing times of these products.
Unsurprisingly, the aggregate regression using the aggregate Food Commodity Index (FCI) yields intermediate results, with persistence ranging between 6 and 7 months.

[Insert Table 3 about here]

The pass-through of a commodity price shock to food consumer prices reported in Table 4 takes as expected a longer time (the impulse responses are significant for up to 10 months). The relative speeds of pass-through for different commodity shocks are in line with those observed for PPI, with meat presenting the fastest pass-through, followed by fats, coffee, cereal and dairy products. We now observe an instantaneous pass-through for sugar, which however is not systematically significant across models. The aggregate regression using the FCI indicates that a change in food commodity prices can affect the corresponding components of HICP food for around eight to nine months. The long-ranging predictive power of EU internal food commodity prices, together with their extreme timeliness, highlights the importance of this dataset for forecasting and policymaking.

[Insert Table 4 about here]

These results strongly contrast with those obtained using the internationally traded commodity prices (not reported in the table).[21] When international commodity prices are used (for cereal, dairy, fats and meat), no significant pass-through to HICP food items is found, except for a quick pass-through (of 2 months) in the case of fats and a somewhat longer pass-through (of 7-8 months) in the case of dairy products.

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 different model specifications and commodities.[22] These are shown in Tables 5 and 6, where each column reports the impact on a particular component of HICP and PPI food prices and the last column reports the weighted average of the impacts, using the weights reported on the top row of the table. The impact is measured as the cumulated impulse response to the shock over time, in this case expressed in quarters rather than months, for the sake of conciseness.
Table 5 reports the pass-through patterns for various HICP food items. Panel A considers the linear case. A number of results stand out. First, there is a large dispersion of elasticities across different food items: the cumulated impact after 6

[21] They are available from the authors upon request.

[22] We make all specifications comparable to each other by scaling down the impulse responses to commodity disturbances in the cases of SCPI (dividing by the sample mean of the standard deviation, h_t), *NCPI* and *NCPI2* (in both cases dividing by the ratio between standard deviations of growth rate of commodity price and such variables).

quarters ranges from 0.02 for sugar to 0.64 for dairy products. Large differences in the size of pass-through by component were also reported in the literature (see SF1 in Section 2.1) and they confirm that the disaggregate approach should be preferred when modelling food price pass-through 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, 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 0.31 in the long run, and a peak of 0.33 in the fourth quarter.[23]

Panels B to E summarize the elasticities for the different non-linear specifications. Non-linear specifications yield on average higher elasticities, indicating that positive shocks, 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 than in the simple, linear case.

Two exceptions are sugar and coffee. Unlike the other commodities in our sample, coffee and sugar are not produced in commercial quantities within the euro area. Therefore the only available commodity price is the international price, which is also an accurate representation of the price of coffee and sugar within the euro area. Both have a small pass-through, a fact possibly explained by the presence of hedging practices against the short and medium term price fluctuations in these commodities. 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 the final products of 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. In fact, 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% of the overall price paid by consumers to purchase food products off the supermarket shelves. Indeed, a good chunk of the actual price of food products includes non-agricultural inputs, such as wages, rents and transport costs. A similar proportion to the one calculated for the United States was also identified in a study for the EU: Bukeviciute et al (2009) calculates that agricultural products represent on average between 15% and 30% of the final price paid by consumers in the EU. Broadly speaking these shares would be consistent with the size of the estimated elasticities reported in the Table.

[Insert Table 5 about here]

Table 6 reports the corresponding impacts on the food items in the PPI. Without going through the details, the general pattern is similar to that described above for food HICP items – only for producer prices, the pass-through is, as expected, generally higher, consistent with the stylised facts reported in the literature (see SF4 in Section 2.1).

[Insert Table 6 about here]

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

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 case, and result in a higher effect of changes in commodity prices on producer and consumer prices. This result is also consistent with the earlier findings in the literature, (see in particular SF5 in Section 2.1).

4.3. Total of commodity-dependent food

The overall effect of commodity prices on the HICP-food and PPI-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 same results, because the aggregate indices may hide the specificities of the pass-through of different items and, especially in presence of non-linear effects, may provide only approximate results. Having noted in Table 2 that the non-linear models outperform their linear counterparts, we expect the bias of the aggregate approach to be sizeable.

Table 7 compares the aggregation of the impulse responses for the single commodities (Panel A) with the same measure obtained with the aggregated approach (Panel B). We argue that the strong difference in the results of the two approaches shows that the disaggregated approach is more useful. The top-down approach leads to an overvaluation of the impact of a shock, as specificities and non-linearities of the pass-through of single commodities are ignored when computing the aggregate indices.

The results reported in Panel C are based on the same (aggregated) approach as in Panel B, but using international food commodity prices 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 models with non-linearities show consistently higher pass-through when impulse responses are aggregated in the first panel of Table 7, but the difference between linear and non-linear models disappears in the aggregate approach, thus confirming further that the latter does not correctly capture asymmetries and non-linearities. The two best performing models, the net2 and the scaled specifications, provide similar results, with long-run elasticities of about 0.36 on the food items affected by commodities, corresponding to 0.18 for overall food inflation, given that the modelled components represent around half of the overall food consumption basket in the HICP.

[Insert Table 7 about here]

The results for food producer prices are broadly similar to those for the HICP, but the levels of pass-through are, as one would expect given that the PPI is measured at a higher level of the production chain, higher in value than those for HICP (see Table 8). Again the results produced using international commodity prices imply low and insignificant pass-through, and the aggregated approach produces very high and seemingly upwardly biased estimates. The main difference with the previous table is found comparing models: the non linear models, still preferred on the basis of our tests, produce impulse responses of similar magnitude, possibly implying that the non-linearities are mainly located in the transmission to consumer prices.

[Insert Table 8 about here]

5. Explaining the hump in 2007-08

Consumer prices of food products rose sharply in many developed and developing economies between 2006 and mid-2008, before falling back amid a deep global recession.[24] Policymakers and economic observers were almost unanimous in suggesting that these increases reflected to a large extent the pass-through to domestic inflation of the rapid acceleration in food commodity prices in international markets. Three main arguments were cited to support the causal link between domestic inflation and food commodity prices: *i)* the rises in commodity prices generally preceded the increases in producer and consumer prices in most countries; *ii)* within food prices, the items that contributed most to the increase in food inflation were those with a relatively high content of commodity inputs, such as cereals, oilseeds and dairy products, whereas seasonal items such as fruits and vegetables and items that are only produced domestically and not traded internationally (such as fish) did not increase that much; *iii)* food inflation increased simultaneously in several major economies during the period, suggesting a common external force behind such increases.

In this section, a shock decomposition analysis is performed to validate this intuitive interpretation. We use the innovation accounting technique proposed by Sims (1980) and apply it on different VAR specifications, by imposing a Choleski decomposition. We assume that the ordering of the equations for the decomposition is the same as in the pricing chain approach (i.e. commodity prices are first, followed by producer and consumer prices), 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 commodity and producer prices. For simplicity, we mainly focus on decompositions based on linear, aggregate VARs, which are easier to handle in practice. However, for illustration purposes, we also report the results for the aggregate, scaled VAR specification.

We compute the decomposition by writing the identified VAR of equation (1) in moving average form:

$$y_t = \sum_{i=0}^{\infty} M_i \varepsilon_{t-i}$$

[24] These price increases reflected, in part, temporary factors, most notably supply disruptions due to bad weather conditions in some important exporting countries which affected wheat crops particularly in Australia, Eastern Europe, and Northern Africa. The increases were magnified by the lack of sector-specific spare capacity, low inventories at the onset of the boom and the imposition of trade restrictions in major food-exporting countries in reaction to the shock. Structurally, food commodity prices were also bolstered by the strong rise in the global demand for foodstuffs resulting from the changes in food consumption patterns in developing economies as well as from the emergence of new sources of demand for some agricultural commodities, such as the production of biofuels. Cross-commodity price linkages may have also played a role, with for example rising animal feed costs feeding through to meat and milk prices. Furthermore, high oil prices contributed to raise the cost of energy-intensive inputs for agriculture, such as fertiliser, fuel for transport and machinery. A comprehensive analysis of the structural factors underpinning the rise in food commodity prices in global markets can be found, for example, in IMF (2008b). The role of financial speculation in commodity markets is unclear. During the commodity price boom, public allegations were widespread that speculation also had a substantial impact on commodity prices (see "Data drilling", The Economist, 9 September 2009). But empirical research has only found limited evidence that the financial innovation in commodity markets may have distorted spot prices (IMF, 2008b; Domaski and Heath, 2008). Krichene (2008) argues that expansionary monetary policies in key industrial countries and sharply depreciating US dollar exchange rate were major driving factors behind the commodity boom over the period.

and decomposing the data in each period into the sum of the contributions of each element of ε_t, so that the sum of the contributions reproduces the observed y_t.

The innovation accounting exercise on the linear model with international commodity prices, reported in Figure 3, shows the little influence of these prices on HICP food prices: the contribution of commodity prices reaches at most 0.5 percentage point (pp) in mid-2008, a time when food price inflation at the consumer level was running at a full 6 pp above trend.

[Insert Figure 3 about here]

This finding is in stark contrast with those in Figure 4, derived from a similar linear specification, but using EU internal market prices instead of international prices for food commodities. In this case, the contribution of commodity price shocks during the 2008 peak amounts to around 3.5 pp of commodity-related food prices. In other words, in mid 2008, commodity price shocks accounted for almost two-thirds of the total deviation of HICP food prices from trend – a contribution that is by far unprecedented during the sample period. We can thus reconcile empirical evidence and conventional wisdom and conclude that commodities, when measured correctly, have been responsible for a considerable part of the fluctuations in HICP food prices observed in recent years.

Interestingly, Figure 4 also provides some tentative evidence that producer and consumer prices rose somewhat in excess of their respective historical norms in the wake of the shock, albeit this acceleration may have been a partial offset for the deterioration in producers' and distributors' margins observed in the 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 falling contributions of producer and consumer price shocks to the overall deviation from trend in HICP food prices in the period.

[Insert Figure 4 about here]

Finally, as a simple illustration of the role played by non-linearities in the recent commodity-driven spike in inflation, we compute the contribution of food commodity prices in the context of the scaled model. Figure 5 depicts the decomposition using international commodity prices, whereas Figure 6 depicts the decomposition using EU internal market prices. Taken together, these figures hint to the same conclusions as the linear specification, namely that a significant pass-through can only be identified when EU internal commodity prices are used. This implies that although non-linearities matter from a theoretical and empirical point of view, accurate measurement of commodity price developments is by far more important when it comes to correctly interpreting recent inflation developments.

[Insert Figures 5 and 6 about here]

6. Concluding remarks

In this paper we analyse empirically 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 artefact, 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 statistically and economically significant, and hence have to be accounted for when measuring the impact of a commodity price shock on consumer prices. However, their main contribution is in calculating the pass-through correctly rather than in finding one. As long as the CAP is put into the picture, differences in estimated pass-through between linear and non-linear models suggest that the key to a proper understanding of recent events was the accurate measurement of commodity prices.

Third, we estimate pass-through patterns both at the aggregate level (condensing all food commodities into a single index) and by individual component. The approach by component 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 modelling and forecasting is that the pass-through should be preferably estimated at a disaggregated level.

Overall, when the appropriate dataset 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; a simple 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.

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Table 1 – Composition of DG AGRI database

Cereals	*Dairy*	*Fats*	*Meat*
Feed oats	*Skim milk powder (SMD)*	*Oil 2%*	*Beef*
Milling oats	*SMD - intervention quality*	*Extra vergin oil 0.5%*	*Joung beef*
Feed rye	*SMD - animal feed quality*	*Extra vergin 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			

Source: European Commission.

Table 2 – Akaike (AIC) and Schwartz Bayesian (SC) information criteria

		Linear	*Asymmetric*	*Net1*	*Net2*	*Scaled*
Panel A: with EU internal market prices						
Cereal	AIC	-5.31	-6.26	-6.52	-6.67	-6.96
	SC	-4.70	-5.84	-6.09	-6.24	-6.72
Coffee	AIC	0.89	-0.60	-1.92	-2.03	-4.41
	SC	1.31	-0.28	-1.31	-1.60	-3.61
Dairy	AIC	-4.39	-5.57	-6.24	-6.31	-5.92
	SC	-3.97	-5.15	-5.81	-5.88	-5.67
Fats	AIC	1.32	0.52	-0.13	-0.45	-1.94
	SC	1.56	0.76	0.11	-0.02	-1.69
Meat	AIC	-4.85	-5.65	-6.18	-6.32	-6.85
	SC	-4.23	-5.03	-5.57	-5.71	-6.04
Sugar	AIC	-3.81	-4.80	-5.56	-5.72	-4.98
	SC	-3.19	-4.18	-5.32	-5.47	-4.37
FCI	AIC	-6.93	-7.78	-8.13	-8.11	-7.97
	SC	-6.50	-7.35	-7.70	-7.69	-7.54
Panel B: with international food commodity prices						
Cereal	AIC	-3.23	-4.05	-4.71	-4.90	-4.83
	SC	-2.99	-3.81	-4.46	-4.65	-4.58
Coffee	AIC	0.89	-0.60	-1.92	-2.03	-4.41
	SC	1.31	-0.28	-1.31	-1.60	-3.61
Dairy	AIC	-0.39	-1.70	-2.77	-3.22	-5.89
	SC	0.04	-1.27	-2.34	-2.80	-5.47
Fats	AIC	2.21	1.29	0.37	0.18	-1.87
	SC	2.46	1.71	0.61	0.42	-1.44
Meat	AIC	-2.50	-3.61	-5.17	-5.28	-6.43
	SC	-1.70	-2.80	-4.56	-4.67	-5.62
Sugar	AIC	-3.81	-4.80	-5.56	-5.72	-4.98
	SC	-3.19	-4.18	-5.32	-5.47	-4.37
FCI international	AIC	-4.63	-5.69	-6.76	-7.00	-6.72
	SC	-4.02	-5.26	-6.34	-6.20	-6.30

Source: authors' calculations.
Note: comparison of AIC and SC statistics for various VAR specifications including food commodity prices (and their non-linear transformations), PPI-food and HICP-food prices. The various VARs are estimated over the sample period from January 1997 to June 2009, using monthly observations.

Table 3 – Persistence of a unit shock in commodity prices: PPI-food[(a)]
(number of months)

	Linear	Asymmetric	Net 1	Net 2	Scaled
Cereal	8	5	5	5	7
Coffee	7	5	8	7	5
Dairy	7	7	8	8	8
Fats	5	4	3	2	4
Meat	3	1	c[(b)]	c[(b)]	3
Sugar	-[(c)]	-[(c)]	-[(c)]	-[(c)]	-[(c)]
FCI	7	6	6	6	7

Source: authors' calculations
Notes: (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% confidence bands. The statistics reported in the table are based on various VAR specifications including food commodity prices (and their non-linear transformations), 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 can be detected.

Table 4 – Persistence of a unit shock in commodity prices: HICP-food[(a)]
(number of months)

	Linear	Asymmetric	Net 1	Net 2	Scaled
Cereal	10	7	7	7	8
Coffee	8	7	9	8	7
Dairy	8	9	10	10	10
Fats	9	9	10	4	10
Meat	7	2	2	2	7
Sugar	-[(c)]	-[(c)]	c[(b)]	c[(b)]	-[(c)]
FCI	9	8	8	8	9

Source: authors' calculations
Notes: (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% confidence bands. The statistics reported in the table are based on various VAR specifications including food commodity prices (and their non-linear transformations), 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 could be identified.

Table 5 – Pass-through of a commodity price shock to HICP-food prices[(a)]
(percentage point, unless otherwise stated)

	Cereal	*Coffee*	*Dairy*	*Fats*	*Meat*	*Sugar*	*Weighted sum* [(b)]
Weights (percent) [(c)]	25.2	3.6	21.8	5.2	35.0	9.4	100.0
Panel A: Linear							
contemporaneous	-0.0014	0.0056	0.0307	-0.0019	0.0477	0.0016	0.0233
1 quarter	0.0614	0.0429	0.2369	0.0960	0.1391	0.0052	0.1226
2 quarters	0.1413	0.0767	0.5361	0.1548	0.1939	0.0094	0.2317
3 quarters	0.2152	0.0930	0.7103	0.1762	0.2303	0.0125	0.3029
4 quarters	0.2583	0.1011	0.7383	0.1829	0.2487	0.0144	0.3270
5 quarters	0.2714	0.1051	0.6918	0.1849	0.2554	0.0153	0.3229
6 quarters	0.2650	0.1071	0.6412	0.1855	0.2564	0.0157	0.3108
Panel B: Asymmetric							
contemporaneous	-0.0011	0.0108	0.0309	-0.0038	0.0730	0.0052	0.0327
1 quarter	0.1640	0.0528	0.4284	0.1414	0.1962	0.0110	0.2133
2 quarters	0.2843	0.1195	0.9790	0.2215	0.2602	0.0147	0.3927
3 quarters	0.3425	0.1408	1.3421	0.2511	0.3071	0.0166	0.5052
4 quarters	0.3636	0.1480	1.4782	0.2611	0.3317	0.0176	0.5496
5 quarters	0.3682	0.1503	1.4723	0.2643	0.3412	0.0180	0.5531
6 quarters	0.3677	0.1508	1.4184	0.2654	0.3428	0.0181	0.5419
Panel C: Net 1							
contemporaneous	-0.0002	0.0095	-0.0105	-0.0024	0.0486	0.0070	0.0156
1 quarter	0.1175	0.0548	0.2238	0.0930	0.1350	0.0132	0.1335
2 quarters	0.2031	0.1016	0.6345	0.1536	0.1502	0.0152	0.2547
3 quarters	0.2469	0.1260	0.9671	0.1785	0.1498	0.0159	0.3402
4 quarters	0.2656	0.1330	1.1413	0.1879	0.1447	0.0162	0.3817
5 quarters	0.2717	0.1323	1.1833	0.1914	0.1400	0.0163	0.3910
6 quarters	0.2730	0.1299	1.1548	0.1927	0.1371	0.0164	0.3840
Panel D: Net 2							
contemporaneous	-0.0037	0.0113	-0.0132	0.0018	0.0505	0.0065	0.0150
1 quarter	0.1213	0.0650	0.2215	0.1239	0.1402	0.0112	0.1375
2 quarters	0.2118	0.1248	0.6494	0.1715	0.1475	0.0127	0.2607
3 quarters	0.2552	0.1487	0.9925	0.1772	0.1287	0.0133	0.3409
4 quarters	0.2750	0.1515	1.1677	0.1769	0.1103	0.0135	0.3776
5 quarters	0.2824	0.1485	1.2059	0.1762	0.0985	0.0136	0.3835
6 quarters	0.2847	0.1462	1.1739	0.1759	0.0925	0.0136	0.3750
Panel E: Scaled							
contemporaneous	0.0019	0.0109	-0.0007	-0.0045	0.0397	0.0003	0.0144
1 quarter	0.0960	0.0482	0.0953	0.1191	0.1412	0.0014	0.1023
2 quarters	0.1839	0.1135	0.3532	0.1888	0.2368	0.0019	0.2200
3 quarters	0.2247	0.1349	0.5997	0.2148	0.2893	-0.0007	0.3041
4 quarters	0.2389	0.1418	0.7396	0.2237	0.3126	-0.0024	0.3468
5 quarters	0.2427	0.1435	0.7782	0.2266	0.3202	-0.0042	0.3589
6 quarters	0.2434	0.1439	0.7644	0.2276	0.3206	-0.0050	0.3561

Source: authors' calculations

Notes: (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 food commodity prices (and their non-linear transformations), 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 (cereal, coffee, dairy, fats, meats, sugar) using the weights reported in the first row of the table. (c) Based on HICP weights, rebased to equal 100 over the selected components.

Table 6 – Pass-through of a commodity price shock to PPI-food prices[(a)]
(percentage point, unless otherwise stated)

	Cereal	*Coffee*	*Dairy*	*Fats*	*Meat*	*Sugar*	*Weighted sum [(b)]*
Weights (percent) [(c)]	6.2	5.9	27.9	6.7	37.7	15.6	100.0
Panel A: Linear							
contemporaneous	0.0064	-0.0079	0.0905	0.1461	0.1625	-0.0007	0.0961
1 quarter	0.2247	0.0684	0.5034	0.4398	0.2825	0.0042	0.2948
2 quarters	0.4163	0.1006	0.8783	0.5214	0.3564	0.0120	0.4475
3 quarters	0.5332	0.1171	1.0115	0.5430	0.3926	0.0144	0.5083
4 quarters	0.5723	0.1253	0.9752	0.5489	0.4058	0.0150	0.5065
5 quarters	0.5593	0.1294	0.8906	0.5505	0.4069	0.0149	0.4829
6 quarters	0.5250	0.1314	0.8339	0.5509	0.4038	0.0147	0.4639
Panel B: Asymmetric							
contemporaneous	0.0287	-0.0016	0.1421	0.1946	0.2265	-0.0040	0.1390
1 quarter	0.4170	0.0885	0.7731	0.6137	0.4022	-0.0130	0.4371
2 quarters	0.6191	0.1601	1.4016	0.7215	0.4955	-0.0099	0.6719
3 quarters	0.6794	0.1785	1.7340	0.7524	0.5456	-0.0098	0.7903
4 quarters	0.6915	0.1847	1.8120	0.7618	0.5650	-0.0098	0.8211
5 quarters	0.6888	0.1864	1.7634	0.7648	0.5675	-0.0099	0.8086
6 quarters	0.6847	0.1867	1.6915	0.7657	0.5639	-0.0100	0.7870
Panel C: Net 1							
contemporaneous	0.0229	0.0093	0.0487	0.1448	0.1090	0.0023	0.0666
1 quarter	0.2957	0.0819	0.4548	0.4052	0.1702	0.0109	0.2428
2 quarters	0.4366	0.1349	0.9531	0.4888	0.1615	0.0123	0.3961
3 quarters	0.4865	0.1612	1.2891	0.5166	0.1483	0.0127	0.4913
4 quarters	0.5028	0.1679	1.4285	0.5265	0.1370	0.0128	0.5280
5 quarters	0.5056	0.1663	1.4330	0.5300	0.1299	0.0129	0.5269
6 quarters	0.5050	0.1633	1.3802	0.5314	0.1264	0.0129	0.5107
Panel D: Net 2							
contemporaneous	0.0219	-0.0025	0.0470	0.1077	0.1000	0.0021	0.0595
1 quarter	0.3071	0.0996	0.4648	0.2829	0.1134	0.0106	0.2177
2 quarters	0.4562	0.1645	0.9821	0.2767	0.0658	0.0116	0.3568
3 quarters	0.5025	0.1828	1.3266	0.2696	0.0204	0.0119	0.4392
4 quarters	0.5204	0.1812	1.4647	0.2657	-0.0085	0.0121	0.4676
5 quarters	0.5253	0.1766	1.4644	0.2644	-0.0231	0.0121	0.4620
6 quarters	0.5260	0.1742	1.4086	0.2640	-0.0289	0.0121	0.4441
Panel E: Scaled							
contemporaneous	0.0314	-0.0063	0.0491	0.1622	0.1537	0.0001	0.0840
1 quarter	0.2923	0.0850	0.2515	0.5195	0.3560	-0.0004	0.2620
2 quarters	0.4389	0.1510	0.5917	0.6142	0.4563	-0.0131	0.4119
3 quarters	0.4944	0.1705	0.8366	0.6416	0.5101	-0.0167	0.5063
4 quarters	0.5107	0.1759	0.9249	0.6501	0.5270	-0.0218	0.5384
5 quarters	0.5143	0.1772	0.9138	0.6528	0.5288	-0.0225	0.5364
6 quarters	0.5147	0.1773	0.8742	0.6537	0.5252	-0.0230	0.5240

Source: authors' calculations
Notes: (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 food commodity prices (and their non-linear transformations), 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 (cereal, coffee, dairy, fats, meats, sugar) using the weights reported in the first row of the table. (c) Based on HICP weights, rebased to equal 100 over the selected components.

Table 7 – Comparing alternative VAR specifications: HICP-food[(a)]
(percentage point)

	Linear	*Asymmetric*	*Net 1*	*Net 2*	*Scaled*
***Panel A: Weighted sum** [(b)]*					
contemporaneous	0.0233	0.0327	0.0156	0.0150	0.0144
1 quarter	0.1226	0.2133	0.1335	0.1375	0.1023
2 quarters	0.2317	0.3927	0.2547	0.2607	0.2200
3 quarters	0.3029	0.5052	0.3402	0.3409	0.3041
4 quarters	0.3270	0.5496	0.3817	0.3776	0.3468
5 quarters	0.3229	0.5531	0.3910	0.3835	0.3589
6 quarters	0.3108	0.5419	0.3840	0.3750	0.3561
***Panel B: FCI** [(c)]*					
contemporaneous	0.0285	0.0456	0.0190	0.0200	0.0234
1 quarter	0.1767	0.3194	0.2045	0.2018	0.1597
2 quarters	0.3246	0.5306	0.3438	0.3412	0.2831
3 quarters	0.4259	0.6516	0.4241	0.4182	0.3602
4 quarters	0.4727	0.7042	0.4606	0.4499	0.3959
5 quarters	0.4846	0.7200	0.4727	0.4580	0.4071
6 quarters	0.4819	0.7207	0.4743	0.4572	0.4078
***Panel C: FCI international** [(d)]*					
contemporaneous	-0.0001	-0.0018	-0.0025	-0.0026	0.0015
1 quarter	0.0070	0.0074	0.0065	0.0055	0.0005
2 quarters	0.0295	0.0446	0.0335	0.0470	0.0078
3 quarters	0.0488	0.0746	0.0555	0.0824	0.0140
4 quarters	0.0600	0.0932	0.0700	0.1047	0.0179
5 quarters	0.0649	0.1038	0.0791	0.1161	0.0202
6 quarters	0.0661	0.1097	0.0848	0.1199	0.0216

Source: authors' calculations
Notes: (a) the reported statistics are 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), 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) Aggregation of the estimated impulse responses for the various food items, using a bottom-up approach (see also the last column in Table 5). (c) 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 14 in the main text for the details of the weights used for the construction of such aggregate indices). (d) Same as in (c), but using prices quoted in international markets, rather than EU internal market prices for food commodities.

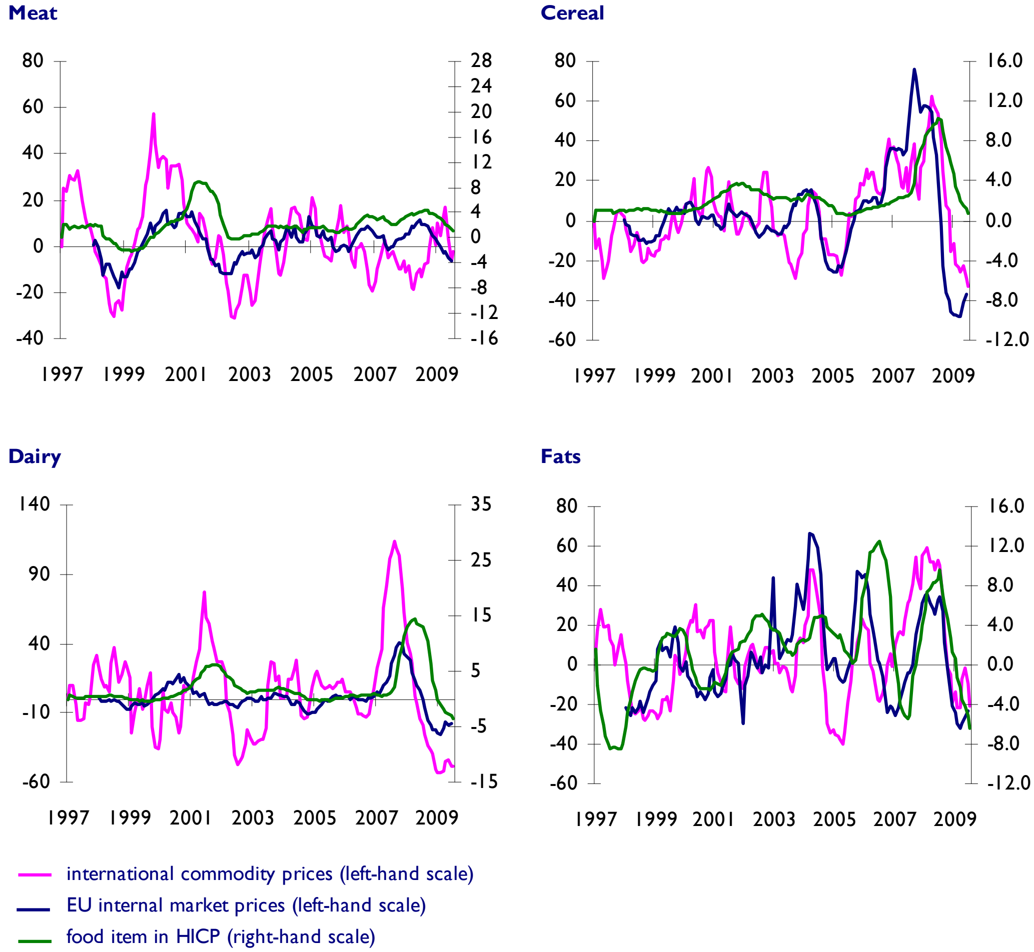
Table 8 – Comparing alternative VAR specifications: PPI-food[a]
(percentage point)

	Linear	*Asymmetric*	*Net 1*	*Net 2*	*Scaled*
Panel A: Weighted sum [b]					
contemporaneous	0.0961	0.1390	0.0666	0.0595	0.0840
1 quarter	0.2948	0.4371	0.2428	0.2177	0.2620
2 quarters	0.4475	0.6719	0.3961	0.3568	0.4119
3 quarters	0.5083	0.7903	0.4913	0.4392	0.5063
4 quarters	0.5065	0.8211	0.5280	0.4676	0.5384
5 quarters	0.4829	0.8086	0.5269	0.4620	0.5364
6 quarters	0.4639	0.7870	0.5107	0.4441	0.5240
Panel B: FCI [c]					
contemporaneous	0.1043	0.1660	0.0952	0.0905	0.0908
1 quarter	0.4496	0.6310	0.3806	0.3448	0.3689
2 quarters	0.6921	0.9259	0.5785	0.5301	0.5567
3 quarters	0.7916	1.0558	0.6720	0.6177	0.6433
4 quarters	0.8095	1.0947	0.7040	0.6458	0.6704
5 quarters	0.7970	1.0964	0.7088	0.6478	0.6717
6 quarters	0.7813	1.0885	0.7051	0.6425	0.6660
Panel C: FCI international [d]					
contemporaneous	0.0131	0.0226	0.0033	0.0018	-0.0215
1 quarter	0.0903	0.1310	0.0582	0.0586	0.0077
2 quarters	0.1280	0.2016	0.1089	0.1250	0.0220
3 quarters	0.1534	0.2437	0.1405	0.1660	0.0308
4 quarters	0.1636	0.2674	0.1597	0.1840	0.0359
5 quarters	0.1658	0.2805	0.1715	0.1875	0.0388
6 quarters	0.1646	0.2876	0.1786	0.1845	0.0404

Source: authors' calculations
Notes: (a) the reported statistics are 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), 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) Aggregation of the estimated impulse responses for the various food items, using a bottom-up approach (see also the last column in Table 6). (c) 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 14 in the main text for the details of the weights used for the construction of such aggregate indices). (d) Same as in (c), but using prices quoted in international markets, as opposed to EU internal market prices for food commodities.

Figure 1 – Consumer and commodity prices

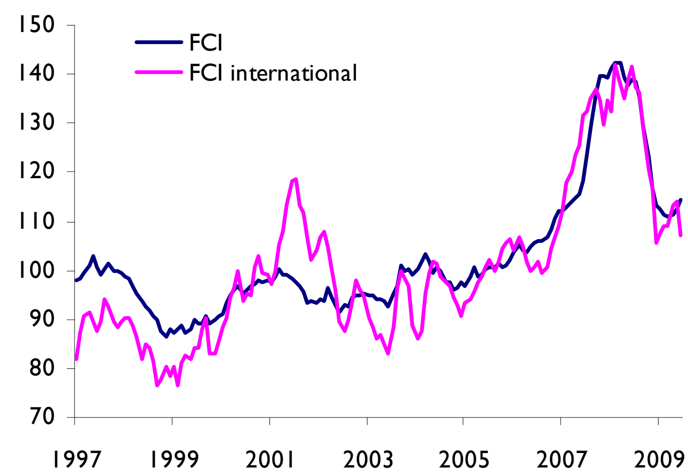
(annual percentage change)



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

Figure 2 – Food commodity indices

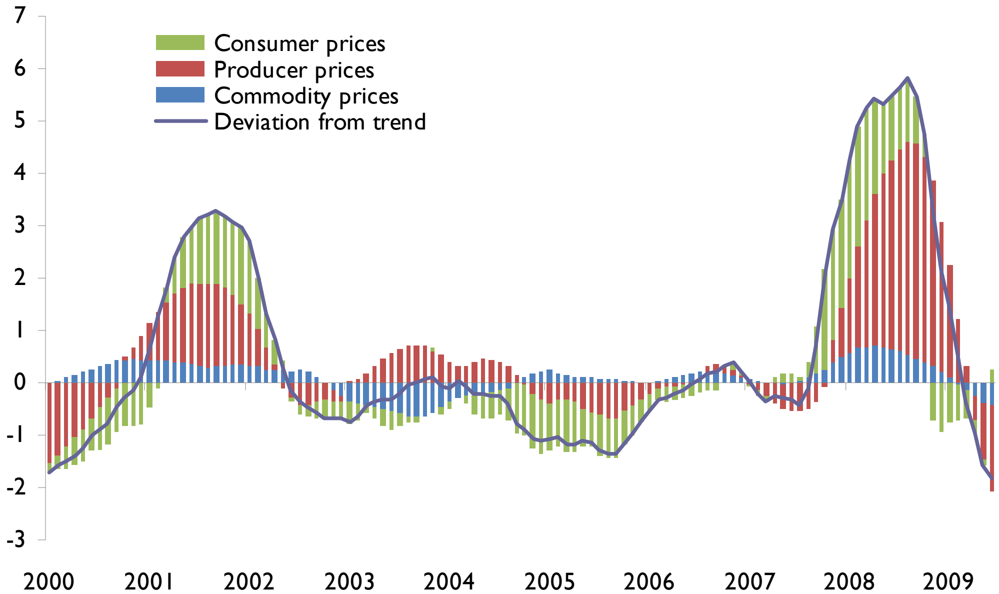
(index level 2005 = 100; in euro)



Sources: European Commission, HWWI and authors' calculations.

Figure 3 – Historical decomposition using the linear VAR: international commodity prices

(annual percentage change and percentage point)

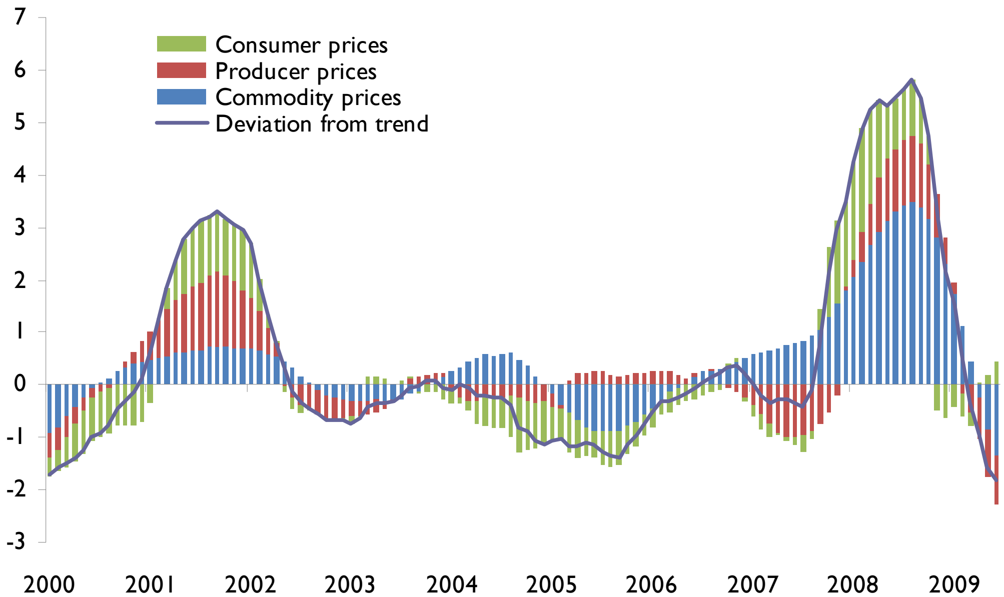


Source: authors' calculations.

Note: historical decomposition of the deviation from trend of selected HICP-food items, using Sim's (1980) innovation accounting methodology. Based on the linear VAR.

Figure 4 – Historical decomposition using the linear VAR: EU farm gate prices

(annual percentage change and percentage point)

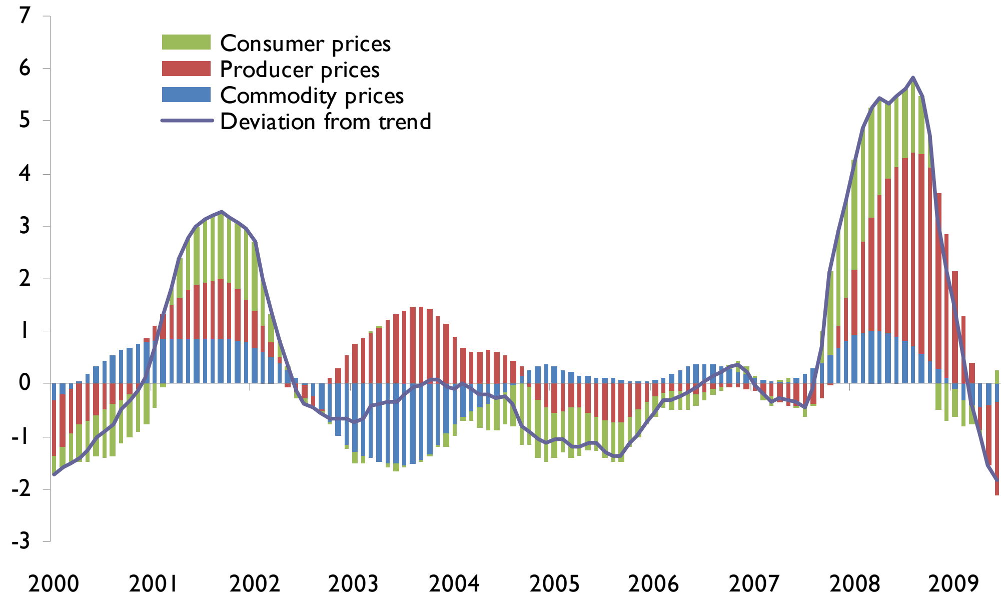


Source: authors' calculations.

Note: historical decomposition of the deviation from trend of selected HICP-food items, using Sim's (1980) innovation accounting methodology. Based on the linear VAR.

Figure 5 – Historical decomposition using the scaled VAR: international commodity prices

(annual percentage change and percentage point)

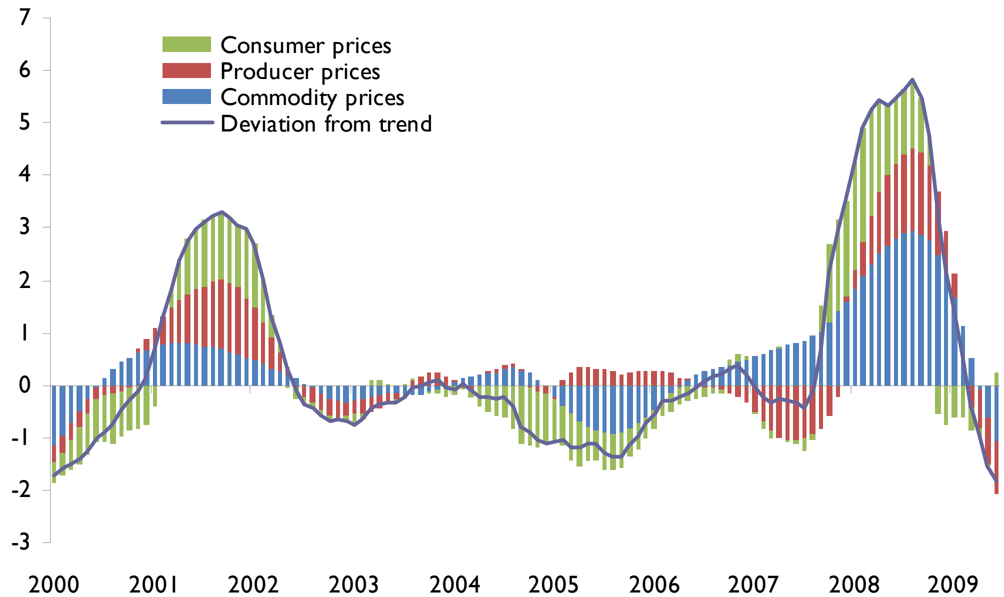


Source: authors' calculations.

Note: historical decomposition of the deviation from trend of selected HICP-food items, using Sim's (1980) innovation accounting methodology. Based on the scaled (non-linear) VAR.

Figure 6 – Historical decomposition using the scaled VAR: EU farm gate prices

(annual percentage change and percentage point)



Source: authors' calculations.

Note: historical decomposition of the deviation from trend of selected HICP-food items, using Sim's (1980) innovation accounting methodology. Based on the scaled (non-linear) VAR.