Asymmetric Price Transmission in Food Supply Chains in the European Union

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ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ ΜΕ ΘΕΜΑ :

Εμπειρική μελέτη στην μη συμμετρική μετάδοση τιμών στην εφοδιαστική αλυσίδα τροφίμων στην Ευρωπαϊκή Ένωση

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
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Περίληψη

Το ενδιαφέρον για τη μετάδοση των τιμών έχει κερδίσει την προσοχή και ο αριθμός των μελετών για το θέμα αυτό έχει αυξηθεί σημαντικά τα τελευταία χρονιά. Η τιμή θεωρείται ότι είναι ο κύριος μηχανισμός που συνδέει τα διάφορα στάδια της αλυσίδας εφοδιασμού τροφίμων.

Η παρούσα εργασία μελετά την ύπαρξη της ασυμμετρίας στη μετάδοση των τιμών κατά μήκος της αλυσίδας εφοδιασμού τροφίμων στις ευρωπαϊκές χώρες των 27. Με άλλα λόγια, η μελέτη αυτή εξετάζει τα ερωτήματα: Πόσο και πόσο γρήγορα οι αλλαγές των τιμών περνούν μέσα από τα διάφορα στάδια της αλυσίδας ; Εάν οι αυξήσεις στις τιμές παραγωγού οδηγούν σε άμεση αύξηση των τιμών καταναλωτή, επίσης εάν οι μειώσεις στις τιμές παραγωγού χρειάζονται χρόνο για να περάσουν στους καταναλωτές; Το παρόν έγγραφο έχει ως στόχο να ελέγξει την προσαρμογή των τιμών στην αλυσίδα εφοδιασμού τροφίμων η οποία είναι ένα σημαντικό χαρακτηριστικό της λειτουργίας των αγορών.

Οι τιμές των τροφίμων έχουν εμφανίσει ακραίες διακυμάνσεις τα τελευταία χρόνια, φτάνοντας σε εξαιρετικά υψηλά επίπεδα κατά το δεύτερο εξάμηνο του 2007 και τους πρώτους μήνες του 2008, προτού πέσουν ραγδαία κατά τη διάρκεια της οικονομικής κρίσης. Αυτή η αυξημένη μεταβλητότητα, τονίζει την ανάγκη να αυξηθεί η αποτελεσματικότητα της αλυσίδας εφοδιασμού τροφίμων . Οι τιμές των εμπορευμάτων είναι οι πιο σημαντικοί καθοριστικοί παράγοντες της παγκόσμιας οικονομικής απόδοσης. Οι επιχειρηματικές αποφάσεις σχετικά με την παραγωγή, την κατανάλωση και την εμπορία των επιχειρήσεων, συνδέονται άμεσα με τις αγορές εμπορευμάτων.

Στην εργασία αυτή , αρχικά αναφέρω συνοπτικά τι είναι η μη συμμετρική μετάδοση των τιμών , τα είδη ασυμμετρίας , τους παράγοντες που προκαλούν ασυμμετρία καθώς και τα αποτελέσματα της έρευνας που έκανα. Οι τιμές που χρησιμοποίησα στην ανάλυση αυτή είναι μηνιαίοι δείκτες με έτος βάσης το 2010, από τον Ιανουάριο του 2005 μέχρι τον Ιανουάριο του 2014. Χρησιμοποίησα την βάση δεδομένων της Eurostat για τους δείκτες τιμών των τροφίμων και για το πετρέλαιο την βάση δεδομένων Mundi.

Μη συμμετρική μετάδοση των τιμών υπάρχει όταν οι καθοδικές τιμές αντιδρούν με διαφορετικό τρόπο στις αλλαγές των ανοδικών τιμών . Αυτό μπορούμε να το καταλάβουμε ευκολά μέσο ενός παραδείγματος. Για παράδειγμα όταν οι τιμές των εισροών αυξάνονται , αυξάνονται και οι τιμές των έτοιμων προϊόντων, αλλά όταν οι τιμές των εισροών μειώνονται, οι τιμές των έτοιμων προϊόντων καθυστερούν να πέφτουν.

Τα είδη ασυμμετρίας είναι : ανάλογα με το μέγεθος (οδηγεί σε μια μόνιμη μετάδοση), ανάλογα με την ταχύτητα (οδηγεί σε προσωρινή μετάδοση) , συνδυασμός ταχύτητας και μεγέθους , θετική μετάδοση τιμών (όταν οι τιμές των εκροών αντιδρούν πιο γρήγορα σε αυξήσεις των τιμών των εισροών απ’ ότι σε μειώσεις) και η αρνητική

μετάδοση τιμών (όταν οι τιμές των εκροών αντιδρούν πιο γρήγορα σε μειώσεις των τιμών των εισροών απ' ότι σε αυξήσεις).
Ποιοι είναι οι παράγοντες που προκαλούν ασυμμετρία ;
Μερικοί από τους παράγοντες που προκαλούν ασυμμετρία είναι :

- Το κόστος ρύθμισης και το Menu costs (όπως το κόστος της λήψης νέων ετικετών και ενημέρωση των εταίρων της αγοράς σχετικά με τις μεταβολές των τιμών)
- Η δύναμη αγοράς (ατελής ανταγωνισμός επιτρέπει στους μεσάζοντες να κάνουν χρήση της ισχύος στην αγορά)
- Η κρατική παρέμβαση (ασυμμετρίες των τιμών μπορεί να είναι το αποτέλεσμα της κυβερνητικής παρέμβασης για τη στήριξη των τιμών παραγωγού)
- Ο πληθωρισμός
- Στρατηγικές διαχείρισης αποθεμάτων (λογιστικές μεθόδους, όπως FIFO (first in first out) θα μπορούσε να προκαλέσει ασύμμετρες στην μετάδοση των τιμών. Όταν εφαρμόζεται (last in first out ή LIFO), η επιχείρηση προσαρμόζεται πολύ γρήγορα την τιμή του σε απάντηση μεταβολές στο κόστος των εισροών)

Το μοντέλο της εφοδιαστικής αλυσίδας τροφίμων.
Η εφοδιαστική αλυσίδα τροφίμων αποτελείτε από 3 τομείς:

1. Γεωργικός τομέας
2. Μεταποιητικός τομέας
3. Λιανοπωλητές

Συγκεκριμένα οι σχέσεις που εξετάζονται στην εργασία αυτή είναι : τιμές πετρελαίου - τιμές στον γεωργικό τομέα, τιμές πετρελαίου – τιμές στον μεταποιητικό τομέα και τιμές πετρελαίου- τιμές στον λιανεμπόριο.
Το λιανικό εμπόριο τροφίμων στην Ευρωπαϊκή Ένωση χαρακτηρίζεται από την αυξημένη παρουσία μεγάλων καταστημάτων λιανικής πώλησης τροφίμων. Μέσα σε ένα μεγαλύτερο και όλο και πιο ολοκληρωμένη ευρωπαϊκή ενιαίας αγοράς, η ενοποίηση μπορεί να οδηγήσει σε βελτίωση της αποδοτικότητας και να θέσει μια πτωτική πίεση στις τιμές.
Από την άλλη πλευρά, στους τομείς της μεταποίησης τροφίμων, τα επίπεδα συγκέντρωσης ποικίλλουν σημαντικά σε όλες τις κατηγορίες των τροφίμων. Σε γενικές γραμμές, οι επιχειρήσεις σε αυτές τις πιο συγκεντρωμένες κατηγορίες τροφίμων λειτουργούν σε παγκόσμιο επίπεδο και συνήθως προσφέρουν διεθνώς επώνυμα προϊόντα.
Από τα αποτελέσματα τις έρευνας προκύπτει ότι ασυμμετρία υπάρχει σε 2 από τις 3 τομείς της εφοδιαστικής αλυσίδας τροφίμων. Ασυμμετρία υπάρχει μεταξύ τιμών πετρελαίου και τιμών στο γεωργικό τομέα . Σε βραχυπρόθεσμο επίπεδο οι τιμές των γεωργικών προϊόντων δεν αντιδρούν σε θετικές αποκλίσεις αλλά θα ανταποκριθούν στις αρνητικές αποκλίσεις κατά περίπου 1,1% ανά μήνα. Επίσης ασυμμετρία υπάρχει και μεταξύ τιμών του πετρελαίου και τιμών στο λιανεμπόριο. Οι τιμές του τομέα των καταναλωτών θα ανταποκριθούν στις θετικές αποκλίσεις κατά 2% ανά μήνα, αλλά δεν θα ανταποκριθούν στις αρνητικές αποκλίσεις.

Abstract

The agricultural sector plays a major role in European economies. Of course, it is also very important to the labour market, the income of the poorest people and food security. The food crisis of 2008 has raised numerous questions about the impact of such variability on welfare and the economic sector which directly concerns the agricultural sector. Given the importance of the agricultural sector to the economies, if governments are to take adequate measures to ensure food security, they need to have a good understanding of the functioning of their markets.

Agricultural markets have been one of the central targets for the analysis of price transmission. The interest in price transmission has recently gained attention and the amount of studies on this subject is rapidly growing. The price is considered to be the principal mechanism connecting the different stages of the food supply chain.

The present thesis studies the existence of asymmetry in the price transmission along the supply chain in the European Countries of 27. In other words, this study addresses the questions: How much and how fast are price changes passed through between the different stages of the chain? Do increases in producer prices lead to immediate increases in consumer prices and also decreases in producer prices take time to be passed down to the consumers? This document aims to check about adjustment of prices in the food supply chain, which is an important characteristic of the functioning of the markets.

Keywords: Price relationships, Asymmetric price transmission, Supply chain in EU.

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Chapter 1

Introduction

Agricultural markets have been one of the central targets for the analysis of price transmission. During the last years food prices have displayed extreme fluctuations, reaching exceptional levels in the second half of 2007 and the first months of 2008, before falling rapidly during the economic crisis. This increased volatility highlights the necessity to increase the efficiency of the food supply chain to ensure consumer food prices reflect the progression of inputs prices. Commodity prices are the most important determinants of world economic performance. Business decisions about producing, consuming and trading firms, have much to gain from fully understanding commodity markets.

The sustained rise in living standards over the last decades in the European Union resulted in a change in the structure of the production cost. The costs of food products paid by final consumers are now influenced more by costs of labor, distribution, energy and marketing, than by the costs of the raw agricultural products. Agricultural products pass through three main sectors; the agricultural sector, the food processing sector and the distribution sector, in order to be available to the consumers.

The adjustment to price shocks along the chain from producer to wholesale and to retail levels, and vice versa, is an important characteristic of the functioning of markets. As such, the process of price transmission through the supply chain has long attracted the attention of agricultural economists, as well as policy makers.

Overview of thesis:

Chapter 2 is a brief summary of relevant theory and a review of literature. The chapter is divided into four sections, namely asymmetric price transmission, types of asymmetry, causes of asymmetry and a review of literature. This chapter represents the theoretical spine of the thesis.

Chapter 3 presents a brief description of the model of the food supply chain used. It gives also a description of the empirical data, collection of these and some notes on how I have processed it. The data will also be presented here.

Chapter 4 will address in detail the econometric models used in the thesis and the formulation of them. This chapter is concluded with some remarks on the interpretation of the results.

Chapter 5 describe the analyses and the results I found. The results of the asymmetry and price transmission analyses are presented in tables and are thoroughly discussed and explained.

Chapter 6 will give a brief summary of the thesis, along with some concluding comments on my main findings and the implications of these.

Chapter 2

Price transmission

The price mechanism is the means by which resources are allocated and re-allocated within a market-based economic system. The twin forces of market demand and supply determine the equilibrium price and this leads to the factor inputs being allocated in both goods and factor markets. The law of demand states that there is an inverse relationship between the price of a good and the demand for a good. As prices fall they cause an expansion of demand. Contrarily, if prices rise one can expect to see a contraction of demand.

However, markets do not usually adjust immediately to equilibrium, and that is basically because of transaction costs. This includes in general costs of obtaining information about the market and costs of finding a marketplace to transact the business (Carman, 1997).

Understanding the microeconomic determinants of price adjustment is therefore important, in order to both refine and appropriately qualify those theories and policy arguments where transmission of price signals plays a central role. In other words, given that policymakers care about the speed and magnitude of transmission of price shocks in many real-life situations, economists ought to understand these processes as much as possible. In those situations of most interest it would be valuable to see how the standard theoretical approximation of instantaneous transmission should be modified, based on a fuller understanding of transmission processes.

The interest in price transmission has recently gained attention and the amount of studies on this subject is rapidly growing. The price is considered to be the principal mechanism connecting the different stages of the food supply chain. Understanding how much and how fast price signals are transmitted in a particular context, as well as understanding what factors delay or impede transmission is also a key input for policy-makers attempting to understand how costly and effective policy interventions will be. Price theory plays a key role in neo-classical economics. Prices drive resource allocation and output mix decisions by economic actors, and price transmission integrates markets vertically and horizontally. For special interest are those processes

that are referred to as asymmetric, i.e. for which transmission differs according to whether prices are increasing or decreasing.

The literature on price transmission and spatial market integration abounds, although the empirical analysis of its determinants has been generally neglected, with some exceptions being the works of Ravallion (1986), Goodwin and Schroeder (1991), Ismet et al. (1998), Peltzman (2000), in an extensive study of price transmission for several hundred producer and consumer goods in the US, found that fewer number of firms lead to more asymmetry and that more concentration lead to less asymmetry. Goodwin and Piggott (2001), Van Campenhout (2007), and Varela, Aldaz-Carroll and Iacovone (2012).

2.1 Asymmetric Price Transmission

Asymmetric price transmission (sometimes abbreviated as APT) refers to a pricing phenomenon occurring when downstream prices react in a different manner to upstream price changes, depending on the characteristics of upstream prices or changes in those prices. The simplest example is when prices of ready products increase promptly whenever prices of inputs increase, but take time to decrease after input price decreases. A widely used classification is between short-run (SR) and long-run (LR) asymmetries, since, in general, a SR analysis is more indicated to compare the intensity of output price variations to positive or negative changes in input prices, whereas a LR perspective is needed if the empirical investigation concentrates on the computation of reaction times, length of fluctuations, as well as speeds of adjustment toward an equilibrium level.

In the economically perfect competitive market, when the exogenous shock against the market equilibrium happens, it is said the price is adjusted instantly and new equilibrium occurs. In the real market, however, price will never be adjusted instantly. The speed of adjustment can be different from price increasing scenario to price decreasing scenario. Thus, Asymmetric price transmission (APT) can be detected under such situation. Positive APT is usually defined as a set of reactions according to which any price movement that squeezes the margin is transmitted more rapidly than the equivalent movement that stretches the margin. Conversely, APT is negative when price movements that stretch the margin are transmitted more rapidly than movements that squeeze it.

In agricultural economics most attempts to test for the presence of asymmetric price transmission have been based on a method for detecting irreversible supply reactions developed by Wolffram (1971) and later adopted by Houck (1977) and Ward (1982). Furthermore, Kinnucan and Forker (1987) tested for the asymmetry in farm-retail transmission for dairy products in the United States, based on Houck's model for estimating nonreversible functions. By using a threshold cointegration model that permitted asymmetric adjustments to positive and negative price shocks, Goodwin and Harper (2000) analyzed price transmission in the U.S. pork sector.

2.1.1 Types of asymmetry

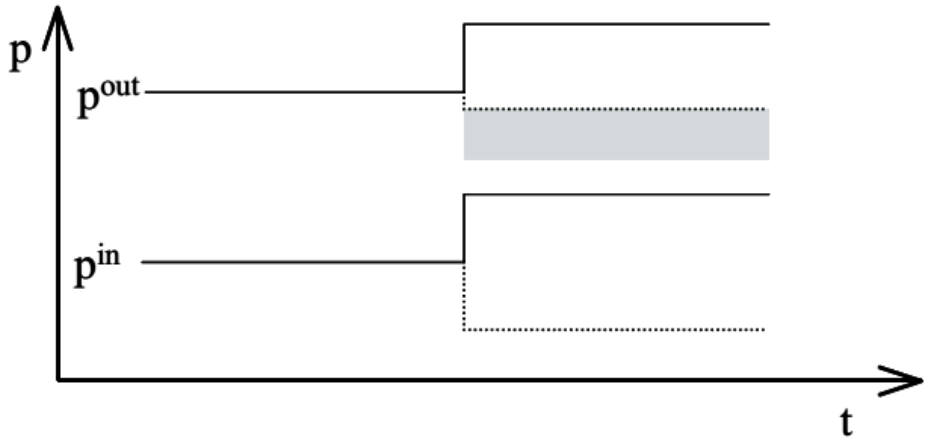
Asymmetry in the context of price transmission can be classified according to three criteria. The first criterion refers to whether it is the speed or the magnitude of price transmission that is asymmetric. The distinction between these two types of APT is depicted in Figure 1, where a price (p^{out}) is assumed to depend on another price (p^{in}) that either increases or decreases at a specific point in time.

In Figure 1(a), the magnitude of the response to a change in p^{in} depends on the direction of this change; in Figure 1(b) it is the speed of the response that depends. In Figure 1(c), price transmission is asymmetric with respect to both speed and magnitude because an increase in p^{in} takes two periods (t_1 and t_2) to be fully transmitted to p^{out} , while a decrease in p^{in} requires three periods (t_1 ,t_2 and t_3) and is not fully transmitted.

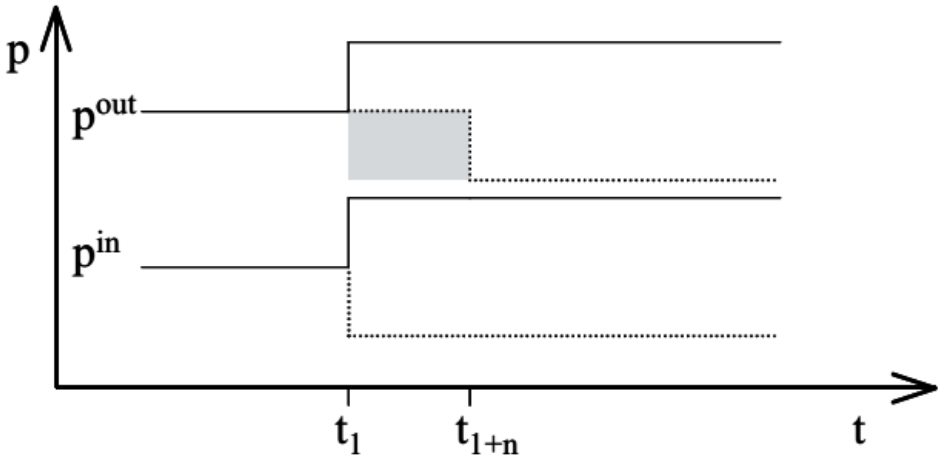
The transfers associated with these two types of APT are depicted schematically as shaded areas in Figure 1. Interpretation is eased by assuming a constant, unchanging volume of transactions over time, i.e. completely price inelastic demand for the output good. Asymmetry with respect to the speed of price transmission leads to a temporary transfer (in this case from buyers of the output good to sellers) the size of which depends on the length of the time interval between t_1 and t_{1+n} as well as the price changes and transaction volumes involved (Figure 1(b)).

Figure 1: Asymmetric Price Transmission

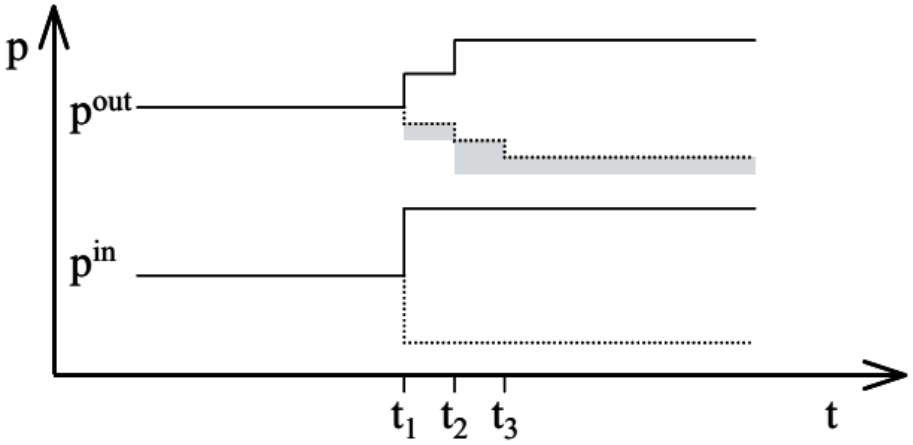
a): Magnitude



b): Speed



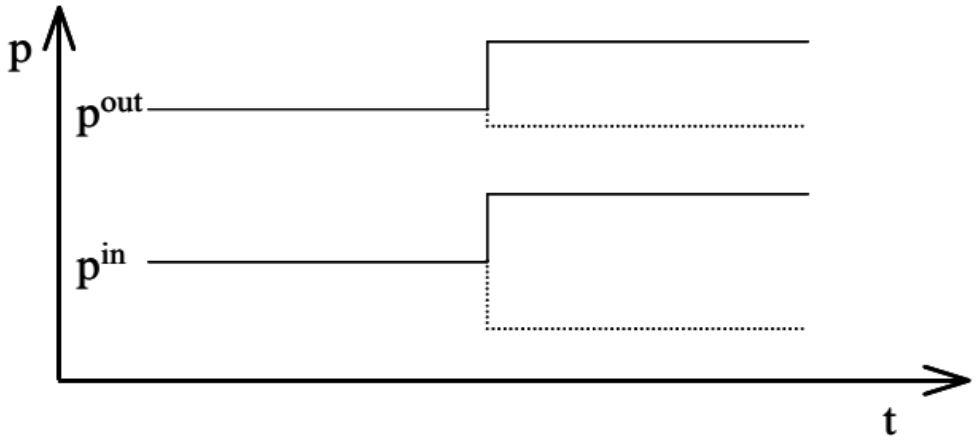
c): Speed and Magnitude



Asymmetry with respect to the magnitude of price transmission leads to a permanent transfer (Figure 1(a)), the size of which depends solely on the price changes and transaction volumes involved. Figure 1(c) shows that asymmetry with respect to speed and magnitude leads to a combination of temporary and permanent transfers. Which type of transfer is of greater concern cannot be determined a priori; depending on the numbers involved, a large temporary transfer could outweigh the present value of smaller permanent transfer.

A second criterion, following a convention employed by Peltzman, allows APT to be classified as either positive or negative. If p^{out} reacts more fully or rapidly to an increase in p^{in} than to a decrease, the asymmetry is termed 'positive' (Figure 2).

Figure 2: Positive Asymmetric Price Transmission

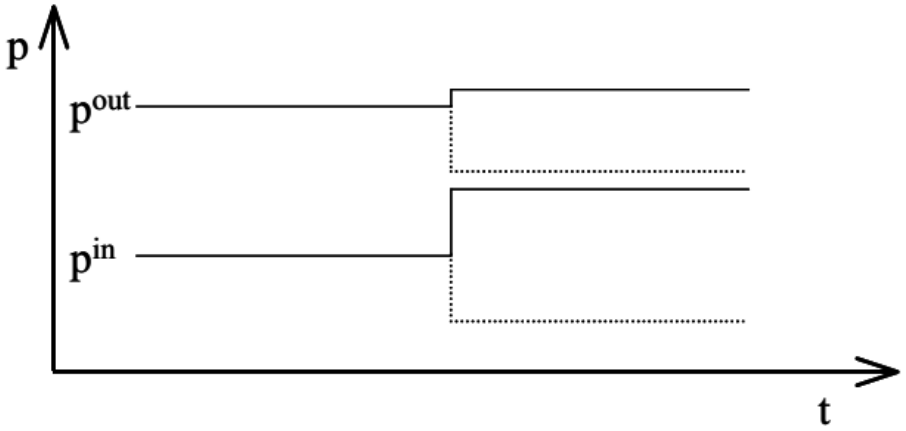


Correspondingly, 'negative' asymmetry denotes a situation in which p^{out} reacts more fully or rapidly to a decrease in p^{in} than to an increase (Figure 3). This convention can be misleading if interpreted in a normative fashion: if p^{in} and p^{out} represent farm gate and retail prices for a commodity, respectively, 'negative' asymmetry is 'good' for the consumer, while 'positive' asymmetry is 'bad' in the sense that the former (latter) is associated with gains (losses).

At the same time, however, this highlights the importance of the distinction between positive and negative asymmetry, as this distinction determines the direction of transfers due to APT.

The distinction between positive and negative APT – defined above with respect to how p^{out} reacts to a change in p^{in} must be generalised. We propose that positive APT be defined as a set of reactions according to which any price movement that squeezes the margin (i.e. an increase in p^{in} or a fall in p^{out}) is transmitted more rapidly and/or completely (to p^{out} or p^{in}, respectively) than the equivalent movement that stretches the margin. Conversely, APT is negative when price movements that stretch the margin are transmitted more rapidly and/or completely than movements that squeeze it.

Figure 3: Negative Asymmetric Price Transmission



The third criterion for classifying APT refers to whether it affects vertical[1] or spatial[2] price transmission. In the first place, spatial PT takes place between two markets where the characteristics of the products are close to being the same, but are separated by transportation costs. Secondly, the vertical PT corresponds to the relationship between two markets of the same production chain (Meyer & von Cramon-Taubadel, 2004). However, there is another aspect associated with vertical PT which is focused on the relationship of two or more joint products produced in a single production process using common input (i.e.: soybean oil and soybean meal, wool and mutton) (Gardner, 1987).

[1] As an example of vertical APT, farmers and consumers often complain that increases in farm prices are more fully and rapidly transmitted to the wholesale and retail levels than equivalent decreases in farm prices.

[2] An example of spatial asymmetry would be a rise in the US wheat price causing a more pronounced reaction in Canadian wheat prices than a corresponding reduction of the same magnitude.

2.1.2 What cause asymmetric price transmission?

Adjustment and Menu Costs

One major cause of asymmetric price transmission are adjustment costs, such as the cost of making new labels and informing market partners about price changes.

To begin with, profit maximizing behavior forces firms in competitive markets to adjust their prices to new cost conditions immediately, and presumably symmetrically. This hold when frictions and imperfections are absent. "Menu" costs, however, preclude instantaneous price adjustment even if firms have no market power. Similarly, accountancy rules and inventory valuation may be responsible for the sluggish adjustment of final prices with respect to increases or decreases in the value of major exogenous variables.

In addition, it is not possible for different firms to have different adjustment costs. For example, meat packers who face high fixed costs and excess capacity may reduce their margins because of competition and therefore producer prices may also rise faster in the case of increased demand than they fall in the case of weakened demand.

Market power

The majority of the publications on the topic of asymmetric price transmission include considerations of non-competitive market structures. Response of retail prices to changes in wholesale or farm-level prices is generally not instantaneous but is instead distributed over time. It is therefore commonly asserted, in the agriculture sector in particular, that imperfect competition allows middlemen to make use of market power[3] (Kinnucan and Forker, 1987). This market power is often expected to lead to positive asymmetry. Hence, it is expected that increases in input prices, which reduce marketing margins will be transmitted faster and more completely than decreases because of market power (Karrenbrock, 1991). Ward (1982) suggests that market power can lead to negative asymmetry if oligopolists are reluctant to risk losing market shares by increasing prices. On the other hand, Bailey & Brorsen (1989), consider market power to lead to positive asymmetry. If a firm believes that no competitor will match a price increase but all will match a price cut, positive asymmetry will result. Otherwise, if the firm conjectures that all firms will match an increase but none will match a price cut,

[3] The most common definition of market power in Industrial Organisation theory is the ability to raise prices above marginal costs.

negative symmetry will result. Hence, it is not clear whether market power will lead to positive or negative asymmetry (Bailey and Brorsen, 1989).

Government intervention

Gardner (1975) pointed out that, in addition to other causes, farm-to-retail price asymmetries might be the result of government intervention to support producer prices. Similarly, Kinnucan and Forker (1987) argued that government policies may lead to asymmetric price adjustments if agents believe that price movements in one direction may be more likely to trigger government intervention than movements in another direction: the government may be more likely to intervene if market shocks lower producer prices than if producer prices increase.

Inflation

Ball and Mankiw (1994) note that in the presence of inflation and nominal input price shocks, the use of menu costs by agents may lead to more resistance to lower prices than to increase them. Bailey and Brorsen (1989) also pointed out that asymmetries in price adjustments may be caused by asymmetries in the underlying costs of adjustments. . General inflation also may affect the type of asymmetry. When input prices rise, firms usually adjust not only for this but also for a general and possibly anticipated rise in operating costs. If the input price lowers, inflation moderates the possibilities for lowering output prices.

Inventory management strategies

Response might also be asymmetric due to inventory management strategies. Retailers may reduce their prices more slowly compared to reduction in farm-level prices to avoid running out of stock (Reagan and Weitzman, 1982). Balke et al. (1998) show that accounting methods such as FIFO (first in first out) could cause asymmetric adjustments to price shocks. For instance, when a historical criterion (first in first out or FIFO) is adopted to value inventories, the firm does not adjust its output immediately when costs change, but awaits until the stocks of inputs bought at the old price are

depleted. When instead a replacement cost criterion (last in first out or LIFO) is applied, the firm adjusts its price very rapidly in response to changes in input costs.
The accounting convention chosen by a firm can therefore have an influence on the speed of adjustment: application of a FIFO criterion results in longer lags than in the case of a LIFO principle.

2.2 Empirical literature on price transmission

A large amount of empirical literature has examined price linkages between different markets. At the end of the Sixties and during the Seventies most of the studies on asymmetric price transmission concentrate on agricultural goods. Tweeten and Quance (1968) investigate the relationship between the level of output (y) and the ratio between input and output prices (x) in the agricultural sector, using an indicator variable to discriminate between positive and negative variations of x.

Wolffram (1971) shows that the approach followed by Tweeten and Quance to distinguish between periods of expansion and periods of reduction of the input/output price ratio can lead to biased estimates.

Ward (1982) pointed out that the price of perishable agricultural products cannot be raised as easily as decreasing the price.

Hazell et. al. (1990) examine whether the volatility in the world market prices has been passed through to producer prices in developing countries. The authors test whether price instability has increased over time and whether fluctuations in domestic markets followed the variability of the world prices. They find that world market prices indeed grew more volatile over time, but that price variation was explained more by declining average prices than by variability around trend.

Griffith and Piggott (1994) analyzed the relationships between retail-wholesale prices, farm-wholesale prices and farm-retail prices for the Australian beef, lamb and pork

markets, using monthly data since January 1971 to December 1988. They suggested that "asymmetrical price response is a strategy used by beef and lamb retailers and wholesalers to adjust to changing input prices but not by pork retailers and wholesalers".

Luoma, A. at al (2004) examined the transmission of producer price changes to consumer prices in Finnish beef and pork markets. Both meat varieties were studied based on monthly observations from 1981 through May 2003. They find that it is the consumer price that responds to the long-term disequilibrium of the consumer and producer prices. The consumer price also reacts to changes in the producer price in the short term.

Jordi and Ramon(2008) analyzed three stages of distribution called a producer's, consumer's and retailer's market of 12 seafood products in Spain and detected APTs with many cases. They discussed that the cause is not due to imperfect competitive market but due to the existence of substitute products in the lower side of the distribution channel.

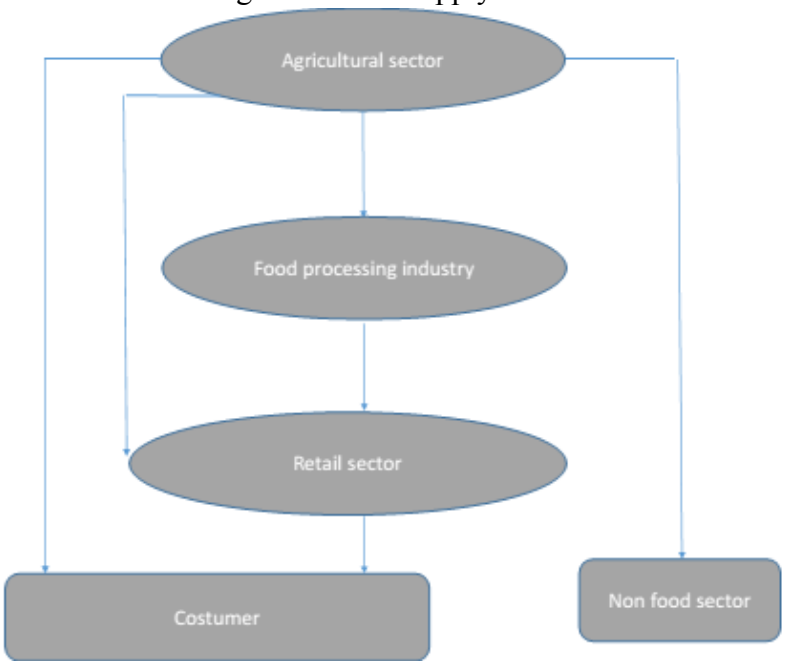
Chapter 3

Model and Data

3.1 Model of food supply chain

A brief description of the food supply chain may create a better understanding of price transmission .The food supply chain connects three main sectors : the agricultural sector, the food processing industry and the distribution sectors (wholesale and retail).The first sector is the agricultural sector. Its activities include crop production and the raising of livestock. As agricultural commodities comprise of very different products, the sector's distribution channels are equally diverse. Firms in the agricultural sector primarily sell their output to the food processing industry and to itself (e.g. animal feed), but also sell directly to retailers, final consumers or alternative markets (e.g. biofuels). The food processing industry is very heterogeneous and comprises of a number of varied activities. The different inputs are processed in successive stages and to different degrees, packaged and dispatched to customers (e.g. distributors, food service). The distribution sector (and retail in particular) is the principal outlet for food products and, being the final link in the supply chain, it interacts directly with final consumers.

Figure 4. Food supply chain



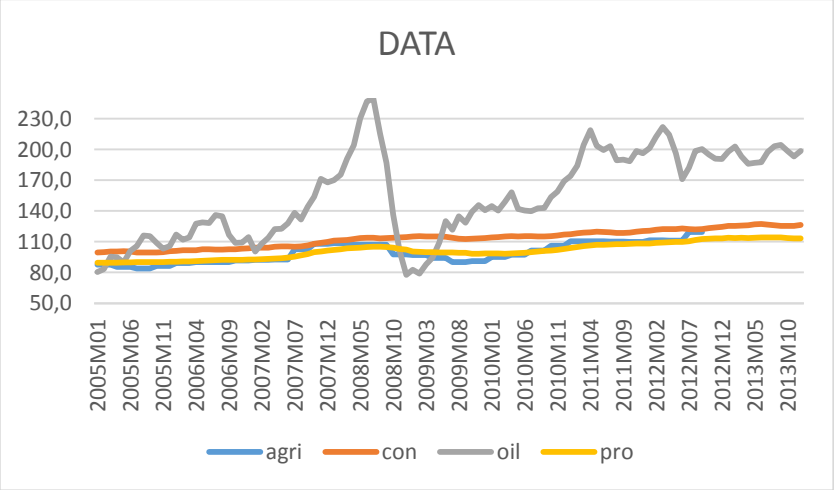
3.2 Collection

Although plenty of data is available for econometric research, the quality of the data is often lacking in quality. There are several reasons for this. First, as noted, most social science data is non-experimental in nature. Therefore, there is the possibility of observational errors, either of omission or commission. Second, even in experimentally collected data, errors of measurement arise from approximations and round offs. Third, the sampling methods used in obtaining the data may vary so widely that is often difficult to compare the results obtained from the various samples. Fourth, economic data is generally available at a highly aggregate level. Such highly aggregated data may not tell us much about the individual or micro units that may be the ultimate object of the study. Lastly, because of confidentiality, certain data can be published only in highly aggregate form.

Because of these and many other problems, the researcher should always keep in mind that the results of research are only as good as the quality of the data.

The data used in this study consists of monthly observations spanning from January 2005 to January 2014 for the world Crude Oil price indices, the Agricultural Commodity Price, Consumer Price and Producer Price for the European Countries of 27. I have collected the date for the agricultural product from Eurostat and the price index for Crude Oil from index mundi.[4]

Figure 5. Data



[4] The base year for the prices index is 2010

3.3 Description

The success of any econometric analysis ultimately depends on the availability of the appropriate data. Table 1 provides some descriptive statistics of the data used in the analysis.

Table 1. Descriptive Statistics

	Mean	*Standard Deviation*	*Min*	*Max*
Agri	99.93	10.40	83.80	122.70
Pro	101.47	7.95	89.62	114.30
Con	98.22	7.41	86.20	110.30
Oil	100.55	28.85	52.32	168.08

Empirically, the lowest observation is 52.32 for oil and the highest observation is 168.08 for oil. For the agricultural sector the lowest observation is 83.80 and the highest 122.70, for the producer sector the lowest observation is 89.62 and the highest 114.30 and for the consumer sector the lowest observation is 86.20 and the highest 110.30.
As we can see from table 1, oil prices had the highest standard deviation while the standard deviation for the prices of agricultural, producers and consumers it is quite low.

Chapter 4

In this chapter I will describe the procedure on structural models for price transmission and the model for testing for asymmetric price transmission. I will check for asymmetric price transmission in the prices of Oil with the 3 sections of food supply chain.

Methodology

Before proceeding with the procedure behind the applied models, I will present a brief review of the development of the estimation of asymmetric price adjustments. Farrel (1952) empirically investigated irreversible demand functions. In agricultural economics the price transmission process was scrutinized by Tweeten and Quance (1969) by adapting a dummy variable approach to estimate irreversible supply functions.

Various other models for testing for asymmetry have gained support and claimed to be more appropriate under certain circumstances. Abdulai and Rieder (1999), and Goodwin and Harper (2000) both used a threshold autoregressive test for unity roots to test for the presence of asymmetric price transmission. Finally, Capps and Sherwell (2005) analysed the behaviour of spatial tests of asymmetric price transmission according to the conventional Houck approach (so-called pre-cointegration method) and to the von Cramon-Taubadel and Loy ECM approach. Using monthly data for seven US large cities, the authors found that the farm-to-retail price transmission process for fluid milk is asymmetric.

4.1 Structural model

The properties of nonstationarity and order of integration can be assessed using the Augmented Dickey–Fuller (ADF) Test (Dickey and Fuller, 1979). As reported in Table 2, the statistics reveal that unit roots can be rejected at the 5% level.

Table 2. Results of the unit root test

	ADF Test statistic		
	None	Trend	Drift
Ln oil-agri	-3.0343***	-3.7627**	-3.0084**
Ln oil-pro	-2.3796**	-3.8915**	-2.8602**
Ln oil-con	-2.2331**	-3.8504**	-2.8595*

Notes : Critical value at 5% :test regression none -1.95, test with trend -3.45, test with drift -2.89

Threshold cointegration analysis

Enders and Siklos (2001) propose a two-regime threshold cointegration approach to entail asymmetric adjustment in cointegration analysis. If a price adjustment process is asymmetric, the Threshold Autoregressive (TAR) model, proposed by Enders and Granger (1998), needs to be used to avoid estimation bias. In this model, cointegration test is conducted by equation (1)

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1 - I_t)\rho_2\mu_{t-1} + \sum_{i=1}^{T}\gamma_i\Delta\mu_{t-i} + \varepsilon_t \qquad (1)$$

$$I_t = \begin{cases} 1 & if \quad \mu_{t-1} \geq \tau \\ 0 & if \quad \mu_{t-1} < \tau \end{cases} \qquad (2)$$

I_t is called Heaviside indicator and the definition is shown in equation (2). Suppose that μ_{t-1} is bigger than the threshold τ, adjustment of this period is shown in $\rho_1\mu_{t-1}$. If μ_{t-1} is smaller than the threshold τ, adjustment of this period is shown in $\rho_2\mu_{t-1}$. When $\rho_1 = \rho_2$ is hold, it means that the adjustment process is symmetric. . However, if the null hypothesis H_0: $\rho_1 = \rho_2$ is rejected then using the TAR model we can capture signs of asymmetry.

In this study, estimations are made using both TAR and M-TAR model. The threshold is estimated using Chan's methodology.

4.2 Procedure on Asymmetric model

In this paper I conduct three different tests to check for asymmetric price transmission between each stage of the supply chain and the price of oil. In estimating the threshold values for consistent TAR and MTAR, the method by Chan (1993) [5] is followed.
First I checked the price transmission between the oil and the agricultural prices. The results of the threshold cointegration test are presented in Table 3.

From the Table 3, the consistent MTAR model has the lowest AIC statistic of -452.046 and BIC statistic of -441.873, and therefore, is deemed to be the best. Focusing on the results from the consistent MTAR model, the F-test for the null hypothesis of no cointegration has a statistic of 6.448 and it is significant at the level 10%. Thus the price of Oil and agricultural product are cointegrated with threshold adjustment.
The point estimate for the price adjustment is−0.075 for positive shocks and−0.227 for negative shocks. Positive deviations from the long-term equilibrium resulting from increases in the world Crude Oil price or decreases in the agricultural prices ($\Delta\mu_{t-i}\geq-0.008$) are eliminated at 7.5 % per month. Negative deviations from the long-term equilibrium resulting from decrease world Crude Oil price indices or increases in the agricultural prices ($\Delta\mu_{t-i}<-0.008$) are eliminated at a rate of 22.7 % per month. In other words positive deviations take about 13 months (1/0.075=13.33 months) to be fully digested while negative deviations take 4.4 months only. Therefore, there is substantially slower convergence for positive (above threshold) deviations from long-term equilibrium than negative (below threshold) deviations.

[5] Chan (1993) proposed a search method for obtaining a consistent estimate of the threshold value

Table 3
Results of the threshold cointegration tests (oil-agri).

Item	TAR	Consistent TAR	MTAR	Consistent MTAR
Estimate				
Lag	1	1	1	1
threshold	0	-0.041	0	-0.008
pos.coeff	-0.104**	-0.089*	-0.084	-0.075*
pos.t.value	(-1.982)	(-1.792)	(-1.655)	(-1.68)
neg.coeff	-0.135**	-0.16***	-0.163***	-0.227***
neg.t.value	(-2.379)	(-2.678)	(-2.805)	(-3.237)
Diagnostics				
AIC	-448.718	-449.437	-449.658	-452.046
BIC	-438.545	-439.264	-439.484	-441.873
LB test(4)	0.571	0.582	0.465	0.605
LB test(8)	0.288	0.326	0.295	0.448
LB test(12)	0.386	0.472	0.382	0.555
Hypotheses				
H_1: no CI	4.641	5.026	5.145	6.448
H_2: no APT	0.16	0.859	1.075	3.445
H_2:p. value	0.69	0.356	0.303	**0.067**

Notes: TAR refers to the threshold autoregressive model and MTAR is the momentum threshold autoregressive model. LB denotes the significance level for Ljung-Box Q statistic. It test serial correlation based on autocorrelation coefficients (4, 8, 12). H_1 is the threshold cointegration test with the critical values from Enders and Siklos (2001). H_2 is the test of asymmetric price transmission.
*** Denotes significance at the 1% level.
**Denotes significance at the 5% level.
* Denotes significance at the 10% level.

Table 4 shows the result of the threshold cointegration test for the price transmission between the oil and the consumer prices. The consistent TAR model has the lowest AIC statistic of -598.771 and BIC statistic of -585.454, and therefore, is deemed to be the best. Focusing on the results from the consistent TAR model, the F-test for the null hypothesis of no cointegration has a statistic of 4.864 and it is significant at the level 10%. Thus the price of Oil and agricultural product are cointegrated with threshold adjustment.

The point estimate for the price adjustment is-0.047.for positive shocks, and it is significant at 10% and -0.143***for negative shocks, which is significant at 1%. Positive deviations from the long-term equilibrium resulting from increases in the world Crude Oil price or decreases in the consumer prices ($\Delta\mu_{t-i}\geq -0.063$) are eliminated at 4.7 % per month. Negative deviations from the long-term equilibrium resulting from decrease world Crude Oil price indices or increases in the consumer prices ($\Delta\mu_{t-i}<-0.063$) are eliminated at a rate of 14.3 % per month. In other words positive deviations take 21 months to be fully digested while negative deviations take 7 months to be fully digested.

Table 4
Results of the threshold cointegration tests (oil-con).

Item	TAR	Consistent TAR	MTAR	Consistent MTAR
Estimate				
Lag	2	2	2	2
Threshold	0	-0.063	0	-0.003
pos.coeff	-0.074**	-0.047.	-0.084**	-0.096***
pos.t.value	(-1.985)	(-1.528)	(-2.195)	(-2.611)
neg.coeff	-0.068*	-0.143***	-0.059.	-0.044
neg.t.value	(-1.789)	(-2.782)	(-1.593)	(-1.143)
Diagnostics				
AIC	-596.04	-598.771	-596.257	-597.052
BIC	-582.722	-585.454	-582.94	-583.734
LB test(4)	0.9	0.908	0.871	0.847
LB test(8)	0.556	0.522	0.552	0.541
LB test(12)	0.561	0.442	0.534	0.504
Hypotheses				
H_1: no CI	3.443	4.864	3.555	3.966
H_2: no APT	0.012	2.674	0.221	0.99
H_2:p. value	0.915	**0.105**	0.639	0.322

Notes: TAR refers to the threshold autoregressive model and MTAR is the momentum threshold autoregressive model. LB denotes the significance level for Ljung-Box Q statistic. It test serial correlation based on autocorrelation coefficients (4, 8, 12). H_1 is the threshold cointegration test with the critical values from Enders and Siklos (2001). H2 is the test of asymmetric price transmission.
**Denotes significance at the 5% level.
*** Denotes significance at the 1% level.

4.3 Interpretation of results

The results of the various tests I run in this study are presented in chapter 5. A test is a decision rule that tells us when to reject H_0 and when not to reject H_0; tests are also specified by a test statistic and a rejection region. The maximum Type I error probability of a test is called its level of significance and is denoted by α. The significance probability or P-value of an observed test statistic is the smallest$\alpha$for which this observation leads to a rejection of H_0.[6]

Consideration of the compatibility of fit of the fitted regression line to a set of data is important when attempting to find out how well the sample regression line fits the data. The coefficient of determination r^2 (two-variable case) or R^2 (multiple regression) is a summary measure that tells how well the sample regression line fits the data. Verbally, R^2 measures the proportion or percentage of the total variation in Y explained by the regression model. The value of R^2 lies between 0 and 1, and the latter means a perfect fit.[7] I will be using the R^2 in this thesis.

[6] Johnson and Bhattacharyya, 1996
[7] Gujarati, 1995

Chapter 5

Results

5.1 Price transmission between oil and the agricultural sector

The first model I ran examined the relationship between the price of oil and the prices in the agricultural sector.

The asymmetric error correction model with threshold cointegration for the price transmission between the oil and the agricultural prices is estimated and the results are reported in Table 5. Diagnostic analyses on the residuals with AIC, BIC and Ljung–Box Q statistics select a lag of 1 for the model. In the equation for Oil, there are five coefficients significant at the 5% level (θ, α_1^- , β_1^-, δ^+, δ^-). In equation for Agricultural prices, there are four significant coefficients (α_1^-, β_1^+, β_1^-, δ^-). The R^2 statistic is 0.316 for Oil and 0.705 for Agricultural. The AIC statistic is -212.084 for Oil and -641.261 for Agricultural. Overall, the model specification has a better fit on Agricultural than on Oil.

The hypotheses of Granger causality between the prices are assessed with F-tests. The F-statistic of 6.189 and the p-value of 0.005 reveal that the Oil prices does Granger cause the price of Agricultural. However, the F-statistic of 2.308 and the p-value of 0.11 indicates that the price of Agricultural marginally does not Grange cause the price of Oil. Similarly, the F-statistics of 2.308 for Oil and 83.902 for Agricultural disclose that the lagged price series have significant impacts on its own price.

Thus, in the short term, the prices of Oil has been evolving independently while the price of Agricultural has been dependent on the price of Oil in the previous periods.

Several types of hypotheses are examined for asymmetric price transmission. The first one is the distributed lag asymmetric effect. In each price equation, the equality of the corresponding positive and negative coefficients is tested. It turns out that two of them are significant at the 10% level. Distributed lag asymmetric effect is found for Agricultural for its own price at lag one.

Table 5. Results of the asymmetric error correction model with threshold cointegration

Item	*Oil*		*Agricultural*	
	Estimate	t-ratio	Estimate	t-ratio
θ	0.031**	2.081	0	-0.224
α_1^+	0.243	1.051	-0.019	-0.788
α_1^-	0.434**	2.179	-0.037*	-1.813
β_1^+	-0.689	-0.728	0.885***	9.164
β_1^-	3.343**	2.148	0.914***	5.758
δ^+	0.307*	1.851	-0.011	-0.673
δ^-	0.552**	2.126	-0.077***	-2.909
R^2	0.316	_	0.705	_
AIC	-212.084	_	-641.261	_
BIC	-191.738	_	-620.914	_
$Q_{LB}(4)$	0.380	_	0.000	_
$Q_{LB}(8)$	0.517	_	0.000	_
$\delta^+ = \delta^-$	0.614	[0.44]	4.251**	[0.04]
Loil (x) does not Gra cause	6.189 ***	[0]	4.051**	[0.02]
Lagri (y) does not Gra cause	2.308.	[0.11]	83.902***	[0]
$\alpha_1^+ = \alpha_1^-$	3.819 *	[0.05]	0.02	[0.89]
$\Sigma_i\alpha_i^+ = \Sigma_i \alpha_i^-$	3.819 *	[0.05]	0.02	[0.89]

Notes: ($\delta^+ = \delta^-$) is about equilibrium adjustment path asymmetric effect. ($\alpha_1^+ = \alpha_1^-$) evaluate distributed lag asymmetric effect. ($\Sigma_i\alpha_i^+ = \Sigma_i \alpha_i^-$) assess the cumulative asymmetric effect
* Denotes significance at the 10% level. ** Denotes significance at the 5% level.
***Denotes significance at the 1% level.

The final type of asymmetry examined is the momentum equilibrium adjustment path asymmetries. For Oil, the F-statistic is 0.614 with a p-value of 0.44. The point estimates of the coefficients for the error correction terms are 0.307 for positive error correction term (significant at 10%) and 0.552 for the negative one (significant at 5%). Therefore, it seems that in the short term the price of Oil has some different responding speed to positive and negative deviations but the difference is weak. In contrast, for Agricultural, the F-statistic is 4.251 with a p-value of 0.04. Thus, there is momentum equilibrium adjustment asymmetry. The point estimates are −0.011 for positive deviation, but is not significant and−0.077 significant at 1%, for negative deviation. The magnitude suggests

that in the short term the price of Agricultural will not respond to the positive deviations, but will respond to negative deviation by 1.1% in a month.

5.2 Price transmission between oil and the consumer sector

The next estimation measures the relationship between the prices of oil and the consumer level price. Table 6 shows the price transmission between the oil and the consumer prices. There are two coefficients significant at the 5% level (α_1^- , δ^-) for the equation of oil. In equation for Consumer prices, there are three significant coefficients (θ , β_1^-, δ^+). The R^2 statistic is 0.28 for Oil and 0.395 for Consumers. The AIC statistic is -240.988 for Oil and -890.378 for Consumer prices. Overall, the model specification has a better fit on Consumers than on Oil.

Table 6. Results of the asymmetric error correction model with threshold cointegration

Item	Oil		Consumer	
	Estimate	t-ratio	Estimate	t-ratio
θ	0.015	0.795	0.002**	2.373
α_1^+	0.061	-0.122	-0.01	-1.06
α_2^+	0.145	0.541	0.002	0.162
α_1^-	0.576***	3.247	0.009	1.093
α_2^-	0.121	0.538	-0.011	-1.417
β_1^+	2.57	1.371	3.314	3.314
β_2^+	0.327	0.91	-0.077	-0.552
β_1^-	-0.385	-0.705	0.931***	4.066
β_2^-	0.885	-0.595	-0.306	-1.342
δ^+	0.211	1.223	-0.02**	-2.473
δ^-	0.741**	2.501	0.008	0.564
R^2	0.280	_	0.395	_
AIC	-240.988	_	-890.378	_
BIC	-209.027	_	-858.417	_
$Q_{LB}(4)$	0.908	_	0.776	_
$Q_{LB}(8)$	0.604	_	0.655	_
$\delta^+ = \delta^-$	2.292.	[0.13]	2.867 *	[0.09]
Loil (x) does not Gra cause	7.004 ***	[0]	0.702	[0.59]
Lcon (y) does not Gra cause	0.348	[0.84]	11.586 ***	[0]
$\alpha_1^+ = \alpha_1^-$	2.749 .	[0.1]	1.64	[0.2]
$\beta_1^+ = \beta_1^-$	0.206	[0.65]	2.401 .	[0.12]

The F-statistic of 7.004 and the p-value of 0.005 reveal that the Oil prices does Granger cause the price of Consumers. However, the F-statistic of 0.702 and the p-value of 0.59 indicates that the price of Oil does not Grange cause the price of Consumers. Similarly, the F-statistics of 0.348 for Oil and 11.586 for Consumers disclose that the lagged price series have significant impacts on its own price.

In addition I examined the momentum equilibrium adjustment path asymmetries. For Oil, the F-statistic is 2.292.with a p-value of 0.13. The point estimates of the coefficients for the error correction terms are 0.211 for positive error correction term (not significant) and 0.741 for the negative one (significant at 5%). Therefore, it seems that in the short term the price of Oil has some different responding speed to positive and negative deviations but the difference is weak for positive and strong for negative deviations[8]. In contrast, for Consumers, the F-statistic is 2.867 with a p-value of 0.09. Thus, there is momentum equilibrium adjustment asymmetry. The point estimates are −0.02 for positive deviation (significant at 5%) and 0.008 (but it is not significant), for negative deviation. In the short term the price of Consumers will respond to the positive deviations by 2% in a month, but will not respond to negative deviation.

5.3 *Summary of price transmission results*

A brief summary of the results from Chapter 5.1 and 5.2 on the price transmission analyses follows:

- From the analysis I did about the price transmission in oil-agricultural prices, I found that there is a momentum equilibrium adjustment asymmetry. In the short term prices of agricultural products will not respond to the positive deviations, but will respond to the negative deviations by about 1,1 % per month.
- From the analysis in the consumer prices sector I found that prices of consumer sector will respond to the positive deviations by 2 % per month but will not respond to the negative deviations.
- Finally from the analysis in asymmetric price transmission between producer prices and oil prices, I did not find evidence of asymmetry.

[8] The prices of Oil will respond to negative deviations by 74.1 % in a month.

Chapter 6

Summary and concluding remarks

The boom in commodity prices which took place in the recent years has raised a new interest in the issue of food security and of the necessity to restructure the agricultural sector. This has also led to an increased need to understand what variables and characteristics determine the evolution of prices. In this context, price transmission is one important element that influences the evolution of domestic prices and is therefore the topic of this paper.

The results of this paper show that of the 3 sectors of the food supply chain, only in 2 of them is there a presence of asymmetry in price transmission. Asymmetry was found in the agricultural sector and the consumer sector, but from the analysis there is no presence of asymmetry in producer sector. It seems that the transmission between oil prices and the prices of producers is symmetric.

The retail sector in particular is characterized by an increased presence of large food retailers. Within a larger and increasingly integrated European Single Market, consolidation can lead to efficiency gains and put a downward pressure on prices. The food retail sector in the European Union is characterized by a high degree of concentration: the five largest retailer chains account for over 50% of the market. Competitive pressures that exist in this level have absorbed some of the increase in producer prices in the euro area.

On the other hand, in the food processing sectors, concentration levels vary strongly across food categories and by extension food sub-industries. In general, the firms in these most concentrated food categories operate at a global level and typically offer internationally branded products.

Chapter 7

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