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Conference:
Competitiveness of Food Economy in the Conditions of Globalization and European Integration

Methodological tools for price transmission studies

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Motivation

- Price transmission is a causal relationship between prices on vertically or spatially separated markets
- Mechanisms: Arbitrage, market power, administrative measures, common shocks

Price transmission – a broad field

- Spatial transmission
- Vertical transmission
- Asymmetric transmission
- **Price transmission**
- Market efficiency
- Law of one price
- Transmission elasticities
- Market integration

Structure of presentation

- Explanations for asymmetric price transmission
- Empirical approaches to date
- Current methodological frameworks
- Case study: the Spanish lamb sector
- Remaining challenges

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Explanations for asymmetric PT

- Market power at the retail level (Boyd and Brorsen, 1988; and Griffith and Piggott, 1994)
- Adjustment costs at the retail level (Blinder et al., 1998)
- Input substitution possibilities (Bettendorf and Verboven, 2000)
- Inventory holding (Reagan and Witzman, 1982)
- Asymmetric information (Bailey and Brorsen (1989)
- Public intervention (Kinnucan and Forker, 1987)

Explanations for asymmetric PT

However, before explanations can be given, it is necessary to analyse the existence of such asymmetric price adjustments.

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Empirical approaches to date

- Time series models have been widely used to analyse the existing asymmetries specific sectors and countries

- Time series models allow to focus on four issues:

  1. the size of the price response at each end of the supply chain to a shock of a given size at the other end;
  2. the speed and profile of the response;
  3. whether responses are symmetric or asymmetric; and
  4. whether adjustments differ depending on direction (i.e., for shocks transmitted backwards or forwards along the supply chain).

Empirical approaches to date

- Basic model

$$p_t^{out} = \alpha + \beta_1 p_t^{in} + \mu_t$$

Assumptions:

- Competitive market (not untenable),
- Fixed proportions processing technology (importance depends on frequency of data),
- CRTS,
- Farm price change causes retail price change (evidence supports this assumption)

Empirical approaches to date

- Incorporate time needed for retail price to adjust to farm price change

- Transform variables to reflect asymmetric response
  - Retail price and other explanatory variables measured in deviation from initial values
  - Decompose farm price into two distinct series – cumulative price increases and cumulative price decreases
  - Changes in P^{out} decomposed into changes from P^{in} increases and P^{in} decreases (Wolffram, 1971, and others):

$$\Delta p_t^{out} = \alpha + \sum_{j=1}^{K}(\beta_j^{+} D^{+} \Delta p_{t-j+1}^{in}) + \sum_{j=1}^{L}(\beta_j^{-} D^{-} \Delta p_{t-j+1}^{in}) + \gamma_t$$

Empirical approaches to date

- Two limitations:

1. Time series properties of data. Price levels often exhibit a non-stationary covariance property which, as a consequence, may bias causality tests and lead to autocorrelation problems in the asymmetric price response function

2. The underlying price transmission mechanism is assumed linear.

Empirical approaches to date

- Possible solution – the asymmetric error correction model (AECM)
  - Symmetric versus asymmetric error correction
  - Test null of symmetric price response

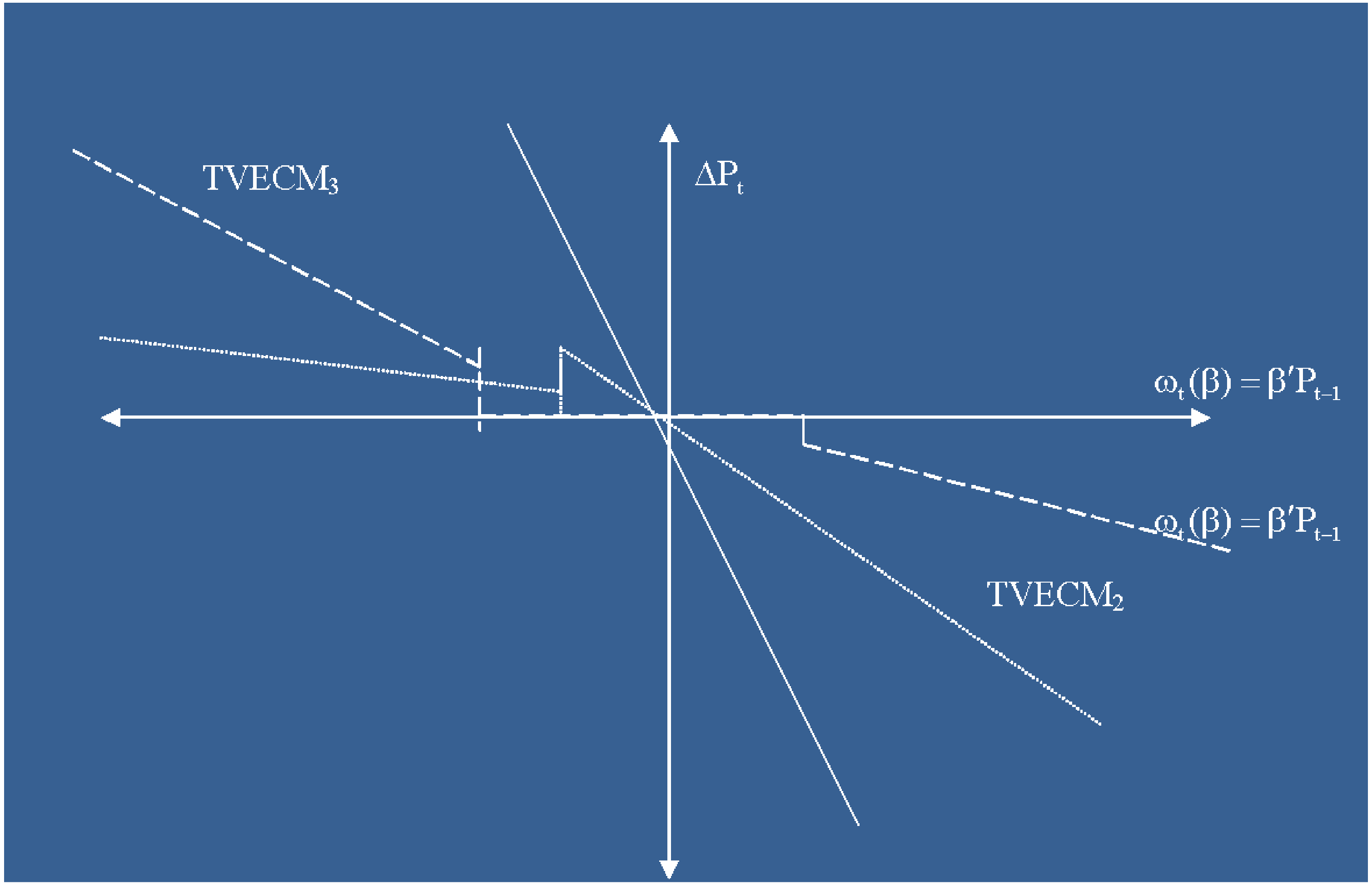
$$\Delta p_t^{out} = \alpha + \sum_{j=1}^{K} (\beta_j^+ D^+ \Delta p_{t-j+1}^{in}) + \sum_{j=1}^{L} (\beta_j^- D^- \Delta p_{t-j+1}^{in}) + \phi^+ ECT_{t-1}^+ + \phi^- ECT_{t-1}^- + \gamma_t$$

Empirical approaches to date

- However, the AECM assumes linear adjustments, which may be restrictive

- Hence, alternatives have been developed to fit better agricultural price behavior
  - Threshold models and Impulse Response Functions
  - Smooth Threshold Models
  - Non-parametric models

Empirical approaches to date



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Threshold models

Let $P_t=(P_{1t},P_{2t})'$ a vector of I(1) time series which is cointegrated with a common cointegrating vector. Following Lo and Zivot (2001), a three regime threshold Vector Error Correction Model (TVECM3), can be written as:

$$\Delta P_t = \begin{cases} \mu^1 + \alpha^1 \omega_{t-1}(\beta) + \sum_{i=1}^{k-1} \Gamma_i^1 \Delta P_{t-i} + \varepsilon_t^1, & \text{if} \quad \omega_{t\text{-}1}(\beta) < \lambda^2 \\ \mu^2 + \alpha^2 \omega_{t-1}(\beta) + \sum_{i=1}^{k-1} \Gamma_i^2 \Delta P_{t-i} + \varepsilon_t^2, & \text{if} \quad \lambda^1 \le \omega_{t\text{-}1}(\beta) \le \lambda^2 \\ \mu^3 + \alpha^3 \omega_{t-1}(\beta) + \sum_{i=1}^{k-1} \Gamma_i^3 \Delta P_{t-i} + \varepsilon_t^3, & \text{if} \quad \omega_{t\text{-}1}(\beta) < \lambda^1 \end{cases}$$

Threshold models

Asymmetry holds if:

- the speeds of adjustment of prices differ in the outer regimes
- the values of λ^1 and λ^2 differ

$$\Delta P_t = \begin{pmatrix} \Delta P_{1t} \\ \Delta P_{2t} \end{pmatrix} = \begin{cases} \begin{pmatrix} \mu_1^1 \\ \mu_2^1 \end{pmatrix} + \begin{pmatrix} \alpha_1^1 \\ \alpha_2^1 \end{pmatrix} \omega_{t-1}(\beta) + \sum_{i=1}^{k-1} \Gamma_i^1 \Delta P_{t-i} + \varepsilon_t^1, & \text{if} \quad \omega_{t-1}(\beta) < \lambda^2 \\ \sum_{i=1}^{k-1} \Gamma_i^2 \Delta P_{t-i} + \varepsilon_t^2, & \text{if} \quad \lambda^1 \le \omega_{t-1}(\beta) \le \lambda^2 \\ \begin{pmatrix} \mu_1^3 \\ \mu_2^3 \end{pmatrix} + \begin{pmatrix} \alpha_1^3 \\ \alpha_2^3 \end{pmatrix} \omega_{t-1}(\beta) + \sum_{i=1}^{k-1} \Gamma_i^3 \Delta P_{t-i} + \varepsilon_t^3, & \text{if} \quad \omega_{t-1}(\beta) < \lambda^1 \end{cases}$$

Threshold models

If threshold parameters (λ^1 and λ^2) are both known a priori, the model is linear in the remaining parameters, and under the assumption that errors εt are iid gaussian, parameters can be estimated by multivariate least squares.

However, in general, threshold parameters are unknown and need to be estimated along with the remaining parameters of the model.

Profile likelihood (implemented using a grid search) is the standard method, but produces biased results. Empirical Bayesian method being developed by Greb et al. (2011)

Smooth Threshold Vector Error Correction Models

$$\Delta P_t = \left(\phi_{1,0} + \alpha_1 z_{t-1} + \sum_{j=1}^{p-1} \phi_{1,j} \Delta P_{t-j}\right)\left(1 - G\left(s_{t-d}; \gamma, c\right)\right) + \left(\phi_{2,0} + \alpha_2 z_{t-1} + \sum_{j=1}^{p-1} \phi_{2,j} \Delta P_{t-j}\right)\left(G\left(s_{t-d}; \gamma, c\right)\right) + \varepsilon_t$$

where:

- P_t is a vector of I(1) prices
- α_i are matrices representing the speed of adjustment (under each regime *i*) of each price to deviations from the equilibrium
- $z_{t-1} = \beta' P_{t-1}$ is a matrix of stationary error correction terms
- β are the parameters of the cointegration relationship
- φ matrices capture the short-run dynamics.
- $G(s_{t-d}; \gamma, c)$ is the transition function, s_{t-d} is the transition variable, γ is the speed of transition from one regime to another and *c* is the threshold

Smooth Threshold Vector Error Correction Models

- The STVECM can be considered as a regime-switching model allowing for two extreme regimes G=0 and G=1, representing different price behavior under different economic conditions.

- The transition from one regime to another is allowed to take place smoothly.

Smooth Threshold Vector Error Correction Models

- STVECMs generalize TVECMs by means of allowing for gradual adjustments between regimes.

- When the transition from one regime to another becomes instantaneous, the STVECM reduces to a TVECM.

- While STVECM are an improvement over TVECM, in being parametric, they still carry the potential for specification biases. Non-parametric techniques are robust to misspecification issues.

Non parametric models: local linear regression estimator (LLRE)

For any residual of the cointegrating relationship (e_{t-1}), the LLRE models Δe_{t-1} linearly around e_{t-1} and applies the linear regression technique to a fraction of the data around e_{t-1}.

A certain weight is assigned to each local fit. The weighted sum of local fits yields the estimated Δe_{t-1} function. Hence, the LLRE is equivalent to solving a weighted least squares problem.

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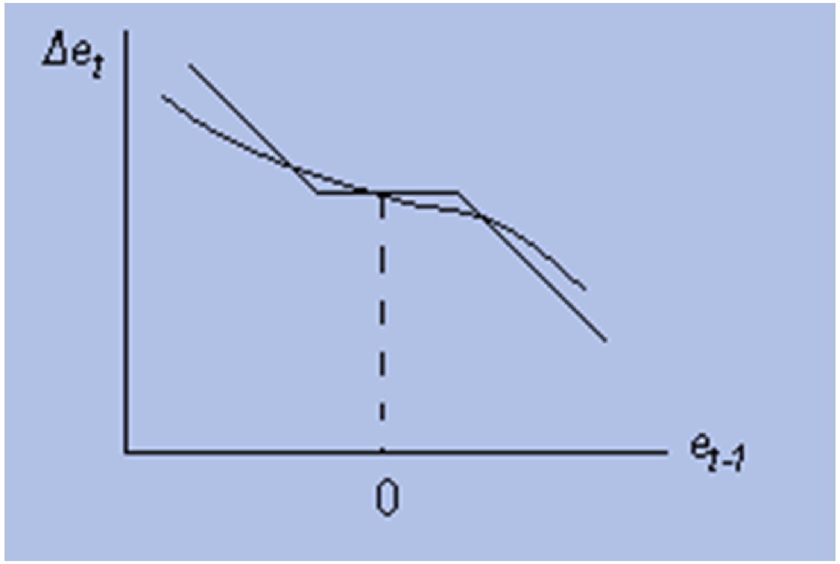
Non parametric Models: local linear regression estimator (LLRE).

The solution to the weighed least squares problem yields the local linear regression estimator (LLRE):



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Case study: the Spanish Lamb Sector

1. Data and preliminary analysis

2. Cointegration analysis

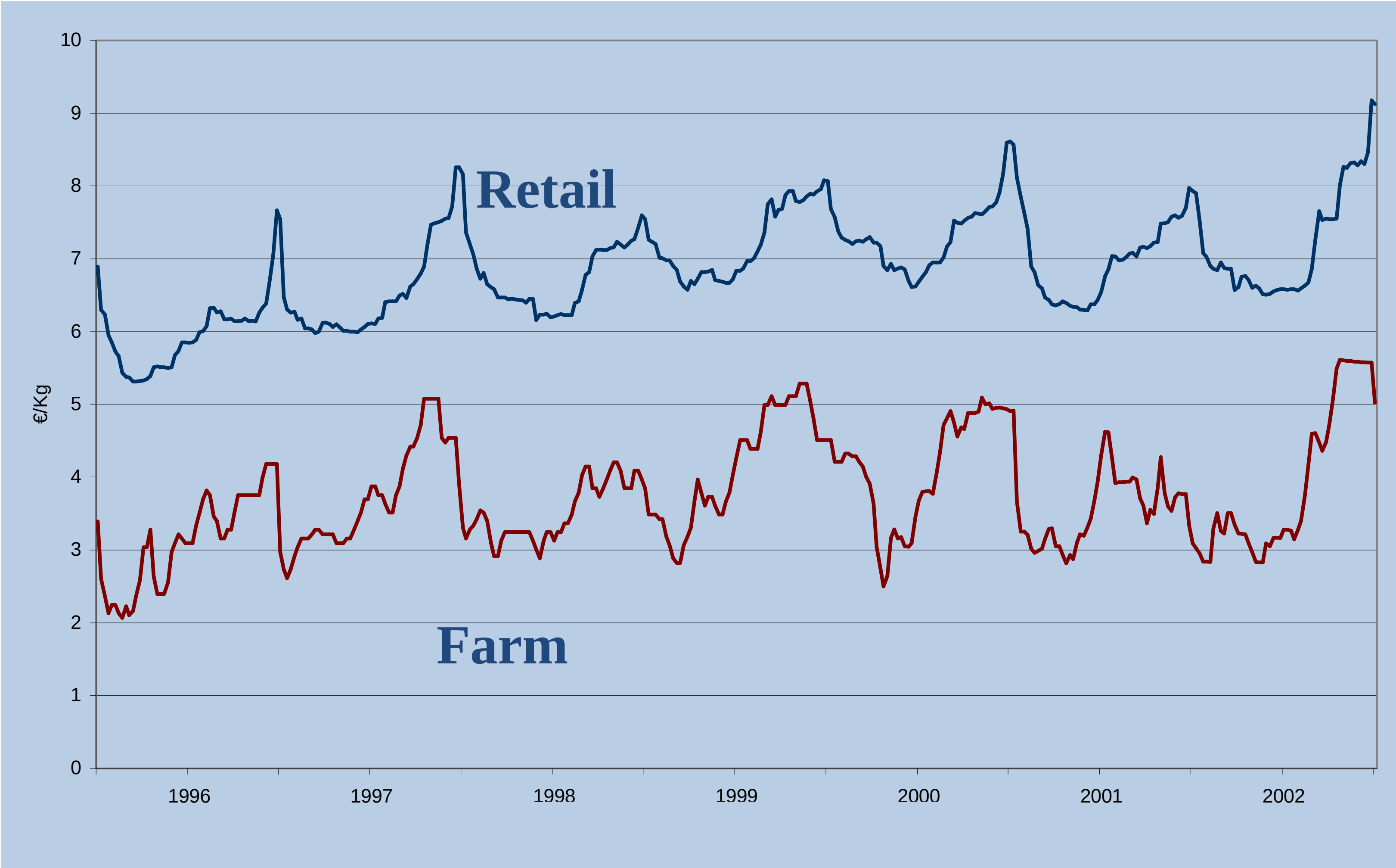
3. Threshold cointegration

4. Short-run dynamics

Data and Preliminary Analysis

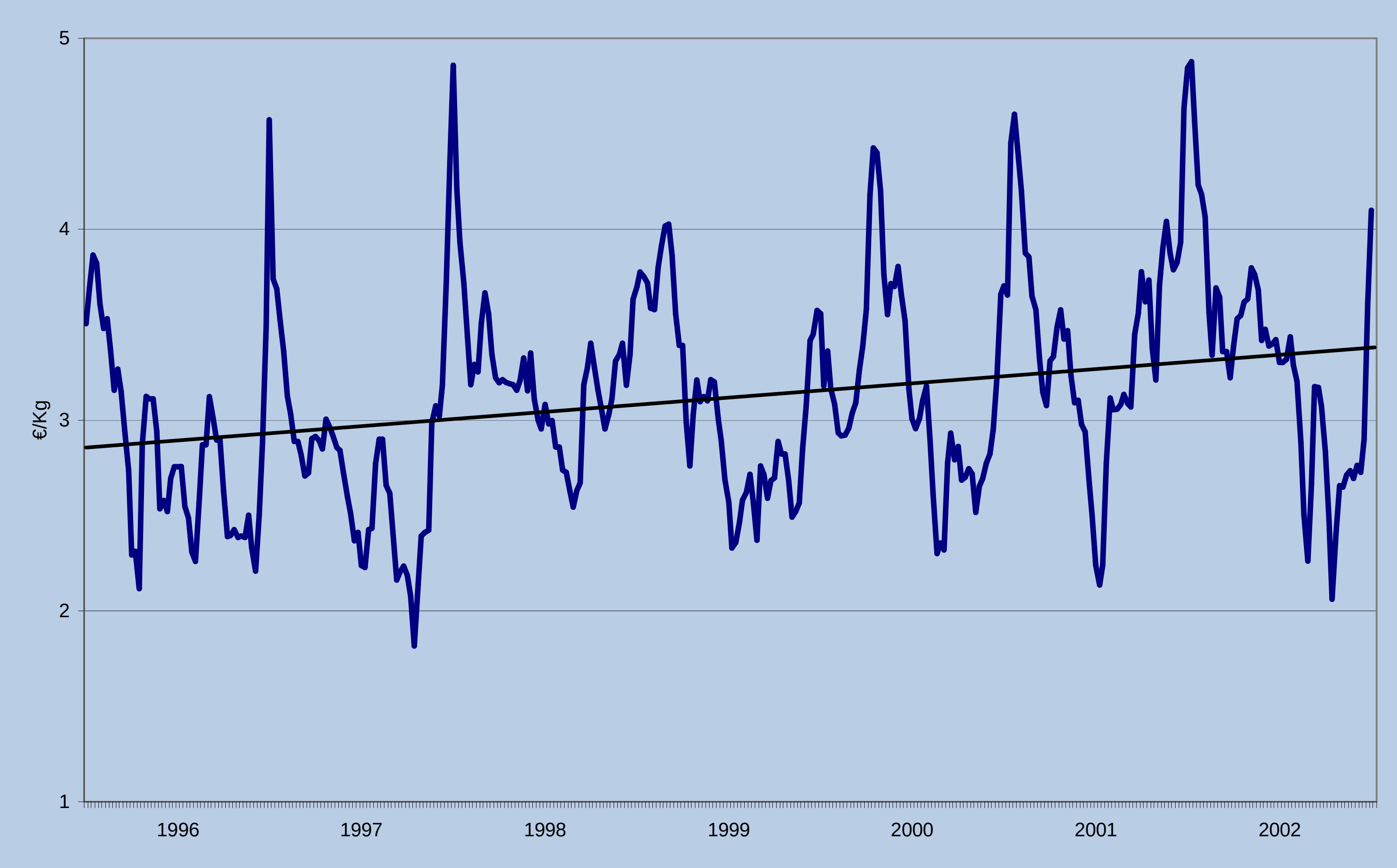
- Spain is the second largest lamb producer within the European Union (EU).
- It represents around 5% of the Spanish Final Agricultural production and 11% of Final Livestock Production.
- 80% of total production is located in the so called Less Favoured Areas (LFA).

Data and preliminary analysis

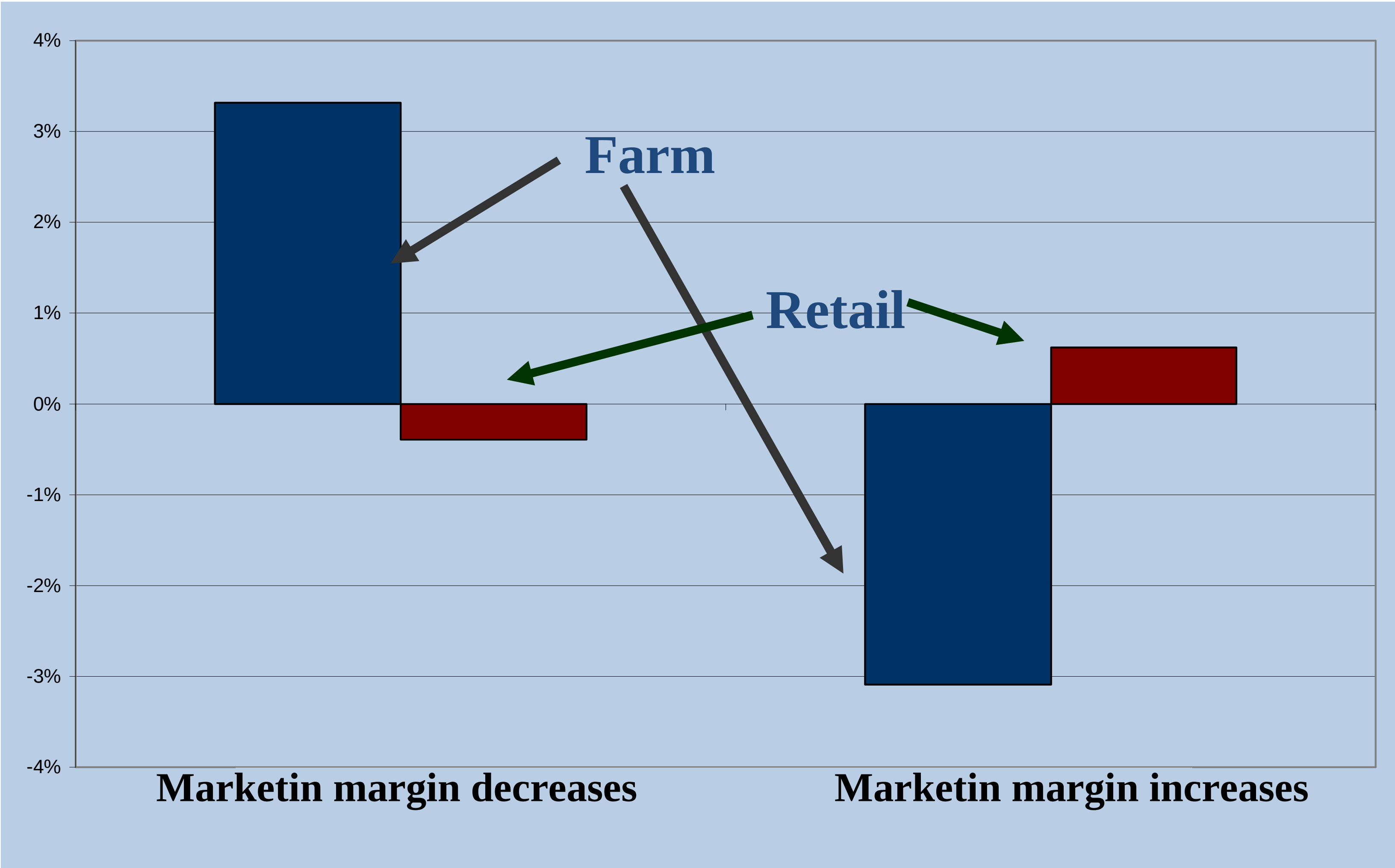


Data and Preliminary Analysis:

Marketing margin



Data and preliminary Analysis:
Price Transmission



Data and Preliminary Analysis

- All variables are expressed in natural logarithms.

- Seasonality:
  - Seasonal Unit Roots: seasonality is deterministic
  - To be parsimonious, has been adequately captured by using a Fourier-type series expansion.

- Non-stationarity:
  - Unit root tests developed by Elliot et al., (1996) and Ng and Perron (2001) as well as the stationary test from Kwiatkowski et al. (1992) (KPSS)
  - All tests are consistent with the presence of a unit root in the three price series, satisfying the first necessary condition for cointegration analyses

Cointegration analysis

- Before implementing Johansen' procedure to test for cointegration, each system has to be correctly specified:
  - Deterministic components
    - a restricted constant term lying in the cointegration space
    - seasonality
  - The optimum lag: 3
- Misspecification tests for autocorrelation and normality
- Farm and retail prices are cointegrated

Cointegration analysis

- In the long run, any change in any of the prices at different levels of the Spanish lamb marketing chain is fully transmitted to the rest.

- The restricted cointegrating vectors are given by:

$$LnRP - lnFP = 0.635$$

- Constant terms represent price spreads. As prices are expressed in logarithms, the retail marketing margins can be expressed as follows:

$$\text{Retail margin} = (e^{\alpha}-1) \times FP \times 100 = 89\% FP$$

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Threshold cointegration

Tests for non-linearities in price adjustments		
	$LR_{1,3}$ [a]	$LR_{2,3}$ [b]
Test statistic	89.72	63.91
FR critical value (5%)[c]	43.46	40.72
PR critical value (5%)[d]	51.55	48.29
Threshold parameters	$\hat{\lambda} = (-0.0679, -0.0065)$	

a The $LR_{1,3}$ tests the null of linearity against the alternative of a three-regime TVECM (Lo and Zivot, 2001).
b The $LR_{2,3}$ tests the null of a two-regime TVECM against the alternative of a three-regime TVECM (Lo and Zivot, 2001).
c Critical values are obtained using the fixed regressor (FR) bootstrapping technique (Hansen and Seo, 2002).
d Critical values are obtained using the parametric residual (PR) bootstrap algorithm (Hansen and Seo, 2002).

Threshold cointegration

Estimated parameters of the TVECM$_3$[a]			
	Regime 1[b] $\omega_{t-1}(\hat{\beta}) < -0.0679$	Regime 2[b] $-0.0679 \leq \omega_{t-1}(\hat{\beta}) \leq -0.0065$	Regime 3[b] $\omega_{t-1}(\hat{\beta}) > -0.0065$
$\begin{pmatrix} \alpha_1^i \\ \alpha_2^i \end{pmatrix}$	$\begin{pmatrix} -0.053 \\ (0.021) \\ 0.026 \\ (0.031) \end{pmatrix}$	$\begin{pmatrix} 0.003 \\ (0.090) \\ -0.0091 \\ (0.023) \end{pmatrix}$	$\begin{pmatrix} -0.054 \\ (0.023) \\ 0.104 \\ (0.041) \end{pmatrix}$
% of observations	33.33	38.33	28.33

Misspecification tests			
Farm prices		Retail prices	
BG(1)-FP[c]	2.59	BG(1)-RP	0.44
BG(52)-FP[c]	1.46	BG(52)-RP	1.13
ARCH(1)-FP[c]	3.84	ARCH(1)-RP	3.32
ARCH(52)-FP[d]	3.76	ARCH(52)-RP	3.86
JB-FP[e]	3.04	JB-RP	4.02

a. Values in parentheses are standard deviations.

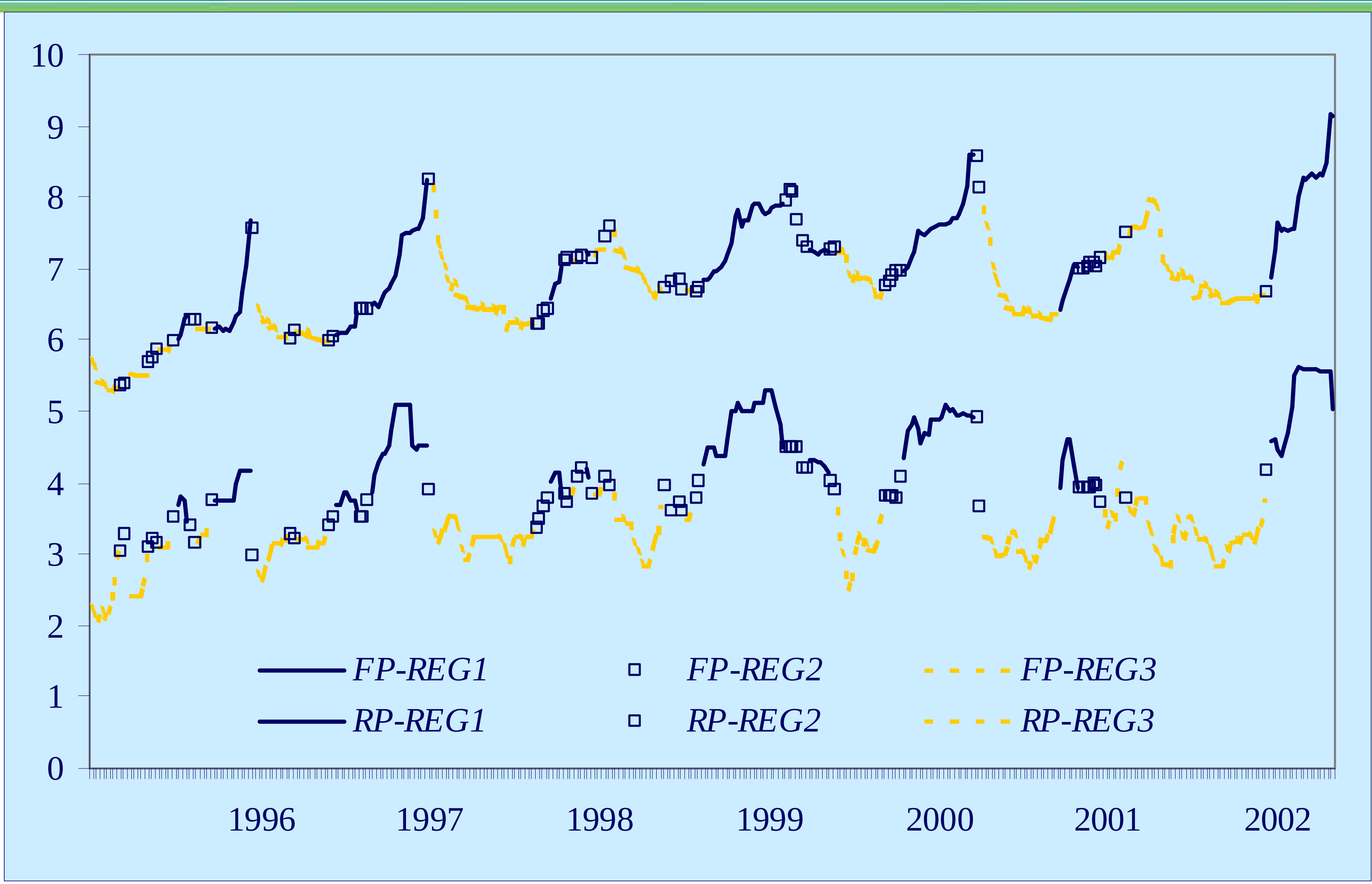
b. $\omega_{t-1}(\hat{\beta}) = RP - FP - 0.635$.

c. BG(i) is the Breusch-Godfrey test for autocorrelation of order i (critical value at the 5% significance level is 3.84).

d. ARCH (i) is the Engle test for conditional heteroscedasticity of order i (critical value at the 5% significance level is 3.84).

e. JB is the Jarque-Bera test for normality (critical value at the 5% significance level is 5.99).

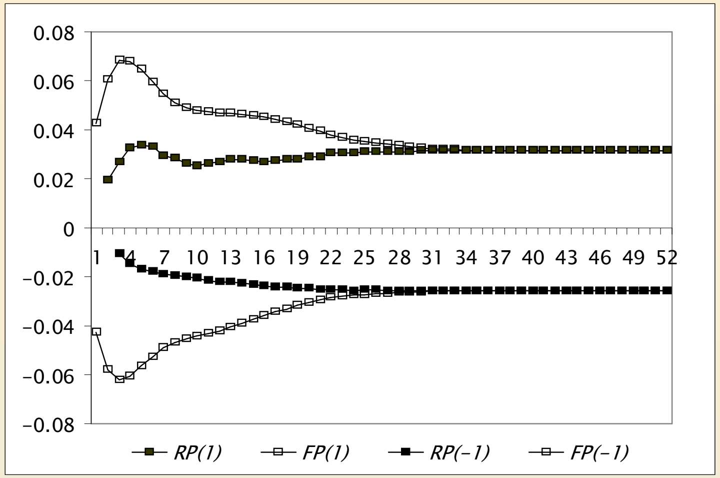
Threshold cointegration



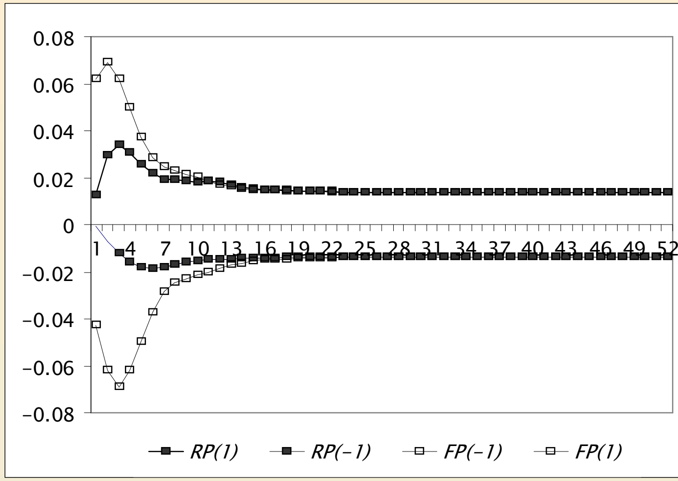
Short-run dynamics

Impulse response functions to positive and negative shocks in FP under the two regimes

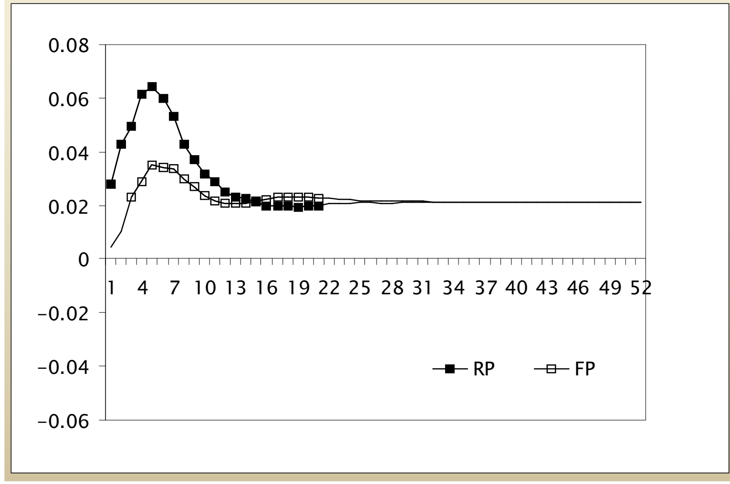
Shock in FP (Regime 1)



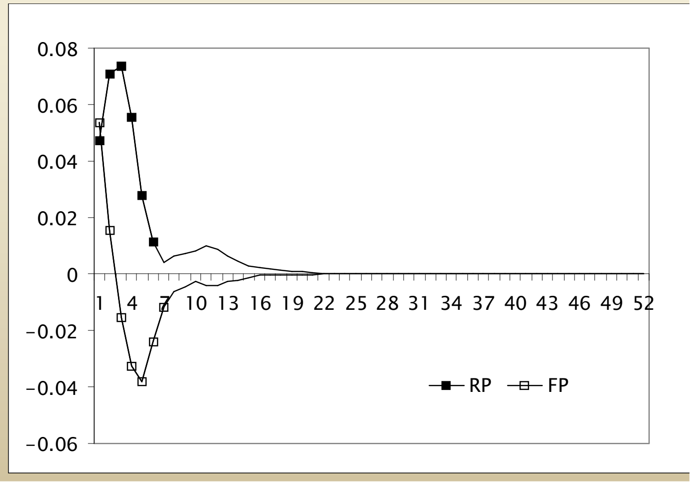
Shock in FP (Regime 3)



Asymmetric responses (Regime 1) Shock in FP



Asymmetric responses (Regime 3) Shock in FP



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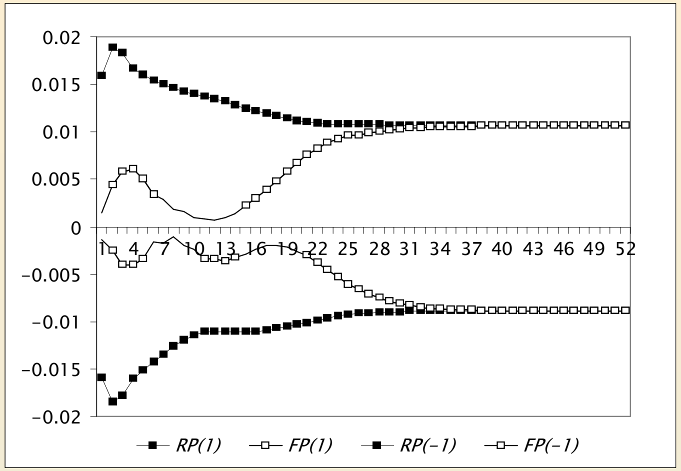
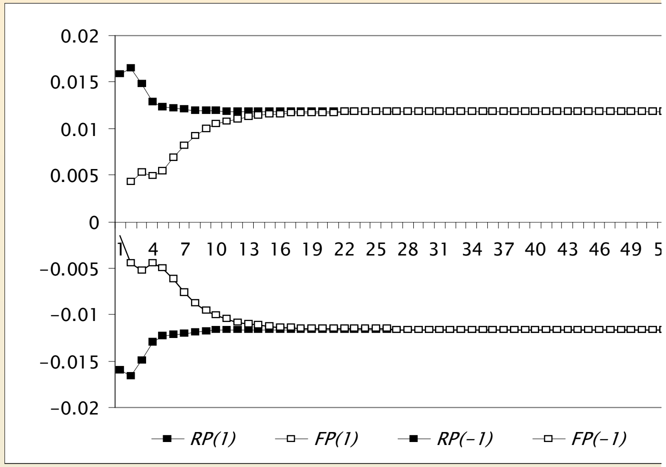
Short-run dynamics

Impulse response functions to positive and negative shocks in RP under the two regimes

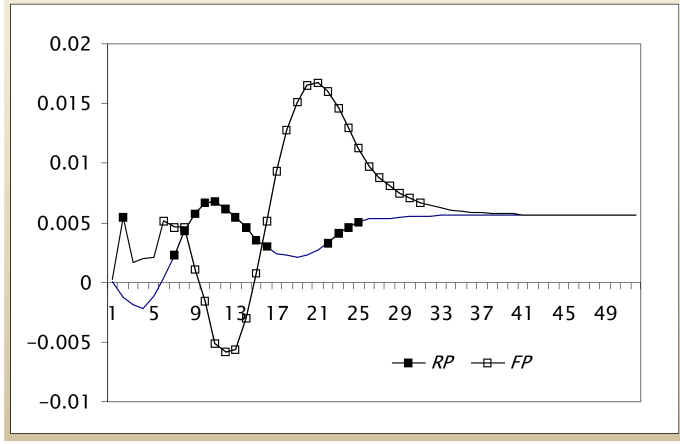
Shock in RP (Regime 1)



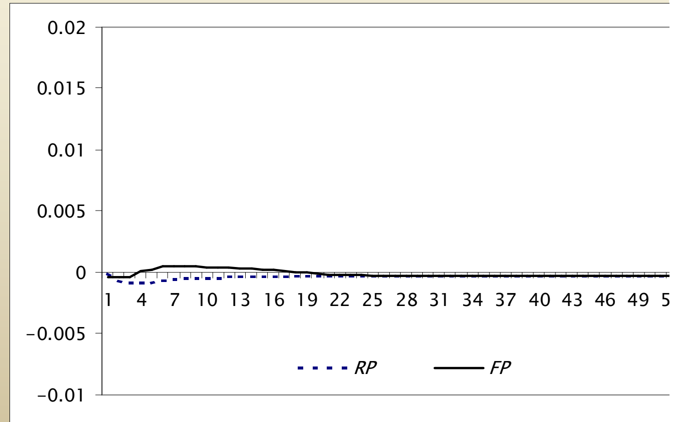
Shock in RP (Regime 3)



Asymmetric responses (Regime 1) Shock in RP



Asymmetric responses (Regime 3) Shock in RP



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Remaining challenges

- Methodological issues
  - Price volatility
  - Multivariate non parametric (tests)
- Data issues
  - Data Frequency
  - Data Aggregation
  - Product homogeneity
- Interpretation issues