Imperfect Mobility and Heterogeneous Labour in CGE Modelling

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THREE ESSAYS ON BLACK SEA GRAIN MARKETS

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FAPRI

College of Agriculture, Food and Natural Resources

Black Sea Grain Market

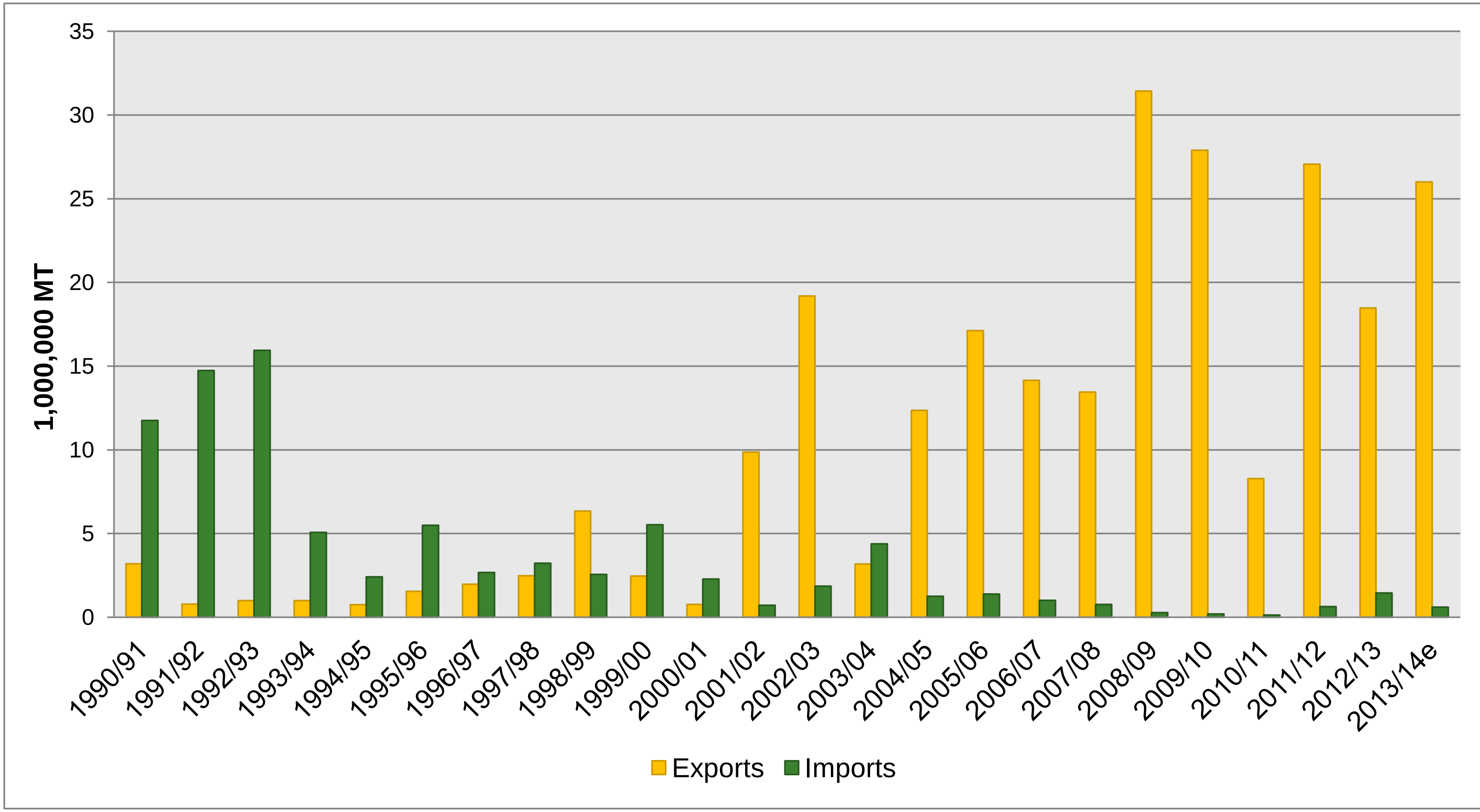
In 2012/13, Ukraine and Russian were among top ten exporters of:

Wheat (18.5 mln. tons)

Corn (14.6 mln. tons)

Barley (4.6 mln tons)

Dynamics of the Russian and Ukrainian wheat exports and imports



Source: USDA, 11/2013

Decision	Period	Wheat	Barley	Corn
10/11/2006	10/17/2006-12/31/2006	400	600	600
12/08/2006	12/14/2006-06/30/2007	3	600	500
02/13/2007	02/15/2007-06/30/2007	3	606	30
02/22/2007	02/26/2007-06/07/2007	3	Quotas cancelled	Quotas cancelled
05/22/2007	05/22/2007	Quotas cancelled	-	-
06/20/2007	07/01/2007-10/31/2007	3	3	3
09/26/2007	01/01/2008-03/31/2008	200	400	600
03/28/2008	04/01/2008 – 04/30/2008	200	400	Automatic licensing
04/23/2008	04/2008-07/01/2008	1,200	900	Automatic licensing
05/21/2008	05/21/2008	Quotas and licenses are cancelled		
10/06/2010	10/20/2010-12/2010	500	200	2,000
12/08/2010	12/2010 – 02/2011	1,000	200	3,000
03/30/2011	04/04/2011 – 07/01/2011	1,000	200	5,000
05/2011	05/2011	Quotas are cancelled		
05/2011	05/2011-01/2012	Tariffs are introduced		
10/2011	10/2011	Tariffs cancelled, except for barley (01/01/2012)		
10/10/2011	07/01/2011 – 06/30/2012	Ministry of Agricultural Policy and Food of Ukraine signed a Memorandum of Understanding with the grain exporters; amount of allowed exports established at 24.76 mmt of grain		
07/2012	07/01/2012 – 06/30/2013	Memorandum of Understanding was extended for 2012-13 marketing year; amount of allowed exports established at 24.76 mmt of grain		
11/2012	11/2012 – 06/30/2013	Export amounts under the Memorandum of Understanding were increased by 1.5 mln. tons (for corn only)		
06/2013	07/01/2013 – 06/30/2014	Memorandum of Understanding was extended for 2013-14 marketing year		

Source: UkrAgroConsult (2013); Kobuta *et al.* (2012); FAO-EBRD (2010).

Price transmission

- Price transmission (or price cointegration) refers to the co-movement shown by prices of the same good in different location;

- Such models are used to assess competitive market equilibrium or market efficiency, a price based indicator that holds on the conditions of spatial equilibrium;

- Some benefits:
  - Use of price data only;
  - Allows for short and long run dynamics' analysis;
  - Allows for relaxing assumptions of linearity and symmetric adjustment.

Limitations

- Frequent reliance on the price data only;
- Transaction and transportation costs are assumed to be equal to zero or set as a fixed proportion of the prices used;
- Price vs. market integration;
- (!) Price transmission parameters summarize overall effects that might affect prices in different markets. Further research is needed to study separate role of each factor.

STRUCTURE OF THE DISSERTATION

- **Essay 1a:** Black Sea and World Wheat Market Price Integration Analysis
- **Essay 1b:** Short- and Long-Run Relationships Between Ukrainian Barley and World Feed Grain Export Prices
- **Essay 2:** Analysis of the Asymmetric Price Transmission in the Ukrainian Wheat Supply Chain
- **Essay 3:** Export Restrictions and Price Volatility in the Ukrainian Wheat Market: Evidence From a Dynamic Conditional Correlation GARCH Model

METHODS USED

Cointegration tests

- Engle and Granger (1987) method

<u>Step 1</u>: Estimate the following regression model in levels: $P_t^{RUS} = \beta_0 + \beta_1 P_t^{US} + \varepsilon_t$

<u>Step 2:</u> Test residuals ε_t for stationarity

- Johansen Maximum Likelihood (ML) method

<u>Goal:</u> Estimate the rank of Π in the following model:

$$\Delta P_t = \Pi_0 + \Pi P_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta P_{t-i} + \theta_t$$

TAR and M-TAR models

- Asymmetric price transmission - implies that the adjustment towards the equilibrium is of different magnitude regardless of the direction of the change.

$$\Delta\bar{\varepsilon}_t = \gamma_1 \bar{\varepsilon}_{t-1} + \sum_{i=1}^{p} \gamma_{i+1} \Delta \bar{\varepsilon}_{t-i} + \omega_t$$

, where

$$\Delta\bar{\varepsilon}_t = I_t \gamma_1 \bar{\varepsilon}_{t-1} + (1 - I_t)\gamma_2 \bar{\varepsilon}_{t-1} + \varphi_t$$

$$I_t = \begin{cases} 1 \; if \;\; \bar{\varepsilon}_{t-1} \geq 0 \\ 0 \; if \;\; \bar{\varepsilon}_{t-1} < 0 \end{cases}$$

or

$$I_t = \begin{cases} 1 \; if \; \Delta\bar{\varepsilon}_{t-1} \geq 0 \\ 0 \; if \; \Delta\bar{\varepsilon}_{t-1} < 0 \end{cases}$$

TAR

M-TAR

Error-Correction Model (short-run dynamics)

- Error Correction Models (ECMs) estimate the speed at which a dependent variable returns to equilibrium after a change in an independent variable

$$\Delta P_t^{FL} = a_0 + a_1 \bar{\varepsilon}_{t-1} + \sum_{i=1}^{p} \delta_i \Delta P_{t-i}^{FL} + \sum_{j=1}^{n} \theta_j \Delta P_{t-j}^{FW} + \mu_t$$

- Threshold Error Correction Models (TECMs)

$$\Delta P_t^{FL} = a_0 + \rho_1 I_t \bar{\varepsilon}_{t-1} + \rho_2 (1 - I_t) \bar{\varepsilon}_{t-1} + \sum_{i=1}^{p} \delta_i \Delta P_{t-i}^{FL} + \sum_{j=1}^{n} \theta_j \Delta P_{t-j}^{FW} + \mu_t$$

Bai and Perron (1998, 2003) Structural Break Test

- Allows for finding multiple breaks at unknown times

- Uses dynamic programming algorithm to identify optimal number of breaks

- Decision is based on finding min Residual Sum of Squares (RSS) and Bayesian Information Criteria (BIC)

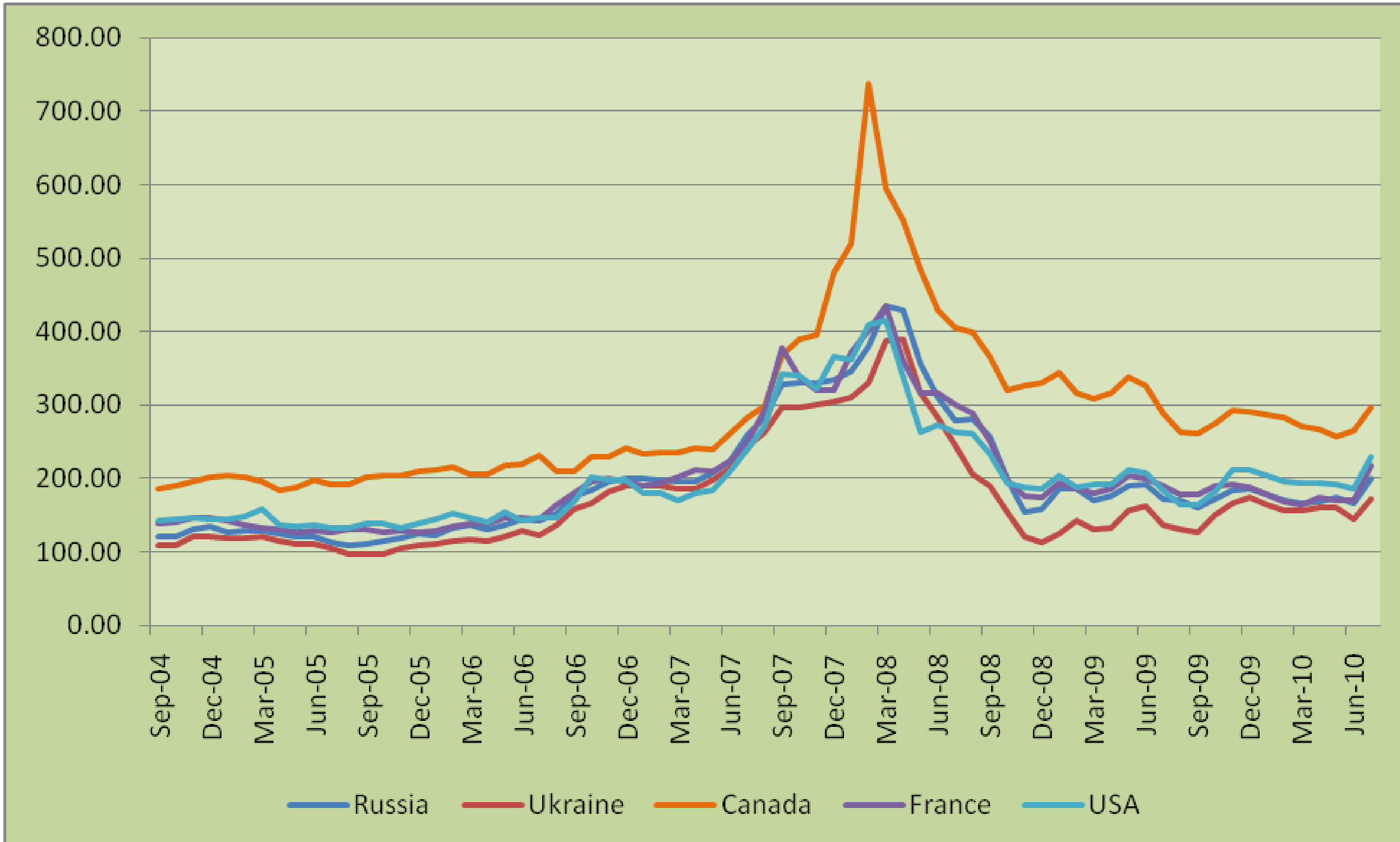
RESEARCH GOALS: Essays 1a & 1b

Horizontal Price Transmission

- To check whether Black sea grain markets are cointegrated with the world grain markets
  - Essay 1a studies price dynamics between Russia and Ukraine and other major wheat exporters – U.S., EU, and Canada
  - Essay 1b investigates price transmission between Ukrainian barley and Australian barley, EU barley, Canadian barley, and U.S. corn
- To test for the presence of the structural change in the identified long-run price relationships
- To analyze if price transmission is symmetric (for the pairs of series that are cointegrated)
- To investigate the short run dynamics between cointegrated series

Essay 1a: Black Sea and World Wheat Market Price Integration Analysis

Comparison of the analyzed wheat price series, **$ per ton**



Source: IGC, 2011

Cointegration tests' results – pairwise for **Russia**

Pairs of series	Engel and Granger procedure			Johansen method		
	# of lags	ADF	PP	Ho(H1)	Trace	5%CV
Russia-France	2	-5.32**	-5.24**	R=0((r>0)	25.98**	19.99
				R=1(r>1)	6.69	9.13
Russia-Canada	1	-2.30	-2.38	R=0((r>0)	13.23	19.99
				R=1(r>1)	5.12	9.13
Russia-USA	1	-3.79**	-3.81**	r=0((r>0)	15.47	19.99
				R=1(r>1)	3.75	9.13

Asterisks denote levels of significance (* for 10 percent, ** for 5 percent). The 5% and 10% critical values for tests with a drift are -3.42 and -3.10 respectively. Critical values were obtained from MacKinnon (1991).

Cointegration tests' results – pairwise for **Ukraine**

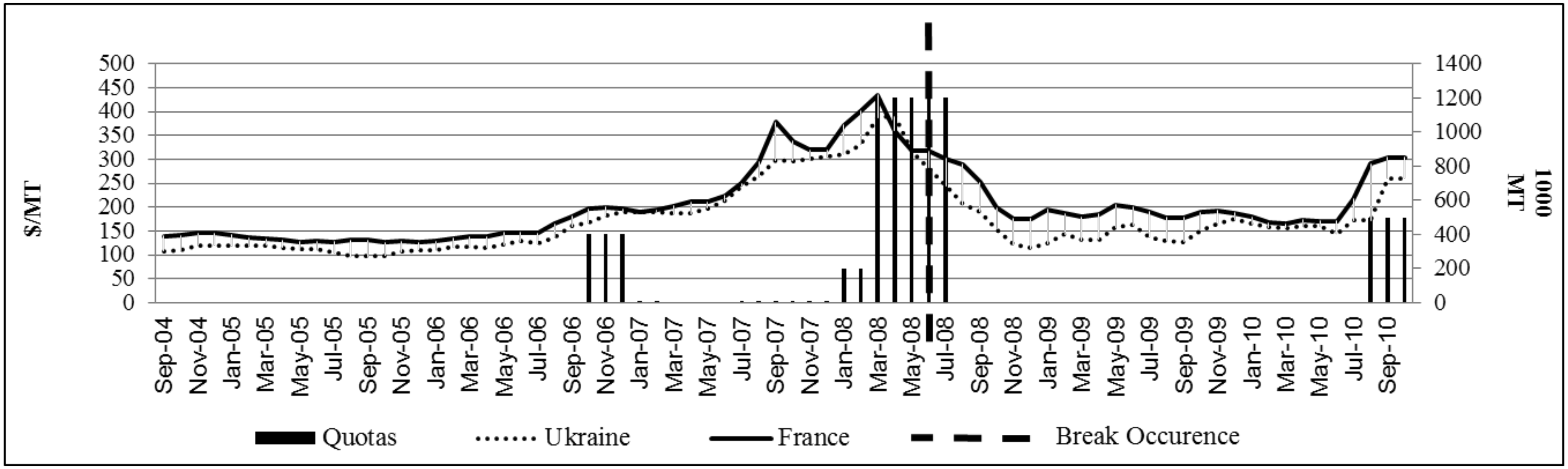
Pairs of series	Engel and Granger procedure			Johansen method		
	# of lags	ADF	PP	Ho(H1)	Trace	5%CV
Ukraine-France	3	-2.33	-3.64*	R=0((r>0)	24.66**	19.99
				R=1(r>1)	5.28	9.13
Ukraine - Canada	1	-1.90	-1.99	R=0((r>0)	12.48	19.99
				R=1(r>1)	4.70	9.13
Ukraine-USA	2	-2.91	-3.24*	r=0((r>0)	12.48	19.99
				R=1(r>1)	4.56	9.13

Asterisks denote levels of significance (* for 10 percent, ** for 5 percent). The 5% and 10% critical values for tests with a drift are -3.42 and -3.10 respectively. Critical values were obtained from MacKinnon (1991).

Long-run dynamics

- The long-run elasticities are equal to
  - 1.04 (case of Russia-France)
  - 1.16 (case of Russia-USA)
  - 1.05 (case of Ukraine-France)

The story of a structural break



	# of lags	ADF	PP	KPSS
Pre-break period	4	-2.61	-3.14*	0.17
Post-break period	2	-1.75	-2.74	0.35*

Source: IGC, 2011

Short-run Dynamics

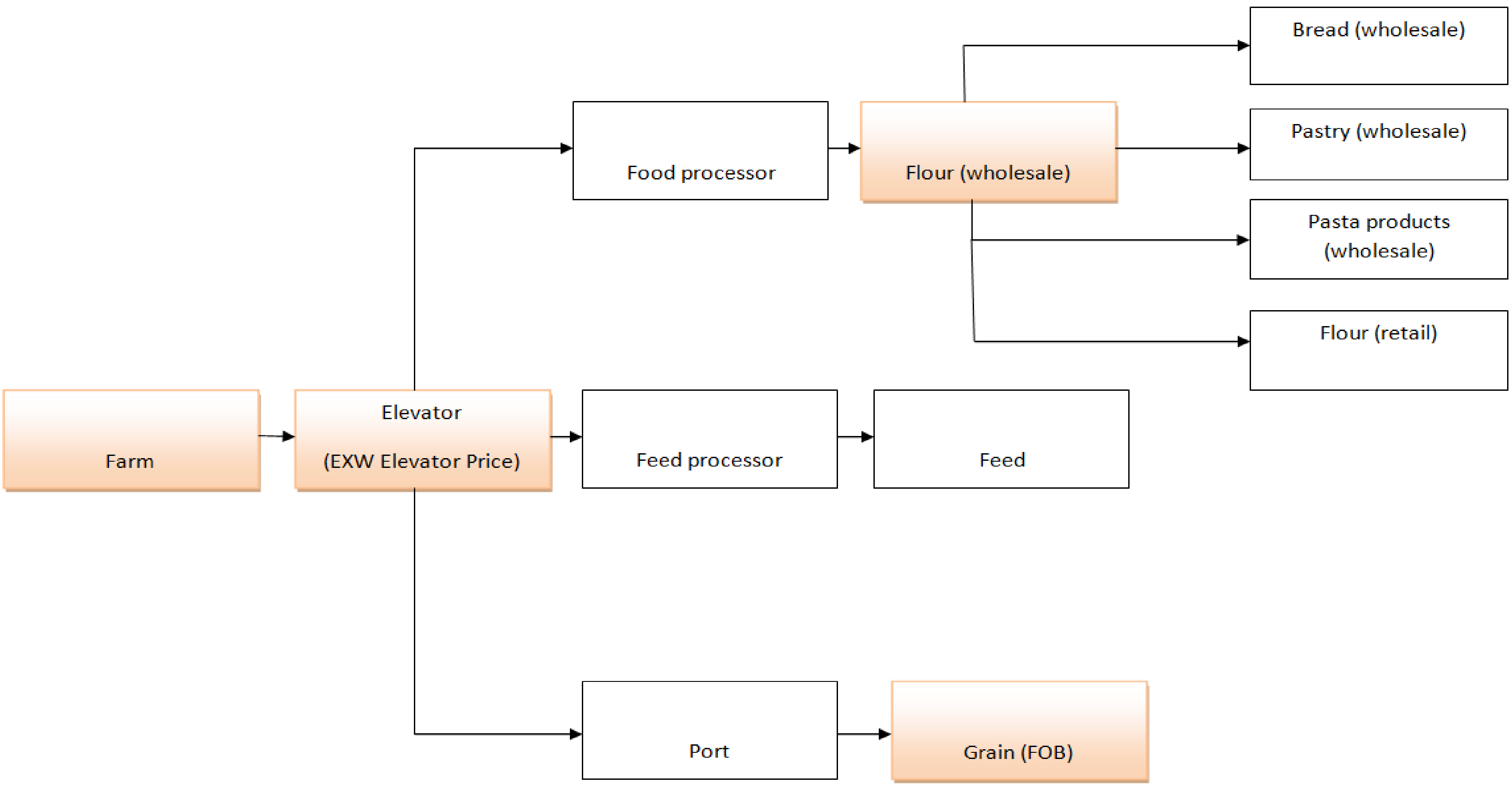
Dependent variable	Independent variable	# of lags	Speed of adjustment, α_1	LM test	F_{test}
Russia	France	2;2	-0.18 (-0.82)	1.87 [0.76]	12.78**
France	Russia	1;1	-0.59 (-2.82)**	1.73 [0.78]	10.08**
Russia	USA	1;1	-0.09 (-0.98)	3.28 [0.51]	14.78**
USA	Russia	1;1	-0.30 (-2.11)**	1.66 [0.79]	4.03**
Ukraine	France	2;2	-0.20 (-1.99)*	0.92 [0.63]	11.38**
France	Ukraine	1;1	-0.25(-2.63)**	2.76 [0.25]	9.13**

<u>Essay 2: </u>Analysis of Asymmetric Price Transmission in the Ukrainian Wheat Supply Chain

Objective:

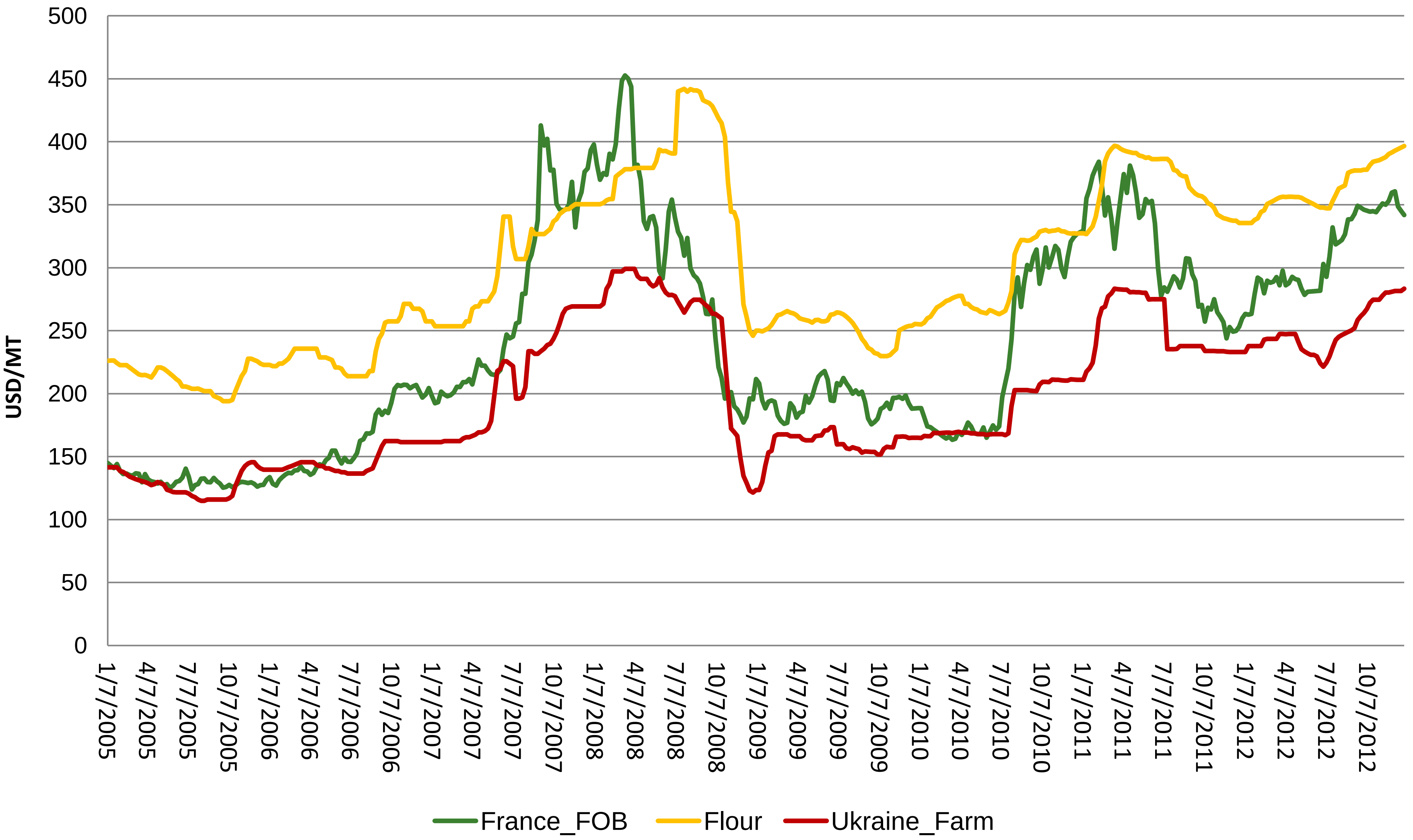
- To investigate short- and long-run vertical price transmission behavior in the Ukrainian wheat supply chain

Simplified Ukrainian wheat supply chain (without the retail level, except for flour)



Source: Canadian International Development Agency, 2007

Data



Source: APK-Inform

Long-run Dynamics

$$P_t^{FL} = \beta_0 + \beta_1 P_t^{FW} + \varepsilon_t$$

Or Dynamic OLS

$$P_t^{FL} = \theta_0 + \theta_1 P_t^{FW} + \sum_{i=-m}^{+m} \Delta P_{t-i}^{FW} + \varepsilon_t$$

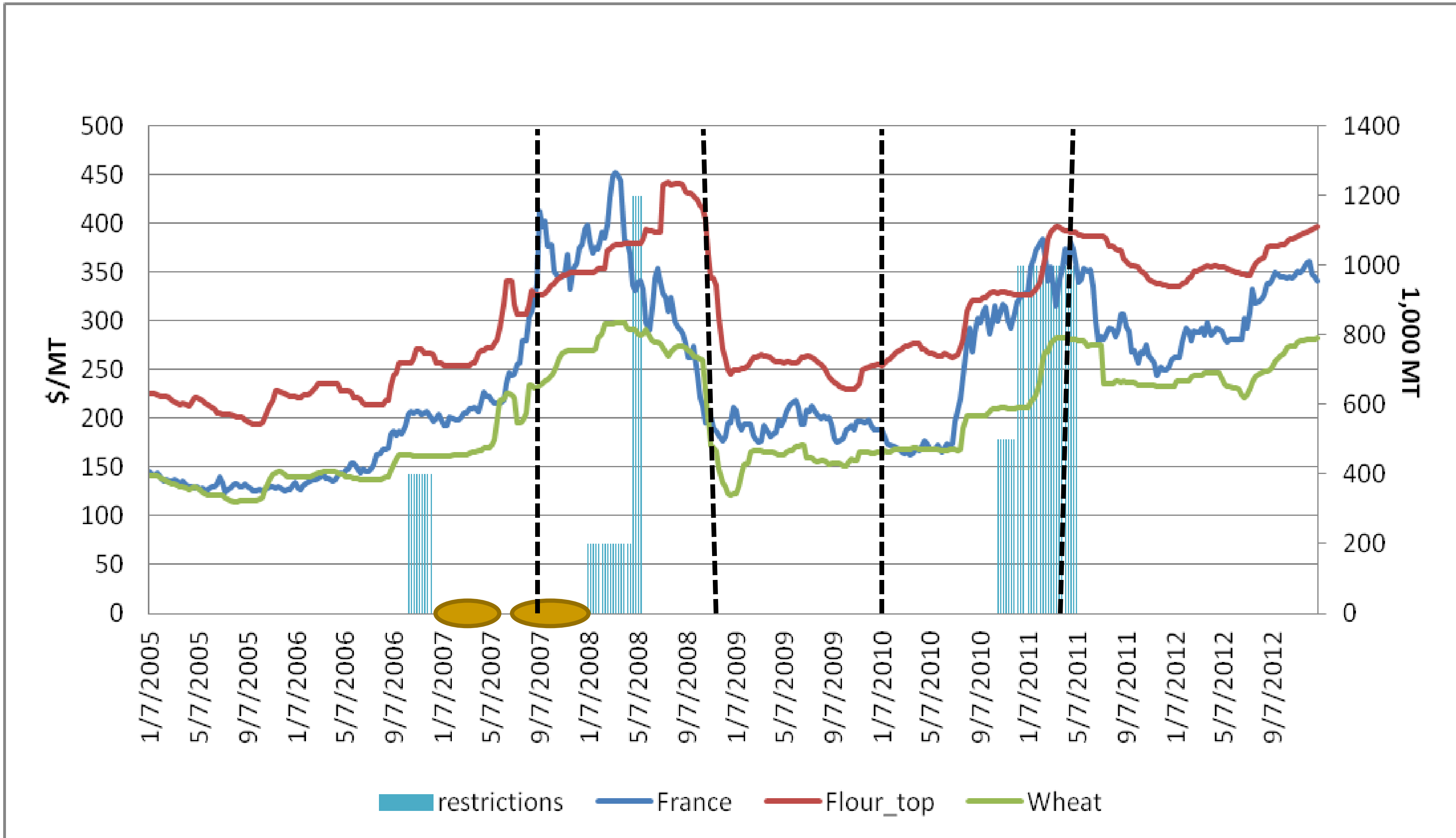
- The long-run elasticities are equal to
  - 0.69 (case of Farm-France)
  - 0.74 (case of Flour-Farm)

Structural breaks

	Break date	Confidence interval	BIC	RSS
Break 1	8/17/2007	07/20/07 – 08/24/07	2.03	-947.44
Break 2	10/24/08	10/17/08 – 10/31/08		
Break 3	01/01/10	12/18/09 – 3/05/11		
Break 4	03/18/11	3/11/11 – 4/1/11		

Period 1 (January 2005 till August 2007)
Period 2 (September 2007 – October 2008)
Period 3 (November 2008 – January 2010)
Period 4 (February 2010 – March 2011)
Period 5 (April 2011 – December 2012)

Chronology of export quotas and structural breaks



Dynamic OLS results for different regime dummies

Variable	Coefficient[e]
Const	2.17 (0.35)***
Trend	0.0005(0.00)***
P_t^{FR}	0.55 (0.06)***
Regime 1	0.01 (0.07)
Regime 2	-0.34 (0.08)***
Regime 3	-0.33 (0.17)*
Regime 4	-0.14 (0.07)**
Const_r1	-0.08 (0.41)
Const_r2	2.08 (0.48)***
Const_r3	1.6 (0.92)*
Const_r4	0.66 (0.38)*
ΔP_{t-1}^{FR}	-0.43(0.09)***
ΔP_{t-2}^{FR}	-0.31 (0.09)***
ΔP_{t+1}^{FR}	-0.04 (0.09)
ΔP_{t+2}^{FR}	-0.02 (0.08)
AIC	-1033.76

[e]The Newey-West heteroskedasticity and autocorrelation robust standard errors are reported in parenthesis. Asterisks denote levels of significance (* for 10 percent, ** for 5 percent, *** for 1 percent).

Testing for asymmetric price transmission: M-TAR model

	France-Wheat	Wheat-Flour
Variable	Parameter estimate	Parameter estimate
γ_1	-0.06 (-2.01)**	-0.03 (-0.99)
γ_2	-0.09(-3.44)**	-0.10 (-4.33)**
$H_0: \gamma_1 = \gamma_2 = 0(\Phi)$	7.72**	9.75**
$H_0: \gamma_1 = \gamma_2 \, (F)$	0.81[0.37]	4.61 [0.03]**
τ	0	0

Short-run Dynamics

Dependent variable	Independent variable	# of lags	Speed of adjustment, ρ_1	Speed of adjustment, ρ_1	Speed of adjustment, ρ_2
FrenchFOB	Wheat	1;1	-0.0240 (-1.33)	-	-
Wheat	FrenchFOB	2;2	-0.0638 (-5.70)**	-	-
Flour	Wheat	1;1	-	-0.02 (-1.23)	-0.11(-6.08)**

<u>Essay 3:</u> Export Restrictions and Price Volatility in the Ukrainian Wheat Market: Evidence from a Dynamic Conditional Correlation GARCH Model

Objective

1) to investigate the development of Ukrainian wheat farm price volatility during the export interventions compared to open trade

2) to study interdependence of the world (French) and Ukrainian domestic wheat price volatility in the analyzed period

GARCH-DCC

- DCC is a type of multivariate GARCH model. See Engle(2002).
- It approximates a dynamics conditional correlation matrix and permits to evaluate the level of interdependence between markets across time

GARCH-DCC (cont.)

$$H_t = D_t R_t D_t$$

- H_t is the conditional covariance matrix of the price returns' vector

- $D_t = diag\{\sqrt{h_{jj}}\}$, j = 1,…,J, is a 3x3 matrix of the standardized disturbance variances from the univariate GARCH models

- $R_t = (diag(Q_t))^{-1/2} Q_t (diag(Q_t))^{-1/2}$ – a symmetric dynamic correlations matrix of standardized residuals, where

$$Q_t = \{\rho_{ij,t}\} = (1 - \alpha - \beta)\bar{Q} + \beta Q_{t-1} + \alpha(u_{t-1} u'_{t-1})$$

- The primary focus of the GARCH-DCC model is on obtaining conditional correlations in R_t:

$$r_{ij,t} = \rho_{ij,t} / \sqrt{\rho_{ii,t}} \sqrt{\rho_{jj,t}}$$

Data

- **Weekly** prices for:
  - Ukrainian ex warehouse prices of milling wheat of Class III
  - German warehouse delivery price of bread wheat
  - French FOB soft wheat price (Rouen)

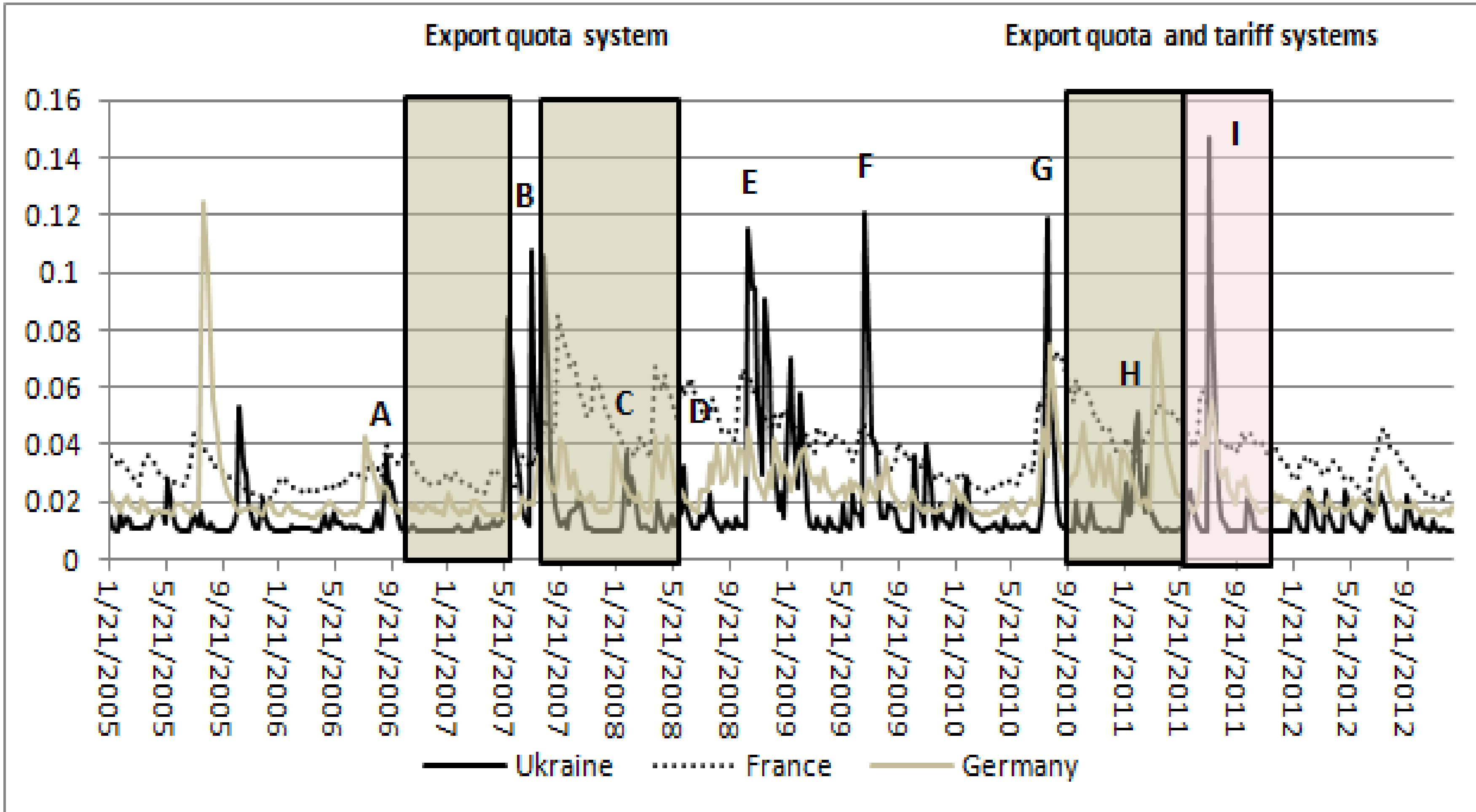
- Time span: **from January 2005 till December 2012**

- Sources: **APK-Inform, AMI, HGCA**

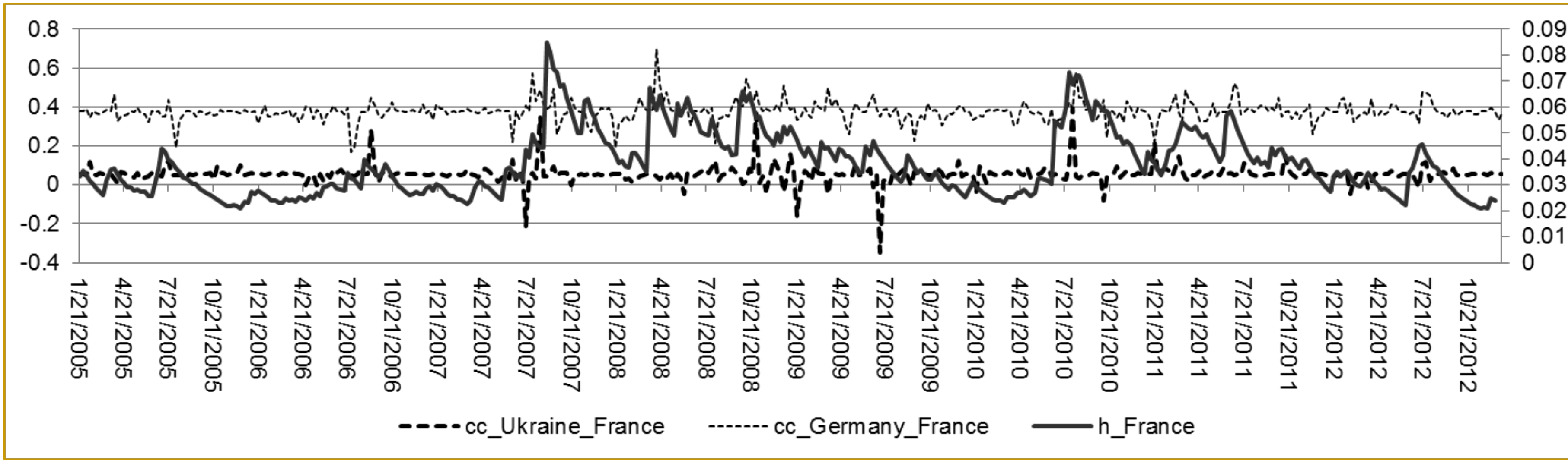
Univariate GARCH models' results

	France	Ukraine	Germany
Volatility equations			
α_0	-0.00 (0.95)	-0.00 (0.75)	0.00 (0.91)
α_1	0.14 (0.02)**	0.74 (0.00)***	0.37 (0.01)**
β_1	0.83 (0.00)***	0.25 (0.00)***	0.56 (0.00)***
$\alpha_1 + \beta_1$	0.97	0.99	0.93
Log Likelihood	809	1270	1041

Conditional variances



Dynamic correlations



	Ukraine-France	Germany-France
$r_{ij,t}min$	-0.34	0.17
$r_{ij,t}max$	0.39	0.69
$r_{ij,t}mean$	0.05	0.38
χ^2-test: $R_t = R$	305.5***	442.9***

Volatility Transmission

	Nakatani & Teräsvirta test		Hafner & Herwartz test	
	π	p-value	τ	p-value
France-Ukraine	6.04	0.19	8.67	0.07*
France-Germany	9.15	0.06*	9.13	0.06*

THANK YOU!