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*Imperfect Mobility and Heterogeneous
Labour in CGE Modelling*

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Universität Hohenheim

Presentation delivered at the 2013 Annual Meeting
of the International Agricultural Trade Research Consortium (IATRC)
Clearwater Beach, FL, December 15-17, 2013

THREE ESSAYS ON BLACK SEA GRAIN MARKETS

Kateryna G. Schroeder

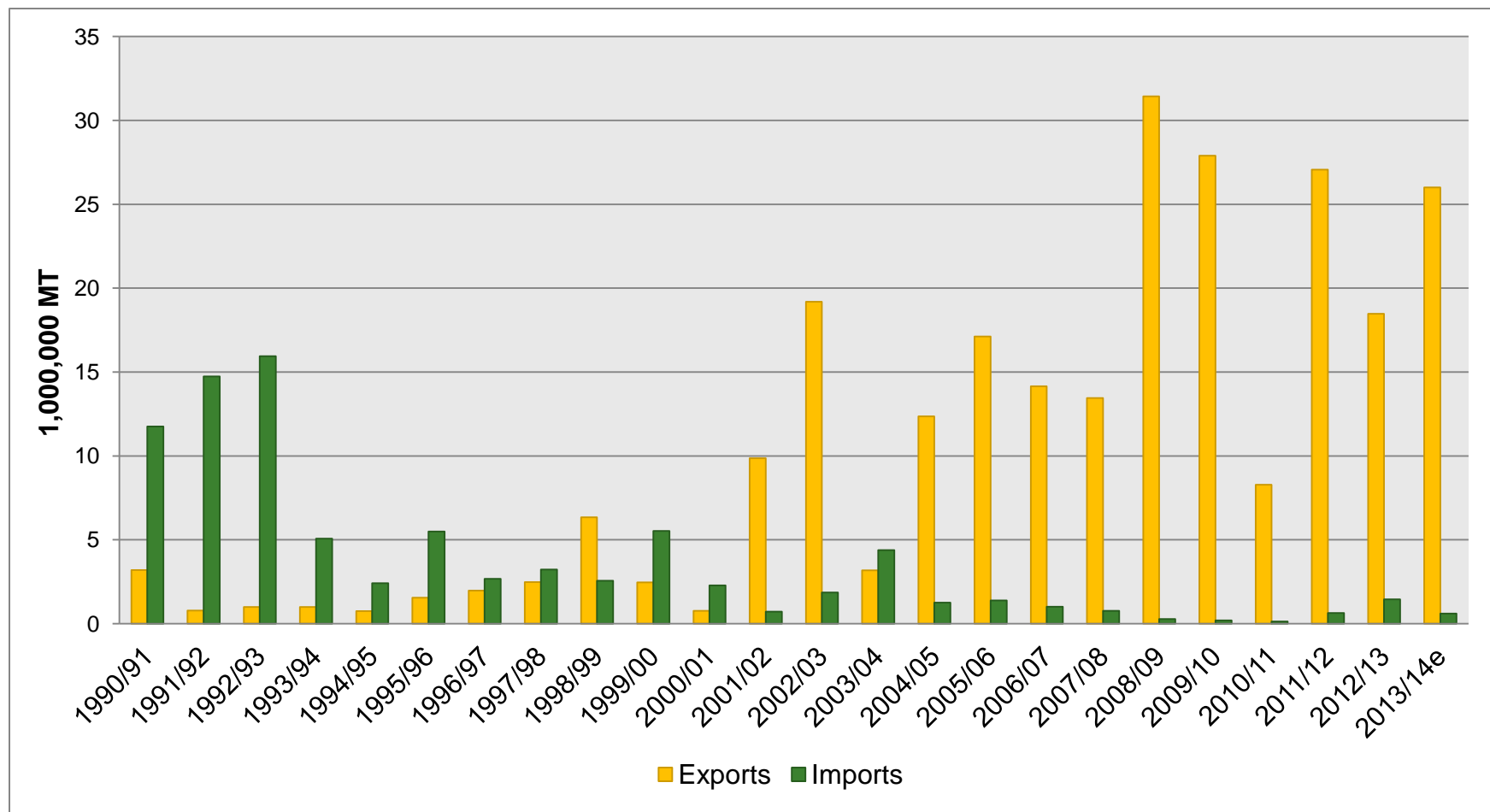
IATRC 2013 Annual Meeting
December 16, 2013

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 <u>mmt</u> 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 <u>mmt</u> of grain		
11/2012	11/2012 – 06/30/2013	Export amounts under the Memorandum of Understanding were increased by 1.5 <u>mln.</u> 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

Step 1: Estimate the following regression model in levels:

$$P_t^{RUS} = \beta_0 + \beta_1 P_t^{US} + \varepsilon_t$$

Step 2: Test residuals ε_t for stationarity


- Johansen Maximum Likelihood (ML) method

Goal: 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.


$$\Delta \bar{\varepsilon}_t = \gamma_1 \bar{\varepsilon}_{t-1} + \sum_{i=1}^p \gamma_{i+1} \Delta \bar{\varepsilon}_{t-i} + \omega_t, \text{ where}$$
$$\Delta \bar{\varepsilon}_t = I_t \gamma_1 \bar{\varepsilon}_{t-1} + (1 - I_t) \gamma_2 \bar{\varepsilon}_{t-1} + \varphi_t$$

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

or

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

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

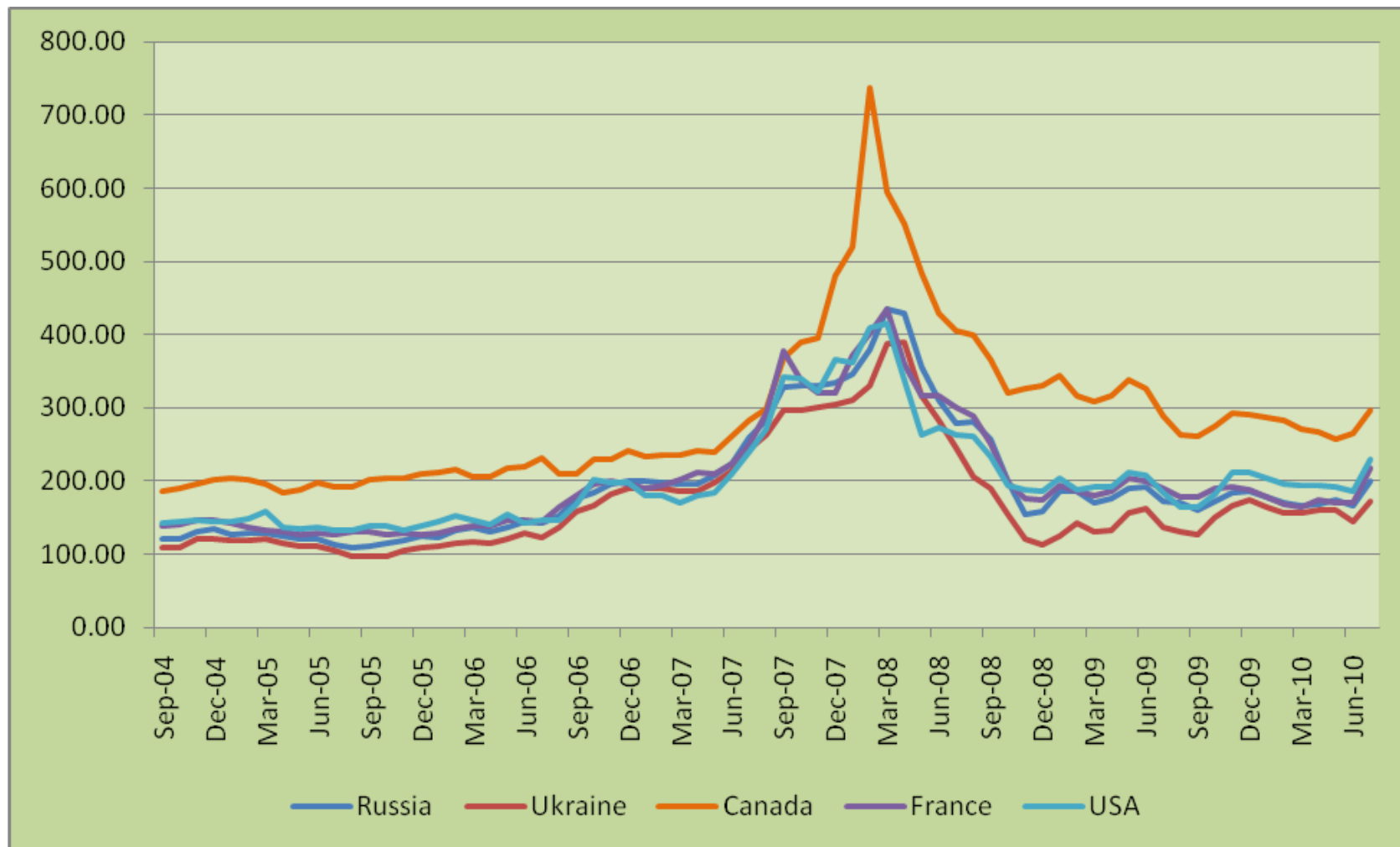
Horizontal Price Transmission

- 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

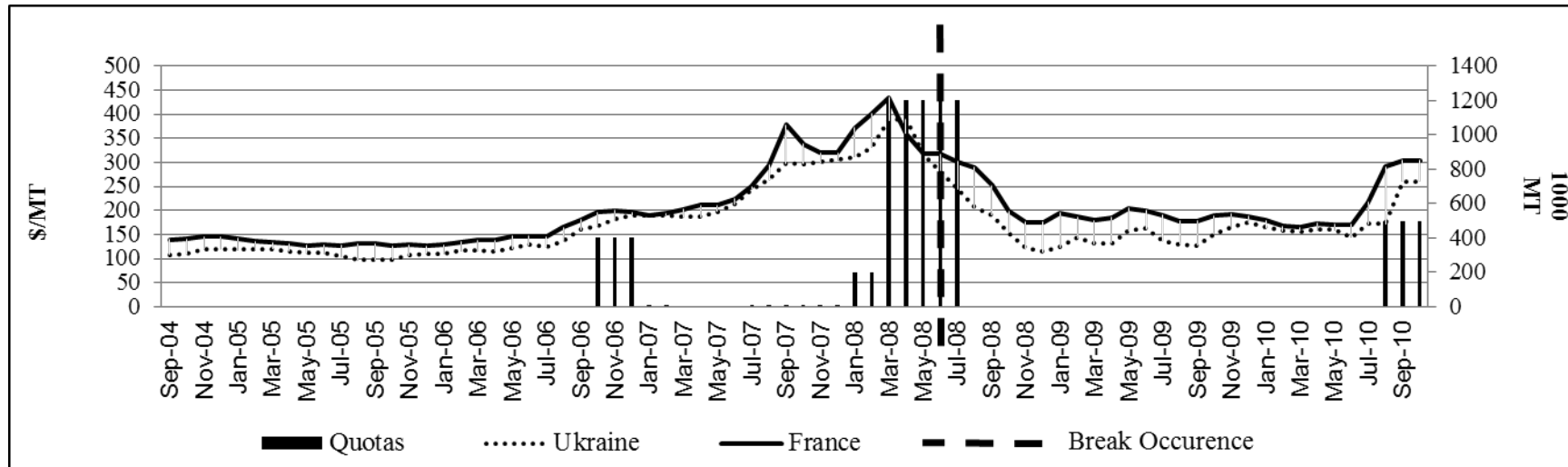
Asterisks denote levels of significance (* for 10 percent, ** for 5 percent). The 5% and 10% critical values for tests with a drift are -3.42 and -3.10 respectively. Critical values were obtained from MacKinnon (1991).



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**

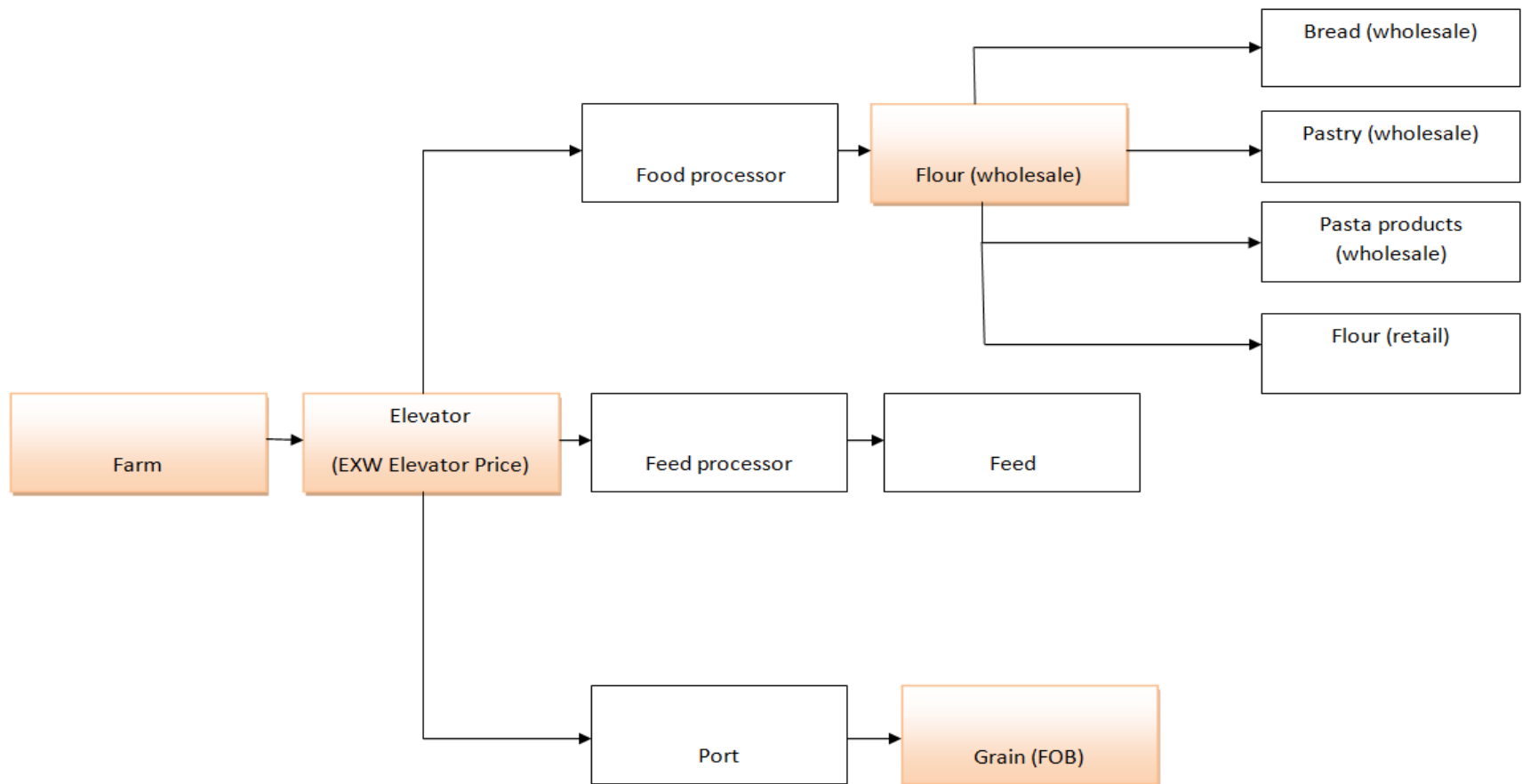
Essay 2: Analysis of Asymmetric Price Transmission in the Ukrainian Wheat Supply Chain



Objective:

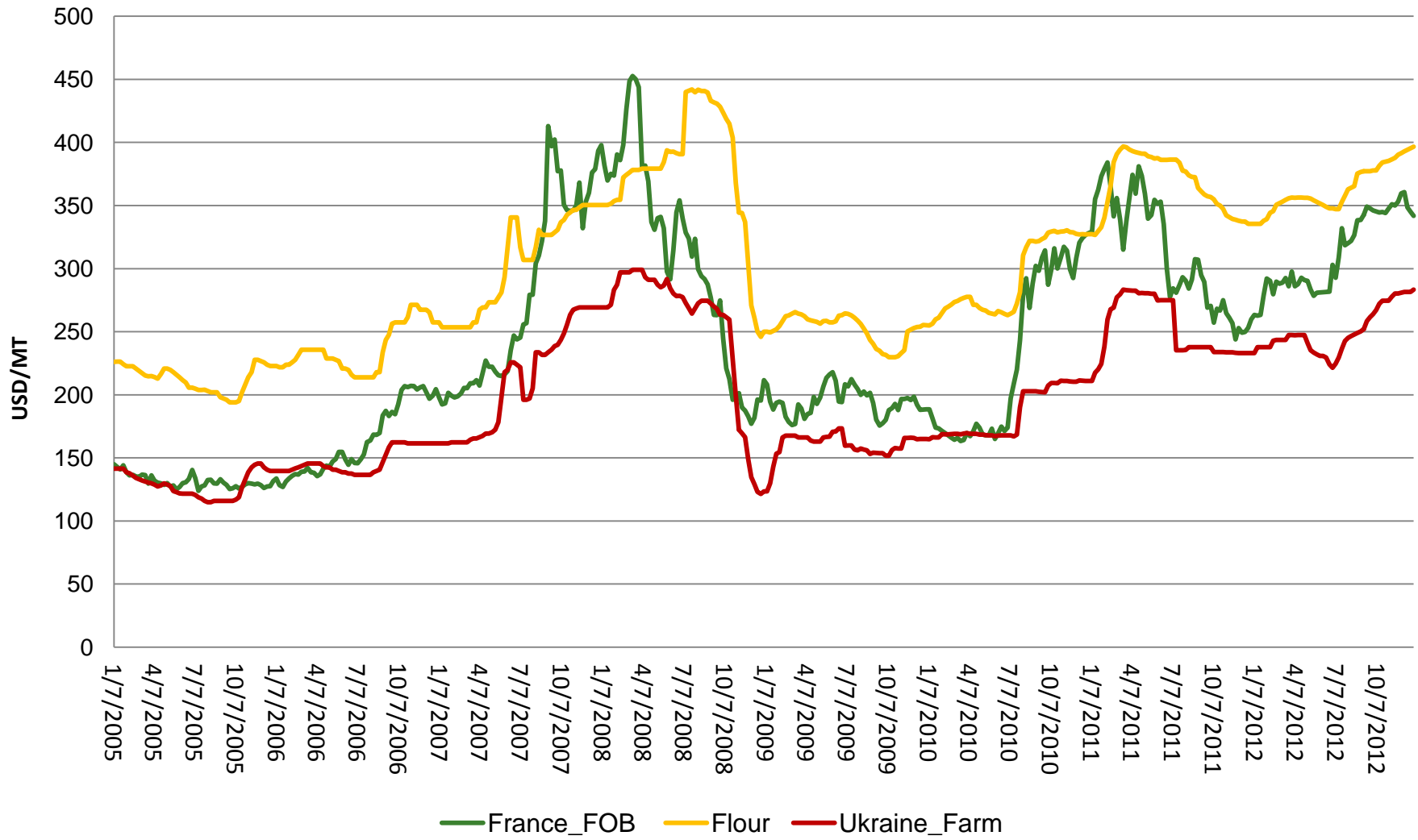
- To investigate short- and long-run vertical price transmission behavior in the Ukrainian wheat supply chain

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)

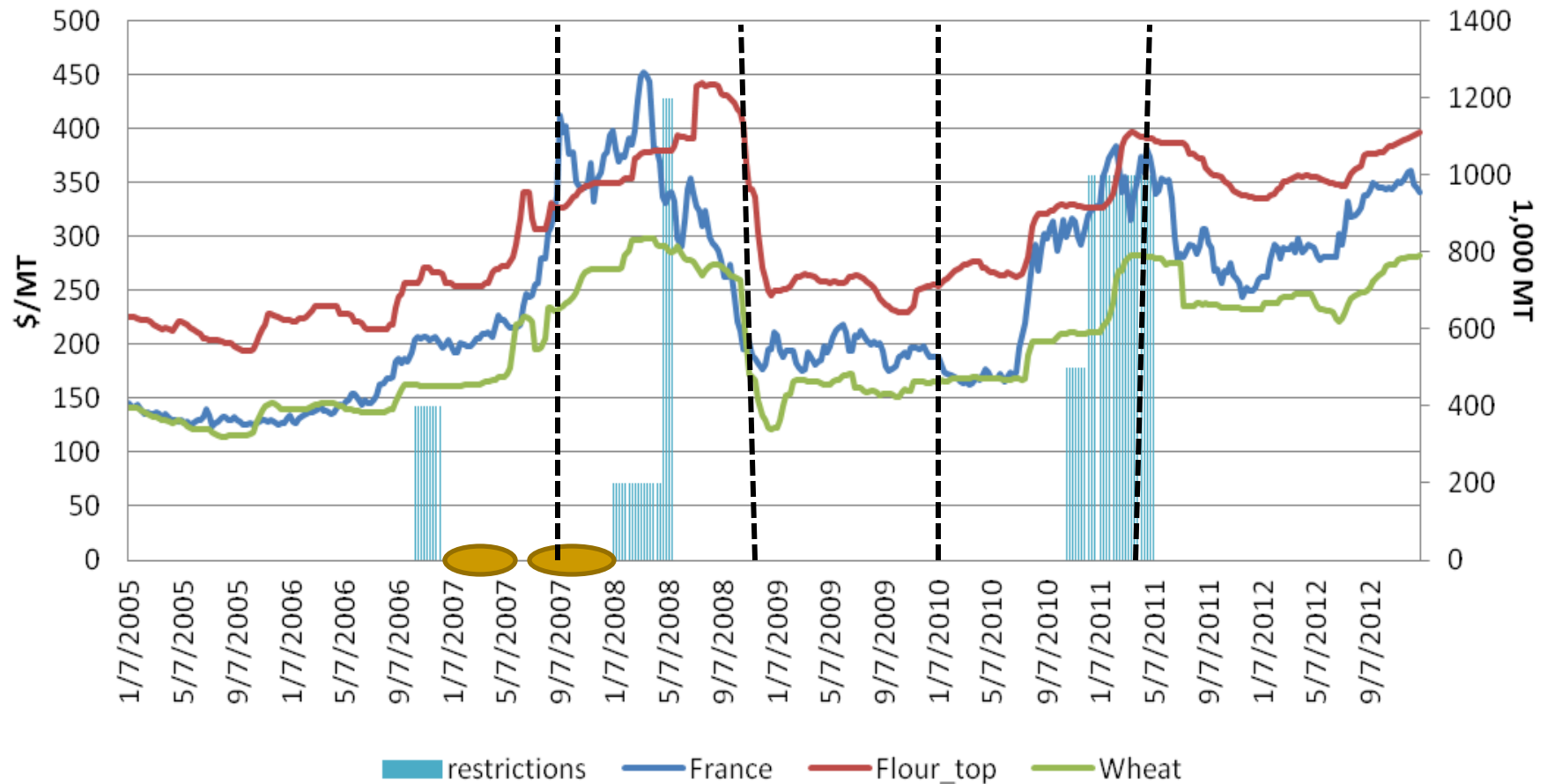
Period 2 (September 2007 – October 2008)

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

^eThe 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
<u>FrenchFOB</u>	Wheat	1;1	-0.0240 (-1.33)	-	-
Wheat	<u>FrenchFOB</u>	2;2	-0.0638 (-5.70)**	-	-
Flour	Wheat	1;1	-	-0.02 (-1.23)	-0.11(-6.08)**

Essay 3: 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
- $D_t = \text{diag}\{\sqrt{h_{jj}}\}, j = 1, \dots, J$, is a 3x3 matrix of the standardized disturbance variances from the univariate GARCH models
- $R_t = (\text{diag}(Q_t))^{-1/2} Q_t (\text{diag}(Q_t))^{-1/2}$ – 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 :

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



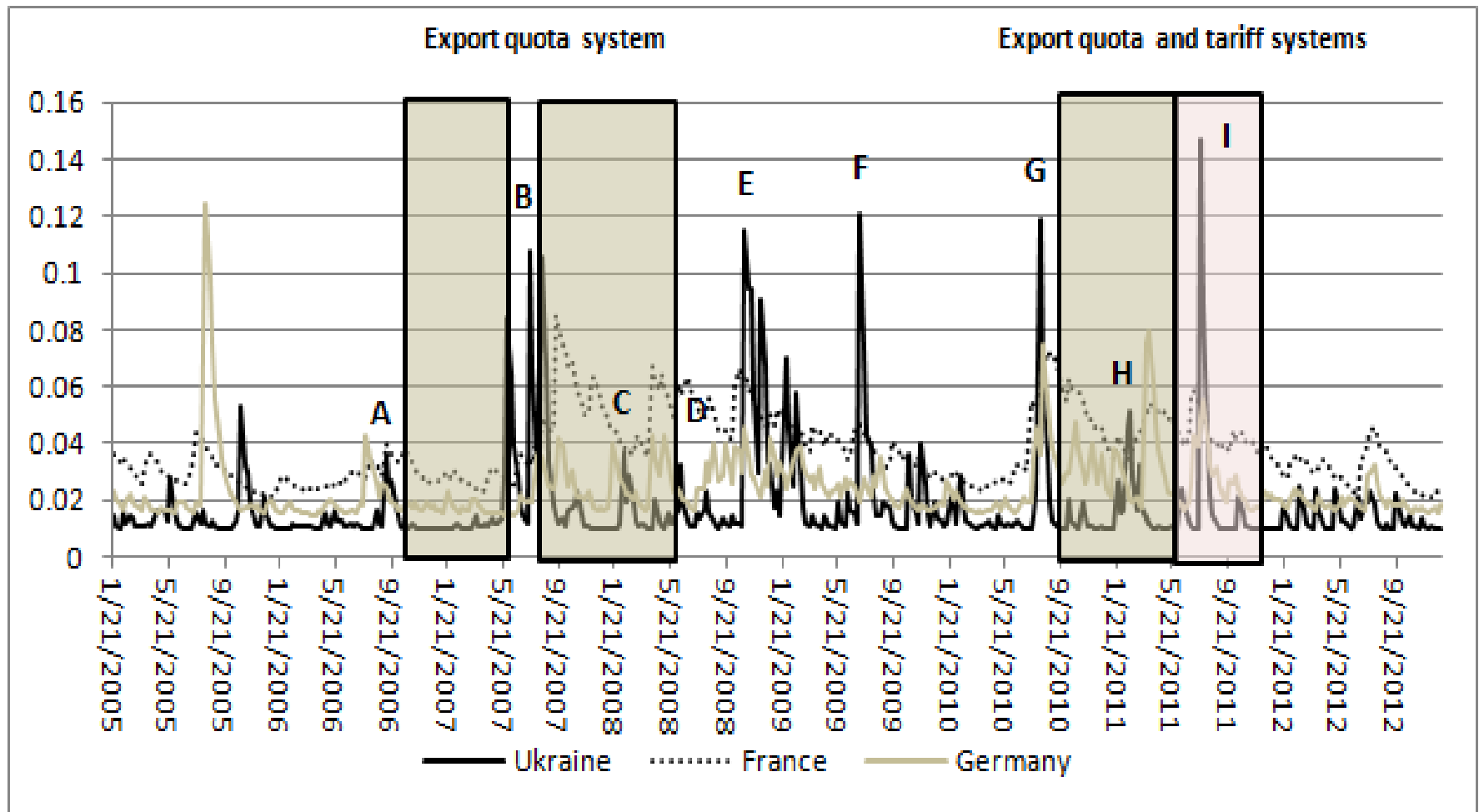
Data

- **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**
-

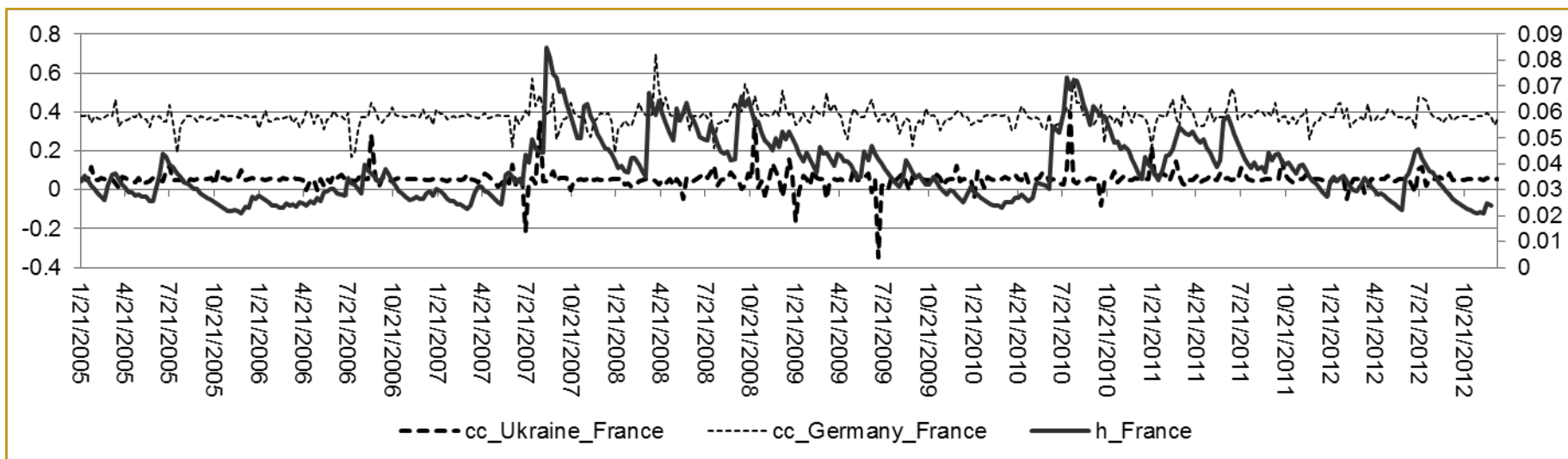
Univariate GARCH models' results

	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
$r_{ij,tmin}$	-0.34	0.17
$r_{ij,tmax}$	0.39	0.69
$r_{ij,tmean}$	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!

