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Leibniz Institute of Agricultural Development
in Transition Economies

***LEIBNIZ INSTITUTE OF AGRICULTURAL DEVELOPMENT
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Estimates for the residual demand elasticity of Russian wheat exports

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- Motivation and research question;
- RDE approach and data requirements;
- Econometric implementation;
- Selected estimation results;
- Concluding remarks.

- Higher and more volatile wheat prices in the last decade;
- Oligopolistic structure of world wheat market: market share of top 5 countries ~70%;
- Russia belongs to top 5 wheat exporters;
- Some importing countries depend on Russian wheat.

Motivation: Top 5 export destinations

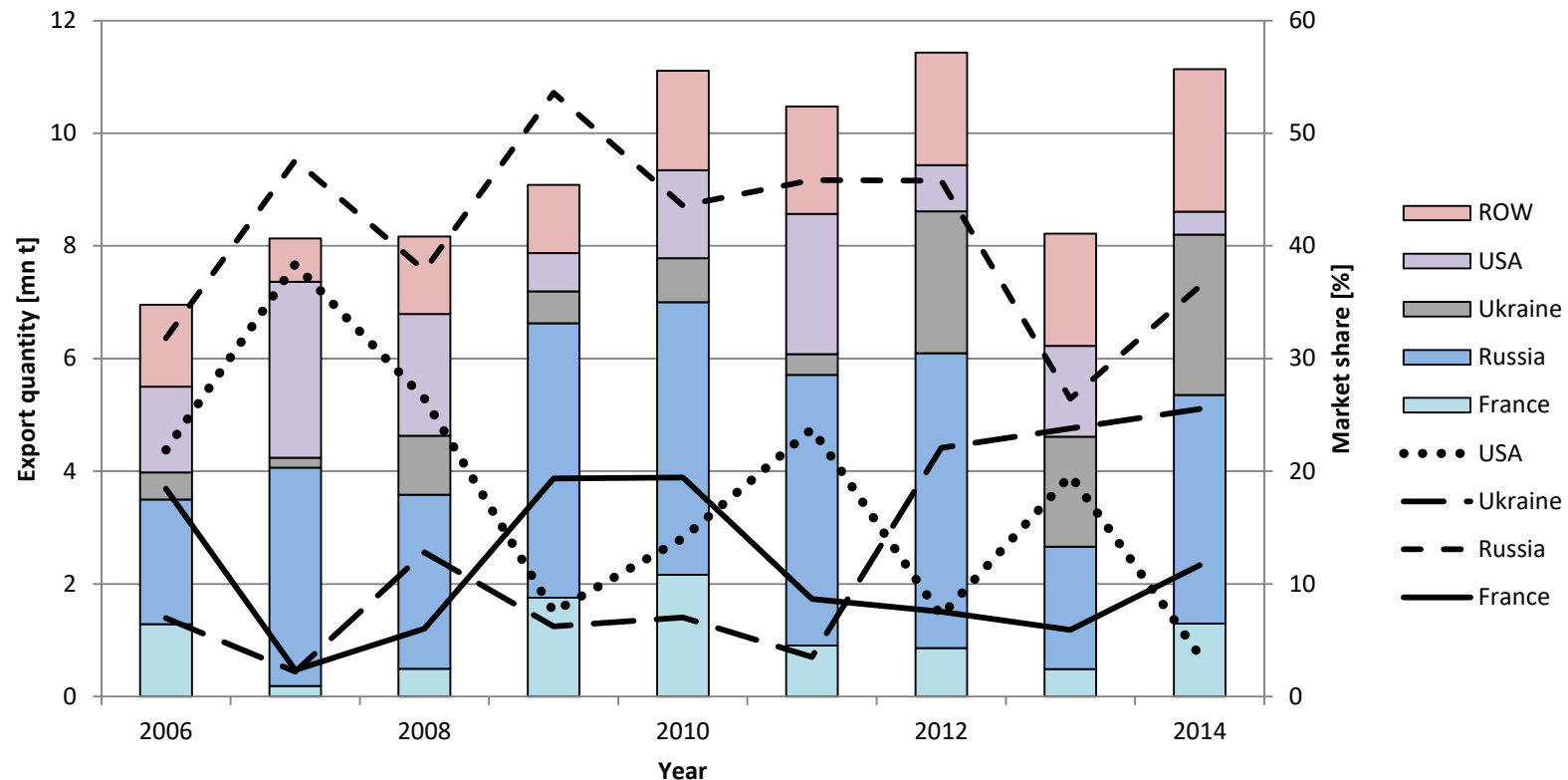
- 114 Russian export destinations for the period 2006-2014;
- More than 40% of Russian wheat was exported to two countries - Egypt and Turkey:

Russia's top 5 export destinations	
Country	Share in Russian wheat exports (average 2006-14, in %)
Egypt	26.5
Turkey	13.8
Yemen	3.9
Azerbaijan	3.6
Iran	3.5

Source: Own compilation based on data provided by APK-Inform.

Motivation: Egypt's wheat market

Figure: Wheat exports to Egypt by major trade partners

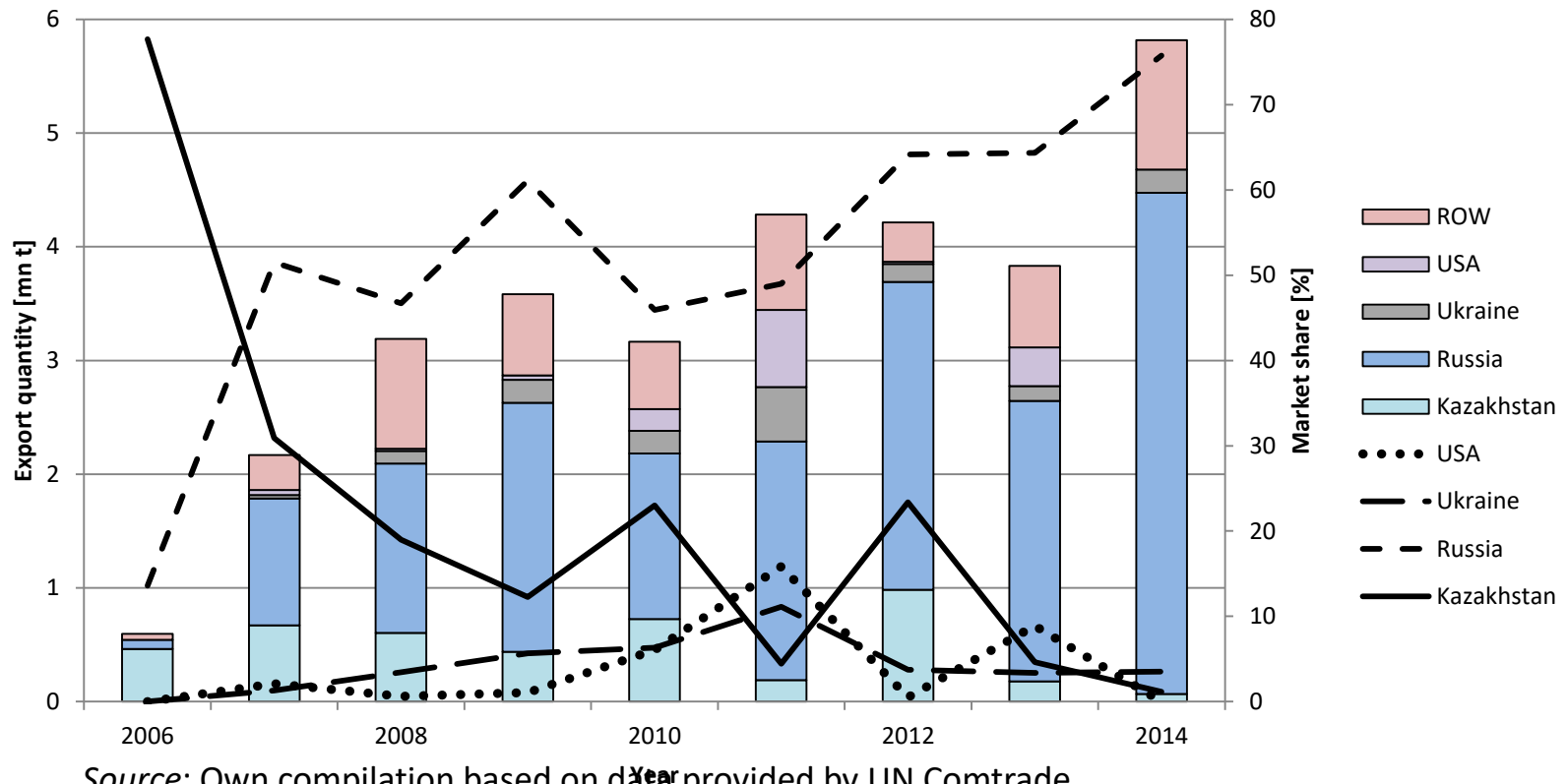


Source: Own compilation based on data provided by UN Comtrade.

Notes: ROW abbreviates Rest of the World. Lines reflect market shares and bars export quantities.

Motivation: Turkey's wheat market

Figure: Wheat exports to Turkey by major trade partners



Source: Own compilation based on data provided by UN Comtrade.

Notes: ROW abbreviates Rest of the World. Lines reflect market shares and bars export quantities.

- Is Russia able to exert market power in its main wheat export markets, Egypt and Turkey?
- To which extent does Russia exert market power?
- Are other exporting countries competing with Russia in Egypt and Turkey?

Studies targeting Russian wheat exports:

Authors (year)	Evidence of market imperfections		Data period	Theoretical approach
	Egypt	Turkey		
Gafarova et al. (2015)	-	-	1996-2012	PTM
Pall et al. (2013)	-	-	2002-2010	PTM
Pall et al. (2014)	-		2002-2009	RDE
Uhl et al. (2016)	-	+	2002-2011	PTM

- Russia's profit maximization problem:

$$\max_{Q_R} \Pi_R = Q_R * \frac{1}{1 + t_R} * P^R(Q_R, Q_C, Z) - e_R * C^R(Q_R, W_R, W)$$

with P_R and P_C : import price of Russia and the competitor; Q_R and Q_C : the corresponding export quantities; t_R : Russian tax rate; Z : demand shifters in export market; e_R : exchange rate of Russia; C^R : Russia's cost function; W_R : cost shifter of Russia; W : cost shifters relevant for both exporters;

- Russia's FOC is given by:

$$MR^R(Q_R, Q_C, t_R, Z) = e_R * MC^R(Q_R, W_R, W)$$

- Russia's inverse RD function:

$$P_R = R(Q_R, e_C, W_C, W, Z)$$

with R terming the inverse residual demand.

$$\ln P_t^R = \text{Cons} + \alpha \ln Q_t^R + \boldsymbol{\beta} \ln Z_t^I + \boldsymbol{\gamma} \ln e_t^C + \boldsymbol{\delta} \ln PP_t^C + \eta \text{BAN}_t^C + \lambda \text{OIL}_t + \boldsymbol{\theta} \text{MONTH}_t + \varepsilon_t$$

- α , η and λ are parameters, and $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, and $\boldsymbol{\delta}$ and $\boldsymbol{\theta}$ vectors of parameters to be estimated;
- P_t^R , Q_t^R : Russian export price and quantity; Z_t^I : demand shifters of importing country; e_t^C : exchange rates of competitors; PP_t^C : producer/export prices of rivals; BAN_t^C : export ban of competitor; OIL_t : oil price; MONTH_t : a vector of monthly dummies (Feb-Dec); ε_t : error term;
- Interpretation of α :
 - Zero estimate: Perfectly elastic RD \rightarrow Perfect competition;
 - Negative sign: Residual demand curve has a negative slope \rightarrow Imperfect competition.

- Price and quantity are determined simultaneously:
 - Q_t^R has to be instrumented;
 - Baker & Bresnahan (1988) propose cost shifters as instrument;
- Selected instruments:
 - Egypt: Export tax Russia;
 - Turkey: Export tax Russia & Wheat producer price Russia;
- Estimation method:
 - GMM.

Variable	Source
Russian export price and quantity	APK-Inform
Weekly exchange rates EGP per EUR EGP per USD EGP per UAH TRY per USD TRY per UAH TRY per KZT	OANDA
CPI food Egypt & Turkey	FAOSTAT
Real GDP per capita	World Bank (World Development Indicators)

Variable	Source
French wheat export price US wheat export price	Agriculture & Horticulture Development Board (AHDB)
Ukrainian wheat producer price	APK-Inform
Kazakh wheat producer price	Agency of Statistics of the Republic Kazakhstan (ASRK)
Russian wheat producer price	Russian Grain Union
Oil price	Thomson Reuters

Selected estimation results

Variable	Egypt		Turkey	
EQ	-0.0056	[-0.198]	-0.1351***	[-6.345]
ER EUR	0.5843***	[6.858]		
ER UAH	0.3721***	[6.589]	0.3706***	[4.017]
PP KAZ			0.1025**	[2.319]
PP UKR	0.4318***	[8.864]	0.4807***	[7.623]
EP FRA	0.5417***	[8.860]		
EP USA	0.0129	[0.247]	0.4508***	[7.614]
GDP	0.2650**	[2.533]	0.3405**	[2.093]
CPI food	-1.0898***	[-3.200]	-0.1529	[-0.250]
No. of obs.	363		342	

Notes: EQ abbreviates Russian wheat export quantity; ER KAZ, ER EUR are the exchange rates in national currency per KZT and EUR, respectively; PP KAZ and PP UKR are the Kazakh and Ukrainian wheat producer prices; EP FRA and EP USA are the French and US wheat export prices; GDP is the real GDP per capita of the importing country; and CPI food is the CPI for food products.

- Direct relationship between inverse RDE and Lerner index (LI) :

$$LI = \frac{P^R - e_R * MC^R}{P^R} = -\alpha$$

- Estimated Russian mark-up in Turkey of about 13.5 %.

- Evidence for Russian market power in Turkey based on RDE estimation;
- No evidence for Russian market power in Egypt;
- Estimated mark-up in Turkey about 13.5 %;
- Results are in line with *a priori* expectations;
- Estimation results are in line with Uhl et al. (2016);
- Estimation results suggest that Russian price setting is bounded by competition;
- Finding of market imperfections in Turkey does not imply negative consequences for Turkish food security.

- Baker, J. B. and T. F. Bresnahan. 1988. Estimating the residual demand curve facing a single firm. *International Journal of Industrial Organization* 6 (3): 283-300.
- Gafarova, G., O. Perekhozhuk and T. Glauben. 2015. Price discrimination and pricing-to-market behavior of Black Sea region wheat exporters. *Journal of Agricultural and Applied Economics* 47 (3): 287-316.
- Krugman, P. 1986. Pricing to market when the exchange rate changes. Working Paper No. 1926. Cambridge MA. National Bureau of Economic Research.
- Pall, Z., O. Perekhozhuk, R. Teuber and T. Glauben. 2013. Are Russian wheat exporter able to price discriminate? Empirical evidence from the last decade. *Journal of Agricultural Economics* 64 (1): 177-196.
- Pall, Z., O. Perekhozhuk, R. Teuber, T. Glauben, S. Prehn and R. Teuber. 2014. Residual demand measures of market power of Russian wheat exporters. *Agricultural Economics* 45 (3): 381-391.
- Uhl, K. M., O. Perekhozhuk and T. Glauben. 2016. Price discrimination in Russian wheat exports: evidence from firm-level data. *Journal of Agricultural Economics* 67 (3): 722-740.

- Two competing exporters ($k = 1, 2$) face inverse residual demand curves:

$$(1) \quad P_1 = P^1(Q_1, Q_2, Z)$$

$$(2) \quad P_2 = P^2(Q_2, Q_1, Z)$$

- With P_1 and P_2 : import price of exporter 1 and 2; Q_1 and Q_2 : export quantity of exporter 1 and 2; Z : demand shifters in export market;

- Profit maximization problem for exporter 1:

$$(3) \quad \max_{Q_1} \Pi_1 = Q_1 * \frac{1}{1 + t_1} * P^1(Q_1, Q_2, Z) - e_1 * C^1(Q_1, W_1, W)$$

- With e_1 : exchange rate of exporter 1; t_1 : tax rate ; C^1 : cost function of exporter 1; W_1 : cost shifter of exporter 1; W : cost shifters relevant for both exporters.

- The corresponding first-order condition:

$$(4) \quad P_1 * \frac{1}{1 + t_1} + Q_1 * \frac{1}{1 + t_1} * [\partial P^1 / \partial Q_1 + (\partial P^1 / \partial Q_2) * (\partial Q^2 / \partial Q_1)] - e_1 * MC^1 = 0$$

- With MC^1 : marginal cost of exporter 1;
- Supply of the two exporters is determined by the optimality conditions:

$$(5) \quad MR^1(Q_1, Q_2, t_1, Z) = e_1 * MC^1(Q_1, W_1, W)$$

$$(6) \quad MR^2(Q_2, Q_1, Z) = e_2 * MC^2(Q_2, W_2, W)$$

- Solve eq. (2) and (6) simultaneously. Thereby, we receive exporter 2's RD function:

$$(7) \quad Q_2 = Q^2(Q_1, Z, e_2, W_2)$$

- Substituting eq. (7) in eq. (1) yields the expression in eq. (8) and after dropping out redundancies yields the term of eq. (9) with R terming the inverse residual demand.

$$(8) \quad P_1 = P^1(Q_1, Q^2(Q_1, Z, e_2, W_2, W), Z)$$

$$(9) \quad P_1 = R(Q_1, e_2, W_2, W, Z)$$

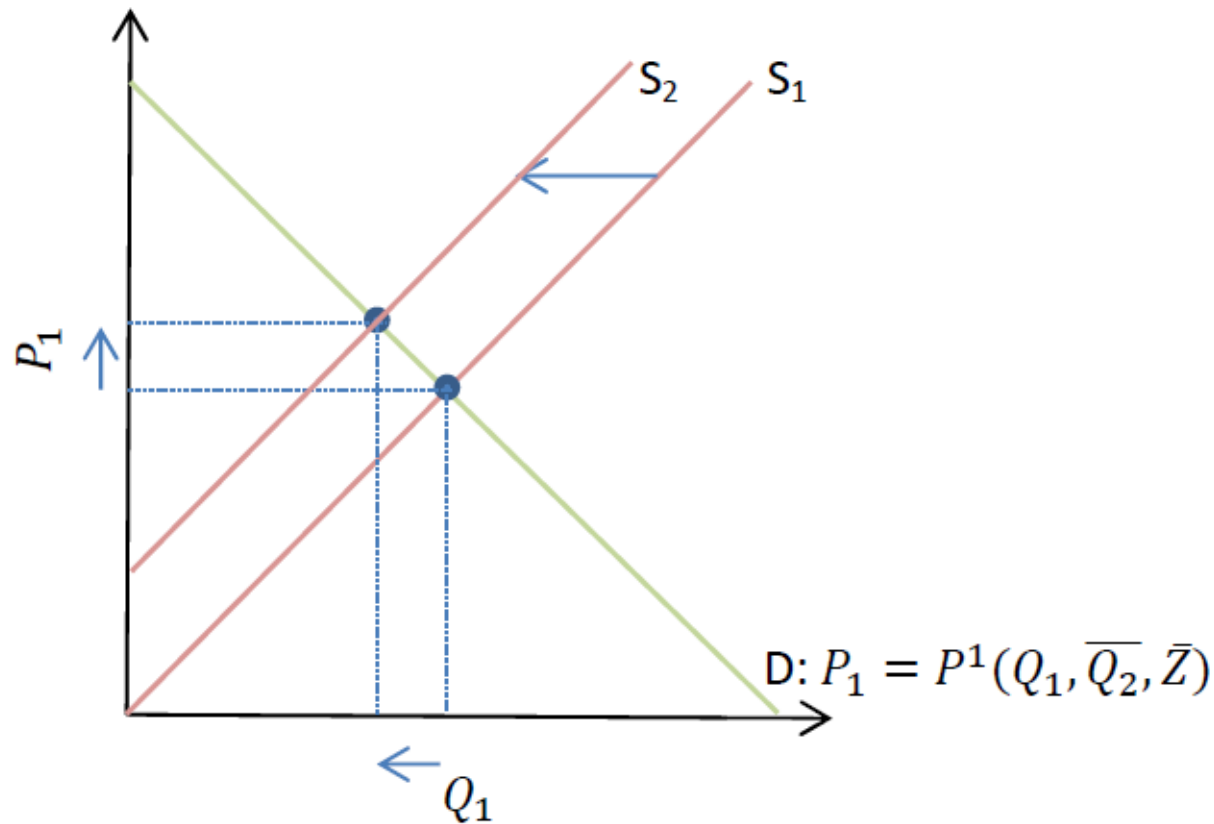
- Differentiating eq. (9) in its log-linear form and considering the correspondence between (8) and (9) yields the following expression for the inverse RDE of exporter 1:

$$(10) \quad \alpha_1 = \frac{\partial \ln R}{\partial \ln Q_1} = \frac{\partial R}{\partial Q_1} * \frac{Q_1}{R} = \frac{\partial P^1}{\partial Q_1} * \frac{Q_1}{P_1} + \frac{\partial P^1}{\partial Q_2} * \frac{\partial Q^2}{\partial Q_1} * \frac{Q_1}{P_1}$$

- By estimating the inverse RDE we estimate the joint impact of the change in wheat price induced by exporter 1's own change in quantity and of exporter 2's quantity adjustment.

Appendix I: Theoretical background

IV



Appendix II: Descriptive statistics

Variable	Egypt			Turkey		
	Mean	Min	Max	Mean	Min	Max
EUV	1318.3	601.5	2273.0	390.1	204.2	633.2
EQ	92129.9	2389.5	460732.5	51815.9	998.0	210335.5
GDP	70.1	55.7	82.7	15.7	12.8	19.3
CPI food	101.1	96.5	106.4	100.9	95.6	105.2
ER EUR	8.0	6.8	9.7			
ER USD	6.0	5.3	7.1	1.7	1.2	2.3
ER UAH	0.8	0.4	1.1	0.2	0.1	0.3
ER KZT				0.011	0.009	0.015
EP FRA	183.9	104.8	301.8			
EP USA	241.7	134.2	433.5	251.4	160.5	424.3

Appendix II: Descriptive statistics II

Variable	Egypt			Turkey		
	Mean	Min	Max	Mean	Min	Max
PP UKR	1517.8	690.0	3300.0	1645.6	815.0	3300.0
PP KAZ				24403.3	11868.4	34326.0
Oil price	99.9	84.8	122.2	99.9	84.8	122.2
Ban KAZ				0.02	0	1

Notes: EUV: export unit value, expressed in importer's currency. EQ: export quantity in tons. ER EUR, ER USD, ER UAH and ER KZT: destination-specific exchange rates per Euro, United States Dollar, Ukrainian Hryvna, and Kazakhstani Tenge. EP FRA and EP USA: French and US wheat export prices. PP UKR and PP KAZ: Ukrainian and Kazakh wheat producer prices. GDP: real GDP per capita of the destination country, expressed in importer's currency, and CPI food: CPI for food items of the importer. The oil price: index. Ban KAZ: dummy variable capturing Kazakh wheat export ban (in force between April 27, 2008 and September 1, 2008).

Appendix III: Estimation results

Variable	Egypt		Turkey	
EQ	-0.0056	[-0.198]	-0.1351***	[-6.345]
GDP	0.2650**	[2.533]	0.3405**	[2.093]
CPI food	-1.0898***	[-3.200]	-0.1529	[-0.250]
ER EUR	0.5843***	[6.858]		
ER USD	0.4642***	[3.195]	0.5716***	[4.138]
ER UAH	0.3721***	[6.589]	0.3706***	[4.017]
ER KZT			0.0433	[0.198]
EP FRA	0.5417***	[8.860]		
EP USA	0.0129	[0.247]	0.4508***	[7.614]
PP UKR	0.4318***	[8.864]	0.4807***	[7.623]
PP KAZ			0.1025**	[2.319]
Oil price	-0.1247	[-1.086]	-0.3374	[-1.506]
Ban KAZ			0.0079	[0.177]
February	0.0022	[0.079]	0.0130	[0.293]
March	-0.0163	[-0.569]	0.0366	[0.786]

Appendix III: Estimation results II

Variable	Egypt		Turkey	
April	-0.0694***	[-3.181]	0.0470	[1.038]
May	-0.0728**	[-2.499]	0.0342	[0.665]
June	-0.0693***	[-2.728]	-0.0221	[-0.507]
July	-0.0891***	[-3.779]	0.0773	[1.601]
August	-0.0653	[-1.589]	0.1518***	[3.092]
September	-0.0391	[-0.986]	0.1425***	[3.058]
October	-0.0196	[-0.616]	0.0874**	[2.096]
November	-0.0193	[-0.627]	0.0777*	[1.927]
December	-0.0097	[-0.349]	0.0806*	[1.866]
Constant	3.7424**	[2.371]	2.0111	[0.667]
No of obs.	363		342	
R-sq.	0.9542		0.8599	
Adj. R-sq.	0.9514		0.8503	

Note: Numbers in brackets are t-statistics.

Source: Own computations using STATA software (version 14.1).

Appendix IV: Selection of instruments

Statistics regarding relevance and validity of chosen instruments

Selection criteria	Egypt	Turkey
Relevance	10.60 [0.0000]	14.18 [0.0000]
Validity	-	0.003365 [0.9537]

Notes: Criteria for relevance of instruments: F-value of first-stage regression; criteria for validity: Test of overidentifying restriction (H_0 : Overidentifying restrictions are valid): Hansen's J statistic; term in brackets are p-values.