# International price volatility, exchange rate uncertainty and cereals exports: Empirical evidence from France

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# Outline

# Motivations

- Impact of exchange rate volatility on trade has been widely studied in both theoretical and empirical literature;
  - From negative results (Hooper and Kohlhagen, 1978) to more nuanced conclusions (De Grauwe, 1988; Tenreyro, 2007);
  - Key role lead by hedging instruments;
- Implicit hypothesis: producing countries can determine prices of agricultural products and face only exchange rate uncertainty;
- The influence of financial commodity markets is largely underestimate in the literature.

# Motivations

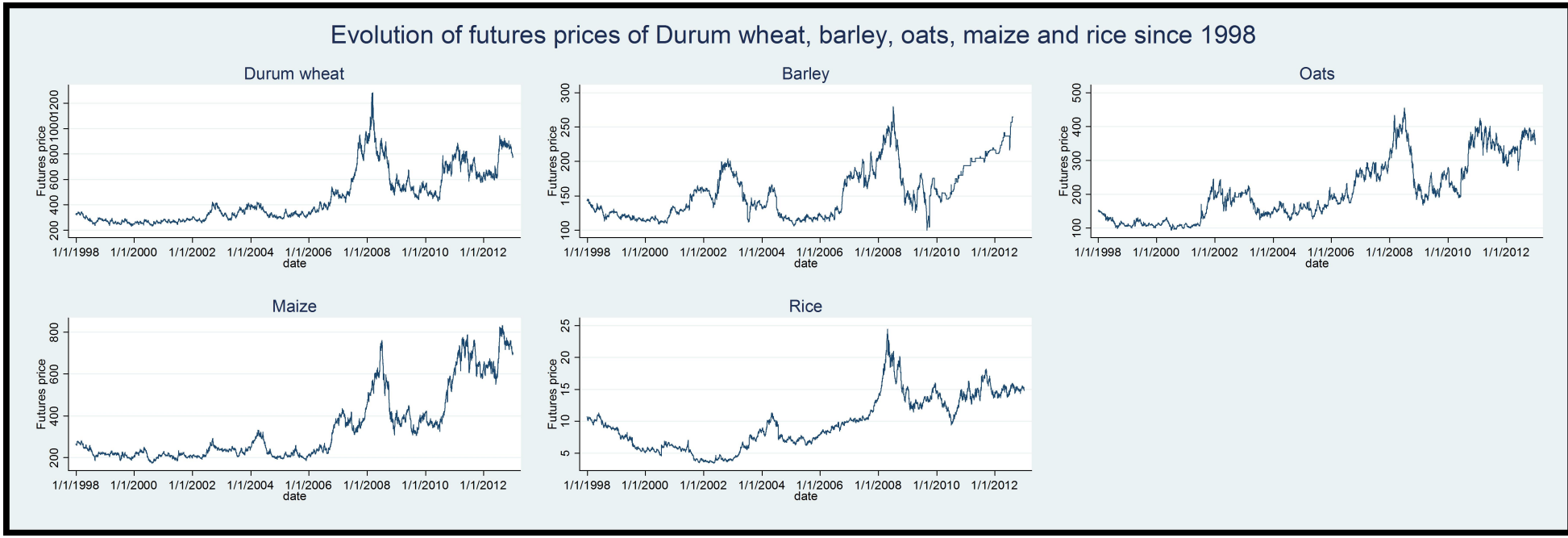
## Three reasons to rely on the futures market

- Futures prices measure expected cash prices, Black (1976, p. 174):
  *"looking at futures prices for various transaction months, participants in this market can decide on the best times to plant, harvest, buy for storage, sell from storage, or process the commodity"*;
- All commercial agricultural contracts use futures price as a reference price;
  - Cash prices for commodities split in two components: a financial price and a price differential;
  - Relationship between physical prices and commodity futures prices (Johnson, 1960);
- Futures contracts help improve inventories management;
  - Theory of storage (Working, 1948; Brennan, 1958);
  - The basis reveals if the market is experiencing shortage or not.

## Contribution of the paper

Study the impact of both exchange rate and futures price uncertainty on bilateral exports of five commodities: barley, maize, oats, rice and wheat;

# Evolution of futures prices of the five commodities



# Outline

# Related literature

## Exchange rate volatility at the country-level

- Early studies emphasize a negative relationship between trade and exchange rate volatility (Hooper and Kohlhagen, 1976; Thursby and Thursby, 1987);
- More recent studies temper this conclusion (e.g. Tenreyro, 2007) relying on the development of derivatives contracts.

## The special case of agricultural products

- Export volume of agricultural products are more sensitive to exchange rate uncertainty than other sectors (Cho *et al.*, 2002; Kandilov, 2008);
- Conclusions need to be commodity-specific (May, 2010; Karemara *et al.*, 2011; Sheldon *et al.*, 2013).

## What about other volatilities?

- Zhang *et al.* (2002) consider three types of volatilities: exchange rate, commodity price and ocean freight costs;
- Only the exchange rate uncertainty is statistically significant (negative);
- Zhang *et al.* (2002) argue that exporters hedge their price risk;
- This statement ignores that the protection offered by commodity derivatives is often imperfect

# Outline

# Empirical model

## A gravity model of trade

- In exponential form:

$$X_{Fjkt} = e^{\alpha_0} Y_{Ft}^{\alpha_1} Y_{jt}^{\alpha_2} D_{Fj}^{\alpha_3} e^{(\alpha_4 cont_{Fj} + \alpha_5 lang_{Fj} + \alpha_6 col_{Fj} + \alpha_7 RTA_{Fjt} + \alpha_8 XV_{Fjt} + \alpha_9 PV_{kt})} \epsilon_{ijt} \quad (1)$$

- log-linearisation of equation (1):

$$\begin{aligned} Ln(X_{Fjkt}) = \alpha_0 + \alpha_1 ln(Y_{Ft}) + \alpha_2 ln(Y_{jt}) + \alpha_3 D_{Fj} + \alpha_4 contig_{Fj} + \alpha_5 lang_{Fj} \\ + \alpha_6 col_{Fj} + \alpha_7 RTA_{Fjt} + \alpha_8 XV_{Fjt} + \alpha_9 PV_{kt} + ln(\epsilon_{ij}) \end{aligned} \quad (2)$$

- Multilateral resistance is taken into account using importer fixed effects (Baldwin and Taglioni, 2006).

# Estimation issues

## Problem of heteroskedasticity

- Problem of Jensen's inequality;
- In the presence of heteroskedasticity, parameters generated by the OLS estimator could be highly misleading (Santos Silva and Tenreyro, 2006).

## Problem of zero trade flows

- Selection bias;
- Our dataset contains 60 % of zero value observations;
- Necessity to include them when investigating exchange rate volatility and trade in a gravity framework (Tenreyro, 2007).

## Method to overcome these problems

- Estimate equation (1) using the Poisson-Pseudo Maximum Likelihood estimator developed by Santos Silva and Tenreyro (2006);
- The PPML estimator remains consistent in case of over-dispersion in the data (Head and Mayer, 2013);
- The PPML estimator is generally well behaved even when the dependent variable has a large proportion of zeros (Santos Silva and Tenreyro, 2011).

# Measuring volatility

## Two measures of exchange rate volatility

- A simple standard deviation (short-run volatility):

$$XV^{S}_{Fjt} = Std.\ dev.[ln(e_{Fjt,m}) - ln(e_{Fjt,m-1})] \tag{3}$$

- A long-run measure:

$$XV^{L}_{Fjt} = \frac{max\ e^{t}_{t-z} - min\ e^{t}_{t-z}}{min\ e^{t}_{t-z}} + \left[1 + \frac{|e_t - e^{p}_{t}|}{e^{p}_{t}}\right] \tag{4}$$

## Two measures of futures price volatility

- The realized, unconditional volatility (standard deviation):

$$PV^{U}_{kt} = Std.\ dev.[ln(P_{kt,d}) - ln(P_{kt,d-1})] \tag{5}$$

- The conditional volatility resulting from a GARCH process:

$$ln(P_{kb,d}) = \mu + \phi_1 ln(P_{kb,d-1}) + \epsilon_{kt,d} \tag{6}$$

Where $\epsilon_{kj,d} \sim N(0, h_{t,d})$ and the conditional variance is:

$$h_{t,d} = \omega + \beta\epsilon^{2}_{kbd} + \alpha h_{b,d-1} \tag{7}$$

- We use daily futures price data from the Chicago board of trade (wheat, oats, maize and rice) and the International continental exchange Canada (barley).

# Data

## Data

- 59 trading partners;
- 5 commodities;
- Period from 2000 to 2011;
- Our dataset consists of 3540 observations of cereals exports from France.

# Outline

# Baseline results with product fixed-effects

| | OLS | | | | PPML | | | |
|---|---|---|---|---|---|---|---|---|
| $Y_{Ft}$ | 3.861** | 3.631* | 4.528** | 4.230* | 6.318*** | 5.919*** | 6.612*** | 6.261*** |
| | (2.08) | (1.75) | (2.35) | (1.92) | (6.00) | (6.76) | (5.26) | (6.31) |
| $Y_{jt}$ | 0.574*** | 0.563*** | 0.572*** | 0.563*** | 0.438*** | 0.554*** | 0.439*** | 0.556*** |
| | (4.20) | (4.02) | (4.19) | (4.02) | (3.12) | (4.39) | (3.11) | (4.41) |
| $RTA_{Fjt}$ | 0.731 | 0.560 | 0.732 | 0.557 | 0.981 | 0.783 | 0.989 | 0.784 |
| | (1.54) | (1.26) | (1.56) | (1.26) | (1.21) | (0.96) | (1.22) | (0.96) |
| $XV^S_{Fjt}$ | 2.631** | | 2.630** | | -2.698 | | -2.595 | |
| | (2.35) | | (2.36) | | (-0.33) | | (-0.33) | |
| $XV^L_{Fjt}$ | | -0.488 | | -0.518 | | -3.488** | | -3.534** |
| | | (-0.43) | | (-0.46) | | (-1.94) | | (-1.99) |
| $PV^U_{kt}$ | 21.82** | 19.24* | | | 23.08*** | 14.17*** | | |
| | (2.08) | (1.72) | | | (4.69) | (2.54) | | |
| $PV^C_{kt}$ | | | 10.90 | 9.095 | | | 8.376** | 3.470 |
| | | | (1.18) | (0.97) | | | (1.85) | (0.88) |
| $contig_{Fj}$ | 2.082*** | 2.072*** | 2.086*** | 2.072*** | 1.185** | 0.661 | 1.185** | 0.652 |
| | (3.65) | (3.28) | (3.66) | (3.29) | (2.34) | (1.56) | (2.35) | (1.55) |
| $col_{Fj}$ | 1.795* | 1.800* | 1.780* | 1.781* | 1.798 | 1.088 | 1.799 | 1.081 |
| | (1.88) | (1.80) | (1.87) | (1.78) | (1.59) | (1.08) | (1.59) | (1.07) |
| $lang_{Fj}$ | -1.016 | -1.079 | -1.009 | -1.067 | -0.267 | 0.398 | -0.265 | 0.407 |
| | (-1.27) | (-1.32) | (-1.26) | (-1.31) | (-0.33) | (0.72) | (-0.33) | (0.74) |
| $D_{Fj}$ | -0.657* | -0.635* | -0.651* | -0.627* | -0.698* | -0.505 | -0.697* | -0.502 |
| | (-1.98) | (-1.91) | (-1.97) | (-1.90) | (-1.80) | (-1.59) | (-1.80) | (-1.58) |
| _cons | -111.2** | -103.8* | -129.9** | -120.5* | -175.7*** | -164.5*** | -183.7*** | -174.0*** |
| | (-2.12) | (-1.77) | (-2.41) | (-1.95) | (-6.15) | (-7.06) | (-5.25) | (-6.40) |
| $N$ | 1455 | 1455 | 1455 | 1455 | 3540 | 3540 | 3540 | 3540 |
| $R^2$ | 0.436 | 0.434 | 0.436 | 0.434 | | | | |
| LL | | | | | 1.76e+10 | 1.69e+10 | 1.76e+10 | 1.69e+10 |

# Results with product and importer fixed effects

| | OLS | | | | PPML | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $Y_{Ft}$ | 5.639*** | 5.349*** | 6.464*** | 6.315*** | 5.860*** | 6.076*** | 6.077*** | 6.258*** |
| | (3.04) | (3.16) | (3.65) | (3.91) | (11.58) | (11.64) | (10.53) | (10.02) |
| $Y_{jt}$ | 0.158 | 0.728 | 0.334 | 0.891 | 0.525** | 0.636*** | 0.557** | 0.675** |
| | (0.20) | (1.01) | (0.42) | (1.21) | (2.50) | (2.64) | (2.37) | (2.43) |
| $RTA_{Fjt}$ | 0.145 | 0.334 | 0.161 | 0.340 | 1.160*** | 1.278*** | 1.176*** | 1.284*** |
| | (0.41) | (0.86) | (0.45) | (0.88) | (5.93) | (6.03) | (5.96) | (5.97) |
| $XV^S_{Fjt}$ | 1.403 | | 1.384 | | 0.0498 | | 0.0528 | |
| | (1.65) | | (1.58) | | (0.09) | | (0.09) | |
| $XV^L_{Fjt}$ | | 2.280*** | | 2.143*** | | 0.991** | | 0.916* |
| | | (3.61) | | (3.39) | | (2.09) | | (1.94) |
| $PV^U_{kt}$ | 29.45*** | 34.04*** | | | 22.05*** | 23.25*** | | |
| | (2.90) | (3.24) | | | (4.57) | (4.58) | | |
| $PV^C_{kt}$ | | | 8.336 | 9.504 | | | 8.019** | 8.466** |
| | | | (0.93) | (1.08) | | | (1.92) | (1.97) |
| _cons | -156.5*** | -168.4*** | -184.7*** | -200.0*** | -172.4*** | -183.1*** | -179.2*** | -189.0*** |
| | (-3.69) | (-4.43) | (-4.70) | (-5.68) | (-9.76) | (-11.43) | (-8.88) | (-9.56) |
| $N$ | 1455 | 1455 | 1455 | 1455 | 3540 | 3540 | 3540 | 3540 |
| $R^2$ | 0.611 | 0.615 | 0.610 | 0.613 | | | | |
| LL | | | | | -8.96e+09 | -8.93e+09 | -9.00e+09 | -8.98e+09 |

# Interpretation of results

## Baseline estimations

- Traditional gravity variables have the expected sign;
- Only long-run exchange rate volatility is significant at the 5 % level (negative);
- Strong and positive impact of futures price volatility on French exports of cereals.

## Robustness checks (importer FE)

- Leading role played by regional trade agreements;
- The negative impact of long-run exchange rate volatility is not supported when importer fixed effects are included in the model;
- Positive and significant impact of futures price volatility confirmed;

# How can we explain this result?

- Key role lead by storage capabilities;
- Producers determine both production and expected inventories holdings (Pindyck, 2001);
- Low inventory levels are associated with a backwardation market structure and high price volatility (Symeonidis *et al.*, 2012);
- Increase in futures price volatility brings uncertainty on the value of the convenience yield (opportunity cost of holding inventories);
- Producers sell their inventories when futures price volatility is high and increase their exports.

# Commodity-specific results (1)

| | PPML with importer fixed effects | | | |
|---|---|---|---|---|
| | $XV^{S}_{Fjt}$ | $XV^{L}_{Fjt}$ | $PV^{U}_{kt}$ | $PV^{C}_{kt}$ |
| Wheat (100110) | -0.392 | - | -2.012 | - |
| Wheat (100110) | -0.371 | - | - | 8.206 |
| Wheat (100110) | | -1.924 | -1.320 | - |
| Wheat (100110) | - | -1.987 | - | 9.919 |
| Barley (100300) | 1.276 | - | 25.510 | - |
| Barley (100300) | 1.202 | - | - | 10.436** |
| Barley (100300) | - | 1.892*** | 27.095 | - |
| Barley (100300) | - | 1.962*** | - | 12.120*** |
| Oats (100400) | -1.327 | - | 10.320* | - |
| Oats (100400) | 5.538 | - | - | 20.103*** |
| Oats (100400) | - | 3.953** | 14.005*** | - |
| Oats (100400) | - | 4.013** | - | 23.814*** |
| Maize (100510) | -3.087 | - | 27.771*** | - |
| Maize (100510) | -2.276 | - | - | 5.210 |
| Maize (100510) | - | -1.009** | 25.666*** | - |
| Maize (100510) | - | -1.626*** | - | 2.210 |
| Rice (100610) | -80.941*** | - | -51.137 | - |
| Rice (100610) | -34.812 | - | - | 10.470 |
| Rice (100610) | - | 9.159 | -11.965 | - |
| Rice (100610) | - | 10.201 | - | 11.461 |

# Commodity-specific results (2)

- Price volatility has a strong positive effect on French exports of barley (unconditional measure), oats (both measures) and maize (conditional measure);
- No significant impact on wheat and rice;
- The use of the rice futures market for hedging purpose is very limited;

# Outline

# Concluding remarks

- We show the importance to take into account the futures market when investigating exports of agricultural products;
- We document the relationship between price volatility and French exports of five cereals;
- Our conclusions hold only for three commodities: barley, oats and maize;