Food price volatility in landlocked developing countries

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Motivation

Data and methods

First results

Discussion

Motivation

- Higher volatility in landlocked developing countries as a result of difficult access to markets?
- Lower volatility?

			Volatility			
Product	N	Prices	Coastal	Landlocked	F stat	p
Beans	878	12	0.134	0.121	1.23	0.28
Bread	149	2	0.029	0.027	1.14	0.56
Cooking oil	592	8	0.105	0.098	1.16	0.20
Cowpea	369	5	0.246	0.218	1.27	0.10
Maize	3450	47	0.116	0.161	0.52	0.00 ***
Millet	2224	30	0.125	0.100	1.55	0.00 ***
Rice	2202	30	0.141	0.084	2.82	0.00 ***
Sorghum	1914	26	0.144	0.115	1.56	0.00 ***
Wheat	224	3	0.122	0.076	2.60	0.00 ***

Source: Nicholas Minot. 2012. Food Price Volatility in Africa - Has it really increased? IFPRI Discussion Paper.

Motivation

- Empirical findings not intuitive and hard to interpret
- Landlockedness only a very rough measure for access to markets (Minot, 2012)? Local factors more important (Deason et al, 2013)?
- Need for a systematic study of food price volatility in landlocked countries

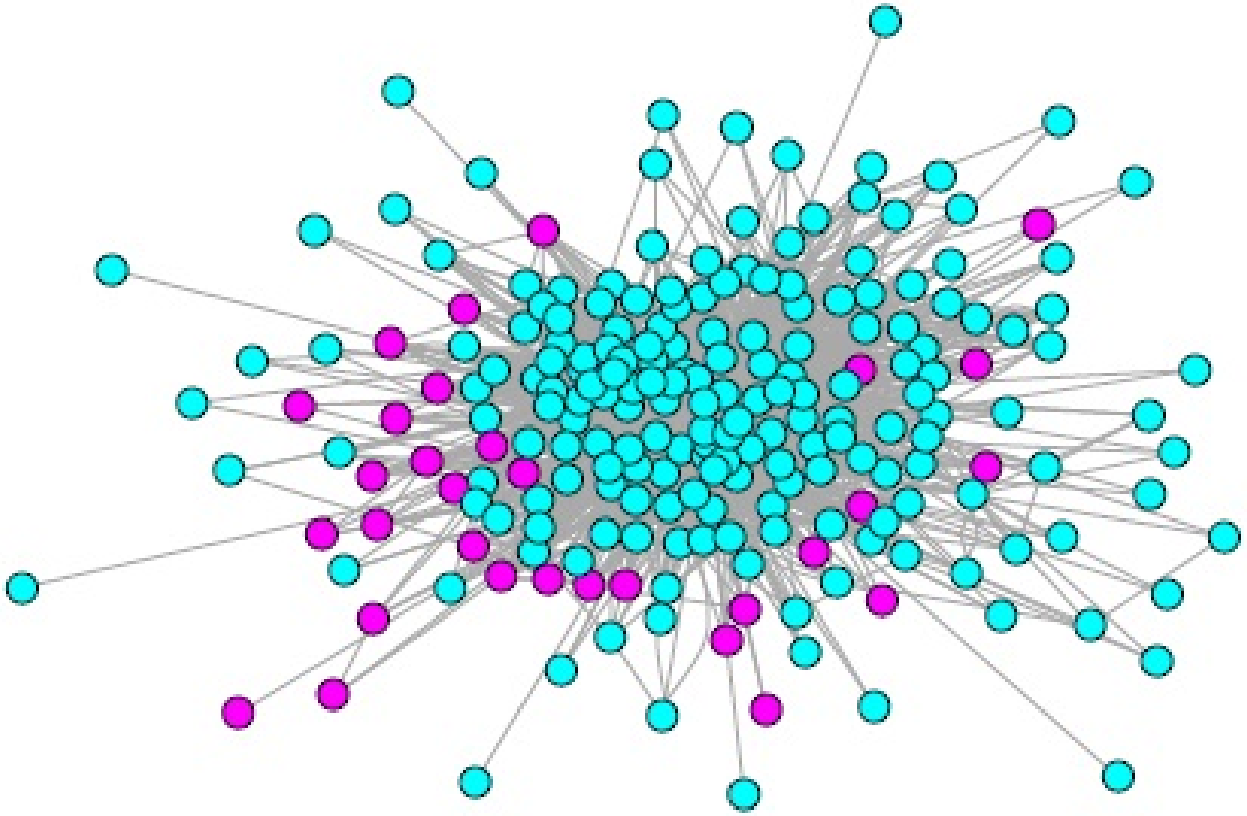
Price data/volatility estimates

- GIEWS data (monthly prices)
- Commodities: rice, wheat, maize, millet, sorghum
- Countries: landlocked developing countries and countries within their regional trade agreements
- Volatility calculated as sample standard deviation of logarithmic returns, i.e. $\sqrt{\frac{1}{N-1}\sum_{n=1}^{N}(r_n - \bar{r})^2}$, for two year periods from 1991 until 2014
- Volatility estimates excluded if prices constant for ≥ 3 months; or if ≤ 12 price observations over the two year period

Additional data

- FAOSTAT food balance sheets: production, import, export, stock changes, total utilization
- WITS: trade networks
- WDI: agriculture value added per worker (constant 2005 USD), trade (% of GDP)
- Shortest distance to coast computed from latitude and longitude of the market

Network of rice trade in 2009



- (Landlocked) countries are (pink) vertices
- Vertices are connected by edges iff countries trade rice with each other

How to measure trade?

- Trade as percentage of GDP?
- What about the relative position in the trade network? Number of trading partners? Significance of trading partners?
- Gray & Potter (2012) explore eigenvector centrality as a measure for the position in the trade system
- Centrality of a vertex is proportional to the sum of the centrality of its neighbors,

$$\lambda C_i = \sum_j a_{ij} C_j$$

C an eigenvector of the adjacency matrix of the graph: eigenvector centrality

Methods

- Different number of volatility estimates for each of 150 markets in 49 countries
- For example, 28 observations for La Paz, Bolivia, but less than five observations for some other markets
- How capture correlation within clusters?

Methods

- Mixed model with random effect for markets i with observations $y_{i1}, \ldots, y_{in_i}$,

$$\mathbf{y}_i = \mathbf{X}_i\beta + \mathbf{1}\gamma_i + \varepsilon_i$$

with

$$\gamma_i \sim \mathcal{N}(0, \sigma_\gamma) \text{ and } \varepsilon_{ij} \sim \mathcal{N}(0, \sigma) \text{ independently}$$

for $\mathbf{y}_i = (y_{i1}, \ldots, y_{in_i})'$, $\mathbf{X}_i = (\mathbf{x}'_{i1}, \ldots, \mathbf{x}'_{in_i})'$, $\mathbf{1} = (1, \ldots, 1)'$, and $\varepsilon_i = (\varepsilon_{i1}, \ldots, \varepsilon_{in_i})'$

- This implies

$$\text{cor}(\mathbf{y}_i, \mathbf{y}'_i) = \sigma^2/(\sigma^2_\gamma + \sigma^2)I_{n_i} + \sigma^2_\gamma/(\sigma^2_\gamma + \sigma^2)\mathbf{1}\mathbf{1}'$$

or correlation $\rho = \sigma^2_\gamma/(\sigma^2_\gamma + \sigma^2)$ between observations for the same market

Comparison of sample means for landlocked and non-landlocked countries' volatility

- Welch Two Sample t-test does not reject

$$H_0: \text{ volatility in LLDCs } \leq \text{ volatility in non-LLDCs}$$

(p-value 0.66, mean(LLDCs)= 0.0882, mean(non-LLDCs)= 0.0895)

- However, volatility might have different drivers in each of the samples ...

Composition of the sample by regions and commodities

	Africa		Southeast Asia		Central Asia		Latin America	
	LL	not LL	LL	not LL	LL	not LL	LL	not LL
Rice	79	108	18	16	3	11	50	79
Wheat	39	36	0	0	54	21	31	37
Maize	136	161	0	0	0	0	20	43
Millet	121	70	0	0	0	0	0	0
Sorghum	93	55	0	0	0	0	0	0
Total	468	430	18	16	57	32	101	159

Eigenvector centrality? Distance to coast?

- Welch Two Sample t-test rejects

$$H_0: \text{ ev centrality in LLDCs } \geq \text{ ev centrality in non-LLDCs}$$

(p-value < 0.0001, mean(LLDCs)$= 0.066$, mean(non-LLDCs)$= 0.093$)

- Welch Two Sample t-test rejects

$$H_0: \text{ dist to coast in LLDCs } \leq \text{ dist to coast in non-LLDCs}$$

(p-value < 0.0001, mean(LLDCs)$= 782322$km, mean(non-LLDCs)$= 310002$km)

Regression results (fixed effects)

	non-landlocked countries			landlocked countries		
	value	std.error	p-value	value	std.error	p-value
intercept	-1.476	0.263	0.000	-1.678	0.241	0.000
trade (% of GDP)	0.002	0.001	0.252	-0.003	0.001	0.001
ev centrality	-0.299	0.256	0.243	-1.343	0.353	0.000
log(ag value)	-0.194	0.037	0.000	-0.094	0.042	0.027
rice	-0.387	0.054	0.000	-0.653	0.057	0.000
wheat	-0.277	0.074	0.000	-0.692	0.066	0.000
distance to coast	0.222	0.140	0.113	0.275	0.093	0.003
wholesale	0.387	0.064	0.000	0.178	0.058	0.002
(ev centrality - 0.5)						
· importshare	-0.304	0.123	0.014	-0.141	0.094	0.132
stock change/use	0.014	0.104	0.895	-0.409	0.105	0.000

Discussion

- Increasing agricultural productivity helps to lower food price volatility
- Stocks are crucial in landlocked countries; food reserves for price stabilization in landlocked countries?
- More trade and a better trade position can reduce volatility especially for landlocked countries
- Difference in the number of wholesale price series (176 vs 357) might contribute to similar volatility levels for landlocked and non-landlocked sample

Next steps

- Include further dimensions of landlockedness (infrastructure in transit countries ... Faye et al, 2004)
- Refine explanatory variables (centrality measure ...)
- Explore alternative measures of price movements (spikes instead of volatility?)
- Draw comparison within regional trade agreements
- Improve specification of correlation structure
- Look into goodness of fit criteria for mixed models

Thank you for your attention!

Literature

- Deason, L, Laborde, D, Minot, N, Rashid, S, and Torero, M, 2013. Food Price Volatility: Effects and Response Mechanisms in Africa. In: Promoting Agricultural Trade to Enhance Resilience in Africa. ReSAKSS Annual Trends and Outlook Report 2013 (IFPRI), 18-37.

- Faye, M, McArthur, J, Sachs, J, and Snow, T, 2004. The Challenges Facing Landlocked Developing Countries. Journal of Human Development, 5(1), 31-68.

- Gray, J, and Potter, P, 2012. Trade and Volatility at the Core and the Periphery of the Global Economy. International Studies Quarterly, 56, 793-800.

- Minot, N, 2012. Food Price Volatility in Africa: Has It Really Increased? IFPRI Discussion Paper.

Details for non-landlocked countries

```
Random effects:
 Formula: ~1 | market
        (Intercept)  Residual
StdDev:   0.4202442 0.4108235

Fixed effects: log(vol) ~ trade + evcALL + log(agvalue2) + I(1 * (commodity ==      1)) + I(1 * (commodity == 2)) + I(dist2coast/1000) + wholesale +      I$
                                  Value  Std.Error  DF   t-value p-value
(Intercept)                   -1.4764406 0.26314496 549 -5.610750  0.0000
trade                          0.0016496 0.00143894 549  1.146403  0.2521
evcALL                        -0.2988960 0.25559393 549 -1.169418  0.2427
log(agvalue2)                 -0.1943544 0.03654569 549 -5.318120  0.0000
I(1 * (commodity == 1))       -0.3867522 0.05384585 549 -7.182582  0.0000
I(1 * (commodity == 2))       -0.2766626 0.07412526 549 -3.732366  0.0002
I(dist2coast/1000)             0.2216811 0.13960110 549  1.587961  0.1129
wholesale                      0.3873976 0.06361965 549  6.089276  0.0000
I((evcALL - 0.5) * importshare) -0.3037931 0.12288247 549 -2.472225  0.0137
I(stocks/total)                0.0137218 0.10401345 549  0.131924  0.8951
 Correlation:
                              (Intr) trade  evcALL lg(g2) I(*(=1 I(*(=2 I(2/10 wholsl I(-0*i
trade                         -0.412
evcALL                         0.078  0.148
log(agvalue2)                 -0.867  0.003 -0.227
I(1 * (commodity == 1))        0.039 -0.095 -0.050 -0.082
I(1 * (commodity == 2))        0.233 -0.164 -0.031 -0.224  0.600
I(dist2coast/1000)            -0.021  0.219  0.021 -0.217  0.065  0.019
wholesale                     -0.021  0.175 -0.070 -0.148  0.089 -0.030 -0.148
I((evcALL - 0.5) * importshare)  0.116 -0.057 -0.066 -0.074  0.481  0.537  0.032 -0.103
I(stocks/total)                0.002 -0.093 -0.079  0.030  0.143  0.074 -0.007  0.024 -0.031

Standardized Within-Group Residuals:
         Min           Q1          Med           Q3          Max
-3.574503776 -0.591540572  0.006756337  0.595218814  3.752373989

Number of Observations: 637
Number of Groups: 79
```

Details for landlocked countries

```
Random effects:
 Formula: ~1 | market
        (Intercept)  Residual
StdDev:   0.2470448 0.4580295

Fixed effects: log(vol) ~ trade + evcALL + log(agvalue2) + I(1 * (commodity ==      1)) + I(1 * (commodity == 2)) + I(dist2coast/1000) + wholesale +      I$
                                Value Std.Error  DF    t-value p-value
(Intercept)                 -1.6784422 0.2412524 559  -6.957203  0.0000
trade                       -0.0034460 0.0010506 559  -3.280104  0.0011
evcALL                      -1.3426980 0.3527496 559  -3.806377  0.0002
log(agvalue2)               -0.0938096 0.0424288 559  -2.210990  0.0274
I(1 * (commodity == 1))     -0.6534463 0.0572895 559 -11.406042  0.0000
I(1 * (commodity == 2))     -0.6916384 0.0655115 559 -10.557506  0.0000
I(dist2coast/1000)           0.2752422 0.0930956 559   2.956555  0.0032
wholesale                    0.1778201 0.0579357 559   3.069266  0.0022
I((evcALL - 0.5) * importshare) -0.1414581 0.0938744 559  -1.506887  0.1324
I(stocks/total)             -0.4087437 0.1046446 559  -3.906018  0.0001
 Correlation:
                            (Intr) trade  evcALL lg(g2) I(*(=1 I(*(=2 I(2/10 wholsl I(-0*i
trade                       -0.144
evcALL                      -0.051  0.180
log(agvalue2)               -0.883 -0.166 -0.107
I(1 * (commodity == 1))      0.031 -0.118 -0.094 -0.085
I(1 * (commodity == 2))      0.228 -0.182 -0.103 -0.248  0.485
I(dist2coast/1000)          -0.003 -0.053  0.062 -0.280  0.148  0.074
wholesale                   -0.098  0.161  0.078 -0.037 -0.015 -0.004 -0.005
I((evcALL - 0.5) * importshare)  0.052 -0.038 -0.111  0.007  0.407  0.255 -0.034 -0.096
I(stocks/total)             -0.100  0.001  0.153  0.127 -0.052 -0.055 -0.059 -0.023  0.114

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-3.16824889 -0.59114055  0.06669482  0.67194443  3.05202071

Number of Observations: 641
Number of Groups: 73
```

Regional trade agreements

- **ECOWAS**: BEN, BFA, CPV, CIV, GHA, GIN, GNB, LBR, MLI, NER, NGA, SEN, SLE, GMB, TGO
- **WAEMU**: BEN, BFA, CIV, GNB, MLI, NER, SEN, TGO
- **CAN**: BOL, COL, ECU, PER
- **CEMAC**: CMR, CAF, TCD, COG, GNQ, GAB
- **COMESA**: DJI, ERI, ETH, BDI, KEN, MWI, RWA, UGA, SWZ, ZMB, ZWE, COD, COM, MUS, SDN, LBY, EGY, MDG, SYC
- **EAEC**: BLR, KAZ, KGZ, RUS, TJK
- **CIS**: ARM, AZE, BLR, KAZ, KGZ, MDA, RUS, TJK, UZB
- **SADC**: AGO, BWA, COD, LSO, MDG, MWI, MUS, MOZ, NAM, SYC, ZAF, SWZ, TZA, ZMB, ZWE
- **SACU**: BWA, LSO, NAM, ZAF, SWZ
- **MERCOSUR**: ARG, BRA, PRY, URY, BOL, VEN
- **EAC**: BDI, KEN, RWA, TZA, UGA

Countries included in the sample

- **Africa**: AGO, BEN, BFA, CAF, CMR, CPV, ETH, GAB, GHA, KEN, LBR, LSO, MDG, MLI, MOZ, MWI, NAM, NER, NGA, RWA, SDN, SEN, TCD, TGO, TZA, UGA, ZAF, ZMB, ZWE
- **Southeast Asia**: CHN, LAO, THA
- **Central Asia**: AFG, ARM, AZE, BLR, IND, KGZ, MNG, RUS, TJK, UZB
- **Latin America**: ARG, BOL, BRA, COL, ECU, PRY, URY