Tools to measure market integration

Fousseini TRAORE & Sunday Odjo
IFPRI-Dakar

PAPA Clinics
Dakar, May 3-4, 2018

Outline

- Market integration: main questions
  - What is market integration?
  - Why is it important? Link with trade
  - How do we measure it?
  - Some examples
- Market integration has to do with price transmission
  - But the methods used to study price transmission rely mainly on time series analysis (particularly cointegration…)
  - A refresher is therefore necessary before measuring MI

Background

- A growing literature on the topic in the past thirty years
- The 2008 food crisis called for questions on price signals transmission
- Main idea (Ravallion, 1986, 1997 ; Sen 1981):
  - More integrated markets yield lower price volatility
  - More welfare gains as local markets become protected from idiosyncratic shocks
  - Surplus areas are linked to deficit ones

Price transmission

- Market integration requires price transmission
- Three main types of price transmission
  - Spatial transmission: between two markets for the same commodity
    - Price of rice in Dakar and price of rice in Kaolack
  - Vertical transmission: between two points (stages) of the value chain
    - Price of wheat and price of floor
  - Cross commodity: between two commodities (substitution effects)
    - Price of rice and price of maize
    - Price of cotton and price of polyester

Why is it important? – Minot (2011)

- Studying MI helps solve root causes
  - If little price transmission from world markets, then trade policy will not be effective in reducing volatility
- It also help forecast prices based on trends in related prices
  - If changes in cotton prices transmitted to polyester markets, then cotton futures markets may predict polyester prices
- And diagnose poorly functioning markets
  - If two markets are close together, but show little price transmission, this may indicate problems with transportation network or market power

Why focus on prices?

- Normally market integration involves free movements of goods and information (prices) in spatially distinct places (Enke, 1951 ; Samuelson, 1952 ; Takayama & Judge, 1971)
- However focus in the literature on prices (law of one price) rather than trade flows
- Main reasons:
  - it is easier to get data on prices at a relatively high frequencies than data on trade flows
  - markets are places where equilibrium prices are set, once transaction costs have been taken into account (Stigler and Sherwin, 1985)
  - If two market places are integrated (trade flows), a shock to the price in one market should be transmitted in the other market's price ⇒ price transmission and comovement of prices tend to be synonymous with market integration (Barett, 1996).
  - How strong should the transmission be? Perfect transmission? Still open to discussion

Law of one price

- Economic agents are supposed rational and doing spatial arbitrage in a perfect competition framework
- On two separate market places (i,j), the prices of an homogenous good are equal, (adjusting for) given the transaction costs (K_{ji})
- We have $\left|P_i - P_j\right| \leq K_{ji}$ or $-K_{ji} \leq P_i - P_j \leq K_{ji}$
- The price is lower in the exporting region
- Equilibrium:
- $P_i \begin{cases} < P_j + K_{ji} \Rightarrow Q_{ji} = 0 \\ = P_j + K_{ji} \Rightarrow Q_{ji} > 0 \end{cases}$

A digression in time series analysis

Stationarity

- When analyzing time series data, a fundamental distinction has to be made between stationary and non stationary processes
- A time series is said to be (weakly or 2nd order or covariance) stationary if its first two moments are finite
- Formally, a process X_t is covariance stationary if:

1. $E(X_t^2) < \infty \ \forall t$
2. $E(X_t) = \mu \ \forall t$
3. $cov(X_{t_1}, X_{t_2}) = cov(X_{t_{1+h}}, X_{t_{2+h}}) \ \forall t_1, t_2, h$

Non stationary processes

- There are two main types of non stationary processes:
  - Trend stationary with a deterministic non stationary nature
  - Difference stationary with a stochastic non stationary nature
- Trend stationary process:

$$X_t = \gamma + \beta t + \varepsilon_t \quad \text{with } \varepsilon_t \sim IID(0, \sigma_\varepsilon^2)$$

$$E(X_t) = \gamma + \beta t \text{ and } V(X_t) = \sigma_\varepsilon^2$$

- Difference stationary process

$$X_t = X_{t-1} + \varepsilon_t = X_0 + \sum_{j=1}^{t} \varepsilon_j$$

$$E(X_t) = X_0 \text{ and } V(X_t) = t\sigma_\varepsilon^2$$

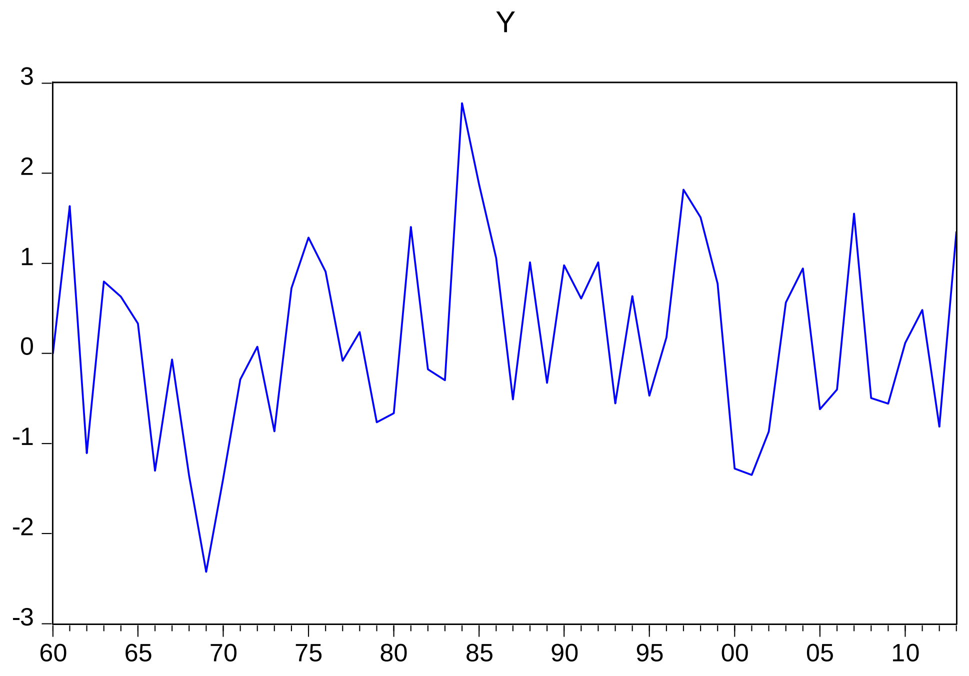
Implication for volatility measures

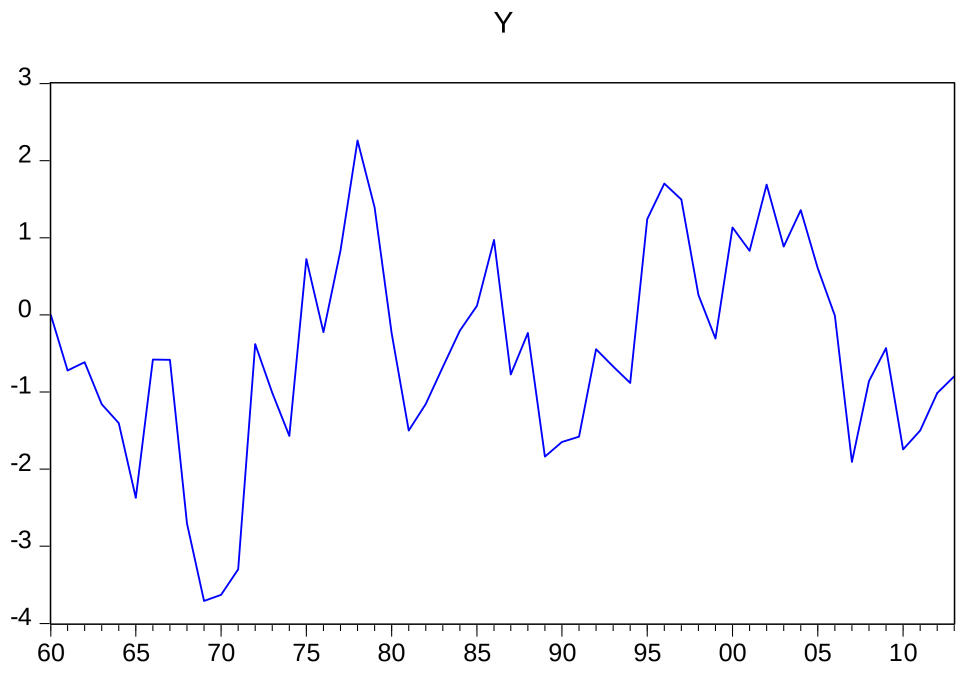
- The relevant concept is the volatility around the trend (cf. standard deviation). Otherwise trend movements will be included in the volatility measures
- Need attribution of variability to the trend itself and to variation around the trend
- With a unit root process, the variance (and thus standard deviation) approaches infinity as the time period approaches infinity ⇒ volatility depends of the sample size if measured with these indicators (Granger, 1986; Engle & Granger, 1987)
- Consequences of wrong trend specifications (Chan et al, 1977; Nelson & Kang, 1981)
  - If one differentiates a TS process ⇒ spurious autocorrelation of order 1
  - If one applies TS to DS process ⇒ spurious cycles

Implications for econometric analysis

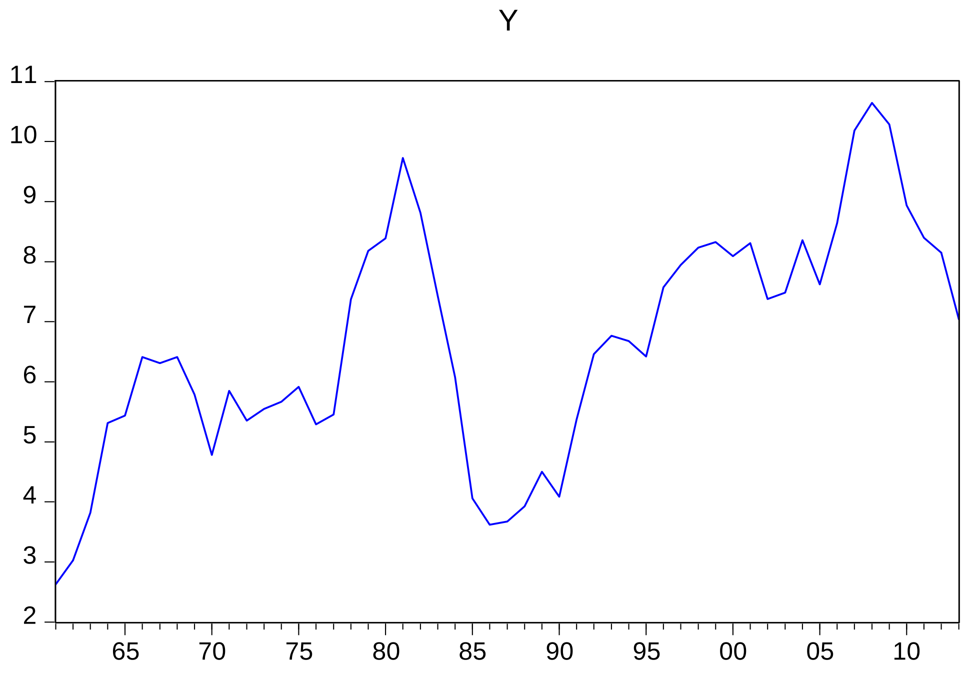
- We get spurious regressions (find results that are statistically significant even when there is no relationship: Granger and Newbold, 1974)
- Increasing the sample size worsens the problem
- Standard tests (T or F tests do not apply, non standard distribution)
- Main symptom: R^2>DW
- Unfortunately many econ variables are non stationary (Nelson and Plosser, 1982)

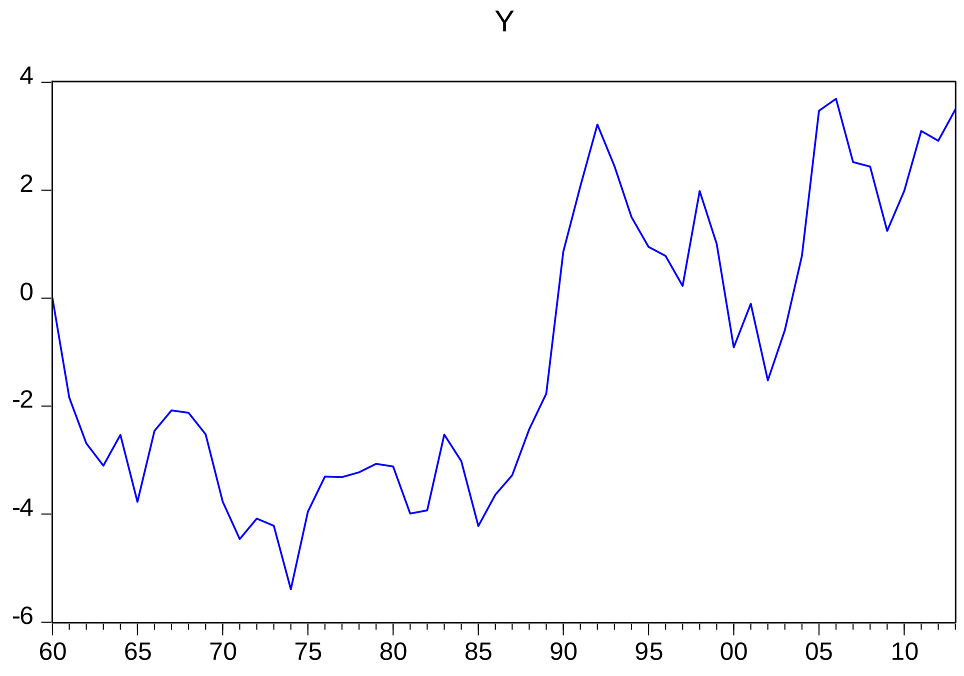
Examples of stationary (I(0)) processes



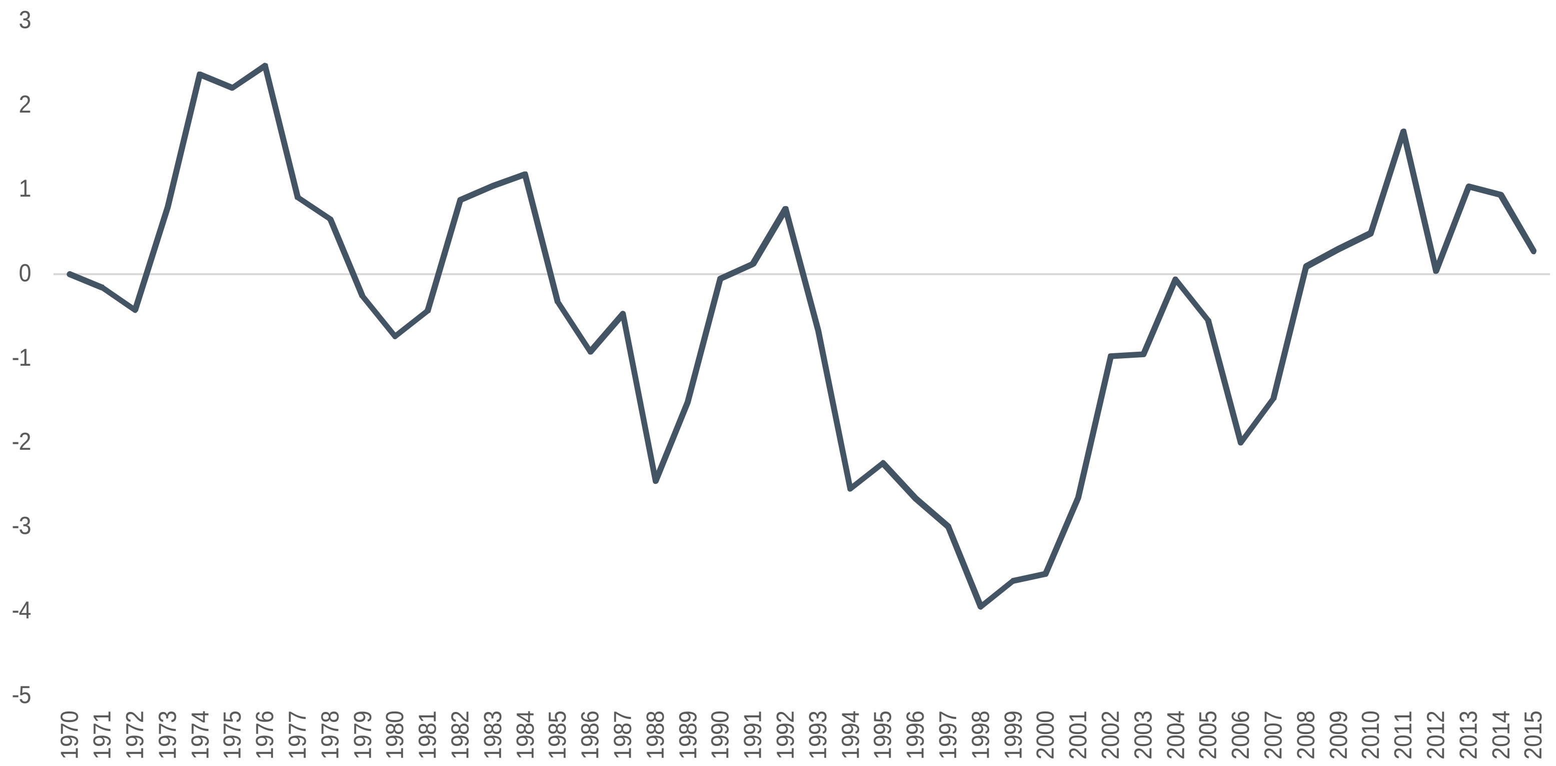


Examples of non stationary (UR) processes





What about this? Need a test?



Unit root tests

- Early and main test: Dickey-Fuller (1979)
  - General model: $X_t = \rho X_{t-1} + \mu + \delta t + \varepsilon_t \Rightarrow \begin{cases} H_0: \rho = 1 \\ H_1: |\rho| < 1 \end{cases}$
  - How to test this properly will be given a special treatment (cf. next slide)
  - Distribution of test statistic non standard! Functionals of Brownian motions
  - $t_{H_0} \sim \frac{W^2(1)/2 - W(1)\int_0^1 W(s)ds}{\sqrt{\int_0^1 W^2(s)ds - \left[\int_0^1 W(s)ds\right]^2}}$ case with just a constant
  - Transformed equation: $\Delta X_t = (\rho - 1)X_{t-1} + \mu + \delta t + \varepsilon_t = \varphi X_{t-1} + \mu + \delta t + \varepsilon_t$ and test $\varphi = 0$ instead.

Other unit root tests

- Taking into account autocorrelation
  - DF assumes no autocorrelation: too restrictive
  - ADF is a parametric correction: $\Delta X_t = \varphi X_{t-1} + \mu + \delta t + \sum_{j=1}^{p} \gamma_j \Delta X_{t-j} + \varepsilon_t$
  - Phillips-Perron ⇒ non parametric approach

- Robustness check KPSS: Ho=stationarity
  - $X_t = \delta * t + r_t + \varepsilon_t$
  - With $r_t = r_{t-1} + u_t$ and $u_t \sim iid(0, \sigma_u^2)$
  - The null hypothesis of stationarity is given by: $H_0: \sigma_u^2 = 0$

- Other tests (not covered here)
  - Dozens of tests! Almost impossible to follow the literature
  - Changes in the mean or in the level of variables: (Perron, 1989) ; Zivot & Andrews (1992)...
  - Bayesian approaches : Sims (1988); Sims & Uhlig (1991)
  - Frequency domain analysis (Choi and Phillips, 1993)

Main issues with unit root tests

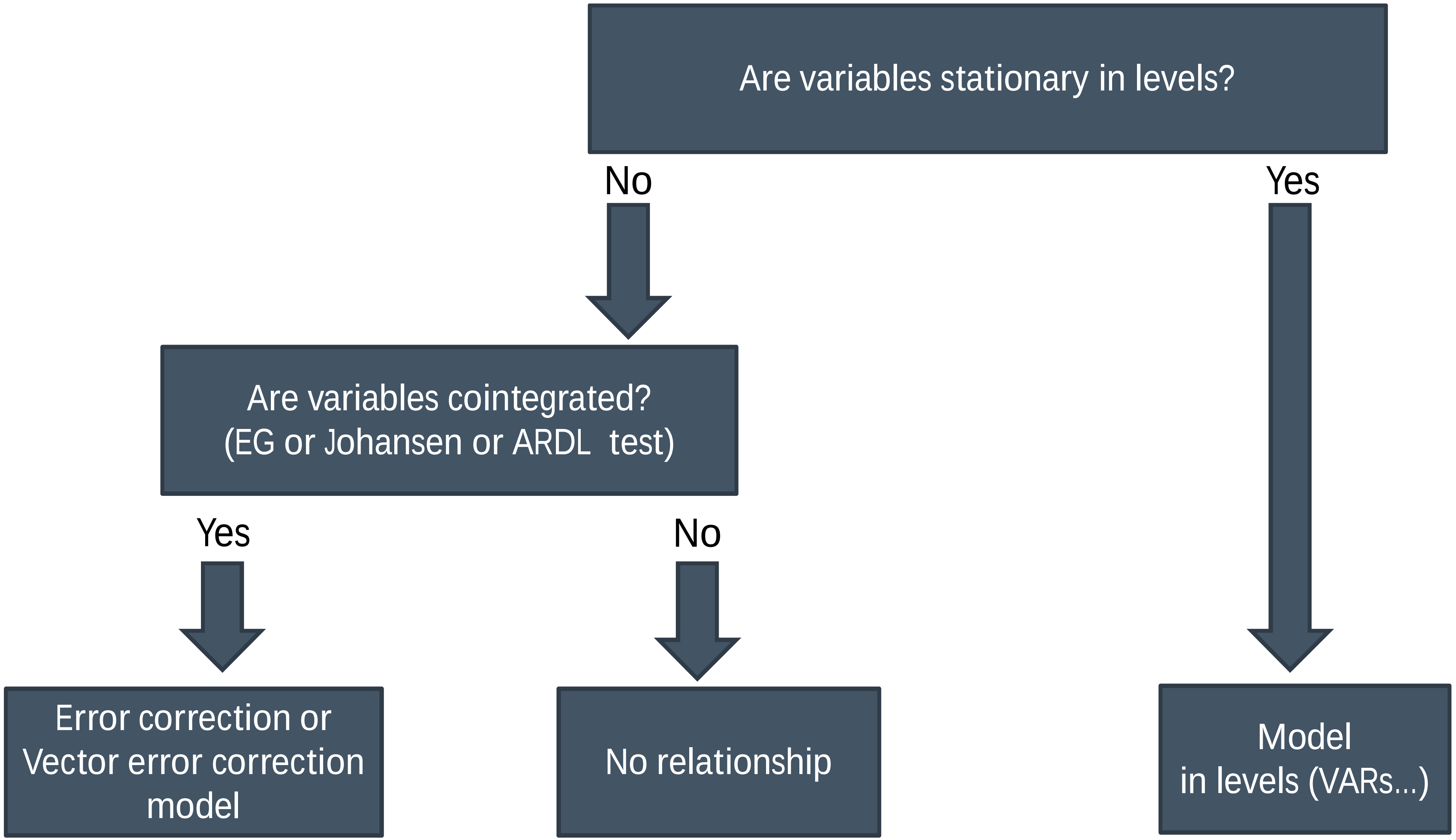
- Low power, over-rejects H_1 (Schwert, 1989; Cochrane, 1991; Blough, 1992)
- ! specification of deterministic components (trend and drift)
- The test statistic depends on deterministic terms and the tests for those terms depend on unit roots! Circular reasoning.
- Start with the general structure including a constant and a trend and test down (using DF tables)

Main message

- Following Park & Phillips (1988), Perron (1988)
  - The non standard distribution (Wiener process) dominates only when the DGP has no drift or trend
  - If the true DGP contains a drift or a trend, the t-statistics for ρ converges to a normal distribution and the test can be done using standard normal tables

Testing procedure: Dolado et al, (1990); Enders (1995)

Solutions with non stationary data



Unit root tests

- File UR_TESTS.XLS
- Annual data 1970 2015
- Six series

Market integration

Descriptive statistic methods (1/3)

- Very early methods (Cummings, 1967 and Lele, 1971, Harriss, 1979)
- Markets are integrated if there is a strong (significant) correlation between prices
- Pearson's correlation coefficient is a natural candidate
- If P_{it} (P_{jt}) denotes prices for market i (market j), we do not reject market integration if $\rho = \frac{cov(P_{it}, P_{jt})}{\sigma_{P_{it}} \sigma_{P_{jt}}}$ is statistically different from zero
- A t-test can be used for that perspective

Descriptive statistic methods (2/3)

- For a sample of size T from a joint distribution, the coefficient is given by:

$$\rho = \frac{\sum_{t=1}^{T}(P_{it} - \bar{P}_i)(P_{jt} - \bar{P}_j)}{\sqrt{\sum_{t=1}^{T}(P_{it} - \bar{P}_i)^2}\sqrt{\sum_{t=1}^{T}(P_{jt} - \bar{P}_j)^2}}$$

- The t-statistic associated to the test $\rho = 0$ is given by:

$$t = \frac{\rho}{s_\rho} = \frac{\rho}{\sqrt{\frac{1-\rho^2}{n-2}}}.$$

- For large samples a normal approximation is possible with

$$U = \frac{\rho}{\sqrt{\frac{1}{n-1}}} = \rho \cdot \sqrt{n-1}.$$

Descriptive statistic methods (3/3)

- Pearson's coefficient assumes a linear relationship between the two variables
- If rejected, should be complemented by a non-parametric test such as Spearman rank correlation coefficient (also robust to outliers)
- Price variables are first converted to ranks $rg_{P_{it}}$ and $rg_{P_{jt}}$ and spearman's (ρ_S) coefficient is just Pearson's ρ applied to ranks
- This yields: $\rho_S = \frac{cov\left(rg_{P_{it}}, rg_{P_{jt}}\right)}{\sigma rg_{P_{it}} \sigma_{rgP_{jt}}}$
- If no ties: $\rho_S = 1 - 6 \frac{\sum\left(rg_{P_{it}} - rg_{P_{jt}}\right)^2}{n(n^2-1)}$
- A t-test can be used here as well

Main issues with descriptive methods

- Lags in information that may overestimate segmentation (information comes with delay, need a dynamic model with adjustment)

- Spurious integration due to common exogenous trends (inflation, common periodicity, seasonality, climatic shocks)= omitted variable bias

Econometric methods (1/5)

- The general econometric model used to test for market integration builds upon Ravallion (1986):

$$P_{it} = a_0 + \sum_{j=1}^{n} a_{ij} P_{it-j} + \sum_{j=0}^{n} b_{ij} P_{ct-j} + d_i X_{it} + \epsilon_{it}$$

- P_c = price in a central market,
- P_i =price in the ith local market
- X a vector of other variables (seasonal dummies, inflation…).
- It is supposed that prices in the central market are weakly exogenous. If not they should be instrumented. Also a granger causality test can be used to detect anteriority of price movements.

Econometric methods (2/5)

- Following Ravallion (1986), the following hypotheses can be tested:

$$P_{it} = a_0 + \sum_{j=1}^{n} a_{ij} P_{it-j} + \sum_{j=0}^{n} b_{ij} P_{ct-j} + d_i X_{it} + \epsilon_{it}$$

- Market segmentation: central (leader) market prices do not influence the ith market prices: $b_{ij} = 0, j = 0,1, \dots n$
- (Long run) market integration: given by the long run equilibrium of (E): $\sum_{j=1}^{n} a_{ij} + \sum_{j=0}^{n} b_{ij} = 1$

Econometric methods (3/5): the ARDL approach

- The Ravallion model (E) can also be transformed into an error correction model, representing a cointegration relationship.
- The cointegration (stable long run) relationships is interpreted as market integration (Palaskas and Harriss, 1993 ; Dercon, 1995)
- The model has an Autoregressive Distributed Lag (ARDL) structure
- The ARDL bounds tests approach developed by Pesaran Shin and Smith (2001) is therefore indicated when testing for cointegration
- Once cointegration cannot be rejected, the long run market integration hypothesis of Ravallion (1986) can then be tested

Econometric methods (4/5): testing for cointegration

- Pesaran, Shin and Smith (2001) following Pesaran and Shin (1997) have developed an ARDL framework for cointegration robust to dynamic misspecification and mixed processes (problem with low power of unit root tests)

$$P_{it} = a_0 + \sum_{j=1}^{n} a_{ij} P_{it-j} + \sum_{j=0}^{n} b_{ij} P_{ct-j} + \epsilon_{it}$$

- These new tests, called "bounds tests" can be described as follows:

- We start with the general unconstrained error correction model of the following form between the two prices

$$\Delta P_{it} = \pi_0 + \pi_1 P_{it-1} + \pi_2 P_{ct-1} + \sum_{j=1}^{p-1} \gamma_{ij} \Delta P_{it-j} + \sum_{i=0}^{q} \delta_{ij} \Delta P_{ct-j} + \varepsilon_t$$

Econometric methods (5/5): testing for cointegration

$$\text{ECM: } \Delta P_{it} = \pi_0 + \pi_1 P_{it-1} + \pi_2 P_{ct-1} + \sum_{j=1}^{p-1} \gamma_{ij} \Delta P_{it-j} + \sum_{i=0}^{q} \delta_{ij} \Delta P_{ct-j} + \varepsilon_t$$

- The null hypothesis of no cointegration between the variables is given by:

$$H_0^{\pi_1}: \pi_1 = 0, H_0^{\pi_2}: \pi_2 = 0 \quad \text{and} \quad H_1^{\pi_1}: \pi_1 \neq 0, H_1^{\pi_2}: \pi_2 \neq 0$$

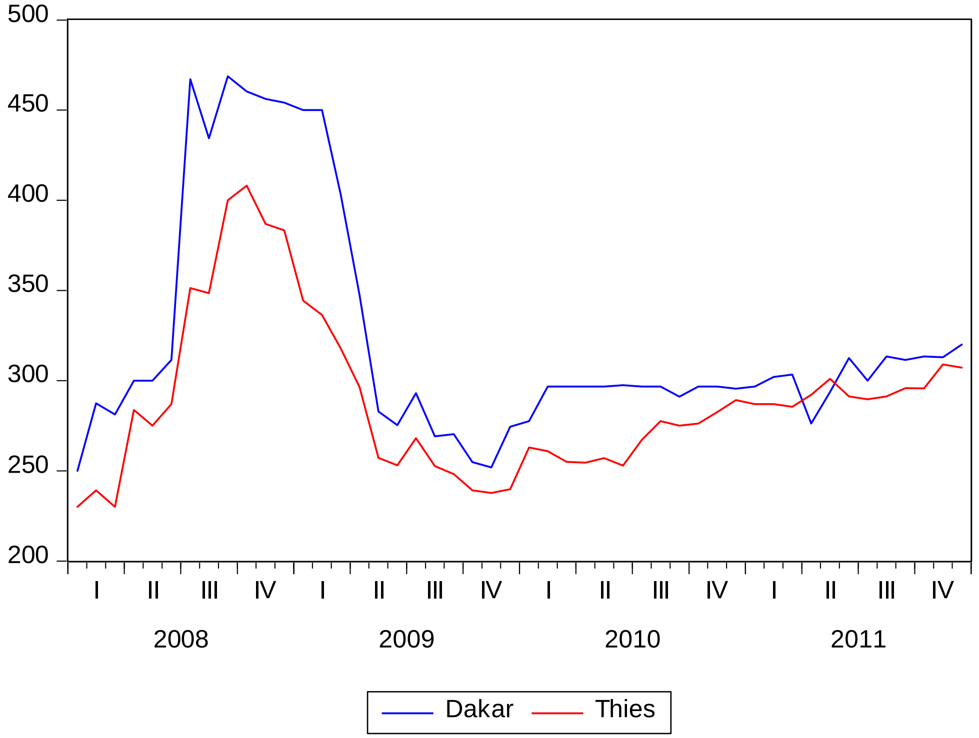
$$\text{i,e } H_0: H_0^{\pi_1} \cap H_0^{\pi_2} \quad \text{and} \quad H_1: H_1^{\pi_1} \cup H_0^{\pi_2}$$

- Testing procedure:
  1. Compute the F-statistic under the null hypothesis
  2. Compare the F-statistic to the two critical values bounds tabulated by Pesaran et al. (2001). The lower bound assumes that all the regressors are I (0) while the upper bound assumes that they are all I (1)
     - i. If F-stat > Upper bound cointegration is not rejected
     - ii. If F-stat < Lower bound cointegration is rejected
     - iii. If F-stat falls within the bound, the test is inconclusive and further investigation is needed

- However, for the test to work, I(2) variables should not be present.

Example: simple case for Senegal with rice market

- Data: monthly imported rice prices from 2008 to 2011 (CFAF/kg)



Correlation analysis

- Simple correlation: $\rho = 0.920$ (p-val=0.000)
- Rank correlation : $\rho = 0.868$ (p-val=0.000)

Econometric analysis

$$P_{it} = a_0 + \sum_{j=1}^{n} a_{ij} P_{it-j} + \sum_{j=0}^{n} b_{ij} P_{ct-j} + d_i X_{it} + \epsilon_{it}$$

- Unit root tests (to be sure that there is no I(2) variables)

	Dakar		Thies	
	ADF	PP	ADF	PP
Level	-0.160	-0.087	0.328	0.109
First Diff	-6.731***	-6.764***	-6.144***	-6.409***

- Test -> ARDL (4,2)
- Market segmentation: $b_{ij} = 0, j = 0,1, \ldots n$

  C(5)=c(6)=c(7)=0 , F-stat=15.36 and p-val=0.000 -> rejects

- Market integration: $\sum_{j=1}^{n} a_{ij} + \sum_{j=0}^{n} b_{ij} = 1$
  - ARDL test (4,2): F-stat =5.75 -> rejects Ho at 5% -> cointegration
  - Long run coefficient = 0.643 =1? , rejects at 1% but seems too restrictive, imperfect transmission or weak integration

A note on granger causality

- Not always obvious where (central market) the causality comes from
- Can test with Granger causality and run VECMs to test for market integration
- Definition and test
  - Refers to improvement of the prediction (forecast error) of Y_t if lagged values of X_t are taken into account and vice versa.
  - Suppose a stationary VAR (2) process:
  - $$\begin{cases} Y_t = \alpha_1^0 + \alpha_1^1 Y_{t-1} + \alpha_1^2 Y_{t-2} + \beta_1^1 X_{t-1} + \beta_1^2 X_{t-2} + \varepsilon_t \\ X_t = \alpha_2^0 + \alpha_2^1 X_{t-1} + \alpha_2^2 X_{t-2} + \beta_2^1 Y_{t-1} + \beta_2^2 Y_{t-2} + u_t \end{cases}$$
  - X_t does not “Granger” causes Y_t if $\beta_1^1 = \beta_1^2 = 0$
  - Y_t does not “Granger” causes X_t if $\beta_2^1 = \beta_2^2 = 0$

What if data are non stationary?

- The distribution of the test statistic becomes very complicated (non standard), functionals of Brownian motions
- Need to work with first differences
- Fortunately Toda and Yamamoto (1995) brought a nice solution to the problem.
- No need to take first differences even if data are I(1)
- Model = Lag augmented VAR model of
- If the true VAR is a VAR(p), just estimate a VAR (p+dmax) but test only for p lags.
- dmax is maximum order of integration of the time series

Toda and Yamamoto (1995) approach

- *A VAR (P) process*
- $$Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{i=p+1}^{dmax} \alpha_i Y_{t-i} + \sum_{i=1}^{p} \beta_i X_{t-i} \sum_{i=p+1}^{dmax} \beta_i X_{t-i} + \varepsilon_t$$
  $$X_t = \gamma_0 + \sum_{i=1}^{p} \gamma_i X_{t-i} + \sum_{i=p+1}^{dmax} \gamma_i X_{t-i} + \sum_{i=1}^{p} \pi_i Y_{t-i} \sum_{i=p+1}^{dmax} \pi_i Y_{t-i} + \epsilon_t$$

  – X_t does not “Granger” causes Y_t if H_0: $\sum_{i=1}^{p} \beta_i = 0$

  – Y_t does not “Granger” causes X_t if H_0: $\sum_{i=1}^{p} \pi_i = 0$

- The test statistic will follow a standard χ^2 distribution

Cointegrated VARs and VECMs: The Johansen approach

- Level specification (VAR (3)): $X_t = \mathbf{\Pi}_1 X_{t-1} + \mathbf{\Pi}_2 X_{t-2} + \mathbf{\Pi}_3 X_{t-3} + \varepsilon_t$
- ECM representation: $\Delta X_t = \mathbf{P}_1 \Delta X_{t-1} + \mathbf{P}_2 \Delta X_{t-2} + \mathbf{\Pi} X_{t-1} + \varepsilon_t$

$$P_1 = -(\mathbf{\Pi}_2 + \mathbf{\Pi}_3) \quad P_2 = -\mathbf{\Pi}_3 \qquad \mathbf{\Pi} = -(I - \mathbf{\Pi}_1 - \mathbf{\Pi}_2 - \mathbf{\Pi}_3)$$

- Granger representation theorem: if $\mathbf{\Pi}$ has reduced rank (r<k), ∃ k*r matrices α and β with rank r, such that $\mathbf{\Pi} = \alpha\beta'$ and $\beta' X_t$ is a stationary process.
- The columns of β are the cointegrating vectors and α are short run adjustment parameters.
- For a VAR with k variables, the LR Test of r cointegrating relations is a test of the rank of $\mathbf{\Pi}$ and the null hypothesis is tested by:

$$LR(r) = -T \sum_{i=r+1}^{k} log(1 - \lambda_i)$$

- λs are the characteristic roots (eigenvalues) from $\mathbf{\Pi}$

Johansen approach (ctd)

- Another test based on the Max eigenvalue (not that much used), Trace test more robust to non normality (Excess skew and kurt).
- If cointegration $\Rightarrow$ use a VECM
- ! Small sample bias (Reimers, 1992, Cheung and Lai, 1993)
- Either multiply the test statistic by the scaling factor SF $= \frac{T-kp}{T}$ or the critical value by $\frac{T}{T-kp}$

Caveats

- Duhem-Quine thesis (problem): difficulty in testing scientific hypothesis in isolation
  - it is almost impossible to fully reject market integration as the hypothesis on integration comes along with many auxiliary ones (background assumptions) such as the nature of transaction costs and the market structure (Araujo Bonjean and Combes, 2010).
  - Goods may not be homogenous

- Caution when testing market integration with cointegration relationships:
  - First the nature of transaction costs is important. The model assumes constant TC. when transaction costs are non stationary, the test is biased towards market segmentation (Barett, 1996).
  - The long run transmission coefficient should be 1 (Ravallion, 1986)
  - Second, threshold effects may be present, price adjustments take place only for large changes (Balke and Fomby, 1997 et Goodwin and Pigott, 2001). Also asymmetry.

Border effects: cross country market integration

Border effects and market integration

- Started with a paper by Engel and Rogers (AER, 1996)
- Focus was on US vs. Canadian markets
- Main idea: study the deviation of the law of one price
  - why the variation of the price of similar goods for two cities in different (neighbor) countries is higher than for two equidistant cities in the same country (border effect)?
  - Compare pairs of markets across and within countries, controlling for distance, exchange rates, non tradable contents….
  - Assumption: the volatility (dispersion) of prices between two cities is positively related to the distance between them, but holding distance constant, it should be higher for two cities separated by a national border
  - A significant border effect is a sign of markets not integrated (trade barriers, …)

Why prices should vary across borders?

- Focus: relative prices $\frac{P_{ik}}{P_{jk}}$ (commodity k in markets i and j)
- Commodity prices have a non-traded component (distribution, marketing…) which are labor intensive -> two national labor markets are likely more separated than local markets
- Prices are expressed in local currencies: so exchange rates movements matter
- Directs costs of crossing the border: tariffs and other trade restrictions

Methodology

- Compare the volatility (growth rate) of relative prices across and within countries. Either take
  - The standard deviation of the difference in logs (Engel & Rogers, 1996) or
  - The speed of adjustment (convergence), half life of shocks between two markets to measure persistence (Araujo-Bonjean & Brunelin, 2013)

$$\sigma_g\left(\frac{P_{ik}}{P_{jk}}\right) = \beta_0 + \beta_1 log(d_{ij}) + \beta_2 Bord_{ij} + \sum_{m=1}^{n} \alpha_m D_m + X\gamma' + \varepsilon_{ij} \quad \text{(Eq1)}$$

- d_{ij}: distance between market i and market j
- $Bord_{ij}$: Dummy variable =1 if i and j are separated by a border and 0 otherwise
- D_m: market dummy variable =1 if m=i or m=j
- X: Vector of other explanatory variables

Significance of the border

- The economic significance of the border can be compared to distance (distance equivalent). From Eq 1:
- $\sigma_g\left(\frac{P_{ik}}{P_{jk}}\right) = \beta_0 + \beta_1 log\left(d_{ij}\right) + \beta_2 Bord_{ij} + \sum_{m=1}^{n} \alpha_m D_m + X\gamma' + \varepsilon_{ij}$
- The distance equivalent of the border effect is given by:
- Solve $\beta_2 = \beta_1 log\left(d_{ij}\right) \rightarrow d_{ij} = e^{\left(\frac{\beta_2}{\beta_1}\right)}$

Caution

- Gorodnichenko and Tesar (2009)
  - city (market) dummy variables are not sufficient to control for within country price heterogeneity (difference within pairs in the absence of treatment)
- Need to introduce a dummy for pairs for one country (cannot introduce all of them)
- EX: US-Canada
- $\sigma_g\left(\frac{P_{ik}}{P_{jk}}\right) = \beta_0 + \beta_1 log\left(d_{ij}\right) + \beta_2 Bord_{ij} + \sum_{m=1}^{n} \alpha_m D_m + \beta_3 CC_{ij} + X\gamma' + \varepsilon_{ij}$
  - β_3: US-US to US-CA pairs
  - β_2- β_3: CA-CA to US-CA pairs

Example: Araujo and Brunelin (2013)

- A study in West and Central Africa (15 countries) for 5 ag products in 142 markets
- Findings:
  - A significant border effect, lower for same currency countries
  - A declining effect from 1990 to 2011
- Distance equivalents in Kms (speed of adjustment specification, no instantaneous adjustment)

	1990-1999	2000-2011
Bénin – Burkina	8.73	8.73
Bénin – Niger	9.49	5.29
Mali – Niger	76.20	35.01
Mauritania-Senegal	114.86	
Guinea-Senegal	2107.38	

- Average distance equivalent (standard deviation of Rel. prices specification):

  92 kms for 1990-1999 and 46 kms for 2000-2011

A Note on “vertical” price transmission

- Cf. Study in Senegal

References

- Ravallion, M. 1986. "Testing Market Integration." *American Journal of Agricultural Economics* 68: 102-109.
- RAVALLION, M. (1997). “Famines and Economics”, *Journal of Economic Literature*, vol. 35, pp. 1205-1242.
- SEN, A. (1981). *Poverty and famines: An essay on entitlement and deprivation*, Oxford:Oxford U. Press.
- STIGLER G. et SHERWIN, R. (1985). “The Extent of the Market”, *Journal of Law and Economics*, vol. 28, pp. 555-85.
- ENKE, S. (1951). “Equilibrium among Spatially Separated Markets: Solution by Electrical Analogue.” *Econometrica* 19: 40-47.
- SAMUELSON, P.A. (1952). “Spatial Price Equilibrium and Linear Programming.” *American Economic Review* 42: 283-303.
- TAKAYAMA, T. and JUDGE G. (1971). *Spatial and Temporal Price Allocation Models*. North-Holland, Amsterdam, The Netherlands.
- BARRETT, C.B. (1996). “Market Analysis Methods: Are Our Enriched Toolkits Well Suited to Enlivened Markets?". *American Journal of Agricultural Economics*, 78: 825-829.
- CUMMINGS R.W. (1967). *Pricing Efficiency in the Indian Wheat Market*, Impex, New Delhi, India.
- Hariss, B. (1979), “There is Method in my Madness: Or Is It Vice Versa? Measuring Agricultural Market Performance”, Food Res. Inst. Stud., 17, 197-218.

- Lele, U. J. (1971), “Food Grain Marketing in India. Private Performance and Public Policy, Cormell University Press, New York.
- Palaskas, T. B. and B. Hariss-White (1993), “Testing Market Integration: New Approaches with Case Material from the West Bengal Food Economy”, The Journal of Development Studies, 30(1), 1-57.
- Dercon, S. (1995), “On Market Integration and Liberalisation: Method and Application to Ethiopia”, The Journal of Development Studies, 32(1), 112-143.
- Pesaran, M. H., Y. Shin and R. J. Smith (2001), “Bounds Testing Approaches to the Analyis of Level Reationships”, Journal of Aspplied Econometrics, 16(3), 289-326.
- Araujo- Bonjean, C. and J. L. Combes (2010), “De la mesure de l’integration des marches agricoles dans les pays en developpement”, Revue d’economie du debeloppement, 18, 5-20.
- GOODWIN, B.K and PIGOTT, N.E. (2001). “Spatial market integration in the Presence of threshold Effects”, *American Journal of Agricultural Economics*, vol. 83, pp. 302-317
- BALKE, N.S. et FOMBY, T.B. (1997). “Threshold cointegration”, *International Economic Review*, vol. 38, pp. 627-645.

- Cheung, Y. W and K. S. Lai (1993), "Finite Sample Properties of Johansens Likelihood Ratio Tests for Cointegration", Oxford Bulletin of Economics and Statistics, (55), 313-332.
- Reimers, H. E (1992), "Comparison of Tests for Multivariate Cointegration", Statistical Papers, 33, 335-359.
- Engel, C. and J. H. Rogers (1996), "How wide is the Border?", The American Economic Review, 85(5), 1112-1125.
- Gorodnichenko, Y. and L. L. Tesar (2009), "Border Effect or Country Effect? Seattle May Not Be so Far from Vancouver After All ", *American Economic Journal: Macroeconomics, 1(1), 219–241.*
- *Araujo Bonjean, C. and S. Brunelin (2013),* "Le commerce agricole en afrique de l'ouest et du centre : les frontières sont-elles abolies ?", Revue d'économie du développement, 21, 5-31.