Economic Outlook:

Cointegrating VAR models and Probability Forecasting

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Outline

- Why Cointegrating VAR models
- Why Probability Forecasting
- Case study: Uruguay
  - VEC model
  - Probability Forecasting

Why Cointegrating VAR

- -vec- command: The default (Johansen normalization)

```
.   webuse lutkepohl
(Quarterly SA West German macro data, Bil DM, from Lutkepohl 1993 Table E.1)
.   vec linvest lconsumption lincome, lags(4) rank(2) noetable
Vector error-correction model
Sample:  1961q1 - 1982q4                        No. of obs      =        88
Identification:  beta is exactly identified
                 Johansen normalization restrictions imposed
```

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
linvestment	1	.	.	.	.	.
lconsumption	0	(omitted)				
lincome	-.863381	.0468879	-18.41	0.000	-.9552796	-.7714825
_cons	.034525	.	.	.	.	.
_ce2						
linvestment	8.67e-19	.	.	.	.	.
lconsumption	1	.	.	.	.	.
lincome	-.9670451	.0045147	-214.20	0.000	-.9758938	-.9581964
_cons	-.1447284	.	.	.	.	.

Why Cointegrating VAR

- -vec- command: Theoretical long-run relationship

```
.   constraint define 1 [_ce1]linvest =1
.   constraint define 2 [_ce1]lincome =-.75
.   constraint define 3 [_ce2]lconsumption=1
.   constraint define 4 [_ce2]lincome =-.9
.   vec linvest lconsumption lincome, lags(4) rank(2) noetable ///
>               bconstraints(1/4) nolog nocnsreport
```

```
Vector error-correction model
Sample:  1961q1 - 1982q4                        No. of obs      =        88
Identification:  beta is exactly identified
```

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
linvestment	1	.	.	.	.	.
lconsumption	-.1172448	.0480998	-2.44	0.015	-.2115187	-.022971
lincome	-.75	.	.	.	.	.
_cons	.0514938	.	.	.	.	.
_ce2						
linvestment	-.0776541	.0068539	-11.33	0.000	-.0910876	-.0642206
lconsumption	1	.	.	.	.	.
lincome	-.9	.	.	.	.	.
_cons	-.1474094	.	.	.	.	.

Why Cointegrating VAR

```
. vec linvest lconsumption lincome, ...
```

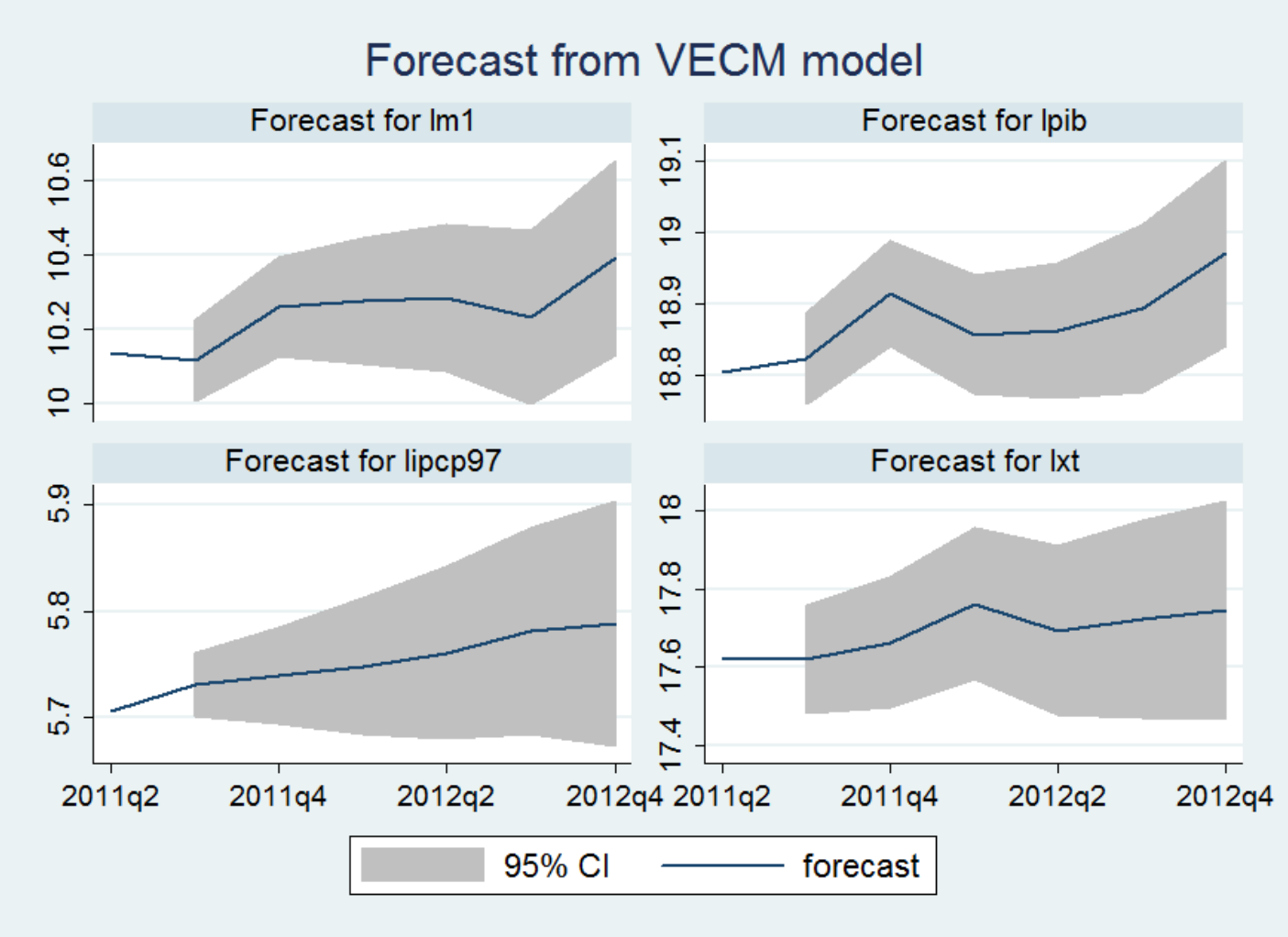
*** Output Omitted ***

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_linvestment						
_ce1						
L1.	-.1040128	.0790621	-1.32	0.188	-.2589717	.0509461
_ce2						
L1.	.6979509	.4424682	1.58	0.115	-.169271	1.565173
linvestment						
LD.	-.2246769	.1290886	-1.74	0.082	-.4776859	.028332
L2D.	-.1279608	.1286637	-0.99	0.320	-.3801371	.1242155
L3D.	.0304474	.126218	0.24	0.809	-.2169353	.2778301
lconsumption						
LD.	.0546931	.6438309	0.08	0.932	-1.207192	1.316578
L2D.	.3857924	.6440095	0.60	0.549	-.8764429	1.648028
L3D.	-.0152393	.5789952	-0.03	0.979	-1.150049	1.11957
lincome						
LD.	1.059818	.6446678	1.64	0.100	-.2037081	2.323343
L2D.	.7647925	.5900074	1.30	0.195	-.3916007	1.921186
L3D.	.7128608	.5460636	1.31	0.192	-.3574042	1.783126
_cons	.0007756	.0211156	0.04	0.971	-.0406103	.0421615

*** Output Omitted ***

Why Probability Forecasting

- Uncertainty expressed in terms of confidence intervals



Why Probability Forecasting

- Uncertainty expressed in terms of simulations for single and composed events
- Probability for single or joint events, conditional on the information contained in the estimation sample.

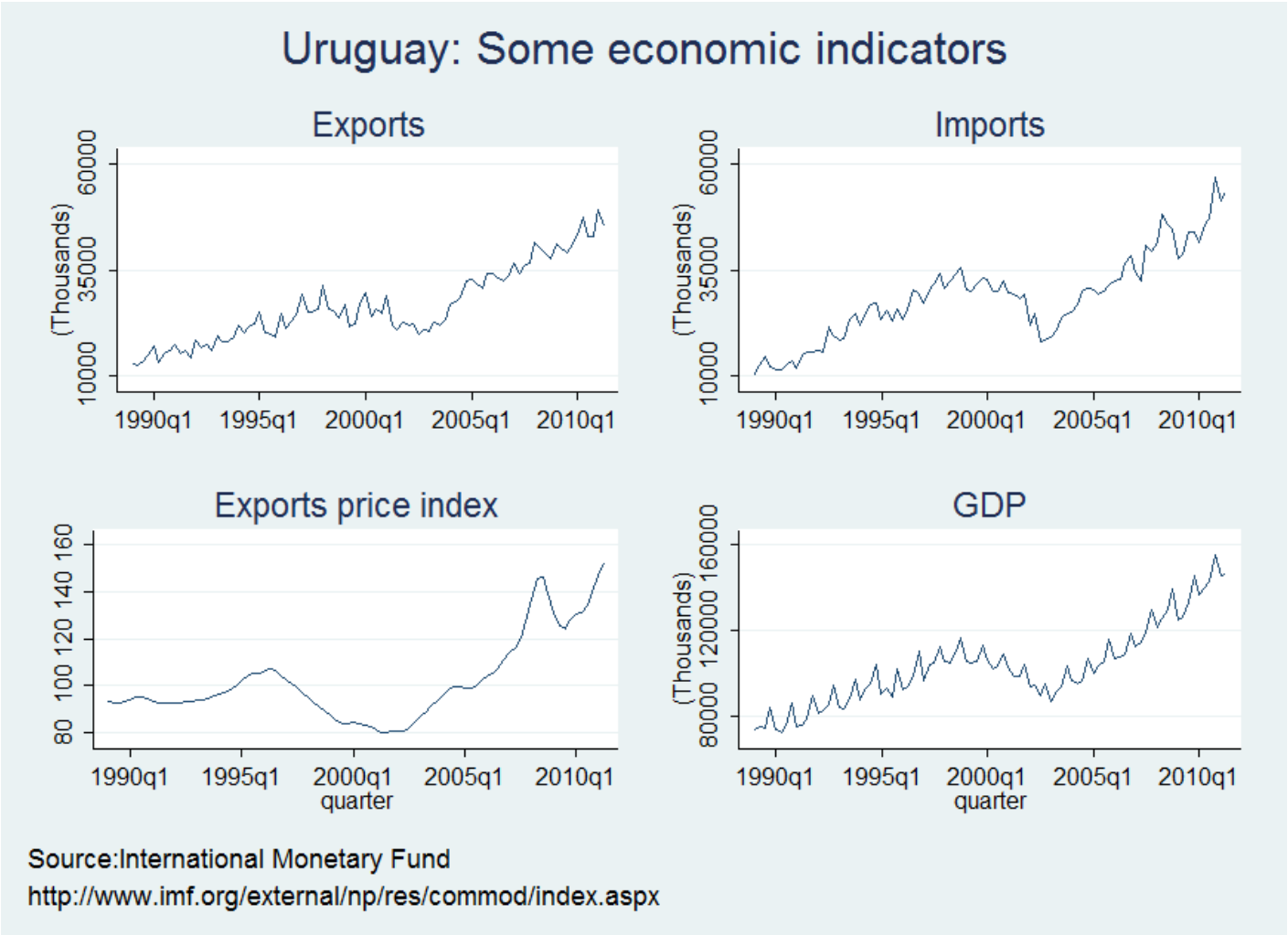
Scenarios for Inflation and change in GDP

Event			Year	Proportion	Std. Err.
Inflation < 8.8			2011	.49	.05024184
GDP change > 7.5			2011	.06	.02386833
Inflation > 4	&	Inflation < 9	2012	.11	.0314466
Inflation < 7.8	&	GDP change > 5.9	2012	.36	.04824182

Case Study: Uruguay

Case study: Uruguay

- Small open economy with soy, livestock, leather, and rice as the main export products.
- International prices, climate and economic performance of main trade partners represent some of the major sources of fluctuation for the Uruguayan exports.
- Imports are mainly affected by the country's economic activity and the appreciation of the domestic currency (peso).



Source:International Monetary Fund
http://www.imf.org/external/np/res/commod/index.aspx

VEC Model

Variables in the cointegrating VAR

- m1 : Currency and demand deposits
- pib : Gross domestic product (GDP)
- tipp906bn : Interest rate.
- tcpn : Exchange rate.
- ipcp97 : Consumer price index (1997 = 100):
- mt : Imports
- xt : Exports
- ipex : Exports price index.

Long-run cointegrating relationships

$$\texttt{\_ce1:} \quad \texttt{lm1} = \beta_{11} \times \texttt{lpib} + \beta_{12} \times \texttt{ltipp906bn} + \beta_{10}$$

$$\texttt{\_ce2:} \quad \texttt{lmt} = \beta_{21} \times \texttt{lpib} + \beta_{22} \times \texttt{ltcpn} + \beta_{20}$$

$$\texttt{\_ce3:} \quad \texttt{lxt} = \beta_{31} \times \texttt{lipcp97} + \beta_{32} \times \texttt{ltcpn} + \beta_{33} \times \texttt{lipex} + \beta_{30}$$

Long-run adjustment restrictions

$$\texttt{[D\_lipex]}\alpha_{\texttt{\_ce1}} = 0$$

$$\texttt{[D\_lipex]}\alpha_{\texttt{\_ce2}} = 0$$

$$\texttt{[D\_lipex]}\alpha_{\texttt{\_ce3}} = 0$$

```
** Restrictions on long-run cointegrating equations (bconstraints) **

        * Restriction on long run equation for lm1 *
                constraint 1 [_ce1]lm1=1
                constraint 2 [_ce1]lipcp97=0
                constraint 3 [_ce1]ltcpn=0
                constraint 4 [_ce1]lmt=0
                constraint 5 [_ce1]lxt=0
                constraint 6 [_ce1]lipex=0

        * Restrictions on long run equation for lmt *
                constraint  7 [_ce2]lm1=0
                constraint  8 [_ce2]ltipp906bn=0
                constraint  9 [_ce2]lipcp97=0
                constraint 10 [_ce2]lmt=1
                constraint 11 [_ce2]lxt=0
                constraint 12 [_ce2]lipex=0

        * Restrictions on  long run equation for lxt *
                constraint 13 [_ce3]lm1=0
                constraint 14 [_ce3]lpib=0
                constraint 15 [_ce3]ltipp906bn=0
                constraint 16 [_ce3]lmt=0
                constraint 17 [_ce3]lxt=1
```

```
* Restrictions on long-run adjustment coefficients (aconstraints) *

        constraint 18 [D_lipex]l._ce1=0
        constraint 19 [D_lipex]l._ce2=0
        constraint 20 [D_lipex]l._ce3=0


*** VEC model specification ***

        vec lm1 lpib ltipp906bn lipcp97 ltcpn lmt lxt lipex, ///
             bconstraints(1/17)                               ///
             aconstraints(18/20)                              ///
             lags(4) rank(3) noetable                         ///
             ltolerance(1e-7) tolerance(1e-4)
```

Cointegrating Equations

Sample: 1990q1 - 2011q2 — No. of obs = 86
AIC = -27.58711
Log likelihood = 1414.246 — HQIC = -24.96839
Det(Sigma_ml) = 7.19e-25 — SBIC = -21.08023

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	2	170.89	0.0000
_ce2	2	115.2276	0.0000
_ce3	3	111.1596	0.0000

Identification: beta is overidentified

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
lm1	1	.	.	.	.	.
lpib	-2.388095	.2667403	-8.95	0.000	-2.910897	-1.865294
ltipp906bn	.2394962	.0401545	5.96	0.000	.1607948	.3181976
lipcp97	0	(omitted)				
ltcpn	0	(omitted)				
lmt	0	(omitted)				
lxt	0	(omitted)				
lipex	0	(omitted)				
_cons	34.28762	.	.	.	.	.

Cointegrating Equations

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce2						
lm1	0	(omitted)				
lpib	-1.190284	.1176426	-10.12	0.000	-1.420859	-.9597084
ltipp906bn	0	(omitted)				
lipcp97	0	(omitted)				
ltcpn	.1906142	.0365307	5.22	0.000	.1190154	.262213
lmt	1	.	.	.	.	.
lxt	0	(omitted)				
lipex	0	(omitted)				
_cons	4.087814	.	.	.	.	.
_ce3						
lm1	0	(omitted)				
lpib	0	(omitted)				
ltipp906bn	0	(omitted)				
lipcp97	268.7157	28.66662	9.37	0.000	212.5301	324.9012
ltcpn	-130.17	27.2982	-4.77	0.000	-183.6735	-76.66648
lmt	0	(omitted)				
lxt	1	.	.	.	.	.
lipex	-337.4693	45.183	-7.47	0.000	-426.0264	-248.9123
_cons	470.4702	.	.	.	.	.

Probability Forecasting

Probability Forecasting

- This methodology can be applied to a wide spectrum of models. Our focus here is on the predictions from a cointegrating VAR model.
- In general, forecasting based on econometric models are subject to:
  - **Future uncertainty**
  - Parameters uncertainty
  - Model uncertainty
  - Measure and policy uncertainty

Probability Forecasting

- Simulation
  - Generate dynamic predictions (from Cointegrating VAR) for the forecasting period.
  - Replications
    - Draw sample of transformed residuals and add them to point dynamic forecasts.
- Define events and obtain proportions with simulated dynamic predictions.

Case study: Uruguay

- Scenarios for Export Prices

Interannual Change in Exports Prices

	Scenario	
Quarter	Inertial	Moderate Impact
2011Q3	17.26	16.40
2011Q4	13.63	9.90
2012Q1	10.28	2.70
2012Q2	7.44	-2.00
2012Q3	6.04	-3.60
2012Q4	7.41	-2.40

Case study: Uruguay

- Probability forecasting for GDP

Scenarios for Change in GDP

Event	Year	Proportion	Std. Err.
Change in GDP < 6	2011	.72	.04512609
Change in GDP > 7.5	2011	.06	.02386833
Change in GDP > 5.5 and < 7.5	2011	.33	.04725816
Change in GDP < 4.2	2012	.41	.04943111
Change in GDP > 5.9	2012	.33	.04725816
Change in GDP > 4.2 and < 5.9	2012	.26	.0440844

References

- Garratt, A., Lee, K., M.H. Pesaran and Y. Shin (2006), "Global and National Macroeconometric Modeling: A long-run structural approach" Oxford University Press, Oxford.
- Johansen, S. (1988) 'Statistical analysis of cointegration vectors' Journal of Economic Dynamics and Control, 12, 231-254.
- International Monetary Fund: http://www.imf.org/external/np/res/commod/index.aspx

Questions - Comments