In this book we present papers in applied economics.These papers were written by Dushko Josheski, Darko Lazarov and also as participants are listed Cane Koteski and Risto Fotov.These papers are part of our efforts as researchers to investigate Applied economics themes. All five papers contain research in applied economics,themes such as causality between wages and prices, unemployment and labour markets, Rogofs theory for Macedonia,Institutions and economic growth etc.

Dushko Josheski

Dushko Joseski was born on 29 August 1983 in Bitola.Dushko is Msc in Economics for business Analysis at Staffordshire University, UK(2008). Since September 2009 he is working at Goce Delcev University.Dushko received the first prize in the Annual Competition for Young Researchers in the field of macroeconomics organized by NBRM 2009.

978-3-8484-3237-0

Writings in Applied Economics

Dushko Josheski, D. Lazarov

Dushko Josheski
Darko Lazarov

Writings in Applied Economics - Part I

LAP LAMBERT Academic Publishing

Dushko Josheski
Darko Lazarov

Writings in Applied Economics - Part I

Dushko Josheski
Darko Lazarov

Writings in Applied Economics - Part I

LAP LAMBERT Academic Publishing

Impressum/Imprint (nur für Deutschland/only for Germany)
Bibliografische Information der Deutschen Nationalbibliothek: Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.d-nb.de abrufbar.

Coverbild: www.ingimage.com

Verlag: LAP LAMBERT Academic Publishing GmbH & Co. KG
Heinrich-Böcking-Str. 6-8, 66121 Saarbrücken, Deutschland
Telefon +49 681 3720-310, Telefax +49 681 3720-3109
Email: info@lap-publishing.com

Herstellung in Deutschland:
Schaltungsdienst Lange o.H.G., Berlin
Books on Demand GmbH, Norderstedt
Reha GmbH, Saarbrücken
Amazon Distribution GmbH, Leipzig
ISBN: 978-3-8484-3237-0

Imprint (only for USA, GB)
Bibliographic information published by the Deutsche Nationalbibliothek: The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

Cover image: www.ingimage.com

Publisher: LAP LAMBERT Academic Publishing GmbH & Co. KG
Heinrich-Böcking-Str. 6-8, 66121 Saarbrücken, Germany
Phone +49 681 3720-310, Fax +49 681 3720-3109
Email: info@lap-publishing.com

Printed in the U.S.A.
Printed in the U.K. by (see last page)
ISBN: 978-3-8484-3237-0

Writings in Applied Economics

Authors: Dushko Josheski and Darko Lazarov

Goce Delcev University-Stip
Macedonia

Table of contents page

Introduction

In this book we present papers in applied economics.These papers were written by Dushko Josheski, Darko Lazarov and also as participants are listed Cane Koteski and Risto Fotov.

Causal relationship between wages and prices in UK: VECM analysis and Granger causality testing

Dushko Josheski (dushkojosheski@gmail.com)
Risto Fotov (risto.fotov@ugd.edu.mk)
Darko Lazarov(darko.lazarov@ugd.edu.mk)
Cane Koteski (cane.koteski@ugd.edu.mk)

Abstract

In this paper the issue of causality between wages and prices in UK has been tested. OLS relationship between prices and wages is positive; productivity is not significant in determination of prices or wages too. These variables from these statistics we can see that are stationary at 1 lag, i.e. they are I(1) variables, except for CPI variables which is I(2) variable. From the VECM model, If the log wages increases by 1%, it is expected that the log of prices would increase by 5.24 percent. In other words, a 1 percent increase in the wages would induce a 5.24 percent increase in the prices.About the short run parameters, the estimators of parameters associated with lagged differences of variables may be interpreted in the usual way.Productivity was exogenous repressor and it is deleted since it has coefficient no different than zero. The relation (causation) between these two variables is from CPI_log→ real_wage_log .Granger causality test showed that only real wages influence CPI or consumer price index that proxies prices, this is one way relationship, price do not influence wages in our model.

Keywords: VECM, Granger causality, real wages, prices, cointegration , OLS

Introduction

In the literature from this area there two sides of economist one that thinks that causality runs from wages to prices and the second that thinks that causality runs from wages to prizes. The evidence in the literature has evidence in support to both hypotheses. Granger causality test is easy to be applied in economics.OLS techniques have been applied to data, and to estimate the long run relationship we apply VECM analysis.

Theoretical overview

In this theoretical review some basic concepts in the theory of wages and prices are outlined, to explain in some extent: what are determinants of wages and prices from neo-classical and neo-keynesian perspective.

The Issue of Time Consistency

New Classical Analysis makes a distinction between anticipated and unanticipated changes in money supply.There exists superiority of fixed policy rules, low inflation requires monetary authorities to commit themselves to low-inflation policy. Government cannot credibly commit to low inflation policy if retain the right to conduct discretionary policy (Kydland,Prescott,1977). The model of optimal policy is as follows:

Let $\pi = (\pi_1, \pi_2, \ldots \pi_T)$ be a sequence of policies for periods 1 to T and

$x = (x_1, x_2 \ldots x_T)$ be the corresponding sequence of economic agents' decisions.

Assume an agreed social welfare function:

$S(x_1, x_2 \ldots x_T, \pi_1, \pi_2, \ldots \pi_T)$ (1)

And that agents' decisions in period t depend on all policy decisions and their own past decisions:

$x_t = X_t(x_1, x_2 \ldots x_{t-1}, \pi_1, \pi_2, \ldots \pi_T)$ (2)

An optimal policy is one which maximises (1) subject to (2).The issue of time consistency is: A policy π is time consistent if for each t, π_t maximises (1) taking as given previous economic agents' decisions and that future policy decisions are taken similarly.Optimal policies are time inconsistent

- therefore lack credibility
- discretionary policies lead to inferior outcomes
- need credible pre-commitment

Consider a two period model in which π_2 is selected to maximise:

$S(x_1, x_2, \pi_1, \pi_2)$ (3)

subject to:

- $x_1 = X_1(\pi_1, \pi_2)$ and
- $x_2 = X_2(x_1, \pi_1, \pi_2)$ (4)

For the policy to be time consistent π_2 must maximise (3), given x_1 and π_1 and given constraint (4). Now we are going to eliminate inflatory bias:Low inflation rule not credible if government retains discretionary powers

- need to gain a reputation for maintaining a low inflation policy mix
  - benefits from cheating < punishment costs
- or need to pre-commit to a low inflation policy goal
  - central bank independence, 'golden rule' for fiscal policy
  - but danger of democratic deficit?

Sources of price rigidity

New Keynesians suggest that small nominal price rigidities may have large macro effects

- incomplete indexing of prices in imperfectly competitive goods, labour and financial markets may be costly in terms of output instability

In goods market small 'menu costs' + unsynchronised price adjustments lead to staggered price adjustments

- fear that rapid price adjustments costly in decision-making time and cause excessive loss of existing customers

Sources of wage rigidity

Efficiency wages

Economy of high wages – productivity and non-wage labour costs may be endogenous in the wage-fixing process, even given excess supply of labour firms may not lower wages because their unit labour costs may rise → persistent unemployment.This repeals law of supply and demand, if the relationship between wages and productivity/non-wage costs varies across industry repeals law of one price. Version of efficiency wage model is:

A representative firm seeks to maximise its profits:

$\pi = Y - wL$ (1)

where Y firm's output and wL its wage costs and:

$Y = F(eL) \quad F'>0 , F''<0$ (2)

where e is workers' effort and:

$e = e(w) \quad e'>0$ (3)

there are L^o identical workers who each supply 1 unit of labour inelastically

The problem of the firm is to:

$\max_{Lw} F(e(w)L - wL$ (4)

when there is unemployment the first order conditions for L and w are:

$F'(e(w)L)e(w) - w = 0 \qquad (5)$

$F'(e(w)L)Le'(w) - L = 0 \qquad (6)$

rewriting (5) gives:

$F'(e(w)L) = w / e(w) \qquad (7)$

substituting (7) into (5) gives:

$we'(w) / e(w) = 1 \qquad (8)$

From (8) at the optimum, the elasticity of effort with respect to wage is 1, i.e. the efficiency wage (w^*) is that which satisfies (8) and minimises the cost of effective labour

With N firms each hiring L* (the solution to (7), then total employment is NL* and as long as $NL^* < L^+$ we observe an efficiency wage (w^*) and unemployment

Literature overview

Empirical facts on the price, wage and productivity relationship - The debate on the direction of causality between wages and prices is one of the central questions surrounding the literature on the determinants of inflation. The purpose of this review is to identify the key theories, concepts or ideas explaining the causality issue between prices and wages.We selected ten studies as to see what method they use in explanation of this relationship, most of the studies use panel methods but some use VECM model just like ours too.

A summary of some studies on the price, wage and productivity relationship

Studies	Title	Method
Strauss, Wohar (2004)	**The Linkage Between Prices, Wages, and Labor Productivity: A Panel Study of Manufacturing Industries**	panel unit root and panel cointegration procedures
Saten Kumar, Don J. Webber and Geoff Perry (2008)	**Real wages, inflation and labour productivity in Australia**	Cointegration; Granger causality
Dubravko Mihaljek and Sweta Saxena	**Wages, productivity and "structural" inflation in emerging market economies**	Empirical methods ,correlations

Erica L. Groshen Mark E. Schweitzer (1997)	**The Effects of Inflation on Wage Adjustments in Firm-Level Data: Grease or Sand?**	40-year panel of wage changes
Kawasaki, Hoeller, Poret, 1997	**Modeling wages and prices for smaller OECD countries**	Error correction mechanism
Peter Flaschel, GÄoran Kauermann, Willi Semmler (2005)	**Testing Wage and Price Phillips Curves for the United States**	parametric and non-parametric estimation.
SHIK HEO(2003)	**THE RELATIONSHIP BETWEEN EFFICIENCY WAGES AND PRICE INDEXATION IN A NOMINAL WAGE CONTRACTING MODEL**	simple nominal wage contracting model
John B. Taylor(1998)	**STAGGERED PRICE AND WAGE SETTING IN MACROECONOMICS**	time-dependent pricing, staggered price and wage setting
Gregory D. Hess and Mark E. Schweitzer	**Does Wage Inflation Cause Price Inflation?**	Granger Causality , panel econometrics
Raymond Robertson(2001)	**Relative Prices and Wage Inequality: Evidence from Mexico**	Ordered Logit Ordered Probit

This table shows that there exist theoretical and empirical models for prices and wages .This si a small sample of ten studies that study the relationship between wages, prices and productivity.

Data and the methodology

We use time series data here for UK industry. Three variables are selected for the model. **LRW** is the log of real wage. This variable represents Real Hourly Compensation in Manufacturing, CPI Basis, in the United Kingdom. The data are from 1960 to 2009 although in our regressions we use data only from 1960 to 2007, because from 2008 financial crisis started which in terms of econometrics represents a huge structural break. This variable is indexed and as base is chosen 2002=100. Second variable is **LCPI** which represents logarithm of consumer price index in UK for all items from 1960 to 2009, we use 1960-2007, and it is indexed 2005=100. **LPROD** is logarithm of productivity for UK manufacturing industry**,** this variable was calculated on a basis of average working hours in manufacturing industry and total output of manufactured goods, second variable was divided by first, and then logarithms were put. OLS and time series methods like VECM and co-integration are going to be applied for this series of data.

OLS regressions

I model: Price as a function of wages and productivity

$$CPI = f(RW, PRODUCTIVITY)$$

II model: Wage is function of price and productivity.

$$RW = f(CPI, PRODUCTIVITY)$$

This functional form is being applied on our data.

Ordinary least squares regressions are presented in the next page[1]:

[1] For detailed output see Appendix 1 OLS regressions

Variables	$CPI = f(RW, PRODUCTIVITY)$			$RW = f(CPI, PRODUCTIVITY)$	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
log	LRW	0.42**	**log**	LCPI	0.21**
	LPROD	-0.017		LPROD	0.06
	CONST	5.81***		CONST	3.33***
	AC test	0.001***		AC test	0.794***
	Ramsey test	0.019*		Ramsey test	0.178***
Δlog	ΔLRW	0.15	**Δlog**	ΔLCPI	0.17
	ΔLPROD	-0.0051		ΔLPROD	0.038
	CONST	0.053		CONST	0.017
	AC test	0.000		AC test	0.000
	Ramsey test	0.943***		Ramsey test	0.943***

***Note 1*:** *** - significant at 1% level of significance; ** - significant at 5% level of significance; * - significant at 10% level of significance. The AC tests indicate the p-value of the Breusch-Godfrey LM test for autocorrelation with H_0: no serial correlation and H_a: H_0 is not true

Here OLS relationship between prices and wages is positive, also and between productivity and prices and productivity and wages except for the fact that these relationships are not significant. These models in column 1 can be represented in a form:

$\hat{lcpi} = \beta_1 lrw + \beta_2 lprod + \beta_0$, where β_0 is intercept, β_1 and β_2 are elasticities that measure elasticity of wages to prices and productivity to prices respectively. Second model in this column is: $\Delta \hat{lcpi} = \beta_1 \Delta lrw + \beta_2 \Delta lprod + \beta_0$, this is the case of first differences of the variables.

Autocorrelation in the models from column I is a serious problem, OLS time series do suffer from serial correlation. Functional form significant at all conventional levels of significance. Finally the estimated coefficients on wages to prices (and vice versa) are positive. This notion is not confirmed with Granger causality test, except for the case that Log of real wages causes LCPI at 5% level of significance.[2]

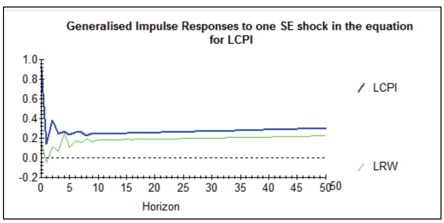
[2] See Appendix 2 Granger causality test

	Log-levels	First-differences
NON-CAUSAL VARIABLES	LR stat	LR stata
LCPI	0.316	0.801
LRW	0.049**	0.133

Note 1: *** - significant at 1% level of significance; ** - significant at 5% level of significance; * - significant at 10% level of significance.

Impulse response graph

On the next graph is given impulse Response for a shock of variables, prices and wages.



Unit root tests[3]

Unit root tests statistics are given in a Table below

Variables tested for unit roots	Test statistic	Decision
real_wage_log	-1.4627	Series is non-stationary
real_wage_log_d1	-3.5693**	Series is stationary
CPI_log	-1.1164	Series is non-stationary
CPI_log_d1	-2.3459	Series is non-stationary
CPI_log_d1_d1_d1	-7.0234***	Series is stationary

Critical values for the test at	1%	5%	10%
	-3.96	-3.41	-3.13

Note 1: *** - significant at 1% level of significance; ** - significant at 5% level of significance; * - significant at 10% level of significance.

[3] See Appendix 3 Unit root tests

These variables from these statistics we can see that are stationary at 1 lag, i.e. they are I(1) variables, except for CPI variables which is I(2) variable. These variables are graphically presented as non-stationary and their differences as stationary in the unit root section Appendix 3.

Johansen Trace test (co-integration test)[4]

Whereas the Akaike Information Criterion (AIC) tends to overestimate the optimal lag order, the Hannan–Quinn information criterion (HQ) provides the most consistent estimates, thus it will be considered as the most reliable criterion.

Cointegration rank

On the next table is summarized the decision fro with how many lags to continue testing.

Variables	Deterministic trend	Johansen trace test		
CPI_log and Real_wage_log		Lag order	LR-stat	p-value
	Constant	1	2.65	0.6540
	Constant and a trend	1	4.97	0.6072

We reject the null for zero lags and we cannot reject the r=1, so we will accept 1 cointegrating vector.

Estimated cointegrating vector

Next we are going to present the estimation for cointegrating vector. This estimation does not include intercepts and does not include trends.

[4] See Appendix 4 test for cointegration

Chosen order =1
44 observations from 1964 to 2007

	Vector 1
LRW	.24600
	(-1.0000)
LCPI	-.18411
	(.74839)

List of variables included in the cointegrating vector:
LRW LCPI

These vectors are normalized in brackets.

Estimated long run coefficient using ARDL approach

Long run coefficient between logarithm of real wages and logarithm of prizes is positive and statistically significant.

Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,0) selected based on Schwarz Bayesian Criterion
Dependent variable is LRW
44 observations used for estimation from 1964 to 2007

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LCPI	.74158	.030294	24.4796[.000]

VECM model

VECM model is presented in the matrix form below

Coefficient matrix

$$\begin{bmatrix} d(CPI\_\log)(t) \\ d(real\_wage\_\log)(t) \end{bmatrix} = \begin{bmatrix} -0.105 \\ -0.031 \end{bmatrix} \left[\begin{bmatrix} 1.000 & -5.246 \end{bmatrix} \begin{bmatrix} CPI(\log(t-1) \\ real\_wage\log(t-1) \end{bmatrix} + \begin{bmatrix} 15.325 \end{bmatrix} \begin{bmatrix} CONST \end{bmatrix} \right] + \begin{bmatrix} -0.010 \\ -0.003 \end{bmatrix} \begin{bmatrix} TREND(t) \end{bmatrix} + \begin{bmatrix} u1(t) \\ u2(t) \end{bmatrix}$$

VECM output consists of coefficients. **Estimation** - The VECM model was estimated using the *Two Stage procedure (S2S)*, with *Johansen procedure* being used in the first stage and Feasible Generalized Least Squares (*FGLS) procedure* being used in the second stage. The

Loading coefficients-even though they may be considered as arbitrary to some extent due to the fact that they are determined by normalization of co-integrating vectors, their t ratios may be interpreted in the usual way as being conditional on the estimated co-integration coefficients, (Lütkhepohl and Krätzig, 2004; Lütkhepohl and Krätzig, 2005,).In our case loading coefficients have t-ratios [-12.616] [-3.907] respectively. Thus, based on the presented evidence, it can be argued that co-integration relation resulting from normalization of cointegrating vector enters significantly.Table of t-stat matrix is given below.

t-stat matrix

$$\begin{bmatrix} d(CPI\_\log)(t) \\ d(real\_wage\_\log)(t) \end{bmatrix} = \begin{bmatrix} -12.616 \\ -3.907 \end{bmatrix} \left[[\ldots \quad -10.401] \begin{bmatrix} CPI(\log(t-1) \\ real\_wage\log(t-1) \end{bmatrix} + [8.779] \quad [CONST] \right]$$
$$+ \begin{bmatrix} -10.933 \\ -3.068 \end{bmatrix} [TREND(t)] + \begin{bmatrix} u1(t) \\ u2(t) \end{bmatrix}$$

Co-integration vectors –The model we can arrange as follows

$$ec^{fgls} = CPI\_\log - 5.246 real\_wage\_\log$$

(-10.401)

If we rearrange

$$CPI\_\log = 5.246 real\_wage\_\log + ec^{fgls}$$

(-10.401)

If the log wages increases by 1%, it is expected that the log of prices would increase by 5.24 percent. In other words, a 1 percent increase in the log wages would induce a 5.24 percent increase in the log of prices.

Short-run parameters - The estimators of parameters associated with lagged differences of variables may be interpreted in the usual way.Productivity was exogenous regressor and it is deleted since it has coefficient no different than zero.

Deterministic Terms –Trend term has statistically significant though very small impact in the two equations.

Conclusion

In our paper we made several conclusions about the relationship between prices and wages. First there exist positive and significant relationship between the two variables and causation is from real wages to CPI. As our Vector Error correction model (VECM) showed on average 1% increase in log of real wages induces by 5.3% increase in CPI for all items in UK, i.e. this means that increase in wages causes inflation in UK, this notion was confirmed with the Granger causality test. The relation (causation) between these two variables is from CPI_log→ real_wage_log .

Appendix 1 OLS regressions

```
  Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LRW
 48 observations used for estimation from 1960 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                          3.3245            1.0646              3.1228[.003]
 LCPI                       .20940            .10131              2.0670[.045]
 LPROD                     .055376           .036035              1.5367[.131]
*******************************************************************************
 R-Squared                     .13049   R-Bar-Squared                  .091842
 S.E. of Regression            .87654   F-stat.    F(  2,  45)    3.3766[.043]
 Mean of Dependent Variable    6.0656   S.D. of Dependent Variable      .91980
 Residual Sum of Squares      34.5748   Equation Log-likelihood       -60.2352
 Akaike Info. Criterion      -63.2352   Schwarz Bayesian Criterion    -66.0420
 DW-statistic                  2.0656
*******************************************************************************


                               Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   1)=  .068405[.794]*F(   1,  44)=  .062794[.803]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   1.8114[.178]*F(   1,  44)=   1.7256[.196]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=  21.5106[.000]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=  .066142[.797]*F(   1,  46)=  .063473[.802]*
*                     *                          *                            *
* E:Predictive Failure*CHSQ(   2)=   .72414[.696]*F(   2,  45)=   .36207[.698]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
   E:A test of adequacy of predictions (Chow's second test)


Test for autocorrelation

  Test of Serial Correlation of Residuals (OLS case)
*******************************************************************************
 Dependent variable is LRW
 List of variables in OLS regression:
 C               LCPI            LPROD
 48 observations used for estimation from 1960 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 OLS RES(- 1)             -.038067            .15191             -.25059[.803]
*******************************************************************************
 Lagrange Multiplier Statistic    CHSQ( 1)=  .068405[.794]
 F Statistic                   F(  1,  44)=  .062794[.803]
*******************************************************************************
```

```
    Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is LCPI
 48 observations used for estimation from 1960 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                          5.8088            1.4061              4.1311[.000]
 LRW                        .41409            .20033              2.0670[.045]
 LPROD                    -.016950           .051925             -.32643[.746]
*******************************************************************************
 R-Squared                     .087020   R-Bar-Squared                   .046443
 S.E. of Regression             1.2326   F-stat.    F(  2,  45)    2.1446[.129]
 Mean of Dependent Variable     7.9939   S.D. of Dependent Variable       1.2623
 Residual Sum of Squares       68.3711   Equation Log-likelihood        -76.5990
 Akaike Info. Criterion       -79.5990   Schwarz Bayesian Criterion     -82.4058
 DW-statistic                   .99136
*******************************************************************************
```

```
                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   1)=  11.9751[.001]*F(   1,  44)=  14.6262[.000]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   5.5049[.019]*F(   1,  44)=   5.6998[.021]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=  12.6934[.002]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=   .98073[.322]*F(   1,  46)=   .95947[.332]*
*                     *                          *                            *
* E:Predictive Failure*CHSQ(   2)=   1.1090[.574]*F(   2,  45)=   .55449[.578]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
   E:A test of adequacy of predictions (Chow's second test)
```

Test for autocorrelation

```
Test of Serial Correlation of Residuals (OLS case)
*******************************************************************************
 Dependent variable is LCPI
 List of variables in OLS regression:
 C               LRW              LPROD
 48 observations used for estimation from 1960 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 OLS RES(- 1)               .51226            .13395              3.8244[.000]
*******************************************************************************
 Lagrange Multiplier Statistic    CHSQ( 1)=  11.9751[.001]
 F Statistic                   F(  1,  44)=  14.6262[.000]
*******************************************************************************
```

o

```
  Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is DLRW
 47 observations used for estimation from 1961 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                         .016183            .18532             .087324[.931]
 DLCPI                      .16411            .15873              1.0340[.307]
 DLPROD                    .037112           .035729              1.0387[.305]
*******************************************************************************
 R-Squared                    .046583   R-Bar-Squared                  .0032454
 S.E. of Regression            1.2690   F-stat.    F(  2,  44)    1.0749[.350]
 Mean of Dependent Variable   .026783   S.D. of Dependent Variable       1.2711
 Residual Sum of Squares      70.8578   Equation Log-likelihood        -76.3375
 Akaike Info. Criterion      -79.3375   Schwarz Bayesian Criterion     -82.1127
 DW-statistic                  2.9188
*******************************************************************************


                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   1)=  10.4302[.001]*F(   1,  43)=  12.2642[.001]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   .86120[.353]*F(   1,  43)=   .80261[.375]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=   .16722[.920]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=   .39955[.527]*F(   1,  45)=   .38583[.538]*
*                     *                          *                            *
* E:Predictive Failure*CHSQ(   2)= .0011216[1.00]*F(   2,  44)= .5608E-3[1.00]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
   E:A test of adequacy of predictions (Chow's second test)

Test for autocorrelation
Test of Serial Correlation of Residuals (OLS case)
*******************************************************************************
 Dependent variable is DLRW
 List of variables in OLS regression:
 C                DLCPI            DLPROD
 47 observations used for estimation from 1961 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 OLS RES(- 1)              -.48305            .13793             -3.5020[.001]
*******************************************************************************
 Lagrange Multiplier Statistic    CHSQ( 1)=  10.4302[.001]
 F Statistic                   F(  1,  43)=  12.2642[.001]
*******************************************************************************
```

```
                      Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is DLCPI
 47 observations used for estimation from 1961 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                         .052526            .17375              .30230[.764]
 DLRW                       .14454            .13979              1.0340[.307]
 DLPROD                  -.0051790           .033930             -.15264[.879]
*******************************************************************************
 R-Squared                    .023721   R-Bar-Squared                  -.020655
 S.E. of Regression            1.1909   F-stat.    F(  2,  44)    .53455[.590]
 Mean of Dependent Variable   .056205   S.D. of Dependent Variable       1.1788
 Residual Sum of Squares      62.4047   Equation Log-likelihood        -73.3522
 Akaike Info. Criterion      -76.3522   Schwarz Bayesian Criterion     -79.1274
 DW-statistic                  3.0912
*******************************************************************************


                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   1)=  14.1529[.000]*F(   1,  43)=  18.5274[.000]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)= .0050795[.943]*F(   1,  43)= .0046477[.946]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)= 156.5101[.000]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=   .37556[.540]*F(   1,  45)=   .36248[.550]*
*                     *                          *                            *
* E:Predictive Failure*CHSQ(   2)= .0010102[1.00]*F(   2,  44)= .5051E-3[1.00]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
   E:A test of adequacy of predictions (Chow's second test)

Test of Serial Correlation of Residuals (OLS case)
*******************************************************************************
 Dependent variable is DLCPI
 List of variables in OLS regression:
 C               DLRW            DLPROD
 47 observations used for estimation from 1961 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 OLS RES(- 1)             -.55190            .12822             -4.3043[.000]
*******************************************************************************
 Lagrange Multiplier Statistic    CHSQ( 1)=  14.1529[.000]
 F Statistic                   F(  1,  43)=  18.5274[.000]
*******************************************************************************
```

Appendix 2 Granger causality test

```
Granger causality
LR Test of Block Granger Non-Causality in the VAR
******************************************************************************
 Based on 46 observations from 1964 to 2009. Order of VAR = 4
 List of variables included in the unrestricted VAR:
 LCPI            LRW
 Maximized value of log-likelihood = -117.7206
******************************************************************************
 List of variable(s) assumed to be "non-causal" under the null hypothesis:
 LCPI
 Maximized value of log-likelihood = -120.0863
******************************************************************************
 LR test of block non-causality, CHSQ(  4)=   4.7314[.316]
******************************************************************************
 The above statistic is for testing the null hypothesis that the coefficients
 of the lagged values of:
 LCPI
 in the block of equations explaining the variable(s):
 LRW
 are zero. The maximum order of the lag(s) is 4.
******************************************************************************
```

```
LR Test of Block Granger Non-Causality in the VAR
******************************************************************************
 Based on 46 observations from 1964 to 2009. Order of VAR = 4
 List of variables included in the unrestricted VAR:
 LCPI            LRW
 Maximized value of log-likelihood = -117.7206
******************************************************************************
 List of variable(s) assumed to be "non-causal" under the null hypothesis:
 LRW
 Maximized value of log-likelihood = -122.4993
******************************************************************************
 LR test of block non-causality, CHSQ(  4)=   9.5574[.049]
******************************************************************************
 The above statistic is for testing the null hypothesis that the coefficients
 of the lagged values of:
 LRW
 in the block of equations explaining the variable(s):
 LCPI
 are zero. The maximum order of the lag(s) is 4.
******************************************************************************
```

```
LR Test of Block Granger Non-Causality in the VAR
*******************************************************************************
 Based on 45 observations from 1965 to 2009. Order of VAR = 4
 List of variables included in the unrestricted VAR:
 DLCPI           DLRW
 Maximized value of log-likelihood = -118.4812
*******************************************************************************
 List of variable(s) assumed to be "non-causal" under the null hypothesis:
 DLCPI
 Maximized value of log-likelihood = -119.3015
*******************************************************************************
 LR test of block non-causality, CHSQ(  4)=   1.6406[.801]
*******************************************************************************
 The above statistic is for testing the null hypothesis that the coefficients
 of the lagged values of:
 DLCPI
 in the block of equations explaining the variable(s):
 DLRW
 are zero. The maximum order of the lag(s) is 4.
*******************************************************************************

LR Test of Block Granger Non-Causality in the VAR
*******************************************************************************
 Based on 45 observations from 1965 to 2009. Order of VAR = 4
 List of variables included in the unrestricted VAR:
 DLCPI           DLRW
 Maximized value of log-likelihood = -118.4812
*******************************************************************************
 List of variable(s) assumed to be "non-causal" under the null hypothesis:
 DLRW
 Maximized value of log-likelihood = -122.0135
*******************************************************************************
 LR test of block non-causality, CHSQ(  4)=   7.0647[.133]
*******************************************************************************
 The above statistic is for testing the null hypothesis that the coefficients
 of the lagged values of:
 DLRW
 in the block of equations explaining the variable(s):
 DLCPI
 are zero. The maximum order of the lag(s) is 4.
*******************************************************************************


LR Test of Block Granger Non-Causality in the VAR
*******************************************************************************
 Based on 45 observations from 1965 to 2009. Order of VAR = 4
 List of variables included in the unrestricted VAR:
 DLRW            DLPROD
 Maximized value of log-likelihood = -185.0739
*******************************************************************************
 List of variable(s) assumed to be "non-causal" under the null hypothesis:
 DLPROD
 Maximized value of log-likelihood = -187.5924
*******************************************************************************
 LR test of block non-causality, CHSQ(  4)=   5.0369[.284]
*******************************************************************************
 The above statistic is for testing the null hypothesis that the coefficients
 of the lagged values of:
 DLPROD
 in the block of equations explaining the variable(s):
 DLRW
 are zero. The maximum order of the lag(s) is 4.
*******************************************************************************
```

```
LR Test of Block Granger Non-Causality in the VAR
*******************************************************************************
 Based on 46 observations from 1964 to 2009. Order of VAR = 4
 List of variables included in the unrestricted VAR:
 LRW             LPROD
 Maximized value of log-likelihood = -185.4792
*******************************************************************************
 List of variable(s) assumed to be "non-causal" under the null hypothesis:
 LPROD
 Maximized value of log-likelihood = -188.4135
*******************************************************************************
 LR test of block non-causality, CHSQ(  4)=   5.8688[.209]
*******************************************************************************
 The above statistic is for testing the null hypothesis that the coefficients
 of the lagged values of:
 LPROD
 in the block of equations explaining the variable(s):
 LRW
 are zero. The maximum order of the lag(s) is 4.
*******************************************************************************
```

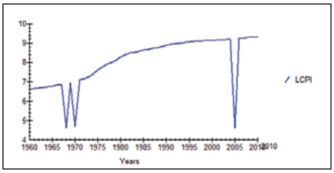
Appendix 3 Unit root tests

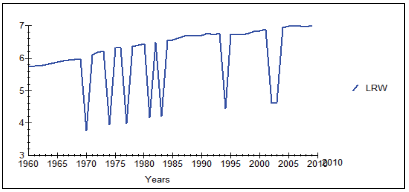
```
Unit root tests

ADF Test for series:      real_wage
sample range:             [1963, 2009], T = 47
lagged differences:       2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708, table 20.1,
Oxford University Press, London
 1%         5%         10%
-3.96      -3.41      -3.13
value of test statistic: -2.5859
regression results:
---------------------------------------
variable      coefficient   t-statistic
---------------------------------------
 x(-1)        -0.2824       -2.5859
dx(-1)         0.2446        1.6202
dx(-2)         0.0087        0.0537
constant       21.0595       2.8098
trend          0.4809        2.5718
RSS            131.2881

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range:             [1971, 2009], T = 39

optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion:    1
Final Prediction Error:   1
Hannan-Quinn Criterion:   0
Schwarz Criterion:        0
```

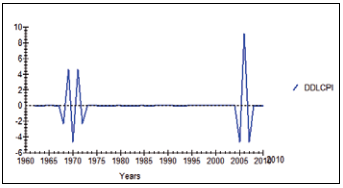
```
ADF Test for series:      real_wage_log_d1
sample range:             [1964, 2009], T = 46
lagged differences:       2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708, table 20.1,
Oxford University Press, London
 1%        5%        10%
-3.96     -3.41     -3.13
value of test statistic: -3.7255
regression results:
---------------------------------------
variable      coefficient   t-statistic
---------------------------------------
 x(-1)        -0.9770       -3.7255
dx(-1)         0.0500        0.2382
dx(-2)        -0.0796       -0.5092
constant       0.0253        3.1793
trend         -0.0007       -2.1044
RSS            0.0279

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range:             [1972, 2009], T = 38

optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion:    0
Final Prediction Error:   0
Hannan-Quinn Criterion:   0
Schwarz Criterion:        0


ADF Test for series:      CPI_log
sample range:             [1964, 2009], T = 46
lagged differences:       2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708, table 20.1,
Oxford University Press, London
 1%        5%        10%
-3.96     -3.41     -3.13
value of test statistic: -1.1182
regression results:
---------------------------------------
variable      coefficient   t-statistic
---------------------------------------
 x(-1)        -0.0173       -1.1182
dx(-1)         0.8453        5.6073
dx(-2)        -0.0500       -0.3167
constant       0.0759        1.3566
trend          0.0006        0.5225
RSS            0.0260

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range:             [1972, 2009], T = 38

optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion:    6
Final Prediction Error:   1
Hannan-Quinn Criterion:   1
Schwarz        Criterion:                                                             1
```

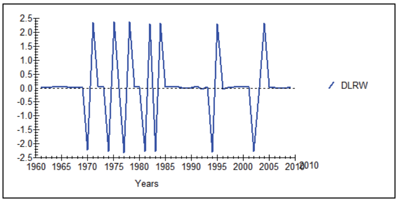
```
DF Test for series:      CPI_log_d1
sample range:             [1964, 2010], T = 47
lagged differences:       2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708, table 20.1,
Oxford University Press, London
 1%        5%        10%
-3.96      -3.41      -3.13
value of test statistic: -2.4032
regression results:
---------------------------------------
variable      coefficient   t-statistic
---------------------------------------
 x(-1)        -0.2326       -2.4032
dx(-1)         0.1002        0.6746
dx(-2)        -0.0687       -0.4624
constant       0.0133        2.0231
trend         -0.0005       -1.7227
RSS            0.0269

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range:             [1972, 2010], T = 39

optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion:    6
Final Prediction Error:   6
Hannan-Quinn Criterion:   0
Schwarz Criterion:        0

ADF Test for series:      CPI_log_d1_d1_d1
sample range:             [1966, 2009], T = 44
lagged differences:       2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708, table 20.1,
Oxford University Press, London
 1%        5%        10%
-3.96      -3.41      -3.13
value of test statistic: -7.0234
regression results:
---------------------------------------
variable      coefficient   t-statistic
---------------------------------------
 x(-1)        -2.4764       -7.0234
dx(-1)         0.8551        3.2501
dx(-2)         0.3935        2.6904
constant      -0.0005       -0.0947
trend          0.0000        0.0928
RSS            0.0408

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range:             [1974, 2009], T = 36

optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion:    3
Final Prediction Error:   3
Hannan-Quinn Criterion:   3
Schwarz Criterion:        3
```

Graphic presentation of the variables









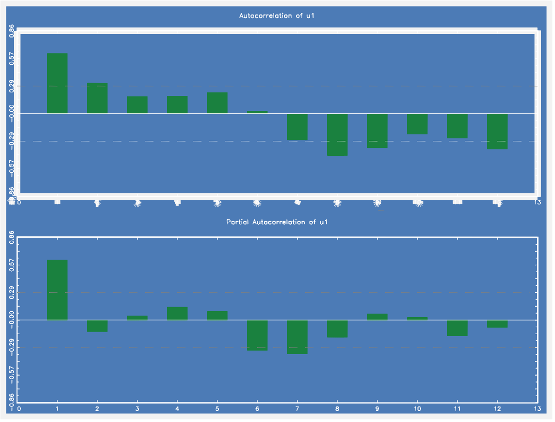
Appendix 4 Test for cointegration

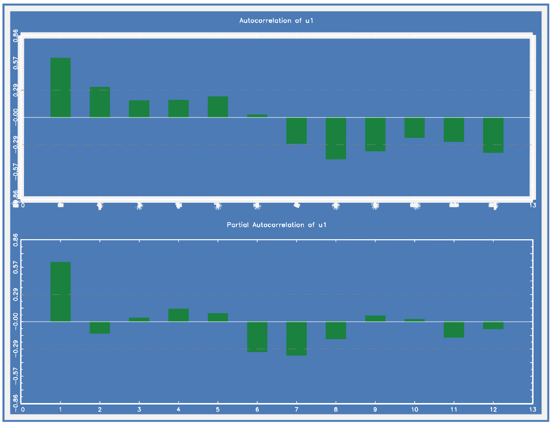
```
Johansen Trace Test for:  CPI_log real_wage_log
sample range:             [1961, 2009], T = 49
included lags (levels):   1
dimension of the process: 2
intercept included
response surface computed:
-----------------------------------------------
 r0  LR       pval     90%      95%      99%
-----------------------------------------------
 0   71.27    0.0000   17.98    20.16    24.69
 1   2.65     0.6540   7.60     9.14     12.53

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range:             [1961, 2009], T = 49

optimal number of lags (searched up to 1 lags of levels):
Akaike Info Criterion:    1
Final Prediction Error:   1
Hannan-Quinn Criterion:   1
Schwarz Criterion:        1

*** Tue, 11 Oct 2011 23:20:41 ***
Johansen Trace Test for:  CPI_log real_wage_log
sample range:             [1961, 2009], T = 49
included lags (levels):   1
dimension of the process: 2
trend and intercept included
response surface computed:
-----------------------------------------------
 r0  LR       pval     90%      95%      99%
-----------------------------------------------
 0   50.61    0.0000   23.32    25.73    30.67
 1   4.97     0.6072   10.68    12.45    16.22

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range:             [1961, 2009], T = 49

optimal number of lags (searched up to 1 lags of levels):
Akaike Info Criterion:    1
Final Prediction Error:   1
Hannan-Quinn Criterion:   1
Schwarz Criterion:        1
```

```
VEC REPRESENTATION
endogenous variables:     CPI_log real_wage_log
exogenous variables:      productivity_log
deterministic variables:  CONST TREND
endogenous lags (diffs):  0
exogenous lags:           0
sample range:             [1961, 2009], T = 49
estimation procedure:     One stage. Johansen approach



Deterministic term:
===================
          d(CPI_log)  d(real_wage_log)
---------------------------------------
TREND(t)|   -0.010    -0.003
        |   (0.001)   (0.001)
        |   {0.000}   {0.002}
        | [-10.933]  [-3.068]
---------------------------------------


Loading coefficients:
=====================
          d(CPI_log)  d(real_wage_log)
---------------------------------------
ec1(t-1)|   -0.105    -0.031
        |   (0.008)   (0.008)
        |   {0.000}   {0.000}
        | [-12.616]  [-3.907]
---------------------------------------

Estimated cointegration relation(s):
====================================
                   ec1(t-1)
----------------------------
CPI_log      (t-1)|    1.000
                  |   (0.000)
                  |   {0.000}
                  |   [0.000]
real_wage_log(t-1)|   -5.246
                  |   (0.504)
                  |   {0.000}
                  | [-10.401]
CONST             |   15.325
                  |   (1.746)
                  |   {0.000}
                  |   [8.779]
----------------------------



VAR REPRESENTATION

modulus of the eigenvalues of the reverse characteristic polynomial:
|z| = ( 1.0000     0.9478     )

Legend:
=======
              Equation 1   Equation 2  ...
------------------------------------------
Variable 1 | Coefficient          ...
           | (Std. Dev.)
           | {p - Value}
           | [t - Value]
Variable 2 |         ...
```

```
...
------------------------------------------


Lagged endogenous term:
=======================
                    CPI_log  real_wage_log
-------------------------------------------
CPI_log      (t-1)|    0.895    -0.031
                  |   (0.008)   (0.008)
                  |   {0.000}   {0.000}
                  | [107.021]  [-3.907]
real_wage_log(t-1)|    0.553     1.161
                  |   (0.044)   (0.041)
                  |   {0.000}   {0.000}
                  |  [12.616]  [28.251]
-------------------------------------------


Deterministic term:
===================
           CPI_log  real_wage_log
----------------------------------
TREND(t)|   -0.010    -0.003
        |   (0.000)   (0.000)
        |   {0.000}   {0.000}
        |   [0.000]   [0.000]
CONST   |   -1.616    -0.469
        |   (0.000)   (0.000)
        |   {0.000}   {0.000}
        |   [0.000]   [0.000]
----------------------------------
```

Residual analysis in VECM





Refferences

1. Gregory,D., Schweitzer, M.,(2000), **Does wage cause Price inflation**?, Federal Reserve Bank of Cleveland
2. **Groshen,E.,** Schweitzer,M.(1997), **The Effects of Inflation on Wage Adjustments in Firm-Level Data: Grease or Sand?,** Federal Reserve Bank of New York, Federal Reserve Bank of Cleveland
3. Heo, **S(2003), THE RELATIONSHIP BETWEEN EFFICIENCY WAGES AND PRICE INDEXATION IN A NOMINAL WAGE CONTRACTING MODEL,**
4. Mihaljek **,D,Sweta,S, (2010)Wages, productivity and "structural" inflation in emerging market economies ,** BIS Papers No 49

   JOURNAL OF ECONOMIC DEVELOPMENT Volume 28, Number 2,
5. Kawasaki, K., Hoeller,P., Poret,P.(1990), **Modeling wages and prices for smaller OECD economies** ,OECD department of economics and statistics
6. Kumar,S,Webber,D,Perry, G,. (2008), **Real wages, inflation and labour productivity in Australia,** *Department of Business Economics, Auckland University of Technology, New Zealand*
7. Mihajlek, D,Sweta, S., **Wages, productivity and “structural” inflation**
8. Peter Flaschel, GÄoran Kauermann, Willi Semmler,(2005), **Testing Wage and Price Phillips Curves for the United States,** Center for Economic Policy Analysis, at the Department of Economics of the New School and the CEM Bielefeld
9. Robertson,R.**,(2001), Relative Prices and Wage Inequality:Evidence from Mexico,** Department of Economics Macalester College
10. Straus,J.Wohar,M.(2004), **The Linkage Between Prices, Wages, and Labor Productivity:A Panel Study of Manufacturing Industries,** Department of Economics, Saint Louis University, University of Nebraska at Omaha
11. Taylor, J., (1998), STAGGERED PRICE AND WAGE SETTING IN MACROECONOMICS, Stanford University
12. Hoxha A., (2010), **Causal relationship between prices and wages:VECM analysis for Germany,** *Department of Economics, Faculty of Economy, University of Prishtina*

Analysis of Purchasing power parity with data for Macedonia

Msc Dushko Josheski
dusko.josevski@ugd.edu.mk
Cane Koteski
cane.koteski@ugd.edu.mk

Abstract

In this paper we test Roggof hypothesys with data for Macedonia.The result is that this hypothesis holds but limited in the case of Macedonia.

Introduction

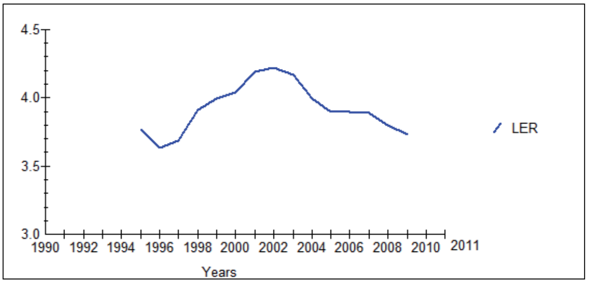
The purchasing power parity theory uses long run equilibrium exchange rate of two currencies to equalize their purchasing power. This theory is developed by Gustav Kassel in 1920, and it is based on the law of one price. This theory states that commodity in two different locations should have same price, regardless of the locations (Zheng, 2009). While few economists take PPP seriously as short-term proposition, they believe in purchasing power parity as an anchor for long run exchange rate (Rogof, 1996). Empirical literature in this field has established consensus on a few facts. First, real exchange rates (nominal adjusted for inflation) tend towards purchasing power parity in the long run. This is the hypothesis we set here and we are going to test later with Macedonian data. Second, short run deviations from purchasing power parity are large and volatile. Balasa Samuelson effect also is one of the most well known channels through which real convergence leads to higher inflation rates. According to this concept, higher productivity growth in the sector of tradable goods, contrary to non-tradable goods sector of one country, will lead to positive inflatory differential and will lead to real appreciation-through the price growth of non-tradable goods on the market(Bogoev,2008) .Following relative PPP, the movements in nominal exchange rates are expected to compensate for price level shifts. So, the real exchange rate should be constant over long-run and their time series should be stationary (Parikh and Wakerly 2000). This is part or a whole second hypothesis that we are testing here. Real exchange rates are calculated from nominal using CPI's:

$$RE_t = E_t (P_t^* / P_t)$$

where RE_t stands for the real exchange rate, E_t is the price of a foreign currency in units of the domestic currency, and P_t^* and P_t represent the foreign price index and the domestic price index(Boršič,Beko, Kavkler,).If we take logarithms of both sides we get

$$\text{Log}(RE_t) = \text{Log}(E_t) + \text{Log}(P_t^*) - \text{Log}(P_t)$$

With the log-log arrangement of the equation we can estimate the elasticities, while with first difference the relative growth of the variables. On the next graph it is plotted natural logarithm of exchange rate variable.



Relative instability of the exchange rate movements in transitional countries (Macedonia is in this group of countries) is in the literature explained by inherited macroeconomic imbalances in transition countries, mixed performance of chosen exchange rate arrangements, and the process of catching up with developed economies(Egert, et al 2006).As in neo-keynesian tradition exchange rate is one of the transmissions channels in the economy through which monetary policy can influence the inflation in the economy and the output gap (Besimi, 2006).

Time series analysis for Purchasing power parity of Macedonia

One of the main tasks in time series analysis is to make conclusions about number of unit roots in a given time series. That way we are making conclusions whether time series is stationary or it has such a non stationary which is removed by differencing. Most popular tests of unit root are D-F and ADF tests .Next table simulates the idea of the models

Autoregressive model AR(1)	Hypothesis
1. $X_t = \phi_0 + \phi_1 X_{t-1} + \varepsilon_t$	$H_0 : \phi_1 = 1 \Rightarrow$ unit root $H_1 : \phi_1 < 1 \Rightarrow$ Stationary
2. $X_t = \phi_0 + \phi_1 t + \phi_1 X_{t-1} + \varepsilon_t$	$H_0 : \phi_1 = 1 \Rightarrow$ unit root $\Rightarrow$ Unit root with a drift $H_1 : \phi_1 < 1 \Rightarrow$ trend stationary

Next we are estimating DW value from **Model** 1 like

$\tau = \dfrac{\hat{\phi}_1 - 1}{s(\hat{\phi})}$ where $s(\hat{\phi})$ is the standard error of the coefficient (model with constant)

And from the second model (model with constant and a trend)

$$\tau_t = \frac{\hat{\phi}_1 - 1}{s(\hat{\phi})}$$

Critical values for comparison we are determining for a given sample T

ype DF test	Level of significance 5 %	Level of significance 10 %
	$\tau^t = -2.8621 - 2.73$	$\tau^t = -2.5671 - 1.$
	$\tau_t^t = -3.4126 - 4.0$	$\tau_t^t = -3.1279 - 2$

In our analysis we use PPP one country's relative price / US price level and CPI indices, trade as percentage to GDP and Exchange rate (local currency relative to US dollar), and the first difference of the logarithms of these series approximates their growth rates.

Testing for unit roots

Graphic tests showed that LNPPP and DLNPPP are non-stationary; also ADF test showed that we cannot reject the null hypothesis of unit root, also LER and DLER are non-stationary and we cannot reject the null hypothesis of unit root.

Co-integration Engle Granger method for Macedonia

Engle-Granger method for cointegration, implies a check if the residuals of thecointegrating regression are stationary.

The estimated equation is:

$$DL\hat{E}R = 0.0086 - 0.41\text{DLPPP}$$

p= [.816] [.602]

Intercept is in the regression because it ensures that error term has zero mean and it is included for statistical purposes only. Dropping the intercept will result in upward biased t-statistics and will lead to incorrect conclusion that certain coefficients are statistically significant. A DLER variable is first difference of natural logarithm of exchange rate. If DLPPP or first difference of the log of relative inflation increases by 1% on average the ER will result in downward change (depreciation) by 0.41%. Unit root test of the residuals from this regression shows that estimated values have less negative value than critical values so that test shows that there exist no long run relationship between this variables

Error correction mechanism

The short run relationship between variables is captured by the coefficient of the independent variable, whereas the adjustment toward the long run equilibrium is given by the coefficients of the EC mechanism (Harris, Sollis, 2003). ECM use second differences of these variables as they appear to be stationary.

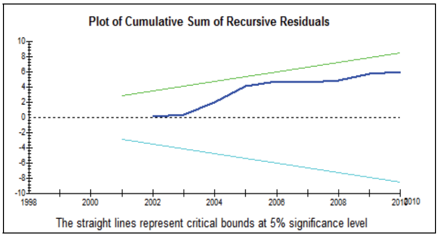
$$DDL\hat{ER} = -0.0052 + 0.297\text{DDLPPP} + 0.50958\text{u}_{t-1}$$

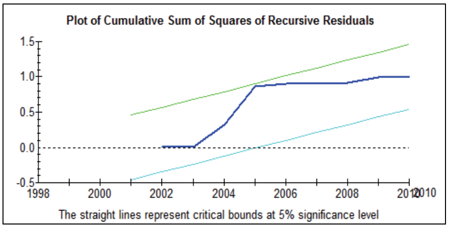
p= [.860] [.653] [.088]

In the short run, 1% relative change will influence change in ER by 0.29%, while in the long run 50,95% of the disequilibrium in the last year between change in ER and inflation will be eliminated in the current year. Short run coefficient is insignificant while long run coefficient is significant. According to the next Table model is well specified.

Hypothesis	p-value of the test	Decision
H_0: No residual correlation	[.080]	Insufficient evidence to reject H_0 at 1, 5 % level of significance
H_0: Linear relationship between variables	[.906]	Insufficient evidence to reject H_0 at 1, 5 and 10% level of significance
H_0: Normality in residuals	[.703]	Insufficient evidence to reject H_0 at 1, 5 and 10% level of significance
H_0: Homoskedasticity	[.287]	Insufficient evidence to reject H_0 at 1, 5 and 10% level of significance

In order to test for parameter stability we perform CUSUM and CUSUMSQ plots are examined





According to CUSUM and CUSUM square there are no structural breaks.

As the variable DDLPPP is not statistically significant, this is consistent with Rogoff (1996), who states that PPP does not hold in long run. So we can rewrite the model and estimate as follows

$$DDL\hat{E}R = -0.0072 + 0.515u_{t-1}$$

p= [.798] [.072]

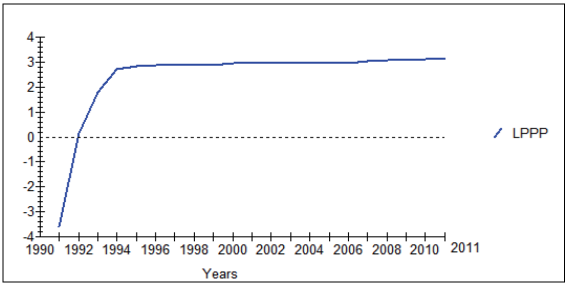
This model suggests that on average 51,5% of the departure of ER from its equilibrium level will be offset in the next period. In summary model provides some evidence of long run PPP.

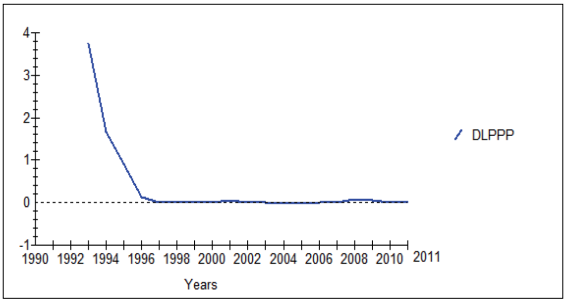
Appendices

PPP	Purchasing power parity conversion factor is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States. This conversion factor is for GDP.
ER-	Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar
DLER	First difference of the natural logarithm of the exchange rate

DLPPP	First difference of the natural logarithm of Purchasing power parity
DDLER	Second difference of the natural logarithm of the exchange rate
	Second of the natural logarithm of Purchasing power parity

Examining the level of integration of PPP





Unit root testing for LPPP and DLPPP

Unit root tests for variable LPPP

The Dickey-Fuller regressions include an intercept but not a trend

18 observations used in the estimation of all ADF regressions.
Sample period from 1994 to 2011

	Test Statistic	LL	AIC	SBC	HQC
DF	-25.1462	23.4847	21.4847	20.5944	21.3620
ADF(1)	-3.0214	24.7318	21.7318	20.3962	21.5476

95% critical value for the augmented Dickey-Fuller statistic = -3.0401
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable LPPP

The Dickey-Fuller regressions include an intercept and a linear trend

18 observations used in the estimation of all ADF regressions.
Sample period from 1994 to 2011

	Test Statistic	LL	AIC	SBC	HQC
DF	-22.4379	25.2004	22.2004	20.8649	22.0163
ADF(1)	-3.4924	26.5330	22.5330	20.7523	22.2875

95% critical value for the augmented Dickey-Fuller statistic = -3.6921
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable DLPPP

The Dickey-Fuller regressions include an intercept but not a trend

14 observations used in the estimation of all ADF regressions.
Sample period from 1998 to 2011

	Test Statistic	LL	AIC	SBC	HQC
DF	-2.6955	32.3708	30.3708	29.7317	30.4300
ADF(1)	-2.4205	32.4282	29.4282	28.4696	29.5169
ADF(2)	-2.3438	32.5517	28.5517	27.2736	28.6700
ADF(3)	-2.3351	32.9825	27.9825	26.3848	28.1304
ADF(4)	-2.3262	33.4397	27.4397	25.5226	27.6172

95% critical value for the augmented Dickey-Fuller statistic = -3.1004
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable DLPPP

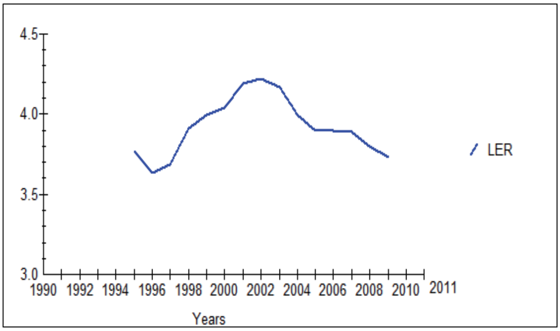
The Dickey-Fuller regressions include an intercept and a linear trend

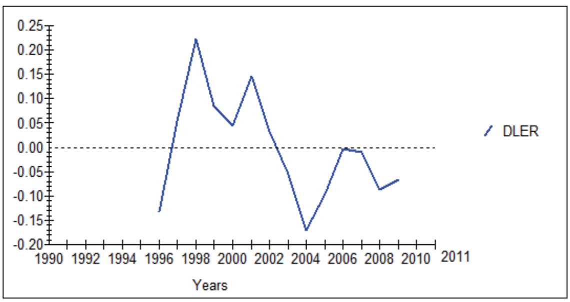
14 observations used in the estimation of all ADF regressions.
Sample period from 1998 to 2011

	Test Statistic	LL	AIC	SBC	HQC
DF	-2.6193	32.4519	29.4519	28.4933	29.5406
ADF(1)	-2.3274	32.4853	28.4853	27.2072	28.6036
ADF(2)	-2.3348	32.8026	27.8026	26.2049	27.9505
ADF(3)	-2.2049	33.0317	27.0317	25.1145	27.2092
ADF(4)	-2.3271	33.8357	26.8357	24.5990	27.0428

95% critical value for the augmented Dickey-Fuller statistic = -3.7921
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Examining the level of integration of ER





Unit root testing for LER and DLER

Unit root tests for variable LER

The Dickey-Fuller regressions include an intercept but not a trend

10 observations used in the estimation of all ADF regressions.

Sample period from 2000 to 2009

	Test Statistic	LL	AIC	SBC	HQC
DF	-.025494	10.5888	8.5888	8.2862	8.9207
ADF(1)	-1.1051	13.3583	10.3583	9.9044	10.8562
ADF(2)	-.92926	13.3738	9.3738	8.7686	10.0377
ADF(3)	-1.7243	15.4770	10.4770	9.7205	11.3068
ADF(4)	-1.9796	16.8237	10.8237	9.9160	11.8195

95% critical value for the augmented Dickey-Fuller statistic = -3.2197

LL = Maximized log-likelihood AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable LER

The Dickey-Fuller regressions include an intercept and a linear trend

10 observations used in the estimation of all ADF regressions.

Sample period from 2000 to 2009

	Test Statistic	LL	AIC	SBC	HQC
DF	-2.1771	14.8938	11.8938	11.4399	12.3917
ADF(1)	-2.4716	16.4990	12.4990	11.8938	13.1629
ADF(2)	-2.6698	18.2639	13.2639	12.5074	14.0937
ADF(3)	-2.6948	19.0103	13.0103	12.1025	14.0061
ADF(4)	-2.3582	20.0806	13.0806	12.0215	14.2424

95% critical value for the augmented Dickey-Fuller statistic = -3.9949

LL = Maximized log-likelihood AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable DLER

The Dickey-Fuller regressions include an intercept but not a trend

9 observations used in the estimation of all ADF regressions.

Sample period from 2001 to 2009

	Test Statistic	LL	AIC	SBC	HQC
DF	-1.5655	10.8647	8.8647	8.6675	9.2903
ADF(1)	-1.6465	11.1942	8.1942	7.8983	8.8326
ADF(2)	-1.3428	12.1052	8.1052	7.7108	8.9564
ADF(3)	-1.2356	12.1842	7.1842	6.6911	8.2482
ADF(4)	-1.3352	12.8284	6.8284	6.2367	8.1052

95% critical value for the augmented Dickey-Fuller statistic = -3.2698

LL = Maximized log-likelihood AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable DLER

The Dickey-Fuller regressions include an intercept and a linear trend

9 observations used in the estimation of all ADF regressions.

Sample period from 2001 to 2009

	Test Statistic	LL	AIC	SBC	HQC
DF	-1.6463	11.2184	8.2184	7.9225	8.8568
ADF(1)	-1.9597	12.1092	8.1092	7.7147	8.9604
ADF(2)	-.96081	12.2432	7.2432	6.7501	8.3072
ADF(3)	-1.1140	12.9075	6.9075	6.3158	8.1843
ADF(4)	-1.8433	15.8901	8.8901	8.1999	10.3798

95% critical value for the augmented Dickey-Fuller statistic = -4.0816

LL = Maximized log-likelihood AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

ENGLE GRANGER CO-INTEGRATION METHOD

```
                          Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is DLER
 14 observations used for estimation from 1996 to 2009
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                        .0086514            .036380             .23781[.816]
 DLPPP                    -.41005             .76646             -.53499[.602]
*******************************************************************************
 R-Squared                     .023295   R-Bar-Squared                -.058097
 S.E. of Regression            .11237    F-stat.    F(  1,  12)    .28621[.602]
 Mean of Dependent Variable -.0023328    S.D. of Dependent Variable     .10924
 Residual Sum of Squares       .15153    Equation Log-likelihood       11.8171
 Akaike Info. Criterion        9.8171    Schwarz Bayesian Criterion     9.1781
 DW-statistic                  .96300
*******************************************************************************
```

```
                          Unit root tests for residuals
*******************************************************************************
 Based on  OLS regression of DLER on:
 C                DLPPP
 14 observations used for estimation from 1997 to 2010
*******************************************************************************
        Test Statistic       LL            AIC            SBC            HQC
 DF          -1.4920       9.8993         8.8993         8.8007         9.1121
 ADF(1)      -1.6077      10.2100         8.2100         8.0127         8.6356
 ADF(2)      -1.2578      10.4964         7.4964         7.2006         8.1348
 ADF(3)      -1.2502      10.6675         6.6675         6.2731         7.5187
 ADF(4)      -1.3010      11.0347         6.0347         5.5416         7.0987
*******************************************************************************
 95% critical value for the Dickey-Fuller statistic =  -4.1109
 LL  = Maximized log-likelihood       AIC = Akaike Information Criterion
 SBC = Schwarz Bayesian Criterion     HQC = Hannan-Quinn Criterion
```

THE ERROR CORRECTION MODEL

```
                          Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is DDLER
 13 observations used for estimation from 1997 to 2009
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 C                       -.0052652            .029085            -.18103[.860]
 DDLPPP                    .29779             .64232              .46362[.653]
 U1                        .50958             .26932              1.8921[.088]
*******************************************************************************
 R-Squared                     .28015    R-Bar-Squared                  .13618
 S.E. of Regression            .10361    F-stat.    F(  2,  10)    1.9459[.193]
 Mean of Dependent Variable -.0051331    S.D. of Dependent Variable     .11148
 Residual Sum of Squares       .10735    Equation Log-likelihood       12.7320
 Akaike Info. Criterion        9.7320    Schwarz Bayesian Criterion     8.8845
 DW-statistic                  1.4022
*******************************************************************************
```

```
                                Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version          *         F Version        *
*******************************************************************************
*                     *                            *                          *
* A:Serial Correlation*CHSQ(   1)=   3.0750[.080]*F(   1,    9)=   2.7885[.129]*
*                     *                            *                          *
* B:Functional Form   *CHSQ(   1)=  .013922[.906]*F(   1,    9)= .0096486[.924]*
*                     *                            *                          *
* C:Normality         *CHSQ(   2)=   .70360[.703]*       Not applicable        *
*                     *                            *                          *
* D:Heteroscedasticity*CHSQ(   1)=   1.1319[.287]*F(   1,   11)=   1.0491[.328]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

References

1. ***Feenstra, C.Roberts***, (2004), *Advanced international trade: theory and evidence*, Princeton University Press

2. ***Krugman, R.Paul, Obstfeld, Maurice*** (2009), *International economics: Theory and Policy* ,Pearson Addison-Wesley

3. ***Madura, Jeff, (2009),*** *International Financial Management*, **Cengage Learning, Tenth edition**

4. ***Obstfeld, Maurice, Rogoff,S.,Kenneth,(1998),*** *Foundations of international macroeconomics,* The MIT Press , London , England

5. ***Rogoff,S.,Kenneth, Husain,M.,Aasin,Mody Asholka, Brooks, Robin, Oomes, Nienke***, (2004), *Evolution and performance of exchange rate regimes*, International Monetary Fund, Washington

6. **The World Bank database**

7. **World Economic Outlook (WEO) database**

Institutions and Growth revisited: OLS, 2SLS, G2SLS Random effects IV regression and Panel Fixed (within) IV regression with cross-country data

Dushko Josheski (dushkojosheski@gmail.com)
Darko Lazarov (darko.lazarov@ugd.edu.mk)
Risto Fotov (risto.fotov@ugd.edu.mk)
Cane Koteski (cane.koteski@ugd.edu.mk)

Abstract

This paper revisits the Institutions and growth models. Econometric techniques have been applied on cross-country data, just to confirm the *apriori* knowledge that Institutions effect on growth is positive and highly statistically significant. This evidence was confirmed by all four models. OLS proved as a better technique for our data than 2SLS, this simply because overidentification test showed that instrument cannot be considered exogenous, also Hausman test showed that OLS is better than 2SLS at 1% and 5% levels of significance. G2SLS estimator and Fixed effects panel estimators just confirmed the results from the OLS and 2SLS. As a proxy variable for institutions we used Rule of law variable, also as instruments were used revolutions and Freedom house rating as well as War casualties variables. Also as conclusion here Trade is insignificant in influence to GDP growth compared with quality of institutions.

Key words: Institutions, Growth, 2SLS, OLS, G2SLS Random effects IV regression and Panel Fixed (within) IV regression, cross-country data, Hausman test, Overidentification test

Literature review of Institution and growth

The growth theory tries to explain the dynamic of growth process and the enormous differences of income per capita and economic performance among countries. From historical perspective, some group of countries have accomplished very high rate of growth and economic performance compared with other countries which face with economic problems (slowly dynamic of growth process). There are many explanations about this fact, basically, three theories analyze the factors which determinate cross-country differences in income levels and growth rate. First, the neoclassical theory of economic growth, based on work of Solow (1956), Lucas (1988), and others, focuses on the inputs of physical and human capital as a main resource of growth process, and late, Romer (1990) focus on technology advances through R&D activities (activities that create new ideas in economy) as a engine of growth. Second, the geographic/location theory explain that the geographic location of country (access to market) and the climate condition are very important for income level and economic performance. The theoretical and empirical research present the strong causality between the geographic location and the income level, the geographic/location theory explain only the income level differences among countries. In other side, the most important question for economist is the engine of growth, and in this direction the growth theory tries to explain the factors which determent the rate of growth. Third, the institutional approach emphasizes the importance of creating an institutional environment and institutions that support and encourage the main foundation of market economy (e.g. protection of property rights, rule of law, enforcement of contracts, and voluntary exchange of market-determined price. Institutions refer to rules, regulations, laws and policies that affect economic incentives such as incentives to invest in technology, physical capital and human capital. In this regard, the good institution framework is necessary for high level investment. Investors do not prefer to risk their capital when the protection of property rights is poorly, there are weak in rule of law and enforcement of contracts, and other illegal activities in market foundation economy. The theoretical explanations for growth that we introduced above are not inconsistent each other and all might play important role, but institutions are the major fundamental cause of economic growth and cross-country differences in economic performance.

The research of our paper focuses on the causality relationship between institutions and growth, and analyzes how quality of institutions influences growth rate. The empirical investigate show the more strong direction of causality of institutional quality to growth than the influence of growth to quality institutions. The explanation of this result is the fact that poor counties have more incentive to improve the quality of their institutions to achieve higher growth rate, rather than develop counties with high growth do not need to improve the institutional environment because that countries already have reached high-quality institutions.

<u>Theoretical model of institutions, capital and economic growth</u>

To develop the growth model with institutions, we start our analysis with aggregate production function which describes how the inputs (physical and human capital, labor and technology) are combined to produce output.[5]

$$Y_t = A_t K_t^{\alpha} H_t^{\beta} L_t^{1-\alpha-\beta} \quad (1)$$

[6]

where Y is output, the parameter A represent the level of technology in economy, K is physical capital, H is human capital, and L is labor. We should make distinction between human capital and labor. The labor force is amount of people who are able to work, in the other side, human capital is the knowledge, skills and abilities of people who are or who may be involved in production process.

The equation of production function can write in per capita form:

$$\frac{Y_t}{L_t} = \frac{K_t^{\alpha}}{L_t}\frac{H_t^{\beta}}{L_t}\frac{A_t L_t^{1-\alpha-\beta}}{L_t} \quad (2)$$

$$y_t = A_t k_t^{\alpha} h^{\beta} \quad (3)$$

Traditional macroeconomic growth models do not include the influence of institutional quality as a factor of economic growth. These models implicitly assume an underlying set of good institutions. The fact that institutions have important role in growth process, the economists try to implement the institutional quality in growth models.

---

[5] The production function is characterize with constant return, $\alpha + \beta \leq 1$.

[6] The equation (1) we can write in this terms: $Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t^{1-\alpha-\beta})$.

$$A_t = A_0 k_t^{\delta_1 (In - In^*)} h_t^{\delta_2 (In - In^*)} \tag{4}$$

where A_0 represents the basic level of technology, In^* represents the best quality institutions, these ideal institutions are assumed in the traditional growth model, and In is the country's current level of institutional quality. The mathematical statement $(In - In^*)$ measures the degree to which the country's institutions fall short of the best conditions. The traditional growth model assume that economies function close to best-quality institutions, $In = In^*$, thus, these growth model reduce the influence of quality institutions.

Substituting the equation (3) into equation of production function per worker, we get:

$$y_t = A_0 k_t^{\delta_1 (In - In^*)} h_t^{\delta_2 (In - In^*)} k_t^{\alpha} h_t^{\beta} \tag{5}$$

Rewriting this equation we get:

$$y_t = A_0 k_t^{\alpha + \delta_1 (In - In^*)} h_t^{\beta + \delta_2 (In - In^*)} \tag{6}$$

To study the dynamic of output per capita, we will use a simple *mathematical trick* that economists often used in the study of growth.[7] The mathematical trick is to "take logs and then derivatives".

If we take logs of equation (6), we obtain:

$$\log y_t = \log A_0 + \left[\alpha + \delta_1 (In - In^*)\right] \log k_t + \left[\beta + \delta_2 (In - In^*)\right] \log h_t \tag{6}$$

Derivatives regarding time t, we obtain following form:

[7] Mathematical notes: The theory of growth uses some properties of natural logarithms. One of that properties is: The statement regarding the timing of the logarithms of a variable, gives the growth rate of that variable: If $y(t) = \log x(t)$, than, $\frac{dy}{dt} = \frac{dy}{dx}\frac{dx}{dt} = \frac{1}{x}\Delta x = \frac{\Delta x}{x}$.

$$\frac{d\log y_t}{dt} = \frac{d\log A_0}{dt} + \left[\alpha + \delta_1(In - In^*)\right]\frac{d\log k_t}{dt} + \left[\beta + \delta_2(In - In^*)\right]\frac{d\log h_t}{dt} \qquad (7)$$

As we can see, the equation (8), show the growth rate of output per capita:

$$\frac{\Delta y_t}{y_t} = \frac{\Delta A_0}{A_0} + \left[\alpha + \delta_1(In - In^*)\right]\frac{\Delta k_t}{k_t} + \left[\beta + \delta_2(In - In^*)\right]\frac{\Delta h_t}{h_t} \text{ [8]} \qquad (8)$$

Rewriting equation (8) we get following form of growth rate of output per capita:

$$\frac{\Delta y_t}{y_t} = \frac{\Delta A_0}{A_0} + \left[(\alpha - \delta_1 In^*) + \delta_1 In\right]\frac{\Delta k_t}{k_t} + \left[(\beta - \delta_2 In^*) + \delta_2 In\right]\frac{\Delta h_t}{h_t} \qquad (9)$$

If we assume that: $\varphi_1 = (\alpha - \delta_1 In^*)$; $\varphi_2 = (\beta - \delta_2 In^*)$ and $\alpha_0 = \Delta A_0$, and adding an error term ε_t, we get final equation of growth rate of output per capita:

$$\frac{\Delta y_t}{y_y} = \alpha_0 + \varphi_1\frac{\Delta k_t}{k_t} + \delta_1 In\frac{\Delta k_t}{k_t} + \varphi_2\frac{\Delta h_t}{h_t} + \delta_2 In\frac{\Delta h_t}{h_t} + \varepsilon_t \qquad (10)$$

The final basic equation that we got in our theoretical model can use to test the impact of institution on the growth by the influence of institution's quality on the productivity of physical and human capital. In addition, we explain the coefficient estimates for $\varphi_1, \varphi_2, \delta_1, \delta_2$. The coefficient φ_1 and φ_2 measure the return to physical and human capital investments (the productivity of capital investments) in a country with the worst possible institutional quality, while coefficient δ_1 and δ_2 showing an increasing return to these capital investments as the country's institutional quality improves to the ideal level for economy based of market foundations.

Measuring problems with institutional quality and their influence of growth

In our theoretical model of institutions, capital and growth we can see that some parameters are relatively easy to measure, for example, K is amount of physical capital and H

[8] Where symbol, Δ, denotes changes of parameters.

is human capita that measure by years of schooling. On the other hand, institutions are not easily to quantifiable and this makes problem to measure the influence of institutions to economic growth. Economists try to solve the problem with measuring the quality of institutions by including some instrumental variables.

First, we will define the range of institutions and put some variables to measure different aspects of institutional environment. Institutions are the rule of game and it encompasses different type of social arrangements, laws, regulation, enforcement of property rights and so on. This definition of institutions is very widely and we can learn relatively little by emphasizing the importance of such a broad set of institutions. It is therefore important to try to understand what types of institutions are more important for economic growth. This is very useful for our empirical analysis of institutions and economic growth. There three type of institutions: political, financial and economic institutions. The quality of each of these type of institutions are measured through different variables. For example, the main variables for political institutions are: political rights and civil liberties that contain the political freedom index, rule of law that contain rule of law index, control of corruption and corruption freedom that contain index of corruption and other variables. On the other hand, the main variables of economic institutions are: protection of property rights, regulation and business freedom index that refer to trade freedom, freedom in doing business, financial freedom, investment freedom, and quality of regulation system.

The investigation of relative roles of different types of institutions is very important because as we can see above different type of institution have different influence of growth and economic performance. The economic institutions have the major role for growth, and in this regard when economist testified the relationship between institutions and growth, have to measure variables that cause quality of economic institutions more that quality of political institutions.

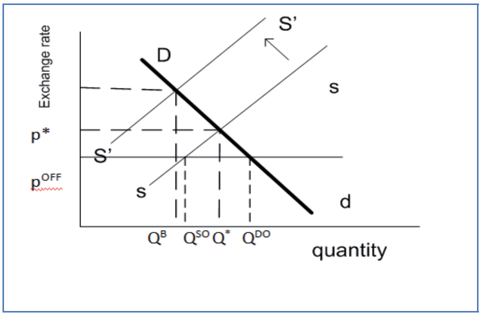
Data and the methodology

Data are from 212 groups of countries and geographic regions. These cross-country data were used in more than one study, including those from Dollar and Kraay (2003). In our study we are going to test the influence of institutions on average GDP growth per capita at PPP. The other variables are:

Rulellaw-law and order rating, we use this variable as proxy for quality of institutions, this variables is expected to be positively correlated with the average growth of GDP per capita.

Wardead-war casualties, **frehouserating**-freedom house rating, **cima_v**-contractintensive money (measure of property rights), **revolution**-revolutions, these variables are proxies for rulellaw. These variables are being used as instruments for rule of law variable and are proxies for quality of institutions.

gdppercap~a-average GDP per capita growth at PPP. This variable is variable of interest in our study. Dependent variable is being expressed in per capita terms and PPP conversion factor for more comparable result has been added. This variable is expressed in log terms.
govconshar~p-government consumption as share of GDP. This variable is expected to be positively correlated with average GDP per capita growth variable. This variable is expressed in log terms.
fdiinflow_~p-FDI inflows as percentage to GDP.
linvestmen~p-log of investment as fraction to GDP
lnbmp-this variable is log of (1+black market premium). Black market premium refers to the amount in excess of the official exchange rate that must be paid to purchase foreign exchange on an illegal ("black") market. Black market premium when the official rate is not market clearing is presented on the next graph. The premium typically arises when a country fixes the value of its exchange rate in relation to another currency irrespective of the rate that would prevail in the commercial market. It is akin to the authorities' fixing a price for a commodity at a non-market-clearing level.



In figure 1, schedule DD reflects demand for foreign exchange, while schedule SS reflects the supply. Under normal circumstances DD will be downward sloping, meaning that demand for foreign exchange will be greater as the price (in units of domestic currency) declines. Similarly, SS will slope upward, since additional foreign currency will be supplied to the market only as the price (in units of local currency per unit of foreign currency) increases. Provided normal economic conditions prevail, the market can be expected to clear at price P*, where the supply and demand schedules intersect. At this price, quantity Q* of foreign exchange will be bought and sold. When a nation fixes its exchange rate at a nonmarket-clearing rate, the normalmarket mechanism is disrupted. At the official exchange rate, POFF, demand for foreign exchange, QDO, exceeds the available supply, QSO. Those wishing to purchase foreign exchange cannot obtain it at the official price in the commercial market. If they seek to obtain foreign exchange from a private source, rather than using the queuing mechanism established by the authorities, they will need to pay more than the official price.The margin will reflect the scarcity value of the foreign exchange, plus a premium to compensate sellers for participating in an illegal (‘‘black’’) market. This risk can be depicted by a leftward (upward) shift in the supply curve to S0S0, making the market-clearing exchange rate, PB, likely to exceed the clearing rate in a legal market. The difference between the clearing rate in the illegal market, PB, and the official exchange rate, POFF, is the black market premium. This variable it is expected to be negatively correlated wioth the average growth of GDP per capita.

Instrumental variables (2SLS) versus OLS

An **Instrumental Variable** is a variable that is correlated with *X* but uncorrelated with *e*.

If Z_i is an instrumental variable:

1. $\mathrm{E}(Z_i X_i) \neq 0$
2. $\mathrm{E}(Z_i e_i) = 0$

The econometrician can use an instrumental variable *Z* to estimate the effect on *Y* of only that part of *X* that is correlated with *Z*. Because *Z* is uncorrelated with *e*, any part of *X* that is correlated with *Z* must also be uncorrelated with *e*. An instrumental variable lets the econometrician find a part of X that behaves as though it had been randomly assigned. When the economist is worried about measurement error, a good choice of instrument is simply a different measure of the same variable. The new measure may have its own errors, but these errors are unlikely to be correlated with the mistakes in the first measure, or with any other component of *e* (Murray, 2006). Instrumental variables are NOT the explanator of interest. We do not simply use instrumental variables as proxies for the explanator of interest.
Instead, we use IV’s as a tool to tease out the “random” (or at least uncorrelated) component of *X*. Let’s construct a consistent IV estimator for the case of measurement error.

1. $Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \quad E(\varepsilon_i) = 0$

2. $Var(\varepsilon_i) = \sigma_\varepsilon^2 < \infty \quad Cov(\varepsilon_i, \varepsilon_j) = 0, i \neq j$

3. $E(X_i, \varepsilon_i) = 0, \quad \frac{1}{n}\sum(x_i^2) \to \sigma_X^2 < \infty$

4. $M_i = X_i + v_i \quad E(v_i) = 0$

5. $Var(v_i) = \sigma_v^2 \; Cov(v_i, v_j) = 0, i \neq j$

6. $Cov(v_i, X_i) = 0 \; Cov(Z_i, X_i) \neq 0$

7. $Cov(Z_i, \varepsilon_i) = 0$

If X_i were uncorrelated with e_i , we would want to weight more heavily observations with a high x_i value. We know that Z_i is correlated with the "clean" part of X_i , so now we want to weight more heavily observations with a high z_i value. Here we ask question what is expectation for IV?

$$E(\hat{\beta}_i^{IV}) = E\left(\frac{\sum z_i Y_i}{\sum z_i x_i}\right) = E\left(\frac{\sum z_i(\beta_0 + \beta_1 X_i + \varepsilon_i)}{\sum z_i x_i}\right)$$
$$= \beta_1 E\left(\frac{\sum z_i X_i}{\sum z_i x_i}\right) + \left(\frac{\sum z_i \varepsilon_i}{\sum z_i x_i}\right)$$
$$= \beta_1 + \sum E\left(\frac{\sum z_i \varepsilon_i}{\sum z_i x_i}\right)$$

Because $Cov(X_i, \varepsilon_i) \neq 0$, the bias term cannot be eliminated IV is biased in the same direction as the bias in OLS.

A variable Z_i can instrument for a particular troublesome explanator, X_{Ri}, if:

$Cov(Z_i, X_{Ri}) \neq 0$

$Cov(Z_i, e_i) = 0$

Z_i must be correlated with the troublesome variable for which it instruments, but need not be correlated with all of the troublesome variables. To estimate a multiple regression consistently, we need at least one instrumental variable for each troublesome explanator. When we have just enough instruments for consistent estimation, we say the regression equation is **exactly identified**. When we have more than enough instruments, the regression equation is **over identified**. When we do not have enough instruments, the equation is **under identified** (and inconsistent). An **Instrumental Variable** is a variable that is correlated with X but uncorrelated with e.

If Z_i is an instrumental variable:

$E(Z_i X_i) \neq 0$

$E(Z_i e_i) = 0$

If X_i were uncorrelated with e_i, we would want to weight more heavily observations with a high x_i value.We know that Z_i is correlated with the "clean" part of X_i, so now we want to weight more heavily observations with a high z_i value.

Beta estimator is

$$\hat{\beta}^{IV} = \frac{\sum z_i Y_i}{\sum z_i x_i}$$

When the regression is under identified, then we do not have a consistent estimator.
When the regression is exactly identified, then we simply use Instrumental Variables Least Squares. When the regression is over identified, we have more instruments than we need. The methods we learned last time are only suitable for the exactly identified case. When the regression equation is over identified, we have more instruments than we need. We could simply discard the additional instruments, but then we throw out valuable information. Ignoring valid instruments is inefficient. Standard OLS estimator is BLUE best linear unbiased estimator, to test whether OLS coefficients or 2SLS coefficients are better we are going to perform Hausman test. The Hausman specification test performs test of significance of one estimator versus alternative estimator

Panel Fixed effects IV model versus Random effects IV model

Potential unobserved heterogeneity is a form of omitted variables bias."Unobserved heterogeneity" refers to omitted variables that are fixed for an individual (at least over a long period of time). With cross-sectional data, there is no particular reason to differentiate between omitted variables that are fixed over time and omitted variables that are changing. However, when an omitted variable is fixed over time; panel data offers another tool for eliminating the bias. **Panel Data** is data in which we observe repeated cross-sections of the same individuals. Examples:

– Annual unemployment rates of each state over several years
– Quarterly sales of individual stores over several quarters
– Wages for the same worker, working at several different jobs

By far the leading type of panel data is repeated cross-sections over time. The key feature of panel data is that we observe the same individual in more than one condition. Omitted variables that are fixed will take on the same values each time we observe the same individual. The Fixed Effects Estimator basic idea is to estimate a separate intercept for each individual.

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_1 X_{1it} + v_i + \mu_{it}$$

$$-Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_1 X_{1it} + v_i + \mu_{it,}$$

$$(Y_{it} - Y_{it}) = 0 + \beta_1 \left(X_{it} - X_{it,}\right) + 0 + 0 + \mu_{it} - \mu_{it}$$

When we difference, the heterogeneity term v_i drops out. (In the distinct intercepts model, the b_{0i} would drop out). By assumption, the m_{it} are uncorrelated with the X_{it} OLS would be a consistent estimator of b_1.

When unobserved heterogeneity is uncorrelated with explanators, panel data techniques are not needed to produce a consistent estimator. However, we do need to correct for serial correlation between observations of the same individual. When $E(X_{it}, v_i) = 0,$, panel data does not offer special benefits. We use Random Effects to overcome the serial correlation of panel data. The key idea of random effects:

- Estimate s_v^2 and s_m^2
- Use these estimates to construct efficient weights of panel data observations

Once we have estimates of s_v^2 and s_m^2, we can re-weight the observations optimally.

These calculations are complicated, but most computer packages can implement them.

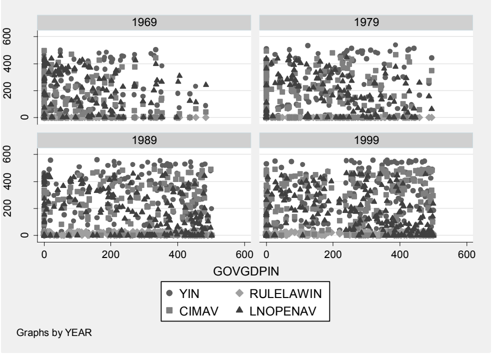
Descriptive statistics of the model

Descriptive statistics of the model is given in the following table

Variable	Obs	Mean	Std. Dev.	Min	Max
lgdppercap~a	848	191.1038	184.5586	1	560
rulellaw	848	5.643868	9.014775	1	31
lavertrade	848	125.4929	150.5476	1	460
govconshar~p	848	150.888	166.4599	1	502
lnbmp	848	110.2618	132.5916	1	420

linvestmen~p	848	3.576252	2.632151	0	6.326149
fdiinflow_~p	848	125.5778	148.9089	1	458
cima_v	848	145.7642	163.9984	1	496
wardead	848	12.44458	28.41316	1	133
revolution	848	4.548349	5.94604	1	30
frehousera~g	848	11.05896	13.34896	1	37

In our sample we use decadal data. Sample contains 4 observations for each of 212 groups in the panel, contains data from 1969-1979,1979-1989, and 1989-1999. Moving of the variables through four decades is shown on the next graphs.



Where YIN here is annual average growth of GDP pre capita in PPP terms variable. Cimav are contract intensive money. Contract Intensive Money (CIM) = (M2 - money outside the banking system)/M2 where M2= Money + Quasi money. Proportion of money supply held by the banking system, sometimes interpreted as a proxy for the rule of law or an indicator of the credibility of financial institutions.LNOPENAV is natural logarithm of the average trade openness of the country, i.e. Average trade. RULELAWIN is the rule of law variable it law and order rating variable.

2SLS VS OLS [9]

2SLS regression is modeled as follows:

[9] See Appendix 1 2SLS regression

$$\ln(GDPpercapita) = \beta_0 + \beta_1 institutions + \beta_2 Trade + \beta_3 controls + u_i$$

Dependent variable log of GDP per capita in PPP terms.

Instrumental variables (2SLS) regression	Variables	Coefficients	p-value P>|t|
rulellaw	Rule of law proxy for quality of institutions	11.45504	0.005
lavertrade	Log of average trade	-0.0905889	0.071
lnbmp	Log of black market premium	-0.1623014	0.000
linvestmen~p	Log of investment as a fraction to GDP	31.56	0.000
govconshar~p	Government consumption as a share to GDP	0.1011464	0.114
fdiinflow_~p	FDI inflows as proportion to GDP	0.126112	0.003
_cons	Constant term	11.75178	0.285

Instrumented: rulellaw

Instruments: lavertrade lnbmp linvestmentgdp govconsharegdp fdiinflow_gdp frehouserating revolution cima_v

From the above Table we can see that the rule of law is highly positively correlated with growth, coefficient is 11.45, p-value is 0.005, meaning that the coefficient is statistically significant at all conventional levels. This is expected positive sign from the theory. Coefficient on the logarithm of average trade is small of size (-0.09), but is statistically significant up to 7% level of significance. Growth is positively correlated with average trade, but trade compared with other explanatory variables here has negative sign, meaning that compared to the institutions is growth deteriorating. Logarithm of black market premium exerts negative sign, which is expected from the *apriori* knowledge. Black market is non-regulated market that doesn't pay taxes to the country in which exists coefficient is -0.16, and is significant at all conventional levels. Private investment and government consumption as a fraction to GDP are expectedly positively correlated with growth with coefficients of 31.56 and 0.11 respectively. And Investment as a fraction to GDP is significant at all conventional levels, while government consumption is almost significant at 10% level of significance. FDI are positively correlated with growth as it is expected from the theory with a sign 0.12. Here instruments for Rule of law are contract intensive money, war casualties and revolutions. OLS regression is presented in a Table [10]

Dependent variable log of GDP per capita in PPP terms.			
Ordinary least squares regression	Variables	Coefficients	p-value P>|t|
rulellaw	Rule of law proxy for quality of institutions	5.024089	0.000
lavertrade	Log of average trade	-0.0384768	0.268
lnbmp	Log of black market premium	-0.1948633	0.000
linvestmen~p	Log of investment as a fraction to GDP	33.33	0.000
govconshar~p	Government consumption as a share to GDP	0.1868692	0.000
fdiinflow_~p	FDI inflows as proportion to GDP	0.1501029	0.000
_cons	Constant term	22.83623	0.003
Ramsey Reset test using powers of the fitted values of the dependent variable			
		F(3, 838) = 1.78	
		Prob > F = 0.1490	

From the above Table only the coefficient of trade is negative and insignificant at all conventional levels. Rule of law as a proxy for institutional quality is again as expected positively correlated with growth, coefficient of 5.02 and highly significant at all levels of significance. Black market premium is negative -0.19 and is significant at all conventional levels. Investment as fraction to GDP, government consumption as a share to GDP and FDI inflows as a fraction to GDP are positively correlated with growth. Coefficients respectively are: 33.33,0.18 and 0.15 and are significant at all conventional levels. Ramsey Reset test showed that the model does not suffer from omitted variables bias. If we reject the null hypothesis of no omitted variables , probability of making Type I error is 15%.

Hausman test

[10] See Appendix 2 OLS regression

This command computes the Hausman test statistic. The null hypothesis is that the OLS estimator is consistent. If accepted, we probably would prefer to use OLS instead of 2SLS. The option constant is necessary to tell Stata to include the constant term in the comparison of both estimates. The sigmamore option tells Stata to use the same estimate of the variance of the error term for both models. This is desirable here since the error term has the same interpretation in both models. The df(1) option tells Stata that the null distribution has one degree of freedom. Stata was able to figure this out when I left this option out, even though the Hausman test is comparing values of two 5- element (not one-element) vectors. It probably knew this by finding only one non-zero eigenvalue of the 5-by-5 covariance matrix estimate that it calls (V_b-V_B) in the output. It's safer to impose the d.f. in the hausman command as above.

```
                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     ivreg          .           Difference          S.E.

    rulellaw |    11.45504     5.024089        6.43095        3.736097
  lavertrade |   -.0905889    -.0384768      -.0521121        .0302748
       lnbmp |   -.1623014    -.1948633        .032562        .0189171
linvestmen~p |       31.56     33.32564      -1.765634        1.025755
govconshar~p |    .1011464     .1868692      -.0857229        .0498012
fdiinflow_~p |     .126112     .1501029      -.0239909        .0139376
       _cons |    11.75178     22.83623      -11.08445        6.439575
```

b = consistent under Ho and Ha; obtained from ivreg

B = inconsistent under Ha, efficient under Ho; obtained from regress

Test: Ho: difference in coefficients not systematic

chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 2.96

Prob>chi2 = 0.0852

(V_b-V_B is not positive definite)

From the above result from Hausman test, we can see that OLS is acceptable at 1% and 5% level of significance, but not at 10% .Otherwise 2SLS squares would be more preferable.

<u>Over identification test[11]</u>

Next are presented results from the overidentification test.

scalar list x^2 pval

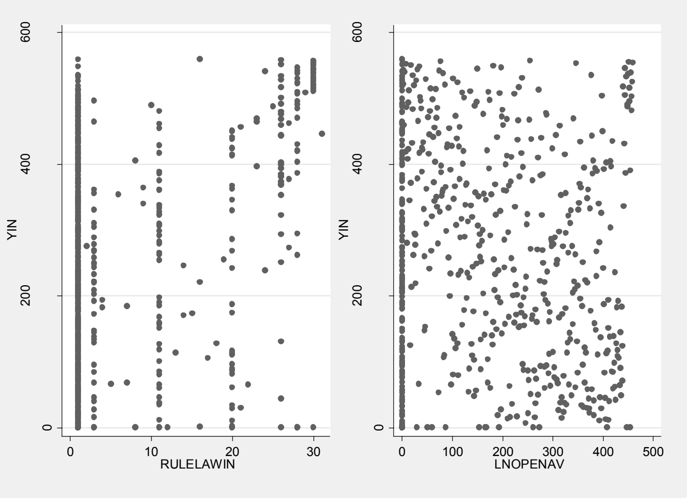
x^2 = 474.82519

pval = 0

So at all conventional levels of significance we can drop hypothesis that instruments are exogenous. We can drop one or two of them but we can't be sure if that solves the problem.

[11] See Hausman test in Appendix 3

So in conclusion about this part we can say that OLS won the battle and is better estimator than OLS , since it has better results in Hausman test and 2SLS did not show good overidentification test. From the below scatters it is evident that Rule of law variable and openness variable are positively correlated with growth.



G2SLS random-effects (RE) model

IV estimation can also be combined with panel data models in a straight forward manner Recall, that under the assumption of unobserved heterogeneity we removed the unobserved heterogeneity by either first differencing or fixed effects. This left us back in the world of OLS. However, one of the demeaned or first-differenced repressors could still be correlated with the error term, suggesting that IV could be helpful. *Ctry* variable i.e. country is panel IIS , ID variable. [12]

[12] See Appendix 4 G2SLS random-effects (RE) model

Dependent variable log of GDP per capita in PPP terms.

Instrumental variables (G2SLS) regression Random effects model	Variables	Coefficients	p-value P>|t|
rulellaw	Rule of law proxy for quality of institutions	1.622535	0.000
lavertrade	Log of average trade	-0.0008549	0.981
linvestmen~p	Log of investment as a fraction to GDP	0.3291961	0.000
govconshar~p	Government consumption as a share to GDP	0.1058485	0.011
_cons	Constant term	65.90368	0.000

Group variable :ctry
Instrumented: rulellaw

Instruments: lavertrade investmentgdp govconsharegdp frehouserating wardead revolution cima_v

From the above regression we can see that rulellaw variable which is being used as proxy for quality of institutions, is positively correlated with growth of GDP per capita variable at PPP terms, coefficient is 1.6 and p-value is 0.000. Coefficient on Trade is highly insignificant, pvalue is 0.981. Investment and government consumption are positively and statistically significant with coefficients 0.32 and 0.11 respectively.
As conclusion Trade is insignificant to growth compared with institutions.

Fixed effects regression (within)IV model[13]

In the next Table is presented Fixed effects panel regression IV model with panel ID variable ctry.

[13] See Appendix 5 Fixed effects regression (within)IV model

Dependent variable log of GDP per capita in PPP terms.			
Fixed effects regression (within)IV model	Variables	Coefficients	p-value P>|t|
rulellaw	Rule of law proxy for quality of institutions	1.579087	0.000
lavertrade	Log of average trade	-0.020254	0.640
linvestmen~p	Log of investment as a fraction to GDP	0.2575612	0.000
govconshar~p	Government consumption as a share to GDP	0.0961099	0.024
_cons	Constant term	84.53991	0.000
Group variable :ctry			

In conclusion institutions and investment as fraction to GDP and government consumption as share to GDP are positively and statistically significantly correlated.

Appendix 2SLS regression

```
Instrumental variables (2SLS) regression

      Source |       SS       df       MS              Number of obs =     848
-------------+------------------------------           F(  6,   841) =  124.71
       Model |  13000377.3     6  2166729.55           Prob > F      =  0.0000
    Residual |  15850017.6   841  18846.6321           R-squared     =  0.4506
-------------+------------------------------           Adj R-squared =  0.4467
       Total |  28850394.9   847  34061.8593           Root MSE      =  137.28

------------------------------------------------------------------------------
lgdppercap~a |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    rulellaw |   11.45504   4.102134     2.79   0.005     3.403417    19.50666
  lavertrade |  -.0905889   .0500865    -1.81   0.071    -.1888982    .0077204
       lnbmp |  -.1623014   .0445351    -3.64   0.000    -.2497144   -.0748884
linvestmen~p |      31.56   2.686769    11.75   0.000     26.28644    36.83356
govconshar~p |   .1011464   .0639289     1.58   0.114    -.0243325    .2266253
fdiinflow_~p |    .126112   .0420451     3.00   0.003     .0435863    .2086377
       _cons |   11.75178   10.98684     1.07   0.285    -9.813075    33.31663
------------------------------------------------------------------------------
Instrumented:  rulellaw
Instruments:   lavertrade lnbmp linvestmentgdp govconsharegdp fdiinflow_gdp
               frehouserating revolution cima_v
------------------------------------------------------------------------------
```

Appendix 2 OLS regression

```
      Source |       SS       df       MS              Number of obs =     848
-------------+------------------------------           F(  6,   841) =  161.59
       Model |  15449333.1     6  2574888.86           Prob > F      =  0.0000
    Residual |  13401061.7   841  15934.6751           R-squared     =  0.5355
-------------+------------------------------           Adj R-squared =  0.5322
       Total |  28850394.9   847  34061.8593           Root MSE      =  126.23

------------------------------------------------------------------------------
lgdppercap~a |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    rulellaw |   5.024089   .5187478     9.69   0.000     4.005897    6.042282
  lavertrade |  -.0384768   .0347058    -1.11   0.268    -.1065969    .0296433
       lnbmp |  -.1948633    .036319    -5.37   0.000    -.2661499   -.1235767
linvestmen~p |   33.32564   2.247488    14.83   0.000     28.91429    37.73698
govconshar~p |   .1868692   .0312295     5.98   0.000     .1255722    .2481662
fdiinflow_~p |   .1501029    .036061     4.16   0.000     .0793227     .220883
       _cons |   22.83623   7.784074     2.93   0.003     7.557735    38.11472
------------------------------------------------------------------------------
Ramsey RESET test using powers of the fitted values of lgdppercapita
       Ho:  model has no omitted variables
                 F(3, 838) =      1.78
                  Prob > F =      0.1490
```

Appendix 3 Hausman test

quietly reg ivresid ruleoflaw lavertrade investmentgdp govconsharegdp

. predict explresid,xb

. matrix accum rssmat = explresid,noconstant
(obs=848)

. matrix accum rssmat = explresid,noconstant
(obs=848)

. matrix accum tssmat = ivresid,noconstant
(obs=847)

. scalar nobs=e(N)

. scalar x2=nobs*rssmat[1,1]/tssmat[1,1]

. scalar pval=1-chi2(1,x2)

. scalar list x2 pval

x2 = 474.82519
pval = 0

Appendix 4 G2SLS random effects IV regression

```
G2SLS random-effects IV regression              Number of obs      =       848
Group variable: ctry                            Number of groups   =       212

R-sq:  within  = 0.3022                         Obs per group: min =         4
       between = 0.6248                                        avg =       4.0
       overall = 0.4837                                        max =         4

                                                Wald chi2(4)       =    437.92
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
lgdppercap~a |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   ruleoflaw |   1.622535    .257857     6.29   0.000     1.117144    2.127925
  lavertrade |  -.0008549   .0366775    -0.02   0.981    -.0727415    .0710317
investment~p |   .3291961   .0285336    11.54   0.000     .2732712     .385121
govconshar~p |   .1058485   .0417191     2.54   0.011     .0240807    .1876164
       _cons |   65.90368   11.21311     5.88   0.000     43.92639    87.88097
-------------+----------------------------------------------------------------
     sigma_u |  128.00592
     sigma_e |  91.331967
         rho |  .66265566   (fraction of variance due to u_i)
------------------------------------------------------------------------------
Instrumented:   ruleoflaw
Instruments:    lavertrade investmentgdp govconsharegdp frehouserating wardead revolution
                cima_v
------------------------------------------------------------------------------
```

Appendix 5 Panel Fixed effect IV regression

```
Fixed-effects (within) IV regression         Number of obs      =         848
Group variable: ctry                         Number of groups   =         212

R-sq:  within  = 0.1198                      Obs per group: min =           4
       between = 0.6100                                     avg =         4.0
       overall = 0.4553                                     max =           4

                                             Wald chi2(4)       =     3974.14
corr(u_i, Xb)  = 0.2832                      Prob > chi2        =      0.0000

------------------------------------------------------------------------------
lgdppercap~a |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   ruleoflaw |   1.579087   .2395886     6.59   0.000     1.109502    2.048672
  lavertrade |   -.020254   .0432842    -0.47   0.640    -.1050896    .0645816
investment~p |   .2575612   .0336336     7.66   0.000     .1916405    .3234819
govconshar~p |   .0961099   .0425786     2.26   0.024     .0126573    .1795625
       _cons |   84.53991   8.688616     9.73   0.000     67.51053    101.5693
-------------+----------------------------------------------------------------
     sigma_u |   111.5128
     sigma_e |  91.331967
         rho |  .59851397   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(211,632) =     4.94         Prob > F    = 0.0000
------------------------------------------------------------------------------
```

References

1. Acemoglu, Daron, Simon Johnson, and James A. Robinson, "The Colonial Origins of Comparative Development: An Empirical Investigation." *American EconomicReview* 91, no. 5 (December 2001), pp. 1369-140
2. Barro, Robert J., "Democracy and Growth." *Journal of Economic Growth* 1, no. 1 (1996), pp. 1-27.
3. Dollar,D, Kraay,A,(2003), Institutions, Trade, and Growth Revisiting the Evidence,The World bank working paper
4. Gwartney, James, and Robert Lawson, *Economic Freedom of the World Annual Report 2003.* Vancouver, B.C.: Fraser Institute, 2003.
5. Green, William. 1993. Econometric Analysis. Second Edition. Macmillan. Canada.
6. Gujarati, Damodar. 2003. Basic Econometrics. Fourth Edition. McGraw Hill. USA.
7. Hall, Robert E., and Charles I. Jones, "Why Do Some Countries Produce So Much More Output Per Worker than Others?" *Quarterly Journal of Economics* 114, no. 1(February 1999), pp. 83-116.
8. Murray, P.,Michael(2006), Econometrics A modern introduction, Pearson ,Addison - Wesley
9. Scully, Gerald W., "The Institutional Framework and Economic Development." *Journal of Political Economy* 96, no. 3 (June 1988), pp. 652-662.
10. Wooldridge, Jeffery. 2006. Introductory Econometrics. A modern approach. Third Edition. Thomson. Canada.

Labor market and natural rate of unemployment in US and Canadian time series analysis

Dushko Josheski (dushkojosheski@gmail.com)
Darko Lazarov (darko.lazarov@ugd.edu.mk)

Abstract

Canadian labor market data are being used in this paper. These series are quarterly data from 1980 Q1 to 2000 Q4. This series are stationary by test for cointegration I(0), meaning that there exist equilibrium relationship between the time series labour productivity (prod), employment (e), unemployment rate (U), real wages (rw).This notion was definitively confirmed with VEC model. VEC model shows long run coefficient, and if the system is in disequilibrium , alteration of the variables will only be -0.003 for real wages or -0.3%, -0.001 for unemployment or -0.1%, -0.000 for productivity or -0%,and -0% for employment. This means that Canadian labour market is in equilibrium working at natural rate of unemployment and by equilibrium wages.

Key words: employment, real wages, labour productivity, VAR , VECM

Long-run Unemployment

Unemployment is one of harder and more severe macroeconomic problems for many reasons. First, the loss of a job causes reduction of income and living standard. Second, unemployment is not only macroeconomic problem, but it is social problem, that interested the society at whole. The unemployment is subject of interest especially for politicians, and the problem of unemployment is usually central topic of political debate. In that regard, economic researchers try to find out the causes of unemployment, and the policy makers try to create and implement policies that will reduce the number of unemployed.

The rate of unemployment is a stock variable that can be measured at a given point in time, and show how many people from the whole size of the population of working age (labour force) are unemployed. The labor force is the sum of the employed and the unemployed:

$$L = E + U \quad [14] \tag{1}$$

In this regard, the rate of unemployment is:

$$u = U/L \quad [15] \tag{2}$$

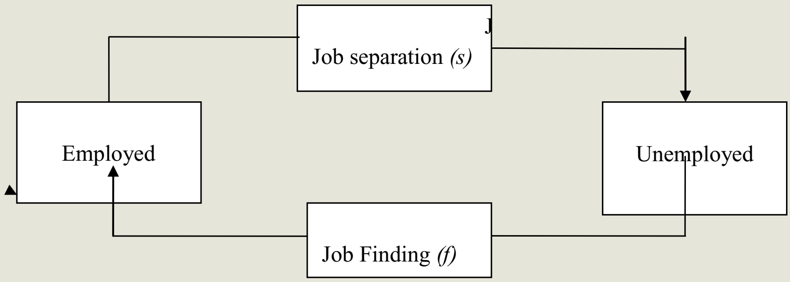
The steady-state rate of unemployment

In this section we will try to explain the factors which determine the natural rate of unemployment throughout creating the model of labour-force. Labour market is specific market in which some people find new job and other lost their jobs. Because our focus is determines of unemployment rate, we assume that the labour force is fixed, and our interest is the transition of people in the labour force between employed and unemployed. In the picture below we illustrate the previous statement. The rate of job separation s is the fraction of

[14] $L = \pi P \Rightarrow L = \pi^{w} P^{w} + \pi^{m} P^{m}$, where P is the size of population of working age, π is participation rate, P^{w} is the size of women of working age, P^{m} is the size of man of working age, π^{w} is participation rate of women, and π^{m} is participation rate of man.

[15] Multiply with 100%, because all rates, including rate of unemployment is expressed in percentage.

employed individuals who lose their job each month (or every quarter), the rate of job finding f is the fraction of unemployed individuals who find a job each month (or every quarter). Together, the rate of job separation s and the rate of job finding f determine the rate of unemployment.



The transitions between Employment and Unemployment in every period, a fraction s of the employed lose their jobs, and fraction f of the unemployed find jobs. The rates of job separation and job finding determine the rate of unemployment.

If the unemployment rate is nearly stable, that means, if the labor market is in a steady state-than the number of people finding job s must equal the number of people losing jobs. The number of people finding jobs is fU , the number of people losing jobs is sE, so we can write the steady state as

$$fU = sE \Rightarrow \text{[16]} \tag{3}$$

$$fU = s(L - U) \tag{4}$$

To solving the mathematical equation for the rate of unemployment, we divide both sides of equation by L to obtain:

$$f\frac{U}{L} = s(1 - \frac{U}{L}) \tag{5}$$

[16] Form previous equation, $L = E + U \Rightarrow E = L - U$.

Now we can solve for $\frac{U}{L}$ to find

$$\frac{U}{L} = \frac{s}{s+f} \quad (6)$$ [17]

From this equation we can conclude that the steady-state rate of unemployment *u=U/L* depends on the rates of job separation and job finding. That means when the rate of job separation increase, the rate of unemployment also increases. On the other hand, when the rate of job finding increase, the rate of unemployment decrease.

In addition, we will present empirical estimation for natural rate of unemployment by job fining and job separation.

$$u = \frac{U}{L} = \frac{7{,}29}{7{,}29 + 8{,}20}$$
$$= 8{,}18$$

The rate of unemployment in American (first quarter of 1995) is 8.18 percent.

$$u = \frac{U}{L} = \frac{6{,}69}{6{,}69 + 7{,}11}$$ [18]
$$= 7{,}63$$

The rate of unemployment in American (first quarter of 2005) is 7.63 percent.

---

[17] Mathematical note: If in equation $f\frac{U}{L} = s(1 - \frac{U}{L})$ we substitute *(E+U)* for *L*, we find $f\frac{U}{L} = s(1 - \frac{U}{E+U}) \Rightarrow f\frac{U}{L} = s(\frac{E + U - U}{E+U})$ if we substitute $\frac{s}{f}E$ for *U*, in the right side of the equation, we obtain: $f\frac{U}{L} = s(\frac{E}{E + \frac{s}{f}E})$ we can rearrange the equation $f\frac{U}{L} = s(\frac{E}{E(\frac{f+s}{f})})$, for $\frac{U}{L}$ the final equation is: $\frac{U}{L} = \frac{s}{s+f}$.

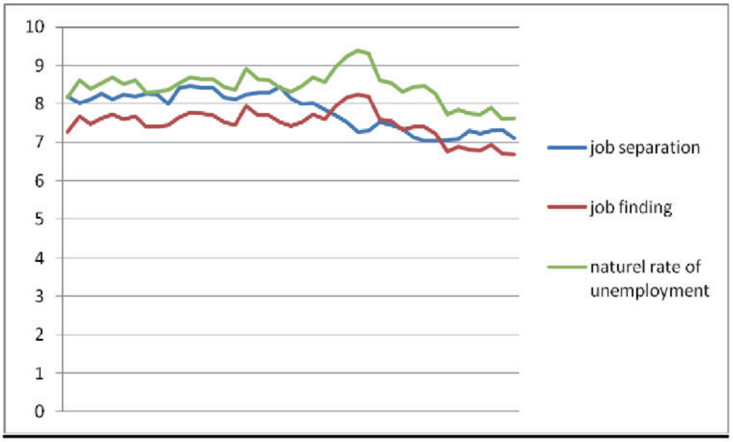
[18] These estimations are based on data for American economy.

Tabel.1 Natural rate of unemployment (steady-state unemployment rate)[19]

year/ er	job finding (f	job separation (s)	rate of unemployment (r)
1995/1	8,20	7,29	8,18
1995/2	8,01	7,67	8,62
1995/3	8,11	7,48	8,40
1995/4	8,26	7,62	8,54
1996/1	8,11	7,72	8,68
1996/2	8,24	7,59	8,51
1996/3	8,20	7,68	8,61
1996/4	8,28	7,40	8,30
1997/1	8,24	7,41	8,31
1997/2	8,00	7,44	8,37
1997/3	8,43	7,64	8,55
1997/4	8,47	7,77	8,69
1998/1	8,42	7,74	8,65
1998/2	8,43	7,71	8,63
1998/3	8,18	7,53	8,45
1998/4	8,11	7,44	8,36
1999/1	8,25	7,95	8,92
1999/2	8,29	7,70	8,63
1999/3	8,30	7,69	8,61
1996/4	8,44	7,52	8,41
2000/1	8,14	7,42	8,33
2000/2	8,00	7,53	8,47
2000/3	8,01	7,73	8,69
2000/4	7,85	7,60	8,57
2001/1	7,71	7,94	8,97
2001/2	7,52	8,16	9,24
2001/3	7,27	8,25	9,39
2001/4	7,31	8,20	9,32
2002/1	7,53	7,60	8,61
2002/2	7,45	7,54	8,55
2002/3	7,36	7,32	8,32
2002/4	7,13	7,40	8,44
2003/1	7,02	7,41	8,46
2003/2	7,04	7,24	8,27
2003/3	7,06	6,76	7,72
2003/4	7,08	6,88	7,86
2004/1	7,31	6,81	7,75
2004/2	7,22	6,79	7,73
2004/3	7,30	6,94	7,90
2004/4	7,34	6,70	7,61
2005/1	7,11	6,69	7,63

Picture1.The natural rate of unemployment flow

[19] The estimation is based on data from The flow approach to Labor markets: Davis, Faberman and Haltiwanger (2006, Journal of Economic Perspectives)



Data description

In this paper we use Canadian time series for, labour productivity (prod), employment (e), unemployment rate (U), real wages (rw).

Original time series are from OECD database, OECD Main Economic Indicators:

- 444113DSA Canadian unemployment rate in %
- 444321KSA Canadian manufacturing real wage index
- 445241K Canadian consumer price index
- OECD Quarterly National Accounts:
- CAN1008S1 Canadian nominal GDP
- OECD Quarterly Labour Force Statistics:
- 445005DSA Canadian civilian employment in 1000 persons

The data included in this file are obtained by the following transformations:

prod = 100*(log(CAN1008S1/445241K)-log(445005DSA))

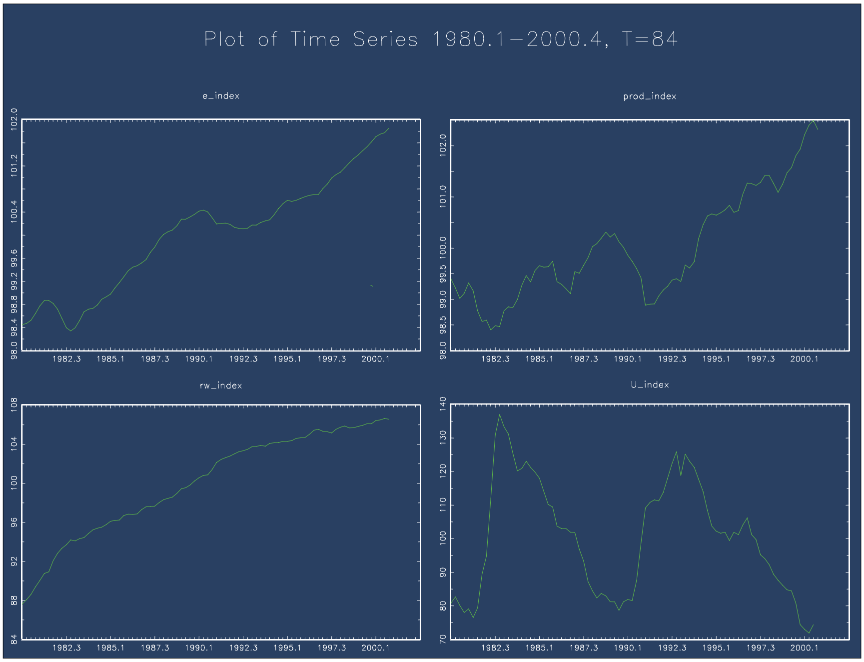
e = 100*log(445005DSA)

U = 444113DSA

rw = 100*log(100*444321KSA)

Plot of time series

On the next page it is presented plot of time series data. This is for purpose of visual inspection of the data and to see their movement across time. These series are quarterly data from 1980 Q1 to 2000 Q4



Descriptive statistics reports standard minimum,maximum and standard deviation.

sample range: [1980 Q1, 2000 Q4], T = 84

DESCRIPTIVE STATISTICS:

variable	mean	min	max	std. dev.
e	9.44257e+02	9.28563e+02	9.61766e+02	9.10304e+00
prod	4.07821e+02	4.01307e+02	4.18003e+02	4.19131e+00
rw	4.40751e+02	3.86136e+02	4.70012e+02	

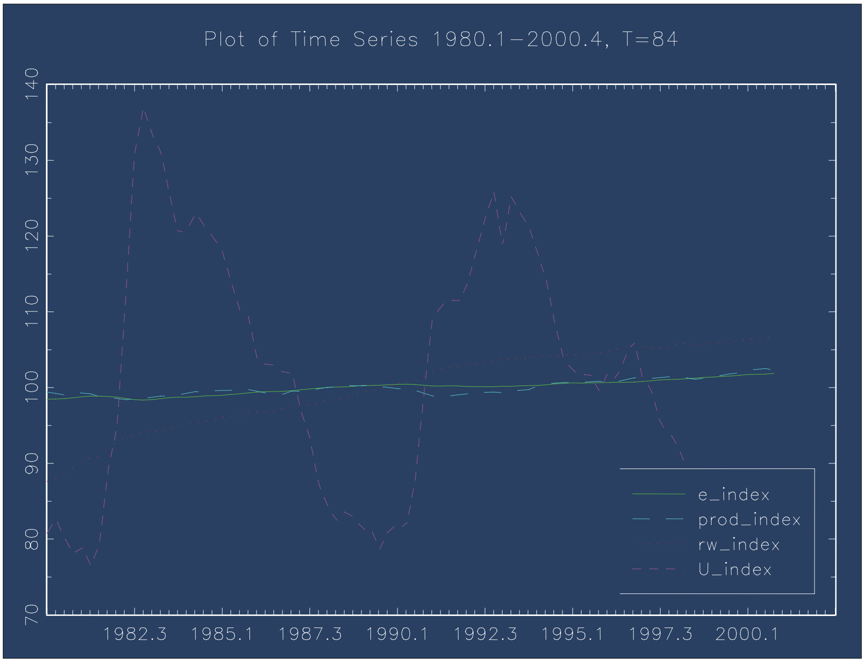
2.31316e+01

U 9.32083e+00 6.70000e+00 1.27700e+01

1.59761e+00

Plot of complete time series

On the next page is presented plot of complete time series data.



<u>Test for normality and heteroscedasticity</u>

Standard Jarque-Bera test for non-normality and test for heteroscedasticity ARCH-LM test will be applied.

```
sample range:   [1980 Q1, 2000 Q4], T = 84
JARQUE-BERA TEST
variable        teststat    p-Value(Chi^2)   skewness    kurtosis
e               3.1121      0.2110          -0.0773      2.0698
prod            6.5488      0.0378           0.6367      2.5006
rw              6.5146      0.0385          -0.5672      2.2422
U               4.5233      0.1042           0.1805      1.9220
```

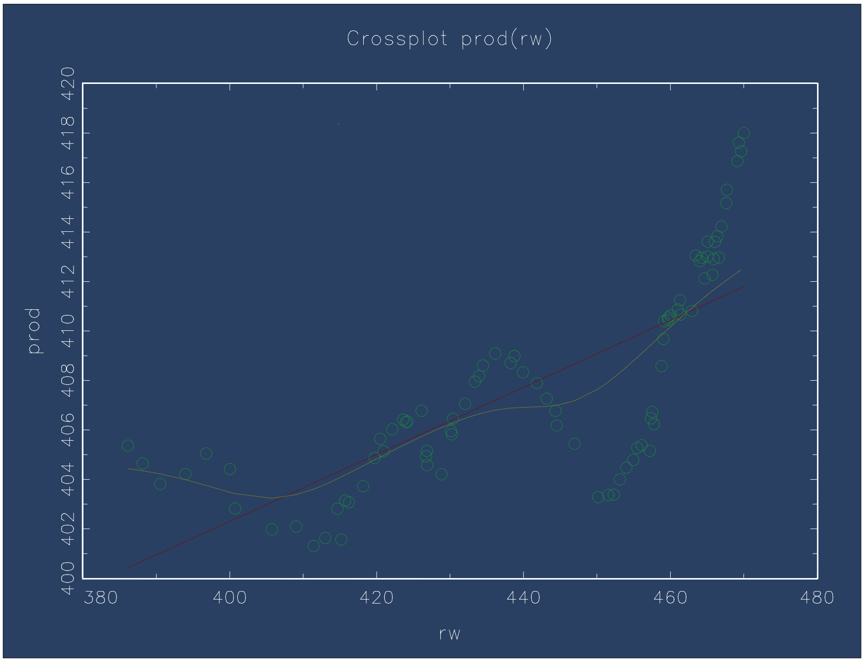
```
sample range:   [1980 Q1, 2000 Q4], T = 84
ARCH-LM TEST with 1 lags
variable        teststat   p-Value(Chi^2)  F stat     p-Value(F)
e               80.7282    0.0000          2949.4304  0.0000
prod            77.0649    0.0000          1077.7141  0.0000
rw              82.1163    0.0000          7712.4830  0.0000
U               60.8812    0.0000          228.4549   0.0000
```

Normality and heteroscdasticity are not serious problem with time series data .

Nadaraya-Watson OLS regression

Next it is presented OLS regression of labour productivity on Real wages. The relationship between variables is positive and significant. This regression is presented graphically by crossplot (see Crossplot (rw)).

```
OLS ESTIMATION
sample range:   [1980 Q1, 2000 Q4], T = 84
dependent:      prod
independent:    rw
prod =  348.0978 +  0.1355 *rw
t-values      =  {  59.3718   10.2004 }
sigma         =  2.8163
R-squared     =  0.5593
```

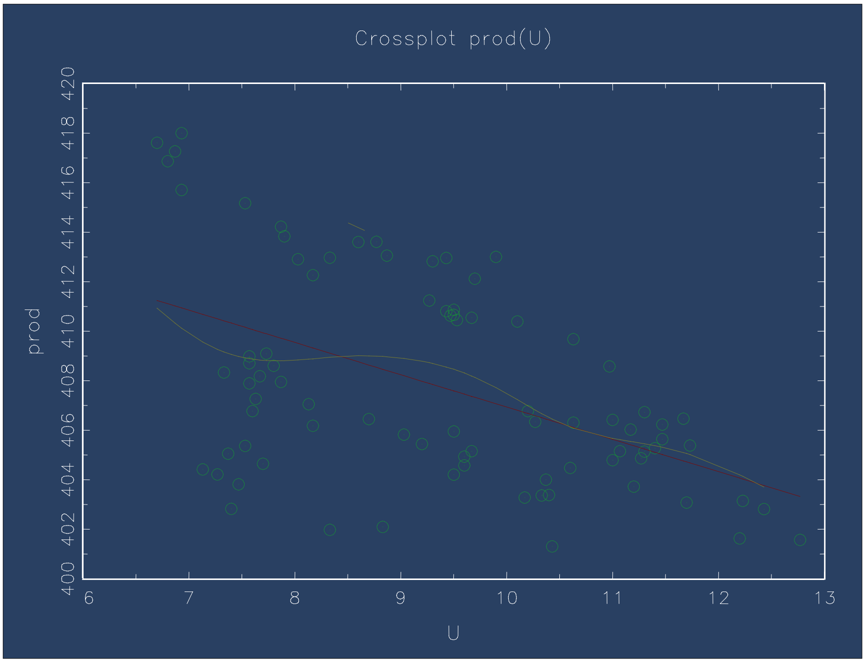


OLS ESTIMATION PRODUCTIVITY VERSUS UNEMPLYMENT

OLS estimation is done on labour productivity versus unemployment and the result is negative and significant. This crossplot is given below OLS table.

OLS ESTIMATION

```
sample range:   [1980 Q1, 2000 Q4], T = 84
dependent:      prod
independent:    U
prod =  419.9796 + -1.3045 *U
t-values      =  {  176.6793  -5.1896  }
sigma         =  3.6805
R-squared     =  0.2472
```

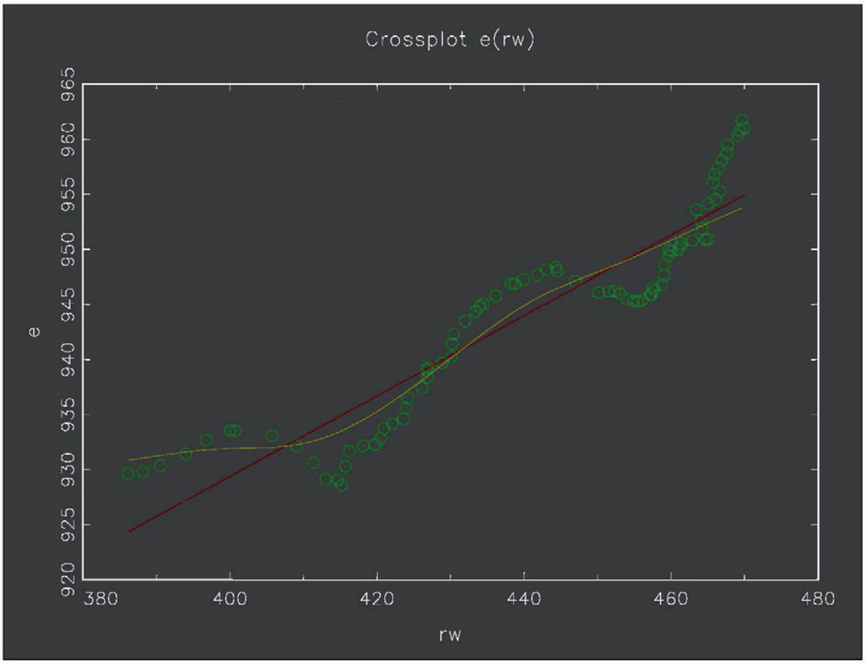


<u>OLS regression Employment vs real wages</u>

Result is presented below and the result is positive and significant. Crossplot of the regression is presented below the OLS table.

OLS ESTIMATION

```
sample range:    [1980 Q1, 2000 Q4], T = 84
dependent:       e
independent:     rw
e =   783.4157 +  0.3649 *rw
t-values       =  {   109.1200    22.4341 }
sigma          =  3.4486
R-squared      =  0.8599
```



ADF TESTS FOR TIME SERIES

ADF test have been preformed to prove whether time series are stationary.

ADF unit root test for employment

```
ADF Test for series:         e
sample range:                [1980 Q4, 2000 Q4], T = 81
lagged differences:          2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708,
table 20.1,
Oxford University Press, London
 1%          5%          10%
-3.96       -3.41       -3.13
value of test statistic: -1.9087
regression results:
```

variable	coefficient	t-statistic
x(-1)	-0.0371	-1.9087
dx(-1)	0.9281	8.6237
dx(-2)	-0.2513	-2.2257
constant	35.2013	1.9165
trend	0.0146	2.0316
RSS	11.2584	

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range: [1982 Q4, 2000 Q4], T = 73

optimal number of lags (searched up to 10 lags of 1. differences):

Akaike Info Criterion	9
Hannan-Quinn Criterion	1
Final Prediction Error	9
Schwarz Criterion	1

This variable is first difference stationary. Optimal number of lags by info criteria is (1,9).

Test for cointegration

Johansens trace test for cointegration is being delivered for employment variable.

Johansen Trace Test for: e

sample range: [1980 Q3, 2000 Q4], T = 82

included lags (levels): 2

dimension of the process: 1

trend and intercept included

response surface computed:

r0 LR pval 90% 95% 99%

```
--------------------------------------------
 0   7.65     0.2905   10.68    12.45    16.22
```

This variable employment, is I(0) variable , meaning that is stationary at fist difference.

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

```
sample range:             [1982 Q3, 2000 Q4], T = 74
optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion                                 3
Hannan-Quinn Criterion                                2
Final Prediction Error                                2
Schwarz Criterion                                     2
```

Optimal number of lags according to info criteria is 2.

<u>ADF test for labour productivity</u>

In the next table it is presented unit root test for labour productivity.

ADF test for productivity

```
ADF Test for series:      prod
sample range:             [1980 Q4, 2000 Q4], T = 81
lagged differences:       2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708, table 20.1,
Oxford University Press, London
 1%          5%          10%
-3.96      -3.41      -3.13
value of test statistic: -1.9875
regression results:
```

variable	coefficient	t-statistic
x(-1)	-0.0758	-1.9875
dx(-1)	0.2849	2.4910
dx(-2)	0.0800	0.6893
constant	31.0128	1.9953
trend	0.0139	2.1640
RSS	35.6712	

This variable has unit root and is not stationary. Optimal number of lags is 1.

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range: [1982 Q4, 2000 Q4], T = 73

optimal number of lags (searched up to 10 lags of 1. differences):

Akaike Info Criterion	1
Hannan-Quinn Criterion	1
Final Prediction Error	1
Schwarz Criterion	1

Test for cointegration

Johansens trace test showed that up to 2 lags this variable is I(0), and optimal number of lags is 2.

Johansen Trace Test for: prod

sample range: [1980 Q3, 2000 Q4], T = 82

included lags (levels): 2

dimension of the process: 1

trend and intercept included

response surface computed:

r0	LR	pval	90%	95%	99%
0	5.45	0.5426	10.68	12.45	16.22

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

sample range: [1982 Q3, 2000 Q4], T = 74

optimal number of lags (searched up to 10 lags of 1. differences):

Akaike Info Criterion	2
Hannan-Quinn Criterion	2
Final Prediction Error	2
Schwarz Criterion	2

<u>ADF test for real wages</u>

ADF test shows that this variable is not stationary and does have unit root.

ADF Test for series: rw

sample range: [1980 Q4, 2000 Q4], T = 81

lagged differences: 2

intercept, time trend

asymptotic critical values

reference: Davidson, R. and MacKinnon, J. (1993),

"Estimation and Inference in Econometrics" p 708, table 20.1,

Oxford University Press, London

1%	5%	10%
-3.96	-3.41	-3.13

value of test statistic: -2.7911

regression results:

variable	coefficient	t-statistic
x(-1)	-0.0584	-2.7911
dx(-1)	0.1835	1.6601
dx(-2)	-0.0454	-0.4127
constant	26.6302	2.8733
trend	0.0339	1.7741
RSS	55.6165	

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

```
OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA
sample range:             [1982 Q4, 2000 Q4], T = 73
optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion                                 4
Hannan-Quinn Criterion                                4
Final Prediction Error                                4
Schwarz Criterion                                     0
```

Test for cointegration

Johansens trace test for variable real wages it has been conducted.

```
Johansen Trace Test for:  rw
sample range:             [1980 Q3, 2000 Q4], T = 82
included lags (levels):   2
dimension of the process: 1
intercept included
response surface computed:
 r0   LR       pval     90%      95%      99%
 0    30.99    0.0000   7.60     9.14     12.53
```

```
OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA
sample range:             [1982 Q4, 2000 Q4], T = 73
optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion                              5
Hannan-Quinn Criterion                             5
Final Prediction Error                             5
Schwarz Criterion                                  1
```

ADF test for unemployment

ADF test for unemployment it has been conducted and the results are presented below.

ADF Test for series: U

```
sample range:              [1980 Q4, 2000 Q4], T = 81
lagged differences:        2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708, table 20.1,
Oxford University Press, London
 1%         5%         10%
-3.96      -3.41      -3.13
value of test statistic: -2.8918
regression results:
variable      coefficient   t-statistic
 x(-1)        -0.0765       -2.8918
dx(-1)         0.5179        4.7868
dx(-2)         0.1157        1.0252
constant       0.7170        2.8492
trend         -0.0029       -1.6544
RSS            9.2220
```

This variable is first difference stationary.

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

```
sample range:              [1982 Q4, 2000 Q4], T = 73
optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion                                     1
Hannan-Quinn Criterion                                    1
Final Prediction Error                                    1
Schwarz Criterion                                         1
```

Test for cointegration

Test for cointegration showed that this variables has cointegration vector r>0.

Johansen Trace Test for: rw

```
sample range:              [1980 Q3, 2000 Q4], T = 82
included lags (levels):    2
dimension of the process: 1
intercept included
response surface computed:
 r0   LR        pval      90%       95%       99%
 0    30.99     0.0000    7.60      9.14      12.53
```

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

```
sample range:               [1982 Q3, 2000 Q4], T = 74
optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion                                 5
Hannan-Quinn Criterion                                5
Final Prediction Error                                1
Schwarz Criterion                                     1
```

ADF test for unemployment

ADF test for unemployment showed that this variable has unit root at one lag but its first difference stationary.

ADF Test for series: U

```
sample range:               [1980 Q4, 2000 Q4], T = 81
lagged differences:         2
intercept, time trend
asymptotic critical values
reference: Davidson, R. and MacKinnon, J. (1993),
"Estimation and Inference in Econometrics" p 708, table 20.1,
Oxford University Press, London
 1%          5%          10%
-3.96       -3.41       -3.13
value of test statistic: -2.8918
regression results:
```

variable	coefficient	t-statistic
x(-1)	-0.0765	-2.8918
dx(-1)	0.5179	4.7868
dx(-2)	0.1157	1.0252
constant	0.7170	2.8492
trend	-0.0029	-1.6544
RSS	9.2220	

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

```
sample range:               [1982 Q4, 2000 Q4], T = 73
optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion                                 1
Hannan-Quinn Criterion                                1
Final Prediction Error                                1
```

```
Schwarz Criterion                                          1
```

Test of cointegration for unemployment variable

Johansens trace test has been conducted for unemployment and proved that this variable is I(0).

```
   Johansen Trace Test for:  U
sample range:             [1980 Q3, 2000 Q4], T = 82
included lags (levels):   2
dimension of the process: 1
intercept included
response surface computed:
 r0  LR       pval     90%      95%      99%
 0   4.99     0.2952   7.60     9.14     12.53
```

Optimal endogenous lags from info criteria is 2.

```
OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA
sample range:             [1982 Q3, 2000 Q4], T = 72
optimal number of lags (searched up to 10 lags of 1. differences):
Akaike Info Criterion                                      2
Hannan-Quinn Criterion                                     2
Final Prediction Error                                     2
Schwarz Criterion                                          2
```

VAR Model

To do a VAR model first we will seek for the optimal number of lags for the model.

```
OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA
endogenous variables:     e prod rw U
deterministic variables:  CONST TREND
sample range:             [1982 Q3, 2000 Q4], T = 74
optimal number of lags (searched up to 10 lags of levels):
Akaike Info Criterion:    3
Final Prediction Error:   3
Hannan-Quinn Criterion:   2
Schwarz Criterion:        1
```

VAR ESTIMATION RESULTS

VAR estimation results are presented in a matrix form while you can look up in the Appendix 1 to see their output format. [20]

$$
\begin{bmatrix} e(t) \\ prod(t) \\ rw(t) \\ U(t) \end{bmatrix} = \begin{bmatrix} 1.764 & 0.185 & -0.072 & 0.122 \\ -0.196 & 1.081 & -0.020 & -0.754 \\ -0.525 & -0.140 & 0.860 & -0.108 \\ -0.631 & -0.116 & 0.003 & 0.634 \end{bmatrix} \begin{bmatrix} e(t-1) \\ prod(t-1) \\ rw(t-1) \\ U(t-1) \end{bmatrix} + \begin{bmatrix} -1.190 & -0.109 & -0.025 & -0.032 \\ -0.155 & -0.181 & -0.201 & 0.743 \\ 0.697 & -0.199 & -0.143 & -0.390 \\ 0.525 & 0.092 & 0.071 & -0.102 \end{bmatrix} \begin{bmatrix} e(t-2) \\ prod(t-2) \\ rw(t-2) \\ U(t-2) \end{bmatrix} + \begin{bmatrix} 0.615 & 0.026 & 0.032 & 0.360 \\ 0.457 & -0.021 & 0.121 & 0.322 \\ -0.260 & 0.142 & 0.221 & 0.063 \\ -0.062 & -0.028 & -0.032 & 0.046 \end{bmatrix} \begin{bmatrix} e(t-3) \\ prod(t-3) \\ rw(t-3) \\ U(t-3) \end{bmatrix}
$$

$$
+ \begin{bmatrix} -193.370 & -0.017 \\ -13.219 & 0.075 \\ 192.777 & 0.083 \\ 163.890 & 0.020 \end{bmatrix} \begin{bmatrix} CONST \\ TREND(t) \end{bmatrix} + \begin{bmatrix} u1(t) \\ u2(t) \\ u3(t) \\ u4(t) \end{bmatrix}
$$

The VAR model is up to three lags since info criteria demanded that this be modeled that way.

VAR matrix coefficients are presented on the previous page.

Granger causality test

From the below table for granger causality test we can see that there is granger causality between labour productivity , employment, real wages and unemployment, but labour productivity does not granger cause three other variables.

```
TEST FOR GRANGER-CAUSALITY:
H0: "prod" do not Granger-cause "e, rw, U"
Test statistic l = 2.8370
pval-F( l; 9, 268) = 0.0033
```

[20] See Appendix 1 VAR OUPUT FORMAT

```
TEST FOR INSTANTANEOUS CAUSALITY:
H0: No instantaneous causality between "prod" and "e, rw, U"
Test statistic: c = 1.5804
pval-Chi( c; 3) = 0.6638
```

VEC MODEL [21]

VEC model for Canadian time series is presented as matrix below.

$$\begin{bmatrix} d(rw)(t) \\ d(U)(t) \\ d(prod)(t) \\ d(e)(t) \end{bmatrix} = \begin{bmatrix} -0.003 \\ -0.001 \\ -0.000 \\ -0.000 \end{bmatrix} \left[\begin{bmatrix} 1.000 & 214.859 & 34.420 & 67.077 \end{bmatrix} \begin{bmatrix} rw(t-1) \\ U(t-1) \\ prod(t-1) \\ e(t-1) \end{bmatrix} + \begin{bmatrix} -79450.285 & -19.816 \end{bmatrix} \begin{bmatrix} CONST \\ TREND(t-1) \end{bmatrix} \right] + \begin{bmatrix} -0.082 & 0.270 & -0.054 & -0.300 \\ -0.016 & -0.159 & -0.085 & -0.584 \\ 0.047 & -0.604 & 0.288 & -0.155 \\ -0.046 & 0.221 & 0.210 & 0.817 \end{bmatrix} \begin{bmatrix} d(rw)(t-1) \\ d(U)(t-1) \\ d(prod)(t-1) \\ d(e)(t-1) \end{bmatrix} + \begin{bmatrix} u1(t) \\ u2(t) \\ u3(t) \\ u4(t) \end{bmatrix}$$

VEC model shows long run coefficient, and if the system is in disequilibrium , alteration of the variables will only be -0.003 for real wages or -0.3%, -0.001 for unemployment or -0.1%, -0.000 for productivity or -0%,and -0% for employment. This means that Canadian labour market is in equilibrium working at natural rate of unemployment and by equilibrium wages.

[21] See Appendix 2 VEC model output in jmulti

Chow test for structural stability

Chow test below shows that VEC model is stable according to this test.

```
CHOW TEST FOR STRUCTURAL BREAK
On the reliability of Chow-type tests..., B. Candelon, H. Lütkepohl,
Economic Letters 73 (2001), 155-160
sample range:                [1980 Q3, 2000 Q4], T = 82
tested break date:           1985 Q1 (18 observations before break)
break point Chow test:       67.7571
 bootstrapped p-value:       0.3600
 asymptotic chi^2 p-value:   0.0071
 degrees of freedom:         42
sample split Chow test:      57.7302
 bootstrapped p-value:       0.0400
 asymptotic chi^2 p-value:   0.0035
 degrees of freedom:         32
Chow forecast test:          0.1847
 bootstrapped p-value:       0.9800
 asymptotic F p-value:       1.0000
 degrees of freedom:         256, 10

Appendix 1 VAR OUTPUT FORMAT

endogenous variables:     e prod rw U
exogenous variables:
deterministic variables:  CONST TREND
endogenous lags:          3
exogenous lags:           0
sample range:             [1980 Q4, 2000 Q4], T = 81

modulus of the eigenvalues of the reverse characteristic polynomial
:
|z| = ( 3.4351       1.7584       1.7584       1.6428       1.6428
1.8444      1.8444      1.2214      1.2214      1.0442      1.0442
3.8469     )
Legend:
=======
```

```
             Equation 1   Equation 2  ...
-------------------------------------------
Variable 1 | Coefficient         ...
           | (Std. Dev.)
           | {p - Value}
           | [t - Value]
Variable 2 |         ...
...
-------------------------------------------
```

Lagged endogenous term:

```
=======================
                 e      prod        rw         U
--------------------------------------------------
e    (t-1)|    1.764    -0.196    -0.525    -0.631
          |   (0.151)   (0.280)   (0.327)   (0.124)
          |   {0.000}   {0.483}   {0.109}   {0.000}
          |  [11.678]  [-0.702]  [-1.602]  [-5.075]
prod(t-1)|    0.185     1.081    -0.140    -0.116
          |   (0.064)   (0.118)   (0.139)   (0.053)
          |   {0.004}   {0.000}   {0.314}   {0.028}
          |   [2.897]   [9.136]  [-1.007]  [-2.203]
rw   (t-1)|   -0.072    -0.020     0.860     0.003
          |   (0.054)   (0.099)   (0.116)   (0.044)
          |   {0.177}   {0.841}   {0.000}   {0.950}
          |  [-1.352]  [-0.201]   [7.405]   [0.062]
U    (t-1)|    0.122    -0.754    -0.108     0.634
          |   (0.198)   (0.367)   (0.430)   (0.163)
          |   {0.539}   {0.040}   {0.801}   {0.000}
          |   [0.615]  [-2.053]  [-0.252]   [3.883]
e    (t-2)|   -1.190    -0.155     0.697     0.525
          |   (0.235)   (0.435)   (0.510)   (0.193)
          |   {0.000}   {0.722}   {0.171}   {0.007}
          |  [-5.064]  [-0.356]   [1.367]   [2.717]
prod(t-2)|   -0.109    -0.181    -0.199     0.092
          |   (0.094)   (0.174)   (0.204)   (0.078)
          |   {0.246}   {0.300}   {0.330}   {0.234}
```

```
          |  [-1.161]  [-1.036]  [-0.975]   [1.189]
rw   (t-2)|   -0.025    -0.201    -0.143     0.071
          |   (0.070)   (0.129)   (0.151)   (0.057)
          |   {0.720}   {0.118}   {0.342}   {0.218}
          |  [-0.358]  [-1.564]  [-0.951]   [1.233]
U    (t-2)|   -0.032     0.743    -0.390    -0.102
          |   (0.246)   (0.455)   (0.533)   (0.202)
          |   {0.895}   {0.102}   {0.464}   {0.612}
          |  [-0.131]   [1.634]  [-0.732]  [-0.507]
e    (t-3)|    0.615     0.457    -0.260    -0.062
          |   (0.166)   (0.308)   (0.360)   (0.137)
          |   {0.000}   {0.137}   {0.470}   {0.651}
          |   [3.699]   [1.487]  [-0.723]  [-0.453]
prod(t-3)|    0.026    -0.021     0.142    -0.028
          |   (0.065)   (0.121)   (0.142)   (0.054)
          |   {0.695}   {0.865}   {0.318}   {0.597}
          |   [0.392]  [-0.169]   [0.999]  [-0.529]
rw   (t-3)|    0.032     0.121     0.221    -0.032
          |   (0.054)   (0.100)   (0.117)   (0.044)
          |   {0.557}   {0.225}   {0.058}   {0.477}
          |   [0.588]   [1.214]   [1.893]  [-0.711]
U    (t-3)|    0.360     0.322     0.063     0.046
          |   (0.206)   (0.381)   (0.446)   (0.169)
          |   {0.080}   {0.398}   {0.888}   {0.788}
          |   [1.748]   [0.845]   [0.140]   [0.269]
--------------------------------------------------
Deterministic term:
===================
                  e      prod        rw         U
--------------------------------------------------
CONST    | -193.370   -13.219   192.777   163.890
         |  (73.005) (135.180) (158.276)  (60.057)
         |   {0.008}   {0.922}   {0.223}   {0.006}
         |  [-2.649]  [-0.098]   [1.218]   [2.729]
TREND(t)|   -0.017     0.075     0.083     0.020
         |   (0.016)   (0.030)   (0.036)   (0.013)
         |   {0.288}   {0.014}   {0.019}   {0.134}
```

	[-1.062]	[2.455]	[2.347]	[1.498]

Appendix 2 VEC model

VEC REPRESENTATION

endogenous variables: rw U prod e

exogenous variables:

deterministic variables: CONST TREND

endogenous lags (diffs): 1

exogenous lags: 0

sample range: [1980 Q3, 2000 Q4], T = 82

estimation procedure: One stage. Johansen approach

Lagged endogenous term:

	d(rw)	d(U)	d(prod)	d(e)
d(rw) (t-1)	-0.082	-0.016	0.047	-0.046
	(0.110)	(0.043)	(0.099)	(0.057)
	{0.457}	{0.714}	{0.636}	{0.416}
	[-0.744]	[-0.366]	[0.473]	[-0.814]
d(U) (t-1)	0.270	-0.159	-0.604	0.221
	(0.368)	(0.143)	(0.334)	(0.190)
	{0.463}	{0.266}	{0.070}	{0.245}
	[0.733]	[-1.112]	[-1.810]	[1.164]
d(prod)(t-1)	-0.054	-0.085	0.288	0.210
	(0.118)	(0.046)	(0.107)	(0.061)
	{0.647}	{0.063}	{0.007}	{0.001}
	[-0.458]	[-1.863]	[2.685]	[3.460]
d(e) (t-1)	-0.300	-0.584	-0.155	0.817
	(0.264)	(0.102)	(0.239)	(0.136)
	{0.254}	{0.000}	{0.516}	{0.000}
	[-1.140]	[-5.709]	[-0.649]	[6.014]

Loading coefficients:

```
=====================
             d(rw)      d(U)   d(prod)      d(e)
-------------------------------------------------
ec1(t-1)|   -0.003    -0.001     0.000     0.000
        |   (0.000)   (0.000)   (0.000)   (0.000)
        |   {0.000}   {0.000}   {0.768}   {0.416}
        |  [-7.568]  [-3.886]  [-0.295]  [-0.813]
-------------------------------------------------

Estimated cointegration relation(s):
====================================
           ec1(t-1)
--------------------
rw  (t-1) |    1.000
          |   (0.000)
          |   {0.000}
          |   [0.000]
U   (t-1) |  214.859
          |  (44.981)
          |   {0.000}
          |   [4.777]
prod(t-1) |   34.420
          |  (19.716)
          |   {0.081}
          |   [1.746]
e   (t-1) |   67.077
          |  (22.682)
          |   {0.003}
          |   [2.957]
CONST     | -79450.285
          | (26488.658)
          |   {0.003}
          |  [-2.999]
TREND(t-1)|  -19.816
          |   (9.336)
          |   {0.034}           |  [-2.123]
--------------------
```

Refferences

1. Steven J. Davis & R. Jason Faberman & John Haltiwanger, 2006. "**The Flow Approach to Labor Markets: New Data Sources and Micro–Macro Links**," Journal of Economic Perspectives, American Economic Association, vol. 20(3), pages 3-26, Summer.

2. Blanchard, Oliver J. and Peter Diamond. 1990. "The Cyclical Behavior of the Gross Flows of U.S. Workers." Brookings Papers on Economic Activity. 1990:2, pp. 85–155

3. Burgess, Simon, Julia I. Lane and David Stevens. 2000. "Job flows, Worker Flows, and Churning." Journal of Labor Economics. 18:3, pp. 473–502

4. OECD Data base

5. Lütkepohl,Helmut & Krätzig,Markus (ed.), 2004. "**Applied Time Series Econometrics**," Cambridge Books, Cambridge University Press, number 9780521839198.

6. Lütkepohl, Helmut & POSKITT, D.S., 1996. "**Testing for Causation Using Infinite Order Vector Autoregressive Processes**," Econometric Theory, Cambridge University Press, vol. 12(01), pages 61-87, March

7. Introductory Econometrics: A Modern Approach, Jeffrey M. Wooldridge, South-Western College

The causal relationship between patent growth and growth of GDP with quarterly data in the G7countries: cointegration, ARDL and error correction models

Dushko Josheski(e-mail address: dushkojosheski@gmail.com)
Cane Koteski (e-mail address: cane.koteski@ugd.edu.mk)

Abstract

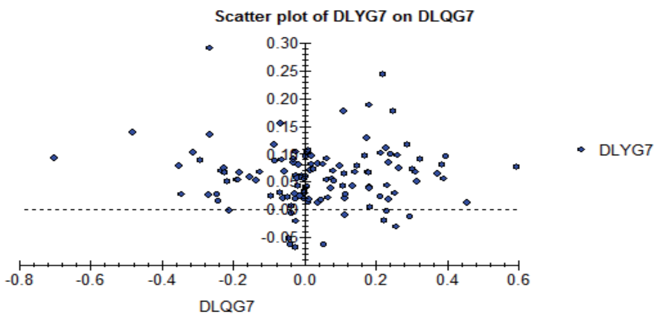
This empirical study investigates the dynamic link between patent growth and GDP growth in G7 economies. ARDL model showed that there exist positive relationship in long run between quarterly growth of patents and quarterly GDP growth. The error correction term suggests that 20,6 percent of the adjustment back to long run equilibrium of industrial production in G7 countries is corrected by 20,6% a year, following a shock like the one in

1974 , which in our study is controlled by a dummy variable D74. In the short run however at one or two lags there exist negative relationship between quarterly patents growth and quarterly growth of GDP. Johansen's procedure for cointegration showed that long run multipliers are positive between the patent growth and GDP growth in G7 economies. Granger causality test showed that patent growth Granger cause GDP growth in G7 countries. Unrestricted VAR showed that there exists positive relationship between patent growth and GDP growth at two or three lags.

Key words: Cointegration, ARDL, Error correction models, Johasens's procedure, Patent growth, GDP growth

Introduction

In 1975 French president Valéry Giscard d'Estaing invited leaders of Germany, Italy, USA, the Unite Kingdom, Japan. The group was discussing oil crisis, stock market crash .So the event was to become annual and that is how the group was formed, later Canada was invited to join and the G7 was created. We use quarterly data on growth of patents and quarterly data of GDP growth (1963Q1 to 1993Q4) from G7 countries, and our purpose here is to estimate the causal relationship between this two variables.Technological revolution in the twentieth century has happened and more innovations than all the earlier centuries happened. Technology and innovation are seen as engines of economic growth (Usmani, Ahmad, Junoh). Technological change has been regarded as a major source of long-run productivity growth (Romer, 1990, Grossman and Helpman, 1991), with innovation no longer being treated as an exogenous process. Patents have become increasingly important, especially over the past two decades. As patent office procedures have adapted to remain abreast of changing economic and scientific circumstances, it has also become increasingly important to define and analyse innovation more precisely(Mcalleer, Slotje, 2005). In the next graph it is presented the relationship between quarterly growth of patents and quarterly growth of GDP.



Scatter plot of GDP growth quarterly data in G7 countries and growth of quarterly patents in G7 countries data from 1963 Q1 to 1993Q4.The scatter plot result is ambiguous, meaning that between growth of quarterly patents and quarterly growth of GDP in G7 countries exist positive as well negative relationship. We will test this result empirically in the latter of the paper. The application of the conventional Granger (1969) causality tests is a common practice in empirical research. In the standard Granger-causality test, a variable X_t Granger-causes Y_t if the lagged values of X_t help improve the forecast of Y_t. One of the problems of the conventional Granger-causality tests which Miller and Russek (1990), and Miller (1991) pointed out is that it is possible to find no causal relationship between two variables that share a common trend. This is the case because a variable that exhibits non-stationarity will show no tendency to return to its long-run equilibrium level in the event of a random disturbance; hence the conventional Granger causality tests may lead to misleading results. One of the important features of the cointegration analysis over the standard Granger causality test is that if two variables are integrated of order one, that is $I(1)$, and cointegrated, there must be Granger-causality in at least one direction because one variable can help predict the other(OWOYE,1995).

Dataandthemethodology

First, in the paper we will use ARDL model to see the long run relationship between this variables. Afterwards we set error correction model to capture short run and long run coefficients as well as the coefficient on the error correction model. Descriptive statistics of the variables and correlation matrix is given as follows:

Descriptive statistics	LYG7	LQG7
Maximum	0.3775 2	51.7423
Mean	-2.4425	47.3223
Minimum	-6.9122	39.8834
Correlation matrix		
	LYG7	LQG7
LYG7	1.00	-
LQG7	.87495	
	1.00	

Autoregressivedistributedlagmodel(ARDL)[22]

In economics we know that rarely Y variable responds instantaneously on X variable let say. Y responds with laps of time. Such a laps of time is called lag (Gujaraty,2003).

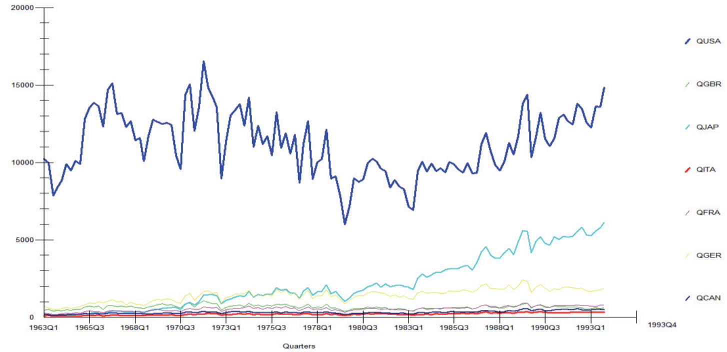
General model with lags is as follows:

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + ... + \beta_k X_{t-k} + u_t$$

Here β_0 is short run coefficient while, $\sum_{i=0}^{k} \beta_i = \beta_0 + \beta_1 + ... + \beta_k = \beta$, is long run coefficient , or total lag distributed multiplier.

Our ARDL is up to four lags, also here we add dummy variable in the model D74 , this variable is used to control for 1973-1974 stock market crash. This was what followed after great oil crash 1973, and after Bretton Woods fall 1972.

This time series is plotted as follows:



On average highest quarterly patents from 1963 to 1993 has USA, followed by quarterly patents of Japan. The third one in G7 countries is Germany, while other 4, France, Canada, Great Britain, and Italy has similar number of quarterly patents in the period.

Firstly there are lags between growth of quarterly patents and quarterly growth of GDP is because the lag between the invention of an idea or device and its development up to a

[22] See Appendices variables definitions.

commercially applicable stage, and the lag which is introduced by the process of diffusion: it takes time before all the old machines are replaced by the better new ones (Griliches,1967). Also contractual obligations permit patents or innovations from diffusion. Also technological reasons like imperfect knowledge may account for lags. For instance many similar products, or similar patents.

Estimated ARDL model[23] **(long run coefficients model) is as follows**:

ARDL(3,3,0) selected based on Schwarz Bayesian Criterion

Dependent variable is DLYG7	Coefficient	p-value
DLYG7(-1)	0.31236	[0.001]
DLYG7(-2)	0.18942	[0.035]
DLYG7(-3)	0.29185	[0.001]
DLQG7	-0.030839	[0.182]
DLQG7(-1)	0.011888	[0.621]
DLQG7(-2)	0.095881	[0.000]
DLQG7(-3)	0.057458	[0.015]
D74	-0.051877	[0.027]
R^2	0.24886	
F-stat	F(7, 110) = 5.2062[.000]	
D-W Statistics	2.0696	

Diagnostics of the model is as follows:

	p-value	decision
Serial Correlation[24]	[0.742]	We cannot reject the null hypothesis of no serial correlation at all conventional levels of significance
Functional Form	[0.113]	We cannot reject the null hypothesis for a good functional form at all levels of significance
Normality	[0.000]	We cannot reject the null hypothesis for normality
Heteroscedasticity	[0.422]	We cannot reject the null hypothesis of homoscedasticity at all levels of significance

[23] See Appendix1

[24] This is very important in time series because of the often presence of serial correlation.

D74 is negatively correlated with the quarterly growth of GDP in G7 countries, and the coefficient is statistically and economically significant. Coefficients on the three lags of the growth of quarterly patents in G7 countries are of small size but positively, as expected correlated with the quarterly growth of GDP in G7 countries. Short run coefficient on quarterly patents is negatively associated with the quarterly growth of GDP in G7 countries, but the coefficient itself is insignificant at conventional levels of significance. Also three coefficient on the lags of quarterly growth of GDP in G7 countries are positively and statistically significantly correlated with the quarterly growth of GDP in G7 AR(4) . D-W statistics above 2(>2) suggests negative correlation among the residuals. Serial correlation is not problem in this time series, and functional form is correctly specified according to the diagnostics table of the model. Also heteroscedasticity is not the problem that out model suffers from. So in conclusion long run coefficients are positive, and there exist positive long run relationship between quarterly growth of patents and quarterly growth of GDP in the selected G-7 countries.

Errorcorrectionmechanism(ECM)fortheselectedARDLmodel

In the error correction model are captured short run and long run coefficients between the variables of interest. Adjustment towards long run equilibrium is given by the coefficients of the EC mechanism (Harris,Sollis, 2003). Error correction mechanism shows that on average lagged quarterly growth of GDP have negative effects on quarterly growth of GDP itself. Similar lagged quarterly growth of patents in the G7 countries have negative effect on short run at 2 years lag. The coefficients are significant at all conventional levels of significance. The coefficient on the Error correction model is negative and statistically significant p-value (0.003). The error correction term represents the speed of adjustment of the change in the quarterly output to its long run equilibrium following a shock in the short run. Moreover the significance of the error correction term confirms the existence of a long run relationship between the regressors and the dependent variable. The error correction term suggests that 20,6 percent of the adjustment back to long run equilibrium is corrected after one year.

Error correction mechanism is presented in the following table.

(b) **Error Correction Representation for the Selected ARDL Model ARDL selected based on Schwarz Bayesian Criterion**

Dependent variable is dDLYG7		
Variable	Coefficient	t-stat (p-value)
dDLYG7(-1)	-0.48127	-5.1456[0.000]
dDLYG7(-2)	-0.29185	-3.4268[0.001]
dDLQG7	-0.030839	-1.3428[0.182]
dDLQG7(-1)	-0.15334	-4.0106[0.000]
dDLQG7(-2)	-0.057458	-2.4788[0.015]
D74	-0.051877	-2.2459[0.027]
ecm(-1)	-0.20637	-3.0592[0.003]
R^2=0.426 s		R^2 =0.39
D-W-stat=2.06	Fstat=13.6547[0.000]	

R-Squared and R-Bar-Squared measures refer to the dependent variable dDLYG7 and in cases where the error correction model is highly restricted, these measures could become negative.

Sensitivity analysis

Test statistic	LM version	F version
I: Serial Correlation	1.9654[0.742]	0.44886[.773]
II: Functional Form	2.5120[0.113]	2.3709[.127]
III :Normality	163.9122[0.000]	n.a.
IV: Heteroscedasticity	0.64474[0.422]	0.63729[0.426]

I: Lagrange multiplier test of residual serial correlation.

II: Ramsey's RESET test using the square of the fitted values.

III: Based on a test of skewness and kurtosis of residuals.

IV: Based on the regression of squared residuals on squared fitted values

The diagnostic tests also pass the overall validity of the model.This is for all tests except for normality.

EstimatedLongRunCoefficientsusingtheARDLApproach[25]

Next we are estimating the long run coefficient using this 118 observations quarterly data for industrial production (quarterly growth of GDP per capita in G7 countries),

Dependent variable is DLYG7
118 observations used for estimation from 1964Q2 to 1993Q3

DLQG7	0.65120	2.4480[0.016]
D74	-0.25138	-1.8365[0.069]

So in long run increase in 1 percentage points in number of quarterly patents increase quarterly growth of GDP per capita by 0.65% in G7 countries. This coefficient is statistically and economically significant.

Cointegration

Next we do cointegration test with no intercepts or trends. x_t and y_t are said to be cointegrated if there exists a parameter α such that

$$u_t \equiv y_t - \alpha x_t$$

is a stationary process.

The first thing to notice is of course that economic series behave like I(1) processes, i.e. they seem to "drift all over the place"; but the second thing to notice is that they seem to drift in such a way that the they do not drift away from each other. If you formulate this statistically you come up with the cointegration model (Sorensen,2005).

CointegrationwithunrestrictedinterceptsandrestrictedtrendsintheVAR

This procedure involves three suggested test tests here for selecting the number of cointegrating vectors. First, we are going to present the results from LR test based on the maximal eingevalue of the stochastic matrix. For order of VAR (4).

[25] See Apendix 2

Cointegration with unrestricted intercepts and restricted trends in the VAR[26]
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

118 observations from 1964Q2 to 1993Q3. Order of VAR = 4.

Null	Alternative	Statistic	95% Critical value	90% critical value
r = 0	r = 1	52.1710	19.2200	17.1800
r <= 1	r = 2	17.9575	12.3900	10.5500

Use the above table to determine r (the number of cointegrating vectors).

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

118 observations from 1964Q2 to 1993Q3. Order of VAR = 4.

Null	Alternative	Statistic	95% Critical value	90% critical value
r = 0	r >= 1	70.1284	25.700	23.0800
r <= 1	r = 2	17.9575	12.3900	10.5500

Use the above table to determine r (the number of cointegrating vectors).

Cointegration with unrestricted intercepts and restricted trends in the VAR
Choice of the Number of Cointegrating Relations Using Model Selection Criteria

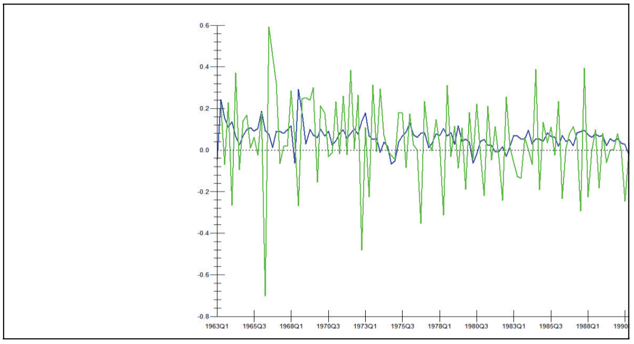
118 observations from 1964Q2 to 1993Q3. Order of VAR = 4.

rank	Maximized LL	AIC	SBC	HQC
r = 0	215.6245	201.6245	182.2297	193.7497
r = 1	241.7100	223.7100	198.7738	213.5852
r= 2	250.688	230.6887	202.4389	219.4389

AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion
HQC = Hannan-Quinn Criterion

[26] See Appendix 3

So from this three tables we choose two cointegrating vectors , maximum possible. From the third table option r=2 has highest AIC info criteria , also from previous two tables we reject the null hypothesis of r=0 in favor of r>=1 , but also r<=1 is rejected in favor of r=2 , so we acept r=2. Next figure shows that second difference of the two variables quarterly growth of GDP per capita in G7 countries (DLYG7) , and growth of quarterly patents in G7 countries (DLQG7) are I(2) variables.



Johansen'sjustidentifyingrestrictions

We use Johansen's just identifying restrictions to display CV's i.e. cointegrating vectors.

Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets) Cointegration with unrestricted intercepts and restricted trends in the VAR

118 observations from 1964Q2 to 1993Q3. Order of VAR = 4, chosen r =2.

	Vector 1	Vector 2
DLYG7	0.80508	3.1108
	(-1.0000)	(-1.0000)
DLQG7	-1.4272	0.64493 (
	(1.7728)	-.20732)
Trend	-0.0013190	.0025745
	(0.0016383)	(-0.8276E-3)

Vector 2 of DLQG7 variable quarterly growth of patents is positive, as it is shown in the Table. While first vector is negative.

Matrixforlongrunmultipliersforthespecified2vectorsinJohansen'sestimation

In this section also of importance is to present the matrix of long run multipliers , because we are interested in long run relationship between the two variables of interest.

Estimated Long Run Matrix in Johansen Estimation
Cointegration with no intercepts or trends in the VAR

118 observations from 1964Q2 to 1993Q3. Order of VAR = 4, chosen r =1
List of variables included in the cointegrating vector: DLYG7 DLQG7

	DLYG7	DLQG7
DLYG7	-0.17149	0.21227
DLQG7	1.1763	-1.4560

Here estimated long run multipliers between DLYG7 (quarterly growth of output in G7 countries), and DLQG7(quarterly growth of patents in G7 countries) is positive.

OLSestimationofunrestrictedVAR

Vector auto regression model is basically an econometric model used to capture the interdependence between multiple time series. In the independent variables there is lagged values of the right hand side variable, and other two variables in our case DLQG7 (quarterly growth of patents in G7 countries) and D74,dummy variable used to control for 1974 crisis. In the next Table are given the results from the unrestricted VAR estimation. You can see the software imprint in Appendix 4.

OLS estimation of a single equation in the Unrestricted VAR

Dependent	variable is	Coefficient	p-value
DLYG7			

DLYG7(-1)	0.25	[0.012]
DLYG7(-2)	0.17	[0.076]
DLYG7(-3)	0.32	[0.001]
DLYG7(-4)	-0.003	[0.968]
DLQG7 (-1)	0.016	[0.503]
DLQG7(-2)	0.092	[0.000]
DLQG7(-3)	0.0801	[0.002]
DLQG7(-4)	0.0312	[0.197]
D74(-1)	-0.04	[0.264]
D74(-2)	-0035	[0.449]
D74(-3)	-0.18	[0.695]
D74(-4)	0.078	[0.028]
R^2	0.29	
F-stat	F(11, 106) =3.8751[.000]	
D-W Statistics	2.0832	

This unrestricted VAR estimation shows that on 2 and 3 lags DLQG7 coefficient is positive and statistically significantly correlated with with growth of quarterly output in G7 countries DLYG7. And the lagged values of DLYG7 are positively and statistically significantly correlated with itself but at 2 and 3 lags. While lagged dummy variable is insignificant except at 4 lags and is negatively correlated with DLYG7.

Sensitivity analysis

Test statistic	LM version	F version
I: Serial Correlation	5.5894[0.232]	1.2679[.288]
II: Functional Form	5.1279[0.024]	4.7702[.031]
III :Normality	218.9722[.000]	n.a.
IV: Heteroscedasticity	0.42751[.513]	0.42179[.517]

The diagnostic tests also pass the overall validity of the model.This is for all tests except for normality.

TestStatisticsandChoiceCriteriaforSelectingtheOrderoftheVARModel

In the following Table are presented the info criteria for selecting the number of lags.

Order	LL	AIC	SBC		LR test	Adjusted LR test
4	340.7379	304.7379	254.8656		------	------
3	329.0688	302.0688	264.6646	CHSQ(9)=	23.3382[.005]	20.9648[.013]
2	313.0761	295.0761	270.1400	CHSQ(18)=	55.3236[.000]	49.6975[.000]
1	294.5061	285.5061	273.0380	CHSQ(27)=	92.4637[.000]	83.0606[.000]
0	193.2824	193.2824	193.2824	CHSQ(36)=	294.9112[.000]	264.9202[.000]

We selected the 4 number of lags as because the AIC has highest info value. That is the section that is highlighted yellow in the table above.

TestofSerialCorrelationofResiduals(OLScase)

Serial correlation is one of the biggest problems in time series data so here we are testing even though formal LM test suggested that serial correlation is not a problem in our models.

Test of Serial Correlation of Residuals (OLS case) Dependent variable is DLYG7
List of variables in OLS regression:
DLYG7(-1) DLYG7(-2) DLYG7(-3) DLYG7(-4) DLQG7(-1)
DLQG7(-2) DLQG7(-3) DLQG7(-4) D74(-1) D74(-2) D74(-3) D74(-4)
118 observations used for estimation from 1964Q2 to 1993Q3

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
OLS RES(- 1)	-1.0106	0.46707	-2.1637[0.033]
OLS RES(- 2)	0.15318	0.32501	0.47132[0.638]
OLS RES(- 3)	0.010309	0.28017	0.036795[0.971]
OLS RES(- 4)	-0.12091	0.19083	-0.63363[0.528]
Lagrange Multiplier Statistic		CHSQ(4)=	5.5894[0.232]
F Statistic		F(4, 102)=	1.2679[0.288]

LM test again showed that we have insufficient evidence to reject H_o of no serial correlation since the p-value of the test is (0.232) , also F statistic has high p-value (0.288).

Grangercausalitytest

Granger causality test is performed to see whether X lagged variable cause Y variable. In this case to see whether DLQG7 cause DLYG7. The test is given in the Table below

```
                    LR Test of Block Granger Non-Causality in the VAR

Based on 118 observations from 1964Q2 to 1993Q3. Order of VAR = 4
List  of  variables  included  in  the  unrestricted
 VAR: DLYG7      DLQG7
Maximized value of log-likelihood =  238.6742

List   of   variable(s)   assumed   to   be   "non-causal"   under   the   null
 hypothesis: DLQG7
Maximized value of log-likelihood =  231.0158

LR test of block non-causality, CHSQ(  4)=  15.3169[.004]

The   above   statistic   is   for   testing   the   null   hypothesis   that   the
 coefficients of the lagged values of:
DLQG7
in    the    block    of    equations    explaining    the
 variable(s): DLYG7
are zero. The maximum order of the lag(s) is 4.
```

LR test shows that we have enough evidence to reject the null hypothesis of insignificant lagged values of DLQG7 in the block equations explaining the variable DLYG7.

Critical values of chi-square statistics from the Tables

df	Probability of exceeding the critical value 0.10	0.05	0.025	0.01	0.001
4	7.779	9.488	11.143	13.277	

Our estimated chi-square statistics 15.319 is > (7.779, 9.488, 11.143, 13.277) at 4 degrees of freedom (df). So we can reject the null and accept the alternative hypothesis that DLQG7 granger causes DLYG7.

So in long run, as conclusion we can confirm that there exists positive relationship between growth of quarterly patents DLQG7 and quarterly growth of GDP in G7 countries DLYG7 variable. While the error correction mechanism showed negative signs on the DLQG7

variable.

Appendices

DLYG7-GROWTH OF QUARTERLY OUTPUT IN G7 COUNTRIES FOR THE PERIOD

1963Q1 TO 1993Q4

DLQG7-GROWTH OF QUARTERLY PATENTS IN G7 COUNTRIES FOR THE PERIOD

1963Q1 TO 1993Q4

D74-DUMMY VARIABLE(0,1) TO CONTROL FOR THE STOCK MARKET CRISIS IN

1974 THAT FOLLOWED GREAT OIL CRASH AND FALL OF BRETTON-

WOODS SYSTEM.

TIME-TIME TREND VARIABLE

G7 COU&TRIES ARE- United States of America, France, Germany, Italy, Japan, United

Kingdom and Canada.

Appendix 1

```
Autoregressive Distributed Lag Estimates
       ARDL(3,3,0) selected based on Schwarz Bayesian Criterion
******************************************************************************
Dependent variable is DLYG7
118 observations used for estimation from 1964Q2 to 1993Q3
******************************************************************************
Regressor                Coefficient       Standard Error         T-Ratio[Prob]
DLYG7(-1)                    .31236             .087264              3.5795[.001]
DLYG7(-2)                    .18942             .088749              2.1343[.035]
DLYG7(-3)                    .29185             .085166              3.4268[.001]
DLQG7                      -.030839             .022966             -1.3428[.182]
DLQG7(-1)                   .011888             .023946              .49646[.621]
DLQG7(-2)                   .095881             .023754              4.0365[.000]
DLQG7(-3)                   .057458             .023180              2.4788[.015] D74
                           -.051877             .023098             -2.2459[.02]
*********************************************************************************
R-Squared                       .24886   R-Bar-Squared                      .20106
S.E. of Regression             .044562   F-stat.    F(  7, 110)    5.2062[.000]
Mean of Dependent Variable     .056314   S.D. of Dependent Variable.049855
Residual Sum of Squares         .21843   Equation Log-likelihood       203.7908
Akaike Info. Criterion        195.7908   Schwarz Bayesian Criterion    184.7080
DW-statistic                    2.0696
******************************************************************************


                 Diagnostic Tests
******************************************************************************
*     Test Statistics  *        LM Version        *         F Version         *
******************************************************************************
*                      *                          *                           *
* A:Serial Correlation*CHSQ(    4)=   1.9654[.742]*F(    4, 106)=   .44886[.773]*
*                      *                          *                           *
* B:Functional Form   *CHSQ(   1)=   2.5120[.113]*F(   1, 109)=   2.3709[.127]*
*                      *                          *                           *
* C:Normality          *CHSQ(   2)= 163.9122[.000]*       Not applicable       *
*                      *                          *                           *
* D:Heteroscedasticity*CHSQ(    1)=   .64474[.422]*F(    1, 116)=   .63729[.426]*
******************************************************************************
A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

Appendix2

Error Correction Representation for the Selected ARDL Model
ARDL(3,3,0) selected based on Schwarz Bayesian Criterion

****

Dependent variable is dDLYG7
118 observations used for estimation from 1964Q2 to 1993Q3

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dDLYG71	-.48127	.093529	-5.1456[.000]
dDLYG72	-.29185	.085166	-3.4268[.001]
dDLQG7	-.030839	.022966	-1.3428[.182]
dDLQG71	-.15334	.038234	-4.0106[.000]
dDLQG72	-.057458	.023180	-2.4788[.015]
dD74	-.051877	.023098	-2.2459[.027]
ecm(-1)	-.20637	.067460	-3.0592[.003]

****

List of additional temporary variables created:
dDLYG7 = DLYG7-DLYG7(-1) dDLYG71
= DLYG7(-1)-DLYG7(-2) dDLYG72 =
DLYG7(-2)-DLYG7(-3) dDLQG7 =
DLQG7-DLQG7(-1) dDLQG71 =
DLQG7(-1)-DLQG7(-2) dDLQG72 =
DLQG7(-2)-DLQG7(-3) dD74 = D74-
D74(-1)
ecm = DLYG7 -.65120*DLQG7 + .25138*D74

****

R-Squared	.42687	R-Bar-Squared	.39040
S.E. of Regression	.044562	F-stat. F(6, 111)	13.6547[.000]
Mean of Dependent Variable	-.9946E-3	S.D. of Dependent Variable	.057074
Residual Sum of Squares	.21843	Equation Log-likelihood	203.7908
Akaike Info. Criterion	195.7908	Schwarz Bayesian Criterion	184.7080
DW-statistic	2.0696		

****

R-Squared and R-Bar-Squared measures refer to the dependent variable dDLYG7 and in cases where the error correction model is highly restricted, these measures could become negative.

Estimated Long Run Coefficients using the ARDL Approach
ARDL(3,3,0) selected based on Schwarz Bayesian Criterion

****

Dependent variable is DLYG7
118 observations used for estimation from 1964Q2 to 1993Q3

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DLQG7	.65120	.26601	2.4480[.016]
D74	-.25138	.13688	-1.8365[.069]

****

Appendix3

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
****
118 observations from 1964Q2 to 1993Q3. Order of VAR = 4.
List of variables included in the cointegrating vector:
DLYG7 DLQG7 Trend
List of eigenvalues in descending order:
.35733 .14117 .0000
****

Null	Alternative	Statistic	95% Critical Value	90% Critical Value r
= 0	r = 1	52.1710	19.2200	17.1800
r<= 1	r = 2	17.9575	12.3900	10.5500

****
Use the above table to determine r (the number of cointegrating vectors).

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix
****
118 observations from 1964Q2 to 1993Q3. Order of VAR = 4.
List of variables included in the cointegrating vector:
DLYG7 DLQG7 Trend
List of eigenvalues in descending order:
.35733 .14117 .0000
****

Null	Alternative	Statistic	95% Critical Value	90% Critical Value r
= 0	r>= 1	70.1284	25.7700	23.0800
r<= 1	r = 2	17.9575	12.3900	10.5500

****
Use the above table to determine r (the number of cointegrating vectors).

Cointegration with unrestricted intercepts and restricted trends in the VAR
Choice of the Number of Cointegrating Relations Using Model Selection Criteria
****
118 observations from 1964Q2 to 1993Q3. Order of VAR = 4.
List of variables included in the cointegrating vector:
DLYG7 DLQG7 Trend
List of eigenvalues in descending order:
.35733 .14117 .0000
****

Rank	Maximized LL	AIC	SBC	HQC
r = 0	215.6245	201.6245	182.2297	193.7497 r
= 1	241.7100	223.7100	198.7738	213.5852 r
= 2	250.6887	230.6887	202.9819	219.4389

****
AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion
HQC = Hannan-Quinn Criterion

Appendix4

Estimated Long Run Matrix in Johansen Estimation
Cointegration with no intercepts or trends in the VAR
****
118 observations from 1964Q2 to 1993Q3. Order of VAR = 4, chosen r =1.
List of variables included in the cointegrating vector:
DLYG7 DLQG7
****

	DLYG7	DLQG7
DLYG7	-.17149	.21227
DLQG7	1.1763	-1.4560

****

OLS estimation of a single equation in the Unrestricted VAR
****
Dependent variable is DLYG7
118 observations used for estimation from 1964Q2 to 1993Q3
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DLYG7(-1)	.24577	.095593	2.5710[.012]
DLYG7(-2)	.16631	.092673	1.7946[.076]
DLYG7(-3)	.32386	.091076	3.5560[.001]
DLYG7(-4)	-.0035231	.087898	-.040081[.968]
DLQG7(-1)	.015439	.022997	.67133[.503]
DLQG7(-2)	.092354	.024091	3.8336[.000]
DLQG7(-3)	.080142	.025360	3.1602[.002]
DLQG7(-4)	.031199	.024036	1.2980[.197]
D74(-1)	-.039840	.035465	-1.1233[.264]
D74(-2)	-.034749	.045725	-.75995[.449]
D74(-3)	-.017797	.045265	-.39318[.695]
D74(-4)	.078542	.035262	2.2274[.028]

****

R-Squared	.28680	R-Bar-Squared	.21279
S.E. of Regression	.044233	F-stat. F(11, 106)	3.8751[.000]
Mean of Dependent Variable	.056314	S.D. of Dependent Variable	.049855
Residual Sum of Squares	.20740	Equation Log-likelihood	206.8491
Akaike Info. Criterion	194.8491	Schwarz Bayesian Criterion	178.2250
DW-statistic	2.0832	System Log-likelihood	340.7379

****

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 5.5894[.232]	F(4, 102)= 1.2679[.288]
B:Functional Form	CHSQ(1)= 5.1279[.024]	F(1, 105)= 4.7702[.031]
C:Normality	CHSQ(2)= 218.9722[.000]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .42751[.513]	F(1, 116)= .42179[.517]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

References

1. Artis, M.J., Kontolemis,Z.,G., Osborn, R.,D.,(1997), *Business Cycles for G7 and European Countries*, The Journal of Business, Vol. 70, No. 2 (April 1997), pp. 249-279

2. Barro, Robert J., and Xavier Sala-i-Martin, ***Economic Growth***, 2nd edition, Cambridge, MA: MIT Press, 2004.

3. Engle, Robert F., Granger, Clive W. J. (1987) "***Co-integration and error correction: Representation, estimation and testing***", *Econometrica*, 55(2), 251-276.

4. Griliches, Zvi, 1981. "***Market value, R&D, and patents***," Economics Letters, Elsevier, vol. 7(2), pages 183-187.

5. Gujarati, Damodar N.(2004), ***Basic Econometrics***. New York: McGraw-Hill,

6. Harris, R., Sollis,R**., (2003),** ***Applied Time Series Modelling and Forecasting***,

7. John Bound & Clint Cummins & Zvi Griliches & Bronwyn H. Hall & Adam B. Jaffe, 1984. "***Who Does R&D and Who Patents***?," NBER Chapters, in: R & D, Patents, and Productivity, pages 21-54 National Bureau of Economic Research, Inc.

8. Lerner, Josh, "***The Empirical Impact of Intellectual Property Rights on Innovation: Puzzles and Clues***", American Economic Review: Papers and Proceedings of the American Economic Association, Vol. 99 No. 2, May 2009, 343–8.

9. Lerner, Joshua, "***Patent policy shifts and innovation over 150 years***", American Economic Review: Papers and Proceedings of the American Economic Association, Vol. 92 No. 2, May 2002, 221–5.

10. Owoye, O., (1995), ***The causal relationship between taxes and expenditures in the G7 countries: cointegration and error-correction models,*** Applied Economics Letters, 1995, **2**, 19–22

11. Qazi, M., Hue, A.,(2009), ***Agriculture on the Road to Industrialisation and Sustainable Economic growth: An Empirical Investigation for Pakistan*****,** International Journal of Agricultural Economics & Rural Development - 2 (2): 2009

12. Qian, Yi, (2007), "***Do Additional 1ational Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment: A Cross-Country Analysis of Pharmaceutical Patent Protection***, 1978–2002", Review of Economics and Statistics, Vol. 89, No. 3, August 2007, 436-453

13. Vichyanond, Jade, "***Intellectual Property Protection and Patterns of Trade", Department of Economics***, Princeton University, November 2009.

14. Zvi Griliches, 1984. "***Introduction to "R & D, Patents, and Productivity*****"**," NBER Chapters, in: R & D, Patents, and Productivity

15. Zvi Griliches, 1984. "***R & D, Patents, and Productivity***," NBER Books, National Bureau of Economic Research, Inc, number gril84-1, March.