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APPENDIX TO CHAPTER 2

Additional figures and tables containing the data analysis of effective labour are included in this appendix. Using the fitted values for labour effectiveness z , as described in table 2.1 and in figure 2.2 in the main text, a new series of effective labour per sector (EL or zL) has been computed and the computed series are included in sectoral growth equations. These estimation results are listed in tables 2.5 to 2.21.

Effective labour

Figure 2.4: The long-run residual (z_2 as dependent variable)

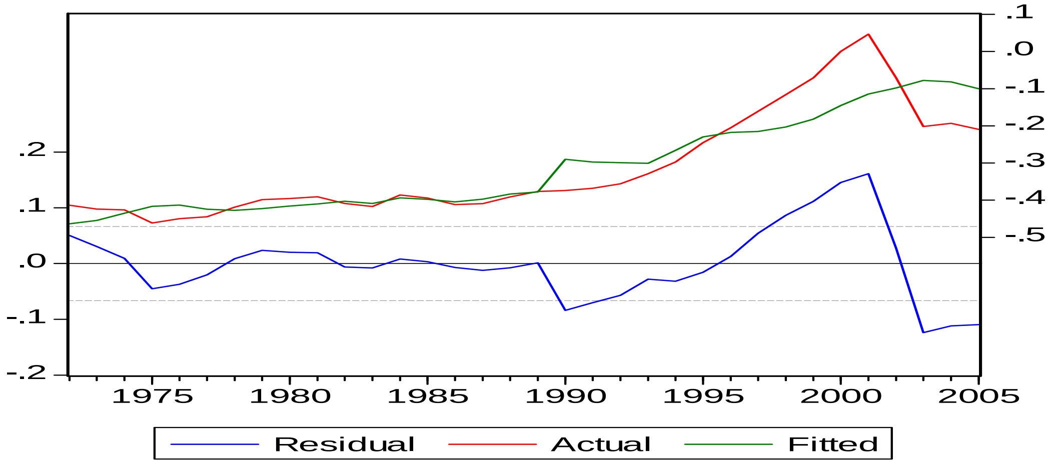


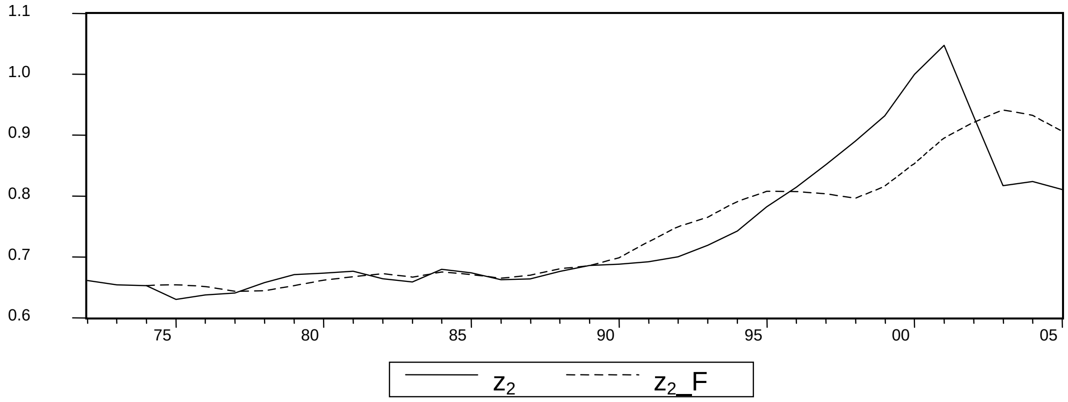
Table 2.5: Cointegration test (z_2 as dependent variable)

Augmented Dickey-Fuller test statistic	**-3.221096****
1% level	-3.653730
5% level	-2.957110
10% level	-2.617434

Table 2.6: Error correction model

Variable	Coefficient	Std. Error	t-Statistic
Difference: D(h)	0.000368	0.000215	1.712202
Difference: D(h(-1))	-0.000228	0.000210	-1.084469
Difference: D(LNz_2(-1))	0.668374	0.170260	3.925610
Difference: D(DUMEDU)	5.76E-05	0.000116	0.495495
Residual(-1)	-0.365407	0.128755	-2.837997
C	-0.000301	0.008363	-0.036005

Figure 2.5: Actual versus Fitted: Model z_2



Sectoral growth equations

Agriculture

Table 2.7: Long-run regression of LNYAGRIC (Log of agricultural output) on capital (LNKAGRIC) and effective labour (LNELAGRIC_SM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNKAGRIC	3.967104	2.950402	1.344598	0.2117
LNELAGRIC_SM	24.76007	10.70353	2.313262	0.0460
C	-369.0831	175.9170	-2.098052	0.0653
R-squared	*0.525614*	*Mean dependent var*		*10.17638*
Adjusted R-squared	*0.420195*	*S.D. dependent var*		*0.087889*
Log likelihood	*17.14934*	*F-statistic*		*4.985942*
Durbin-Watson stat	*1.647653*	*Prob(F-statistic)*		*0.034881*

Figure 2.6: Long-run residual (Agriculture)

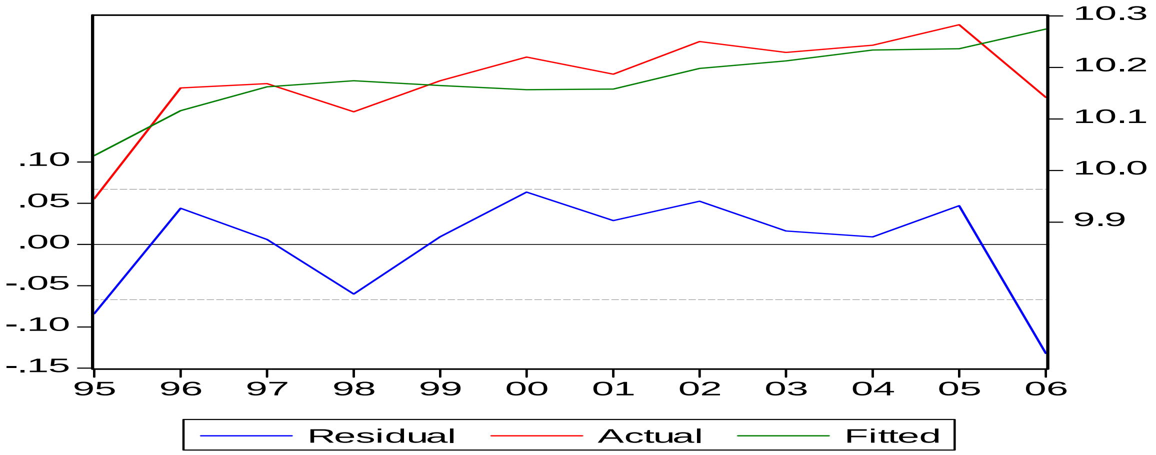


Table 2.8: Cointegration test (Agriculture)

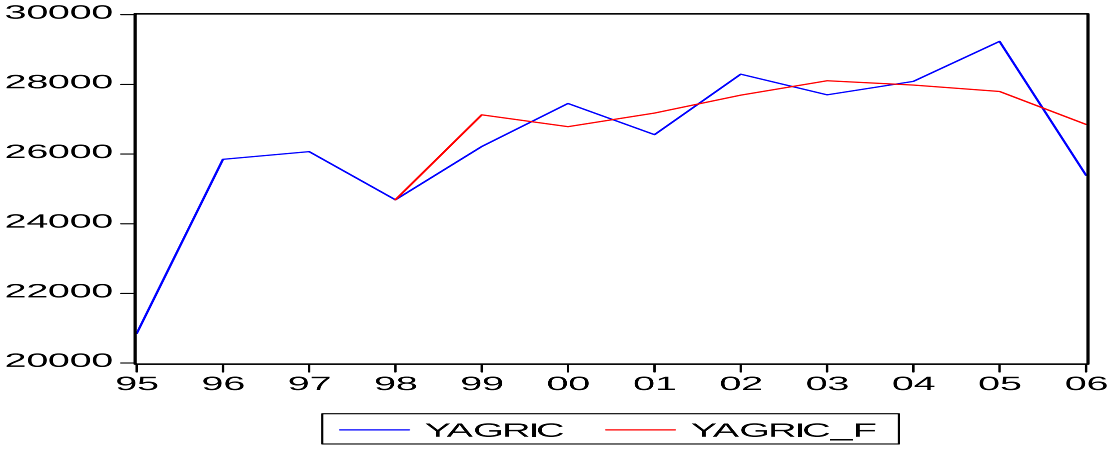
ADF Test Statistic	-1.742080	1% Critical Value*	-4.3260
		5% Critical Value	-3.2195
		10% Critical Value	-2.7557

*MacKinnon critical values for rejection of hypothesis of a unit root.

Table 2.9: Error correction model (Agriculture)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNYAGRIC(-1))	-0.822767	0.115140	-7.145789	0.0056
D(LNYAGRIC(-2))	-0.359423	0.080557	-4.461708	0.0210
D(LNELAGRIC_SM(-1))	6.42E+08	1.98E+08	3.241459	0.0478
D(LNELAGRIC_SM(-2))	-6.40E+08	1.97E+08	-3.241428	0.0478
RESIDAGRIC(-1)	-0.135101	0.172320	-0.784010	0.4902
C	-1266.425	388.0274	-3.263752	0.0470
R-squared	*0.978361*	*Mean dependent var*		*0.003281*
Adjusted R-squared	*0.942295*	*S.D. dependent var*		*0.041757*

Figure 2.7: Actual (YAGRIC) versus Fitted (YAGRIC_F)



Mining

Table 2.10: Long-run regression of LNYMIN (Log of Mining Output) on capital (LNKMIN) and effective labour (LNELMIN_SM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNKMIN	0.735996	0.204247	3.603461	0.0057
LNELMIN_SM	0.094988	0.054368	1.747144	0.1146
C	1.036020	2.804829	0.369370	0.7204
R-squared	*0.592706*	*Mean dependent var*		*11.08793*
Sum squared resid	*0.003989*	*Schwarz criterion*		*-4.549978*
Log likelihood	*31.02723*	*F-statistic*		*6.548518*
Durbin-Watson stat	*0.671088*	*Prob(F-statistic)*		*0.017563*

Figure 2.8: Long-run residual (Mining)

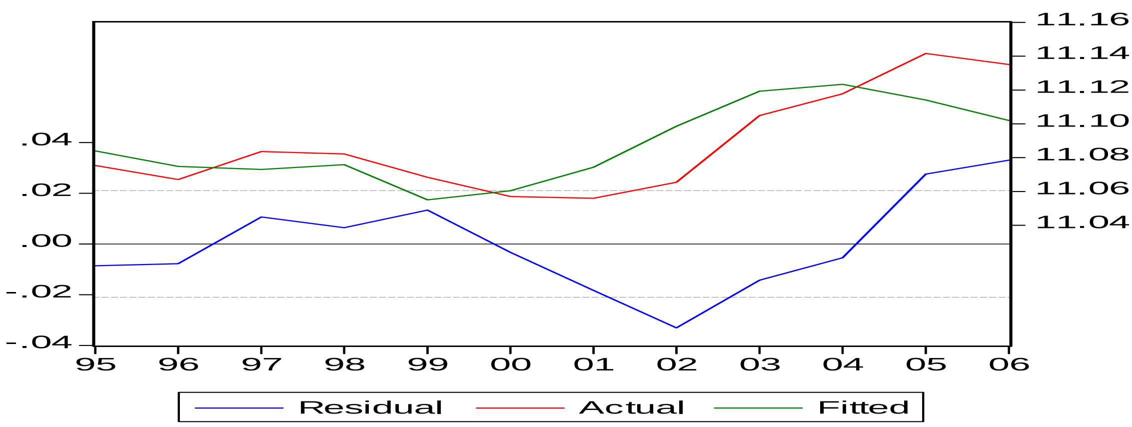


Table 2.11: Cointegration test (Mining)

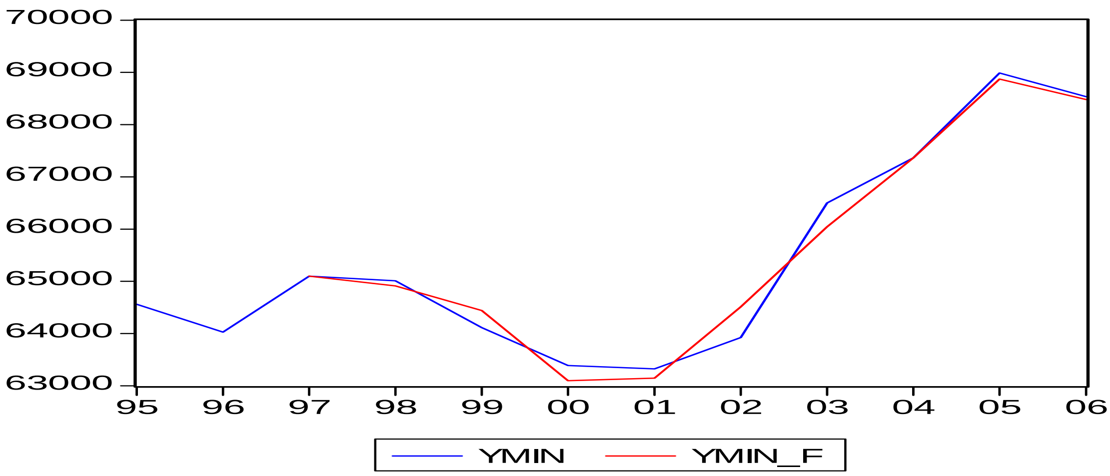
ADF Test Statistic	-1.720712	1% Critical Value*	-4.3260
		5% Critical Value	-3.2195
		10% Critical Value	-2.7557

*MacKinnon critical values for rejection of hypothesis of a unit root.

Table 2.12: Error correction model (Mining)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNYMIN(-1))	0.361318	0.130047	2.778365	0.0321
D(LNKMIN(-1))	-1.010303	0.296536	-3.407020	0.0144
RESIDMIN(-1)	-1.306875	0.193425	-6.756483	0.0005
C	0.008196	0.002590	3.164653	0.0195
R-squared	*0.906847*	*Mean dependent var*		*0.006803*
Adjusted R-squared	*0.860270*	*S.D. dependent var*		*0.016872*
Log likelihood	*39.02587*	*F-statistic*		*19.47004*
Durbin-Watson stat	*3.177162*	*Prob(F-statistic)*		*0.001705*

Figure 2.9: Actual (YMIN) versus Fitted (YMIN_F)



Construction & Buildings

Table 2.13: Long-run regression of LNYCONSTR (Log of Construction & Buildings Output) on capital (LNKCONSTR) and effective labour (LNELCONSTR_SM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNKCONSTR	0.706290	0.043565	16.21225	0.0000
LNELCONSTR_SM	0.349187	0.105169	3.320247	0.0089
C	-0.928966	1.408352	-0.659612	0.5260
R-squared	*0.967806*	*Mean dependent var*		*10.07238*
Adjusted R-squared	*0.960652*	*S.D. dependent var*		*0.186337*
Sum squared resid	*0.012296*	*Schwarz criterion*		*-3.424288*
Durbin-Watson stat	*1.666631*	*Prob(F-statistic)*		*0.000000*

Figure 2.9: Long-run residual (Construction & Buildings)

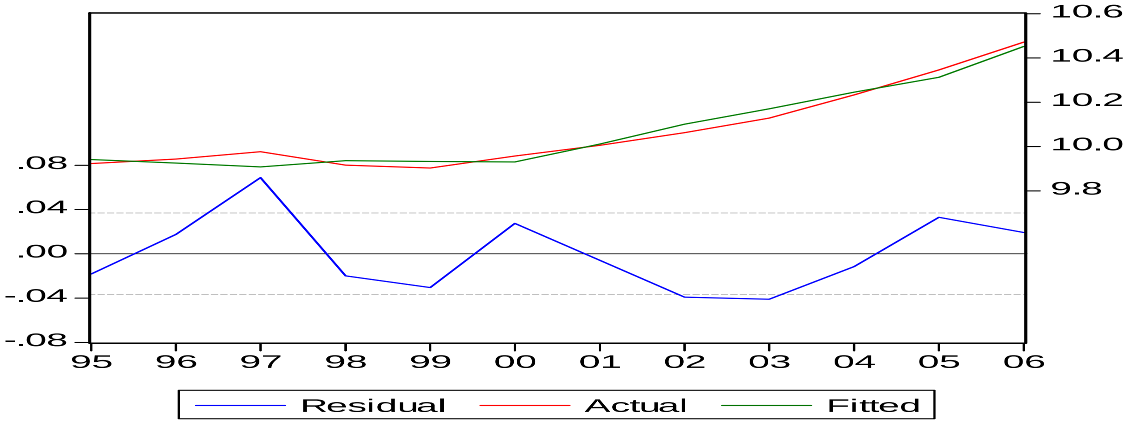


Table 2.14: Cointegration test (Construction & Buildings)

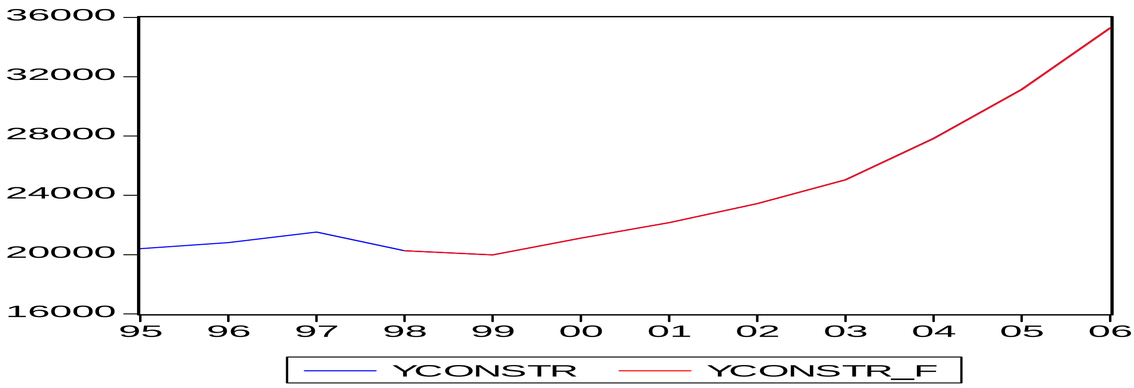
ADF Test Statistic	-3.213112	1% Critical Value*	-4.3260
		5% Critical Value	-3.2195
		10% Critical Value	-2.7557

*MacKinnon critical values for rejection of hypothesis of a unit root.

Table 2.15: Error correction model (Construction & Buildings)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNYCONSTR(-1))	-0.284763	0.008789	-32.39947	0.0196
D(LNKCONSTR)	0.934876	0.017633	53.01987	0.0120
D(LNKCONSTR(-1))	0.157567	0.010743	14.66754	0.0433
D(LNKCONSTR(-2))	1.363403	0.014705	92.71793	0.0069
D(LNELCONSTR_SM)	-0.120158	0.003464	-34.69203	0.0183
D(LNELCONSTR_SM(-1))	-0.091734	0.002886	-31.78122	0.0200
RESIDCONSTR(-1)	0.123374	0.013700	9.005178	0.0704
C	-0.094840	0.000966	-98.13191	0.0065
R-squared	*0.999996*	*Mean dependent var*		*0.054892*
Adjusted R-squared	*0.999968*	*S.D. dependent var*		*0.060204*
Sum squared resid	*1.17E-07*	*Schwarz criterion*		*-13.36311*
Log likelihood	*68.92291*	*F-statistic*		*35254.85*
Durbin-Watson stat	*2.760296*	*Prob(F-statistic)*		*0.004101*

Figure 2.10: Actual (YCONSTR) versus Fitted (YCONSTR_F)



Transport & Communication

Table 2.16: Long-run regression of LNYCOMTRS (Log of Transport & Communication Output) on capital (LNKCOMTRS) and effective labour (DUMELCOMTRS)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNKCOMTRS	2.439538	0.224226	10.87983	0.0000
DUMELCOMTRS	0.006470	0.002751	2.351630	0.0432
C	-19.82394	2.842835	-6.973300	0.0001
R-squared	*0.983899*	*Mean dependent var*		*11.32851*
Adjusted R-squared	*0.980321*	*S.D. dependent var*		*0.224358*
Log likelihood	*26.20209*	*F-statistic*		*274.9807*
Durbin-Watson stat	*1.285933*	*Prob(F-statistic)*		*0.000000*

Figure 2.11: Long-run residual (Transport & Communication)

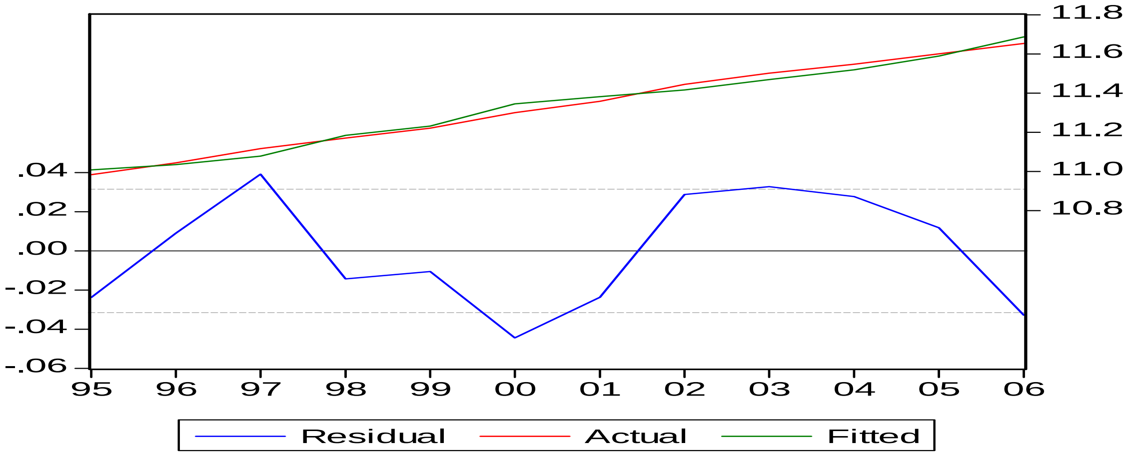


Table 2.17: Cointegration test (Transport & Communication)

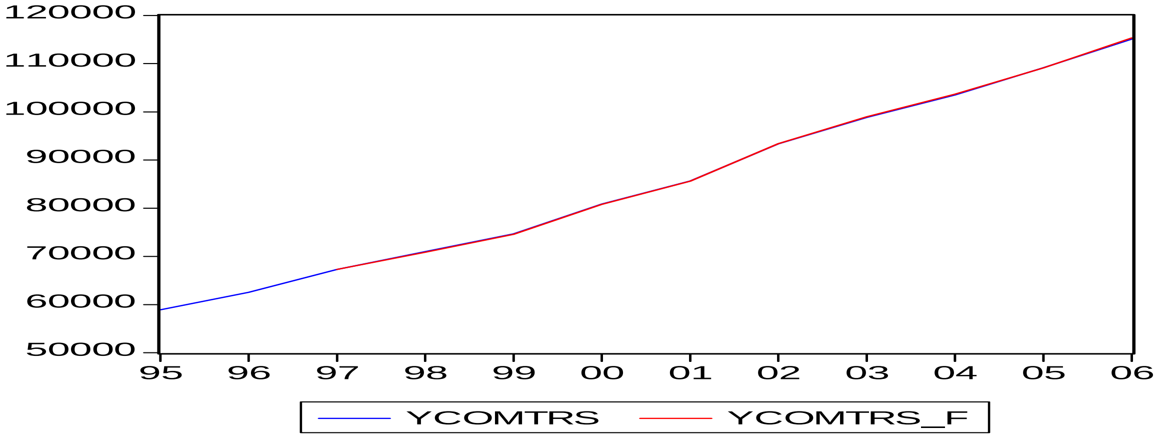
ADF Test Statistic	-2.356290	1% Critical Value*	-4.3260
		5% Critical Value	-3.2195
		10% Critical Value	-2.7557

*MacKinnon critical values for rejection of hypothesis of a unit root.

Table 2.18: Error correction model (Transport & Communication)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNKCOMTRS)	0.170938	0.086959	1.965723	0.1208
D(LNKCOMTRS(-1))	-1.121195	0.077685	-14.43263	0.0001
D(DUMELCOMTRS)	0.000420	0.000182	2.304277	0.0825
D(DUMELCOMTRS(-1))	-0.003542	0.000254	-13.93497	0.0002
RESIDCOMTRS(-1)	-0.594360	0.042790	-13.89021	0.0002
C	0.087225	0.002241	38.92403	0.0000
R-squared	*0.991675*	*Mean dependent var*		*0.060991*
Adjusted R-squared	*0.981270*	*S.D. dependent var*		*0.013717*
Log likelihood	*53.17145*	*F-statistic*		*95.30140*
Durbin-Watson stat	*1.386433*	*Prob(F-statistic)*		*0.000301*

Figure 2.12: Actual (YCOMTRS) versus Fitted (YCOMTRS_F)



Manufacturing

Table 2.19: Long-run regression of LYMAN (Log of Manufacturing Output) on capital (LNKMAM) and effective labour (LNELMAM_SM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNKMAN	0.783062	0.460422	1.700750	0.1232
LNELMAN_SM	0.352829	0.110842	3.183161	0.0111
C	-1.855128	4.719687	-0.393062	0.7034
R-squared	*0.908193*	*Mean dependent var*		*11.98385*
Adjusted R-squared	*0.887792*	*S.D. dependent var*		*0.101936*
Sum squared resid	*0.010494*	*Schwarz criterion*		*-3.582802*
Log likelihood	*25.22417*	*F-statistic*		*44.51591*
Durbin-Watson stat	*1.096677*	*Prob(F-statistic)*		*0.000022*

Figure 2.13: Long-run residual (Manufacturing)

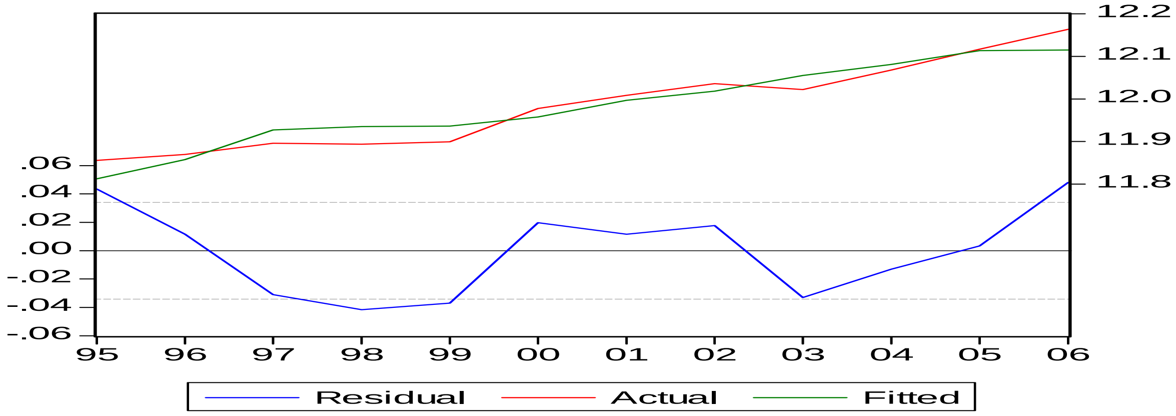


Table 2.20: Cointegration test (Manufacturing)

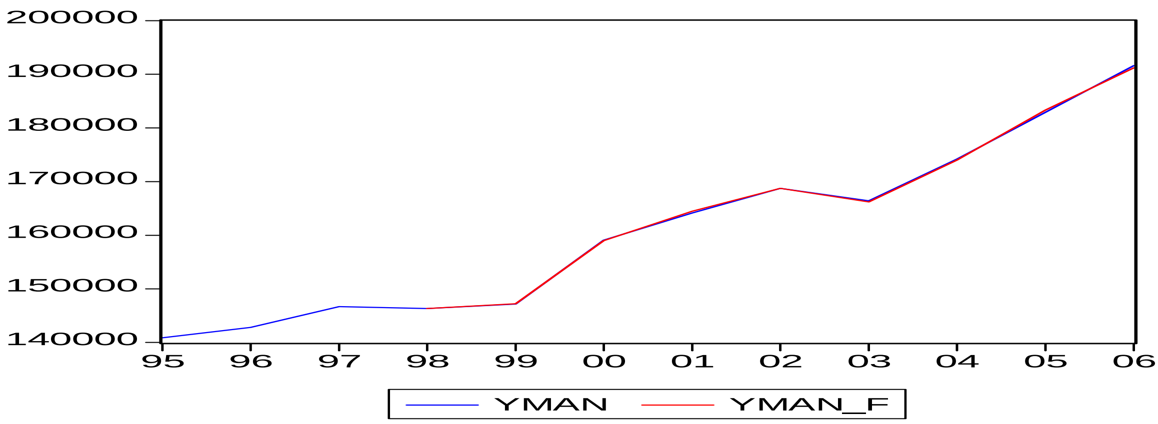
ADF Test Statistic	-2.362856	1% Critical Value*	-4.3260
		5% Critical Value	-3.2195
		10% Critical Value	-2.7557

*MacKinnon critical values for rejection of hypothesis of a unit root.

Table 2.21: Error correction model (Manufacturing)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNKMAN)	-0.586090	0.269826	-2.172106	0.1620
D(LNKMAN(-1))	2.580581	0.402524	6.410996	0.0235
D(LNKMAN(-2))	-3.287029	0.264823	-12.41218	0.0064
D(LNELMAN_SM(-1))	-0.216757	0.024414	-8.878537	0.0124
D(LNELMAN_SM(-2))	-0.384598	0.024378	-15.77668	0.0040
RESIDMAN(-1)	-0.711648	0.061717	-11.53074	0.0074
C	0.074911	0.003101	24.15642	0.0017
R-squared	*0.996434*	*Mean dependent var*		*0.029692*
Adjusted R-squared	*0.985735*	*S.D. dependent var*		*0.029034*
Sum squared resid	*2.41E-05*	*Schwarz criterion*		*-8.285723*
Log likelihood	*44.97604*	*F-statistic*		*93.13303*
Durbin-Watson stat	*2.616651*	*Prob(F-statistic)*		*0.010661*

Figure 2.14: Actual (YMAN) versus Fitted (YMAN_F)



APPENDICES TO CHAPTER 3

APPENDIX A: Deriving the RFE (Continuous time)

Considering the three equations: (1) sales supply; (2) sales demand; and (3) entry/exit; the final RFE-DA have been derived as follows:

$$\frac{\dot{S}_S}{S_S} = \theta_1 \frac{\dot{A}}{A} + \left(\frac{\dot{\Phi}}{\Phi} + \frac{\dot{N}}{N} \right) + \theta_2 \frac{\dot{P}_Q}{P_Q} + \theta_3 \frac{\dot{w}}{w} + \theta_4 \frac{\dot{r}}{r} + \sum_{l=1}^{T} \sigma_l \frac{\dot{P}_l}{P_l} + \theta_5 \frac{\dot{z}}{z} + \theta_6 \frac{\dot{\Gamma}}{\Gamma}$$

(2.2.4)

$$\frac{\dot{S}_D}{S_D} = (1-\Delta)\frac{\dot{P}_Q}{P_Q} + \frac{(\dot{BD})}{(BD)} + (\lambda_1 + \Delta)\frac{\dot{P}_Q^e}{P_Q^e} + \chi_{j1}\frac{\dot{Y}_d}{Y_d} + \chi_{j2}\frac{\dot{WY}}{WY} \qquad (2.3.4)$$

$$\frac{\dot{N}}{N} = C_E(S_S - \pi^e) \qquad (2.6.1)$$

Equating equations 2.2.4 and 2.3.4:

$$\theta_1 \frac{\dot{A}}{A} + \left(\frac{\dot{\Phi}}{\Phi} + \frac{N(\dot{\Gamma})}{N(\Gamma)} \right) + \theta_2 \frac{\dot{P}_Q}{P_Q} + \theta_3 \frac{\dot{w}}{w} + \theta_4 \frac{\dot{r}}{r} + \sum_{l=1}^{T} \sigma_l \frac{\dot{P}_l}{P_l} + \theta_5 \frac{\dot{z}}{z} + \theta_6 \frac{\dot{\Gamma}}{\Gamma} = (1-\Delta)\frac{\dot{P}_Q}{P_Q} + \left(\frac{\dot{B}}{B} + \frac{\dot{D}}{D} \right)$$

$$+ (\lambda_1 + \Delta)\frac{\dot{P}_Q^e}{P_Q^e} + \chi_1 \frac{\dot{Y}_d}{Y_d} + \chi_2 \frac{\dot{WY}}{WY}$$

(A.1)

Replacing $\frac{\dot{N}}{N}$ in equation A.1 by equation 2.6.1:

$$\frac{\dot{P}_Q}{P_Q} = \frac{C_E}{\theta_2 - 1 + \Delta}.\pi^e - \frac{C_E}{\theta_2 - 1 + \Delta}.S_S + \frac{1}{\theta_2 - 1 + \Delta}.\frac{\dot{D}}{D} + \frac{(\lambda_1 + \Delta)}{\theta_2 - 1 + \Delta}.\frac{\dot{P}_Q^e}{P_Q^e} - \frac{\theta_1}{\theta_2 - 1 + \Delta}.\frac{\dot{A}}{A} - \frac{\theta_3}{\theta_2 - 1 + \Delta}.\frac{\dot{w}}{w}$$

$$- \frac{\theta_4}{\theta_2 - 1 + \Delta}.\frac{\dot{r}}{r} - \frac{\sum_{l=1}^{T} \sigma_l}{\theta_2 - 1 + \Delta}.\frac{\dot{P}_l}{P_l} - \frac{\theta_5}{\theta_2 - 1 + \Delta}.\frac{\dot{z}}{z} - \frac{\theta_6}{\theta_2 - 1 + \Delta}.\frac{\dot{\Gamma}}{\Gamma} + \frac{\chi_1}{\theta_2 - 1 + \Delta}.\frac{\dot{Y}_d}{Y_d} + \frac{\chi_2}{\theta_2 - 1 + \Delta}.\frac{\dot{WY}}{WY}$$

(A.2)

Plugging A.2 and 2.6.1 into 2.2.4can be written in a simplified form with equation 2.3.4 plugged into equation 2.2.4 in order to obtain the following RFE-DA for price and sales supply:

$$\frac{\dot{S}_{Si}}{S_{Si}} = \theta'_{0i} + \theta'_{1i} S_{Si} + \theta'_{2i}\frac{\dot{D}_i}{D_i} + \theta'_{3i}\frac{\dot{A}_i}{A_i} + \theta'_{4i}\frac{\dot{w}_i}{w_i} + \theta'_{5i}\frac{\dot{r}}{r} + \theta'_{6i}\frac{\dot{z}_i}{z_i} + \theta'_{7i}\frac{\dot{Y}_d}{Y_d} + \theta'_{8i}\frac{\dot{WY}}{WY} + \theta'_{9i}\frac{\dot{\Gamma}}{\Gamma} + \sum_{l=1}^{T}\wp_{il}\frac{\dot{P}_{il}}{P_{il}}$$

$$\frac{\dot{P}_{Qi}}{P_{Qi}} = \sigma'_{0i} + \sigma'_{1i} S_{Si} + \sigma'_{2i}\frac{\dot{D}_i}{D_i} + \sigma'_{3i}\frac{\dot{A}_i}{A_i} + \sigma'_{4i}\frac{\dot{w}_i}{w_i} + \sigma'_{5i}\frac{\dot{r}}{r} + \sigma'_{6i}\frac{\dot{z}_i}{z_i} + \sigma'_{7i}\frac{\dot{Y}_d}{Y_d} + \sigma'_{8i}\frac{\dot{WY}}{WY} + \sigma'_{9i}\frac{\dot{\Gamma}}{\Gamma} + \sum_{l=1}^{T}\wp_{il}\frac{\dot{P}_{il}}{P_{il}}$$

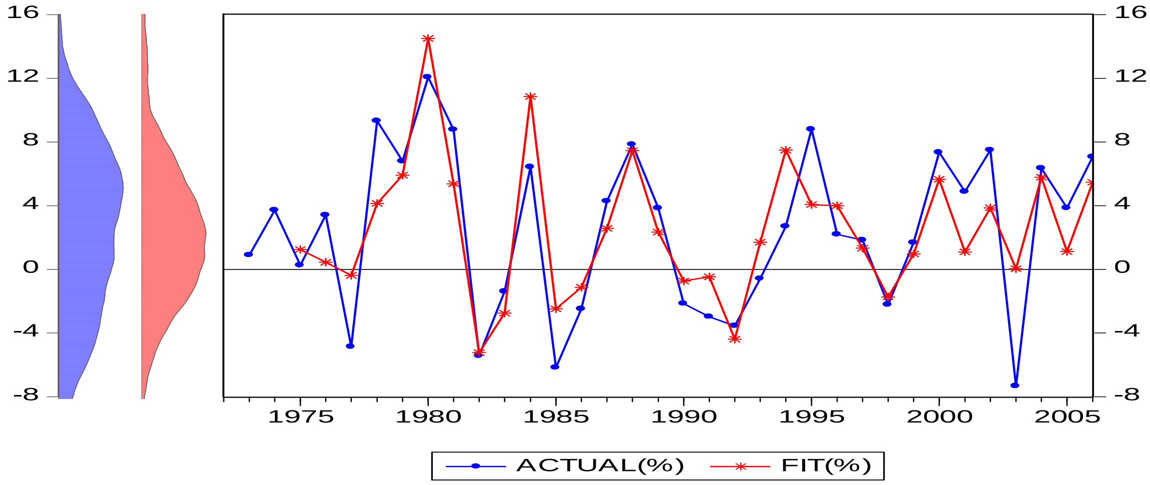
with: $$\sum_{l=1}^{T}\wp_{il}\frac{\dot{P}_{il}}{P_{il}} = \frac{(\lambda_1+\Delta)}{\theta_2 - 1 + \Delta}.\frac{\dot{P}^e_{Q_{it}}}{P^e_{Q_{it}}} - \frac{\sum_{l=1}^{T}\sigma_l}{\theta_2 - 1 + \Delta}.\frac{\dot{P}_l}{P_l}$$

APPENDIX B

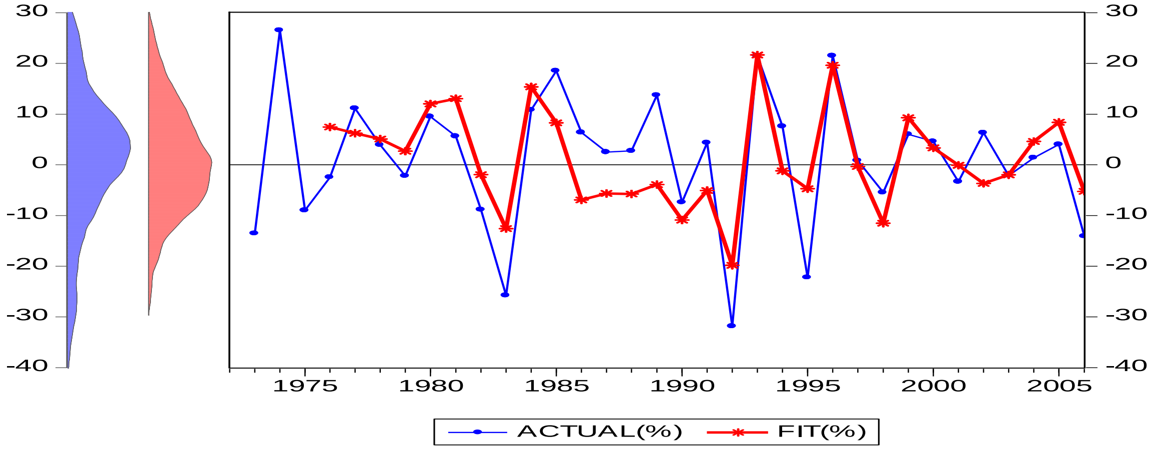
B.1. Model fitness results

All graphs represent 'actual' versus 'fitted' series of sectoral sales growth: $\ln\left(\frac{S_{i,t}}{S_{i,t-1}}\right)$; including the Kernel Density Estimation at the left. The sample size ranges from 1972 to 2006.

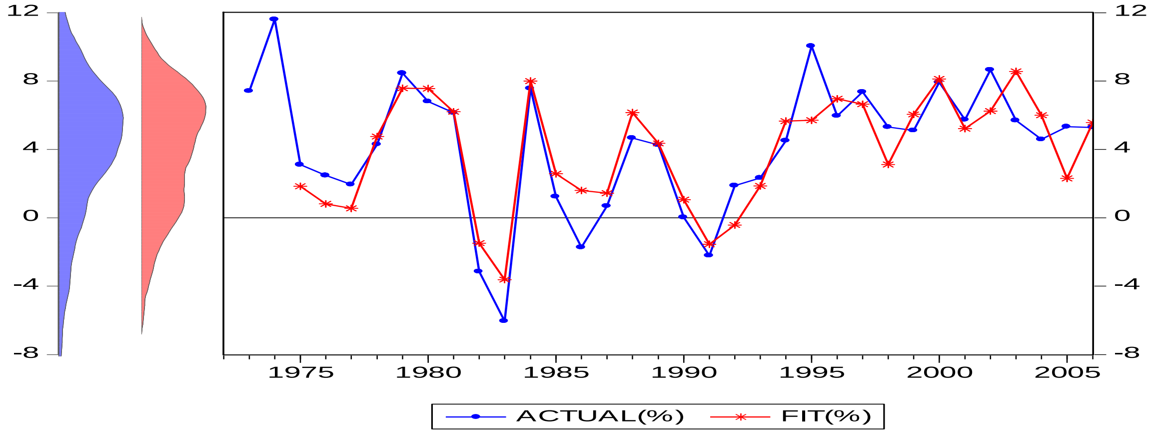
Figure 3.2: Model fitness: Actual versus Fitted Series per sector



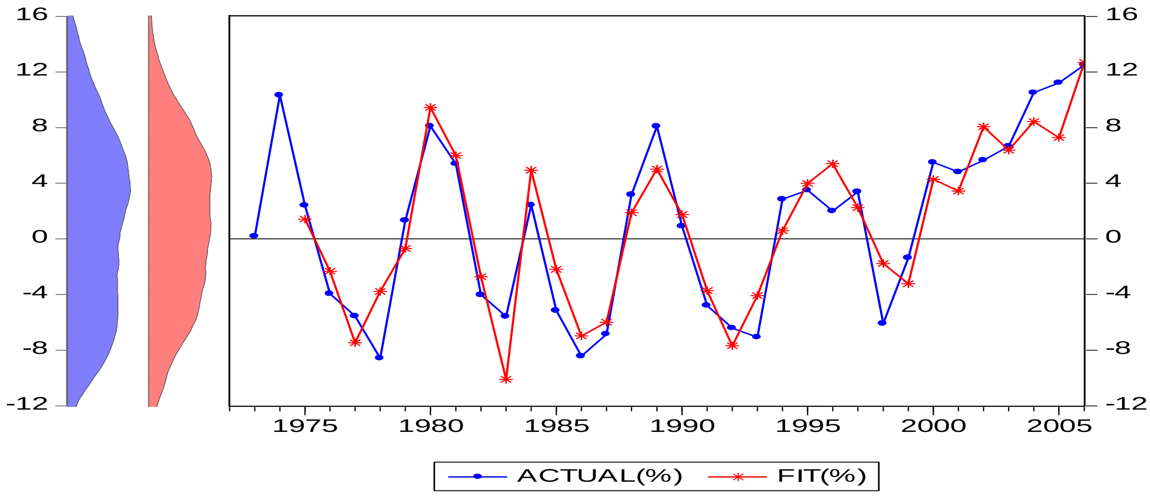
Manufacturing



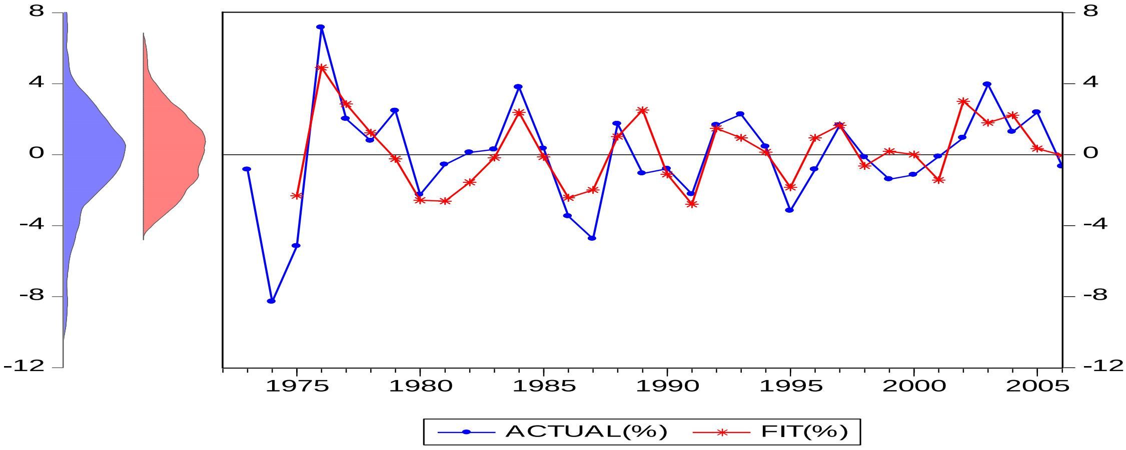
Agriculture



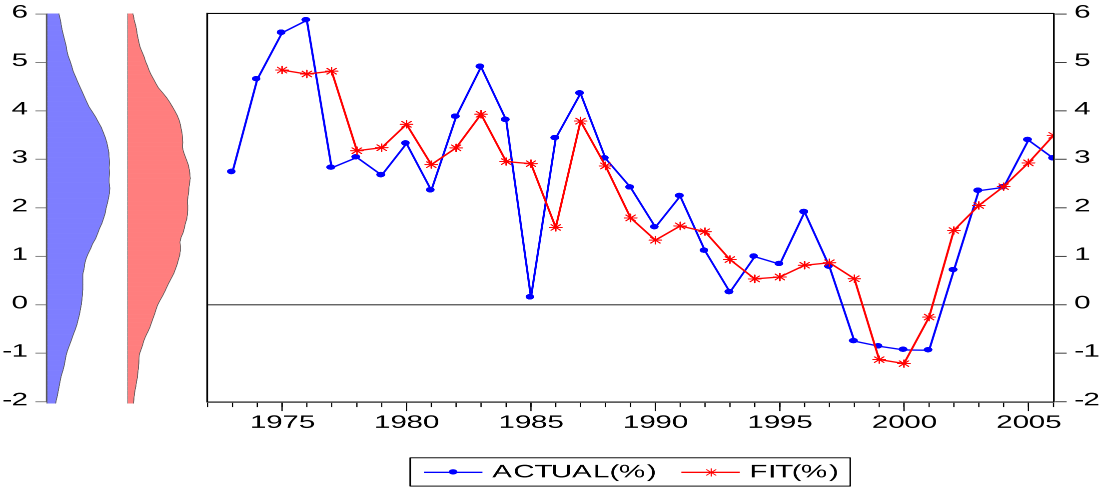
Transport



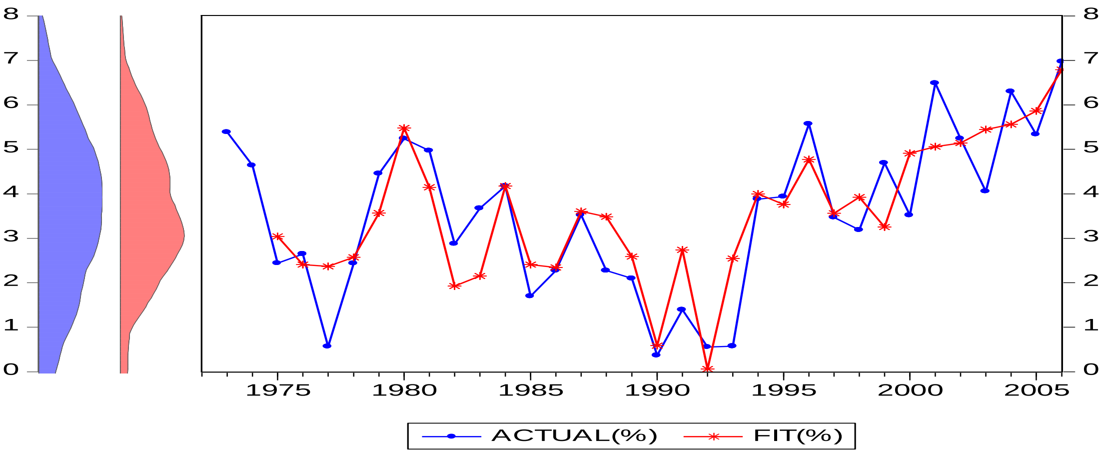
Construction



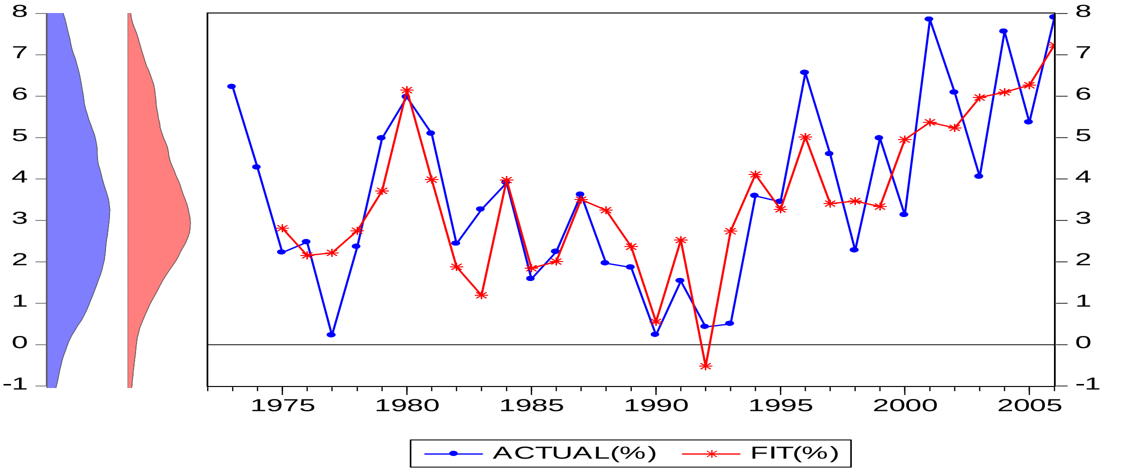
Mining



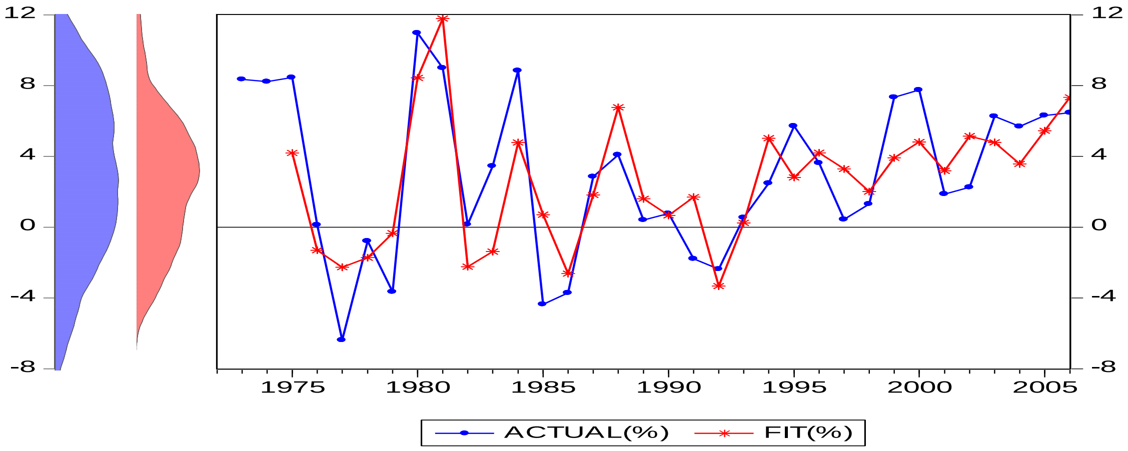
Government



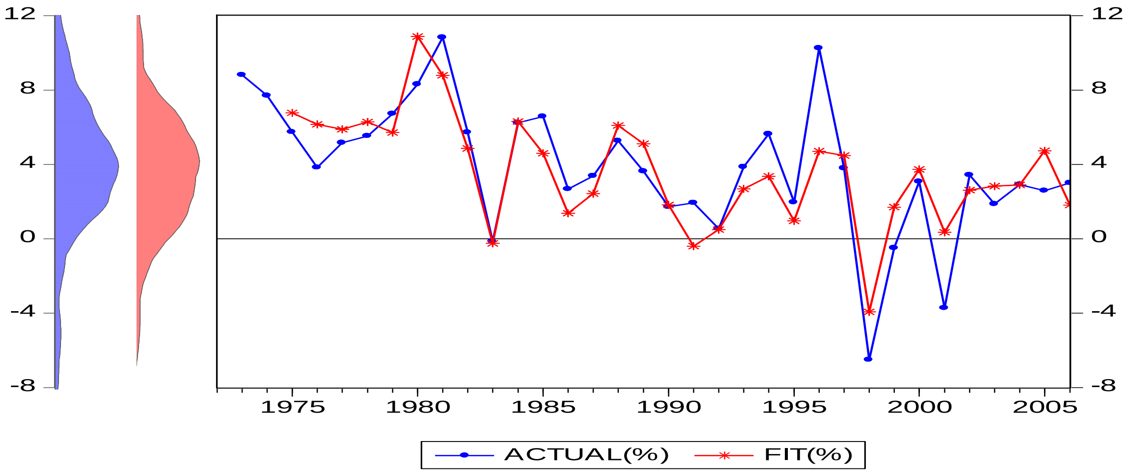
Community services



Financial sector



Wholesale

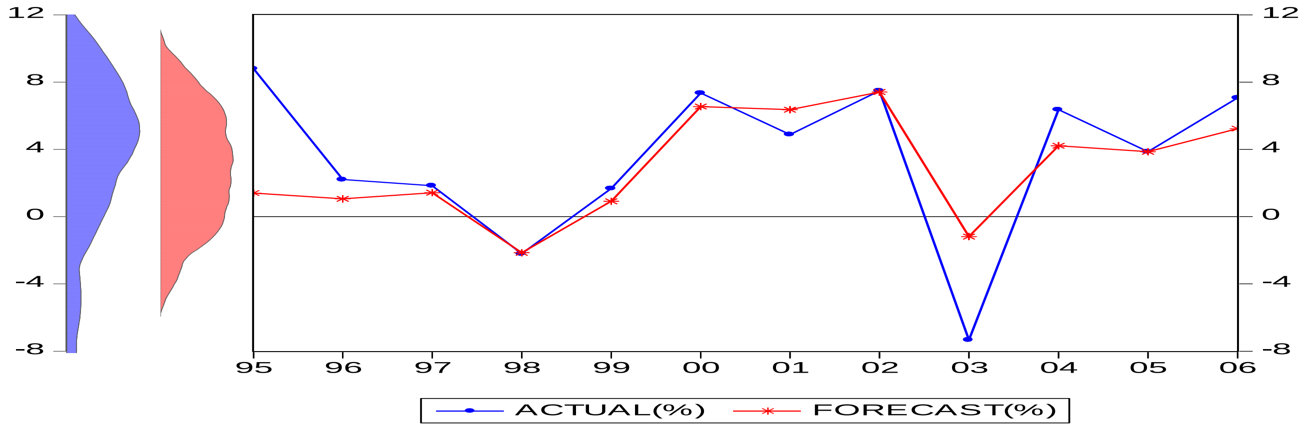


Electricity

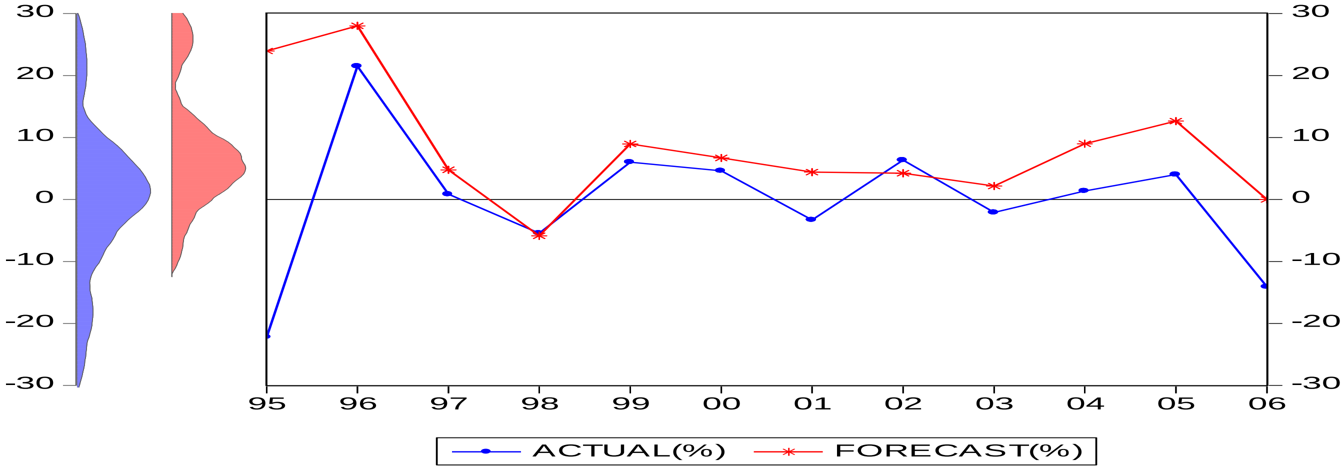
B.2. Model's Prediction Ability: Actual versus Predictions (Forecasts)

In this section, results of the one-year-ahead forecast are provided for individual sectors assessing the forecasting performance of the MMM-DA. Predictions are conducted from 1995 until 2006. Also the figures include the Kernel Density Estimation.

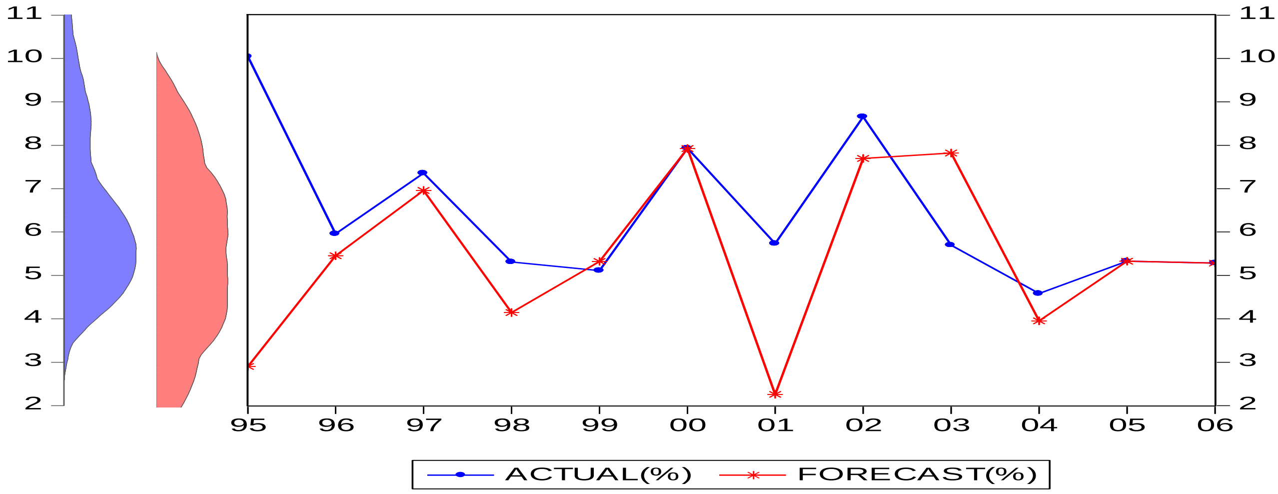
Figure 3.3: Forecasting results: Actual versus Forecasted Series per sector



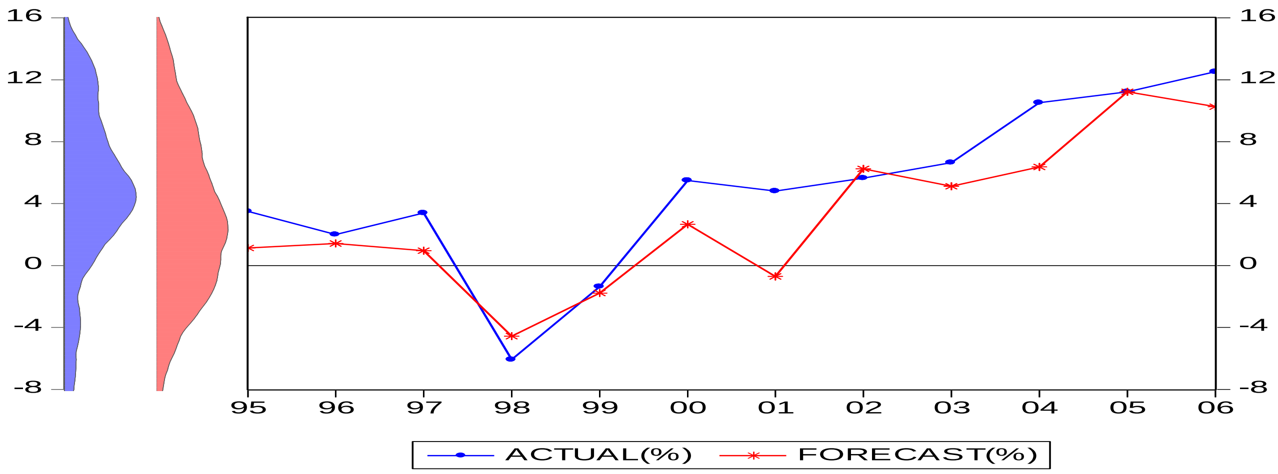
Manufacturing



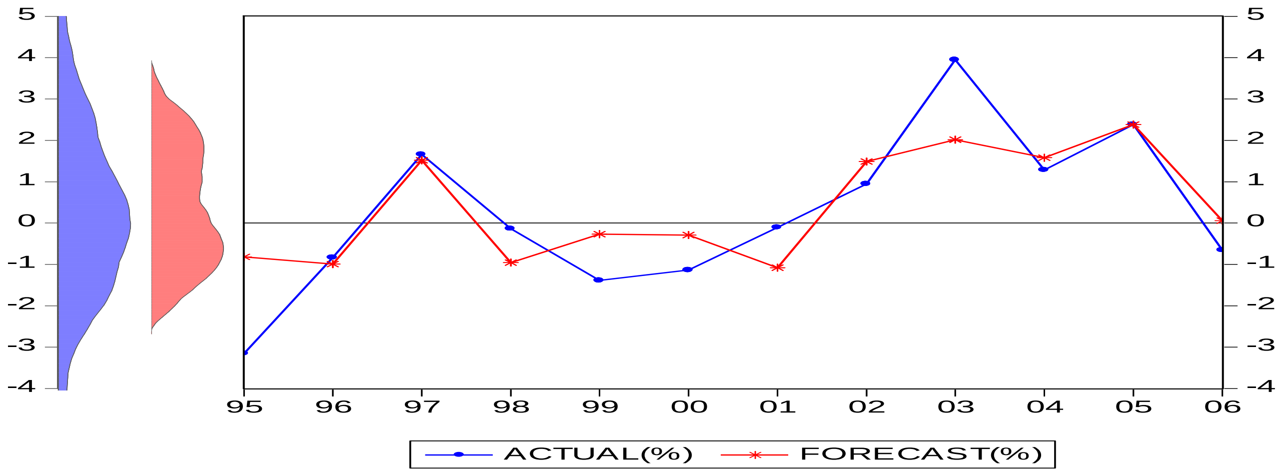
Agriculture



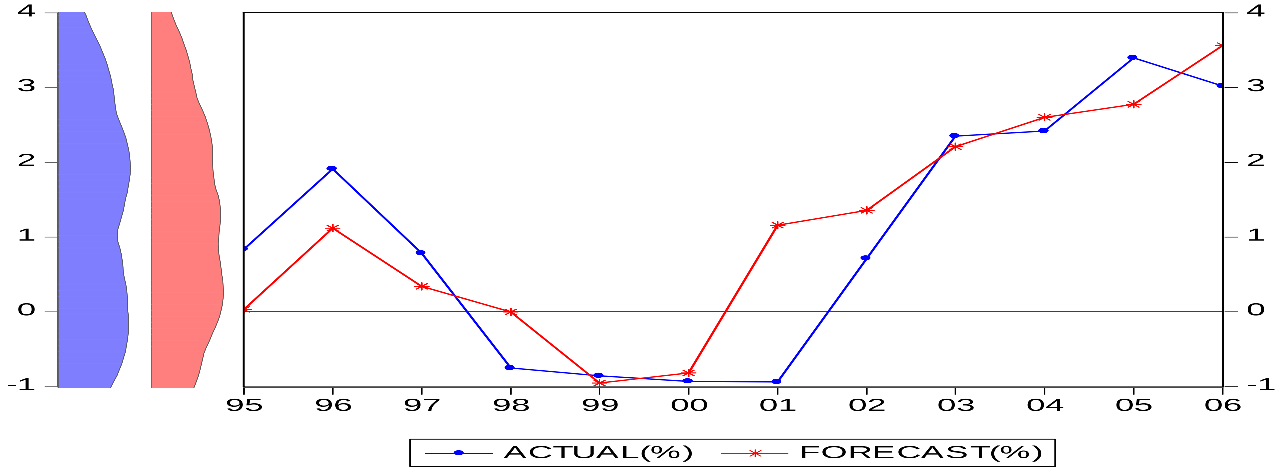
Transport



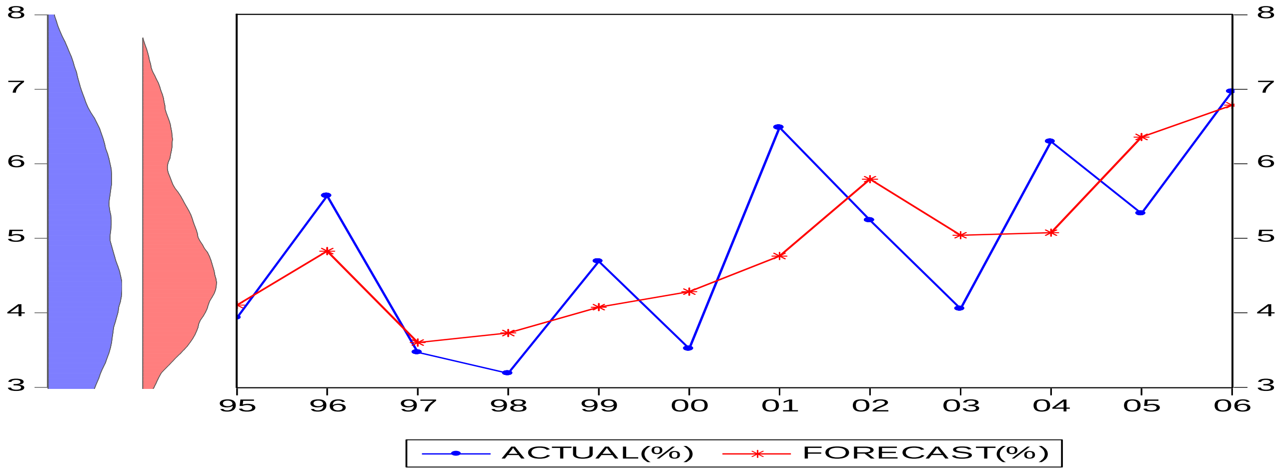
Construction



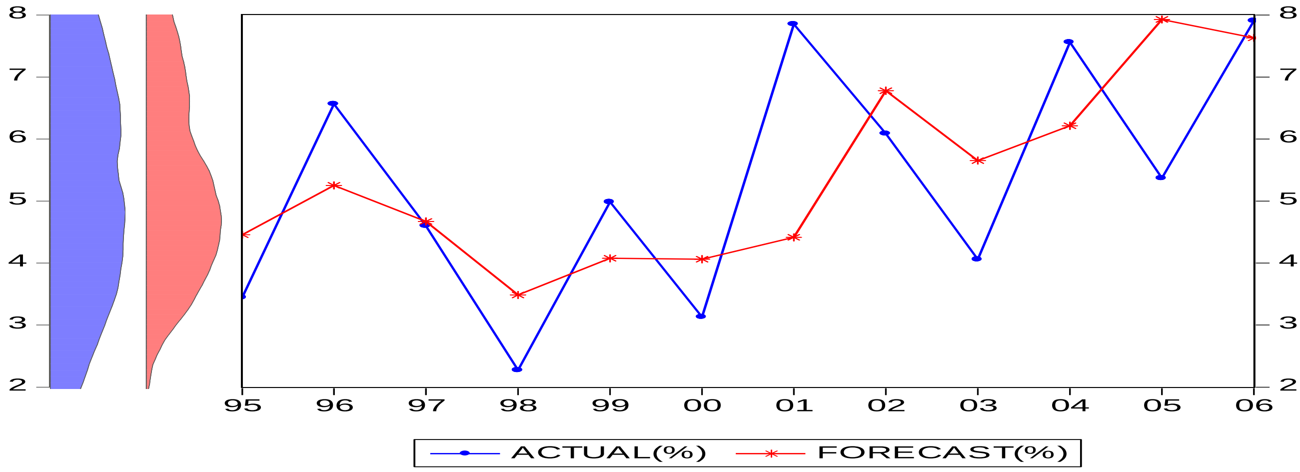
Mining



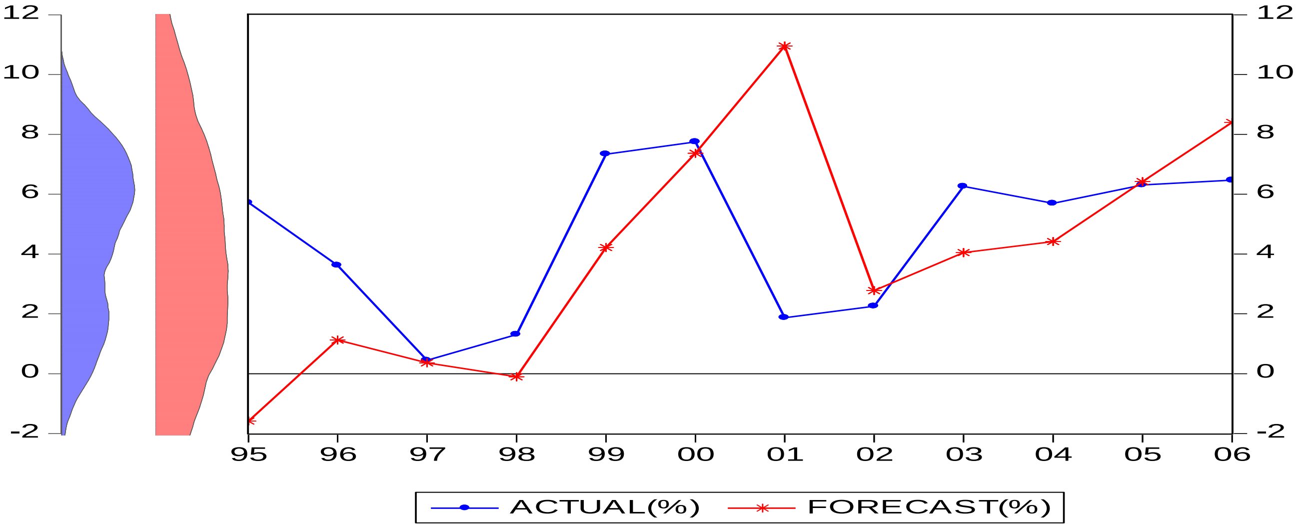
Government



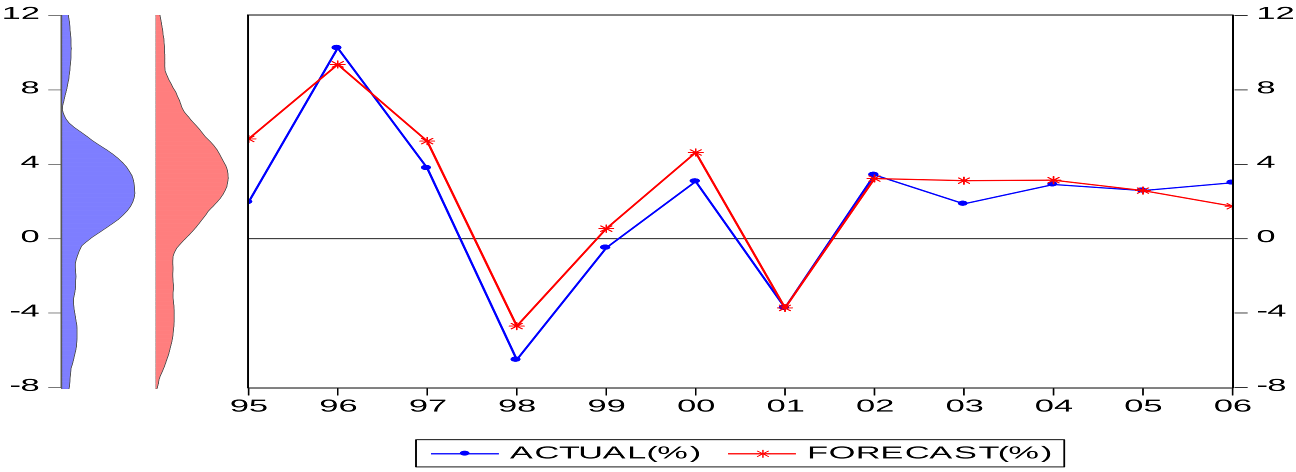
Community services



Financial services



Wholesales

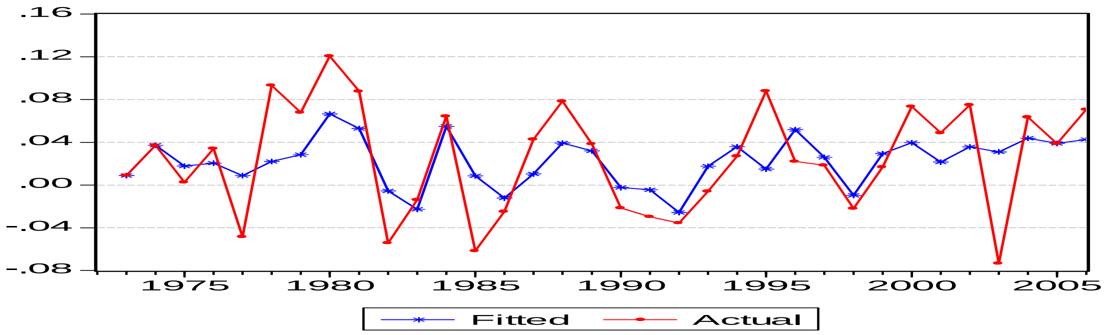


Electricity

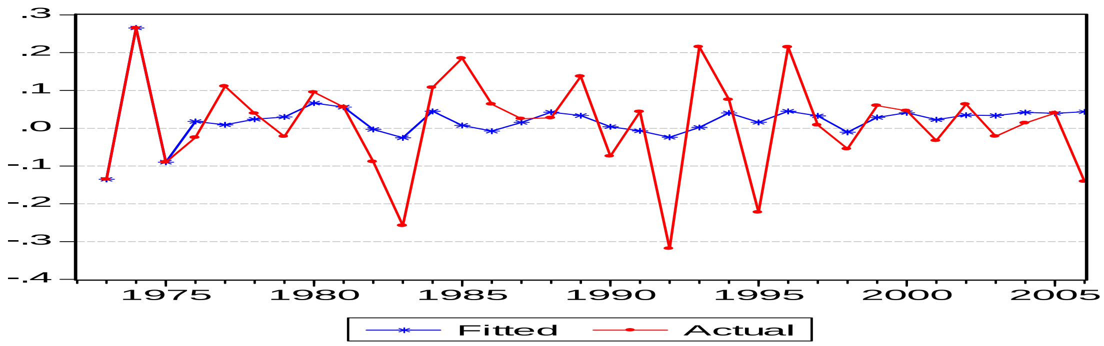
B.3. Model fitness using complete shrinkage

All graphs represent 'actual' versus 'fitted' series of sectoral sales growth using complete shrinkage with the sample size ranging from 1972 to 2006.

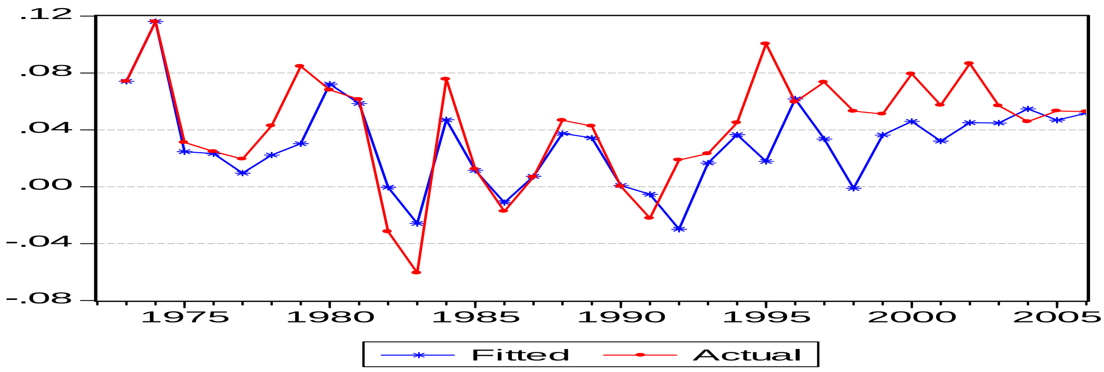
Figure 3.4: Model fitness using complete shrinkage: Actual versus Fitted Series



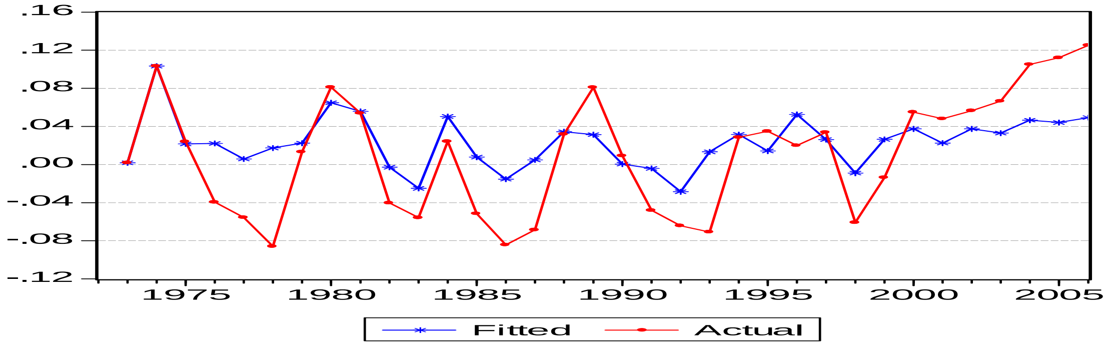
Manufacturing



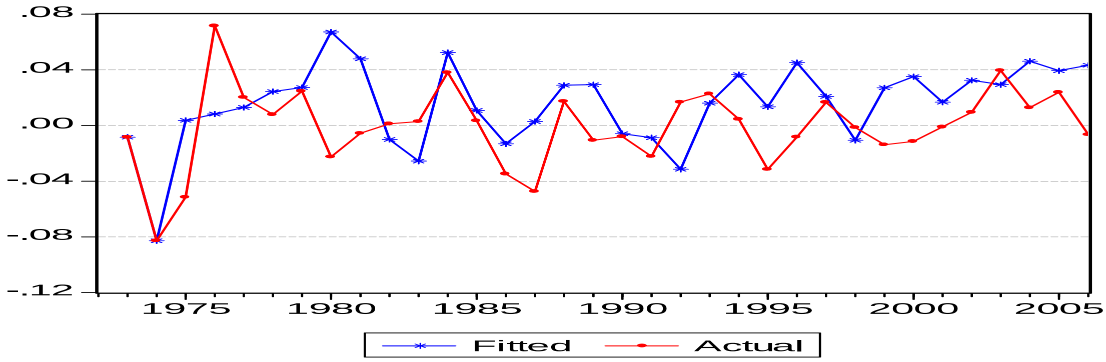
Agriculture



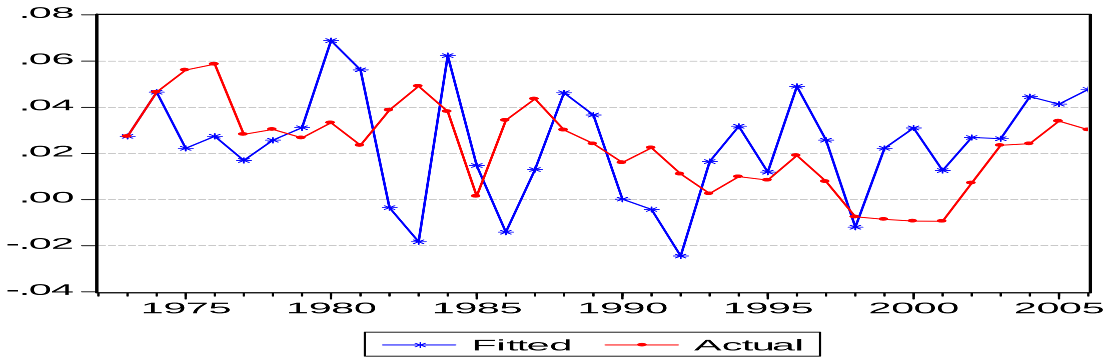
Transport



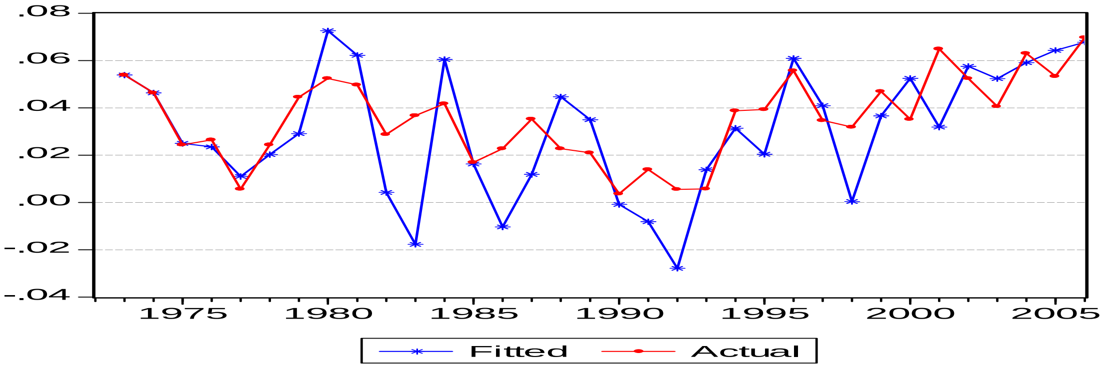
Construction



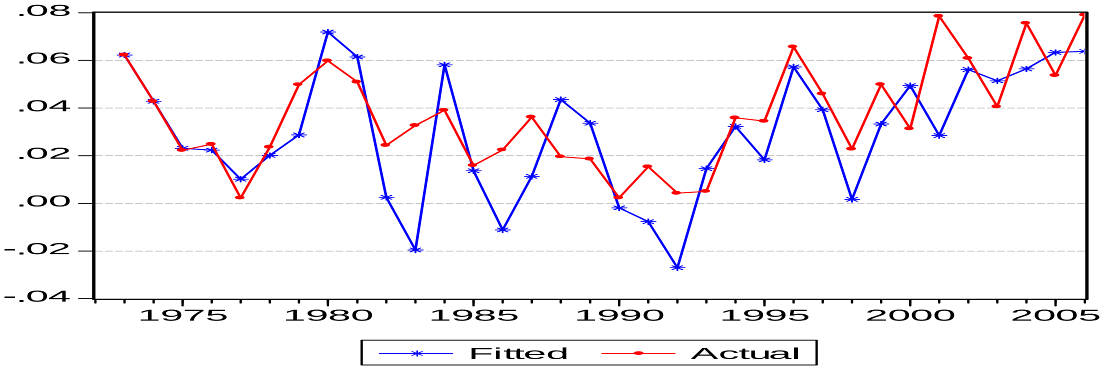
Mining



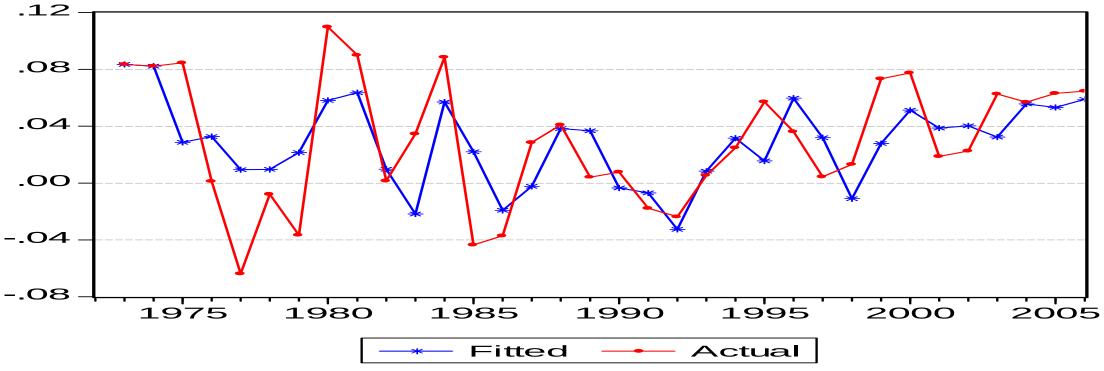
Government



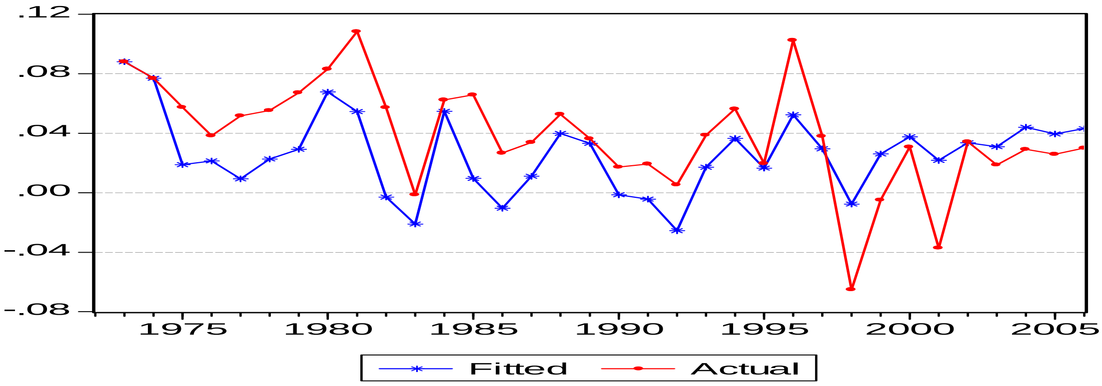
Community



Financial



Wholesales

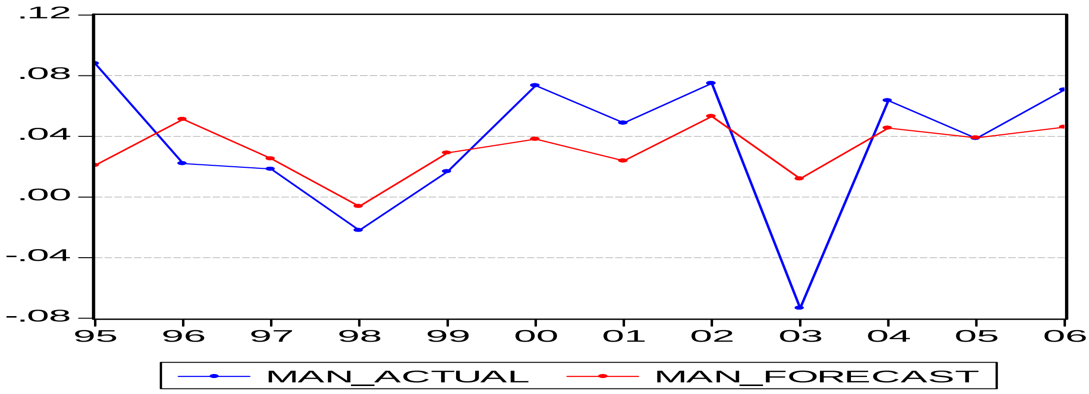


Electricity

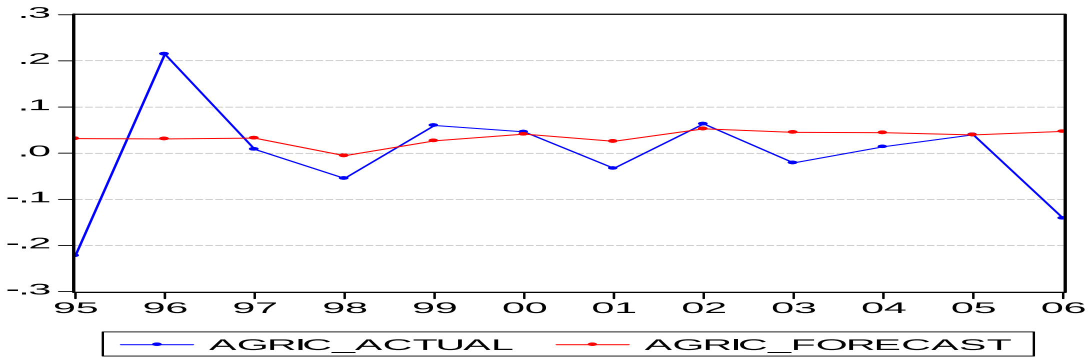
B.4. Predictions (forecasting) using shrinkage technique

This constitutes a repetition of B.2 assuming complete shrinkage.

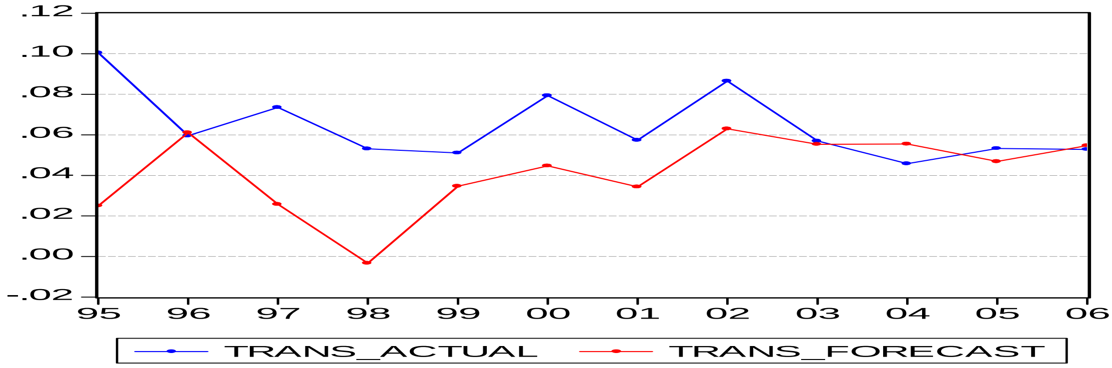
Figure 3.5: Forecasting using complete shrinkage: Actual versus Forecasted Series



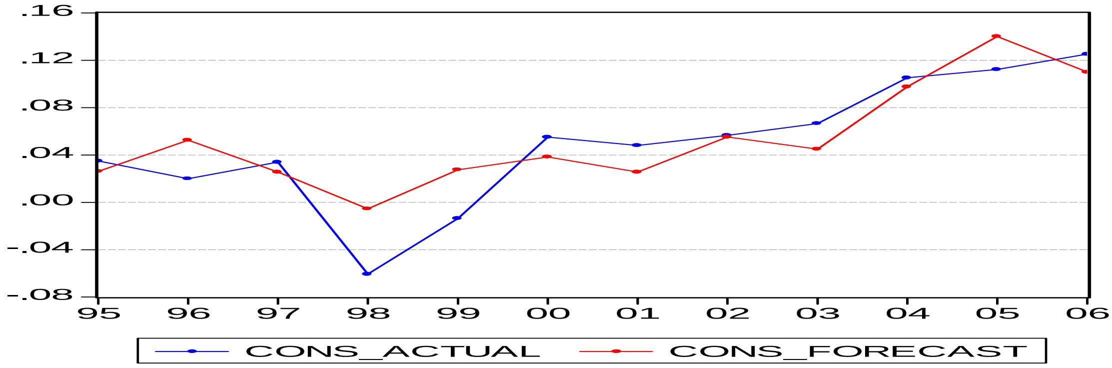
Manufacturing



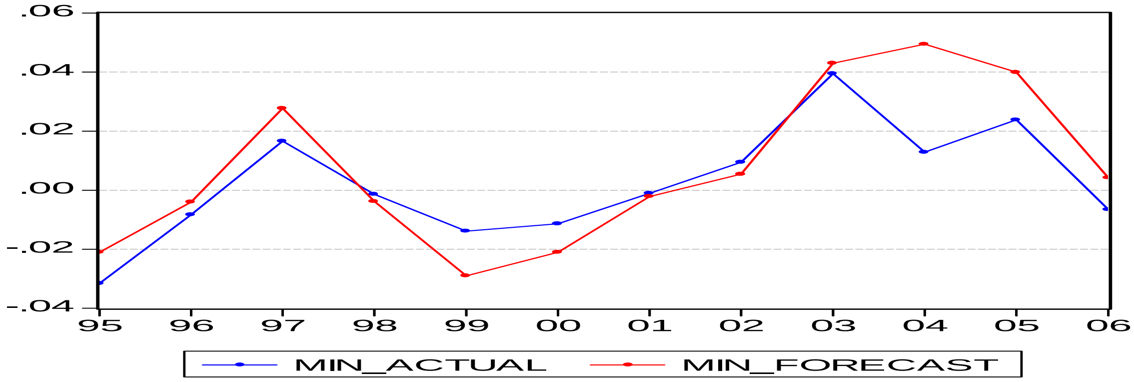
Agriculture



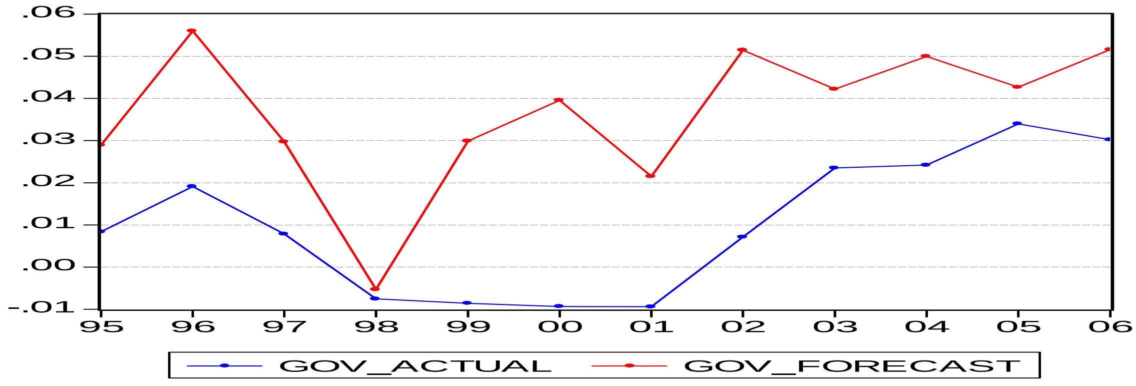
Transport



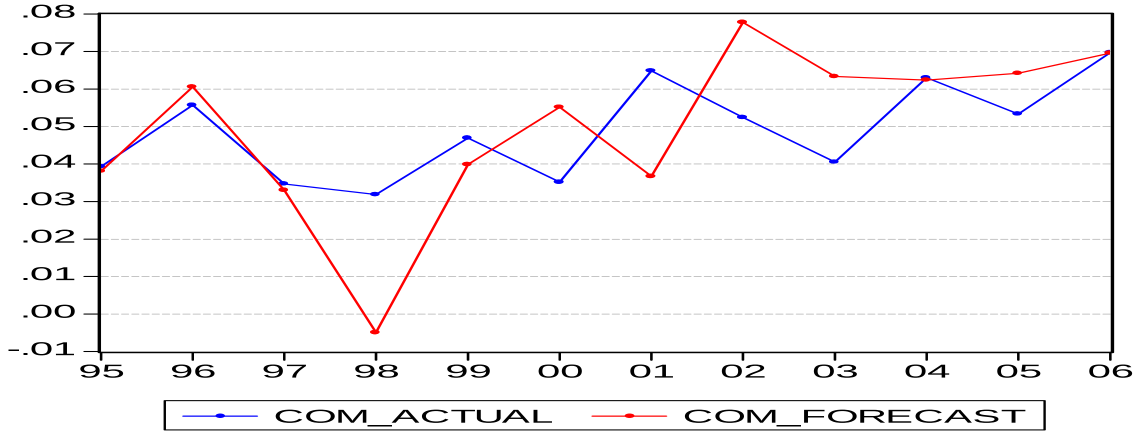
Construction



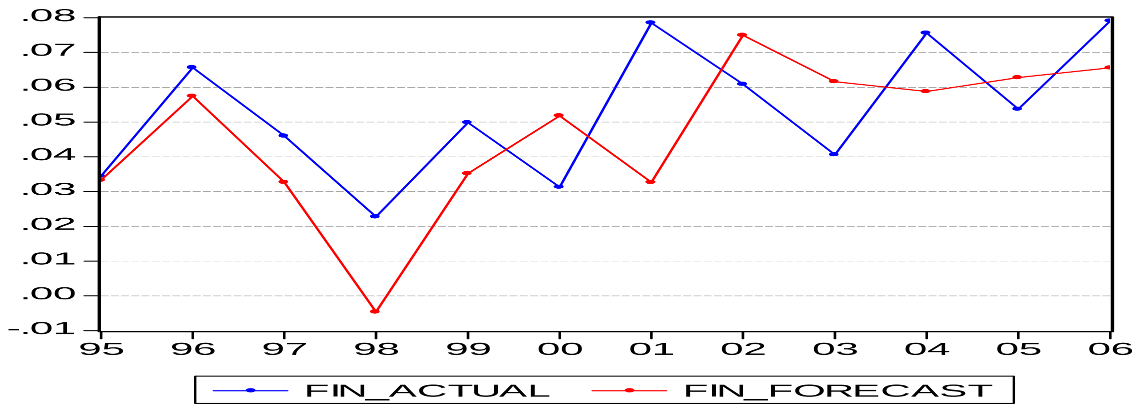
Mining



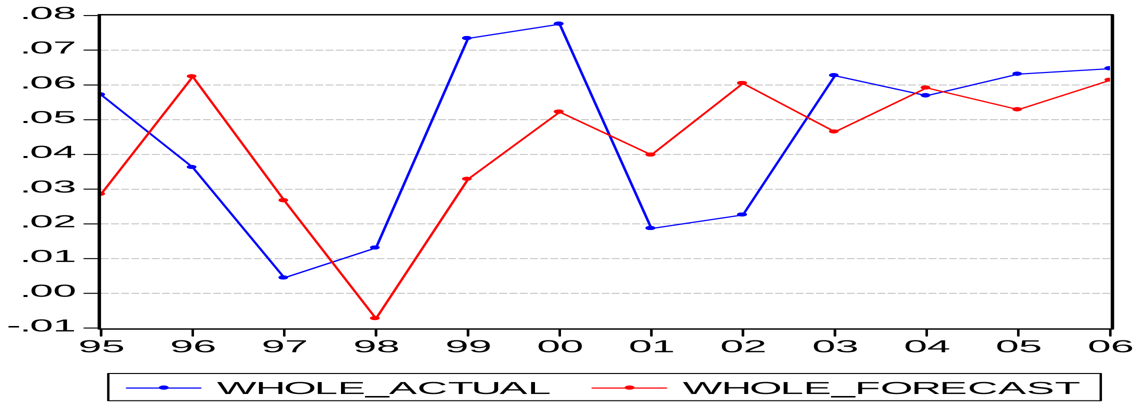
Government



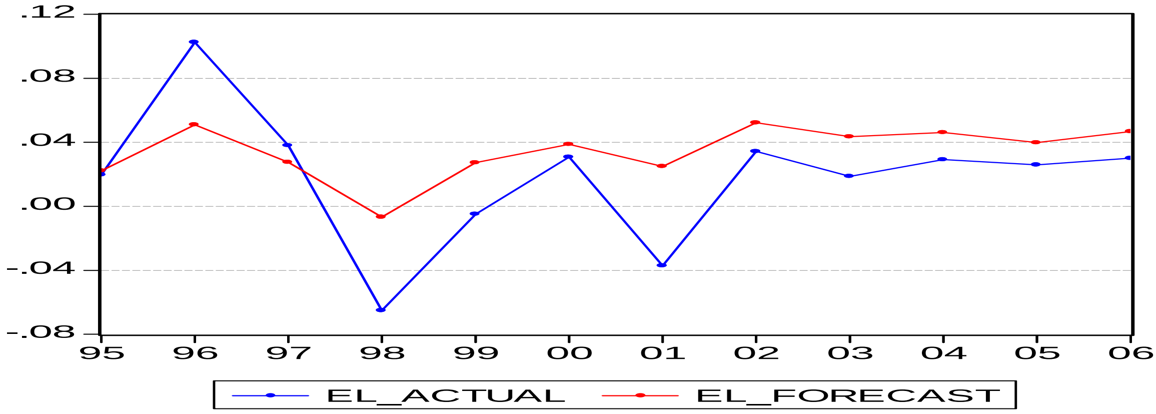
Community



Financial services



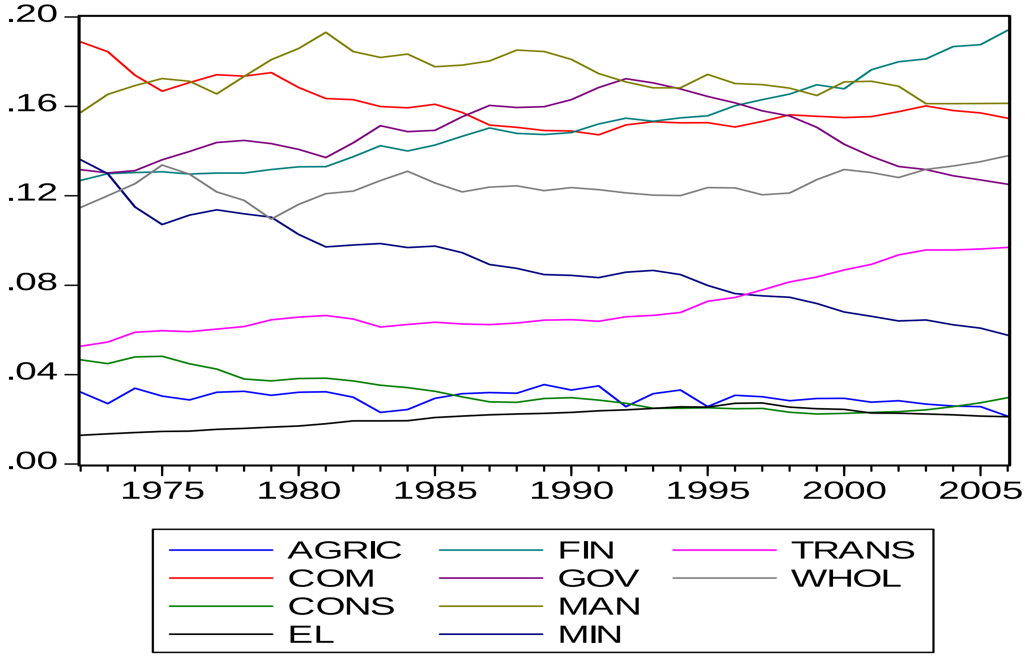
Wholesales



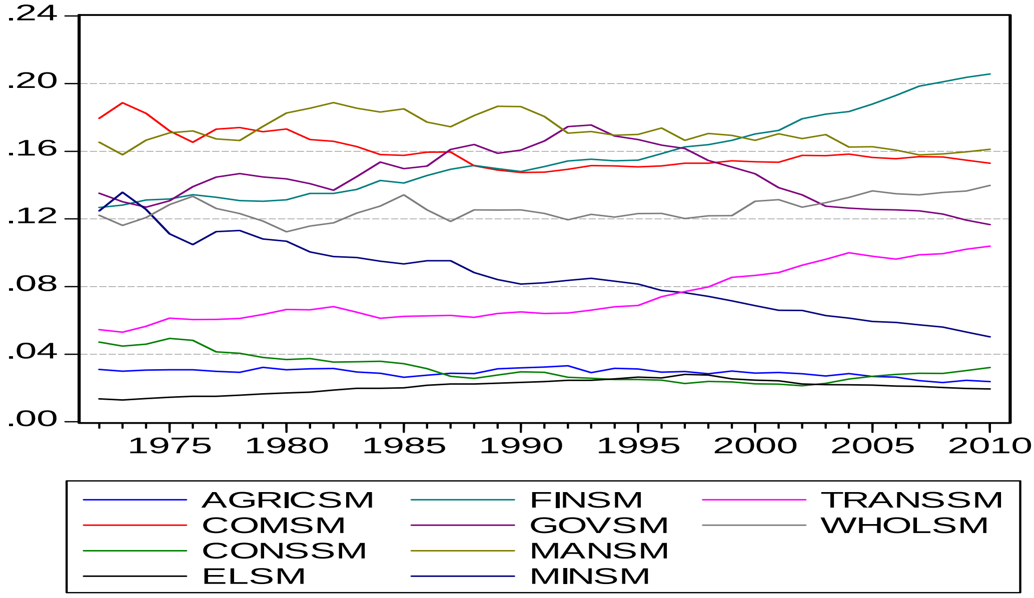
Electricity

APPENDIX C: Sectors' Weights as compared to the National GDP (1972-2006)

C.1. Sectors' shares (Lines)

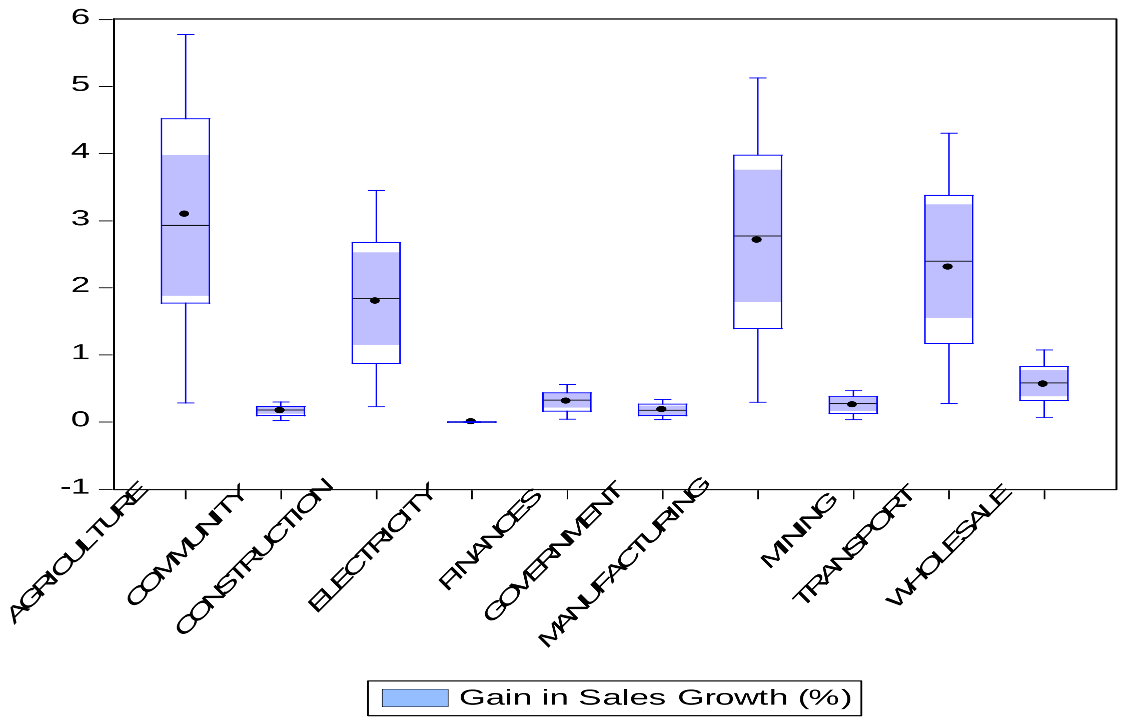


C.2. Weights forecasts (until 2010) using the HWM (Holt Winter Multiplicative) exponential filter

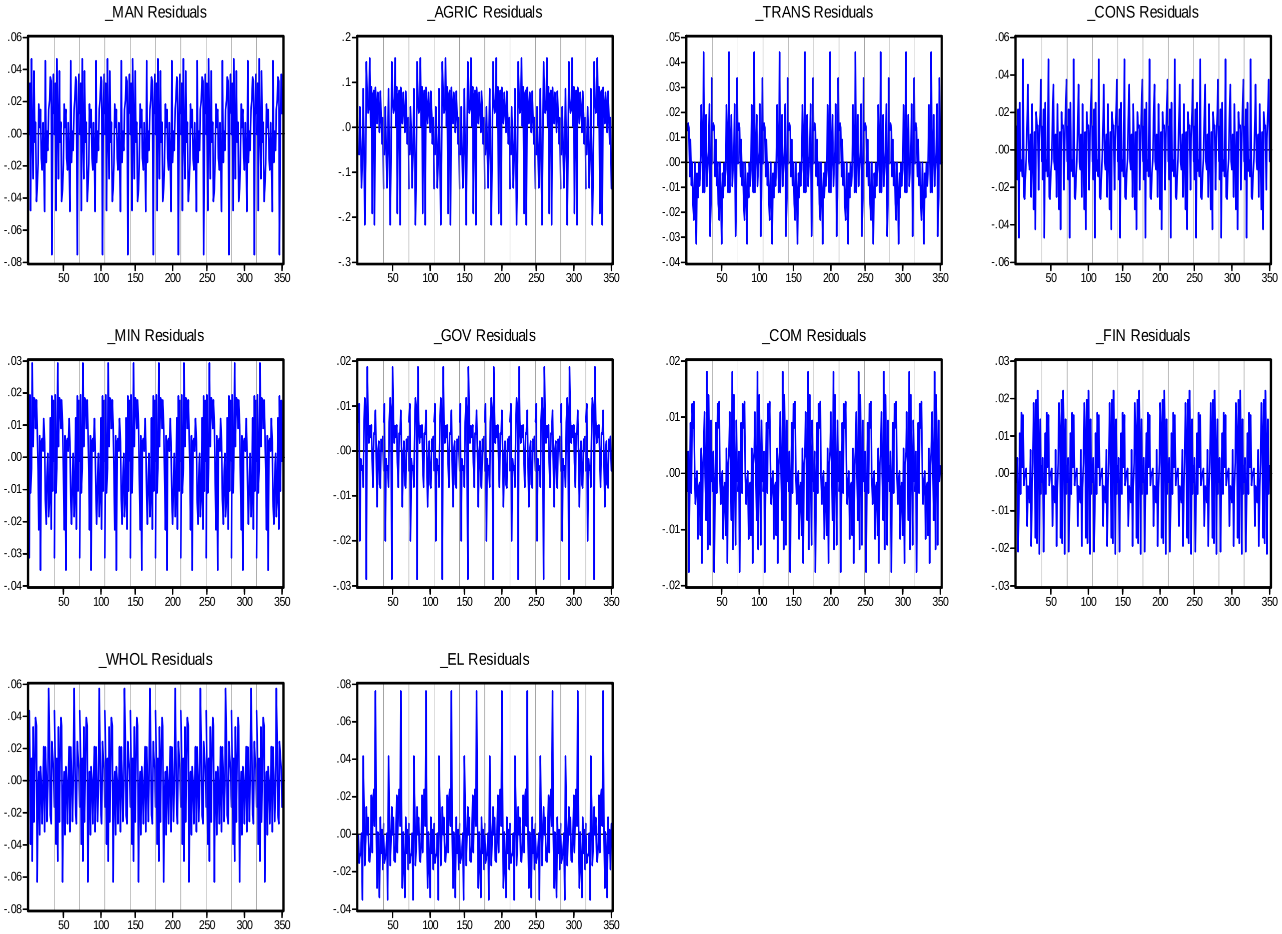


APPENDIX D: POLICY SHOCKS

A 10 percent shock has been applied on selected variables from 1990 onward and the box plot summarizes the reaction across all sectors.



APPENDIX E: RESIDUAL GRAPHS



APPENDIX F: INTRODUCING AN ENTRY COST IN THE MMM: SUR APPROACH (RFE-DA)

At this stage of the MMM-DA, I have introduced a cost of entry charged on each firm willing to enter the sector. In fact, the cost of entry shall be some nonlinear function of several entry requirements. However, in order to palliate to data unavailability, the model makes use of a proxy: other taxes on production by firms. These other taxes constitute additional amount that firms need to pay in addition to the normal operating costs.

Table F.1: Cross section ISUR of $\ln\left(\frac{S_{S,it}}{S_{S,i(t-1)}}\right)$ using Γ and Y_d as demand shifter.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_MAN—C	0.207542	0.021395	9.700555	0.0000
_AGRIC—C	0.300368	0.054945	5.466705	0.0000
_TRANS—C	0.032553	0.011304	2.879812	0.0040
_CONS—C	-0.065646	0.016695	-3.932079	0.0001
_MIN—C	0.419283	0.030240	13.86522	0.0000
_GOV—C	0.029906	0.005590	5.349672	0.0000
_COM—C	0.071430	0.005411	13.20020	0.0000
_FIN—C	0.080668	0.006716	12.01062	0.0000
_WHOL—C	-0.030871	0.019135	-1.613343	0.1068
_EL—C	0.056147	0.011835	4.744170	0.0000
_MAN--S_MAN	-0.002006	0.000172	-11.67989	0.0000
_AGRIC--S_AGRIC	-1.28E-05	2.01E-06	-6.396167	0.0000
_TRANS--S_TRANS	-1.75E-07	9.90E-08	-1.772195	0.0765
_CONS--S_CONS	1.83E-06	6.63E-07	2.759967	0.0058
_MIN--S_MIN	-6.47E-06	4.60E-07	-14.08115	0.0000
_GOV--S_GOV	-2.06E-07	3.56E-08	-5.784847	0.0000
_COM--S_COM	-6.13E-08	1.92E-08	-3.198191	0.0014
_FIN--S_FIN	-8.04E-08	3.09E-08	-2.598721	0.0094
_WHOL--S_WHOL	3.28E-07	1.27E-07	2.590682	0.0096
_EL--S_EL	-4.11E-06	3.80E-07	-10.80525	0.0000
_MAN—LNP2_MAN	-0.569565	0.064303	-8.857470	0.0000
_AGRIC—LNP2_AGRIC	0.255161	0.124264	2.053372	0.0401
_TRANS—LNP2_TRANS	-0.399277	0.039123	-10.20568	0.0000
_CONS—LNP2_CONS	-0.099211	0.046252	-2.144983	0.0320
_MIN—LNP2_MIN	0.000681	0.000116	5.865821	0.0000
_GOV—LNP2_GOV	0.247573	0.031723	7.804161	0.0000

_COM—LNP2_COM	-0.132345	0.034300	-3.858430	0.0001
_FIN—LNP2_FIN	-0.082079	0.042999	-1.908865	0.0564
_WHOL—LNP2_WHOL	-0.087528	0.102955	-0.850155	0.3953
_EL—LNP2_EL	-0.120834	0.082076	-1.472218	0.1411
_MAN—LNP3_MAN	0.272028	0.068214	3.987852	0.0001
_AGRIC—LNP3_AGRIC	-0.043427	0.103707	-0.418743	0.6754
_TRANS—LNP3_TRANS	0.147271	0.037980	3.877584	0.0001
_CONS—LNP3_CONS	-0.387414	0.043284	-8.950418	0.0000
_MIN—LNP3_MIN	-0.000274	0.000120	-2.282093	0.0226
_GOV—LNP3_GOV	0.003997	0.040586	0.098486	0.9216
_COM—LNP3_COM	0.032495	0.041286	0.787064	0.4313
_FIN—LNP3_FIN	0.028269	0.051498	0.548936	0.5831
_WHOL—LNP3_WHOL	0.302534	0.123701	2.445694	0.0145
_EL—LNP3_EL	0.196447	0.102173	1.922691	0.0546
_MAN—LNP4_MAN	-0.514556	0.064029	-8.036337	0.0000
_AGRIC—LNP4_AGRIC	-0.171434	0.103312	-1.659382	0.0971
_TRANS—LNP4_TRANS	-0.112284	0.035638	-3.150690	0.0016
_CONS—LNP4_CONS	-0.196563	0.038767	-5.070308	0.0000
_MIN—LNP4_MIN	0.000744	0.000133	5.601234	0.0000
_GOV—LNP4_GOV	-0.032975	0.032810	-1.005048	0.3150
_COM—LNP4_COM	-0.274004	0.033128	-8.271155	0.0000
_FIN—LNP4_FIN	-0.430970	0.041567	-10.36806	0.0000
_WHOL—LNP4_WHOL	-0.647351	0.100001	-6.473438	0.0000
_EL—LNP4_EL	0.020907	0.082841	0.252378	0.8008
_MAN—LNM22_MAN	0.234037	0.033932	6.897243	0.0000
_AGRIC—LNM22_AGRIC	0.085560	0.113318	0.755044	0.4503
_TRANS—LNM22_TRANS	0.097773	0.026767	3.652800	0.0003
_CONS—LNM22_CONS	0.383823	0.031105	12.33971	0.0000
_MIN—LNM22_MIN	0.006271	0.018037	0.347663	0.7281
_GOV—LNM22_GOV	-0.019635	0.011542	-1.701092	0.0890
_COM—LNM22_COM	0.070039	0.011304	6.195866	0.0000
_FIN—LNM22_FIN	0.079343	0.014228	5.576391	0.0000
_WHOL—LNM22_WHOL	0.261961	0.032894	7.963842	0.0000
_EL—LNM22_EL	0.097955	0.028804	3.400699	0.0007
_MAN—LNSP2_MAN	0.015270	0.005216	2.927544	0.0034
_AGRIC—LNSP2_AGRIC	-0.053507	0.018815	-2.843845	0.0045
_TRANS—LNSP2_TRANS	0.009041	0.003585	2.521602	0.0117
_CONS—LNSP2_CONS	-0.015857	0.004310	-3.678708	0.0002
_MIN—LNSP2_MIN	-0.016224	0.002802	-5.790186	0.0000

_GOV—LNSP2_GOV	-0.012492	0.001743	-7.167865	0.0000
_COM—LNSP2_COM	0.004616	0.001665	2.771912	0.0056
_FIN—LNSP2_FIN	0.001021	0.002096	0.487098	0.6262
_WHOL—LNSP2_WHOL	0.032170	0.004765	6.751456	0.0000
_EL—LNSP2_EL	0.000698	0.004382	0.159322	0.8734
_MAN—LNYD1_MAN	1.124663	0.087477	12.85662	0.0000
_AGRIC—LNYD1_AGRIC	2.361450	0.288425	8.187406	0.0000
_TRANS—LNYD1_TRANS	0.805426	0.071744	11.22633	0.0000
_CONS—LNYD1_CONS	1.645082	0.082965	19.82874	0.0000
_MIN—LNYD1_MIN	0.204862	0.044207	4.634188	0.0000
_GOV—LNYD1_GOV	0.150384	0.029837	5.040153	0.0000
_COM—LNYD1_COM	0.261179	0.029313	8.910141	0.0000
_FIN—LNYD1_FIN	0.382525	0.036893	10.36853	0.0000
_WHOL—LNYD1_WHOL	0.615491	0.086535	7.112589	0.0000
_EL—LNYD1_EL	0.688065	0.075281	9.139921	0.0000
_MAN—LNR1_MAN	0.044961	0.007781	5.778412	0.0000
_AGRIC—LNR1_AGRIC	-0.059833	0.025898	-2.310334	0.0209
_TRANS—LNR1_TRANS	-0.020986	0.005755	-3.646744	0.0003
_CONS—LNR1_CONS	0.016031	0.006459	2.481866	0.0131
_MIN—LNR1_MIN	0.001399	0.003929	0.356054	0.7218
_GOV—LNR1_GOV	0.006570	0.002707	2.427113	0.0153
_COM—LNR1_COM	0.009065	0.002686	3.374614	0.0007
_FIN—LNR1_FIN	0.009263	0.003374	2.745563	0.0061
_WHOL—LNR1_WHOL	0.066023	0.007823	8.439108	0.0000
_EL—LNR1_EL	-0.007498	0.006729	-1.114419	0.2652
_MAN—LNW1_MAN	-0.024886	0.014008	-1.776495	0.0758
_AGRIC—LNW1_AGRIC	-0.112130	0.049324	-2.273318	0.0231
_TRANS—LNW1_TRANS	-0.006213	0.010196	-0.609399	0.5423
_CONS—LNW1_CONS	-0.015561	0.011974	-1.299531	0.1939
_MIN—LNW1_MIN	-0.017010	0.007590	-2.241056	0.0251
_GOV—LNW1_GOV	-0.006799	0.004765	-1.426853	0.1537
_COM—LNW1_COM	0.027575	0.004668	5.907230	0.0000
_FIN—LNW1_FIN	0.014807	0.005876	2.519983	0.0118
_WHOL—LNW1_WHOL	0.013395	0.013585	0.986062	0.3242
_EL—LNW1_EL	-0.019852	0.011854	-1.674624	0.0941
_MAN—LNH1_MAN	0.063030	0.049354	1.277109	0.2017
_AGRIC—LNH1_AGRIC	-0.434422	0.158645	-2.738335	0.0062
_TRANS—LNH1_TRANS	-0.061789	0.033713	-1.832796	0.0669
_CONS—LNH1_CONS	-0.015225	0.039407	-0.386358	0.6993

_MIN—LNH1_MIN	0.131804	0.025457	5.177426	0.0000
_GOV—LNH1_GOV	0.102724	0.016123	6.371262	0.0000
_COM—LNH1_COM	0.012771	0.017583	0.726316	0.4677
_FIN—LNH1_FIN	-0.019574	0.022351	-0.875786	0.3812
_WHOL—LNH1_WHOL	-0.128228	0.052941	-2.422071	0.0155
_EL—LNH1_EL	0.056061	0.040388	1.388045	0.1652
_MAN—LNZ1_MAN	0.517990	0.095303	5.435172	0.0000
_AGRIC—LNZ1_AGRIC	-0.421887	0.363651	-1.160143	0.2461
_TRANS—LNZ1_TRANS	0.287233	0.072077	3.985114	0.0001
_CONS—LNZ1_CONS	0.245771	0.095775	2.566141	0.0103
_MIN—LNZ1_MIN	-0.376915	0.057276	-6.580663	0.0000
_GOV—LNZ1_GOV	-0.393812	0.032105	-12.26637	0.0000
_COM—LNZ1_COM	0.069786	0.030122	2.316774	0.0206
_FIN—LNZ1_FIN	0.093974	0.037757	2.488934	0.0129
_WHOL—LNZ1_WHOL	0.552889	0.086423	6.397442	0.0000
_EL—LNZ1_EL	-0.008782	0.078797	-0.111448	0.9113
_MAN—LNΓ1_MAN	0.022903	0.028409	0.806192	0.4202
_AGRIC—LNΓ1_AGRIC	-0.204187	0.084591	-2.413804	0.0158
_TRANS—LNΓ1_TRANS	0.067262	0.020681	3.252400	0.0012
_CONS—LNΓ1_CONS	-0.039554	0.023413	-1.689363	0.0913
_MIN—LNΓ1_MIN	0.076200	0.013092	5.820254	0.0000
_GOV—LNΓ1_GOV	-0.021357	0.009290	-2.298862	0.0216
_COM—LNΓ1_COM	-0.046539	0.009353	-4.975578	0.0000
_FIN—LNΓ1_FIN	-0.038240	0.011756	-3.252825	0.0012
_WHOL—LNΓ1_WHOL	0.043408	0.027649	1.569937	0.1165
_EL—LNΓ1_EL	0.059533	0.023256	2.559866	0.0105
Weighted Statistics				
R-squared	0.857411	**Mean dependent var**		0.844553
Adjusted R-squared	0.851218	**S.D. dependent var**		2.583258
F-statistic	138.4424	**Durbin-Watson stat**		2.193141
Prob(F-statistic)	0.000000			

MAE = 0.84

RMSE = 1.75

Table F.2: Wald coefficients test

Test Statistic	Value	Df	Probability
F-statistic	99.38386	(2, 2970)	0.0000
Chi-square	198.7677	2	0.0000

Null Hypothesis Summary

Normalized Restriction (= 0)	Value	Std. Err.
C(3): lag of order 2	0.032553	0.011304
C(5): lag of order 3	0.419283	0.030240

Table F.3: ISUR of $\ln\left(\frac{S_{S,it}}{S_{S,i(t-1)}}\right)$ using imposed restrictions on the parameters

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_MAN--C	0.022157	0.016447	1.347172	0.1780
_AGRIC--C	0.240582	0.046653	5.156871	0.0000
_TRANS--C	-0.007155	0.009703	-0.737418	0.4609
_CONS--C	-0.093549	0.017009	-5.499839	0.0000
_MIN--C	0.404997	0.032407	12.49717	0.0000
_GOV--C	0.054457	0.004402	12.37242	0.0000
_COM--C	0.046019	0.004412	10.43045	0.0000
_FIN--C	0.054102	0.005703	9.486295	0.0000
_WHOL--C	0.001826	0.016135	0.113192	0.9099
_EL--C	0.059855	0.009441	6.339724	0.0000
_MAN—S_MAN	-0.000749	0.000141	-5.319932	0.0000
_AGRIC—S_AGRIC	-1.08E-05	1.62E-06	-6.647116	0.0000
_TRANS—S_TRANS	-1.59E-07	9.43E-08	-1.688080	0.0915
_CONS—S_CONS	2.50E-06	6.41E-07	3.908054	0.0001
_MIN—S_MIN	-6.30E-06	4.92E-07	-12.80196	0.0000
_GOV—S_GOV	-3.61E-07	2.79E-08	-12.97633	0.0000
_COM—S_COM	1.41E-08	1.58E-08	0.888283	0.3745
_FIN—S_FIN	1.18E-08	2.66E-08	0.443480	0.6574
_WHOL—S_WHOL	-1.08E-08	1.07E-07	-0.101165	0.9194
_EL—S_EL	-3.95E-06	3.01E-07	-13.11604	0.0000
_MAN--LNP3_MAN	-0.018389	0.056709	-0.324265	0.7458
_AGRIC--LNP3_AGRIC	-0.137550	0.081894	-1.679610	0.0931
_TRANS--LNP3_TRANS	-0.077944	0.029230	-2.666597	0.0077
_CONS--LNP3_CONS	-0.514074	0.031707	-16.21339	0.0000
_MIN--LNP3_MIN	-0.000233	0.000146	-1.593624	0.1111

_GOV--LNP3_GOV	0.185260	0.018250	10.15133	0.0000
_COM--LNP3_COM	-0.229821	0.021804	-10.54008	0.0000
_FIN--LNP3_FIN	-0.299377	0.028626	-10.45822	0.0000
_WHOL--LNP3_WHOL	-0.282031	0.069506	-4.057640	0.0001
_EL--LNP3_EL	0.002468	0.051328	0.048084	0.9617
_MAN--LNM22_MAN	0.189303	0.036823	5.140908	0.0000
_AGRIC--LNM22_AGRIC	0.094121	0.118647	0.793284	0.4277
_TRANS--LNM22_TRANS	0.221060	0.027502	8.037994	0.0000
_CONS--LNM22_CONS	0.431060	0.030949	13.92817	0.0000
_MIN--LNM22_MIN	0.014904	0.022914	0.650456	0.5154
_GOV--LNM22_GOV	-0.021538	0.011793	-1.826314	0.0679
_COM--LNM22_COM	0.039208	0.011262	3.481251	0.0005
_FIN--LNM22_FIN	0.030501	0.014649	2.082044	0.0374
_WHOL--LNM22_WHOL	0.209973	0.035424	5.927339	0.0000
_EL--LNM22_EL	0.101473	0.027105	3.743649	0.0002
_MAN--LNSP2_MAN	0.011778	0.005416	2.174398	0.0298
_AGRIC--LNSP2_AGRIC	-0.050288	0.017513	-2.871497	0.0041
_TRANS--LNSP2_TRANS	0.018091	0.003965	4.563249	0.0000
_CONS--LNSP2_CONS	-0.009083	0.004575	-1.985142	0.0472
_MIN--LNSP2_MIN	-0.021101	0.003475	-6.072419	0.0000
_GOV--LNSP2_GOV	-0.006422	0.001721	-3.731331	0.0002
_COM--LNSP2_COM	0.002727	0.001643	1.659701	0.0971
_FIN--LNSP2_FIN	0.000318	0.002137	0.148833	0.8817
_WHOL--LNSP2_WHOL	0.037017	0.005209	7.106177	0.0000
_EL--LNSP2_EL	-0.001267	0.003961	-0.319717	0.7492
_MAN--LNYD1_MAN	1.500029	0.081905	18.31427	0.0000
_AGRIC--LNYD1_AGRIC	2.321036	0.272964	8.503085	0.0000
_TRANS--LNYD1_TRANS	1.103019	0.062980	17.51373	0.0000
_CONS--LNYD1_CONS	1.502805	0.069334	21.67473	0.0000
_MIN--LNYD1_MIN	0.379807	0.051711	7.344788	0.0000
_GOV--LNYD1_GOV	0.000868	0.026982	0.032154	0.9744
_COM--LNYD1_COM	0.309022	0.026141	11.82142	0.0000
_FIN--LNYD1_FIN	0.395932	0.033994	11.64709	0.0000
_WHOL--LNYD1_WHOL	0.426333	0.081584	5.225710	0.0000
_EL--LNYD1_EL	0.704079	0.061845	11.38456	0.0000
_MAN--LNR1_MAN	0.033228	0.008363	3.973049	0.0001
_AGRIC--LNR1_AGRIC	-0.046851	0.027266	-1.718271	0.0858
_TRANS--LNR1_TRANS	-0.037534	0.006376	-5.886482	0.0000
_CONS--LNR1_CONS	0.010630	0.006695	1.587802	0.1124

_MIN--LNR1_MIN	-0.004746	0.004988	-0.951503	0.3414
_GOV--LNR1_GOV	0.004033	0.002793	1.443930	0.1489
_COM--LNR1_COM	0.010063	0.002743	3.668872	0.0002
_FIN--LNR1_FIN	0.009181	0.003568	2.573312	0.0101
_WHOL--LNR1_WHOL	0.062387	0.008597	7.256942	0.0000
_EL--LNR1_EL	-0.000377	0.006530	-0.057795	0.9539
_MAN--LNW1_MAN	0.006762	0.014888	0.454161	0.6497
_AGRIC--LNW1_AGRIC	-0.060738	0.048932	-1.241271	0.2146
_TRANS--LNW1_TRANS	0.024160	0.011099	2.176742	0.0296
_CONS--LNW1_CONS	0.001840	0.012473	0.147491	0.8828
_MIN--LNW1_MIN	-0.023948	0.009447	-2.535062	0.0113
_GOV--LNW1_GOV	0.000261	0.004852	0.053764	0.9571
_COM--LNW1_COM	0.036117	0.004640	7.783115	0.0000
_FIN--LNW1_FIN	0.030418	0.006032	5.042307	0.0000
_WHOL--LNW1_WHOL	0.050534	0.014609	3.459070	0.0005
_EL--LNW1_EL	-0.020360	0.011093	-1.835395	0.0665
_MAN--LNH1_MAN	-0.099905	0.042903	-2.328617	0.0199
_AGRIC--LNH1_AGRIC	-0.418356	0.137081	-3.051897	0.0023
_TRANS--LNH1_TRANS	-0.058437	0.033431	-1.747971	0.0806
_CONS--LNH1_CONS	0.077385	0.040130	1.928380	0.0539
_MIN--LNH1_MIN	-0.019118	0.025701	-0.743873	0.4570
_GOV--LNH1_GOV	0.169798	0.014358	11.82600	0.0000
_COM--LNH1_COM	-0.002042	0.014336	-0.142436	0.8867
_FIN--LNH1_FIN	-0.006005	0.018755	-0.320192	0.7488
_WHOL--LNH1_WHOL	0.065066	0.045311	1.436005	0.1511
_EL--LNH1_EL	0.004117	0.033974	0.121168	0.9036
_MAN--LNZ1_MAN	0.533376	0.100821	5.290348	0.0000
_AGRIC--LNZ1_AGRIC	-0.222763	0.339970	-0.655244	0.5124
_TRANS--LNZ1_TRANS	0.386548	0.077089	5.014334	0.0000
_CONS--LNZ1_CONS	0.396817	0.098007	4.048878	0.0001
_MIN--LNZ1_MIN	-0.495985	0.069993	-7.086246	0.0000
_GOV--LNZ1_GOV	-0.345682	0.033421	-10.34340	0.0000
_COM--LNZ1_COM	0.031246	0.031288	0.998678	0.3180
_FIN--LNZ1_FIN	0.051733	0.040596	1.274334	0.2026
_WHOL--LNZ1_WHOL	0.488901	0.097885	4.994623	0.0000
_EL--LNZ1_EL	-0.015838	0.076466	-0.207128	0.8359
_MAN--LNT1_MAN	-0.010435	0.028267	-0.369165	0.7120
_AGRIC--LNT1_AGRIC	-0.096588	0.087000	-1.110205	0.2670
_TRANS--LNT1_TRANS	-0.019897	0.021752	-0.914695	0.3604

_CONS--LNT1_CONS	-0.102693	0.022054	-4.656375	0.0000
_MIN--LNT1_MIN	0.081649	0.016589	4.921806	0.0000
_GOV--LNT1_GOV	-0.034269	0.009415	-3.639995	0.0003
_COM--LNT1_COM	-0.037831	0.009473	-3.993695	0.0001
_FIN--LNT1_FIN	-0.031786	0.012346	-2.574628	0.0101
_WHOL--LNT1_WHOL	-0.008293	0.029828	-0.278011	0.7810
_EL--LNT1_EL	0.085853	0.022415	3.830139	0.0001
Weighted Statistics				
R-squared	0.870926	**Mean dependent var**		0.846794
Adjusted R-squared	0.866373	**S.D. dependent var**		2.749309
S.E. of regression	1.005012	**Sum squared resid**		3121.051
F-statistic	191.2818	**Durbin-Watson stat**		2.151326
Prob(F-statistic)	0.000000			

MAE = 0.85

RMSE = 2.1

Note: The restriction imposed doesn't seem to bring much improvement on the model's performance.

Table F.4: Wald test: testing restrictions on parameters C4 (lnP3) and C5 (lnP4)

Test Statistic	Value	df	Probability
F-statistic	96.59128	(2, 3090)	0.0000
Chi-square	193.1826	2	0.0000

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-0.093549	0.017009
C(5)	0.404997	0.032407

Table F.5: SUR estimates with new restrictions on C4 and C5

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_MAN--C	0.059670	0.021641	2.757222	0.0059
_AGRIC--C	0.247667	0.047247	5.241933	0.0000
_TRANS--C	0.026220	0.010275	2.551847	0.0108
_CONS--C	-0.095115	0.018779	-5.064829	0.0000
_MIN--C	0.733153	0.040659	18.03158	0.0000
_GOV--C	0.040302	0.004428	9.101580	0.0000
_COM--C	0.047378	0.004954	9.563238	0.0000
_FIN--C	0.048106	0.006584	7.306451	0.0000
_WHOL--C	0.006882	0.017570	0.391688	0.6953
_EL--C	0.046592	0.010395	4.482232	0.0000
_MAN—S_MAN	-0.000819	0.000176	-4.646826	0.0000
_AGRIC—S_AGRIC	-1.17E-05	1.70E-06	-6.871994	0.0000
_TRANS—S_TRANS	-3.14E-07	8.48E-08	-3.702702	0.0002
_CONS—S_CONS	2.72E-06	7.32E-07	3.716595	0.0002
_MIN—S_MIN	-1.13E-05	6.26E-07	-18.00766	0.0000
_GOV—S_GOV	-2.88E-07	2.58E-08	-11.15009	0.0000
_COM—S_COM	-5.02E-10	1.70E-08	-0.029554	0.9764
_FIN—S_FIN	1.92E-08	2.94E-08	0.653462	0.5135
_WHOL—S_WHOL	-7.53E-08	1.11E-07	-0.677204	0.4983
_EL—S_EL	-3.37E-06	3.19E-07	-10.57176	0.0000
_MAN--LNP2_MAN	-0.260111	0.068058	-3.821934	0.0001
_AGRIC--LNP2_AGRIC	0.159311	0.095806	1.662845	0.0964
_TRANS--LNP2_TRANS	-0.240756	0.032905	-7.316634	0.0000
_CONS--LNP2_CONS	-0.407386	0.039662	-10.27151	0.0000
_MIN--LNP2_MIN	0.001273	0.000169	7.511315	0.0000
_GOV--LNP2_GOV	0.234573	0.015857	14.79332	0.0000
_COM--LNP2_COM	-0.184939	0.021106	-8.762238	0.0000
_FIN--LNP2_FIN	-0.198783	0.028501	-6.974580	0.0000
_WHOL--LNP2_WHOL	-0.241449	0.064913	-3.719560	0.0002
_EL--LNP2_EL	0.060099	0.048683	1.234511	0.2171
_MAN--LNM22_MAN	0.121334	0.038631	3.140825	0.0017
_AGRIC--LNM22_AGRIC	0.087374	0.113013	0.773134	0.4395
_TRANS--LNM22_TRANS	0.173294	0.027583	6.282725	0.0000
_CONS--LNM22_CONS	0.401841	0.037331	10.76437	0.0000
_MIN--LNM22_MIN	-0.006705	0.026058	-0.257325	0.7969
_GOV--LNM22_GOV	-0.019251	0.011080	-1.737471	0.0824

_COM--LNM22_COM	0.028337	0.011308	2.506034	0.0123
_FIN--LNM22_FIN	0.013992	0.014970	0.934699	0.3500
_WHOL--LNM22_WHOL	0.209780	0.034064	6.158482	0.0000
_EL--LNM22_EL	0.077855	0.026605	2.926278	0.0035
_MAN--LNSP2_MAN	0.021176	0.005689	3.722342	0.0002
_AGRIC--LNSP2_AGRIC	-0.054749	0.017172	-3.188309	0.0014
_TRANS--LNSP2_TRANS	0.010450	0.003807	2.744914	0.0061
_CONS--LNSP2_CONS	-0.011203	0.005361	-2.089822	0.0367
_MIN--LNSP2_MIN	-0.006060	0.003934	-1.540627	0.1235
_GOV--LNSP2_GOV	-0.009807	0.001657	-5.917235	0.0000
_COM--LNSP2_COM	0.006319	0.001681	3.759435	0.0002
_FIN--LNSP2_FIN	0.004871	0.002225	2.188688	0.0287
_WHOL--LNSP2_WHOL	0.039717	0.005031	7.894828	0.0000
_EL--LNSP2_EL	-0.000499	0.004049	-0.123213	0.9019
_MAN--LNYD1_MAN	1.087168	0.093857	11.58328	0.0000
_AGRIC--LNYD1_AGRIC	2.598321	0.248433	10.45883	0.0000
_TRANS--LNYD1_TRANS	0.944645	0.062062	15.22102	0.0000
_CONS--LNYD1_CONS	1.084394	0.084594	12.81887	0.0000
_MIN--LNYD1_MIN	0.363823	0.058929	6.173966	0.0000
_GOV--LNYD1_GOV	0.089166	0.025425	3.507072	0.0005
_COM--LNYD1_COM	0.222324	0.026473	8.398308	0.0000
_FIN--LNYD1_FIN	0.288445	0.035150	8.206002	0.0000
_WHOL--LNYD1_WHOL	0.363530	0.080534	4.513973	0.0000
_EL--LNYD1_EL	0.644744	0.063003	10.23358	0.0000
_MAN--LNR1_MAN	0.033972	0.009096	3.734785	0.0002
_AGRIC--LNR1_AGRIC	-0.062370	0.025440	-2.451644	0.0143
_TRANS--LNR1_TRANS	-0.027031	0.006096	-4.434383	0.0000
_CONS--LNR1_CONS	0.022375	0.008078	2.769857	0.0056
_MIN--LNR1_MIN	-0.014228	0.005674	-2.507320	0.0122
_GOV--LNR1_GOV	0.005409	0.002581	2.095758	0.0362
_COM--LNR1_COM	0.003775	0.002710	1.392913	0.1637
_FIN--LNR1_FIN	0.000418	0.003591	0.116429	0.9073
_WHOL--LNR1_WHOL	0.056674	0.008139	6.963400	0.0000
_EL--LNR1_EL	-0.002089	0.006316	-0.330732	0.7409
_MAN--LNW1_MAN	-0.005734	0.016141	-0.355238	0.7224
_AGRIC--LNW1_AGRIC	-0.090168	0.048231	-1.869507	0.0616
_TRANS--LNW1_TRANS	0.015029	0.010630	1.413817	0.1575
_CONS--LNW1_CONS	-0.035653	0.014638	-2.435706	0.0149
_MIN--LNW1_MIN	-0.018224	0.010898	-1.672282	0.0946

_GOV--LNW1_GOV	-0.002125	0.004662	-0.455813	0.6486
_COM--LNW1_COM	0.036431	0.004754	7.663047	0.0000
_FIN--LNW1_FIN	0.030295	0.006292	4.815088	0.0000
_WHOL--LNW1_WHOL	0.053229	0.014345	3.710525	0.0002
_EL--LNW1_EL	-0.023811	0.011153	-2.135007	0.0328
_MAN--LNH1_MAN	-0.021377	0.051250	-0.417109	0.6766
_AGRIC--LNH1_AGRIC	-0.450713	0.136556	-3.300582	0.0010
_TRANS--LNH1_TRANS	-0.012590	0.032846	-0.383308	0.7015
_CONS--LNH1_CONS	0.233127	0.044670	5.218911	0.0000
_MIN--LNH1_MIN	-0.032259	0.029358	-1.098822	0.2719
_GOV--LNH1_GOV	0.137948	0.012664	10.89313	0.0000
_COM--LNH1_COM	0.060358	0.013764	4.385171	0.0000
_FIN--LNH1_FIN	0.073348	0.018425	3.980798	0.0001
_WHOL--LNH1_WHOL	0.136217	0.041885	3.252182	0.0012
_EL--LNH1_EL	0.018625	0.030487	0.610904	0.5413
_MAN--LNZ1_MAN	0.541744	0.109949	4.927242	0.0000
_AGRIC--LNZ1_AGRIC	-0.204062	0.336745	-0.605984	0.5446
_TRANS--LNZ1_TRANS	0.336292	0.072293	4.651800	0.0000
_CONS--LNZ1_CONS	0.605857	0.112646	5.378418	0.0000
_MIN--LNZ1_MIN	-0.562514	0.077709	-7.238724	0.0000
_GOV--LNZ1_GOV	-0.380903	0.032249	-11.81132	0.0000
_COM--LNZ1_COM	0.039167	0.032253	1.214392	0.2247
_FIN--LNZ1_FIN	0.052667	0.042569	1.237210	0.2161
_WHOL--LNZ1_WHOL	0.498702	0.096468	5.169638	0.0000
_EL--LNZ1_EL	-0.053190	0.077667	-0.684845	0.4935
_MAN--LNT1_MAN	0.046983	0.029528	1.591143	0.1117
_AGRIC--LNT1_AGRIC	-0.181823	0.081778	-2.223380	0.0263
_TRANS--LNT1_TRANS	-0.007935	0.020092	-0.394954	0.6929
_CONS--LNT1_CONS	-0.112233	0.026545	-4.227976	0.0000
_MIN--LNT1_MIN	0.089142	0.017973	4.959849	0.0000
_GOV--LNT1_GOV	-0.034087	0.008442	-4.037738	0.0001
_COM--LNT1_COM	-0.052365	0.008986	-5.827371	0.0000
_FIN--LNT1_FIN	-0.051540	0.011942	-4.315870	0.0000
_WHOL--LNT1_WHOL	-0.031571	0.027153	-1.162721	0.2450
_EL--LNT1_EL	0.098936	0.020973	4.717280	0.0000

Weighted Statistics				
R-squared	0.873331	**Mean dependent var**		0.946239
Adjusted R-squared	0.869003	**S.D. dependent var**		2.770911
S.E. of regression	1.002890	**Sum squared resid**		3208.464
F-statistic	201.7778	**Durbin-Watson stat**		1.990235
Prob(F-statistic)	0.000000			

APPENDIX G: PRICE EQUATIONS (WITH ENTRY COST)

Table G.1: Cross section ISUR of price equation with Γ.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_MAN--C	0.109258	0.012334	8.858137	0.0000
_AGRIC--C	0.200674	0.023663	8.480581	0.0000
_TRANS--C	0.051690	0.008902	5.806397	0.0000
_CONS--C	0.007207	0.010174	0.708354	0.4788
_MIN--C	19.59402	11.77791	1.663624	0.0963
_GOV--C	0.026930	0.004359	6.178600	0.0000
_COM--C	0.029192	0.004144	7.043800	0.0000
_FIN--C	0.029258	0.004152	7.045892	0.0000
_WHOL--C	0.030166	0.004946	6.099392	0.0000
_EL--C	0.024807	0.004077	6.084881	0.0000
_MAN—S_MAN	-0.000635	9.30E-05	-6.820433	0.0000
_AGRIC—S_AGRIC	-4.23E-06	7.78E-07	-5.441587	0.0000
_TRANS—S_TRANS	-4.22E-07	5.74E-08	-7.361696	0.0000
_CONS—S_CONS	4.57E-07	3.00E-07	1.522390	0.1280
_MIN—S_MIN	-0.000368	0.000180	-2.046793	0.0408
_GOV—S_GOV	-1.23E-07	1.47E-08	-8.376776	0.0000
_COM—S_COM	-8.39E-08	8.14E-09	-10.30173	0.0000
_FIN—S_FIN	-1.11E-07	1.08E-08	-10.26587	0.0000
_WHOL—S_WHOL	-1.48E-07	2.18E-08	-6.783265	0.0000
_EL—S_EL	-6.07E-07	6.32E-08	-9.610115	0.0000
_MAN--LNP2_MAN	0.556328	0.037856	14.69600	0.0000
_AGRIC--LNP2_AGRIC	-0.062509	0.046470	-1.345143	0.1787
_TRANS--LNP2_TRANS	0.743295	0.045920	16.18678	0.0000
_CONS--LNP2_CONS	0.752110	0.051495	14.60544	0.0000
_MIN--LNP2_MIN	0.141569	0.045862	3.086834	0.0020
_GOV--LNP2_GOV	0.796238	0.037653	21.14682	0.0000
_COM--LNP2_COM	0.781418	0.036264	21.54820	0.0000
_FIN--LNP2_FIN	0.780703	0.036340	21.48330	0.0000
_WHOL--LNP2_WHOL	0.786956	0.039876	19.73510	0.0000
_EL--LNP2_EL	0.789785	0.036723	21.50627	0.0000
_MAN--LNP3_MAN	-0.381199	0.044072	-8.649402	0.0000
_AGRIC--LNP3_AGRIC	0.025951	0.041847	0.620152	0.5352
_TRANS--LNP3_TRANS	-0.261118	0.044662	-5.846491	0.0000
_CONS--LNP3_CONS	-0.257964	0.049743	-5.185899	0.0000
_MIN--LNP3_MIN	0.141633	0.044563	3.178308	0.0015

_GOV--LNP3_GOV	-0.516770	0.055102	-9.378481	0.0000
_COM--LNP3_COM	-0.504715	0.052864	-9.547380	0.0000
_FIN--LNP3_FIN	-0.504359	0.052835	-9.545990	0.0000
_WHOL--LNP3_WHOL	-0.508308	0.057218	-8.883724	0.0000
_EL--LNP3_EL	-0.511741	0.053812	-9.509807	0.0000
_MAN--LNP4_MAN	-0.043966	0.035717	-1.230954	0.2184
_AGRIC--LNP4_AGRIC	-0.548804	0.039453	-13.91018	0.0000
_TRANS--LNP4_TRANS	0.018003	0.041128	0.437737	0.6616
_CONS--LNP4_CONS	0.063902	0.045625	1.400582	0.1614
_MIN--LNP4_MIN	0.246105	0.051699	4.760364	0.0000
_GOV--LNP4_GOV	0.398564	0.044442	8.968172	0.0000
_COM--LNP4_COM	0.375145	0.042468	8.833556	0.0000
_FIN--LNP4_FIN	0.376150	0.042478	8.855180	0.0000
_WHOL--LNP4_WHOL	0.365229	0.046174	7.909911	0.0000
_EL--LNP4_EL	0.383219	0.043270	8.856533	0.0000
_MAN—LNM22_MAN	0.106281	0.026327	4.036950	0.0001
_AGRIC—LNM22_AGRIC	-0.044100	0.054206	-0.813569	0.4160
_TRANS—LNM22_TRANS	0.265922	0.033686	7.894171	0.0000
_CONS—LNM22_CONS	0.264479	0.037936	6.971740	0.0000
_MIN—LNM22_MIN	30.37939	7.373927	4.119839	0.0000
_GOV—LNM22_GOV	0.027866	0.017539	1.588822	0.1122
_COM—LNM22_COM	0.030443	0.016843	1.807463	0.0708
_FIN—LNM22_FIN	0.030745	0.016791	1.831035	0.0672
_WHOL—LNM22_WHOL	0.032472	0.018027	1.801346	0.0717
_EL—LNM22_EL	0.030701	0.017165	1.788530	0.0738
_MAN--LNSP2_MAN	-0.012321	0.004145	-2.972747	0.0030
_AGRIC--LNSP2_AGRIC	0.038589	0.009014	4.281024	0.0000
_TRANS--LNSP2_TRANS	-0.027355	0.005025	-5.443391	0.0000
_CONS--LNSP2_CONS	-0.025780	0.005648	-4.564202	0.0000
_MIN--LNSP2_MIN	-7.777968	1.142792	-6.806111	0.0000
_GOV--LNSP2_GOV	0.010485	0.002635	3.978731	0.0001
_COM--LNSP2_COM	0.009836	0.002525	3.895138	0.0001
_FIN--LNSP2_FIN	0.009831	0.002517	3.905672	0.0001
_WHOL--LNSP2_WHOL	0.008646	0.002697	3.206097	0.0014
_EL--LNSP2_EL	0.010855	0.002581	4.206041	0.0000
_MAN--LNYD1_MAN	-0.058037	0.073347	-0.791264	0.4289
_AGRIC--LNYD1_AGRIC	-0.512678	0.154083	-3.327286	0.0009
_TRANS--LNYD1_TRANS	-0.261171	0.100336	-2.602979	0.0093
_CONS--LNYD1_CONS	-0.318383	0.112343	-2.834030	0.0046

_MIN--LNYD1_MIN	146.1545	20.13600	7.258369	0.0000
_GOV--LNYD1_GOV	-0.217961	0.048541	-4.490223	0.0000
_COM--LNYD1_COM	-0.212355	0.046611	-4.555906	0.0000
_FIN--LNYD1_FIN	-0.212697	0.046478	-4.576337	0.0000
_WHOL--LNYD1_WHOL	-0.210822	0.049913	-4.223776	0.0000
_EL--LNYD1_EL	-0.221287	0.047521	-4.656632	0.0000
_MAN--LNR1_MAN	0.015644	0.006024	2.597009	0.0095
_AGRIC--LNR1_AGRIC	0.111820	0.012499	8.946414	0.0000
_TRANS--LNR1_TRANS	0.017977	0.007402	2.428584	0.0152
_CONS--LNR1_CONS	0.026058	0.008223	3.168882	0.0015
_MIN--LNR1_MIN	4.677231	1.597822	2.927253	0.0034
_GOV--LNR1_GOV	0.009534	0.003980	2.395134	0.0167
_COM--LNR1_COM	0.008184	0.003830	2.136567	0.0327
_FIN--LNR1_FIN	0.008106	0.003819	2.122337	0.0339
_WHOL--LNR1_WHOL	0.009607	0.004100	2.343397	0.0192
_EL--LNR1_EL	0.008982	0.003895	2.305861	0.0212
_MAN--LNW1_MAN	0.007812	0.011516	0.678347	0.4976
_AGRIC--LNW1_AGRIC	0.023301	0.024088	0.967333	0.3335
_TRANS--LNW1_TRANS	0.021253	0.014301	1.486128	0.1374
_CONS--LNW1_CONS	0.020476	0.016060	1.274970	0.2024
_MIN--LNW1_MIN	-10.23044	3.241618	-3.155967	0.0016
_GOV--LNW1_GOV	0.024599	0.007794	3.156126	0.0016
_COM--LNW1_COM	0.024142	0.007484	3.225925	0.0013
_FIN--LNW1_FIN	0.024409	0.007461	3.271465	0.0011
_WHOL--LNW1_WHOL	0.023160	0.008012	2.890437	0.0039
_EL--LNW1_EL	0.024887	0.007626	3.263322	0.0011
_MAN--LNH1_MAN	0.066698	0.034608	1.927264	0.0540
_AGRIC--LNH1_AGRIC	0.135573	0.070372	1.926508	0.0541
_TRANS--LNH1_TRANS	0.110581	0.041868	2.641176	0.0083
_CONS--LNH1_CONS	0.031886	0.046689	0.682938	0.4947
_MIN--LNH1_MIN	22.50610	10.23523	2.198886	0.0280
_GOV--LNH1_GOV	0.045496	0.022900	1.986762	0.0470
_COM--LNH1_COM	0.069489	0.022217	3.127798	0.0018
_FIN--LNH1_FIN	0.072773	0.022228	3.273963	0.0011
_WHOL--LNH1_WHOL	0.060584	0.024018	2.522507	0.0117
_EL--LNH1_EL	0.047821	0.022360	2.138719	0.0325
_MAN--LNOP1_MAN	-0.010967	0.005749	-1.907595	0.0565
_AGRIC--LNOP1_AGRIC	-0.012243	0.011894	-1.029331	0.3034
_TRANS--LNOP1_TRANS	0.005760	0.007506	0.767438	0.4429

_CONS--LNOP1_CONS	0.005111	0.008421	0.606975	0.5439
_MIN--LNOP1_MIN	-16.89719	1.641766	-10.29208	0.0000
_GOV--LNOP1_GOV	-0.006558	0.003912	-1.676285	0.0938
_COM--LNOP1_COM	-0.006413	0.003757	-1.707145	0.0879
_FIN--LNOP1_FIN	-0.006333	0.003745	-1.690744	0.0910
_WHOL--LNOP1_WHOL	-0.007719	0.004023	-1.918619	0.0551
_EL--LNOP1_EL	-0.006776	0.003828	-1.770077	0.0768
_MAN--LNT1_MAN	0.107442	0.020353	5.278926	0.0000
_AGRIC--LNT1_AGRIC	0.318080	0.040363	7.880583	0.0000
_TRANS--LNT1_TRANS	-0.145871	0.026382	-5.529238	0.0000
_CONS--LNT1_CONS	-0.101352	0.029301	-3.458966	0.0005
_MIN--LNT1_MIN	-15.67584	5.243171	-2.989762	0.0028
_GOV--LNT1_GOV	0.092441	0.013234	6.985058	0.0000
_COM--LNT1_COM	0.084375	0.012775	6.604883	0.0000
_FIN--LNT1_FIN	0.083338	0.012753	6.534972	0.0000
_WHOL--LNT1_WHOL	0.090211	0.013707	6.581316	0.0000
_EL--LNT1_EL	0.088973	0.012957	6.866585	0.0000
Weighted Statistics				
R-squared	0.937490	**Mean dependent var**		1.332331
Adjusted R-squared	0.934775	**S.D. dependent var**		3.051673
S.E. of regression	0.779374	**Sum squared resid**		1804.050
F-statistic	345.2887	**Durbin-Watson stat**		2.230358
Prob(F-statistic)	0.000000			

MAE = 1.33

RMSE = 3.05

Note: As expected, it is noticeable that in most cases, rise in the growth of entry cost leads to higher growth in the price level (more inflation).

APPENDIX H: INTRODUCING THE WORLD INCOME

It will be incomplete and rather unrealistic to present a full-fledged MMM-DA model with omission of the world impact on sectors' production activities. Since most countries, with higher emphasis on South Africa, are actively engaged in international trade through high volumes of exports and imports, the world income must appear in the sales equations. It will probably be a much better option with more accuracy to introduce the disposable income of the main exporting countries. However, as the number of export partners is high and export partners might change over time, it is simpler to consider the world income. In several occasions, the use of world income to capture the countries export volumes has produced reliable results. Therefore I have run another set of seemingly unrelated regressions for both sales and price with world income includes.

Table H.1: ISUR of Sales Supply using IY (International Income)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_MAN—C	0.224956	0.021429	10.49787	0.0000
_AGRIC—C	0.253067	0.058538	4.323097	0.0000
_TRANS—C	0.059333	0.010222	5.804525	0.0000
_CONS—C	-0.074249	0.017190	-4.319215	0.0000
_MIN—C	0.290666	0.030559	9.511691	0.0000
_GOV—C	0.032408	0.005586	5.801359	0.0000
_COM—C	0.076694	0.005416	14.16027	0.0000
_FIN—C	0.085535	0.006669	12.82603	0.0000
_WHOL—C	-0.031086	0.019206	-1.618580	0.1056
_EL—C	0.049232	0.011890	4.140538	0.0000
_MAN—S_MAN	-0.002129	0.000170	-12.55533	0.0000
_AGRIC—S_AGRIC	-1.06E-05	2.09E-06	-5.047176	0.0000
_TRANS—S_TRANS	-5.55E-07	9.35E-08	-5.941307	0.0000
_CONS—S_CONS	2.06E-06	6.72E-07	3.069566	0.0022
_MIN—S_MIN	-4.69E-06	4.58E-07	-10.24115	0.0000
_GOV—S_GOV	-2.21E-07	3.54E-08	-6.245820	0.0000
_COM—S_COM	-7.18E-08	1.89E-08	-3.793242	0.0002
_FIN—S_FIN	-8.25E-08	3.02E-08	-2.730396	0.0064
_WHOL—S_WHOL	3.47E-07	1.26E-07	2.745026	0.0061
_EL—S_EL	-3.58E-06	3.80E-07	-9.419370	0.0000

_MAN--LNP2_MAN	-0.609981	0.064195	-9.502055	0.0000
_AGRIC--LNP2_AGRIC	0.494675	0.135652	3.646641	0.0003
_TRANS--LNP2_TRANS	-0.381977	0.035226	-10.84370	0.0000
_CONS--LNP2_CONS	-0.077373	0.046706	-1.656607	0.0977
_MIN--LNP2_MIN	0.000357	0.000108	3.305762	0.0010
_GOV--LNP2_GOV	0.244255	0.032141	7.599470	0.0000
_COM--LNP2_COM	-0.170525	0.034826	-4.896430	0.0000
_FIN--LNP2_FIN	-0.128519	0.043356	-2.964279	0.0031
_WHOL--LNP2_WHOL	-0.108209	0.105465	-1.026018	0.3050
_EL--LNP2_EL	-0.127471	0.083399	-1.528439	0.1265
_MAN--LNP3_MAN	0.278969	0.067344	4.142455	0.0000
_AGRIC--LNP3_AGRIC	-0.238034	0.103536	-2.299060	0.0216
_TRANS--LNP3_TRANS	0.009701	0.036044	0.269143	0.7878
_CONS--LNP3_CONS	-0.420762	0.045419	-9.263986	0.0000
_MIN--LNP3_MIN	-0.000616	0.000112	-5.480574	0.0000
_GOV--LNP3_GOV	-0.023384	0.040823	-0.572805	0.5668
_COM--LNP3_COM	0.061498	0.041495	1.482047	0.1384
_FIN--LNP3_FIN	0.078785	0.051318	1.535217	0.1248
_WHOL--LNP3_WHOL	0.312087	0.126057	2.475768	0.0134
_EL--LNP3_EL	0.280659	0.103178	2.720159	0.0066
_MAN--LNP4_MAN	-0.521400	0.063636	-8.193533	0.0000
_AGRIC--LNP4_AGRIC	-0.150309	0.101553	-1.480098	0.1390
_TRANS--LNP4_TRANS	-0.166523	0.032253	-5.162959	0.0000
_CONS--LNP4_CONS	-0.204335	0.038895	-5.253448	0.0000
_MIN--LNP4_MIN	0.000845	0.000122	6.946741	0.0000
_GOV--LNP4_GOV	-0.012779	0.032633	-0.391604	0.6954
_COM--LNP4_COM	-0.279908	0.032800	-8.533884	0.0000
_FIN--LNP4_FIN	-0.444830	0.040759	-10.91363	0.0000
_WHOL--LNP4_WHOL	-0.634444	0.100180	-6.333009	0.0000
_EL--LNP4_EL	-0.024955	0.082140	-0.303810	0.7613
_MAN—LNM22_MAN	0.237641	0.033878	7.014672	0.0000
_AGRIC—LNM22_AGRIC	0.039306	0.113311	0.346885	0.7287
_TRANS—LNM22_TRANS	0.080794	0.024445	3.305177	0.0010
_CONS—LNM22_CONS	0.386094	0.031017	12.44767	0.0000
_MIN—LNM22_MIN	0.003638	0.016281	0.223476	0.8232
_GOV—LNM22_GOV	-0.021130	0.011535	-1.831809	0.0671
_COM—LNM22_COM	0.069237	0.011194	6.185230	0.0000
_FIN—LNM22_FIN	0.077869	0.013879	5.610644	0.0000
_WHOL—LNM22_WHOL	0.258536	0.032877	7.863839	0.0000

_EL—LNM22_EL	0.094225	0.028198	3.341523	0.0008
_MAN--LNSP2_MAN	0.015886	0.005198	3.055854	0.0023
_AGRIC--LNSP2_AGRIC	-0.073847	0.019246	-3.837105	0.0001
_TRANS--LNSP2_TRANS	0.007072	0.003289	2.150195	0.0316
_CONS--LNSP2_CONS	-0.015397	0.004293	-3.586984	0.0003
_MIN--LNSP2_MIN	-0.018756	0.002547	-7.363221	0.0000
_GOV--LNSP2_GOV	-0.012285	0.001740	-7.060539	0.0000
_COM--LNSP2_COM	0.005128	0.001651	3.105742	0.0019
_FIN--LNSP2_FIN	0.001584	0.002047	0.773509	0.4393
_WHOL--LNSP2_WHOL	0.032535	0.004769	6.821593	0.0000
_EL--LNSP2_EL	-0.000554	0.004294	-0.128946	0.8974
_MAN--LNYD1_MAN	1.115951	0.087781	12.71295	0.0000
_AGRIC--LNYD1_AGRIC	2.495401	0.287618	8.676084	0.0000
_TRANS--LNYD1_TRANS	0.801753	0.065529	12.23513	0.0000
_CONS--LNYD1_CONS	1.654479	0.083192	19.88739	0.0000
_MIN--LNYD1_MIN	0.077666	0.041593	1.867300	0.0620
_GOV--LNYD1_GOV	0.141292	0.029851	4.733169	0.0000
_COM--LNYD1_COM	0.258900	0.029077	8.903974	0.0000
_FIN--LNYD1_FIN	0.389040	0.036093	10.77896	0.0000
_WHOL--LNYD1_WHOL	0.616917	0.086578	7.125584	0.0000
_EL--LNYD1_EL	0.738397	0.073956	9.984290	0.0000
_MAN--LNR1_MAN	0.044700	0.007766	5.756105	0.0000
_AGRIC--LNR1_AGRIC	-0.046768	0.025897	-1.805892	0.0710
_TRANS--LNR1_TRANS	-0.027422	0.005301	-5.172934	0.0000
_CONS--LNR1_CONS	0.015562	0.006432	2.419454	0.0156
_MIN--LNR1_MIN	0.002223	0.003545	0.627128	0.5306
_GOV--LNR1_GOV	0.007016	0.002704	2.594764	0.0095
_COM--LNR1_COM	0.008772	0.002657	3.300782	0.0010
_FIN--LNR1_FIN	0.009018	0.003290	2.741070	0.0062
_WHOL--LNR1_WHOL	0.066356	0.007817	8.488567	0.0000
_EL--LNR1_EL	-0.006670	0.006594	-1.011542	0.3118
_MAN--LNW1_MAN	-0.026972	0.014039	-1.921146	0.0548
_AGRIC--LNW1_AGRIC	-0.139676	0.049359	-2.829816	0.0047
_TRANS--LNW1_TRANS	0.006860	0.009440	0.726763	0.4674
_CONS--LNW1_CONS	-0.011345	0.012030	-0.943078	0.3457
_MIN--LNW1_MIN	-0.018097	0.006853	-2.640654	0.0083
_GOV--LNW1_GOV	-0.005745	0.004769	-1.204526	0.2285
_COM--LNW1_COM	0.026978	0.004630	5.827013	0.0000
_FIN--LNW1_FIN	0.013365	0.005741	2.328066	0.0200

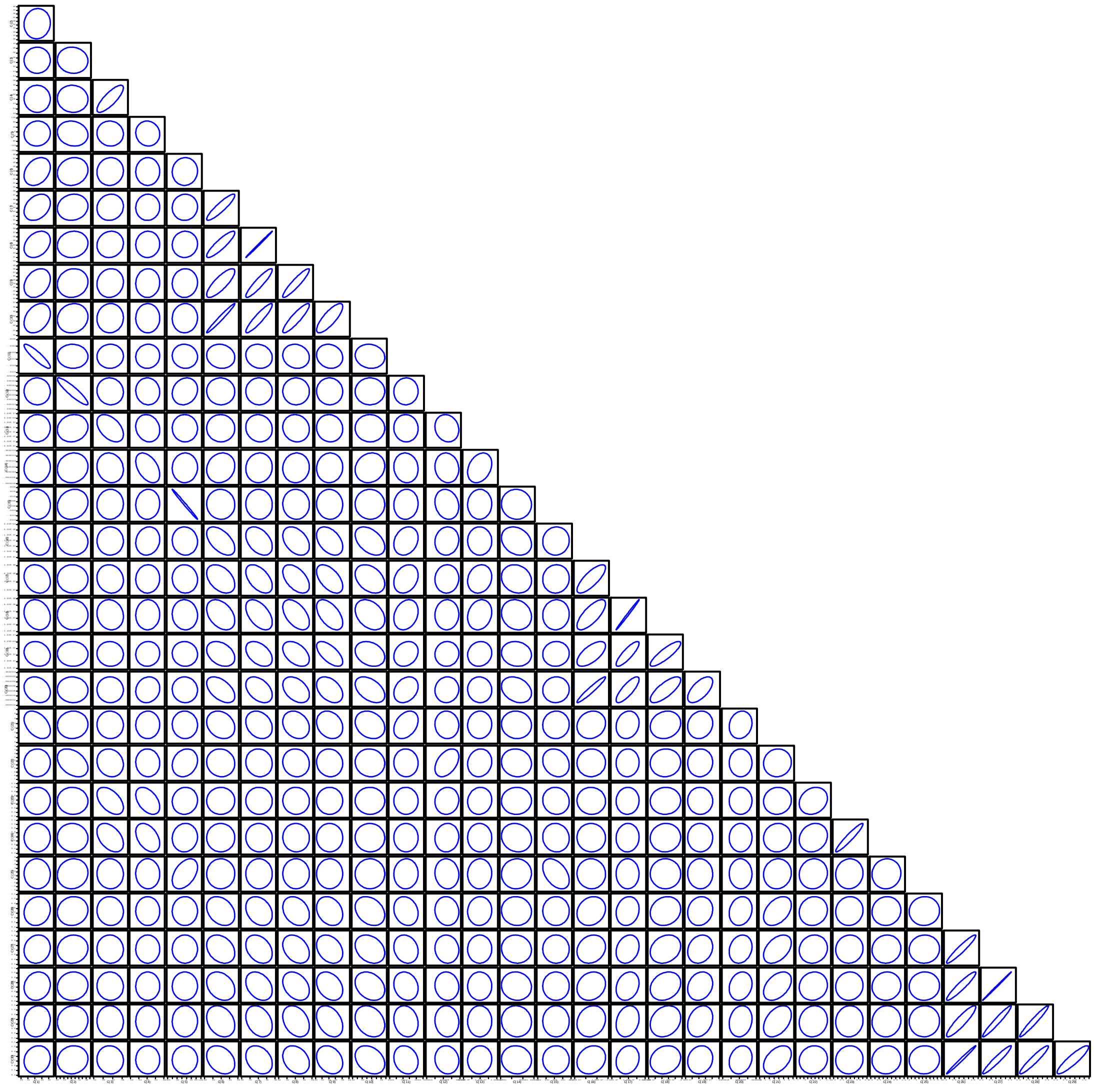
_WHOL--LNW1_WHOL	0.013647	0.013597	1.003643	0.3156
_EL--LNW1_EL	-0.024318	0.011616	-2.093510	0.0364
_MAN--LNH1_MAN	0.067467	0.050926	1.324801	0.1853
_AGRIC--LNH1_AGRIC	-0.563717	0.159377	-3.537007	0.0004
_TRANS--LNH1_TRANS	0.043358	0.032583	1.330698	0.1834
_CONS--LNH1_CONS	-0.013542	0.039743	-0.340742	0.7333
_MIN--LNH1_MIN	0.230470	0.024793	9.295697	0.0000
_GOV--LNH1_GOV	0.103868	0.016604	6.255652	0.0000
_COM--LNH1_COM	0.008211	0.017835	0.460375	0.6453
_FIN--LNH1_FIN	-0.035093	0.022365	-1.569106	0.1167
_WHOL--LNH1_WHOL	-0.138401	0.054243	-2.551516	0.0108
_EL--LNH1_EL	0.017981	0.040922	0.439401	0.6604
_MAN--LNZ1_MAN	0.478053	0.104373	4.580226	0.0000
_AGRIC--LNZ1_AGRIC	-0.659462	0.371712	-1.774124	0.0761
_TRANS--LNZ1_TRANS	0.436403	0.068880	6.335665	0.0000
_CONS--LNZ1_CONS	0.309575	0.103168	3.000693	0.0027
_MIN--LNZ1_MIN	-0.157804	0.057676	-2.736054	0.0063
_GOV--LNZ1_GOV	-0.382706	0.035122	-10.89637	0.0000
_COM--LNZ1_COM	0.038282	0.032632	1.173122	0.2408
_FIN--LNZ1_FIN	0.029684	0.040275	0.737033	0.4612
_WHOL--LNZ1_WHOL	0.517185	0.094631	5.465277	0.0000
_EL--LNZ1_EL	-0.148677	0.084427	-1.761018	0.0783
_MAN--LNT1_MAN	0.021862	0.028719	0.761233	0.4466
_AGRIC--LNT1_AGRIC	-0.212278	0.085433	-2.484732	0.0130
_TRANS--LNT1_TRANS	0.032712	0.019237	1.700453	0.0892
_CONS--LNT1_CONS	-0.040241	0.023409	-1.719037	0.0857
_MIN--LNT1_MIN	0.072577	0.011877	6.110674	0.0000
_GOV--LNT1_GOV	-0.020087	0.009435	-2.128844	0.0333
_COM--LNT1_COM	-0.044286	0.009374	-4.724508	0.0000
_FIN--LNT1_FIN	-0.032620	0.011616	-2.808050	0.0050
_WHOL--LNT1_WHOL	0.048924	0.028035	1.745074	0.0811
_EL--LNT1_EL	0.075409	0.023212	3.248678	0.0012
_MAN--LNIY1_MAN	-0.123157	0.098768	-1.246941	0.2125
_AGRIC--LNIY1_AGRIC	0.143401	0.355053	0.403885	0.6863
_TRANS--LNIY1_TRANS	0.675974	0.071508	9.453065	0.0000
_CONS--LNIY1_CONS	0.158558	0.087655	1.808876	0.0706
_MIN--LNIY1_MIN	0.501851	0.051933	9.663517	0.0000
_GOV--LNIY1_GOV	0.016838	0.034046	0.494558	0.6209
_COM--LNIY1_COM	-0.086361	0.032943	-2.621544	0.0088

_FIN--LNIY1_FIN	-0.161830	0.040845	-3.962082	0.0001
_WHOL--LNIY1_WHOL	-0.084989	0.096755	-0.878390	0.3798
_EL--LNIY1_EL	-0.272744	0.082762	-3.295523	0.0010
Weighted Statistics				
R-squared	0.871534	**Mean dependent var**		0.824852
Adjusted R-squared	0.865501	**S.D. dependent var**		2.714652
S.E. of regression	0.995575	**Sum squared resid**		2933.859
F-statistic	144.4680	**Durbin-Watson stat**		2.228069
Prob(F-statistic)	0.000000			

MAE = 0.02

RMSE = 1.93

APPENDIX I: CONFIDENCE ELLIPSE OF THE ISUR MODEL



APPENDIX J: Simplified RE Models

Assuming that exogenous variables grow at a constant rate, basic simulations could be performed on a shorter scale of the RFE model including only two lag terms.

$$\ln\left(\frac{S_{St}}{S_{S(t-1)}}\right) \approx \theta_0^{'} + \theta_1^{'} S_{S(t-1)} + \theta_2^{'} \ln\left(\frac{P_{Q_{(t-1)}}}{P_{Q_{(t-2)}}}\right) \quad (1)$$

$$\ln\left(\frac{P_{Q_t}}{P_{Q_{(t-1)}}}\right) \approx \sigma_0^{'} + \sigma_1^{'} S_{S(t-1)} + \sigma_2^{'} \ln\left(\frac{P_{t-1}}{P_{t-2}}\right) \quad (2)$$

$$\ln\left(\frac{w_t}{w_{t-1}}\right) \approx \lambda_0^{'} + \lambda_1^{'} S_{S(t-1)} + \lambda_2^{'} \ln\left(\frac{P_{t-1}}{P_{t-2}}\right) \quad (3)$$

$$\ln\left(\frac{r_t}{r_{t-1}}\right) \approx \tau_0^{'} + \tau_1^{'} S_{S(t-1)} + \tau_2^{'} \ln\left(\frac{P_{t-1}}{P_{t-2}}\right) \quad (4)$$

Basic simulation results of the RFEM:

In this annex, estimated values are assigned to the parameters and the variables (Sales and Prices) to observe the path of these series. The main idea is to point out cyclical patterns that may exist in observed series. When there is no much cyclical effect in the observed variables, the use of RFEM is justifiable. At this stage the same exercise can be performed for all sectors since the RFEM is meant to be disaggregated (RFEM-DA).

a) Manufacturing

Eq. 1: LNSSM_1 = -0.0009847859031*SSM(-1) - 0.5033795221*LNPPM_2 + 0.1586284306

(0.1608) *(0.0968)* *(0.0568)*

Eq. 2: LNPPM_1 = -0.0008523978602*SSM(-1) + 0.4960335134*LNPPM_2 + 0.1212367301

(0.0242) *(0.0031)* *(0.0071)*

Eq. 3: LNWM_1 = -0.002792525535*SSM(-1) - 0.3888479686*LNPPM_2 + 0.3461588654

(0.1212) *(0.6083)* *(0.1011)*

Eq. 4: LNKM_1 = -0.001528755074*SSM(-1) - 0.1852182113*LNPPM_2 + 0.1797313182

(0.0012) *(0.3209)* *(0.0012)*

Eq. 5: R_1 = -0.003593766788*SSM(-1) + 0.06682734982*LNPPM_2 + 1.338182137

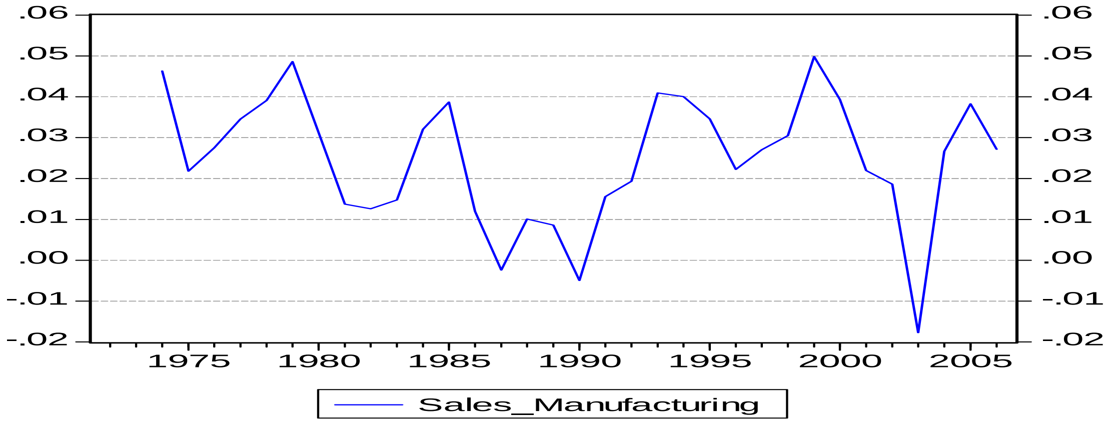
Eq. 6: LNLM_1 = -0.0004352825144*SSM(-1) + 0.155023422*LNPPM_2 + 0.02242745282

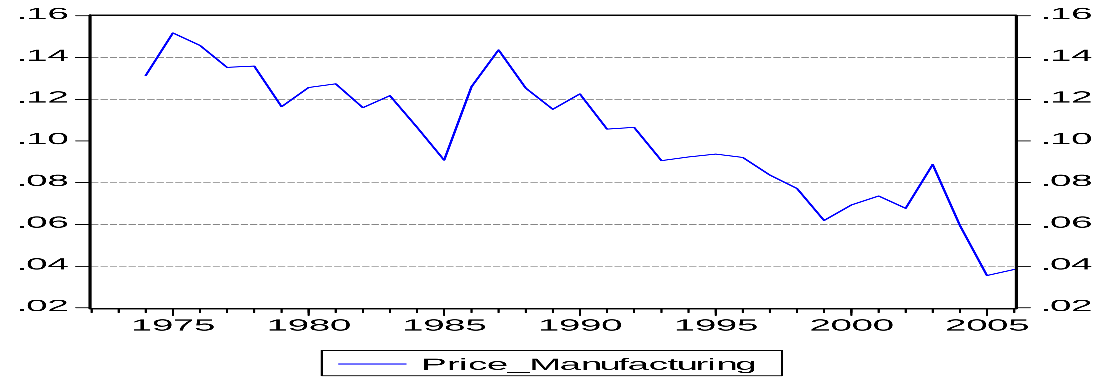
(0.2547) *(0.3425)* *(0.6124)*

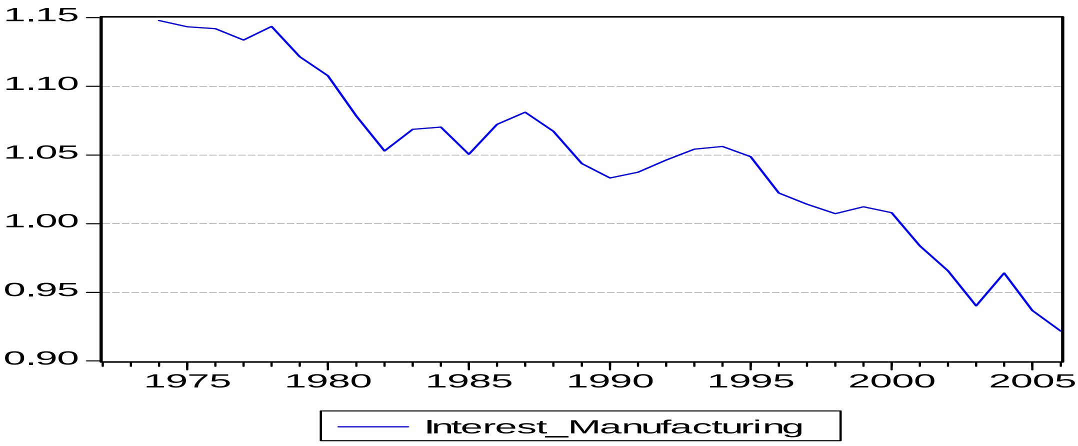
Eq. 7: LNM2_1 = 0.0004810211352*SSM(-1) + 0.4820351334*LNPPM_2 + 0.06256657467

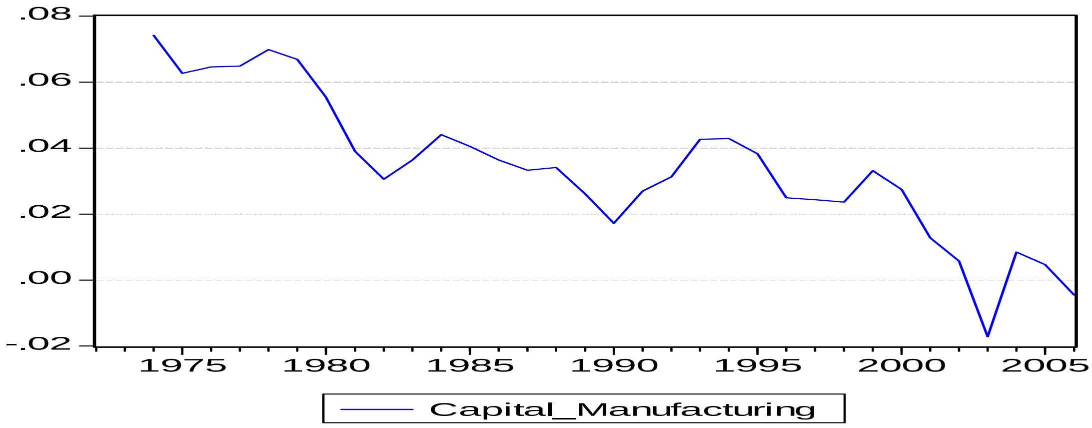
(0.5373) *(0.1551)* *(0.4127)*

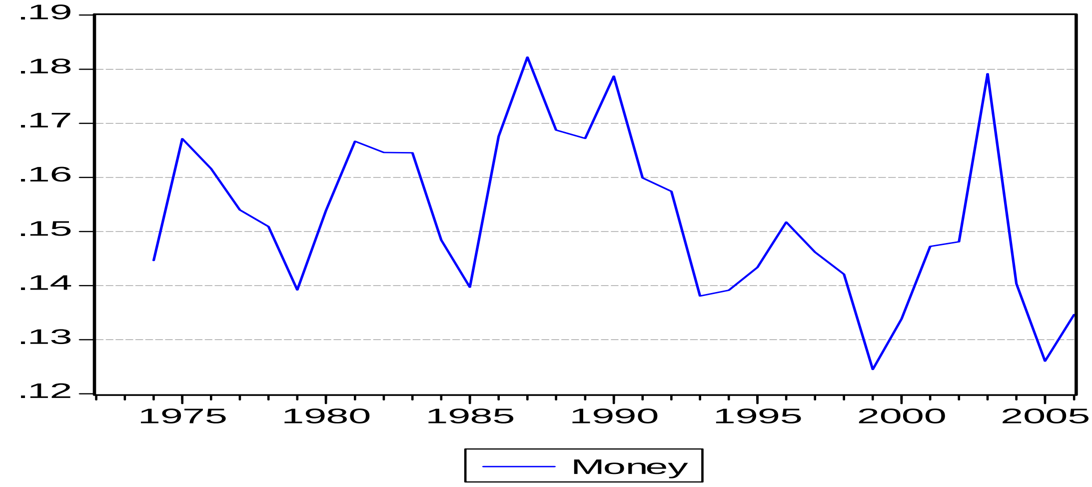
N.B. p-values in brackets











Sales and Money (*M2*) present very high cyclicality while other variables present a relatively smooth trend. It is therefore reasonable to use REM-DA to model Sales as price variables have a smooth trend.

b) Agriculture (Forestry and Fishing)

For all the sectors, trends for, *r*, *w*, and *M2* remain the same since those variables are assumed to be given in the aggregate economy.

Eq. 1: LNSA_1 = -1.449860774e-005*SA(-1) + 0.0164657689*LNPPA_2 + 0.3478267106

(0.0205) *(0.09657)* *(0.0342)*

Eq. 2: LNPPA_1 = -3.37661597e-006*SA(-1) + 0.1969181616*LNPPA_2 + 0.1472646375

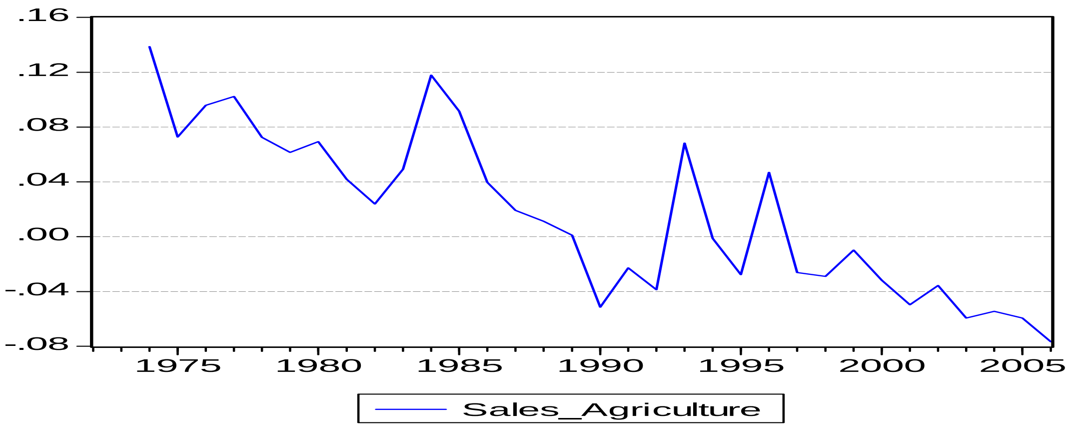
(0.2554) *(0.2997)* *(0.0655)*

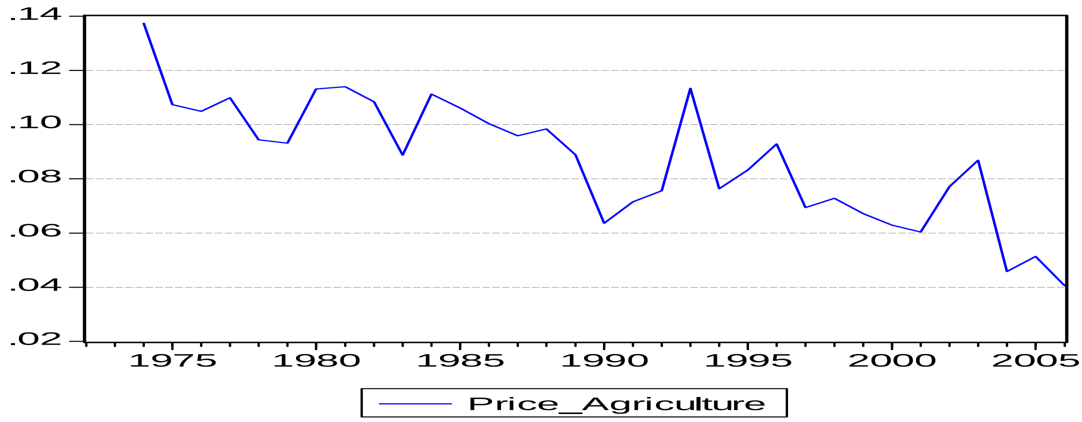
Eq. 3: LNKA_1 = -1.325510058e-006*SA(-1) + 0.0419274253*LNPPA_2 + 0.02485148132

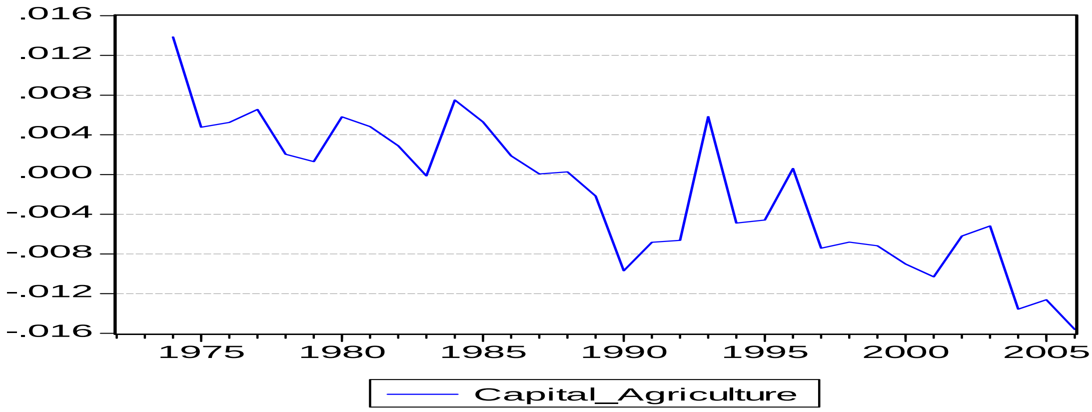
(0.1643) *(0.4870)* *(0.3204)*

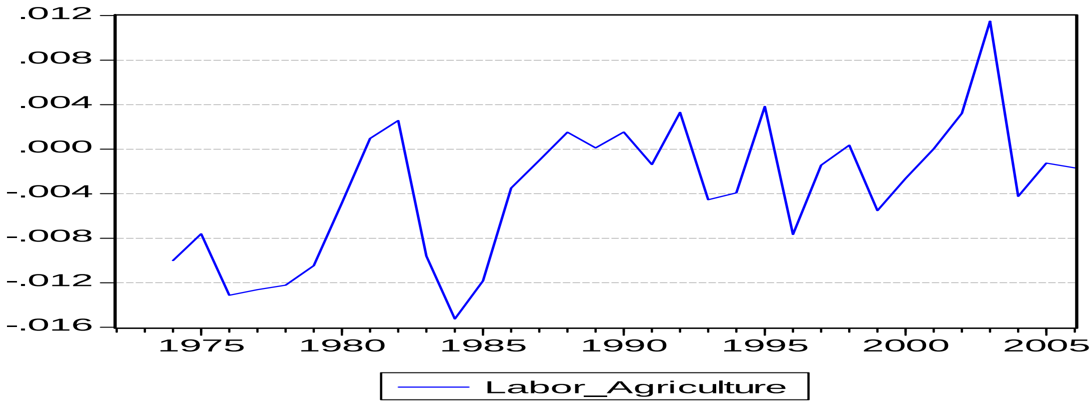
Eq. 4: LNLA_1 = 1.692814882e-006*SA(-1) + 0.06753534749*LNPPA_2 - 0.0484189937

(0.0237) *(0.1483)* *(0.0151)*









c) Transport & Communication

Eq. 1: LNST_1 = -3.700812868e-007*ST(-1) - 0.5426323197*LNPT_2 + 0.1080195039

(0.2443) *(0.0002)* *(0.0003)*

Eq. 2: LNPT_1 = -6.718483327e-007*ST(-1) + 0.5125717372*LNPT_2 + 0.07728127176

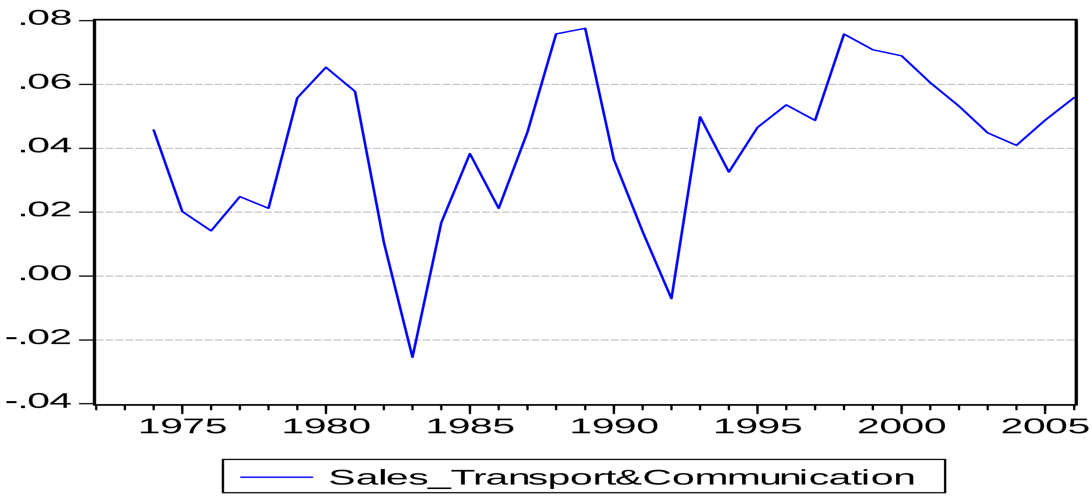
(0.0950) *(0.0036)* *(0.0249)*

Eq. 3: LNKT_1 = -4.389509723e-008*ST(-1) + 0.05838576312*LNPT_2 + 0.01884831656

(0.8458) *(0.5358)* *(0.3237)*

Eq. 4: LNLT_1 = 2.090997945e-007*ST(-1) - 0.004150279626*LNPT_2 + 0.008136863475

(0.0385) *(0.9185)* *(0.3238)*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1975
1980
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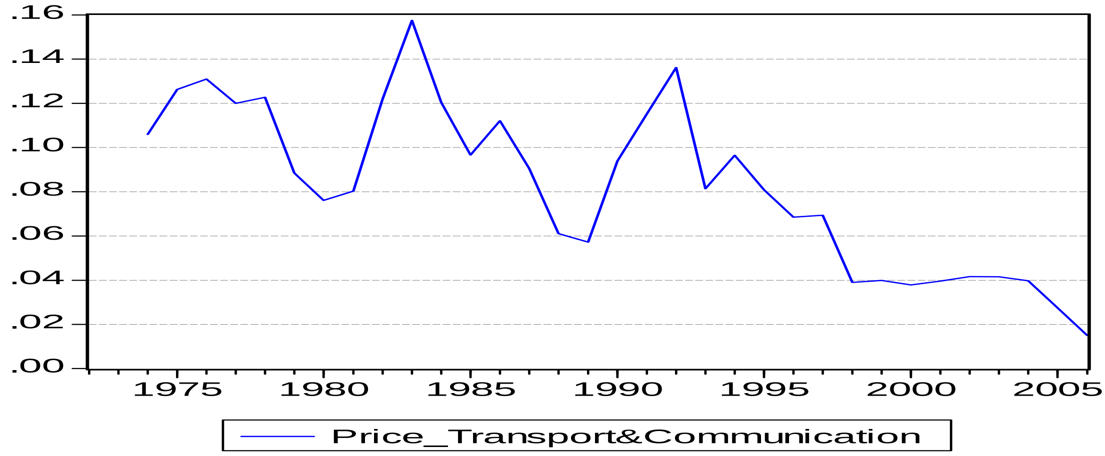
2005
Sales_Transport&Communication


.16
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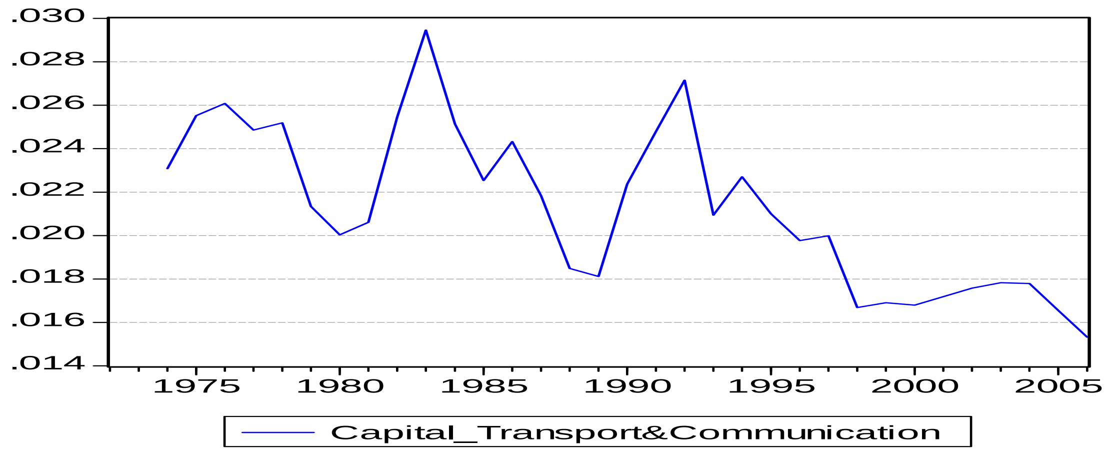
Price_Transport&Communication


.030
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.018
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1975
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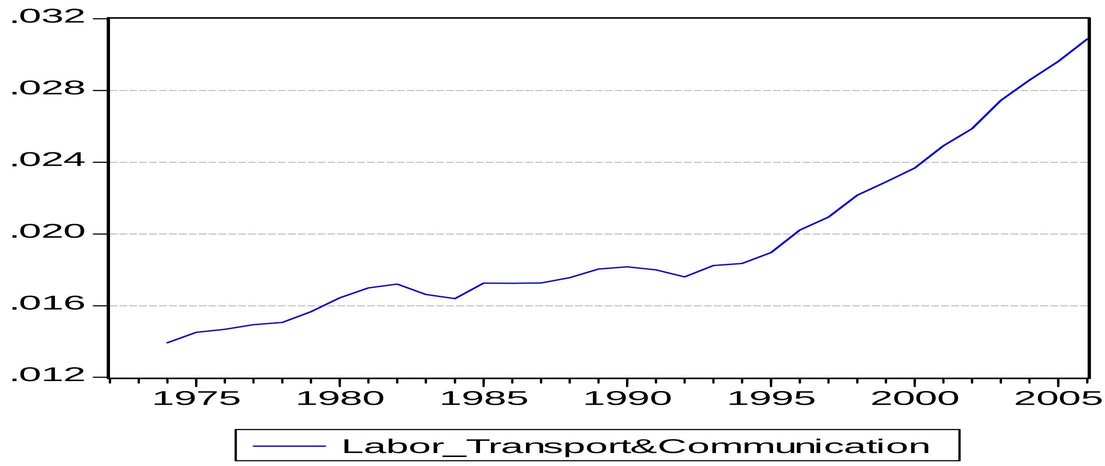
2000
2005
Capital_Transport&Communication



d) Construction and Buildings

Eq. 1: LNSC_1 = 7.161355464e-006*SC(-1) - 0.8320176048*LNPC_2 - 0.08593985072

(0.0335) (0.0001) (0.2441)

Eq. 2: LNPC_1 = 3.193400134e-006*SC(-1) + 0.6192166157*LNPC_2 - 0.04440839336

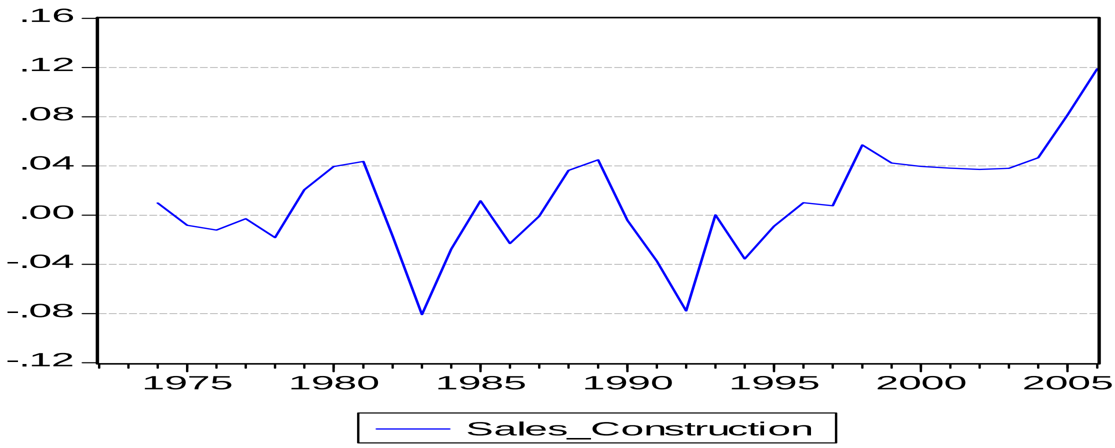
(0.2266) (0.0001) (0.4516)

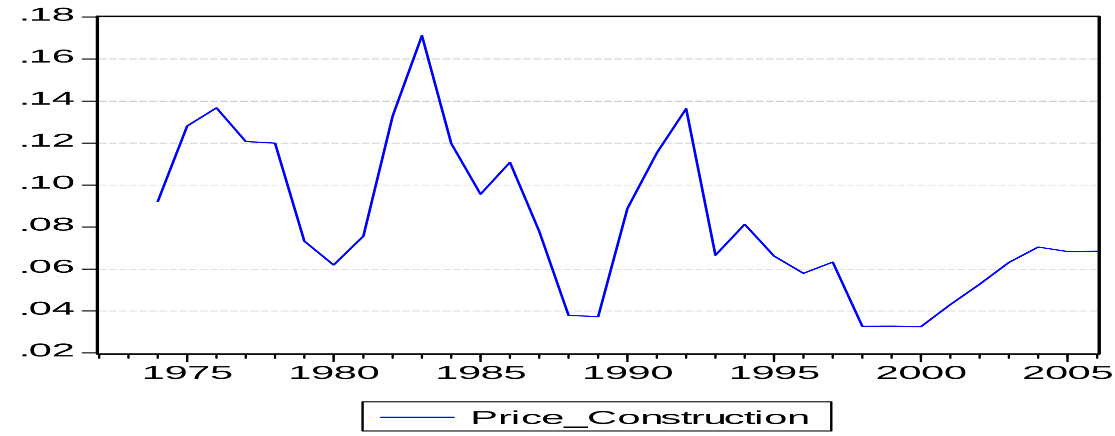
Eq. 3: LNKC_1 = 1.166027905e-005*SC(-1) - 0.4080082195*LNPC_2 - 0.2081604311

(0.0003) (0.0135) (0.0026)

Eq. 4: LNLC_1 = 1.484073785e-005*SC(-1) - 0.7906665729*LNPC_2 - 0.2770053927

(0.0349) (0.0408) (0.0768)




.18
.16
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1975
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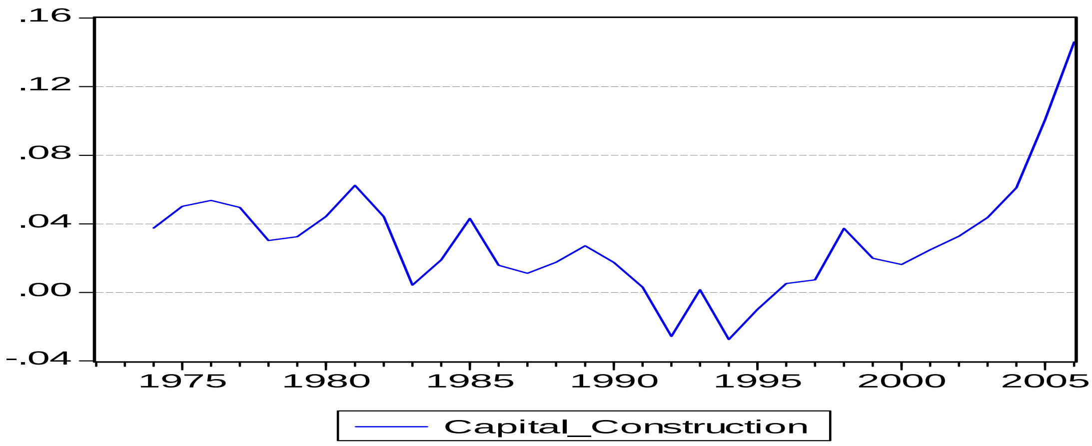
Price_Construction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1975
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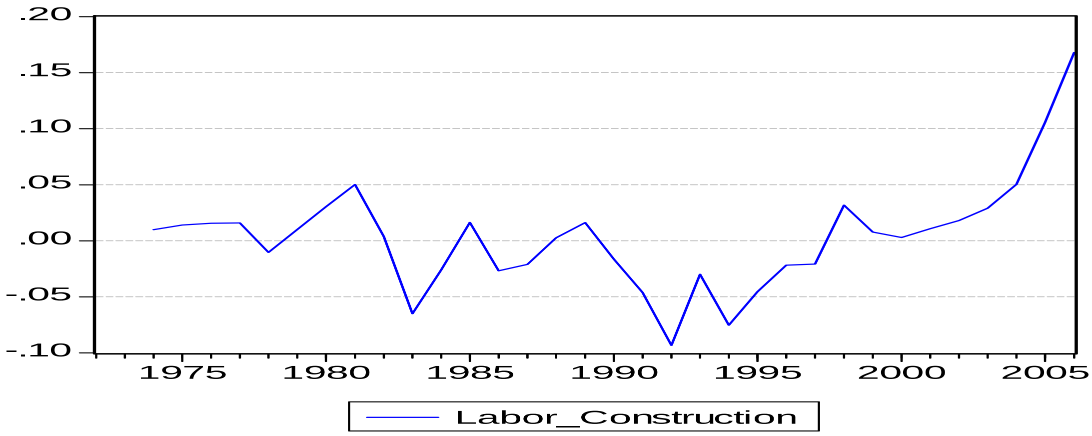
Capital_Construction


.20
.15
.10
.05
.00
-.05
-.10
1975
1980
1985
1990
1995
2000
2005
Labor_Construction

e) Mining

The price variable used here is the 'mining shares prices of non-gold products'. The employment figures used here represent the employment in the private sector.

Eq. 1: LNSMIN_1 = -6.931141118e-006*SMIN(-1) + 0.001028145553*PMIN_2 + 0.458080001

(0.0026) *(0.1274)* *(0.0027)*

Eq. 2 : PMIN_1 = 0.0004849421609*SMIN(-1) + 0.1922480139*PMIN_2 - 33.18159384

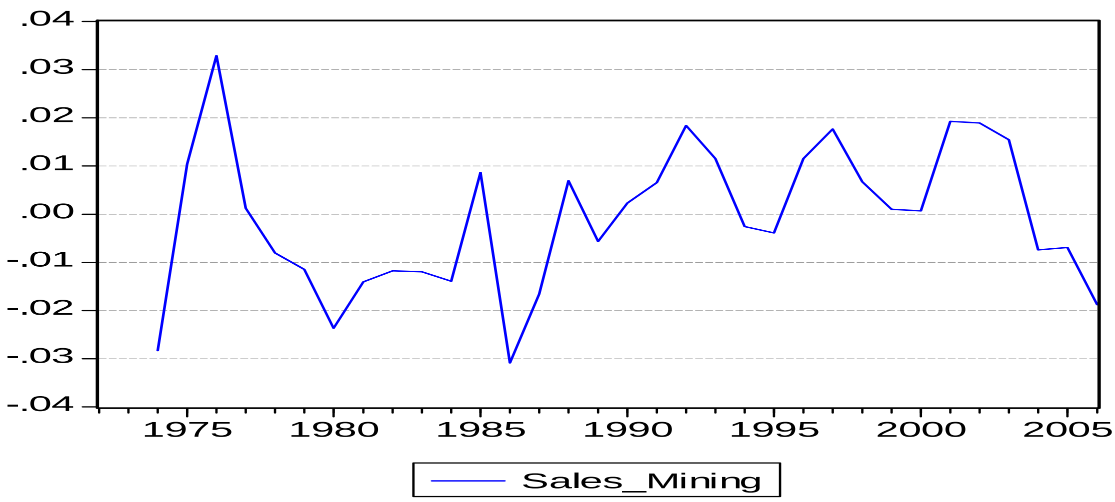
(0.4396) *(0.3256)* *(0.4251)*

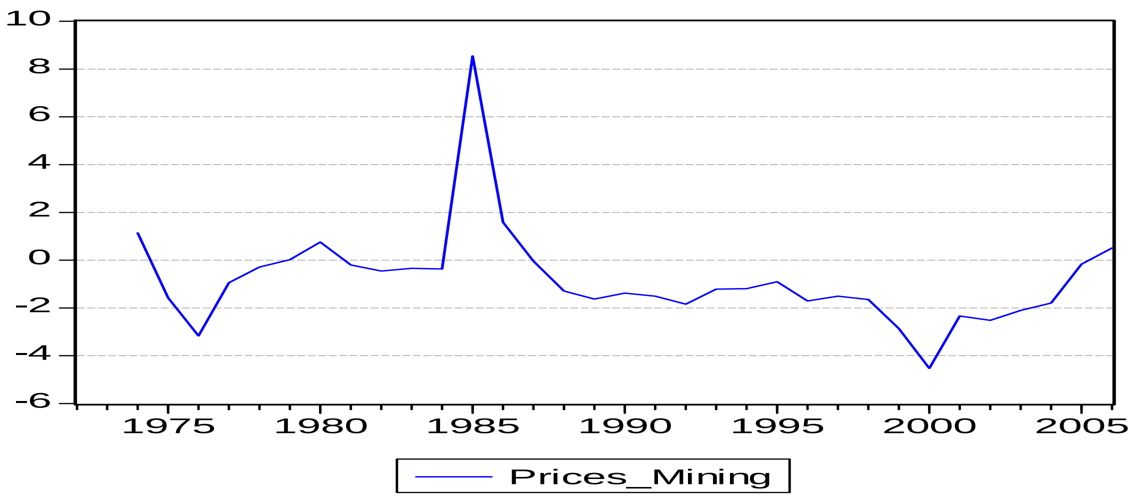
Eq. 3 : LNLMIN_1 = 7.302960494e-006*SMIN(-1) + 0.0004871534778*PMIN_2 - 0.4966305143

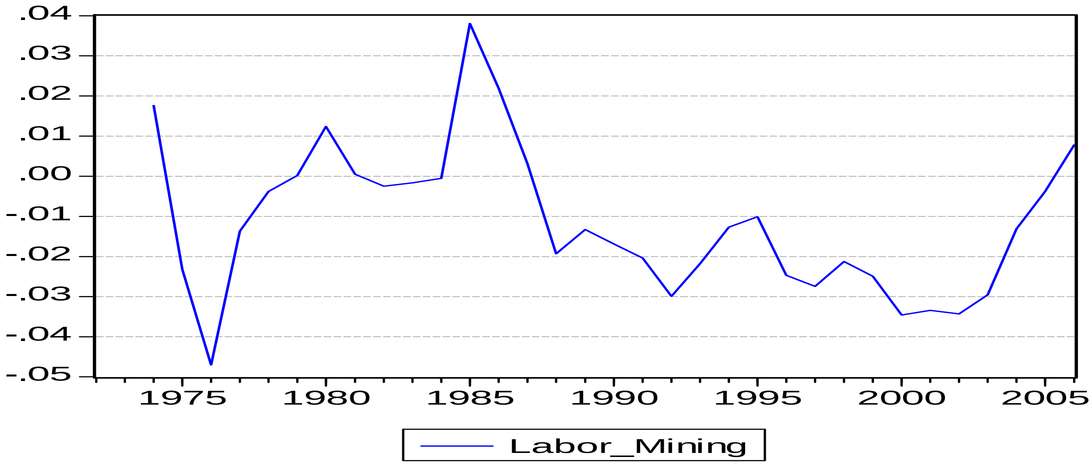
(0.0852) *(0.7051)* *(0.0778)*

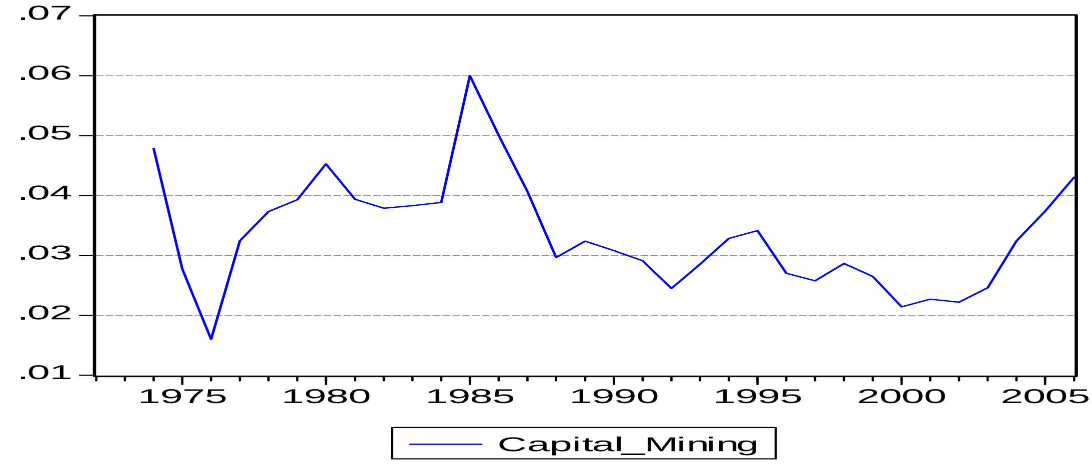
Eq. 4 : LNKMIN_1 = 3.599247421e-006*SMIN(-1) + 0.0002943772211*PMIN_2 - 0.2056379422

(0.2063) *(0.7362)* *(0.2743)*









For other sectors with no specific data on price and wage the normal 'consumer price index' is used with the wage for non-agricultural sectors.

APPENDIX K: WALD TEST ON SECOND MODEL APPROXIMATION

Table K.1: Wald test: testing restrictions on parameters C2 ($S_{i(t-1)}$) and C3 ($S_{i(t-2)}$) from SUR 1

Test Statistic	Value	df	Probability
F-statistic	3.657067	(1, 179)	0.0574
Chi-square	3.657067	1	0.0558

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2)	0.260753	0.136352

Note: According to the Wald test that we performed, we can only impose a restriction on C2, and not on other parameters.

APPENDIX L: CONFIDENCE ELLIPSE FOR MODEL 2

Figure L.1: Confidence ellipse for ISUR (Sales Supply)

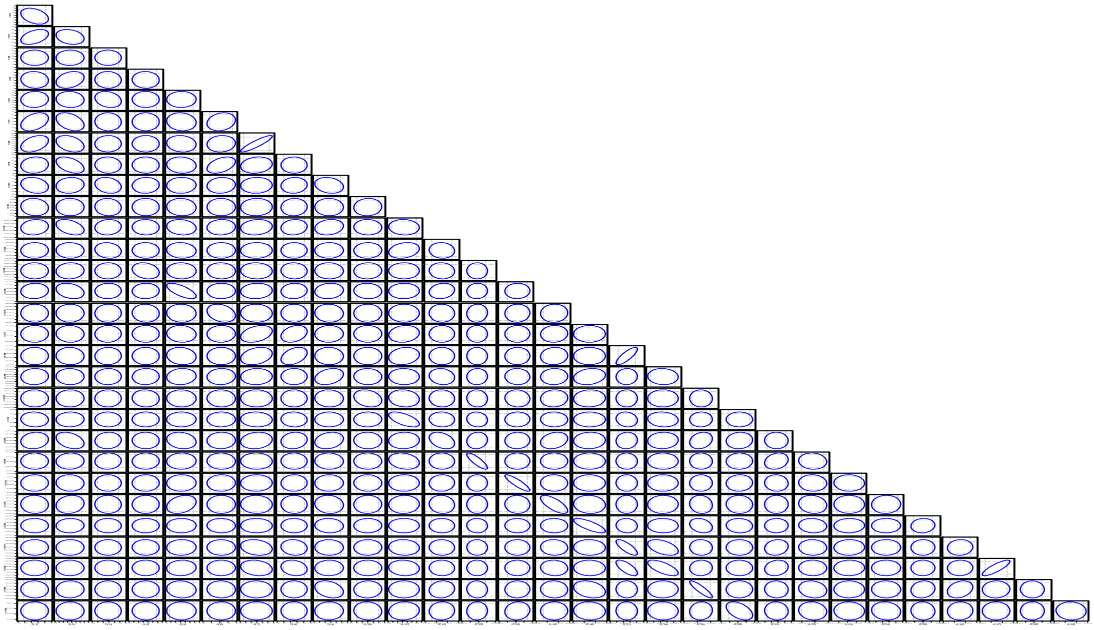
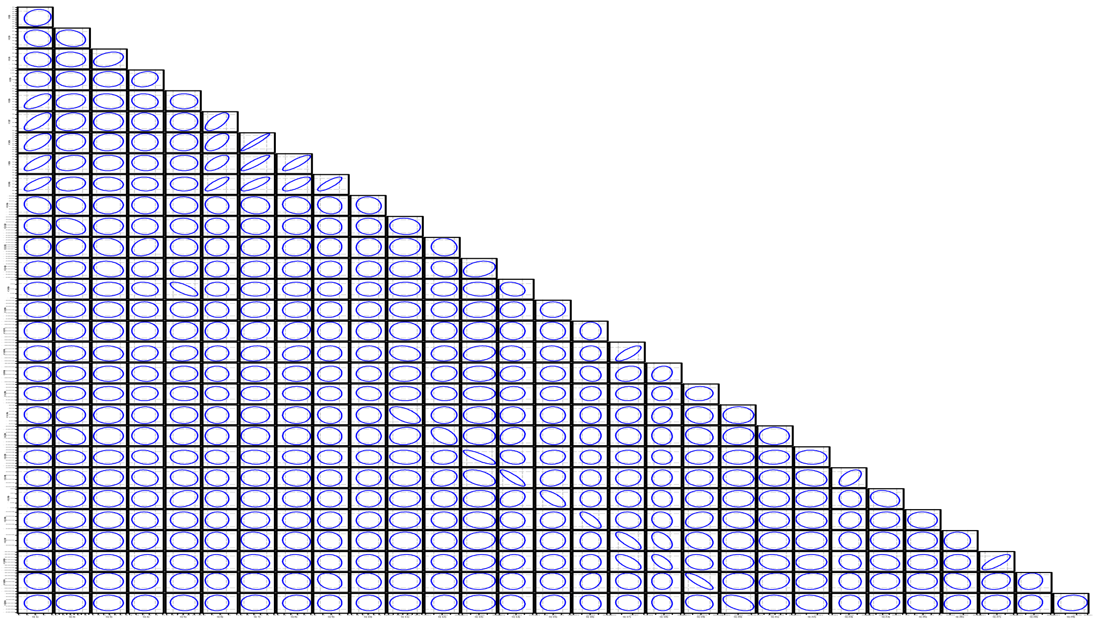


Figure L.2: Confidence ellipse for ISUR (Price)



APPENDIX M: A DISCUSSION ON THE MARKET OF MEDICAL SERVICES WITH VARYING QUALITY OF INPUTS (Rosen's Quality Model)

a) The choice between public health coverage and private health insurance plans

A fruitful advise on the choice between the two types of policies will be determined by the results showing how effective are the public expenditures on enhancing household production activities. To this regard, many may reflexively argue that private health insurance coverage is more efficient while more expensive than public health coverage. And as the quality of health outcomes matters most, the general opinion tends to support private health insurance rather than public coverage. Some evidence, mainly on the US health system, could be garnered as to orientate the debate. Many analysts have suggested that the US congress makes use of federal funds to assist in subsidizing the purchase of private health coverage. Reliable evidence has been used to indicate that public coverage is less expensive than the private one and offers comparable service though[34].

In relation to the adverse selection problem, people with insurance coverage are more likely to present higher incidence of sickness requiring higher care as compared to those without insurance. And administration of private health insurance cost more than public coverage.

Returning to the issue of efficiency, the low cost of public insurances attract more demanders and that renders the delivery of public health less effective. Individuals with public coverage find it more difficult to be timely served as medical practitioners are overwhelmed by a large demand.

The present annex does not address into much detail the question of choice between public and private health insurance systems. It rather includes both aspects in the model.

b) The supply model of medical services

Model requirements (see Abowd, 1977):

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[34] Center on Budget and Policy Priorities, May 2007.

- The model must acknowledge and account for the fact that all inputs (medical doctors; nurses; prescription drugs;…) have nontrivial differences regarding outputs for which they contribute to the production;
- The market of medical services is also subject to generic equilibrium principles: the market price is determined by the interaction between supply and demand. However both agents (suppliers or demanders) will not necessarily trade at the same price. Whenever the market clearing mechanism is not achieved, the equilibrium position is obtained through rationing;

It is important to understand that market of medical services will often follow unusual behavioural patterns due to major role played by the external forces such as subsidies (local or international). Policy simulations should therefore be more realistic and they will often differ from market conditions. In this discussion of the market of medical services (M) we make use of the underlying foundations of the implicit market (Rosen, 1974). We allow differences in the output quality. There will be different levels of competition at the different quality levels determining different prices. That is specified under a hedonic function. In the model specification, both distributions (demand and supply) are endogenous. The demand for quality MS is a monotonic function of medical inputs such as: medical doctors; nurses; etc. The econometric analysis of this extension of our model could focus on measuring the impact of these input variables on MS.
We refer to a quadratic spline function with stable functional form over years allowing parameters to vary from year to year as a result of changes in the market conditions. The model ties up a quality index to the input producing MS and to the type of health coverage received.

It is important to mention some restrictions set in this model. No household can simultaneously buy the same input with different quality levels in order to enjoy a price lower than the one for intermediate inputs. In fact, our model should be able to address issues such as the impact that more public coverage or more private coverage will have on the production of MS, on the production of health characteristics and on the household’s utility. The differences existing between public coverage and private coverage are highlighted in the setting of our constraints.

The supply model:

$$N_i(c_i; q_i; \mathrm{O}_i) = M_i[\psi_i(o_i; h_i)] \quad (1)$$

Where:

- N_i is a function continuously differentiated twice, convex and strictly increasing. It represents the 'production possibility frontier' assuming M_i fixed;
- c_i is the number of consultations (visits) to a medical doctor or any other type of medical practitioner that a household has made during a considered period;
- q_i is an index of quality of medical doctors or medical practitioners;
- O_i represents other activities established between the household and health facilities;
- M_i is a function continuously differentiated twice, concave and strictly increasing. It represents an isoquant assuming N_i fixed;
- ψ_i represents the vector of input variables.

This joint production function has the advantage of allowing an unlimited number of outputs for the same number of inputs. c_i can be purchased at a price P_{c_i}. The theory of profit maximization will be easily applicable in this case. The household will choose output based on equalizing the price ratio (output prices) with the rate of product transformation. It is assumed that even high quality doctors or other types of medical practitioners can be interested in residual income.

I also assume that any liabilities regarding tax are included in the expenditures on other activities.

The objective function:

$$Y = Max\sum_{t=1}^{\infty} \lambda^t U(c_{it}; q_{it}; \mathrm{O}_{it}) \quad (2)$$

Subject to:

$$P_{c_{i(t+1)}} = P_{c_{it}} c_{it} + I_{c_t} \quad (3)$$

$$P_{o_{i(t+1)}} o_{i(t+1)} = P_{o_{it}} o_{it} + I_{o_t} \quad (4)$$

$$P_{\psi_{i(t+1)}} \psi_{i(t+1)} = P_{\psi_{it}} (1-\delta_\psi)\psi_{it} + I_{\psi_{it}} \quad (5)$$

$$W_{(t+1)} = (1+r)W_t + s_t + P_{c_{it}} c_{it} + P_{\mathrm{O}_{it}} \mathrm{O}_{it} - I_{c_t} - I_{\mathrm{O}_t} \quad (6)$$

Where:

- W_{t+1} is the wealth generated by the household in period (t+1);
- r is the market rate of return on wealth;
- s is the accruing subsidies.

Prices and subsidies can be assumed to be exogenous to the decision making units. The health care units are assumed to be subject to some sort of competition when it comes to factor markets and output markets.

Functional form of the supply model:

$$Max\left\lfloor U(cit;qit;\mathrm{O}it)+\lambda Y(W_{t+1};P_{c_{(t+1)}};P_{\mathrm{O}_{(t+1)}};P_{\psi_{(t+1)}};\delta_{\psi_{(t+1)}})\right\rfloor \quad (7)$$

Subject to:

$$P_{c_{i(t+1)}}=P_{c_{it}}c_{it}+I_{c_t} \quad (8)$$

$$P_{o_{i(t+1)}}o_{i(t+1)}=P_{o_{it}}o_{it}+I_{o_t} \quad (9)$$

$$P_{\psi_{i(t+1)}}\psi_{i(t+1)}=P_{\psi_{it}}(1-\delta_{\psi})\psi_{it}+I_{\psi_{it}} \quad (10)$$

$$W_{(t+1)}=(1+r)W_t+s_t+P_{c_{it}}c_{it}+P_{\mathrm{O}_{it}}\mathrm{O}_{it}-I_{c_t}-I_{\mathrm{O}_t} \quad (11)$$

Y must be proven to be: existent; unique; and concave.

First order conditions:

$$(1)\ \frac{\partial U}{\partial c_i}+\lambda\frac{\partial Y}{\partial W}(Pc_i)-\chi\frac{\partial N_i}{\partial c_i}=0 \quad (12)$$

$$(2)\ \frac{\partial U}{\partial q_i}+\lambda\frac{\partial Y}{\partial W}.\frac{\partial W}{\partial ci}.\frac{\partial c_i}{\partial q_i}-\chi\frac{\partial N_i}{\partial q_i}=0 \quad (13)$$

$$(3)\ \frac{\partial U}{\partial \mathrm{O}_i}+\lambda\frac{\partial Y}{\partial W}P_{\mathrm{O}_i}-\chi\frac{\partial N_i}{\partial \mathrm{O}_i}=0 \quad (14)$$

$$(4)\ -\lambda\frac{\partial Y}{\partial W}+\lambda\frac{\partial Y}{P_{c_{(t+1)}}}.\frac{1}{P_{c_{(t+1)}}}=0 \quad (15)$$

$$(5)\ -\lambda\frac{\partial Y}{\partial W}+\lambda\frac{\partial Y}{\partial P_{\mathrm{O}_{(t+1)}}}.\frac{1}{P_{\mathrm{O}_{(t+1)}}}=0 \quad (16)$$

$$(6)\ -\lambda\frac{\partial Y}{\partial W}+\lambda\frac{\partial Y}{\partial P_{\psi_{(t+1)}}}.\frac{1}{P_{\psi_{(t+1)}}}=0 \qquad (17)$$

With $\frac{\partial Y}{\partial W}$ being the measure of the incremental value of wealth.

Having agreed that Y is concave, $\frac{\partial Y}{\partial W}$ will be decreasing as compared to W. A rise of W leads the discounted utility to increase at a decreasing rate.

In addition to what was said earlier, some features of the model need to be highlighted:

- The $\vec{\psi}_i^{\,*}$ is determined solely by the vector market price $\vec{P}_{\psi_i}$ and the two other prices (P_{c_i}, P_{O_i});
- χ is the multiplier or the shadow value of N_i expressed in terms of units of utility and it is function of $\frac{\partial Y}{\partial W}$. Therefore χ cannot be identically considered as maximizing shadow present value of N_i.

The demand model:

In this subsection, I discuss the household’s demand model for medical services with consideration the quality of MS offered. Once again, I make use of a lifetime wealth function. The household demands for quality MS to enhance it’s number of working hours for n years. It is important to indicate that the household makes use of its labour time added to the quality of medical services acquired during a year in order to produce household characteristics (human capital) for the following year. In fact, quality MS is demanded for the production of household’s health characteristics that is later translated into human capital for the economic growth function.

$$H_{t+1}=(1-\delta_H)H_t+\phi(g;q)H_t \qquad (18)$$

Where:

- r is the return on human capital;
- W_t is the wealth in year t (opportunity wage in year t);
- H_t is the human capital stock in year t;
- g is the portion of market time allocated to the production of H_t;
- σ is the vector of medical fees parameters.

H_t enters the production of human capital using Hicks neutral, implying that H_t is much more efficient in producing H_t.

The demand model can therefore be formulated as follows:

$$F_1(H_1;R_1;\sigma_1;c_1;\delta_H) = Max\sum_{t=1}^{n}\lambda^t r_t H_t(1-g_t) - \left[P_{tH}(q_t;\sigma_t) + f\right]I_{tH} \tag{19}$$

Constraints:

(1) $H_{t+1} = (1-\delta_H)H_t + \phi(g;q)H_t$ (20)

(2) $r_{t+1} = r(r_t)$ (21)

(3) $\sigma_{t+1} = \sigma(\sigma_t)$ (22)

The functional form equation:

$$F_1(H_1;R_1;\sigma_1;c_1;\delta_H) = \underset{q,g}{Max}\left\{R_1 H_1(1-g) - [P_{1H}(q_1;\sigma_1) + c]I_{1H} + \lambda F_2(H_2;R_2;\sigma_2;c_2;\delta_H)\right\}$$

(23)

APPENDIX N: OPTIMISING THE LIFE CYCLE HOUSEHOLD UTILITY FUNCTION INTRODUCING THE PROBABILITY OF DEATH

The comprehension of how households work at maximizing their utility over live, scientifically termed the life cycle utility optimization, has captivated several economic thinkers. In fact, the literature has provided clear evidence that the individual (assumed to be rational to some extent) follows a certain pattern (behaviour) when it comes to its decision to consume. The theory of consumer behaviour constitutes a seminal reference to this regard[35]. Friedman and several others conducted prominent researches in order to provide a clearer understanding of the consumer behaviour on a life cycle basis.

The permanent income hypotheses as well as the relationship between measured consumption and measured income have been tested on several data sets. The results obtained have not always confirmed Friedman's theory. However, better explanations of the concept have been garnered in the literature over years. From the various empirical studies conducted to test the income-consumption relationship, rather obvious correlation between the two was found. The magnitude of estimates was revealed to be less likely predictable and understandable according to the theory though. Consumption couldn't be solely related to income. It was therefore well understood that both consumption and income include permanent components that determine the individual's consumption habits.

Nowadays, the income-consumption relationship is much better explained and the weight of evidence in favour of the permanent income hypothesis remains consistent. The notion of permanent wealth, also initiated by Friedman, appears to be much more convenient and realistic as compared to income since wealth is a much broader and more comprehensive tool used in the consumer's behaviour. The consumer, while taking consumption decisions, faces different forms of uncertainty, making the optimization problem more complex. The use of stochastic processes combined with other sequential optimization methods have come up to enhance the life cycle utility

[35] Milton Friedman: "A theory of the Consumption Function", Princeton University Press, Princeton, 1957.

problem. More recent literature on the topic has made major contributions on how to deal with issues such as: additive separability; risk; etc.

Assuming that the consumer understands the life cycle process, she (he) organizes her (his) stream of expenditures in an appropriate manner. Therefore, the consumer borrows or lends timely with aim to stabilize expenditures over years and earn interests on transferring wealth across time periods. It is relevant to understand that, during starvation, consumption decisions are taken differently. Considering that nearly 2.8 billion people in the world live on less than $ 2 a day, consumer behaviour under poverty can not be overlooked in the literature[36]. The level of uncertainty is much higher and the consumer is unsecured about the future. She (he) is constantly facing the probability that calamities or major disasters can occur and cause sudden death in the life cycle. It highly determines the consumer's consumption pattern on every period. If an individual, who is already under starvation, is aware that she (he) is more likely to die after one period, she (he) will tend to consume most of her wealth under the current period and not save for the next periods. The utility problem in this case will be different. The consumer will have to face two types of probabilistic utilities: (1) a utility with probability to live until the end of the cycle; (2) a utility with probability to die before the end of the cycle. Under rationality assumption, the consumer will opt for the expected utility of the two kinds.

In this annex, we aim at using this argument to enrich the literature on some canonical elements previously omitted or rather not explicitly stated. The question of uncertainty in life-cycle optimization has been addressed without explicit consideration that the consumer facing low confidence in the future will take decisions based on the probability to live until the end of the cycle.

Admittedly, the emergence of all sorts of life insurance policies tends to embody the consumer with less fear in future consumption planning. However, most wealthy individuals, who have less probability to die, are the one that can afford life coverage,

[36] Here we refer to the poverty headcount ratio using the purchasing power parity as published by 'Global Impact' (2007 annual report). In Sub-Saharan Africa, more than 70 % of the population lives with less than $ 2 a day.

while poor people, who usually have very high death probability, can not afford to be covered.

Fisher is among the pioneers in the design of the intertemporal consumption theory. Nevertheless, the use of discounted utility functions goes back as far as the 50s with economists such as Modigliani and Ando. Friedman's life-cycle models advertised a flat lifetime consumption, assuming that people save when income is high and borrow during low income periods, keeping a balanced and flat life-cycle consumption. Several critics arose against Friedman's life-cycle model in the sense that the model overlooked different facts [37]. People don't always save enough during pick income periods and they often consume much less during downturn in order to borrow less.
Various alterations have hence been suggested to render Friedman's theory more consistent with the data evidence. Although, one of the alterations suggested to Friedman's model consisted of having a changing utility function or making use of state space modelling[38]. The present annex makes use of non-changing utility function to prove how previous results could be seriously biased by omitting the probability of death in life cycle optimization.

In the more recent literature, the behavioural life cycle hypothesis has been suggested, associating individual's emotions in decision making process. Kahneman (2002) was awarded a Nobel Prize for his contribution to the use of psychology to explain consumer behavior under the so called: Prospect Theory. There are undoubtedly inaccurate results that were obtained in the use of expected utility. The introduction of discount factors in life-cycle models has been of great impact, and the use of hyperbolic discount factors is quoted among the major contribution though. It was rather unrealistic to use a linear discount factor. The discounting process can go much faster or much slower depending on how close is the future considered. Herrnstein (1961) was among the first to introduce the 'Melioration Theory', which is a theory borrowed from behavioral sciences to explain utility discounting over time.
The point we intend to prove at this stage is pretty obvious and justifiable by behavioral economics. As Herrnstein (1961) made use of hyperbolic discounting

[37] See Courant et al. (1984).
[38] State-space models allow the estimated parameters to vary at different states.

theory to explain that time lags between payoffs and the size of payoffs have joint significance in consumer behavior, this annex aims to describe how the probability of sudden death also matters in consumers behavior. The higher is the probability of death, the less the consumer will be willing to save for future periods. While applied to poor populations living under starvation, this argument supports the idea that the consumer will not 'underconsume' in the current period and yet will not be willing to save for future periods. However, she (he) might still borrow from future periods without guaranty to repay.

A simple 2 period life cycle model

Assuming that a consumer has the following 2 period utility function:

$$U(C_1;C_2) = kC_1^{\alpha_1}C_2^{\alpha_2}$$

where: - U : Utility

- C_1 : Consumption in period one;
- C_2 : Consumption in period two;
- α_1 : share of life cycle wealth spent during period one;
- α_2 : share of life cycle wealth spent during period two.

The consumer is subject to a life cycle constraint:

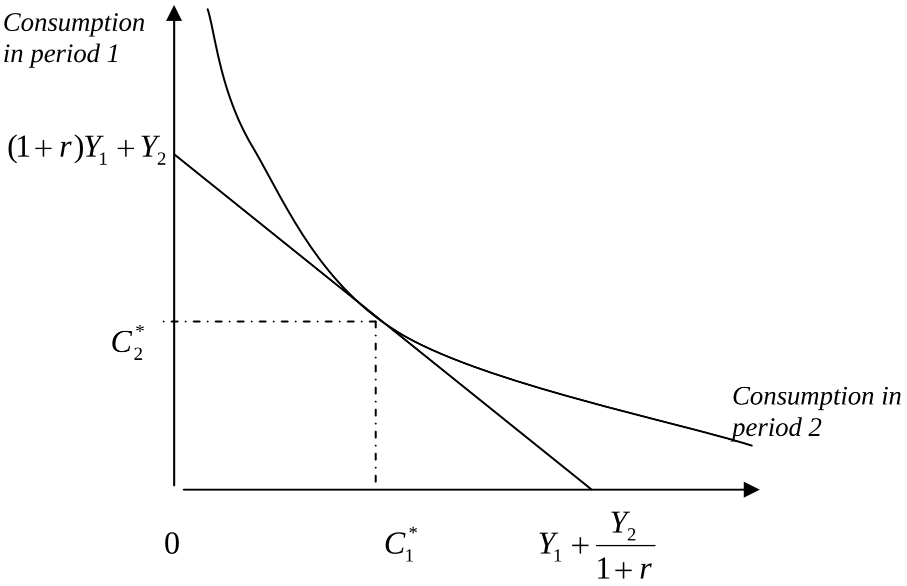
$$W_1 = Y_1 + \frac{Y_2}{1+r} \quad \text{or} \quad W_2 = Y_1(1+r)Y_1 + Y_2$$

where:

- W_1 : maximum amount the consumer can spend in period 1 if she (he) plans to consume nothing in period 2;
- W_2 : maximum amount the consumer can spend in period 2 if she (he) spends nothing in period 1;
- Y_1 : expected financial resources for period 1;
- Y_2 : expected financial resources for period 2;
- r : interest rate capturing the valuation or devaluation of the financial resources across time.

a) Under certainty

Graph:



This graph represents the utility optimization problem under certainty. Therefore the consumer's utility is maximized as follows:

$$U^*(C_1^*;C_2^*) = kC_1^{\alpha_1}C_2^{\alpha_2}$$

b) Under uncertainty

The reality of life provides sufficient evidence that the consumer (individual or household) may die after period 1 and never reach period 2 for unforeseen reasons such as calamities. Importantly the consumer is aware of that aspect and therefore takes consumption decisions accordingly. The 2-period problem will therefore be based on expected utility function obtained by the some of two probabilistic outcomes: (1) the consumer die after period 1; (2) the consumer survives until the end of period 2.

b.1) The outcome is 'death after the first period'

If the outcome is death after period 1, the problem will be reformulated as follows:

$$U(C_1;C_2) = kC_1^{\alpha_1}C_2^0$$

$$U(C_1) = kC_1^1$$

Subject to the constraint:

$$W_1 = Y_1$$

In this case $\alpha_2 = 0$ and $\alpha_1 = 1$ since the consumer uses the total wealth during period 1 and nothing is left for the second period. The consumer will limit her (him) expenditures during period 1 based on the income earned in that period only. Provide that she (he) decides to borrow extra money from what she could earn if she (he) could live and work during period two, taking advantage of asymmetric information, the lending institutions will not easily allocate her (him) any loan as her outcome is to die after first period. She will be restricted to only consume what she earns during period one unless she (he) can really take advantage of an uninformed lender. Now the reality is that there is only a probability ρ that this outcome occurs. ρ is the probability to die before the next period and $(1-\rho)$ the probability to live. In the consumer's expected utility function, $\rho U(C_1)$ will be the first component.

b.2) The outcome is 'no death after period 1'

Should the outcome be that the consumer survives until the end of period 2, the probabilistic outcome will be:

$$(1-\rho)U^*(C_1^*;C_2^*) = kC_1^{\alpha_1}C_2^{\alpha_2}$$

Where the constraint will be:

$$W_1 = Y_1 + \frac{Y_2}{1+r}$$

As the consumer is confident that she (he) will survive until period 2, she (he) will allocate the share α_1 of the total available resources (life wealth) to the consumption in period 1.

b.3) The consumer's expected utility

The use of probability in the optimization outcomes has transformed the life cycle model into a set of stochastic equations. Earlier work on the issue suggested the use of expected utility to be maximized. Notwithstanding, repetitive and very constructive critics have been made against the use of expected utility functions. The theory of expected utility functions made consistent progress to assuage the criticism by introducing more realistic approaches such as: the hyperbolic discount factor; etc. In this case we have initiated the discussion by the simple 2 period model where the discounting process does not constitute a major concern.

The expected utility is therefore the following:

$$EU = \rho U^*(C_1^{**}) + (1-\rho)U^*(C_1^*; C_2^*)$$

Sequential optimization using Bellman equations

Sequential optimization is undoubtedly one of the most appropriate methods to be used in this case; however, it has not been used extensively in the literature mainly because of its complexity. This new aspect of sudden death that has been brought up earlier in our model affects the optimization process mainly when we move from one period to the next one. This section mainly focuses on evidence that omitting death at that level includes bias in the results. It is clearly considered that ρ is not constant over time (see fig.1). It is unrealistic to assume that household members' probability of death remains constant across age. Ageing together with other factors raise the value of ρ while technological progress tends to reduce the probability of death and render it less U-shaped (horizontal).

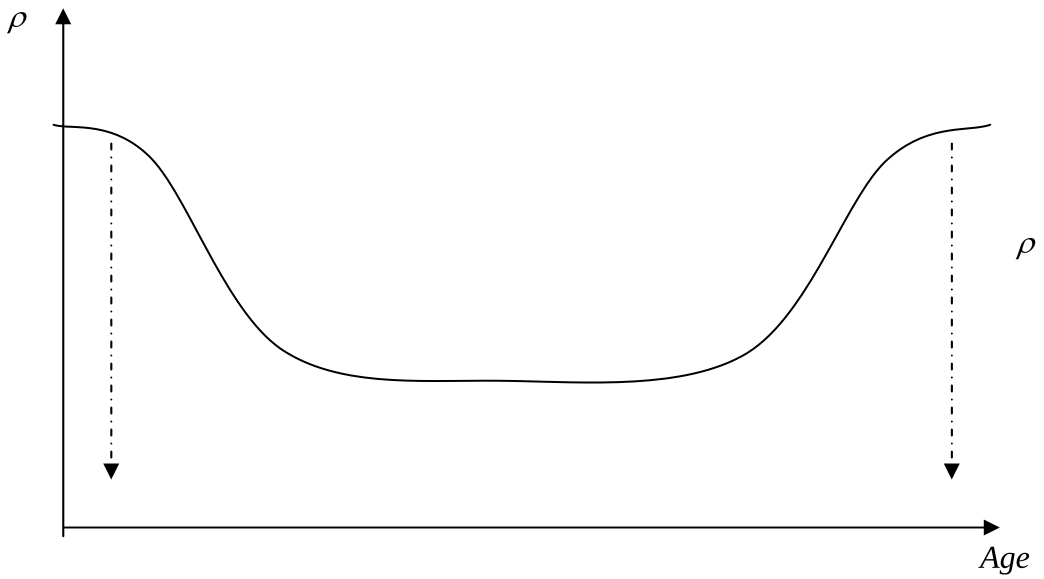


Fig. b.1

An interesting point of discussion to rise at this level will be to determine whether ρ is a 'Brownian Motion'. From the very first approximation, that can be easily assumed. The probability of death is constantly in movement with both diffusions and osmotic movements during an individual's life; although it follows a general U-shaped trend (see fig.1). ρ is random and uncertain reason why it is assumable to be a 'brownian motion'. It is therefore possible to derive a steady state for the distribution function associated to the Brownian motion.

The horizontal $\rho^{'}$ represents an ideal probability curve, lower than ρ, that is obtained with technological progress. Technological progress and improvement in health care reduce both infant and elderly mortality, making probability of death much less affected by age. The death of one member is dependent (correlated) with the death of other household members.

The traditional model for sequential optimization (Bellman Equations) using expected utility is stated as follows:

$$V^{*}(C_0) = \max_{\substack{\{C_{t+1}\}_{t=0}^{\infty} \\ C_{t+1}\in\Omega(C_t)}} \left\{ \sum_{t=0}^{\infty} \beta^{t} EU(C_t;C_{t+1}) \right. \quad (1)$$

$$V^{*}(C_0) = \max_{C_1\in\Omega(C_0)} \left\{ EU(C_0;C_1) + \max_{\{Ct+1\}_{t=1}^{\infty}} \sum_{t=1}^{\infty} \beta^{t} EU(C_t;C_{t+1}) \right\} \quad (2)$$

$$V^{*}(C_0) = \max_{C_1\in\Omega(C_0)} \left\{ EU(C_0;C_1) + \beta \max_{\{C_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^{t} EU(C_{t+1};C_{t+2}) \right\} \quad (3)$$

$$V^{*}(C_0) = \max_{C_1\in\Omega(C_0)} \left\{ EU(C_0;C_1) + \beta V^{*}(C_1) \right\} \quad (4)$$

Equation 4 is used to derive the functional form:

$$V(C_0) = \max_{C_1\in\Omega(C_0)} \left\{ EU(C_0;C_1) + \beta V(C_1) \right\} \quad (5)$$

Equation 5 is used to determine V^{*} since one of the optimality principles states that $V = V^{*}$

$$V^{*}(C_0) > \sup_{\substack{\{C_{t+1}\}_{t=0}^{\infty} \\ C_{t+1}\in\Omega(C_t)}} \sum_{t=0}^{\infty} \beta^{t} EU(C_t;C_{t+1}) \quad (6)$$

Rigorous principles of optimality need to be followed when it comes to solve the functional form equation. V^{*} is the unique and optimal value in solving the functional form. Therefore, in our household model specification all C_i^{*} are all optimal and have unique solution for the functional form.

At first, we introduce ρ in the sequential optimization and later on we bring up more updates on its functional characteristics.

$$\rho \;= n.\varpi \tag{7}$$

where:

- $\varpi(t)$: the probability that one of the active member of the household dies;
- n: number of active members of the household.

The literature has implicitly approached this issue using dynamic optimization of utility under uncertainty as we mentioned earlier. The dynamic process did not account for the fact that ρ varies with age of active household members. Therefore, our Bellman model can be reformulated as follows:

$$V^*(C_0) = \max_{\substack{\{C_{t+1}\}_{t=0}^{\infty} \\ C_{t+1}\in\Omega(C_t)}} \left\{ \sum_{t=0}^{\infty} \beta^t EU(C_t; C_{t+1}) \right\} \tag{8}$$

$$V^*(C_0) = \max_{C_1\in\Omega(C_0)} \left\{ EU(C_0; C_1) + (1-\rho(t)) \max_{\{Ct+1\}_{t=1}^{\infty}} \sum_{t=1}^{\infty} \beta^t EU(C_t; C_{t+1}) \right\} \tag{9}$$

$$V^*(C_0) = \max_{C_1\in\Omega(C_0)} \left\{ EU(C_0; C_1) + (1-\rho(t))\beta \max_{\{C_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t EU(C_{t+1}; C_{t+2}) \right\} \tag{10}$$

$$V^*(C_0) = \max_{C_1\in\Omega(C_0)} \left\{ EU(C_0; C_1) + (1-\rho(t))\beta V^*(C_1) \right\} \tag{11}$$

Equation 11 is used to derive the functional form:

$$V(C_0) = \max_{C_1\in\Omega(C_0)} \left\{ EU(C_0; C_1) + (1-\rho(t))\beta V(C_1) \right\} \tag{12}$$

Equation 12 is used to determine V^* since one of the optimality principles states that $V = V^*$

$$V^*(C_0) > (1-\rho(t)) \sup_{\substack{\{C_{t+1}\}_{t=0}^{\infty} \\ C_{t+1}\in\Omega(C_t)}} \sum_{t=0}^{\infty} \beta^t EU(C_t; C_{t+1}) \tag{13}$$

Setting that: $0 < \rho < 1$; the value of V^*, assuming that $\rho = 0$, as it is the case in most studies, will be smaller than the V^* obtained when $\rho \neq 0$. The larger is the time period considered, the bigger is the gap between the two solutions. However changes in the value of ρ, as the household members grow older, reduce or increase the bias.