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THE ELASTICITY OF SUBSTITUTION IN DEMAND FOR NON-TRADABLE GOODS IN BOLIVIA

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Contents

List of tables..1
List of figures..2
Acknowledgments...3
Abstract..4
1. INTRODUCTION...7
2. RESEARCH METHODOLOGY AND STRATEGY...............................8
   Methodology..8
   Data collection procedures..9
3. THE BOLIVIAN DATA..10
4. ECONOMETRIC PROCEDURE AND ELASTICITY ESTIMATION...19
   Statistical properties of data..19
   Elasticity estimation...23
5. CONCLUSION..26
References..28
Appendix 3.1..30
Appendix 4.1..40

Tables

3.1 Structure of the Bolivian input-output matrix
3.2 Bolivian tradable and non-tradable goods industries
4.1 ADF unit root tests on the variables of interest
4.2 HEGY testing procedure for seasonal unit roots
4.3 HEGY seasonal unit root tests on residuals
4.4 Johansen cointegration test on filtered data
4.5 ADF unit root tests on residuals of estimated cointegrating equations

Appendix Tables

4.1 Vector error correction model: Regression estimates
4.2 Vector error correction normality tests
4.3 Vector error correction residuals tests for autocorrelations

Figures

3.1 Participation of non-tradable goods sectors on GDP
3.2 Ratio of exports plus imports to gross production
3.3 Real consumption of tradables and non-tradables
3.4 Ratio of non-tradable consumption relative to global consumption
3.5 Ratio of non-tradable to tradable consumption in real terms
3.6 Ratio of non-tradable to tradable consumption in nominal terms
3.7 Price index for tradable and non-tradable goods
3.8 Ratio of the price index of non-tradable to tradable
3.9 Comparison between internal and external real exchange rate
4.1 Log of the real consumption ratio of non-tradable relative to tradable goods (LR)
4.2 Log of the price ratio of non-tradable relative to tradable goods (LP)
4.3 Log of real absorption (LA)
4.4 Filtered series of LR (LR1)
4.5 Filtered series of LP (LP1)

Appendix Figures

3.1 Cut-off criteria application to the 35 sector/products of the Input-Output Matrix
3.2 Comparing the annual series produced by the first and second methodologies
4.1 Autocorrelations of residuals

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Abstract

This paper uses a CES function to estimate the constant elasticity of substitution in consumption for non-tradables relative to tradables, in a dependent economy framework. The methodology to generate the data for real consumption of tradable and non-tradable goods, real prices of tradable and non-tradable goods and real absorption, are based on the Bolivian Input-Output Matrix, producing quarterly data for the period 1990.1 to 2002.4. The data identifies Bolivia as a country highly open to trade, with an average ratio of 55% in the value of its exports and imports relative to its GDP, an economy with a large participation of its non-tradable goods industry in an average of 52% of GDP and an economy where the internal and external real exchange rates differ in their behaviour. The HEGY test is used to identify and separate out seasonal unit roots in the data. A cointegrating relationship was found between real absorption, non-tradable to tradable consumption ratio and non-tradable to tradable price ratio, suggesting inelasticity of substitution.

1. INTRODUCTION

In developing countries there is interest on knowing the elasticity of substitution in the demand for non-tradable goods relative to tradable goods. This elasticity is known to play a critical role in the analysis of several key economic phenomena that affect macroeconomic structure.

The elasticity of substitution in demand is a measure of the extent to which the consumption of non-tradable goods substitutes the consumption of tradable goods, for a given utility level. The extent non-tradable and tradable substitute each other in consumption, helps in understanding the consumer response to changing relative prices between non-tradable and tradable (the real exchange rate) by adjusting the combination or mix of non-tradable and tradable that are consumed.

A large literature in open-economy macroeconomics has shown that the elasticity of substitution in the demand for non-tradable relative to tradable, is an important determinant of the short-run response of the real exchange rate to shocks hitting the economy, and that in turn the real-exchange-rate response is critical for determining the responses of macroeconomic variables to those same shocks.

Several important issues for which knowledge of the elasticity of substitution in demand for non-tradable relative to tradable is crucial are: (1) The response of the trade balance and the current account to terms-of-trade shocks (the Harberger-Laursen-Metzler effect) or more generally the response of the external accounts, consumption, saving and investment to terms-of-trade shocks (Ostry and Reinhart, 1992, Mendoza, 1995, and Engel and Kletzer, 1989). (2) The analysis of deviations from real interest rate parity (Dornbusch, 1983). (3) The business cycle dynamics of emerging economies facing devaluation risk (Calvo and Vegh, 1993, and Mendoza and Uribe, 2000). (4) Sudden Stops of capital inflows into emerging markets driven by borrowing constraints and liability dollarization (Aghion, Baccheta and Banerjee, 2002, and Mendoza, 2002). (5) The effects of Sudden Stops on the real exchange rate and fiscal sustainability (Calvo, Izquierdo and Talvi, 2002). (6) The long-run real effects of economic reform (Fernandez de Cordoba and Kehoe, 2000). (7) The home bias in investment portfolios of the residents of industrial nations (Baxter, Jermann and King, 1998).

Despite the central role that the elasticity of substitution for demand of non-tradable plays in many areas of international macroeconomics, there is little empirical work showing estimates on the value of this elasticity in developing countries. The objective of this paper is to provide an estimate of the elasticity of substitution in the demand for non-tradable relative to tradable goods for Bolivia.

Beside this first section, the second explains the research methodology and strategy, the third implements the methodology for producing the time series data required for analysis and econometric estimation. The fourth section estimates the elasticity of substitution for the Bolivian case based on cointegration and an error correction model. Finally the fifth section summarizes the findings and its implications.

2. RESEARCH METHODOLOGY AND STRATEGY

Methodology

Consider an open economy with constant-elasticity-of-substitution preferences with respect to consumption of tradable (CT) and non-tradable (CN): U(C(CT,CN)) where U(.) could be the standard constant-relative-risk aversion utility function in terms of the composite good C(.), and C(.) is a CES aggregator of CT and CN. In this environment and without need of full characterization of the utility function, utility maximization by households subject to a standard budget constraint can be expressed in the following form:

$$\text{Maximize} \quad [?\,(CT_t)^{-?} + (1-?)(CN_t)^{-?}]^{-1/?}$$

$$\text{Subject to:} \quad PT_t*CT_t + PN_t*CN_t = M_t$$

The parameter ? determines the elasticity of substitution between consumption of tradable goods and consumption of non-tradable goods, which is given by v = 1/(1+?), ? is the standard CES weighing factor, PT is the price of tradable goods, PN is the price of non-tradable goods, M is a budget constraint and t is time.

Solution of the maximization problem yields the following optimality condition for the allocation of consumption across CT and CN:

$$CN_t/CT_t = [(?/(1-?))*(PN_t/PT_t)]^{-1/(?+1)}$$

This is the key relationship that must be used to produce the estimates of v. Using logarithms the above condition reduces to the following log-linear testable relationships:

$$\ln(r_t) = a_0 + a_1 \ln(p_t) \quad \textit{where} \quad a_0 = -v \ln(?/(1-?)) \quad \textit{and} \quad a_1 = -v$$

$$\ln(n_t) = ß_0 + ß_1 \ln(p_t) \quad \textit{where} \quad ß_0 = -v \ln(?/(1-?)) \quad \textit{and} \quad ß_1 = -(v+1)$$

Where p is the relative price of non-tradable goods in units of tradable goods (p= PN/PT), which is our definition of real exchange rate. Knowing that consumption data can be measured in real and current prices (NCN=PN*RCN and NCT=PT*RCT), r is the non-tradable to tradable real consumption ratio (RCN/RCT) and n is the non-tradable to tradable nominal consumption ratio (NCN/NCT). Notice from the above relationships that $ß_1 = a_1 + 1$ must hold.

In a more general framework, beside relative prices the choice behaviour of non-tradable over tradable will also depend on total absorption. The dependent economy model originally introduced by Salter and Swan and presented in P.R. Agenor and P.J. Montiel (1996) suggest the following relationships:

$$A_T = A_T(p, A), \quad 0<dA_T/dA<1 \quad dA_T/dp>0$$

$$A_N = A_N(p, A), \quad 0<dA_N/dA=1-dA_T/dA<1 \quad dA_N/dp<0$$

Where A is total absorption, A_T is demand for tradable goods and A_N is demand for non-tradable goods. Thus the above testable relationship can be expanded in order to control for potential expenditure effects in the following way:

$$\ln(r_t) = a_0 + a_1 \ln(p_t) + a_2 \ln(A)$$

Data collection procedures

Econometric estimation of the above log-linear relationships requires nominal and real time series data for prices and consumption of non-tradable and tradable. There are three standard approaches that have been proposed for breaking down macroeconomic and price data into tradable and non-tradable, these are the following: National Accounts Procedure, Expenditure Survey Procedure and the Consumer Price Index Procedure. Having three procedures implies the possibility of having three sets of measures that could be used for validation, although in practice the reason for having more than one procedure has been data availability in the hope that at least one procedure can be fully performed. The rest of this section explains each of the three procedures.

National accounts procedure

This procedure requires gathering from National Accounts data by decomposition of the components of aggregate demand and supply in terms of the major sectors of economic activity. Data for the following items are needed both at current prices (N) and at constant prices (R), for each sector i (i = n sectors): Gross production (NYi and RYi), exports (NXi and RXi), imports (NIMi and RIMi) and private consumption (NCi and RCi).

The data is used to determine which sectors represent non-tradable goods and which sectors represent tradable goods. To do this, exports and imports data at current prices are added up to measure total trade in each sector: NTTi=NXi+NIMi. Total trade and gross production data at current prices are then used to compute by sector ratios of total trade to gross output: TTYi=NTTi/NYi. Threshold values z are selected for this ratio, z = 0.01,0.05, or 0.1. A sector i is then classified as part of the tradable goods industry (according to threshold z) if TTYi > z, otherwise the sector is classified as part of the non-tradable goods industry.

After the major industrial sectors have been allocated into tradable and non-tradable the private consumption data is used to create measures of consumption expenditures in tradable and non-tradable and the corresponding prices. The data at current prices is used to define "nominal" consumption of tradable NCT and non-tradable NCN. The data at constant prices is used to define "real" consumption of tradable and nontradables, RCT and RCN respectively. Finally, the combined nominal and real data are used to construct implicit deflators that represent the price indices of tradable and non-tradable as PT=NCT/RCT and PN=NCN/RCN. These indices have the same base year as the data at constant prices gathered from the National Accounts.

Expenditure survey procedure

This procedure requires current and constant prices data from either National Accounts or an Expenditure Survey for these variables: Private consumption of non-durable goods (NCNDUR and RCNDUR), private consumption of services (NCSER and RCSER) and private consumption of durable goods (NCDUR and RCDUR). The procedure is based on the assumption that consumption of services is identical to the total consumption of non-tradable and that consumption of nondurable and/or durables represents the total consumption of tradable. The robustness of this assumption needs to be evaluated by examining the total trade ratios computed by the national accounts procedure.

The procedure adopts three alternative definitions of tradable consumption at current prices: NCT1 (NCNDUR), NCT2 (NCDUR) or NCT3 (NCNDUR+NCDUR), and one definition of non-tradable consumption at current prices: NCN (NCSER). Accordingly, there are three alternative definitions of real tradable consumption RCT1 (RCNDUR), RCT2 (RCDUR) or RCT3 (RCNDUR+RCDUR) and one definition of real non-tradable consumption RCN (RCSER). These generated time series can be used to construct implicit deflators that represent prices of tradable and nontradables. The price of non-tradable is PN=NCN/RCN and there are three alternative definitions of the price of tradable (PT1=NCT1/RCT1, PT2=NCT2/RCT2, PT3=NCT3/RCT3).

CPI procedure

The CPI procedure takes advantage of the direct, final consumer price data collected in the process of computing the consumer price index. Time-series data for two price indexes need to be retrieved: the CPI for durables (PD) and the CPI for services (PS). The procedure is based on the assumptions that the price of durables is equal to the price of tradable and the price of services is equal to the price of nontradables. The robustness of this assumption needs to be evaluated by examining the total trade ratios computed by the national accounts procedure.

The drawback of the CPI procedure is that corresponding data for consumption expenditures is generally not available. The weights of the CPI are derived and revised using infrequent expenditure surveys, but the recurrent surveys on which CPI data are based are price surveys, not expenditure surveys. Hence, the data on consumption of services and durables gathered for the expenditure survey procedure can be used as proxies.

3. THE BOLIVIAN DATA

The source for the national accounts data used in the research is the quarterly Input-Output Matrix (IOM), processed and produced by the Instituto Nacional de Estadistica (INE). The IOM has the following structure:

Table 3.1
Structure of the Bolivian Input-Output Matrix

XX	MM	DM	IP	MG	OT	Product/Industry	1 2 3.....35	CIP	CH	CGT	FK	VE	EE	DT
						1								
						2								
						....								
						....								
						35								
						CIR								
						ZZ								
						VA								

Notes:
XX = Gross Production Value
MM = Imports at CIF values
DM = Import Tariffs
IP = Indirect Taxes
OT = Total Supply
CIP = Intermediate Consumption
CH = Final Household Consumption
MG = Commerce and Transportation Margins
CGT = Final Consumption of Public Adm.
FK = Gross Formation of Fixed Capital
VE = Stock Variation
EE = Exports
CIR = Sector Intermediate Consumption
VA = Sector Value Added
ZZ = Sector Production
DT = Final Demand
Source: Instituto Nacional de Estadística.

Data in the IOM is divided into 35 products/sectors: **1** Non-industrial agriculture products; **2** Industrial agriculture products; **3** Coca leaf; **4** Cattle products **5** Forestry, hunting and fishing; **6** Crude oil and natural gas; **7** Metal and non-metal minerals; **8** Fresh and elaborated meats; **9** Milk products; **10** Mill and bakery products; **11** Sugar and confectionery products; **12** Diverse food products; **13** Beverages; **14** Elaborated tobacco; **15** Textiles, clothing articles and leather products; **16** Wood and wood products; **17** Paper and paper products; **18** Chemical substances and products; **19** Petroleum refinery products; **20** Non-metal mineral products; **21** Basic metal products; **22** Metal products, machinery and equipment; **23** Diverse manufactured products; **24** Electricity, gas and water; **25** Construction and public works; **26** Commerce; **27** Storage and transportation; **28** Communications; **29** Financial services; **30** Services to firms; **31** Housing property; **32** Social, personal and communal services; **33** Hotels and restaurants; **34** Household services; **35** Public administration services.

INE produces the IOM on a quarterly basis and time series (base 1990) for all of its components are available from 1990 to the fourth quarter of 2002, in nominal and real terms. That is 52 observations for each of the variables and sectors that assemble the IOM. This includes gross production (NY and RY), exports (NX and RX), imports (NM and RM) and private household consumption (NC and RC). Data on exports appear as EE in the demand quadrant (right side) of the IOM. Data for imports appear as MM in the supply quadrant (left side) of the IOM. The column next to imports in the IOM (DM) was added to imports to approximate values at market prices. Price deflators for each sector and variable are obtained dividing quarterly nominal and real IOM data.

The IOM matrix is neither an "industry-industry" nor a "product-product" type; rather it is the combination of both: "product-industry". Concepts regarding its structure and definitions regarding all of its variables are found in the Bolivian IOM methodological document (Instituto Nacional de Estadística, 2000).

Summary statistics based on the IOM are published by INE under the title of *Producto Interno Bruto Trimestral*. This includes data on macroeconomic aggregates and sector aggregates, nominal terms, real terms and price deflators. There is also the traditional *Anuario Estadistico* that contains annual GDP by type of expenditure, GDP by sectors and price deflators, among other general economic information, which is also available on the Internet.

The following steps describe the computations based on the national accounts procedure described above:

Step 1: Computation of total trade in each sector in nominal terms NTT = NX + NM + DM and computation of sector ratios of nominal total trade to nominal gross output TTY = NTT/NY. Appendix Graph 3.1 presents the evolution of the ratio for each of the 35 sectors.

Table 3.2
Bolivian Tradable and Non-tradable goods industries

Tradable goods industry	Non-tradable goods industry
1 Non-industrial agriculture products;	**For z<=0.01:**
2 Industrial agriculture products;	**24** Electricity, gas and water;
3 Coca leaf;	**25** Construction and public works;
5 Forestry, hunting and fishing;	**26** Commerce;
6 Crude oil and natural gas;	**31** Housing property;
7 Metal and non-metal minerals;	**34** Household services;
9 Milk products;	**35** Public administration services.
10 Mill and bakery products;	
11 Sugar and confectionery products;	**In addition, for 0.01<z<=0.05:**
12 Diverse food products;	**4** Cattle products;
14 Elaborated tobacco;	**8** Fresh and elaborated meats;
15 Textiles, clothing and leather products;	**32** Social, personal and communal services.
16 Wood and wood products;	
17 Paper and paper products;	
18 Chemical substances and products;	**In addition, for 0.05<z<=0.10:**
19 Petroleum refinery products;	**13** Beverages;
20 Non-metal mineral products;	**29** Financial services;
21 Basic metal products;	**30** Services to firms.
22 Metal products, machinery, equipment;	
23 Diverse manufactured products;	
27 Storage and transportation;	
28 Communications;	
33 Hotels and restaurants;	

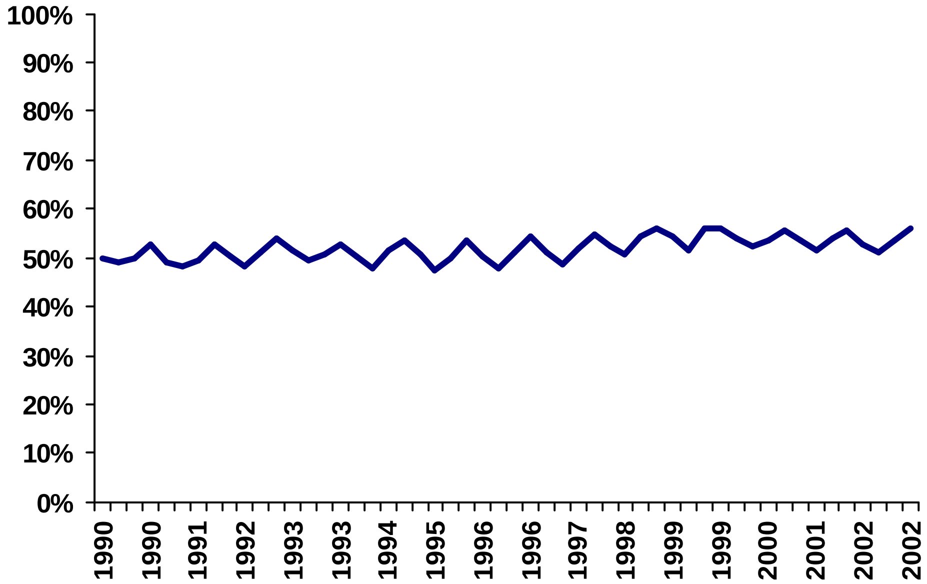
Source: Authors own calculations. See Appendix 3.1

Step 2: Classification of each sector as tradable or non-tradable according to a threshold value z. The classification uses the criteria of defining a sector as tradable if TTY > z and non-tradable otherwise. Three values of z were used, z = 0.01, 0.05 and 0.1. This way a non-tradable sector was characterized by a very low (close to zero) proportion of exports and imports compared to its gross production. Figures in Appendix Graph 3.1 include the threshold z represented by horizontal lines. Visual inspection of each figure led to the classification of each sector as tradable or nontradable. Table 3.2 presents the final classification.

A total of 12 sectors out of the 35 were classified as non-tradable, six of them under the threshold criteria of strictly z<=0.01, three more under z<=0.05 and three more sectors under z<=0.10. The inequality sign is not strict given the observed behavior over time of the sector ratios. There are cases where some points in time are bellow z<=0.05 but most points are bellow z<=0.01. In other cases some points in time are bellow z<=0.05 and other above z>0.10, but most of the observations fall in the range 0.05<z<=0.10. In these special cases, the study adopted the classification criteria according to the range where most of the observations lied, regardless of period of time.

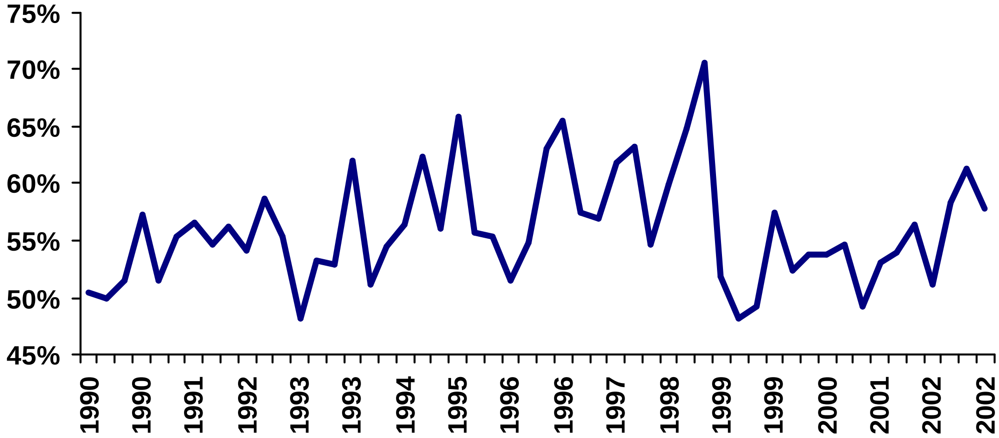
Once the classification was defined, the research study proceeded only for the case of 12 non-tradable sectors corresponding to z<=0.10. Figure 3.1 shows the participation of non-tradable goods sectors on GDP, this participation represents on average 52% of GDP (minimum of 47% and maximum of 58%). Figure 3.2 summarizes the ratio of exports plus imports to gross production for the economy as a whole, showing the increasing degree of openness of the Bolivian economy to an average of about 55% up to 1999, when the economy experienced an external shock and was forced into recession.

Figure 3.1
Participation of non-tradable goods sectors on GDP



Source : Computation based on disaggregated Input-Outoput Matrix Data

Figure 3.2
Ratio of exports plus imports to gross production

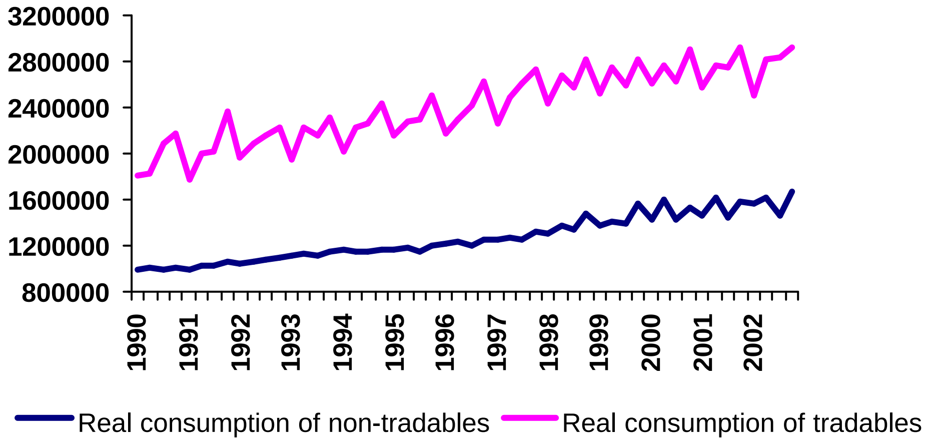


Source : Computation based on disaggregated Input-Outoput Matrix Data

Step 3: Computation of the nominal consumption of tradable (NCT) as the sum of the nominal consumption of sectors defined as tradable. Computation of the nominal private consumption of non-tradable (NCN) as the sum of the nominal consumption of sectors defined as non-tradable. Computation of the real consumption of tradable (RCT) as the sum of the real consumption of sectors defined as tradable. Computation of the real consumption of non-tradable (RCN) as the sum of the real consumption of sectors defined as non-tradable.

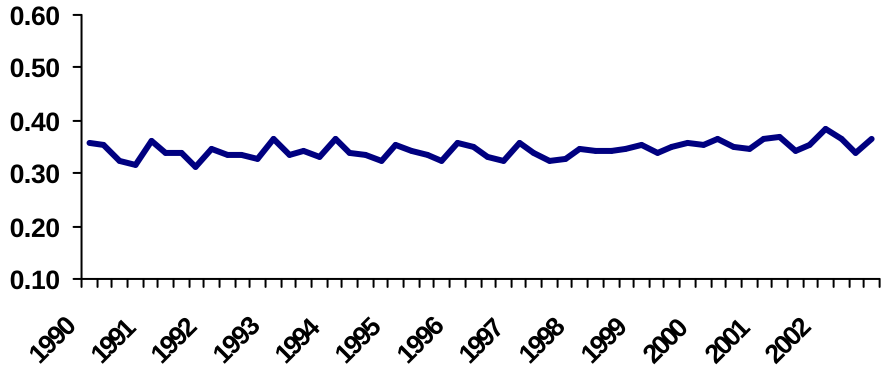
Figure 3.3 shows the time series of real consumption of tradables and non-tradables, both showing similar tendency to increase over time although the latter with greater volatility. Figure 3.4 is the ratio of non-tradable consumption relative to global consumption RCN/(RCN+RCT), showing that non-tradable real consumption has participated with an average of 34% of global consumption (minimum of 31% and maximum of 38%).

Figure 3.3
Real consumption of tradables and non-tradables



Source : Computation based on disaggregated Input-Outoput Matrix Data

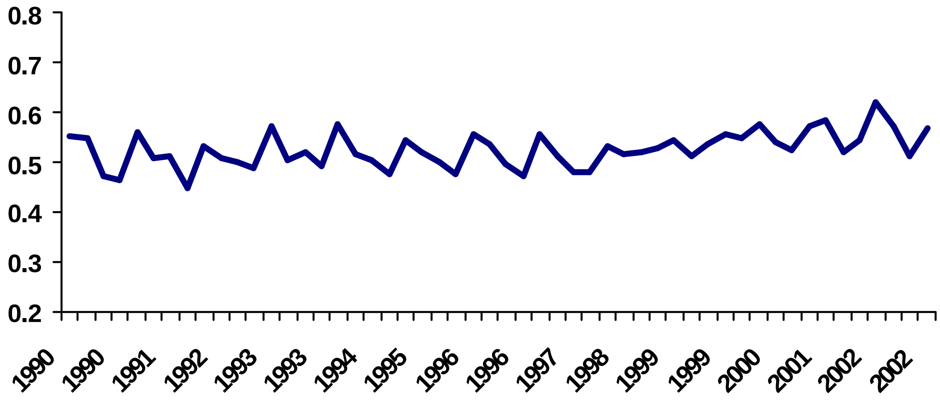
Figure 3.4
Ratio of non-tradable consumption relative to global consumption



Source : Computation based on disaggregated Input-Outoput Matrix Data

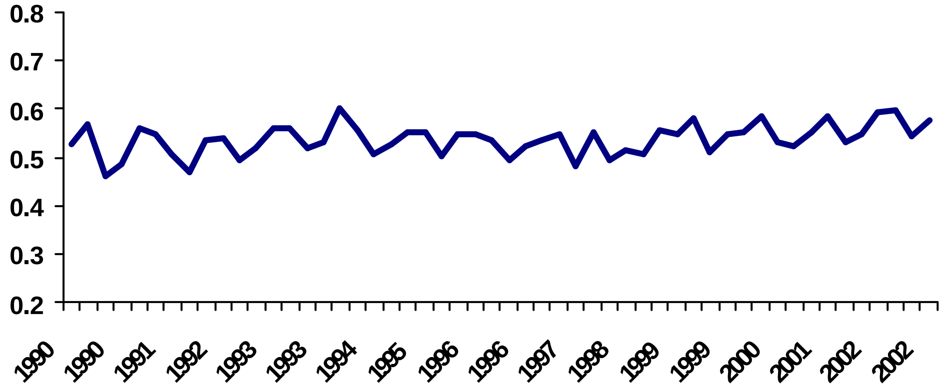
Step 4: Computation of the ratio of non-tradable to tradable consumption in nominal terms N=NCN/NCT and real terms R=RCN/RCT. Figures 3.5 and 3.6 show the time series of these ratios. These are the variables of interest as they reflect the choice behavior between tradable and non-tradable in Bolivian demand.

Figure 3.5
Ratio of non-tradable to tradable consumption in real terms



Source : Computation based on disaggregated Input-Outoput Matrix Data

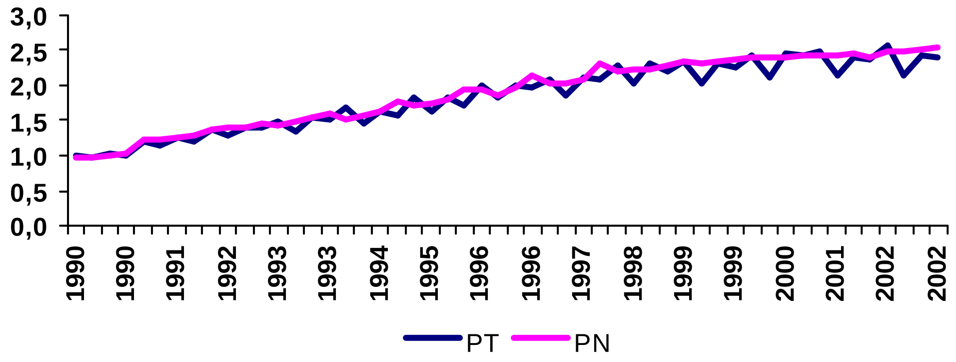
Figure 3.6
Ratio of non-tradable to tradable consumption in nominal terms



Source : Computation based on disaggregated Input-Outoput Matrix Data

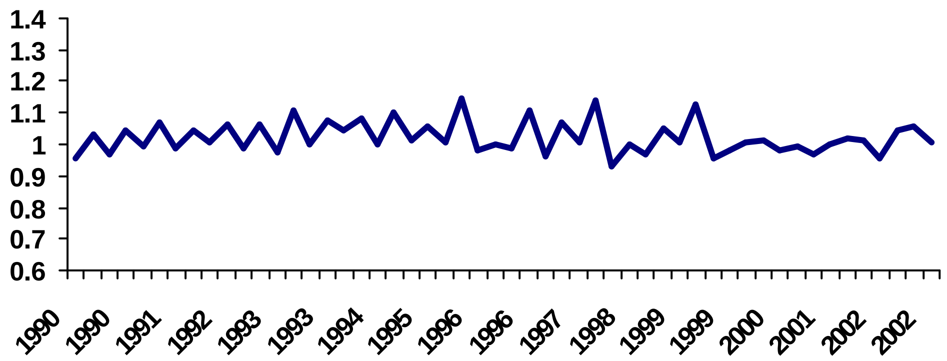
Step 5: Computation of the implicit price deflator for tradable goods industry, PT=NCT/RCT, and non-tradable goods industry, PN=NCN/RCN. With these, computation of the relative price of non-tradable goods in units of tradable, P=PN/PT. Figure 3.7 shows the time series of the price index for tradable and non-tradable independently and Figure 3.8 shows the ratio of the price index of non-tradable to tradable.

Figure 3.7
Price index for tradable and nontradable goods



Source: Computation based on disaggregated Input-Outoput Matrix Data

Figure 3.8
Ratio of the price index of non-tradable to tradable

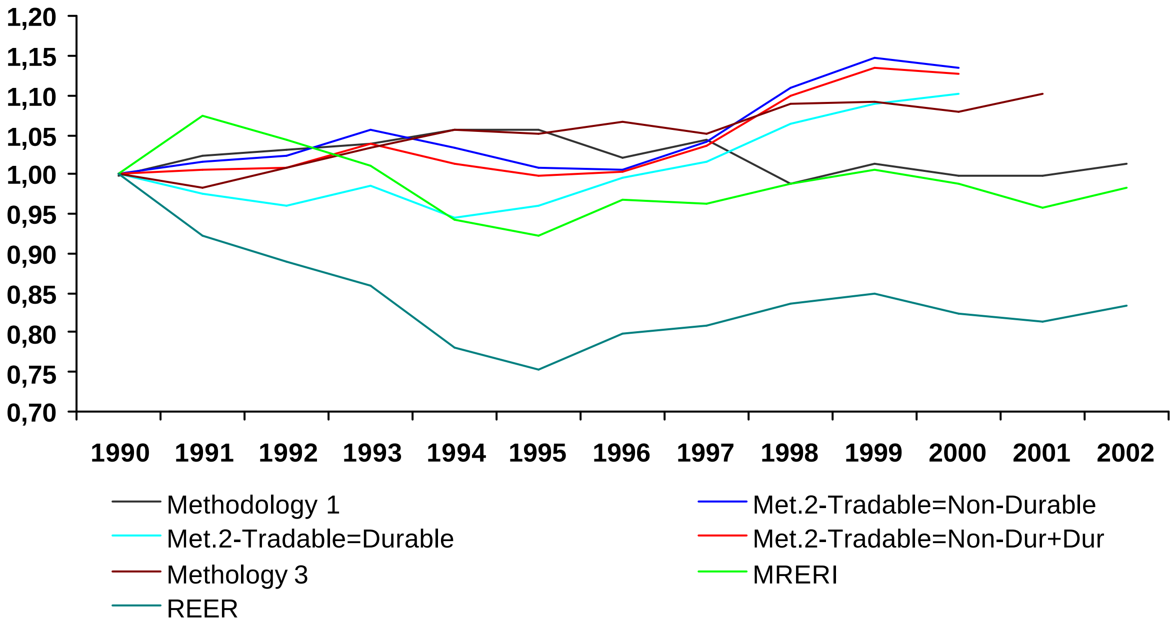


Source: Computation based on disaggregated Input-Outoput Matrix Data

The variable P (real exchange rate) is of interest as explanatory of the consumption ratio, it corresponds to the main macroeconomic signal given for the choice decision in demand. Seen independently, both series PT and PN present a long term tendency to increase characterized by dominant short term volatility around a changing mean. The ratio P shows that on average the real exchange rate has been fluctuating around one during the decade (minimum of 0.93 for depreciation and maximum of 1.15 for appreciation).

The expenditure survey procedure (method 2) and the CPI procedure (method 3) are presented in Appendix 3.2 and Appendix 3.3 respectively. Both explain the source of data, assumptions and computations. Figure 3.9 summarizes the output from these other methods in computing the real exchange rate index and compares them to the national accounts procedure presented here (method 1). These methods for determining the real exchange rate can also be referred to as "internal" because they are strictly based on domestic data and therefore reflect domestic structure. The real exchange rate is more often computed from data that reflect price behaviour and nominal exchange rates of countries with whom a home has trade relations. These can be referred to as "external" real exchange rates. The Bolivian Central Bank computes real equilibrium exchange rate (REER) and the government's Unit of Economic and Social Policy Analysis computes the multilateral real exchange rate index (MRERI). The time series of these other measures are also included in Figure 3.9, which were adjusted to a common 1990 base.

Figure 3.9
Comparision between internal and external real exchange rates



Source: Computation based on disaggregated Input-Outoput Matrix Data, Annex B, Annex C, Bolivian Central Bank and the Unit of Economic and Social Policy Analysis.
Note: For every method the real exhange rate is computed as the ratio of the price of non-tradables to the price of tradables

Several observations can be derived from Figure 3.9. The different methods to compute the real exchange rate seem to present both divergence and convergence in some aspects. The rates computed by internal methods 2 and external methods REER and MRERI have moved together in the same direction, particularly after 1993.

The rate computed by method 3 has also moved together in the same direction with methods 2 and external methods, but only since 1995. However, methods 2 and method 3 indicate that the real exchange rate has been appreciated during the period, while the external methods, in comparison, indicate that it has been mostly depreciated (MRERI) and strongly depreciated (REER) during the period, although the latter individually shows a tendency towards appreciation since 1995.

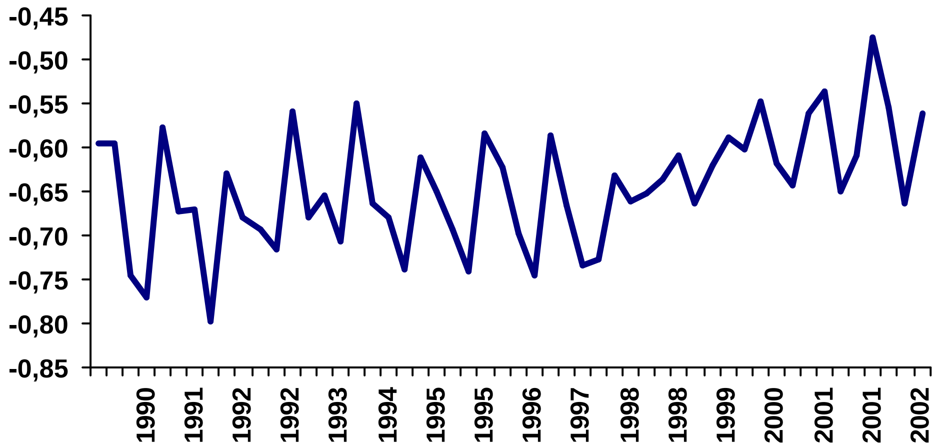
Method 1 shows a real exchange rate fluctuating around one but in opposite movement as compared to all other methods, at least until 1998. While internal methods 2 and 3 suggest an appreciated rate during the period, external methods suggest the opposite of a depreciated rate during the period, and method 1 neither. Internal and external methods of computing the exchange rate don't have to move necessarily in the same direction as explained by Hinkle and Nsengiyumoa (1999).

4. ECONOMETRIC PROCEDURE AND ELASTICITY ESTIMATION

Statistical properties of data

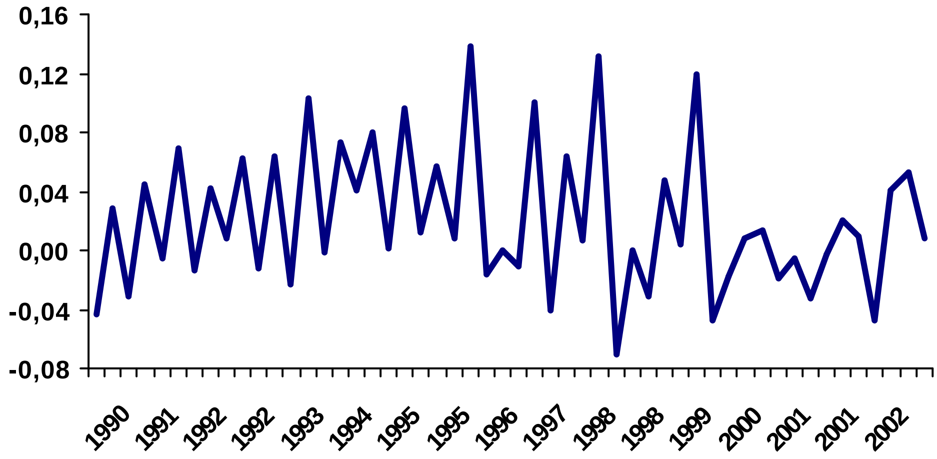
The following figures present the raw quarterly time series data of interest generated from the Bolivian Input-Output Matrix (IOM), where LR is log of the real consumption ratio of non-tradable relative to tradable goods, LP is log of the price ratio of non-tradable relative to tradable goods and LA is log of real absortion. Visual inspection shows high volatility in the data, particularly LR and LP, which may be due to seasonal effects alone or most probably a combination of seasonal effects and errors in variables. The latter might be related to INE's procedures in the effort of building the quarterly IOM given quarterly data constraints, resulting in the introduction of systematic rather then random measurement errors.

Figure 4.1
Log of the real consumption ratio of non-tradable relative to tradable goods (LR)



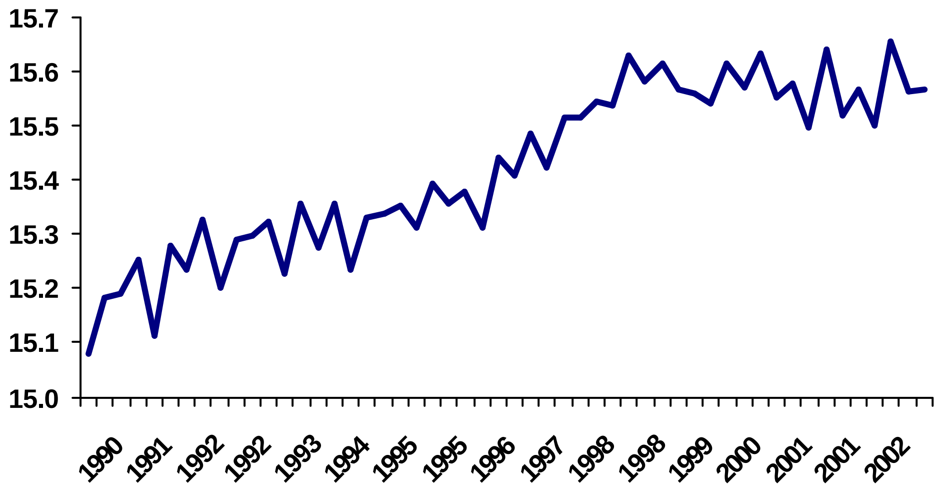
Source : Computation based on disaggregated Input-Outoput Matrix Data

Figure 4.2
Log of the price ratio of non-tradable relative to tradable goods (LP)



Source : Computation based on disaggregated Input-Outoput Matrix Data

Figure 4.3
Log of real absortion (LA)



Source : Computation based on National Accounts statistics

Seasonal differencing is often used to remove nonstationarity in seasonal data. In this case the quarterly difference operator is $?_4 y_t = y_t - y_{t-4}$. Table 4.1 presents the standard ADF test applied to the quarterly difference of the data. While all three variables are non-stationary in levels only LA is stationary in first differences. LR and LP are stationary under quarterly seasonal differencing. The fact that $?_4$ LR and $?_4$ LP are stationary implies that these time series contain either a nonseasonal unit root, a biannual unit root, or an annual unit root, or a combination of two of these types of unit roots or all three types of unit roots. The HEGY procedure introduced by Hylleberg et al. (1990) is appropriate to find out which types of unit roots are contained in the data.

Table 4.1
ADF unit root tests on the variables of interest

Variable	Specification	Lag length	ADF statistic	Stationarity
LR	None	7	-1.55	Non-Stationary
	Constant	7	-0.28	Non-Stationary
	Constant, trend	7	-1.30	Non-Stationary
LP	None	6	-0.88	Non-Stationary
	Constant	6	-1.39	Non-Stationary
	Constant, trend	6	-2.33	Non-Stationary
LA	None	5	1.24	Non-Stationary
	Constant	5	-1.71	Non-Stationary
	Constant, trend	5	-1.37	Non-Stationary
$?_4$ LR	None	4	-2.63***	Stationary
	Constant	4	-3.06**	Stationary
	Constant, trend	4	-3.17	Non-Stationary
$?_4$ LP	None	4	-4.37***	Stationary
	Constant	4	-4.33***	Stationary
	Constant, trend	4	-4.36***	Stationary
$?_4$ LA	None	5	-1.37	Non-Stationary
	Constant	5	-1.55	Non-Stationary
	Constant, trend	5	-1.69	Non-Stationary
$?_1$ LA	None	2	-7.53***	Stationary
	Constant	2	-8.93***	Stationary
	Constant, trend	2	-9.28***	Stationary

Notes: (*), (**) and (***) denotes rejection of the null hypothesis of unit root at 10%, 5% and 1% respectively.
Except for $?_1$LA, the lag length was selected by the Akaike Information Criterion (AIC).
In all cases a shorter lag length was enough to produce white noise residuals. AIC suggests four lags for the case of $?_1$LA,
when stationarity is accepted at 5% level only when the specification does not contain constant or constant and trend.
Source: Authors own calculations.

Traditional unit root and cointegration tests were developed for nonseasonal or zero frequency data, which could also be applied to quarterly data only if it is proven that unit roots at other frequencies are not present (half frequency or biannual unit root and one fourth frequency of annual unit root). It is important to notice that the elasticity of interest in this study corresponds to the long run equilibrium relationship between LR and LP, that is, it is strictly a nonseasonal or zero frequency relationship in the data.

The quarterly difference operator $?_4 = (I\text{-}L^4)$ can be decomposed as

$$(I-L^4) = (I-L)(I+L)(I+L^2) = (I-L)(I+L+L^2+L^3)$$

which has four roots, one at zero frequency, one at two cycles per year and two complex pairs at one cycle per year. The HEGY procedure consists in the following testable regression model, which can be estimated by OLS,

$$y_{4t} = \mu_t + p_1 y_{1,t-1} + p_2 y_{2,t-1} + p_3 y_{3,t-2} + p_4 y_{3,t-1} + (\text{lags of } y_{4t}) + e_t$$

where

$y_{1t} = (I+L)(I+L^2)y_t = y_t + y_{t-1} + y_{t-2} + y_{t-3}$
$y_{2t} = -(I-L)(I+L^2)y_t = -(y_t - y_{t-1} + y_{t-2} - y_{t-3})$
$y_{3t} = -(I-L)(I+L)y_t = -(I-L^2)y_t = -(y_t - y_{t-2})$
$y_{4t} = ?_4 y_t = y_t - y_{t-4}$
μ_t = constant, trend and seasonal dummies
Lags of y_{4t} are included to ensure white noise residuals
e_t = i.i.d. residuals.

Based on the HEGY regression the following hypothesis can be tested using critical values computed by Hylleberg et al:

H_A: $p_1=0$ or nonseasonal unit root
H_B: $p_2=0$ or biannual unit root
H_C: $p_3=p_4=0$ or annual unit root

Table 4.2 presents estimated statistics from application of the HEGY regression to the LR and LP data. In the case of LR there is a consistent failure to reject H_A, H_B, and H_C implying unit roots at all frequencies. In the case of LP there is consistent failure to reject H_A, and H_B, while H_C is not rejected only when the model contains seasonal dummies.

Table 4.2
HEGY testing procedure for seasonal unit roots

	Lag length	't' $p_1=0$	't' $p_2=0$	't' $p_3=0$	't' $p_4=0$	'F' $p_3=p_4=0$
LR						
None	0	-1.47	-1.43	-1.97**	1.09	2.56*
C	0	-0.06	-1.41	-1.94**	1.08	2.49*
C, t	0	-1.43	-1.40	-1.75*	1.12	2.19
C, q_1 q_2 q_3	0	-0.07	-1.65	-2.98	0.36	4.47
C, t, q_1 q_2 q_3	0	-1.02	-1.70	-2.85	0.47	4.15
LP						
None	0	-1.28	-1.28	-2.62*	-0.16	3.47**
C	0	-2.20	-1.26	-2.70****	-0.10	3.67**
c, t	0	-3.02	-1.19	-2.63***	-0.09	3.47**
c, q_1 q_2 q_3	0	-1.68	-1.56	-2.83	-0.21	4.04
C, t, q_1 q_2 q_3	0	-2.38	-1.75	-2.81	-0.01	3.96

Notes: Critical values where obtained from the HEGY tables for n=48.
For the HEGY 't' test (*), (**), (***) and (****) denotes rejection of the null hypothesis at 10%, 5%, 2.5% and 1% respectively.
For the HEGY 'F' test (*), (**), (***) and (****) denotes rejection of the null hypothesis at 90%, 95%, 97.5% and 99% respectively.
Residuals of all regressions are white noise and approximately normally distributed without the addition of lags of y_{t4}.
The q_i are seasonal dummies.
Source: Authors own calculations.

Elasticity estimation

One way to proceed from here is to estimate a relationship between LR and LP by OLS and then test the residuals for unit roots at all frequencies. If these residuals are stationary at zero frequency then the estimated regression would correspond to a long run relationship. This approach is suggested by Hylleberg et al. when the cointegrating coefficients are known, although one may think that known means previously estimated. The following was the estimated regression:

LR = -0.63 – 0.69 LP + Residuals
t = (-70.66)(-4.13)
R2 = 0.25

Table 4.3 presents the unit root test using the HEGY procedure. Failure to reject the null of $p_1=0$ which corresponds to the zero frequency indicates there is no long run relationship between LR and LP, at least when no other explanatory variables are included in the model. However, the null of $p_2=0$ was rejected at the 5% level (cases when dummies were not included), implying the above equation is recognized as a valid cointegrating relationship at the biannual frequency. One problem with this procedure is that presence of unit roots and cointegration at different frequencies in the data may not produce consistent OLS estimates of the coefficients, it is unclear which coefficient would be chosen by the static regression.

Table 4.3
HEGY seasonal unit root tests on residuals

	Lag length	‘t’ $p_1=0$	‘t’ $p_2=0$	‘t’ $p_3=0$	‘t’ $p_4=0$	‘F’ $p_3= p_4=0$
Residuals						
None	0	-0.61	-2.35***	-2.39***	0.14	2.87*
C	0	-0.45	-2.25**	-2.35***	0.22	2.79*
C, t	0	-1.26	-2.27***	-2.28***	0.25	2.63*
C, q_1 q_2 q_3	0	-1.45	-2.23	-3.35*	-0.21	5.78*
C, t, q_1 q_2 q_3	0	-1.73	-2.22	-3.34*	-0.16	5.71*

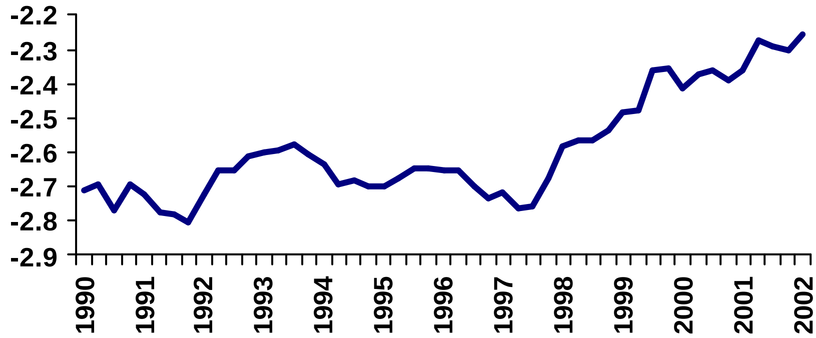
Notes: For the HEGY ‘t’ test (*), (**), (***) and (****) denotes rejection of the null hypothesis at 10%, 5%, 2.5% and 1% respectively.
For the HEGY ‘F’ test (*), (**), (***) and (****) denotes rejection of the null hypothesis at 90%, 95%, 97.5% and 99% respectively.
Residuals of all regressions are white noise and approximately normally distributed without the addition of lags of y_{t4}.
The q_i are seasonal dummies.
Source: Authors own calculations.

An alternative strategy, also suggested by Hylleberg et al. is to filter out the unit root components other then the one of interest and apply the standard Johansen cointegration test to the filtered series. The filter to remove seasonal roots would be

$$(I-L^4)/(I-L)y_t = (I+L+L^2+L^3)\ y_t = y_{1t}$$

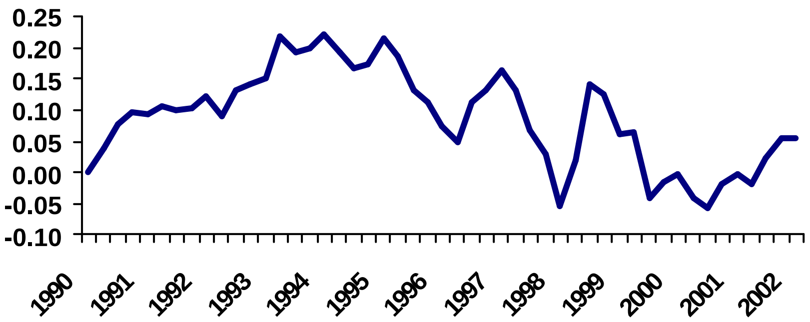
where y_{1t} is the filtered series already computed above. The filtered series for LR and LP are LR1 and LP1 whose graphs are the following:

Figure 4.4
Filtered serie of LR (LR1)



Source : Computation based on disaggregated Input-Outoput Matrix Data

Figure 4.5
Filtered serie of LP (LP1)



Source : Computation based on disaggregated Input-Outoput Matrix Data

Testing for co integration requires the following steps: 1) Unit root testing is necessary in order to verify if the series are integrated of first order I(1), this was performed using the Augmented Dickey-Fuller test (ADF) and the HEGY test. Notice that by construction LR1 and LP1 are I(1) series and LA was determined I(1). Now it is possible to estimate cointegrating relationships between LR1, LP1 and LA. 2) It is necessary to establish the lag order of the co integration test, this is done by use of the Akaike Information Criterion. 3) Perform the co integration test if the time series are I(1), using the optimum lag and considering different assumptions regarding trend and intercept.

The process involves estimating the following unrestricted VAR:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \dots\dots\dots + A_p y_{t-p} + Bx_t + e_t$$

in order to compute: $? = ? (A_i - I)$ and $G_i = -? A_j$

Where y_t is a k-vector of non-stationary I(1) variables, x_t is a d-vector of deterministic variables and e_t is a vector of innovations. The following are the Trace statistic (computed for the null hypothesis of r co integrating relations against the alternative of k co integrating relations) and the Maximum Eigenvalue statistic (computed for the null hypothesis of r co integrating relations against the alternative of r+1 co integrating relations):

$$LR_{tr}\ (r|k) = -T\ ?\ \log(1-?_{i}) \qquad\qquad LR_{max}\ (r|r+1) = -T\ \log(1-?_{r+1})$$

The variables LR1, LA and LP1 where determined to be I(1) time series. An important issue was weather these variables were co integrated, that is if there is a linear combination of LR1, LP1 and LA that is stationary. If these variables were co integrated, then the linear combination would express the long term relationship among them.

Table 4.4 presents the cointegration test results and the coefficients of long run relationships among the variables of interest. Model i) corresponds to a test between LR1 and LP1 alone, finding no cointegration. Models ii) and iii) correspond to tests among LR1, LP1 and LA where the hypothesis of no cointegration (r=0) is rejected at the 1% level. The difference between these last models is the inclusion or not of a time trend in the cointegrating equation, which has an important impact on the estimated coefficients of LA and LP1. In model ii) the elasticity of LA is not significant and the elasticity of LP1 is above one. In model iii) the elasticity of LA is significant and the coefficient of LP1 is below one.

Table 4.4
Johansen cointegration test on filtered data

Variables and Specification	Lag length	H_0: rank=r	Trace Statistic	Max-Eigen Statistic	Normalized Coefficients
i) LR1, LP1					
c in CE and	1	r = 0	8.42	8.41	No cointegration
C in VAR		r <= 1	0.01	0.01	
ii) LR1, LA, LP1		r = 0	44.01**	29.16**	LR1 LA LP1
c in CE and	7	r <= 1	14.85	14.00	1 -0.24 1.60
C in VAR		r <= 2	0.84	0.84	(-1.13) (4.18)
iii) LR1, LA, LP1		r = 0	76.76**	51.44**	LR1 LA LP1 t
c, t in CE and	7	r <= 1	25.32*	17.61	1 1.29 0.72 -0.017
C in VAR		r <= 2	7.70	7.70	(9.36) (9.07)(12.85)

Notes: (*) and (**) indicates significance at the 5% and 1% level respectively.
The lag length was determined by the Akaike Information Criterion.
CE is cointegrating equation, VAR is vector autoregression.
Source: Authors own calculations.

To solve this issue and select a final model, a standard ADF test was performed on the residuals generated from the estimated cointegrating equations. Table 4.5 show that residuals from both estimated cointegrating equations are stationary when no constant or trend are introduced in the test specification and the lag length is determined by AIC. The difference is that residuals from the cointegrating equation of model iii) are stationary at 1% and of model ii) at 5%. A second difference is that in the first case stationarity is a consistent with other lag order criteria, while the second is not.

Table 4.5
ADF unit root tests on residuals of estimated cointegrating equations

Variable	Specification	Lag length	ADF statistic	Stationarity
Residuals of CE, model iii)	None	5 (AIC, SC)	-2.68***	Stationary at 1%
	Constant	5 (AIC, SC)	-2.91*	Stationary at 10%
	Constant, trend	5 (AIC, SC)	-2.86	Non-Stationary
Residuals of CE, model ii)	None	2 (AIC)	2.41**	Stationary at 5%
	Constant	2 (AIC)	-2.29	Non-Stationary
	Constant, trend	2 (AIC)	-2.30	Non-Stationary
Residuals of CE, model ii)	None	1 (SC)	1.80*	Stationary at 10%
	Constant	1 (SC)	-1.70	Non-Stationary
	Constant, trend	1 (SC)	-1.76	Non-Stationary

Notes: AIC is Akaike Information Criterion and SC is Schwarz Information Criterion.
(*), (**) and (***) denotes rejection of the null hypothesis of unit root at 10%, 5% and 1% respectively.
Source: Authors own calculations.

Considering all of the above tests we conclude that model iii) is the proper model due to its statistical precision. Annex E presents the corresponding full error correction of model iii) were the estimated long term equilibrium relationship is

$$LR1 = 16.99 – 0.72\ LP1 – 1.29\ LA + 0.017\ t.$$

This result suggests on average an elasticity of substitution of 0.72 in the consumption of non-tradables relative to tradables. In terms of the quality of the error correction model, Annex E present graphs of the residual autocorrelations which show white noise (except maybe in one cross correlation at lag 10). The Portmanteau test suggests rejection of the null of no residual autocorrelation starting at lag 8 (which is not consistent with the previous graph), however the LM test suggest failure to reject the null of no serial correlation. Regarding normality of residuals there is failure to reject the null of zero skewness, however there is rejection of the null of normally behaved kurtosis. That is, the distribution of residuals is symmetric but short tailed. Overall the Jarque-Bera test rejects the null that residuals are multivariate normal, which maybe explained by the small sample size, however it questions the validity of test statistics based on the assumption of normality.

5. CONCLUSION

1. Three cut-off criteria were used to identify tradable from non-tradable sectors in the Bolivian economy. Out of the 35 sectors contained in the Bolivian Input-Output Matrix, six were identified as non-tradable by the criteria of $z<=0.01$, three more by $z<=0.05$ and three more by $z<=0.10$, where z is the proportion of export plus imports to gross product. The study concentrated in the last case of twelve non-tradable sectors.

2. For the period of study (1990.1 to 2002.4), non-tradable goods industry represent on average 52% of GDP and the economy degree of openness has been

on average fluctuating around 55%, ratifying other studies (Agenor and Montiel, 1999).

3. For exchange rate policy purposes, the conflicting behavior of internal and external real exchange rates indexes (due to its different computing methodology) must be taken into account, in order to avoid pervasive effects on internal consumption and production decisions, ratifying other studies (Hinkle and Nsengiyumoa, 1999).

4. Cointegration at zero frequency was found between the time series of real consumption ratio, price ratio (real exchange rate) and real absorption, implying the existence of a long term equilibrium relationship between these variables as predicted by theory. The corresponding error correction model also supports the existence of a correction mechanism in that the dependent variable (consumption ratio) will adjust according to its discrepancy between its actual an equilibrium value.

5. Theory would suggest that depreciation of the real exchange rate, measured by the ratio of non-tradable price relative to tradable price, would discourage consumption of tradable goods and encourage consumption of non-tradable goods. The data supports this result expressed by the negative sign of the coefficient of the real exchange rate when used as an explanatory variable for the behavior of the ratio of consumption of non-tradable relative to tradable goods. It has also been found that when the economy's absorption increases, it has the effect to discourage consumption of non-tradable in favor of tradable goods.

6. The constant elasticity of substitution in consumption of non-tradable relative to tradable goods has been found to have a value of 0.72 on average, implying low substitution behavior or inelasticity.

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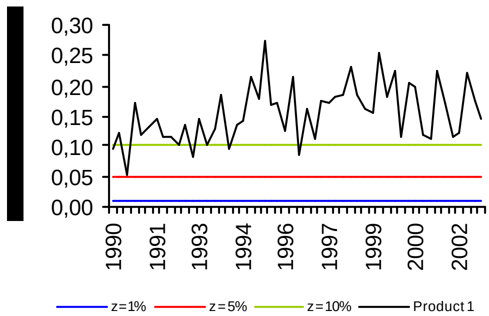
Appendix Graph 3.1

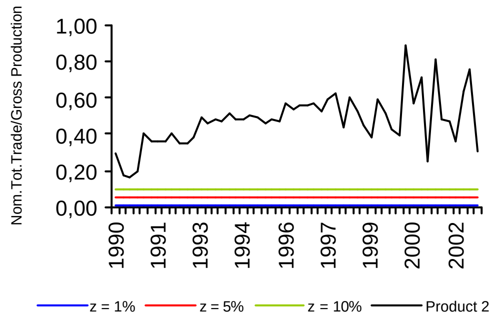
Cut-off criteria application to the 35 sector/products of the Input-Output Matrix

Figure A.1
Product 1



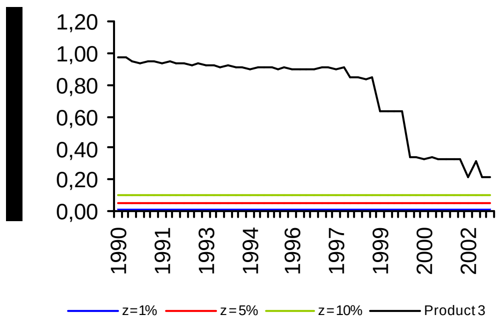
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.2
Product 2



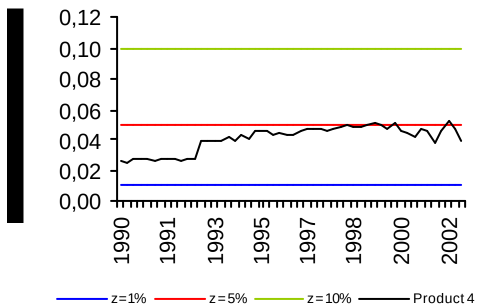
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.3
Product 3



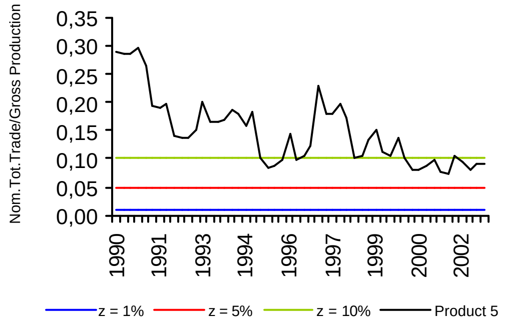
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.4
Product 4



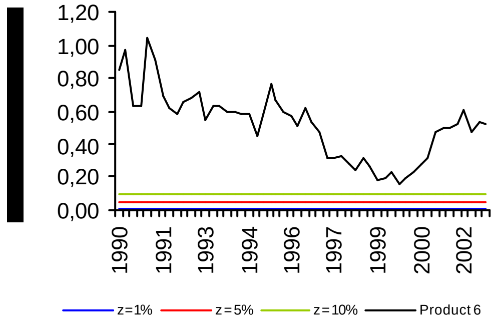
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.5
Product 5



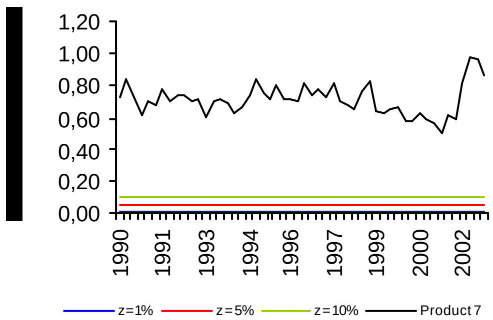
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.6
Product 6



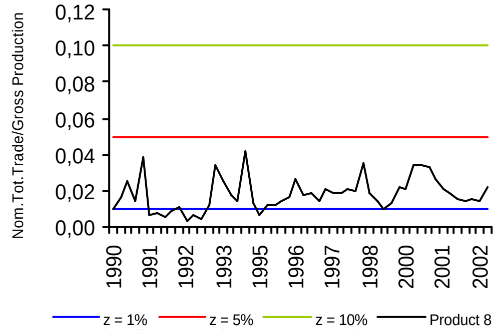
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.7
Product 7



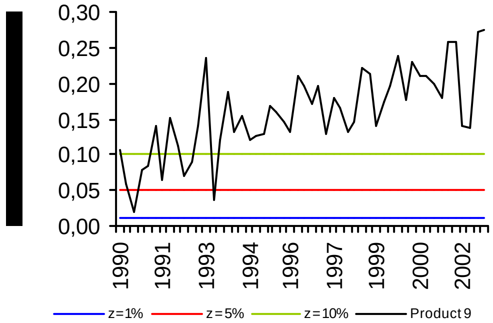
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.8
Product 8



Source: Based on disaggregated Input-Outoput Matrix Data

Figure A.9
Product 9



Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.10
Product 10

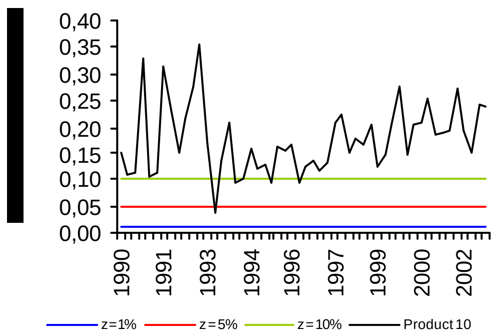


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Figure A.11
Product 11

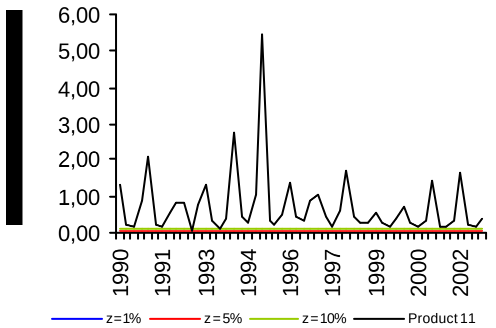

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Figure A.12
Product 12

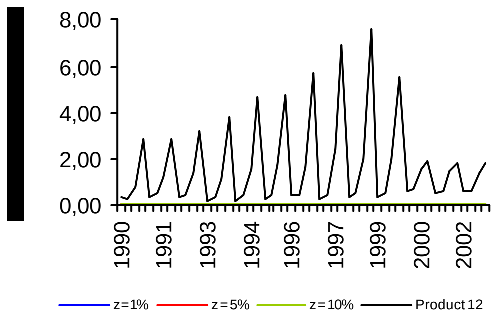

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Figure A.13
Product 13

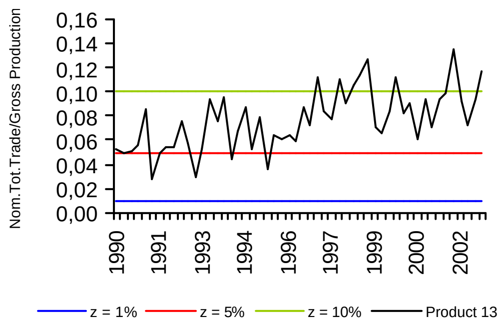

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Figure A.14
Product 14

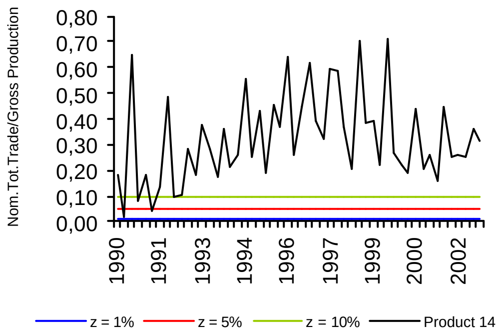

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Figure A.15
Product 15

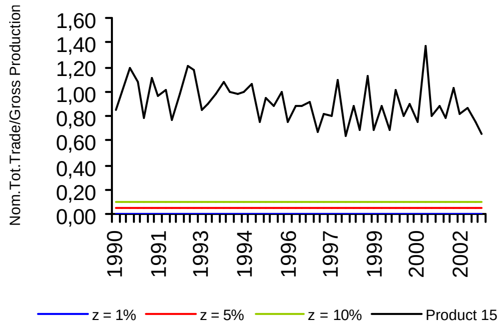

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Figure A.16
Product 16

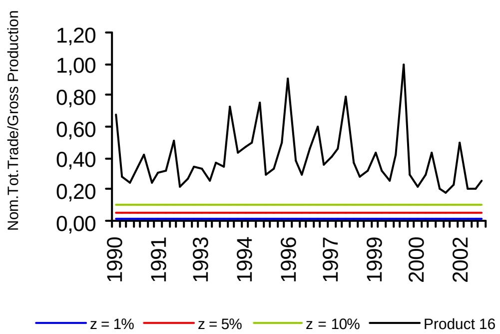

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Figure A.17
Product 17

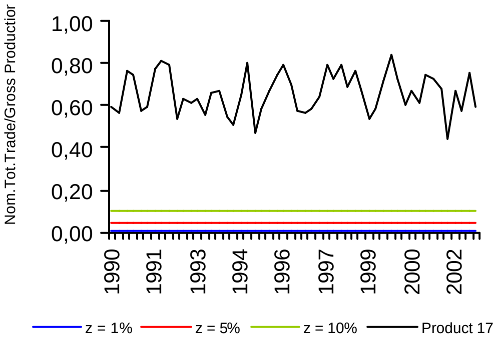

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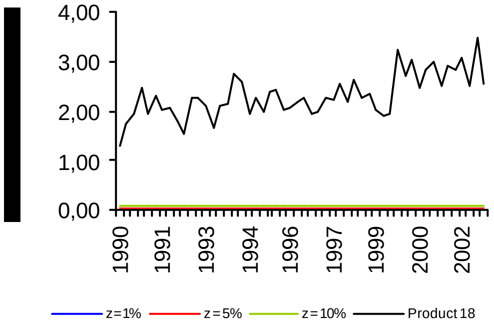
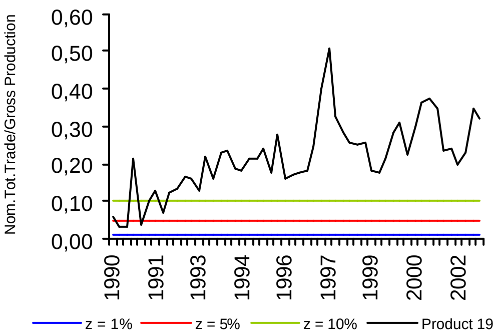
Figure A.18
Product 18



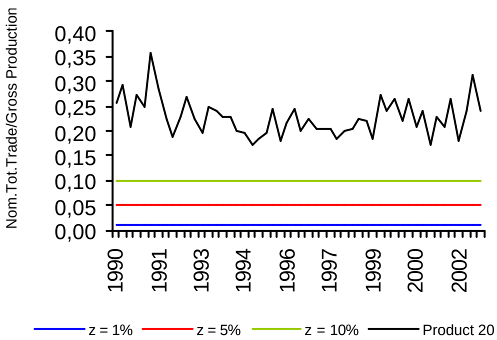
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.19
Product 19



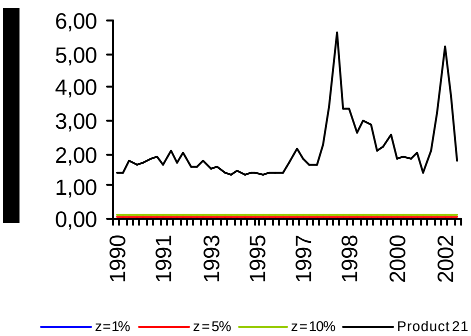
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.20
Product 20



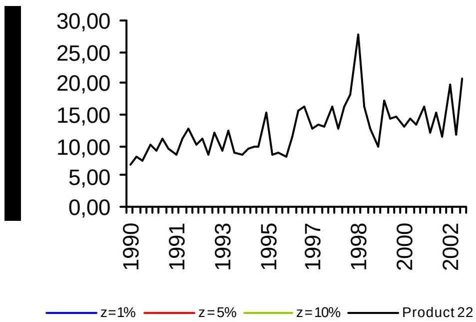
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.21
Product 21



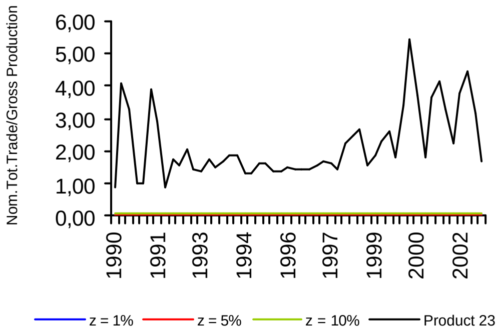
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.22
Product 22



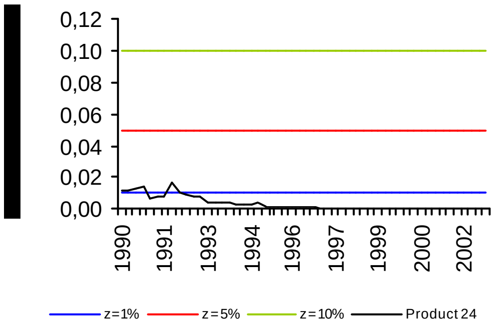
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.23
Product 23



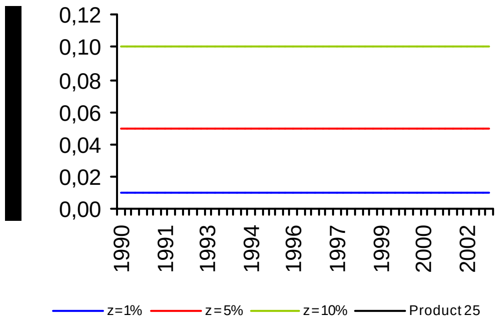
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.24
Product 24



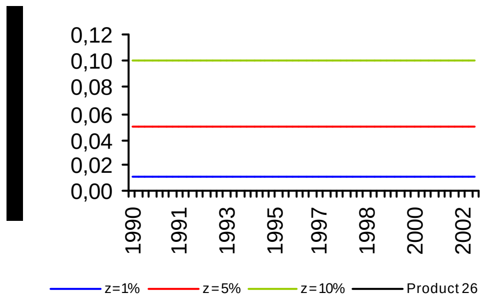
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.25
Product 25



Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.26
Product 26



Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.27
Product 27

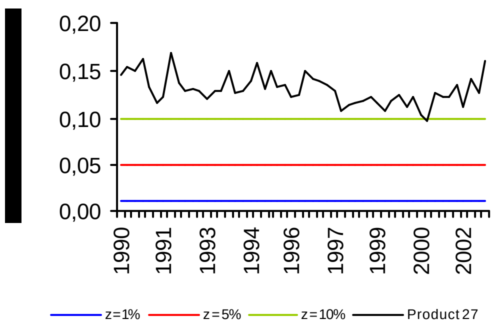


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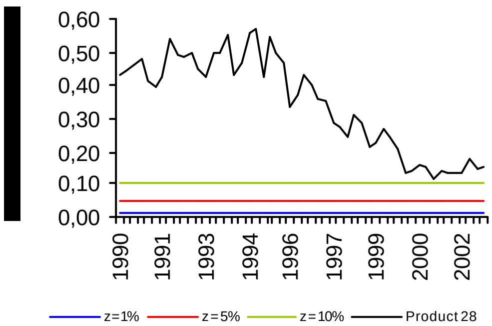
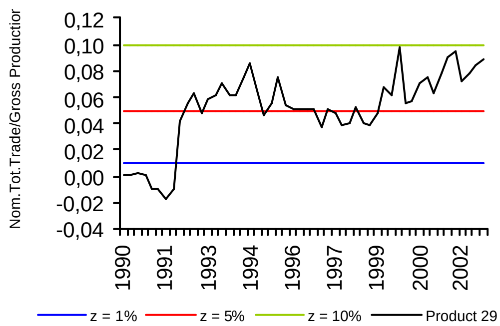
Figure A.28
Product 28



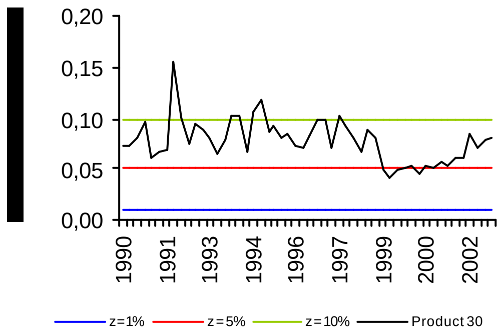
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.29
Product 29



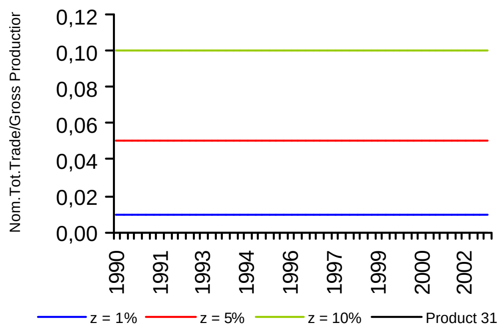
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.30
Product 30



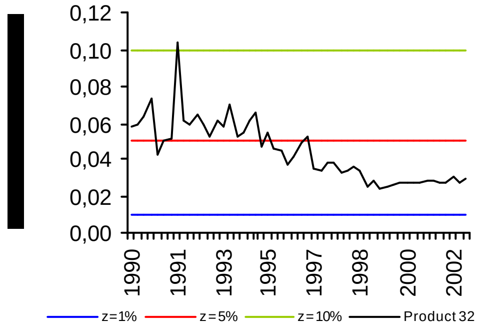
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.31
Product 31



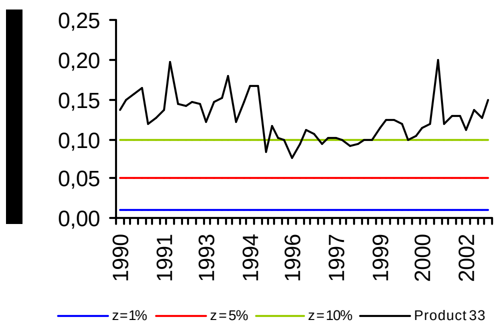
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.32
Product 32



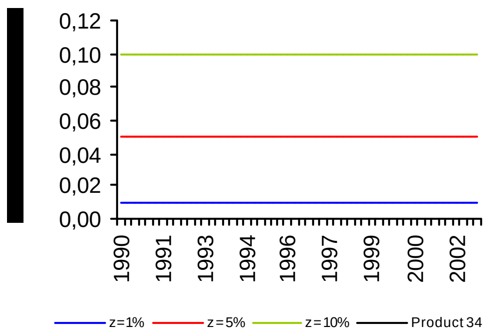
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.33
Product 33



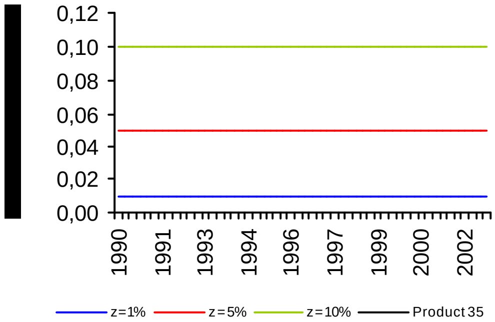
Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.34
Product 34



Source : Based on disaggregated Input-Outoput Matrix Data

Figure A.35
Product 35



Source : Based on disaggregated Input-Outoput Matrix Data

Appendix 3.2
Expenditure Survey Procedure

Private household consumption is available in the Bolivian national accounts under a product classification with 8 groups and 32 subgroups of goods. The classification and weights used come from the EPF applied to the private household consumption data from national accounts. The EPF is the Household Budget Survey made in 1990 with the purpose of building the basic structure of private household consumption of goods and services. The survey was implemented in the four main Bolivian cities. The definition of private household consumption, based of the EPF structure, is the same used in the IOM.

The private household consumption data, based on the 1990 EPF structure, is available at current and constant prices, from 1988 to 2002, at an annual frequency. Annual time series of price deflators series can also be obtained for the data based on the EPF structure, from 1990 to 2000.

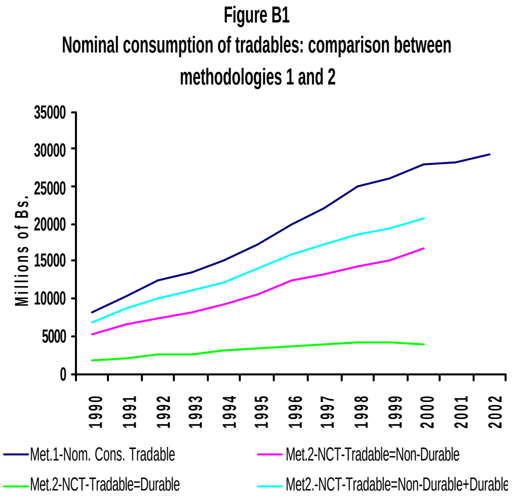
The following steps describe the computations made at each point in time.

Step 1: The private household consumption data, based on the EPF, was reclassified into service and durable goods, obtaining non-durable goods by difference. The consumption of each service good was defined as consumption of a non-tradable, and all of the non-tradable were added to produce a time series of consumption of non-tradable goods. The consumption of each durable and non-durable good was defined as a tradable good, then all tradable goods were added to produce a time series of consumption of tradable goods. All of these computations were done in nominal and real terms.

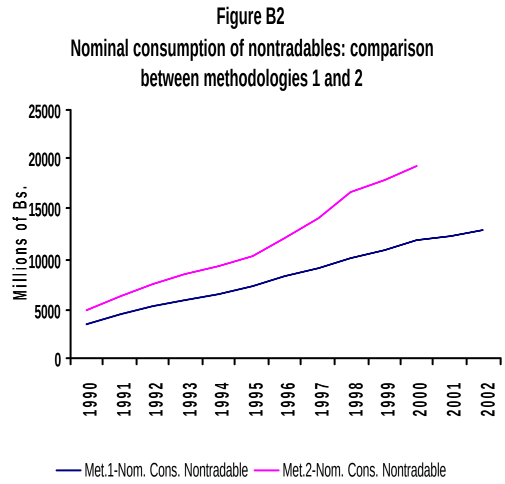
Step 2: Given that both series can be computed in nominal and real terms, then price deflators for tradable and non-tradable were computed, as well as the price ratio.

Step 3: Given that the time series produced are annual and short in length, then these are used as reference data to check the quality of data produced by the first methodology or national accounts procedure. The following figures compare the annual series of nominal and real consumption of tradables and non-tradable goods computed by the first and second methodologies.

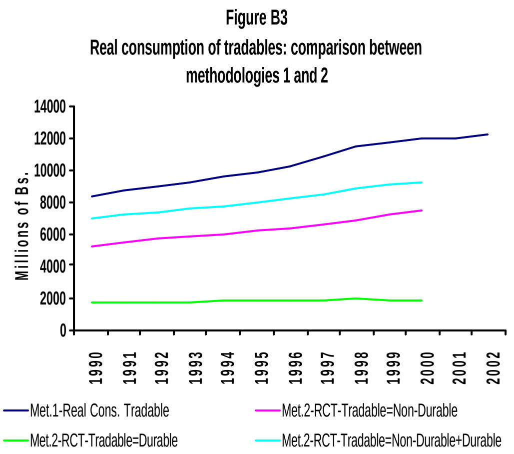
Appendix Graph 3.2
Comparing the annual series produced by the first and second methodologies



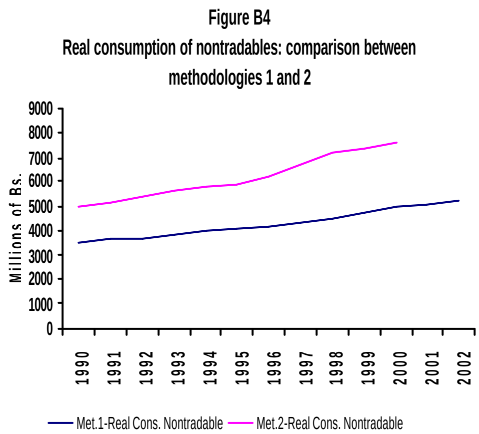
Source: Based on disaggregated Input-Outoput Matrix and private household consumption data



Source : Based on disaggregated Input-Outoput Matrix and private household consumption data



Source: Based on disaggregated Input-Outoput Matrix and private household consumption data



Source : Based on disaggregated Input-Outoput Matrix and private household consumption data

Appendix 3.3
Consumer Price Index Procedure

The consumer price index (CPI) (base 1991) is computed by INE using the traditional methodology of the Laspeyres Index, based on a basket of goods and services classified into several levels of desegregation: 9 chapters, 25 groups, 57 subgroups and a number of goods and services that varies by cities (257 in La Paz, 224 in El Alto, 258 in Cochabamba and 244 in Santa Cruz). The CPI covers the four largest Bolivian cities, which concentrates most of the urban population. The basic basket for goods and services used in the CPI comes from the Household Budget Survey of 1990. Complementing it, another survey of specification was conducted in 1991 in order to define detailed description of each good and service. The CPI time series is available on a monthly basis, for the coverage mentioned above, from 1991 to 2002, for each of the levels of classification: chapters, groups, subgroups and goods.

The CPI procedure for this research required reclassification of the CPI into a CPI of durable and CPI of services. The first is then defined as CPI for tradable and the second as CPI for non-tradable. These series are then used to produce the price ratio of non-tradable to tradable goods. These series were produced monthly from 1991 to present (base 1991) and transformed to quarterly and annual time series, which were used only as reference.

All goods listed in the CPI basket have also been classified into two groups by INE, tradable and non-tradable, allowing the production of price indexes for tradable and non-tradable, and therefore their price ratio. INE's definition of tradable and non-tradable are the following: i) Non tradable are all goods whose characteristics (highly perishable, high transportation costs, tariff barriers and goods related to our culture), determine that do not trade in international markets, therefore correspond to those produced and consumed in the domestic market. ii) Tradable are all goods whose characteristics determine that can be easily traded in international markets. These time series are available on a monthly basis and were transformed to quarterly and annual series to be used only as reference.

Appendix Table 4.1
Vector Error Correction Model: Regresión Estimates

Cointegrating Model	Equation		
LR1(-1)	1.0000		
LA(-1)	1.2963		
	[9.36]		
LP1(-1)	0.7296		
	[9.07]		
T	-0.0175		
	[-12.85]		
C	-16.99		
Error Correction Model	**D(LR1)**	**D(LA)**	**D(LP1)**
Error correction variable	-0.9850	-0.2207	0.3468
	[-3.43]	[-0.87]	[0.87]
D(LR1(-1))	0.6642	0.0047	0.3624
	[2.69]	[0.02]	[1.05]
D(LR1(-2))	0.0849	0.2389	0.1311
	[0.30]	[0.98]	[0.34]
D(LR1(-3))	0.9282	-0.5641	-0.2767
	[3.57]	[-2.48]	[-0.76]
D(LR1(-4))	0.0579	0.6938	-0.1393
	[0.20]	[2.74]	[-0.34]
D(LR1(-5))	0.4580	-0.2237	-0.1826
	[2.14]	[-1.19]	[-0.61]
D(LR1(-6))	0.2025	0.0280	0.1845
	[0.94]	[0.14]	[0.62]
D(LR1(-7))	0.0266	-0.1180	0.1504
	[0.13]	[-0.68]	[0.55]
D(LA(-1))	0.1361	-0.2921	0.7781
	[0.35]	[-0.85]	[1.44]
D(LA(-2))	-0.5965	0.0258	0.5461
	[-2.13]	[0.10]	[1.40]
D(LA(-3))	-0.1581	-0.1553	0.1126
	[-0.62]	[-0.69]	[0.31]
D(LA(-4))	-0.2433	0.5661	0.2255
	[-1.15]	[3.05]	[0.76]
D(LA(-5))	0.3126	0.0162	-0.4875
	[1.11]	[0.06]	[-1.25]

Continuation Table 4.1

D(LA(-6))	0.5978	-0.3493	-0.1979
	[2.94]	[-1.96]	[-0.70]
D(LA(-7))	-0.0115	-0.0253	-0.0452
	[-0.05]	[-0.13]	[-0.14]
D(LP1(-1))	0.5821	0.0201	0.1913
	[2.40]	[0.09]	[0.56]
D(LP1(-2))	0.1104	0.3208	-0.0669
	[0.45]	[1.50]	[-0.19]
D(LP1(-3))	0.5379	0.0331	-0.3364
	[2.22]	[0.15]	[-1.00]
D(LP1(-4))	0.7352	0.3538	-0.7242
	[3.39]	[1.86]	[-2.41]
D(LP1(-5))	0.7717	0.2127	-0.3356
	[3.49]	[1.10]	[-1.09]
D(LP1(-6))	0.5251	-0.4124	-0.2297
	[2.10]	[-1.88]	[-0.66]
D(LP1(-7))	-0.1563	0.1528	0.4224
	[-0.60]	[0.67]	[1.17]
C	-0.0062	0.0106	-0.0151
	[-0.43]	[0.85]	[-0.77]
R-squared	0.75	0.94	0.59
Included observations	41	41	41
Sample adjusted 1992:4 2002:4			

Notes: LR1 is log of the consumption ratio of non-tradables to tradables (filtered series).
LP1 is log of the price ratio of non-tradables to tradables (filtered series),
LA is log of real absorption.
D(.) is first difference of the variable. Numbers in [ ] are t-statistics.

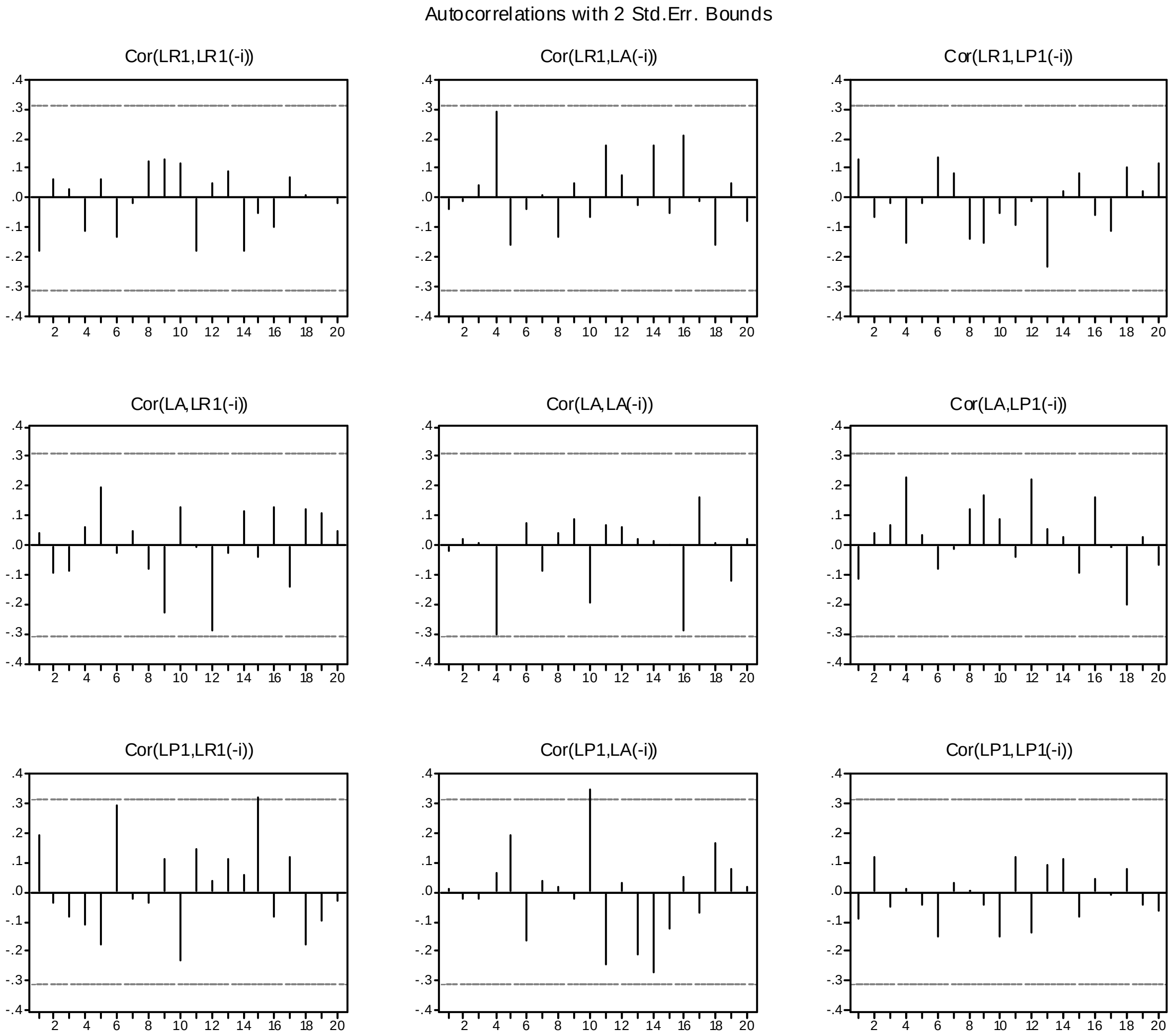
Source: Authors own calculations.

Appendix Table 4.2
Vector Error Correction Normality Tests

Component	Skewness	Chi-sq	df	Prob.
1	0.0532	0.0193	1	0.8893
2	-0.0375	0.0096	1	0.9219
3	-0.0362	0.0089	1	0.9245
Joint		0.0379	3	0.9981
Component	**Kurtosis**	**Chi-sq**	**df**	**Prob.**
1	0.3623	11.8852	1	0.0006
2	0.5054	10.6308	1	0.0011
3	0.5478	10.2722	1	0.0014
Joint		32.7883	3	0.0000
Component	**Jarque-Bera**	**Df**	**Prob.**	
1	11.9046	2	0.0026	
2	10.6404	2	0.0049	
3	10.2812	2	0.0059	
Joint	32.8262	6	0.0000	

Notes: H0: residuals are multivariate normal.
Source: Authors own calculations.

Appendix Graph 4.1
Autocorrelations of residuals



Appendix Table 4.3
Vector Error Correction Residual Tests for Autocorrelation

Portmanteau Tests							Serial Correlation LM Tests		
Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df		Lags	LM-Stat	Prob
1	7.5285	-	7.7167	-	-		1	10.6446	0.3009
2	9.3931	-	9.677	-	-		2	2.6206	0.9775
3	15.6082	-	16.3827	-	-		3	4.1958	0.8981
4	23.7536	-	25.4086	-	-		4	12.6460	0.1793
5	34.7186	-	37.8966	-	-		5	10.1486	0.3386
6	41.5068	-	45.8485	-	-		6	6.0869	0.7312
7	43.8592	-	48.6852	-	-		7	2.5395	0.9798
8	48.7925	0.0000	54.8144	0	9		8	4.5868	0.8687
9	56.2027	0.0000	64.3088	0	18		9	7.227	0.6135
10	62.9200	0.0001	73.1929	0	27		10	6.8692	0.6507
11	68.0098	0.0010	80.149	0	36		11	6.2750	0.7121
12	78.8898	0.0013	95.5311	0	45		12	10.0875	0.3434
13	90.5699	0.0013	112.6341	0	54		13	10.7665	0.2921
14	100.5259	0.0019	127.7524	0	63		14	12.3757	0.1929
15	111.0290	0.0022	144.3151	0	72		15	13.7854	0.1302
16	117.5279	0.0050	154.9732	0	81		16	15.3509	0.0817
17	121.7047	0.0146	162.1086	0	90		17	10.879	0.2841
18	126.4706	0.0327	170.6042	0	99		18	8.6441	0.4708
19	128.4555	0.0874	174.3035	0.0001	108		19	6.5865	0.6801
20	129.9762	0.1943	177.2724	0.0003	117		20	4.1991	0.8978

Notes: For the Portmanteau tests H0: no residual autocorrelation up to lag h.
The test is valid only for four lags larger than the VAR lag order, and df is degrees of freedom for (approximate) chi-square.
For the Serial Correlation LM tests H0: no residual autocorrelation at to order h. Probs from chi-square with 9 df.
Source: Authors own calculations.