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Macroeconomic Links in Mexico: an Econometric Approach

Tesis para obtener el grado de Doctor en Economía

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Contents

Introduction

The objective of this dissertation is twofold. First, we try to shed light on the workings of some aspects of the Mexican economy from an heterodox perspective. Specifically, we try to explain how output, wages and exchange rate changes are determined in the Mexican economy and we look for the impact of Keynesian demand-side variables on them, such as money supply, government expenditure, unemployment and so on.

In other words, we aim to explain how a key macroeconomic variable, output, and two key prices, wages and the exchange rate, are determined and describe the relevant macroeconomic interactions among them, based on a Keynesian-Structuralist framework. This framework emphasizes demand as the main factor underlying output determination, and stresses the limits posed by the external sector to government demand management[1]. Second, we look for reliable empirical evidence on the behavior of such variables and their transmission mechanisms by applying a relatively novel econometric methodology proposed by Aris Spanos (1986). Such methodology tries to reach statistically adequate inferences by using a probabilistic framework, for modeling empirical data, which really allows us to "learn from the data" increasing our chances of improving our knowledge of economic phenomena.

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[1] The Keynesian component of our framework was originally developed by Keynes (1936) and Kalecki (1939); and the Structuralist component by Prebisch and his collaborators at ECLAC.

To sum up, in this research work we are offering rather novel theoretical and empirical approaches to discuss the macroeconomic issues of the Mexican economy. We explain the behavior of variables such as the nominal exchange rate, nominal wage and output and describe the interactions among them and their associated transmission mechanisms in the context of the Keynesian theory. Additionally, we illustrate and apply a rigorous econometric methodology that focuses on reaching reliable empirical results from a statistical point of view.

The need to propose an heterodox approach to macroeconomic issues and use a rigorous empirical methodology comes from the following two facts. First, during the last two decades Mexico's economic authorities have faithfully followed the recommendations endorsed by the so-called "Washington Consensus", which are supported by the economic mainstream. The results so far achieved with this economic strategy have not been satisfactory; to say the least. Other schools of thought criticize the recommendations of conventional thinking. This is notably the case of Keynesian economics, and of Latin American Structuralism. According to our results, their criticisms appear to be justified.

Second, it is unfortunate that in economics the discussion on strategies and policies relies seldom on reliable knowledge built upon real data. Often, assessing the validity of the theory has nothing to do with their empirical adequacy of the econometric models (Spanos, 1986). Rather, it has become a competition between conjectures based on rhetoric and aesthetics and not on substantive qualities such as empirical adequacy of the models. Frequently, good theories are considered as such because they emanate from certain "authorities" in the field. A theory is accepted as valid depending on how many people the author can convince; if enough people are convinced it becomes a fad. If the author comes from a well-known institution then the probability of becoming a fad is high. When the credibility of theories, is challenged, modifications of the old theories are invented which appear to do better at accounting for certain anomalies (including empirical regularities) but no real empirical tests are performed; the whole process relies on anecdotal evidence (Hendry, 2001).

Thus, in this dissertation, we have used econometric evidence in an attempt to ensure the reliability of our evidence. We endeavor to put forward a dialogue between the theory and observed data, the ultimate aim being to assess the validity of theories aiming to explain the economic phenomena of interest. Without such empirical evidence, substantive advances will not be reached. Most importantly, economic strategies will fail to bring about the expected results. As we have said, in this research work we use a methodology which allows us to postulate econometric models which provide strong and reliable support for Keynesian hypothesis on macroeconomic relationships and interactions for prices, exchanges rates and other real variables.

An original aspect of this research work is the effort in associating some probabilistic concepts with economic behavior. Such an effort is not often done in the empirical literature. For example, we associate the concepts of probabilistic distributions and probabilistic dependence to the economic behavior of agents. What we mean is that not only is it worth to a get a statistical characterization of the data but also to associate an empirical finding to a theoretical concept.

Finally, it is important to mention that the research work in this report was developed under the premise of writing a set of four original empirical essays under the same econometric framework and empirical methodology to reach reliable economic results. In what follows we make a brief summary of the chapters of this dissertation.

A Brief Overview of the Dissertation

The main objective of the first chapter is to explain and illustrate the working of our econometric methodology, which (following Spanos, 1986) we will call the probabilistic reduction approach to econometrics (PR). We do so by respecifying and estimating two empirical VAR models published by Stock and Watson (2001) and Johansen and Juselius (1990) respectively. Such respecification exercises are performed in order to show the adverse consequences of using the traditional econometric modeling strategy in applied work and ignoring the importance of having Statistically Adequate Models (SAM) as the basis for reliable statistical inference[2]. In general, this section provides us with the appropriate econometric methodology to specify the macroeconometric models for the next three chapters.

The Probabilistic Reduction (PR) approach, discussed along this chapter, emphasizes the use of statistically adequate models as the basis of drawing reliable inferences (Spanos; 1986, 1999, 2006a, 2006b). The foundation of this approach is a purely probabilistic construal of the notion of a statistical model, considered to be a set of internally consistent probabilistic assumptions aimed to capture the statistical information in the data (chance regularity patterns – see Spanos, 1999; Andreou, Pittis and Spanos, 2001). In other words, economic theory suggests the potential theoretical relationships and the relevant data, but the statistical model is specified by viewing the observed data as a realization of a generic vector stochastic process with a probabilistic structure that would render the observed data a truly typical realization thereof. That is, the structural model is based on substantive subject matter information, but the

[2] A model can be considered statistically adequate (*SAM*) once its main assumptions have been validated by using a battery of misspecification tests. For instance, the assumptions to be verified in the case normal linear regression model are: normality, linearity, homoskedasticity, no autocorrelation and parameter t-invariance.

statistical model is chosen to reflect the systematic statistical information contained in the particular data. The way the two sources of information can be blended harmoniously is to embed the structural model into a statistically adequate statistical model.

In chapter two we provide an essay on the dynamics of money wages in Mexico. Specifically, we try to identify the factors that govern the behavior of money wages in the manufacturing sector and the maquila industry. Our main empirical findings show that money wages are jointly determined in both industries, and that a relatively similar set of conditioning variables determines their dynamics. It is also found that money wages in both sectors depend on shocks to underemployment and on the specific conditions of the sector, the latter summarized by output growth in the manufacturing sector and by productivity growth in the maquila industry. This fact reveals that insider workers have certain bargaining power in Mexico and that using the other sector's wage is probably a good convention in the wage-setting process, because it provides workers with an indication as to the wage that can be successfully bargained for.

Our results let us conclude that wages in those two industries in Mexico can be successfully explained by theories of wage determination that emphasize the institutional aspects of the labor market (Lindbeck and Snower, 1986; Lindbeck, 2001), and that take into account the dual or segmented structure of the labor market in today's capitalism, in conjunction with some of the ideas proposed by Keynes in his General Theory[3].

It is worth to mention that the previous results were obtained by making use of modern econometric techniques. An SVAR model was estimated making emphasis on

[3] There are very few Published work on the empirical determinants of wages in Mexico from this point of view. A good reference regarding applied work about the wage setting process is the article by López Antonia and López Julio (2006). Their conclusions are very similar to ours but they use a panel econometric approach.

the use of the PR approach to econometric modeling. So, we are able to say that our SVAR model is congruent from statistical and theoretical viewpoints.

The third chapter is an empirical essay on the effects of selected economic policy measures, and of the evolution of the international environment, in Mexico's economic performance. An important feature of our empirical modeling is that we postulate a model based on the Keynesian Structuralist perspective and we make use of the PR approach and system-based cointegration methods in an attempt to capture the interdependencies in the economy. These econometric procedures allows for an appropriate empirical analysis in the presence of non-stationary time series and endogeneity among the relevant variables.

Specifically, we look for the effects on output of monetary and credit policies, government spending, and variations in the exchange rate. Our econometric results show, first, that US economic growth is very important for Mexico's long-run evolution. This finding validates the emphasis that the Latin American Structuralist school of though, as well as the Post Keynesian approach, put on the external constraint on growth. Second, money and government spending have a positive impact on output. Third, we find that rationing of credit plays a negative role on output. These last two results are compatible with the principle of effective demand supporting our research and with the post Keynesian and new Keynesian views about the expansionary effects of liquidity and money on output (Minsky, 1975, 1982; Davidson, 2002; Blinder, 1987; Greenwald and Stiglitz, 1988). A fourth important finding of our work shows the existence of an inverse association between the real exchange rate and output. In other words, currency depreciation would depress output when it is not accompanied with complementary policy measures. This result supports the contractionary devaluation hypothesis, which has given rise to a long debate, mostly in Latin America (Diaz-

Alejandro, 1963; Krugman and Taylor, 1978). It also runs counter the supposed expansionary effect of currency depreciation, assumed in conventional macroeconomic thinking (Dornbusch and Werner, 1994).

We also conclude that in spite of its external economic dependence, the Mexican government can exert a certain degree of influence on economic development. In particular, expansionary fiscal and monetary policies can contribute to stimulate economic growth. Now, it is known that, when carried too far, these policies negatively affect the trade balance and the balance of payments. This suggests that they should be accompanied with policies that improve competitiveness. Such policies in conjunction with adequate management of the exchange rate appear to be fundamental. According to our finding, a currency depreciation, by itself, has a negative impact on the level of output. However, if it is combined with adequate fiscal and monetary policy, it can help to sustain a growth resumption strategy in conditions of balance of payments equilibrium. However, in the long run other measures to improve competitiveness would be required.

Finally, in chapter four we discuss the dynamics of exchange rate determination and estimate a model of the dynamics of the Peso-US dollar exchange rate variations and its volatility. The main objective of this chapter is to model the US/Mexican peso exchange rate variations and to provide a simple explanation of the underlying economic mechanism which governs such movements over time. In order to do so we depart radically from the econometric mainstream. Indeed, here we make use of the student's t autoregressive model with dynamic heteroskedasticity, *Star(l,p,v)*, proposed by Spanos (1992). This model constitutes an alternative to the ARCH- type specifications currently used for modeling "speculative prices", and it has the advantage that it takes into account all the “stylized facts”, widely accepted in the quantitative financial literature, such as: bell shape symmetry, thick tails and non-linear dependence.

The main findings of this chapter can be summarized as follows. First, the exchange rate returns setting process is shaped by speculators who with their actions generate the leptokurtic and dependent pattern of exchange rate dynamics, which can be captured by the *star(l,p,v)* model. Second, the main hypothesis is that the participants in the forex market are interested in future appreciation or depreciation and have dependent expectations on the direction in which prices are going to change and their speculative activity generates the probabilistic patterns of the data. Third, the existence of different expectations is in fact needed to ensure the maintenance of equilibrium in the market plus the existence of a long run equilibrium value (or set of equilibrium values).

1. Econometric Methodology In Practice: The Probabilistic Reduction (PR) Approach To Econometrics

1.1 Introduction

The main objective of this chapter is to explain and illustrate the workings of the econometric methodology we will use in this work, which following Spanos, (1986) we will call the probabilistic reduction approach to econometrics (PR). We do so by discussing, and then respecifying two empirical VAR models estimated by Stock and Watson (2001) and Johansen and Juselius (1990) respectively. Our empirical exercises illustrate the adverse consequences of using the traditional modeling strategy (textbook approach) in applied work and ignoring the importance of having *Statistically Adequate Models* (SAM) as the basis for reliable statistical inference[1].

This chapter is structured as follows. After this brief introduction, the second section explains how a VAR model can be understood in the context of the PR approach. The third section discusses the traditional approach to VAR modeling (textbook approach). In the next section the *PR* approach to empirical modeling is used to evaluate and respecify the aforementioned *VAR* models. In order to compare the reliability of the estimates arising from the use of both approaches, we make a brief comparison of the performance of the Juselius and Johansen's VAR (2) model and our

[1] A model can be considered statistically adequate (*SAM*) once its main assumptions have been validated by using a battery of misspecification tests. For instance, the assumptions to be verified in the case normal linear regression model are: normality, linearity, homoskedasticity, no autocorrelation and parameter t-invariance.

respecified model via inferences such as cointegration analysis and impulse response functions. A final section draws upon the lessons learned and provides a summary of our conclusions.

1.2 VAR Model And The PR Approach To Econometrics

The PR approach to econometrics constitutes a blending of theoretical and statistical information in such a way that we can learn about observable phenomena using data. The theoretical information derives from the postulated economic theory and the statistical information is reflected in the chance regularity patterns exhibited by the data. In other words, the two kinds of information are encapsulated initially by two different models, the theory and statistical models (Spanos, 1999). The theoretical model is specified in terms of economic variables, a priori causal relationships and even economic dynamics, but the statistical model is specified exclusively in terms of the observable random variables underlying the data. Therefore, the choice of the statistical model is not only influenced by the probabilistic theory but also by the economic theory from the very beginning of the modeling process. Even at the end of such a process economic theory also provides us with useful restrictions that allow us reach more parsimonious and meaningful models.

It is worth to say that the PR approach has its roots in LSE tradition of econometrics which has been a leading school since the 1970s, (Hendry, 1995; 2003) . Among the main scholars of this tradition we find people like Hendry, Sargan, Ericsson and so on.

In the context of the PR approach to econometrics any statistical model can be seen as a set of assumptions regarding the probabilistic structure of the data (Spanos, 1986). That is, economic theory suggests the theoretical relationships to be modeled and the data to be used, but the statistical model must be defined in terms of the probabilistic features of the data on hand.

In other words, in order to get an adequate empirical model, we make the hypothesis that the economic time series data correspond to realizations of stochastic processes. Thus, we can start by imposing one assumption of each one of the three following categories of *reduction assumptions* to the joint distribution $D\ (Z_1, Z_2, \ldots, Z_T, \varphi)$ of the set of the economic variables involved in our model .

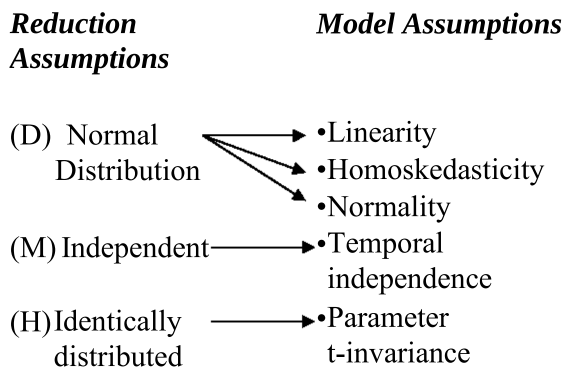
Distribution: Normal, Student's t, Gamma, Beta, Exponential, Weibull, etc

(M) Memory: independence, markov dependence, ergodicity, etc.

Heterogeneity: stationarity, identical distribution, etc.

In short, we can get operational models by imposing reduction assumptions, from these three broad categories, to the stochastic process underlying the data $\{Z_t, t \in \Pi\}$. The assumptions needed to postulate an empirical model can be assessed by means of graphical techniques such as t-plots, scatter-plots, P-P plots and so on. But we can and should use several tests to validate our assumptions.

For instance, if we have normal, independent and identically distributed data we can postulate the normal linear regression as a reasonable approximation of the statistical mechanism giving rise to the data. That is, we can propose the following set of assumptions which leads to a set of verifiable model assumptions.



In case the postulated model is statistically inadequate (misspecified) for the data on hand we can go back and propose a different set of reduction assumptions and find a new statistical model[2]. As a result, the success of econometric modeling depends on how well the data supports the postulated assumptions. Then, misspecification testing (diagnostic checking) plays a fundamental role to ensure the statistical adequacy of the model and the reliability of the inferences based on such model.

Therefore, empirical modeling in the context of the PR approach consists of four interrelated stages:

Specification: refers to the actual choice of the statistical model, taking into account the probabilistic features of the data[3].

Misspecification testing: once we have a fully specified model we proceed to assess the validity of the underlying probabilistic assumptions. That is, we formally test the model assumptions ("diagnostic checking").

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[2] Suppose, for instance, that the independence assumption is not supported by the data on hand, then we can change it for Markov dependence which gives rise to the normal linear autoregressive model AR (p). Additionally, if the same data exhibits second order dependence, leptokurticity and thick tails we could change normality for another distributive assumption like student's t distribution which gives rise to the students't autoregressive model Spanos (1990).

[3] Looking at the plots, and misspecification testing in order to postulate and estimate an adequate statistical model are not considered unwarranted data mining activities in the context of the PR approach to econometrics (Spanos, 2000b).

Respecification: in case the model is found to be misspecified we proceed to reconsider the reduction assumptions on the joint distribution of the observable random variables in order to propose a new statistical model.

Identification: once we have a SAM model we proceed to link it to the theoretical model by imposing restrictions to the former to transform it into a meaningful economic model.

Now, in order to illustrate the workings of such a framework we discuss the specification of a VAR (1) model[4].

In order to specify a VAR (1) model we start by imposing the following reduction assumptions, in the aforementioned (D) (M) (H) categories, on the joint distribution of the stochastic process $\{Z_t, t \in \Pi\}$:

(D): Distribution: Normality

(M): Dependence: Markovness

(S): Heterogeneity: Stationarity

This reduces the Joint distribution via:

$$D(Z_1, Z_2, ..., Z_T; \psi(t)) = D_1(Z_1, \phi_1(t)) \prod_{t=2}^{T} D(Z_t \mid Z_{t-1}, Z_{t-2}, ..., Z_1; \phi_2(t))$$

$$\overset{M}{=} D(Z_1, \phi_1(t)) \prod_{t=2}^{T} D(Z_t \mid Z_{t-1}; \phi_2(t))$$

$$\overset{M\&S}{=} D\ (Z_1, \phi_1) \prod_{t=2}^{T} D(Z_t \mid Z_{t-1}; \phi_2), \quad (Z_1, Z_2, ..., Z_T) \in \Re^{mT}$$

The first equality says that any joint distribution can be written as the product of one marginal distribution and T-1 conditional distributions. The second follows from the Markovness assumption (*M*), which let us deal with the increasing conditioning set; and the last inequality follows from Stationarity (*M&S*).

[4] The VAR(1) specification is used because it can be generalized to the VAR(p) case with relative ease.

If Normality is also imposed, then $D(Z_t \mid Z_{t-1}, \phi)$ takes the form:

$$\begin{bmatrix} Z_t \\ Z_{t-1} \end{bmatrix} \sim N\left[\begin{bmatrix} \mu \\ \mu \end{bmatrix}\begin{bmatrix} \Sigma(0) & \Sigma(1) \\ \Sigma(1)^T & \Sigma(0) \end{bmatrix}\right], t \in T$$

Which via the orthogonal decomposition $Z_t = E(Z_t \mid \sigma(Z^o_{t-1})) + u_t, t \in T$ gives rise to:

$$Z_t = \alpha_0 + A_1 Z_{t-1} + u_t, t \in T$$

Where $Z^o_{t-1} := (Z_{t-1}, Z_{t-2}, ..., Z_1)$ is the sigma field generated by Z^o_{t-1}.

The previous *reduction assumptions* imply that the VAR(1) can be seen, in the context of the *PR* approach, as the following *set of model assumptions* regarding the conditional process $\{(Z_t \mid Z^o_{t-1}), t \in T\}$:

[1] Statistical Generating Mechanism: $Z_t = \alpha_0 + A_1 Z_{t-1} + u_t, t \in T$

[2] The systematic and non-systematic components are:

$$\mu_t = E(Z_t \mid \sigma(Z^o_{t-1})) = \alpha_0 + A_1 Z_{t-1}$$

$$u_t = Z - E(Z_t \mid \sigma(Z^o_{t-1}))$$

[3] The statistical parameters of interest $\phi = (\alpha_0, A, \Omega)$ are related to the primary parameters $\psi = (\mu, \Sigma(0), \Sigma(1))$ via the following parameterization:

$$\alpha_0 = (I - A)\mu$$

$$A_1 = \Sigma(1)\Sigma(0)^{-1}$$

$$\Omega = \Sigma(0) - \Sigma(1)^T \Sigma(0)^{-1} \Sigma(0)$$

[4] All the eigenvalues of A_1 have modulus less than one.

[5] No a priori restrictions on ϕ.

[6] Rank {Zt, t ∈ T} = k

[7] (i) Normality: $D(Z_t \mid Z^o_{t-1}; \psi)$ is Normal

(ii) Linearity: $E(Z_t \mid \sigma(Z_{t-1}^o)) = \alpha_0 + A_1 Z_{t-1}$ (linear in Z_{t-1})

(iii) Homoskedasticity: $Cov(Z_t \mid \sigma(Z_{t-1}^o)) = \Omega$ (free of Z_{t-1})

[8] t-homogeneity: (α_0, A, Ω) are not functions of t ∈ T.

[9] Sampling model: $(Z_1, Z_2, \ldots, Z_T)$ is a non-random sample (i.e. – it is Markov stationary) drawn from $D(Z_t \mid Z_{t-1}^o; \psi)$ for t = 1, …, T.

This formulation of the VAR has the advantage that the model is seen as set of consistent assumptions that might be assessed in a systematic way, and changed in case of having a misspecified model.

In the next section we briefly discuss the VAR formulation in the context of the textbook approach to econometrics and in the fourth section we discuss how such traditional view might lead us specify inappropriate VAR models, from a statistical point of view, that often result in misleading conclusions and unreliable inferences.

1.3 VAR Models and the Textbook Approach to Econometrics

In the context of the traditional approach the VAR (1) model is seen as a system of dynamic equations with a stochastic error term attached (i.e. Hamilton, 1994). That is:

$$Z_t = \alpha_0 + A_1 Z_{t-1} + u_t, t \in \mathrm{T}, \qquad u_t \approx \text{NIID } (0, \Omega)$$

Where:

Z_t: a kx1 stochastic vector,

α_0: a kx1 vector of constant coefficients,

A: a kxk matrix of constant coefficients,

u_t: a kx1 stochastic vector.

Since we are dealing with a dynamic linear system its general solution takes the following form:

$$Z_t = \left[I_K + A_1 + A_1^2 + \ldots.. + A_1^j\right]\alpha_0 + A_1^{j+1} Z_{t-j-1} + \sum_{i=0}^{j} A_1^i u_{t-i}$$

If all eigenvalues of A_1 have modulus less than one the infinite sum $\sum_{i=0}^{j} A_1^i u_{t-i}$ exists in mean square and:

$$\left[I_K + A_1 + A_1^2 + \ldots.. + A_1^j\right]\alpha_0 \underset{j\to\infty}{\Longrightarrow} \left[I_K - A_i\right]^{-1}\alpha_0 := \mu$$

$$A_1^i \underset{j\to\infty}{\Longrightarrow} 0$$

Therefore, the VAR(1) model has the following VMA(∞) representation (Vector Moving Average representation):

$$Z_t = \mu + \sum_{i=0}^{\infty} A_1^i u_{t-i} := \mu + \sum_{i=0}^{\infty} \Phi_i u_{t-i}$$

This last equation constitutes the basis for the discussion on some of the typical VAR innovation accounting techniques, like impulse response and variance decomposition analysis[5].

As opposed to the PR approach, detailed in the previous section, more traditional VAR methodology focuses in estimating the model and making use of several types of inferences *without necessarily paying attention to the statistical adequacy of the model* (see Greene, 2000, Hamilton, 1994, Enders, 1995). That is, textbooks emphasizes is in describing the workings of inferences, such as Impulse Response Analysis, Variance Decomposition, Granger Causality and Cointegration Analysis, but little attention is paid to the testing of the VAR assumptions and to the negative consequences of having a misspecified VAR model.

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[5] See Enders (1995) for a comprehensive discussion on such techniques.

1.4 Illustration: Assessing the Statistical Adequacy of Two VAR Models

It is widely accepted that the optimal properties of estimators and the reliability of econometric estimates depend on the validity of the model assumptions for the data on hand. However, as mentioned, a common practice in empirical work is to use VARs to make statistical inference without testing most of their underlying assumptions.

In what follows, the PR approach is used to assess and propose alternative specifications for two empirical VARs estimated by Stock and Watson (2001) and Johansen and Juselius (1990) respectively. Note, the authors selected for our exercises are amongst the leading figures in VAR modeling; which reveals that the criticism we make are not limited to uninformed practitioners. These two exercises are carried out in order to illustrate the adverse consequences of ignoring the importance of having a *SAM* model as the basis to get reliable statistical inference.

1.4.1 Assessing Stock and Watson's model (2001)

The first empirical model to be assessed can be found in a paper by Stock and Watson (2001) on Vector Autoregressions. The paper reports a structural VAR with four lags including interest rates, inflation rates, and unemployment rates for the U.S. over the period 1960:01 – 2000:04. This work includes a detailed discussion on the economic effects resulting from the estimated model, but it does not report any misspecification tests on the VAR assumptions, which reduces the reliability of the paper's conclusions.

Stock and Watson's paper initially run through the basics of the vector autoregressions methodology in an attempt to show how the various tools associated with these models can be used. After describing and estimating a VAR (4) for the aforementioned variables the authors report and discuss some results like Granger-causality tests, impulse response graphs and forecast error variance decompositions. They conclude, among other things, that unemployment can be used to predict inflation, but that the federal funds interest rate does not help to predict inflation. These conclusions are appealing because they allow the modelers to issue conclusions on the economic implications of a given change in any of the system's variables. However, in this case, the use of the estimated VAR model to extract such conclusions is unwarranted due to the lack of misspecification testing for this model.

Table 1 shows how Stock and Watson's VAR (4) performed against a battery of individual and multivariate misspecification tests.

Table 1

Single equation misspecification tests for Stock and Watson's VAR (4) model

		Interest Rate			Inflation Rate			Unemployment Rate		
Assumption	Test type*	Test Statistic	P-value	Conclusion**	Test Statistic	P-value	Conclusion**	Test Statistic	P-value	Conclusion**
Normality	DKS	138.370	0.000	SL	35.490	0.000	SL	14.633	0.000	SL
	DAP	43.496	0.000	SL	18.125	0.000	SL	13.252	0.001	SL
Linearity	KG(2)	2.494	0.000	SL	1.250	0.173	SS	1.728	0.011	SL
	RESET(2)	1.748	0.188	SS	0.183	0.670	SS	3.134	0.046	LS
	RESET(3)	3.336	0.038	LS	0.255	0.775	SS	2.394	0.071	WS
Independence	ML(2)	3.370	0.186	SS	8.580	0.013	SL	12.120	0.002	SL
	ML(3)	3.970	0.265	SS	8.940	0.030	LS	12.700	0.005	SL
	ML(4)	9.960	0.041	LS	9.700	0.046	LS	16.000	0.003	SL
	LB (2)	0.091	0.944	SS	0.242	0.886	SS	0.514	0.774	SS
	LB (2)	0.467	0.926	SS	1.340	0.718	SS	1.340	0.720	SS
	LB (2)	1.440	0.837	SS	4.210	0.378	SS	5.450	0.244	SS
	LM(3)	1.560	0.201	SS	1.611	0.190	SS	2.110	0.102	SS
	LM(4)	1.988	0.100	SS	2.335	0.059	WS	2.385	0.054	
Homoskedasticity	ARCH (3)	1.148	0.332	SS	3.447	0.019	SL	2.870	0.025	SL
	RESET(2)	2.154	0.120	SS	5.997	0.003	SL	1.461	0.235	SS
	RESET(3)	1.827	0.145	SS	3.990	0.009	SL	1.010	0.387	SS
t-invariance	F-Test: including a linear trend	0.003	0.984	SS	1.366	0.244	SS	0.247	0.620	SS
	F-Test: including a quadratic trend	0.223	0.800	SS	7.112	0.001	SL	0.813	0.446	SS
Overall - Conditional Mean***	F-Test: including all three below	1.470	0.203	SS	1.520	0.187	SS	2.020	0.080	WS
1st order dependence	F-Test: including 3 lags of residuals	1.520	0.211	SS	1.402	0.245	SS	1.696	0.171	SS
linearity	FF-RESET(2)	2.598	0.109	SS	0.248	0.619	SS	3.689	0.057	WS
t-invariance	F-Test: including a linear trend	0.480	0.489	SS	1.901	0.170	SS	0.294	0.589	SS
Overall - Conditional Variance***	F-Test: including all three below	1.821	0.128	SS	4.313	0.001	SL	2.872	0.025	SL
2nd Order Dependence	F-Test: including 2 lags of residuals	0.866	0.423	SS	3.267	0.023	SL	3.050	0.050	WS
Homoskedasticity	HH-RESET(2)	1.874	0.173	SS	1.770	0.186	SS	0.292	0.590	SS
t-invariance	F-Test: including a linear trend	3.298	0.072	WS	4.928	0.008	SL	1.970	0.163	SS

Notes:

* **DKS**: D'Agostino Pearson Kurtosis and Skewness test, **DAP**: D'Agostino and Pearson normality test, **KG**:Kolmogorov-Gabor linearity test, **RESET**: F-type linearity test
ML: MacLeod-Li test of second order dependence, **LM**: Lagrange Multiplier test for autocorreltion, **LB**: Ljung-Box test of linear dependence,

** **SS**- Strong Support for the null, **WS**-Weak support for the null, **LS**-Lack of support for the null, **SL**-Strong lag of support for the null.

*** Conditional mean and conditional variance tests are joint tests which let us assess three asumptions at the same time and detect possible sources of misspecification.

Table 2

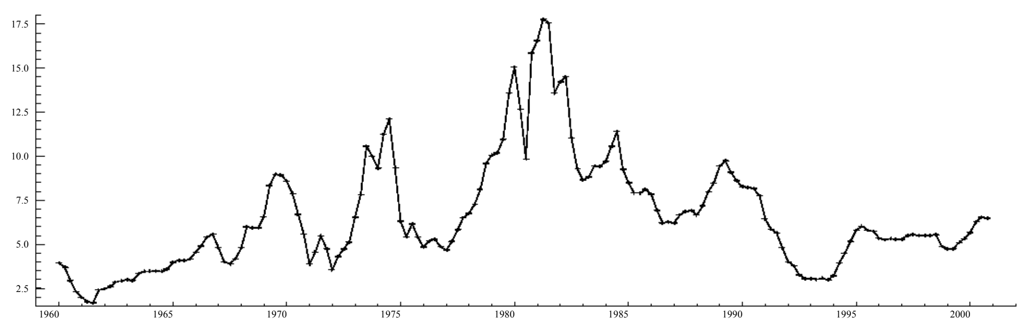
Multivariate misspecification tests for Stock and Watson's VAR (4) model

Assumption	P-value
Joint Normality	0.0000
Joint Homoskedasticity (ARCH)	0.0057
Joint Autocorrelation	0.0066

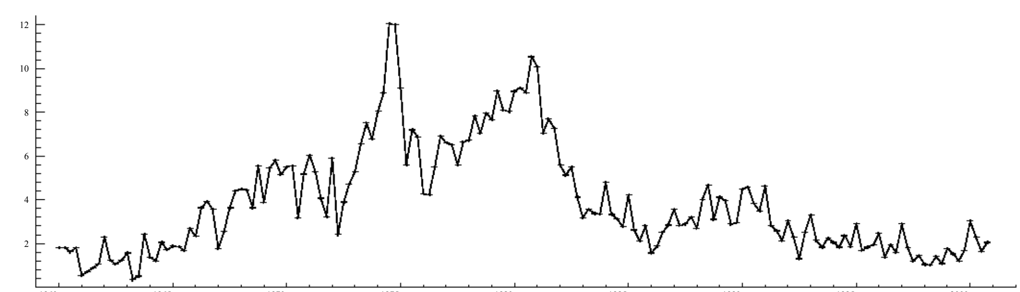
Single equation and multivariate misspecification tests show that this 3-equation VAR has significant problems with normality (strong lack of support for the null of normality) and each of the individual equations failed at least one test on the underlying assumptions of the model.

Given that this model is clearly misspecified we proceed to verify the probabilistic properties of the data in order to suggest an alternative statistically adequate model. Graph 1 shows the t-plots of the three variables used for the VAR model: Interest Rate, Inflation Rate, and Unemployment Rate.

Graph 1
Interest Rate



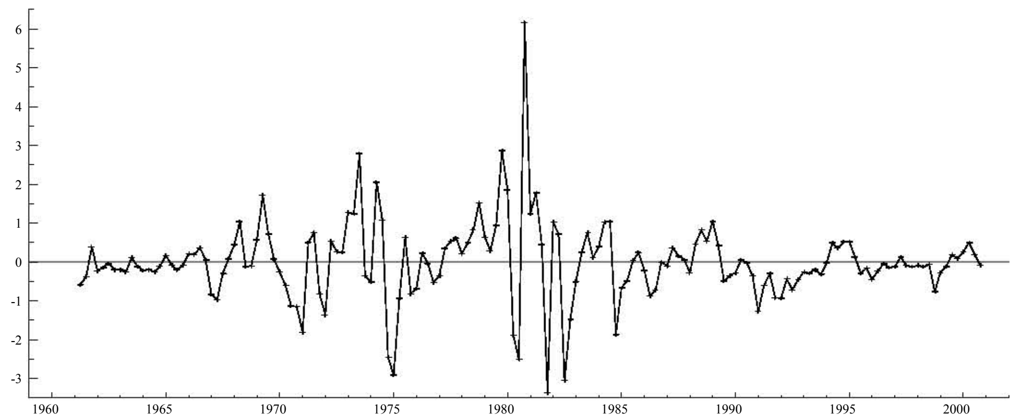
Inflation Rate



Unemployment Rate

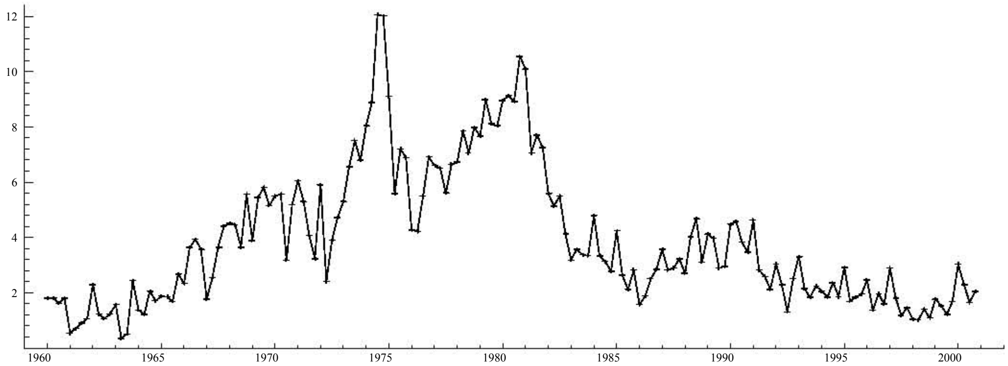
Dememorizing[6] the data results in the t-plots in graph 2.

Graph 2
Dememorized Interest Rate

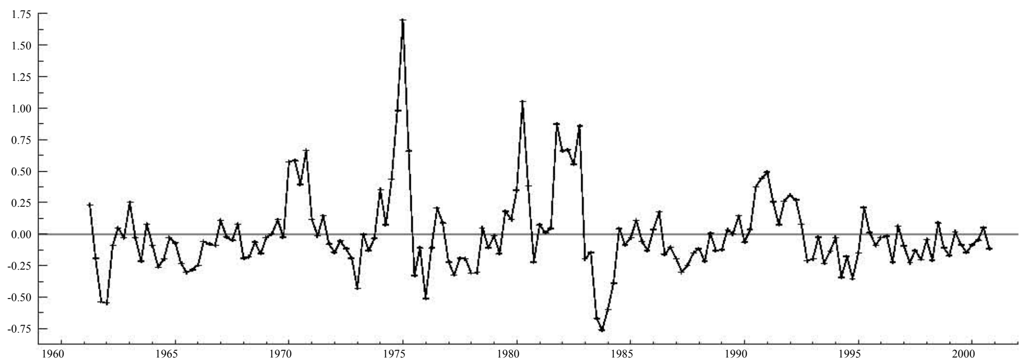


[6] In order to asses the distributive features of the data and the possible association among the variables it is convenient to use de-trended and de-memorized data. In this case, since there are no clear deterministic trends in the data we take out any dependence information present in the data by using an AR (1).

Dememorized Inflation Rate

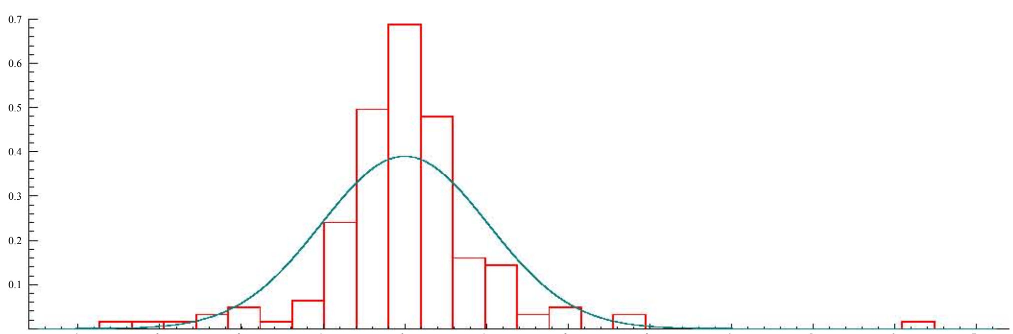


Dememorized Unemployment Rate

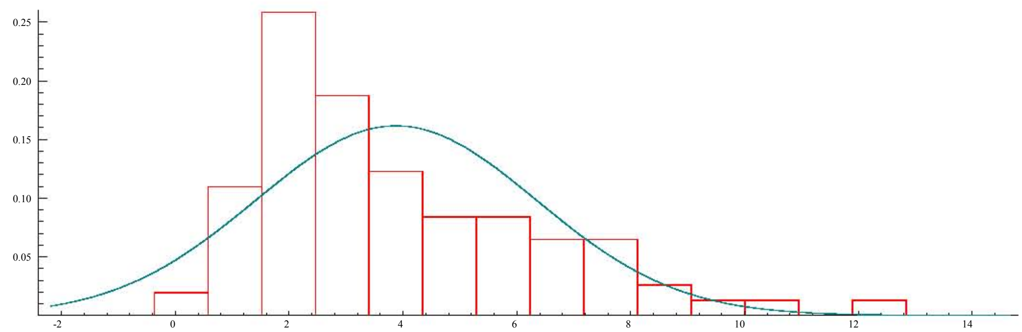


The histograms for the dememorized series are shown below.

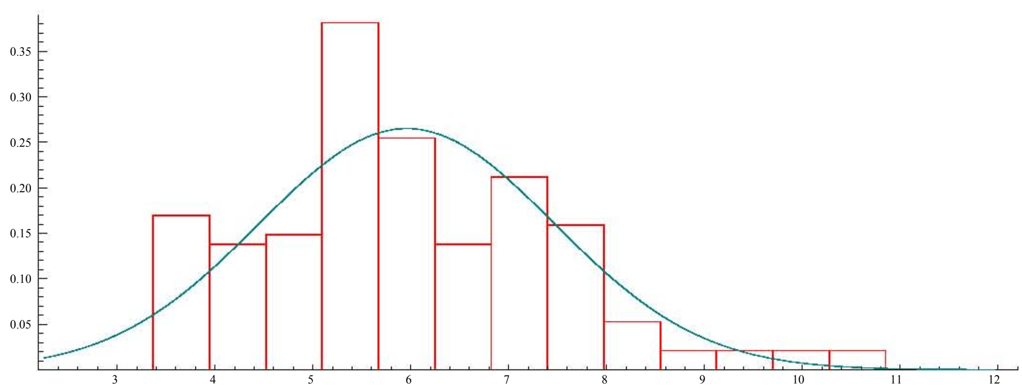
Graph 3
Histogram Interest Rate



Histogram Inflation Rate



Histogram Unemployment Rate



From the previous graphical analysis we can conclude that normality does not seem to be an appropriate assumption for Stock and Watson's data, as is clearly shown by the histograms of the dememorized data and the results of the single equation misspecification tests in table 1. The failure of the multivariate Normality test also suggests that the assumption that this VAR is multivariate normal is not correct. The high degree of leptokurtosis seen in the histograms suggests that a Student's t distribution might be a more appropriate assumption for this VAR. Even more, following the PR approach we could propose the following reduction assumptions for modeling this data:

(D) – Student's t

(M) – Markovness (of order p)

(H) – Stationarity

Unfortunately, the state of modeling for a Student's t distributed VAR is somewhat underdeveloped, and we are unable to take our specification any further[7].

However, we have shown that Stock and Watson's VAR model is misspecified and that the economic conclusions discussed in the paper are unreliable from a statistical point of view. In plain words, their conclusions, that unemployment can be used to predict inflation, but that the federal funds interest rate does not help to predict inflation, are in fact not supported by their empirical model.

1.4.2 Assessing Juselius and Johansen's model (1990)

Juselius and Johansen's paper main aim is to illustrate the workings of the cointegration test procedure, developed by Johansen, and some of the associated inference tools. In order to do so, they estimate two long-run relationships representing the money demand for Denmark and Finland. The procedure requires estimating a VAR (P) to perform the tests and get the cointegrating vectors (Johansen, 1988).

In this section we assess the statistical adequacy of the VAR (2), for Denmark, used by the authors to perform some of their tests. We conclude that the estimated VAR should not have been used for inference purposes, such as cointegration testing, since the model is clearly misspecified. Besides, in order to show that statistical inference based on misspecified models can lead to misleading conclusions we respecify the model, using the same data, and compare the results on cointegration and impulse

[7] There are some advances in time series modeling using the student's t distribution such as the *STAR* model proposed by Spanos (1990).

response analysis drawn from the original model and those derived from our respecified model. We find that the results shown by the authors are inaccurate since we get different results based on an improved VAR (2) model. This exercise is relevant because, besides showing that one of the common failures of practitioners and researchers is to ignore the testing of the underlying assumptions of each model, is puts forward a way to construct a well specified model from a previous one lacking this property.

This section is structured as follows. First, we discuss the modeling-related aspects of the Juselius and Johansen´s paper. Second, we re-estimate their model for Denmark and test it for misspecification. Finally, we propose an alternative specification of the model and compare the results derived from both models in order to show the adverse consequences of working with a misspecified model.

1.4.2.1 Discussion of modeling aspects of the Juselius and Johansen's Paper

In order to perform the cointegration tests the authors specify VARs with two lags for the monetary sector of Denmark and Finland[8]. The number of lags chosen was decided by selecting a VAR model which were statistically adequate from an statistical point of view, that is a model which survives a battery of misspecification tests. The models are estimated using quarterly data for the money demand, the interest rate and the real income. The traditional VAR model specification, referred to in the paper, can be stated as follows:

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[8] The authors did not mention the criteria followed to choose the number of lags in those VAR models. The Akaike criterion is often used to decide the number of lags. However, in the context of the *PR* approach we choose the number of lags based on statistical adequacy grounds. The double log—linear functional form is often chosen since the estimates can be interpreted as elasticities and such transformation stabilizes the variance of the series.

$$X_t = \Pi_1 X_{T-1} + ,...,+ \Pi_K X_{T-K} + \mu + \Phi D_T + \varepsilon$$

with $\varepsilon^T \approx IIN(0, \Lambda)$

Where D^T are centered seasonal dummies, ε is a vector of normal, independent and identically distributed disturbances[9]. Given the non-stationary data the authors suggest estimating the alternative model:

$$\Delta X_t = \Gamma_1 \Delta X_{T-1} + ,...,+ \Gamma_{K-1} \Delta X_{T-K-1} + \Pi X_{T-K} + \mu + \Phi D_T + \varepsilon$$

The next step is to test for the rank of the matrix Π, which must indicate the existence of cointegrating vectors and the number of such relationships[10]. In order to perform those procedures the authors start by stating a theoretical relationship, suggested by the economic theory, regarding money demand[11]

$$M^d = f(y,p,c).$$

Where (M^d) corresponds to the demand for money, (y) is the real income, (p) is the price level and (c) is the cost of holding money.

Based on this theory, they select the data that could be useful to represent those variables, for example they choose (m2) for the money demand in the case of Denmark but they choose (m1) in the case of Finland[12]. Finally, they estimate two VARs for the Danish and the Finnish monetary sectors using OLS. It is interesting to note that the

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[9] It must be pointed out that in this traditional specification, discussed in the third section, the VAR model is seen as dynamic system with a vector of disturbances attached; as opposed to the *PR* approach where the variables included in the VAR model are all considered random variables.

[10] In this paper we are not interested in discussing the M.L.E. estimation procedures or the asymptotic results shown in Johansen´s paper, since we concentrate on the appropriateness of the VARs used to illustrate the cointegration procedure.

[11] The theoretical explanation for the money demand function can be found in Laidler (1985) or any other macroeconomics textbook.

[12] The reason provided by the authors on the different choices of series (m1 and m2) to represent money demand is that with those variables they could find cointegration relations. This argument is not strong since the choice of variables looking for a significant relation is considered an unwarranted "data mining activity" Spanos(2000). A classical discussion on data mining can be found in Hoover and Perez(2000).

specification of the models is scarcely discussed in the paper and, so is the misspecification tests used to verify the validity of the model.

Regarding those aspects there are only two paragraphs:

" model (3.1) including a constant term and seasonal dummies is fitted to the Danish and Finish money demand data described in section 3.1. For k=2 the residuals for the Danish data passed the test for being uncorrelated. For the Finish data, the statistic test for the residuals in the equation for Δy is almost significant. The autocorrelation suggest that there is some seasonality left in the residuals, but since the seasonal autocorrelation is rather small we have chosen to ignore this. Accordingly, model (3.1) with K=2 was fitted to both data sets…"

"…Since the parameter estimates of the VAR are not of particular interest in this paper, they are not reported……..The normality assumption is tested by the Jarque and Bera test… and reported below[13]. For the Finnish data, the residuals from the Δm and Δp equations do not pass the test.

The deviations from normality are mainly due to too many large residuals. They are however, approximately symmetrically distributed around zero, which "probably" is less serious than a skewed distribution. The robustness of the ML cointegration procedure for deviations from normality has not been investigated so far…"

We can find a lot of problems in the previous arguments provided by Johansen and Juselius to justify the choice of their VAR (2) model. Firstly, we notice that they implicitly recognize that they want to fit a curve to the data; which implies that they see an econometric model as a theoretical model with an error term attached. This way of seeing a statistical model often leads to misspecified models which are not reliable for

[13] Juselius and Johansen did not skip to test the normality assumption since they are interested in hypothesis testing. However most of the applied papers estimating VAR's ignore the normality assumption. In the context of the VAR (P) model the normality assumption is implied by the two way linearity and homoskedasticity assumptions (Spanos, 1995a).

statistical inference, since they ignore the probabilistic structure of the data on hand[14] and, as a result, the odds of reaching an inadequate model are very high.

Secondly, the authors assume that two is the appropriate number of lags for both models, without any reference to some statistical criteria or dependence assumption underlying the VAR (P) model (i.e. Markov dependence).

Thirdly, it is assumed that the error term has the following probabilistic features:

$$\varepsilon_T \approx \mathrm{I\,I\,N}\,(0, \Lambda)$$

The latter assumption implies to carry out single and multivariate tests for the following assumptions: normality, no autocorrelation, homoskedasticity and parameter constancy. However, the authors completely overlook the multivariate testing of such assumptions and concentrate almost exclusively in the discussion of only two assumptions: autocorrelation and normality for each single equation of the VAR.

On the other hand, Juselius and Johansen find evidence of autocorrelation in one of the equations (the equation for the difference of the real income Δy). However, they ignore this result arguing that the null hypothesis of no autocorrelation is “almost significant”, and that *the autocorrelation left on the residuals* is very small.

All the previous problems and arguments reveal that the statistical adequacy of the model is not considered as a relevant issue for the authors; similarly than for many econometricians who follow the traditional approach to econometrics. In this particular case, the authors prefer to ignore the autocorrelation problem although they are aware of the severe consequences for the usual significance tests and the efficiency of the estimators.

The authors also realized that the normality assumption was rejected in some of the equations for the Finnish model. Nevertheless they ignore the problem, again,

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[14] A broad discussion in this respect can be found in Spanos (1995b).

arguing that the non-normality of the equations is “probably” non-serious since the distributions are not so skewed and that the problem is due to “many large residuals”. In contrast, in the context of the PR approach, non-normality is explained by finding the possible sources of departures from normality such as the possible existence of outlying values in the series.

In short, the authors ignore the assumptions of the model and quickly jump to show the workings of the cointegration test. However, their results might be wrong since the single equations seem to be misspecified.

1.4.2.2 Misspecification Testing of the Model used by Juselius and Johansen

In this section, we briefly discuss the statistical adequacy of the model used by Johansen and Juselius to test for cointegration in their paper. Firstly, we re-estimate their VAR (2) model for Denmark and test it for misspecification. The battery of tests includes the following model assumptions[15]: Normality, Heteroskedasticity, Linearity, Autocorrelation, and parameter t-invariance. The results and p-values are reported in table 3 below.

[15] The tests for the individual equations were performed using F type tests based on the appropriate auxiliary regressions.

Table 3

Single Equation Misspecification Tests for Juselius and Johansen's VAR (2) Model

	Money demand			Real income			Interest on bonds			Interest on	
Test type*	**Test Statistic**	**P-value**	**Conclusion****	**Test Statistic**	**P-value**	**Conclusion****	**Test Statistic**	**P-value**	**Conclusion**	**Test Statistic**	**P-value**
DKS	2.814	0.245	SS	13.920	0.001	SL	0.253	0.881	SS	22.593	0.000
DAP	3.849	0.146	SS	12.227	0.002	SL	0.847	0.655	SS	9.645	0.008
KG(2)	2.600	0.980	SS	0.054	0.870	SS	0.020	0.960	SS	0.035	0.860
RESET(2)	3.710	0.060	WS	0.291	0.593	SS	0.944	0.337	SS	0.030	0.861
RESET(3)	1.860	0.169	SS	0.386	0.682	SS	0.460	0.634	SS	0.558	0.577
ML(2)	0.848	0.654	SS	0.626	0.731	SS	0.671	0.715	SS	1.27	0.529
ML(3)	1.86	0.601	SS	0.627	0.898	SS	1.09	0.778	SS	1.95	0.583
ML(4)	2.47	0.65	SS	1.06	0.901	SS	1.47	0.831	SS	1.99	0.738
LB (2)	0.328	0.849	SS	0.245	0.885	SS	0.964	0.617	SS	0.05	0.974
LB (2)	1.46	0.691	SS	2.98	0.394	SS	1.56	0.669	SS	0.721	0.868
LB (2)	2.58	0.631	SS	3.56	0.469	SS	3.62	0.459	SS	1.86	0.762
LM(2)	0.120	0.880	SS	0.101	0.904	SS	0.256	0.856	SS	0.015	0.985
ARCH (3)	0.366	0.778	SS	0.166	0.918	SS	0.7201	0.547	SS	0.347	0.791
RESET(1)	0.152	0.7	SS	0.4416	0.510	SS	0.499	0.484	SS	1.14	0.328
RESET(2)	0.170	0.844	SS	0.234	0.796	SS	1.375	0.265	SS	0.989	0.408
F-Test: including a linear trend	2.12	0.153	SS	0.032	0.859	SS	2.0122	0.164	SS	6.57	0.0142
F-Test: including a quadratic trend	3.6	0.0367	WS	0.033	0.967	SS	3.169	0.053	WS	4.628	0.0157
F-Test: including all three below	2.03	0.0908	SS	0.446	0.865	SS	1.64	0.163	SS	4.012	0.002
F-Test: including 4 lags of residuals	0.739	0.572	SS	0.693	0.603	SS	1.831	0.149	SS	4.6593	0.005
FF-RESET(2)	8.62	0.006	SL	0.252	0.778	SS	2.813	0.0759	SS	4.206	0.025
F-Test: including a linear trend	7.39	0.01	SS	0.102	0.778	SS	3.28	0.080	SS	19.435	0.000
F-Test: including all three below	0.498	0.737	SS	0.236	0.902	SS	1.156	0.353	SS	0.532	0.779
F-Test: including 2 lags of residuals squared	0.447	0.643	SS	0.325	0.725	SS	0.859	0.472	SS	0.486	0.692
HH-RESET(2)	1.110	0.299	SS	0.206	0.652	SS	2.663	0.113	SS	0.248	0.622
F-Test: including a linear trend	1.340	0.255	SS	0.000	0.990	SS	0.343	0.562	SS	0.696	0.410

urtosis and Skewness test, **DAP**: D'Agostino and Pearson normality test, **KG**:Kolmogorov-Gabor linearity test, **RESET**: F-type linearity test
nd order dependence, **LM**: Lagrange Multiplier test for autocorreltion, **LB**: Ljung-Box test of linear dependence,
ull, **WS**-Weak support for the null, **LS**-Lack of support for the null, **SL**-Strong lag of support for the null.
ional variance tests are joint tests which let us assess three asumptions at the same time and detect possible sources of misspecification.

Table 4

Multivariate Misspecification Tests for Juselius and Johansen's VAR (2) Model

Assumption	P-value
Joint Normality	0.0005
Joint Homoskedasticity (ARCH)	0.5621
Joint Autocorrelation	0.0625

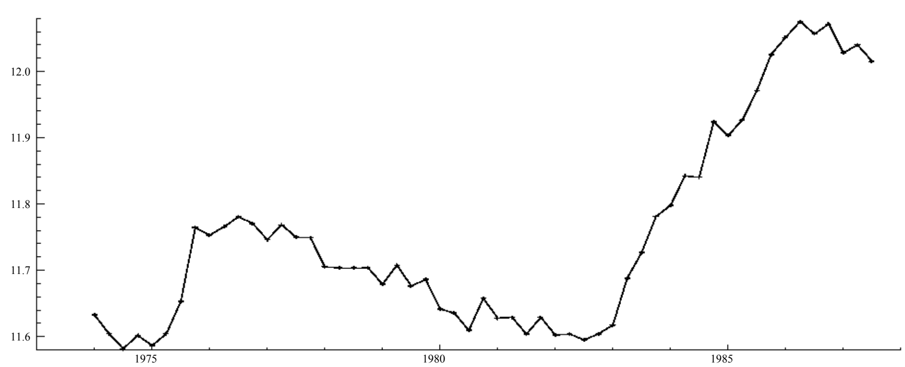
The joint normality test and some of the single equation tests show that the model used in the paper is clearly misspecified and it is not a good basis to perform any type of statistical inference.

1.4.2.3 Respecified VAR (2) under the Probabilistic Reduction Approach to Econometrics

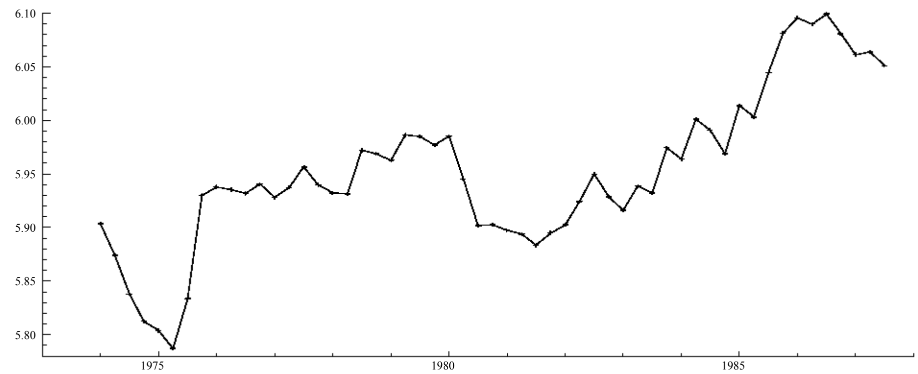
In this section, we respecify Juselius and Johansen's VAR (2) model using the PR approach to econometrics. The first step is to assess the possible reduction assumptions for the data on the monetary sector of the Danish economy. In order to do so, we plot the data for money demand, real income, the interest rate on bonds and the interest rate on deposits from 1974-01 to 1987-03.

Graph 4

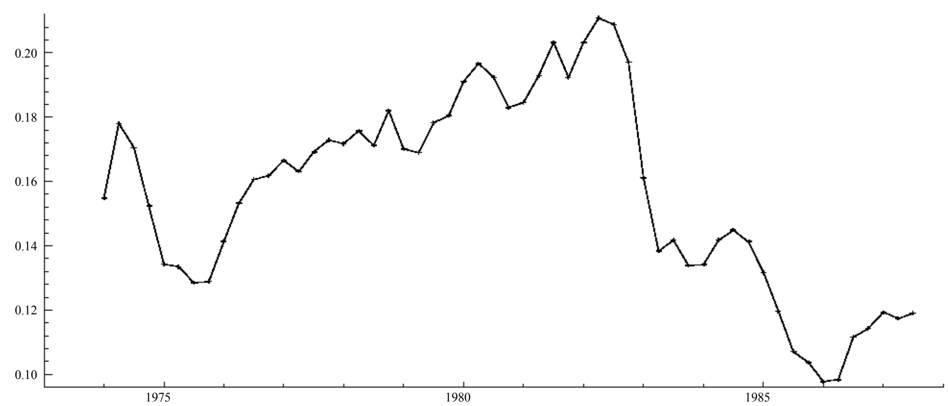
Money Demand (M2)



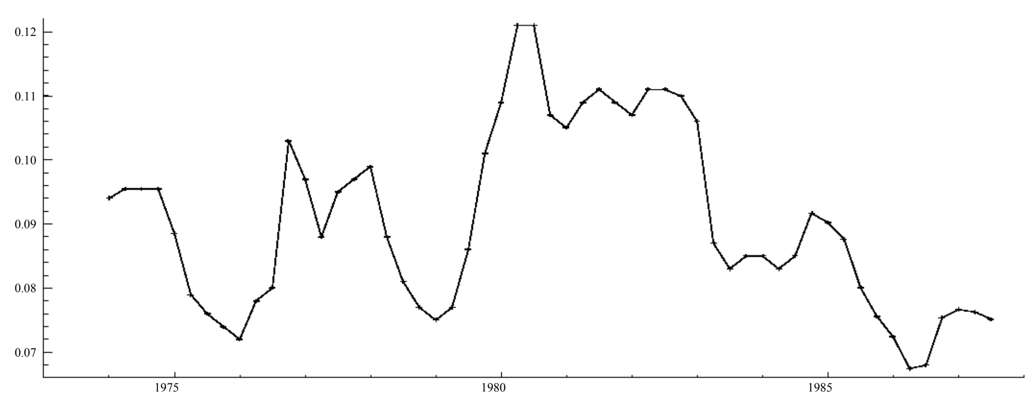
Real Income



Interest on Bonds



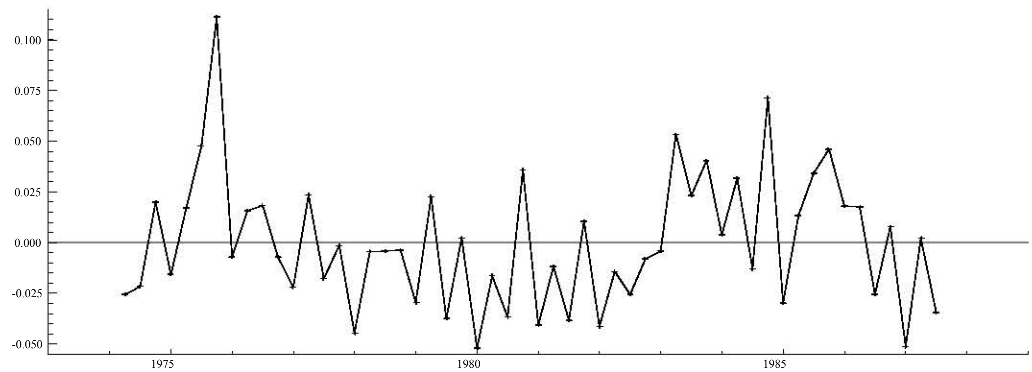
Interest on Deposits



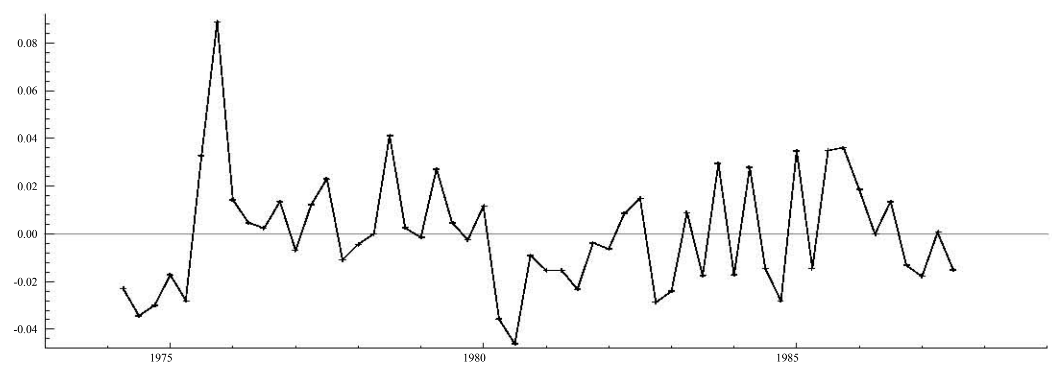
These graphs reveal that the data exhibits trend heterogeneity patterns and some abrupt changes. Besides, in order to detect distributive patterns in the data we can also graph the detrended and dememorized data graphs.

Graph 5

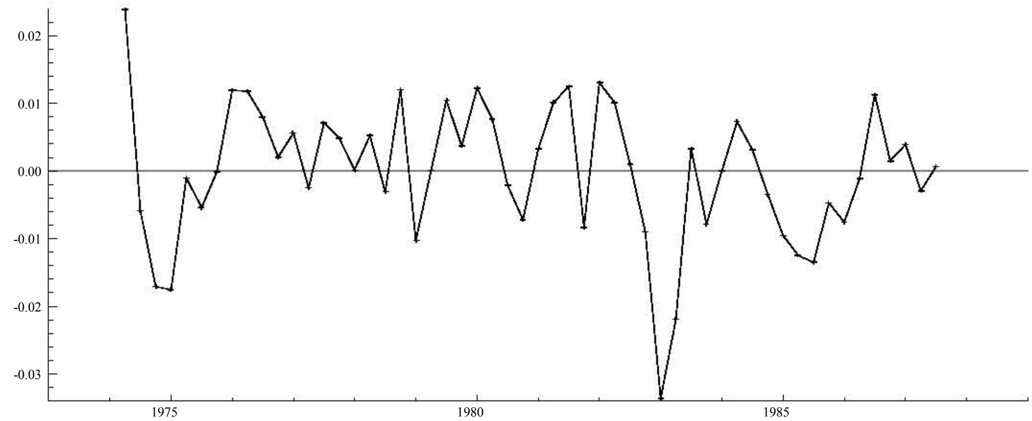
Dememorized and Detrended Money Demand (M2)



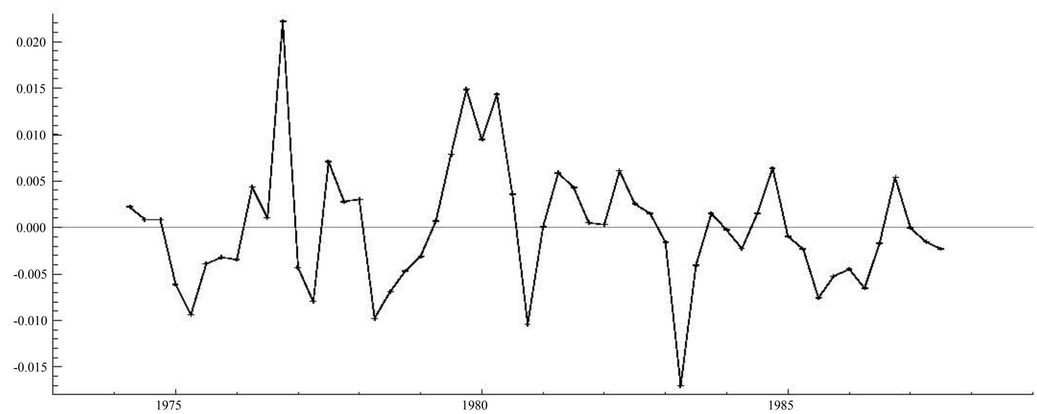
Dememorized and Detrended Real Income



Dememorized Interest Rate on Bonds



Dememorized Interest Rate on Deposits



From the graphs is possible to detect the presence of cycles, which indicate that Markov dependence is a good assumption for this data. Besides, we can say that the assumption of normality for the VAR model is a good one, since the apparent non-normality of the money demand and the interest rate on bonds, in this case, can be explained by the presence of some outliers.

Therefore, we can postulate a VAR (P) model with the following assumptions:

(D) Distribution Normal

(M) Memory Markov Dependence

(H) Heterogeneity Covariance Stationary, Trend and Seasonal effects.

From those assumptions we, then, proceed to estimate a VAR (2) model from 1974 (3) to 1987 (3) using OLS. This model included two lags of the same variables that Johansen and Juselius used: Money demand, Real Income, Interest rate on bonds, the interest rate on deposits and two dummy variables[16]. The first is trying to capture the trend of the process starting at 1982:2. The other dummy variable is capturing the effect of an outlier, this variable takes the value of one at 1984:4 and zero otherwise. Finally, our model included some seasonal dummies as suggested by the authors.

When we test the assumptions to this model we clearly see that our proposed specification is statistically adequate. However, a test on the general significance of the interest rate on deposits IDE showed that this variable is not relevant in the whole VAR. Therefore, we estimate a VAR (2) model which included only the interest rate on bonds as a measure of the cost of holding money.

Thus we proceed to estimate a second VAR model using only two lags of three variables: money demand, real income, interest rate on bonds and the aforementioned dummies.

[16] Suitable critical values based on the asymptotic null distributions can be found in Saikkonen and Lütkepohl (1996; 1999; 2000). The same papers include a discussion about the appropriate critical values for different VAR and VECM specifications. Software like Rats and Disco include asymptotic critical values for VAR models with shift and impulse dummies in the deterministic part of the models.

Table 5

Single equation misspecification tests for the respecified Juselius and Johansen's

VAR (2) Model

		Money demand			Real income			Interest rate on bonds		
Assumption	**Test type***	**Test Statistic**	**P-value**	**Conclusion****	**Test Statistic**	**P-value**	**Conclusion****	**Test Statistic**	**P-value**	**Conclusion****
Normality	DKS	2.947	0.229	SS	3.03	0.219	SS	0.572	0.751	SS
	DAP	3.760	0.152	SS	3.508	0.173	SS	1.225	0.542	SS
Linearity	KG(2)	0.981	0.52	SS	0.350	0.954	SS	0.642	0.854	SS
	RESET(3)	1.683	0.199	SS	0.105	0.9	SS	0.385	0.613	SS
Independence	ML(2)	1.81	0.404	SS	0.228	0.892	SS	1.36	0.506	SS
	ML(3)	2.49	0.476	SS	0.291	0.962	SS	1.76	0.623	SS
	ML(4)	2.57	0.632	SS	2.2	0.699	SS	1.85	0.763	SS
	LB (2)	0.679	0.712	SS	0.713	0.700	SS	0.491	0.782	SS
	LB (3)	4.14	0.246	SS	1.13	0.771	SS	0.5	0.921	SS
	LB (4)	4.31	0.365	SS	1.41	0.843	SS	2.29	0.683	SS
	LM(1)	0.327	0.723	SS	0.26	0.772	SS	0.21	0.811	SS
	LM(2)	1.18	0.331	SS	0.233	0.872	SS	0.154	0.926	SS
Homoskedasticity	ARCH (order 2)	0.505	0.682	SS	0.080	0.922	SS	1.789	0.182	SS
	ARCH (order 3)	0.382	0.82	SS	0.083	0.97	SS	1.251	0.322	SS
	RESET(1)	0.199	0.659	SS	0.054	0.996	SS	0.552	0.58	SS
	RESET(2)	0.197	0.822	SS	0.102	0.904	SS	0.685	0.568	SS
t-invariance										
	F-Test: including a quadratic trend	2.042	0.161	SS	0.010	0.920	SS	2.59	0.115	SS
Overall - Conditional Mean***	F-Test: including all three below	2.0098	0.115	SS	1.115	0.365	SS	0.7862	0.542	SS
1st order dependence	F-Test: including 3 lags of residuals	3.9	0.029	LS	2.15	0.13	SS	1.5737	0.221	SS
linearity	FF-RESET(2)	0.234	0.872	SS	1.104	0.36	SS	1.0507	0.382	SS
t-invariance	F-Test: including a linear trend	1.045	0.384	SS	0.169	0.895	SS	0.445	0.722	SS
Overall - Conditional Variance***	F-Test: including all three below	0.906	0.485	SS	0.106	0.991	SS	1.217	0.317	SS
2nd Order Dependence	F-Test: including 2 lags of residuals	0.690	0.563	SS	0.080	0.968	SS	0.447	0.721	SS
Homoskedasticity	HH-RESET(2)	1.480	0.232	SS	0.072	0.974	SS	1.636	0.721	SS
t-invariance	F-Test: including a linear trend	0.548	0.701	SS	0.128	0.971	SS	1.464	0.228	SS

Notes:

* **DKS**: D'Agostino Pearson Kurtosis and Skewness test, **DAP**: D'Agostino and Pearson normality test, **KG**:Kolmogorov-Gabor linearity test, **RESET**: F-type linearity test
ML: MacLeod-Li test of second order dependence, **LM**: Lagrange Multiplier test for autocorreltion, **LB**: Ljung-Box test of linear dependence,

** **SS**- Strong Support for the null, **WS**-Weak support for the null, **LS**-Lack of support for the null, **SL**-Strong lag of support for the null.

*** Conditional mean and conditional variance tests are joint tests which let us assess three asumptions at the same time and detect possible sources of misspecification.

Table 6

Multivariate misspecification tests for the respecified Juselius and Johansen's

VAR (2) Model

Assumption	P-value
Joint Normality	0.5331
Joint Homoskedasticity (ARCH)	0.8621
Joint Autocorrelation	0.1046

As we can see, the proposed model was successfully assessed by using a large battery of misspecification tests, including multivariate tests. Therefore, this model can be used to perform statistical inference and get reliable results.

1.4.2.4 Comparing statistical inference from the SAM model and Juselius and Johansen's VAR Model

Since we have a statistically adequate model we can perform some of the common results based on a VAR model and compare them against the results performed by Juselius and Johansen in their paper. For comparison purposes we only perform cointegration and impulse response analysis.

i) Cointegration Tests.

In order to test for cointegration we use the procedure suggested by Johansen (1988). Below, we report the cointegration results obtained using our SAM model.

Table 7

Johansen cointegration test using the statistically adequate model

Ho	Trace	95%	99%
r=0	34.28838	34.91	41.07
r ≤1	4.618294	9.24	12.97

Note:r=number of cointegrating vectors.The estimated VAR included 2 lags and two dummy variables from 1974-03 to 1987-03

The trace statistic shows that no cointegration vector exists among the variables used in our SAM model. This inference is opposed to Juselius and Johansen´s results, who found evidence of cointegration and reported the following cointegrating vector:

m2 = 1.0329***y**-5.2069* **ibo**+4.2158***ide**+6.06

Where m2 is the money demand, y is the real income and ibo and ide represent the interest rate on bonds and deposits respectively.

Given that Juselius and Johansen find a cointegration relationship based on a misspecified model their conclusion is not reliable. Even more, although the authors justify their results based on the “statistical significance” of the coefficients, we must remember that in the presence of misspecification the t-ratios can be very misleading. A better criterion to judge the model’s performance is given by the statistical adequacy of the model. Anyway, it is simply unwarranted to conclude, as they do, that a long-run equilibrium relationship exists between money demand, real income and the interest rate on bonds and deposits

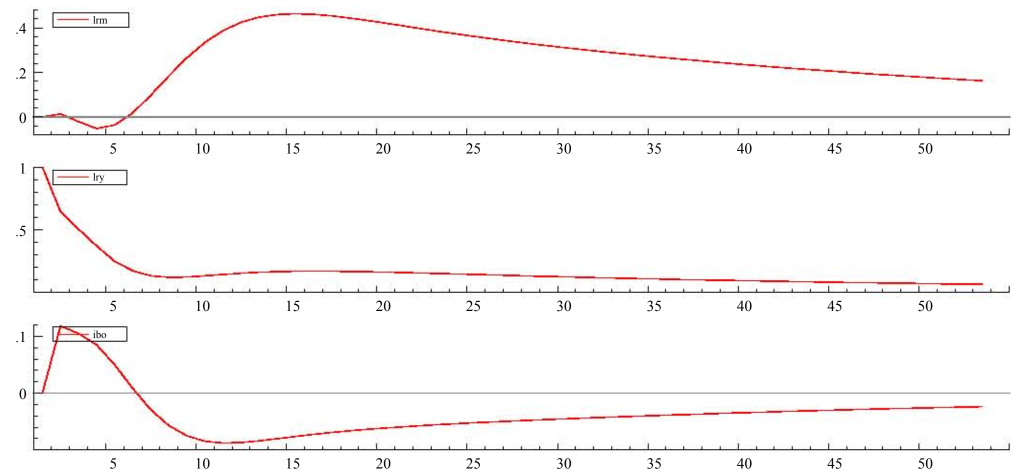
In conclusion, this comparison between the two models can teach us how different the results obtained from a statistically adequate model and a misspecified model can be. Besides, since the original model is misspecified, statistical inference is not reliable and any other the criteria to justify the adequacy of the results are not appropriate on statistical grounds. Finally, as a result, the selection of a Vector Error Correction Model for the demand for money might be wrong.

ii) Impulse Response Functions

As a second example of the different inferences derived from those two VAR models we can get the impulse response graphs for some of the variables.

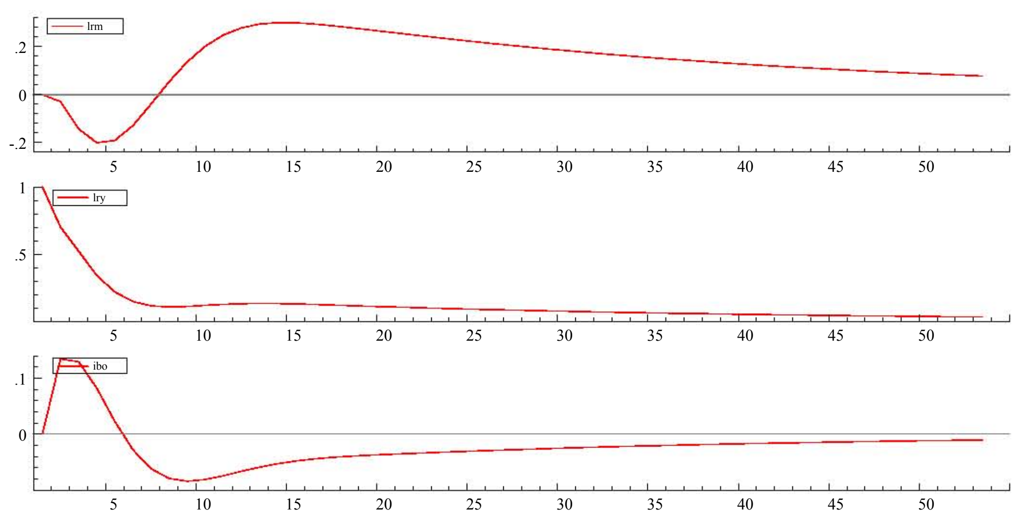
Graph 6

Impulse Response Function from Juselius and Johansen's model



Graph 7

Impulse Response Function from Respecified Model



These graphs reveal that the inferences regarding to shocks to the innovations are different in both models. For example, we apply a shock to the innovations of the real income equation and we find that the convergence in the number of periods and the impact of the shock differ in both models[17].

1.5 Conclusions

The applied work using Vector Auto Regressions is often based on inadequate models from a statistical point of view. This fact affects the reliability of all inference procedures that are performed with a VAR model: forecast, Granger causality testing, cointegration analysis, impulse response analysis and variance decomposition.

This problem can be attributed to the traditional approach to econometrics which has taught econometricians to see the models as theoretical relationships with an error term attached and ignores the probabilistic features of the data (of the underlying stochastic process). The final result is that most of the empirical work using VARs ends up with a statistically inadequate models (misspecified) and unreliable conclusions from a statistical point of view.

In this chapter we illustrated the aforementioned problems by testing and respecifying two empirical VAR (P) models. We found that not only both models were badly misspecified but also that inferences such as cointegration analysis and impulse response analysis are very sensitive to the statistical adequacy of the model used.

[17] We must be careful about impulse response graphs since they are very sensitive to the order of the variables in the VAR.

2. Wage Setting Process in the Manufacturing and Maquila Industries in Mexico 1990-2002

2.1 Introduction

In this section we offer reliable empirical evidence on the wage setting process in the maquila and manufacturing industries by making use of the econometric methodology, discussed in the previous chapter (Spanos, 1986), to specify a SVAR model. Specifically, the main objective of this chapter will be to study the determinants of manufacturing money wages in Mexico during the last two decades. We study the factors that shape money wages in the manufacturing sector and the maquila (in-bond) industry in the long run. We will analyse and contrast the behavior of money wages in such sectors because it is money and not real wages that workers bargain for.

We are conscious that by narrowing the focus of our research we will not be able to answer some important questions, especially on the feedback between money wages in manufacturing and in maquilas with the overall economic situation. However, we believe the points we will explore are relevant, especially because studies that use econometric methods to analyze these issues in Mexico are almost non-existent. The main questions we would like to consider are the following:

(1) Are there regularities in the workings of the labor market which would allow the use of econometric models to explain the determinants of wages?

(2) Are wages in the two industries functionally related?

(3) Are wages in the two industries explained by a similar or radically different set of economic determinants in a similar specification of an econometric model?

To study such questions we make use of two structural VAR (SVAR) systems and we find that such econometric models allow us give a positive answer to each of those questions. In addition, we have found that some ideas put forward by Keynes in The General Theory can be useful – though not without important qualifications -- to explain the wage setting process in a developing economy as Mexico.

2.2 The Labour Market: Institutional and Economic Background

To understand Mexico's current economic evolution, it is important to give some information on the institutional arrangement of the labour market. According to a recent comparative study (Marshall, 1999) the country's wage regime is in an intermediate position in comparison with other Latin American countries[1]. Mexico has a permissive right to strike and permanent tripartite bodies. In addition, wage setting is free of government control. More specific details are as follows.

Labour unionization in Mexico is low, and has been declining during the last two decades (Fairris and Levine, 2004). In the industrial sector the rate of unionization with respect to the Economically Active Population was 13.9 in 1992 and 9.8 in 2000. At the same time, the rate of unionization with respect to employment in firms where unions are legally allowed fell from 22 per cent to 15 per cent in such period. The widespread absence of codified rules that belong to important aspects of the labor process is another relevant characteristic of the labour movement. In 1999 changes in labor organization were codified in only 3.7 percent of manufacturing firms, while the percentages for temporary turnover of personnel and introduction of new technologies

[1] The other countries considered were Argentina, Brazil, Chile, Colombia, Peru, Uruguay and Venezuela.

were 4.2 per cent and 3 per cent respectively (figures taken from Herrera and Melgoza, 2003).

On the other hand, wage bargaining has been historically decentralized in Mexico, meaning that workers traditionally negotiate at the plant or the firm level. This suggests that we can expect the evolution of wages to vary between different sectors (Bendesky, Godínez and Salas, 2004). Nevertheless, there are common underlying forces that shape wage's behavior, resulting from the overall economic situation, and also from institutional determinants. The most important of these institutional determinants is most likely the labor legislation, which is the same for all industries and workers. Another common determinant arises from negotiations that take place each year between representatives from the largest trade union and representatives from entrepreneurs unions and the government. These negotiations have been found to bear certain weight on the settling of the average wage (López 1999).

Wage bargaining was unconstrained until 1987 when the government implemented the so-called "Pacts" (*Pactos*): tri-partite agreements between representatives of workers, entrepreneurs, and the government which were established to bring inflationary pressures under control[2]. According to the Pacts, workers had to limit wage demands and firms were obliged to put a cap on their profit margins, while the government agreed to restrain its expenditure. Under different names, the Pacts ruled until 1994 but failed to outlast the crisis that erupted at the end of that year.

Segmentation is another significant feature of the Mexican labor market. Especially important to our argument is the existence of a sector which, up until recently, was economically and geographically separated from the rest of the economy: the maquila or in-bond industry (see Buitelaar and Padilla, 2000, and Bendesky, et al

[2] Inflation was extremely high after 1982, having reached its peak in 1987 with an annual average rate of over 150 percent.

(2004), for details and analysis). The history of this industry started with the 1965 maquila program in Mexico, after the US ended a previous bilateral agreement which allowed Mexican workers temporary access to the US labour market. Thus the Border Industrialization Program (*Programa de Industrialización Fronteriza*) was created, with the main objectives of creating jobs and attracting foreign direct investments to set up assembly operations for exports in the border zone. The program liberalized both trade and capital flows. Maquila firms (*Maquiladoras*) could be 100 per cent foreign owned at a time when foreign firms outside the program were restricted to less than 50 per cent foreign ownership. They could also import input duty-free and did not face non-tariff barriers, under the condition that their output be entirely exported. *Maquiladoras* importing input from the US and re-exporting to the US could also benefit from Tariff Item 807.00, which permits imports of goods assembled in foreign countries containing components manufactured in the US[3]. The area where maquila firms could be operated was further extended in 1971-72 to cover the whole territory with the sole exception of industrialized areas. At present they can be located practically anywhere in Mexico[4].

It is also useful to provide the reader with an overview on the labour market. Graph 1A depicts manufacturing and minimum real wages behavior between 1976 and 2001, and Graph 1B depicts the same series for the maquila industry. In Graph 2 the evolution of employment in the second sector is displayed. Finally, Graph 3 compares the real wage index (1990.1=100) in the two sectors[5]. It is important to note that in this section we refer to real rather than money wages, as real wages are more informative

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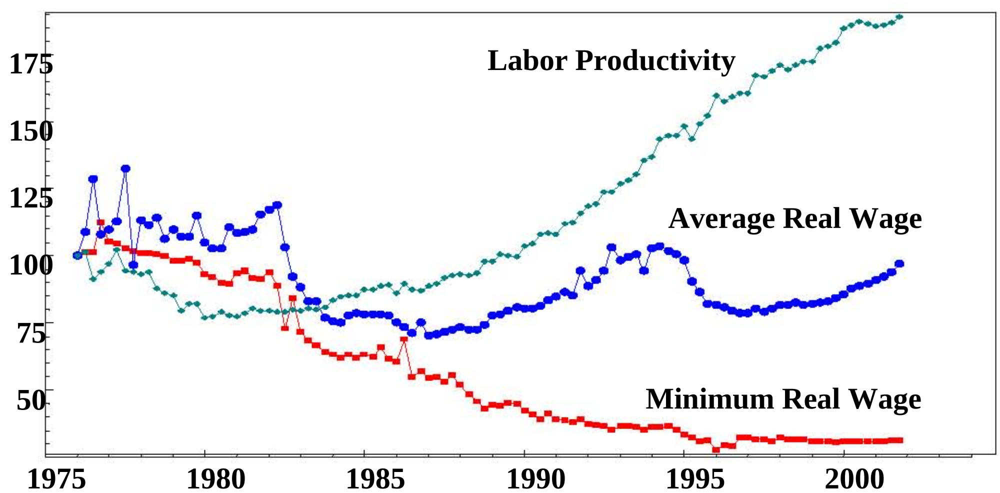
[3] In 2000 the share of maquila exports on total exports was about 40 percent, and its share on manufacturing exports about 48 percent.
[4] In 1980, about 88 percent of maquila workers had a job in firms located in the border area of the country; in 2000 that proportion had fallen to 58 percent (Carrillo and De la O, 2003).
[5] In these and in the following graphs and tables, as well as in the econometric analysis, we use figures from INEGI (Mexico's statistical office).

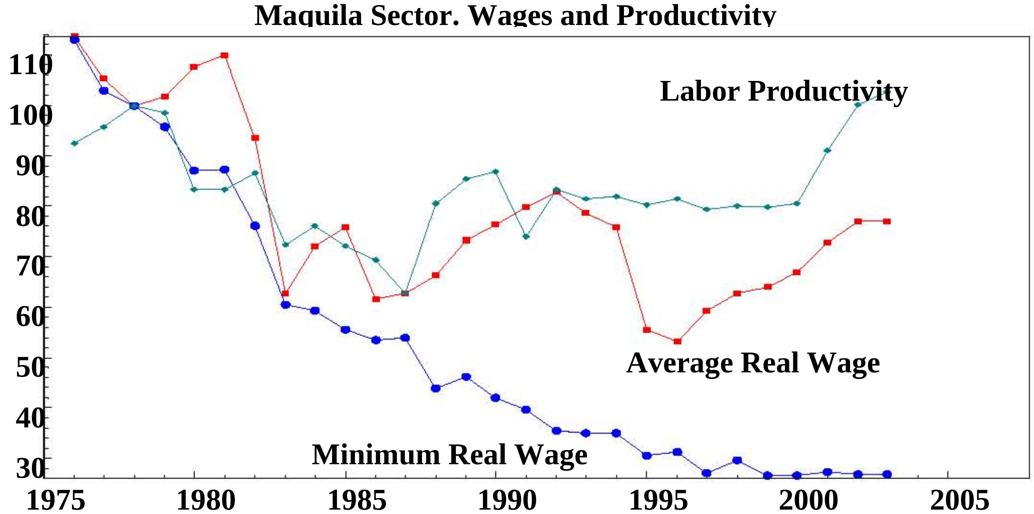
about the situation of the labour market under conditions of high inflation, as was the case in Mexico during part of the third stage.

Graph 1A
Manufacturing Sector. Wages and Productivity



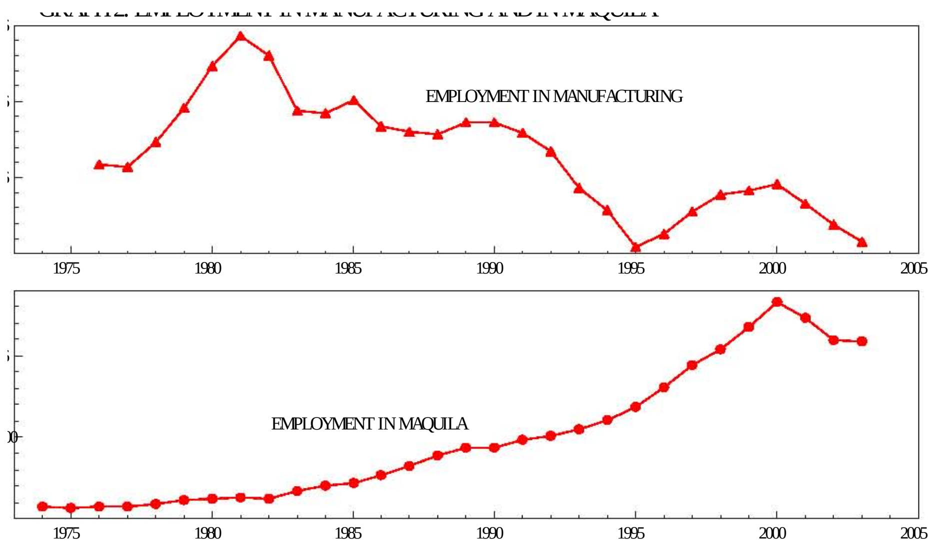
Graph 1B.

Maquila Sector. Wages and Productivity



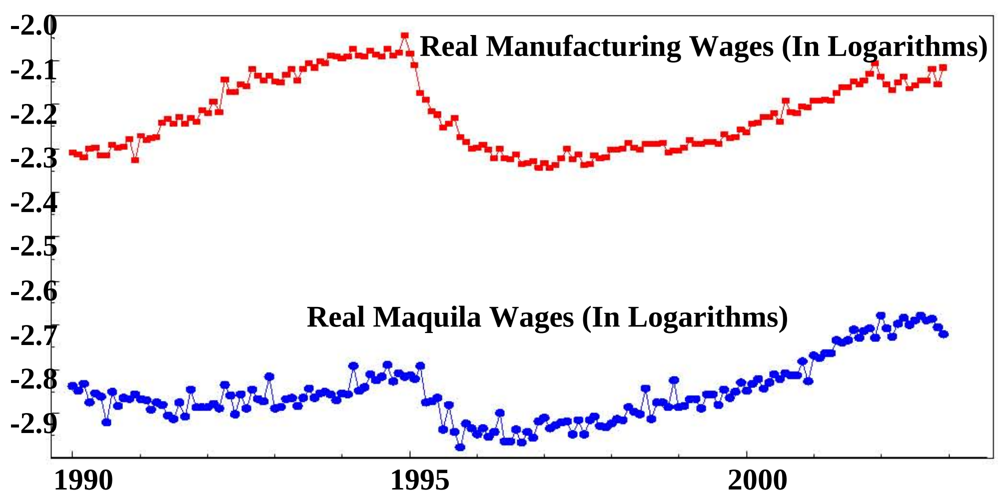
Graph 2.

Employment in Manufacturing and in Maquila



Graph 3.

Real Manufacturing and Maquila Wages



Some important facts emerge from the graphs. First, average wages in the maquiladora industry have always been lower than average wages in manufacturing;

about 40 per cent below in 1994, and 37 per cent in 2001. (Bendesky, Godínez and Salas, 2004). Second, wages in the two industries show somewhat similar behaviour. It appears that while neither manufacturing nor maquila workers have benefited much from any of the economic booms, they have indeed been hard-hit by the crises. Take for example average real manufacturing wages[6]. They rose and fell wildly between 1976 and 1982, but grew about 15 per cent overall. Subsequently, they declined about 40 percent between the 1982 peak and the 1987 low, recovering part (about half) of the loss by 1994, and almost falling again to their previous low by mid-1996. To date they have recovered only part of their previous loss.

Third, real wages have behaved irregularly with respect to the employment situation. Namely, they stagnated during the 1977-1982 economic and employment boom, and rose in the 1987-1994 period when the economy was growing at a somewhat moderate pace. However, manufacturing employment was declining. Only between 1997 and 2001 did wage growth coincide with employment growth (i.e., with a tightening of the labor market).

Fourth, real wages and labour productivity show a certain relation in both the manufacturing and the maquila sectors; but this association breaks down when the economy is subject to a crisis (as in 1983 and 1995). Yet since labour productivity rose at a much faster speed in the former sector, the gap between productivity and wages has widened much more in manufacturing, especially after the 1995 crisis[7]. Finally, the minimum real wage has persistently fallen along all the three stages, and in mid-2002 it was less than one-third of its 1976 original level. Accordingly, the distance between the

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[6] See Salas and Zepeda, 2003, for details. Pagán and Tijerina (2000) carry out an econometric analysis to study the relationship between changes in relative formal/informal employment, wages levels, and wage inequality; but unfortunately their study finishes in 1993.

[7] The pressure of competition in the foreign and domestic market which began in the mid-eighties and forced modernization, most likely explains the faster rate of growth of labor productivity in manufacturing than in the maquila industry.

average real manufacturing wage and the minimum wage, which is paid to low-skilled workers[8], has widened enormously during this last quarter of a century.

On the other hand, according to Graph 2, manufacturing employment has consistently declined, by 35 per cent between its 1981 peak and its 2001 peak. Moreover, only during the 1977-1982 period did employment grow unambiguously. Its decline began in 1982 and lasted till the first half of 1995, and growth resumption in the third stage did not bring about any increase in manufacturing employment between 1987 and the first half of 1995. On the contrary, employment in the maquila industry grew steadily and at a high rate in the entire period between 1974 and 2000, although from that year onwards it has been declining. Thus, the share of employment in the maquila industry has been growing at a fast rate, rising from 8.9 per cent in 1985 to 28 per cent of total manufacturing employment in 2003.

Finally, it should be added that open unemployment has remained stable and at a low level. It represented 3.9 per cent in 1987 and 2.7 per cent in 2002 (as a share of the workforce)[9]. This is because of the lack of unemployment insurance and to the low-level of family income (which does not enable the family to support its unemployed members). Because of these reasons, potential workers must often accept whatever job they can get. Underemployment, which includes both open unemployment and workers employed for less than 35 hours a week, has also remained stable, though naturally at a

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[8] The increasing wage inequality in Mexico has been found to be strongly associated with worker's education level (Ramirez, 2004) and (Meza, 2003, 2004)

[9] People over twelve years old are considered to have been employed whenever they: (i) worked at least one hour in exchange for a salary or benefit or were self-employed; (ii) took part as relatives or non-relatives unpaid workers; (iii) were temporarily out of work due to illness, travel, holidays, studies or personal reasons, while receiving a payment; (iv) did not work or receive any payment but were thinking of either starting a new occupation or returning to a previous job within a 4 week span. Thus, the Mexican definition for unemployment is much narrower than the standard OECD-ILO definition. According to the OECD, if we adjust the unemployment definition towards a standard measure, we should add 1 or 2 percentage points to the reported rate, but this is still low according to OECD standards. See OECD (1996) and López (1999).

much higher level. It represented 17 per cent of the workforce in 1987, and 13 per cent in 2002.

2.3 Theoretical Framework

According to the neoclassical school of thought, at equilibrium, real wage must be equal to the marginal productivity of labor, in a perfect competition setting. It also states that, in the short run, there is an inverse relationship between wages and unemployment, because of the so-called law of decreasing marginal returns to labor. Besides, such theory assumes that prices raise when labor productivity falls and that money wages raise with employment (Mortensen, 2003; Burdett, 1998).

Keynes accepted that equilibrium real wage would be equal to labor productivity (though he later recanted this view), but he considered that wages also depend on the institutional setup and on customary norms.

In 1958 Phillips in famous paper developed the idea that the degree of unemployment determines the evolution of wages. The Philips' curve has to do with the adjustment dynamics of the rate of change of wages to the unemployment rate, and therefore considers a transient phenomenon (Verner, 1999). Phillips' argument has been remolded in the recent past under the notion of the "wage-curve" (Blanchflower and Oswald, 1995:153). However, the notion of the "wage curve" refers to a state of equilibrium between the rate of unemployment and the wage-rate.

Post-Keynesian authors often follow the pioneering approach of Doeringer and Piore (1971), and make emphasis on the dual or segmented structure of the labor market in today's capitalism. In such situation, workers at the oligopolistic firms can get wages that are higher than those prevailing in the competitive sector. Higher wages are due to the specific needs of capital-intensive firms, and due to worker's greater bargaining power. In Seccarecchia's words (2003:382),

"One important feature of the primary sector is the existence of internal labour markets that regulate internal mobility and promotion and are characterized by more rigid and hierarchical wage structures patterned along formal seniority levels. Such internal labour markets are assumed to be largely insulated from the external labour market, except at the ports of entry…"

Recent literature includes productivity levels as an extra argument in the wage equation. The association between wages and productivity has been rationalized in two different but complementary ways. First, workers get a part of the extra output resulting from higher productivity since they have the monopoly of specific skills or a big "bargaining power". Second, firms are willing to pay their workers a premium above the "reservation wage" to avert labor shirking, or guarantee a satisfactory productivity level.

2.4 Econometric Methodology

In this section we briefly discuss the Structural VAR methodology (SVAR) as an analytical tool for our econometric analysis (Sims, 1986; Amisano and Giannini, 1997). The main objective of SVAR analysis is to find out the dynamic responses of different economic variables to disturbances by combining time series analysis and economic theory. The SVAR approach makes up a good alternative to the traditional atheoretic VAR analysis (Sims, 1980), since economic theory plays a key role in the modeling process.

The standard VAR approach suggests estimating a model which includes only lags of all the variables as follows.

(1) $y_t = d_t + Cy_{t-1} + \upsilon_t$

Where y_t is a vector of endogenous variables, d_t is a vector of deterministic components (constant, trend and seasonal or intervention dummies) and υ_t is a vector of innovations.

At first sight, it seems that equation (1) does not offer any explanation of the instantaneous relationships (contemporaneous effects) among the relevant variables, only of the lagged effects. However, such contemporaneous effects are naturally hidden in the correlation structure of the covariance matrix of the vector υ_t. This fact implies that the innovations in the vector υ_t will be contemporaneously correlated.

Exhaustive examination of the so-called *primitive VAR* lead us to a better understanding of such difficulty (Enders, 1995).

(2) $By_t = d_t + Ay_{t-1} + \varepsilon_t$

In this last equation the errors in ε_t are not cross correlated. Matrix *B* in equation (2) contains the contemporaneous interactions among the variables. Matrix A in the right hand side of the same equation encapsulates all the lagged interactions among the same variables.

From equations (1) and (2) we can infer that the *reduced VAR* model (1) is simply a reparameterization of the more general specification given by the *primitive VAR* model (2). In fact, it is easy to see that $C = B^{-1}A$ and $\upsilon_t = B^{-1}\varepsilon_t$. That is, the errors of the *reduced VAR* model υ_t are linear combinations of the uncorrelated shocks ε_t.

To recover the contemporaneous interactions of interest, contained in the matrix B, we can impose a triangular structure on B like the standard Cholesky decomposition. This decomposition is used to compute the impulse response function in traditional

VAR analysis. The standard Cholesky decomposition is often used since it allow us to accomplish the necessary condition for identification, which states that the number of non zero elements in the matrix B must be equal or less than $\left(\frac{n^2 - n}{2}\right)$.However, we can impose a different decomposition of such a matrix containing any other restrictions that allow us to identify the contemporaneous interactions from the disturbances of the *reduced form* VAR model.

The use of the structural VAR methodology can be carried out in three steps: First, we estimate a standard VAR model and compute a matrix of disturbances. Second, we use these disturbances to estimate the B matrix by using FIML (Full Information Maximum Likelihood Method). Thirdly, we estimate the reactions of the system to individual exogenous shocks and graph the so-called impulse responses combining information from the first two steps.

2.4.1 Empirical Evidence on Money Wages in Mexico

In our empirical inquiry we will take into account the previously-mentioned variables we argued can influence wages, to model manufacturing and maquila nominal wages in Mexico. We also recognize that there are different theoretical perspectives which seldom coincide. Accordingly, we prefer to be rather eclectic in the selection of possible variables to be included in the estimated models.

For the econometric analysis, as a first step, we estimate two statistically adequate VAR models from 1994 to 2002; one for the manufacturing wages and the other for maquila wages. The former includes three lags[10], a linear trend and a crash dummy variable, in 1995-1, which captures the effects of the 1995 financial crisis. The maquila VAR includes two lags and a linear trend and a crash dummy variable, in 2000-5, which captures the abrupt closing of some maquila industries in Mexico. Individual and Joint misspecification tests of the VAR (5) model are shown in appendix A.

To estimate the contemporaneous interactions of interest between wages and their determinants, we start from two exactly-identified structures given by the Cholesky decomposition of the variance covariance matrix of the VARs disturbances. Then we restrict the non-significant parameters to be zero moving to a situation of overidentification. Finally, we ensure the validity of the imposed restrictions by means of a LR tests. Then, we reach the following specification for the contemporaneous interactions for the manufacturing model.

$$\begin{bmatrix} \upsilon_{LIMWNU} \\ \upsilon_{LMAQWNU} \\ \upsilon_{LIMYBR} \\ \upsilon_{LDES} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 \\ b_{31} & 0 & b_{33} & 0 \\ b_{41} & 0 & 0 & b_{44} \end{bmatrix} \begin{bmatrix} \varepsilon_{LMWNU} \\ \varepsilon_{LMAQWNU} \\ \varepsilon_{LIMYBR} \\ \varepsilon_{LDES} \end{bmatrix}$$

Where u is a vector of the VAR observed disturbances of each variable. The first column of the B matrix includes all the contemporaneous effects of the maquila wages (b_{21}), manufacturing gross production (b_{31}) and unemployment on manufacturing wages (*LIMWNU*). The vector ε comprises the unobserved innovations of the *primitive VAR*.

Similarly, the corresponding specification for the maquila model is as follows.

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[10] Lags are chosen based on statistical adequacy grounds. None of the equation and vector misspecification tests were rejected. All estimates, data and tests are available from the author upon request. We use quarterly data of the US-peso nominal exchange rate (e) and of the differences between the following domestic (x) and foreign variables (x*): *output* (y-y*), *interest rates* (i-i*) and *money stocks* (M2-M2*) from 1980 to 2005.

$$\begin{bmatrix} \upsilon_{LMAQWNU} \\ \upsilon_{LIMWN} \\ \upsilon_{LIMQPT} \\ \upsilon_{LDES} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 \\ b_{31} & 0 & b_{33} & 0 \\ b_{41} & 0 & 0 & b_{44} \end{bmatrix} \begin{bmatrix} \varepsilon_{LMAQWNU} \\ \varepsilon_{LIMWN} \\ \varepsilon_{LIMQPT} \\ \varepsilon_{LDES} \end{bmatrix}$$

The first column of the B matrix includes the contemporaneous effects of unemployment (b_{41}), manufacturing wages (b_{21}) and productivity (b_{31}) on maquila wages (*LMAQWNU*).

Our estimation results are shown in table 1 and 2 below.

Table 1

Estimated Contemporaneous Effects for the manufacturing wages

Contemporaneous Effects	Coefficient	Probabililty
b(2,1)	0.531	0.0048
b(3,1)	0.526	0.0099
b(4,1)	-0.978	0.0872
Sample: From 1995:1 to 2000:12		
Number of observations 60		
Over identification LR test Chi(2)=13.63592 (0.0409)		

Table 2

Estimated Contemporaneous Effects for the maquila wages

Contemporaneous Effects	Coefficient	Probability
b(2,1)	0.154	0.0048
b(3,1)	0.448	0.0000
b(4,1)	-0.557	0.0705
Sample: From 1995:1 to 2000:12		
Included observations: 60		
Over identification LR test Chi(2)= 0.057(0.81077)		

We discuss now the results of tables one and two. A first important finding from our inquiry is that we were able to effectively estimate statistically valid econometric models whereby money wages can be explained on the basis of a few arguments, and the variables appearing in the two models can be given a sensible theoretical justification. We can then give a positive answer to our first question: Are there regularities in the functioning of the labor market which would allow the estimation of econometric models explaining the determinants of wages?

Now then, regarding our second question (Are wages in the two industries functionally related?), we found that indeed wages in the two sectors are related. More specifically, in each sector the wage of the other sector appears as an important and statistically significant variable amongst the determinant of this sector's wage.

Conversely, we found that there are common factors influencing wages in the two sectors. Most notably, the rate of underemployment and the particular economic situation of the sector appear as determinants of both manufacturing wages and maquila wages. We also found, though, that in each sector the remaining variables that determine wages are different. In this sense, we can agree that the wages in the two industries are affected by some common, but also by a somewhat different set of variables (in answer to our third question: Are wages in the two industries determined by similar or by a radically different set of variables?).

We will now carry out now a more detailed discussion of the economic implications of our econometric results. Let us begin with our last point. The contemporaneous interactions in tables 1 and 2 show the close interrelationship between both sectors, in the sense that a shock to wages one industry tends to affect wages in the other[11] (see coefficients b_{21} in such tables). Thus, a shock to maquila wages tends to stimulate a rise of manufacturing wages, while a shock to manufacturing wages tends to stimulate an increase in maquila wages.

[11] This point appears to have been first pointed out by Fujii and Gaona (2004).

In any event, our findings about the presence of the other sector's wage in each sector's wage equation[12] lends support to an important aspect of wage bargaining put forward in The General Theory, though in a very different socioeconomic context to the one for which it was originally formulated. This is an aspect which has seldom received much attention in contemporary literature. Keynes states that

…any individual or group of individuals, who consent to a reduction of money-wages relatively to others, will suffer a relative reduction in real wages, which is a sufficient justification for them to resist it…

In other words the struggle about money-wages primarily affects the distribution of the aggregate real wage between different groups…The effect of combination on the part of a group of workers is to protect their relative real wage" (Keynes, 1954: 14; emphasis in the original).

We must add that the wage level that workers were able to negotiate in other sectors gives a hint as to the wage level that the government, business leaders, or both, are willing to accept. In essence, it points to the wage that is considered fair by all parties.

Our second result is that a shock to underemployment seems to negatively affect the level of money wages in both sectors (see coefficients b_{41} in tables 1 and 2). In this sense, the notion of a "wage curve" appears relevant to the two sectors we have analyzed.

Third, according to our estimates, it appears that the particular conditions in each industry tend to influence the level of that industry's wage (see coefficients b_{31} in tables 1 and 2). More specifically, a shock to gross value of production in manufacturing tends

[12] M. Piore (1985) wrote one of the pioneering studies referring to wage differentials between industrial sectors or among different groups of workers. He argued that wage rates define relationships between entrepreneurs and workers, as well as between different groups of workers and between different institutional entities. Lindbeck and Snower (1988) is another reference for the insider-outsider theory.

to raise manufacturing wages. Higher labor productivity in the maquila industry has a positive impact on maquila wages.

The association between wages and the gross value of manufacturing production can be rationalized with two different, but not contradictory arguments. The first argument suggests that when firms attain higher production and sales, they are willing to accept higher wage demands because profits are also higher. But it may also imply that higher manufacturing wages bring about higher domestic demand, stimulating output expansion. This second rationalization, however, cannot be adequately discussed within the framework of our inquiry, because we have carried out our analysis within the confine of partial equilibrium analysis, where the feedback from higher wages to (higher?) demand is ignored.

The other argument is that the positive association between productivity shocks and wages in the maquila industry can be rationalized with the notion that firms can afford to pay higher wages without jeopardizing profits when labor productivity increases[13].

In any event, the association between wages and output found in the manufacturing industry, and between wages and productivity found in the maquila industry, tend to support the insider theory of wages. That is, insider workers in Mexico seem to be able to reap part of the benefits of higher productivity or of higher output and sales. We consider this to be a relevant finding, because the insider theory of wages was originally proposed with developed capitalist economies in mind, where unemployment tends to be relatively minor. Our result suggests that even in a situation

[13] It is important to recognize that output does not appear as an argument in the wage equation for the maquila industry. In a wider analytical framework, this finding may perhaps be rationalized with the argument that the latter sector sells practically the whole of its production abroad, so that higher maquila wages do not stimulate demand for maquila goods.

where a large pool of unemployed or underemployed workforce exists, as in Mexico, insider workers have a certain bargaining power.

Another interesting finding of our estimates is that prices are absent as an argument of the wage equation in both of the two sectors under inquiry. This appears at first sight intriguing because we know that especially in an inflationary environment such as Mexico's, expectations of inflation are taken into account by workers in their wage negotiation. It is usually taken for granted that these expectations are based on past inflation. Yet we think that this puzzle can be explained once we take into account that we are dealing here with a long-term relationship, and not with a short-term adjustment. In this context, we can relate this finding to the first result already referred to. As Keynes forcefully pointed out, in an uncertain situation agents rely on conventions in order to make decisions that involve the unknown future. Using the other sector's wage is probably a good convention in the wage-setting process, because it gives an indication as to the wage that can be successfully bargained for.

Summarizing our results we can say that manufacturing wages are positively associated to disturbances in maquila wages and shocks to manufacturing gross value of production. They are negatively associated with underemployment shocks. Conversely, maquila wages are positively associated to shocks to manufacturing wages and labor productivity. They are negatively associated with underemployment disturbances. These results are similar to the ones found in López (2006) for Mexico's manufacturing industry where dynamic panel estimates are use to determine the effects of unemployment, productivity and wages in other sectors.

Further evidence confirming our previous findings can be obtained by making use of the impulse response analysis which shows the dynamic behavior of manufacturing and maquila wages due to shocks in the other variables. The details can be seen in Figures 4 and 5 below. Specifically, the second and the fourth graphs of each figure depict the wages responses to shocks in wages of the other industry and to shocks in unemployment. The third graph depicts the wage response to the aggregate production and productivity shocks respectively.

Figure 1

Impulse Response Functions for Manufacturing Industry

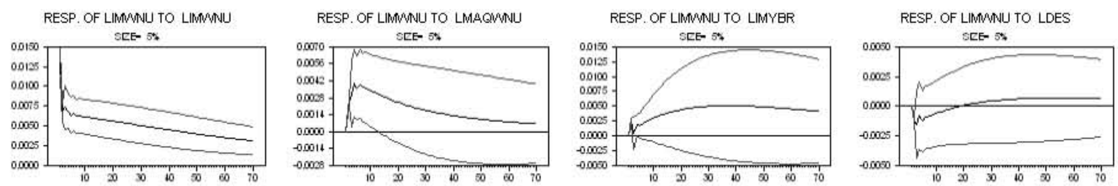
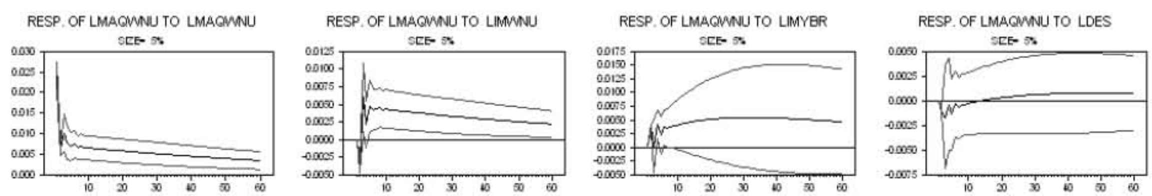


Figure 2

Impulse Response Functions for Maquiladora Industry



The Impulse-Response graphs show that a one standard deviation shock in maquila wages and gross value of production will lead to a long run rise in manufacturing wages. On the other hand, a shock in manufacturing wages and productivity will have a positive effect on maquila wages. The response of a shock to unemployment generates a negative response of wages in both industries.

Finally, figure 3 and 4 depict the variance decomposition graphs associated to each variable. It is worth to notice that wages in the other industry explain most of the variations on wages in each industry.

Figure 3

Variance Decompositions for Manufacturing Industry.

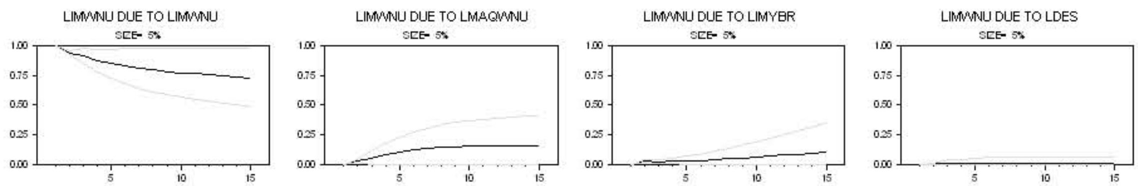
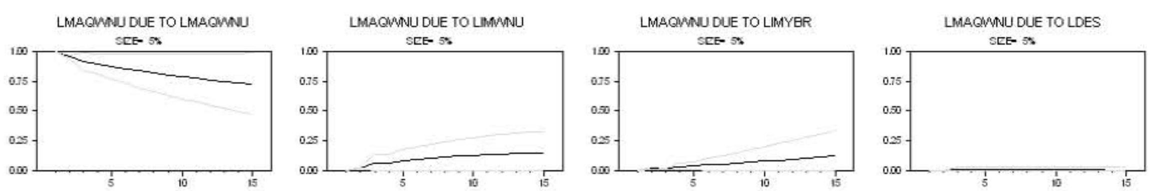


Figure 4

Variance Decompositions for Maquila Industry



2.5 Conclusions

The main aim of this paper has been to identify the factors that govern the behavior of money wages in the manufacturing sector and the maquila industry in Mexico. Such objective has been accomplished by using modern econometric techniques, with specific emphasis on the use of congruent econometric models from statistical and theoretical viewpoints and the SVAR methodology.

Our main empirical findings show that money wages are jointly determined in both industries, and that a relatively similar set of conditioning variables determines their dynamics (Bendesky, Godínez and Salas, 2004). More particularly, it is found that money wages in both sectors depend on shocks to underemployment and on the specific conditions of the sector, the latter summarized by output growth in the manufacturing sector and by productivity growth in the maquila industry, it is worth to mention that similar conclusions were shown by López(2006) in an article about Mexico's manufacturing wages. This fact reveals that insider workers have certain bargaining power in Mexico and that using the other sector's wage is probably a good convention in the wage-setting process, because it provides workers with an indication as to the wage that can be successfully bargained for.

Such results let us conclude that wage behaviour in those two industries in Mexico can be successfully explained by theories of wage determination that emphasize the institutional aspects of the labor market, and that take into account the dual or segmented structure of the labor market in today's capitalism, in conjunction with some of the ideas proposed by Keynes in his General Theory.

Appendix

Manufacturing Model

Single Misspecification Tests						
	Autocorrelation		**Normality**		**Heteroskedasticity**	
Variable	**Stat**	**P-value**	**Stat**	**P-value**	**Stat**	**P-value**
LMWNU	**1.5457**	**[0.1816]**	**2.4788**	**[0.2896]**	**0.4662**	**[0.9928]**
LIMAQWNU	**0.52908**	**[0.7837]**	**1.2833**	**[0.5264]**	**0.40874**	**[0.9910]**
LDES	**0.95942**	**[0.4615]**	**9.0106**	**[0.0111]***	**0.31089**	**[0.9989]**
LMYBR	**2.3369**	**[0.0447]***	**1.5263**	**[0.4662]**	**1.0706**	**[0.4295]**
Not: (*) VAR model with 3 lags and a linear trend						

Joint Tests		
	Stat	**P-value**
Autocorrelación	**1.0315**	**[0.4318]**
Normalidad	**14.724**	**[0.0647]**
Heterocedasticidad	**0.45016**	**[0.9979]**

Maquila Model

Single Misspecification Tests						
	Autocorrelation		**Normality**		**Heteroskedasticity**	
Variable	**Stat**	**P-value**	**Stat**	**P-value**	**Stat**	**P-value**
LMAQWNU	**2.3024**	**[0.0455]***	**2.3675**	**[0.3061]**	**0.62767**	**[0.8531]**
LIMWNU	**2.0839**	**[0.0681]**	**0.28873**	**[0.8656]**	**0.99501**	**[0.4792]**
LMAQPT	**0.99952**	**[0.4340]**	**0.11923**	**[0.9421]**	**0.47223**	**[0.9540]**
LDES	**0.34522**	**[0.9100]**	**6.4036**	**[0.0407]**	**0.45112**	**[0.9627]**
Note: VAR model with 2 lags and a linear trend						

Joint Tests		
	STAT	**P-VALUE**
Autocorrelation	**1.2059**	**[0.1478]**
Normality	**15.88**	**[0.0441]**
Heteroskedasticity	**0.67713**	**[0.9980]**

3. Macroeconomic linkages in Mexico: a keynesian-structuralist perspective

3.1 Introduction

The main purpose of this chapter is to study the effects of selected economic policy measures in Mexico's situation. Specifically, we look for the effects on output of monetary and credit policies, government spending, and variations in the exchange rate. We adopt what we call a Keynesian-Structuralist perspective, a term we explain below. We use econometric analysis to provide reliable evidence for the warranted conclusions. As we have already discussed in the previous chapters, reliability is used to denote statistical reliability in the sense that the inferences are based on *statistically adequate models.* A model is said to be statistically adequate if the probabilistic assumptions constituting the statistical model in question are valid for the particular data. An important feature of our empirical modeling is that we use system-based cointegration methods in an attempt to capture the interdependencies in the economy. This procedure allows for an appropriate econometric analysis in the presence of non-stationary time series and endogeneity among the relevant variables.

We briefly anticipate our findings. Our econometric results show, first, that US economic growth is dramatically important for Mexico's long-run evolution, this has also been confirmed by Garcés (2003) in an empirical study for Mexico using the US industrial output as a variable affecting Mexico´s output. This finding validates the emphasis that the Latin American Structuralist school of though, as well as the Post

Keynesian approach, put on the role of demand and the external constraint on economic growth (Commendatore, D´Acunto, Panico and Pinto, 2002)[1], (Loría, 2003). Second, money and government spending have a positive impact on output. Third, we find that rationing of credit plays a negative role on output. These last two results are compatible with the principle of effective demand supporting our research and with the post Keynesian and new Keynesian views about the expansionary effects of liquidity and money on output (Minsky, 1975, 1982; Davidson, 2002; Blinder, 1987; Greenwald and Stiglitz, 1988). They also contradict alternative visions. Most importantly, they discard the macroeconomic outlook whereby government intervention would have harmful consequences for the economy (Barro, 1974), and money would not have any real effects on output (Lucas, 1972). A fourth important finding of our work shows the existence of an inverse association between the real exchange rate and output. In other words, currency depreciation would depress output when it is not accompanied with complementary policy measures. This result supports the contractionary devaluation hypothesis, which has given rise to a long debate, mostly in Latin America (Diaz-Alejandro, 1963; Krugman and Taylor, 1978). It also runs counter the supposed expansionary effect of currency depreciation, assumed in conventional macroeconomic thinking (Dornbusch and Werner, 1994).

The remainder of this chapter is as follows. In the second section, we propose our analytical framework. The third section discusses the methodological issues involved in the econometric modeling of the macroeconomic links among output and the factors which affect its evolution through time. The last section summarizes our main findings and points out future research work on the topic.

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[1] This article constitute and excellent attempt to provide a unified framework of the Post-Keynesian ideas on growth, dealing with the influence of the different component of aggregate demand on the rate of growth in a system which does not tend necessarily to full employment.

3.2 Theoretical model

The theoretical perspective adopted in this dissertation is the Keynesian-Structuralist view. The term Keynesian should be clear to everybody. We think it is enough to say that, following Keynes (1936) and Kalecki (1939), we hold that aggregate demand governs output. We posit also that demand depends on autonomous expenditure as well as income distribution. Following Kalecki (1954), we submit that income distribution is shaped by the relationship between prices and prime costs, and by the ratio between the cost of material inputs and wage costs. We assume that firms in an industrial sector, characterized by oligopolies, set prices by adding a mark-up over prime costs, the latter consisting of wages and imported inputs[2].

Now, the higher the mark-up, the lower will be the share of wages in value added. Given the higher-than-average propensity to consume of workers, a higher mark-up will entail a lower value of the multiplier of autonomous expenditure. By the same token, an increase in the ratio between the cost of material inputs and wage costs, which also reduces the share of wages in value added, diminishes the value of the multiplier.

We further assume that government spending and liquidity have a positive effect on aggregate demand. Government expenditure expands total demand when it is not

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[2] Simplifying, Kalecki's theory of effective demand and of income distribution can be is specified as follows:

$$Y = \frac{I + Ck + \Gamma + \Theta}{1 - \omega}$$

$$\omega = \frac{1}{1 + (\mu - 1)(j + 1)}, \quad \mu > 1$$

Y is output; I is (private) investment; Γ is the budget deficit and Θ is net exports. Further, ω is the relative share of wages in value added (or output), μ is the "degree of monopoly", or the ratio of aggregate proceeds to aggregate prime costs, and j is the ratio of aggregate cost of materials to the wage bill.

financed with taxes on wages. Liquidity also plays a key role in demand determination, given its strong influence on private expenditure.

In principle, governments can shape the level of demand, and of employment, with monetary and fiscal policies. However, they are not free to choose whatever level of aggregate demand they want. There are several limits restricting government policy choices. In our opinion, and unlike in the New Keynesian view (See for example Layard, Nickell and Jackman, 2005), the most important limit is not wage and price inflation. In semi-industrialized Latin American economies, and possibly also in economies of a different type, normally the binding restriction on government policy and on growth is the foreign exchange constraint.

Keynes and Kalecki, the founding fathers of the principle of effective demand, emphasized that import capacity normally sets up a limit on the level of aggregate demand and output. However, most of the growth models inspired on the principle of effective demand assumed initially closed economies. The integration of the foreign-exchange barrier on post-Keynesian growth model came somewhat later (Beckerman 1962 and 1965; Cornwall 1977). Thirlwall's (1979) classic paper brilliantly synthesized the previous discussion.

In contrast, the Latin American Structuralist School growth theory stressed from its inception the need that faces any country to balance its external sector (Prebisch 1951 and 1954; Furtado, 1966). True, Structuralists did not specify a formal growth model. However, they did use an implicit growth theory which gave strong prominence to the foreign exchange constraint[3]. This is a tradition we also try to recuperate in the present work.

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[3] In anticipation to what came to be known later as "Thirlwall's Law" (Thirlwall, 1979), Prebish (1954, 410) wrote: "The rate of growth of income will match the rate of growth of exports, divided by the elasticity of imports"

In the Structuralist perspective output growth in the developing countries (the Periphery) closely follows changes in foreign demand for their exports (Prebisch, 1949). Thus, when boom conditions build up in the developed countries (the Center) the increasing demand will bring a rise in the relative prices and in the value of exports of the Periphery. The export rise increases demand and stimulates domestic expenditure and investment through the multiplier. It may also induce more foreign capital inflows to the developing country. Also, the fiscal and monetary policy stance becomes more expansionary when the balance of payments conditions improve. Finally, bank credit will expand thus expanding liquidity (or, what amounts to the same, reducing credit rationing).

A rise in exports brings about a rise in profits and wages, as well as taxes. Now, an important feature of Latin American economies is the large relative share of export taxes in total government revenues. When exports rise the additional government revenue does not involve a decline in private earnings. Nor does it stimulate a rise in domestic prices, which could reduce the purchasing power of the population. In this sense, its expansionary effects are much like a budget deficit.

We may consider now the pattern of the business cycle. In the Post Keynesian view, the business cycle is entirely shaped by the investment cycle. In contrast, Structuralist economists argue that the trade balance entirely determines the cycle of the Periphery. Thus for example, a slowdown in foreign demand weakens the relative prices and volume of exports, making the balance-of-payments constraint dramatically binding.

Having set forth our analytical outlook, we now specify a model that we shall be using for our econometric estimates. We base our model on the Keynesian demand equation, where *y* is output, *c* private consumption, *i* private investment, *t* the trade balance (i.e. net exports) and *g* government spending:

$$y = c + i + t + g$$

We also assume that private consumption depends on income and on the share of wages in the value added (ω), while the latter depends also on the real exchange rate *s*[4]. Further, investment depends on income (as a proxy for demand). It also depends on the indebtedness ratio of firms (that is, the ratio of debt to capital or to profits) and on the relative price of capital goods. Now, the indebtedness ratio and the relative prices of capital goods are also determined by the real exchange rate. Indeed, a currency depreciation increases the debt of firms indebted in foreign currency and the price of capital goods. Thus, investment depends on income, and on the real exchange rate. Besides, private spending depends on the degree of liquidity prevailing in the economy, say *m*. The trade balance *t* depends on domestic and external output, on the real exchange rate and on the degree of liberalization. Finally, both *m* and government spending are exogenous policy variables. Therefore, we can reduce (1) as follows:

$$(1) \qquad y = c\,[\omega(s), y, m] + i\,(s, y, m) + t\,(y, y^*, s) + g$$

Where *c* is total consumption, *s* is the real exchange rate and ω is the relative share of wages in value added. It can be easily seen that we can further reduce the model in such a way that output depends only on *g*, *y**, *m* and s; formally:

$$(2) \qquad y = y\,(g, y^*, m, s)$$

We are conscious that in many cases, in our empirical work, lack of adequate information will force us to use variables which are only imperfect proxies for our

[4] We can explain the association between the real exchange rate and the relative share of wages in the value added with the help of Kalecki's (1954) theory of income distribution. Let us assume for example currency devaluation. This causes an increase in the price of imports, which provokes a rise in the ratio of the aggregate cost of materials to the wage bill (j). It may also tend to augment the price-cost ratio (μ) because the pressure of foreign competition in the domestic market has diminished (See also Hernández Laos, 2000, for an econometric estimate of these effects for Mexico).

theoretical variables of interest. This is inevitable in empirical work, and even more so when dealing with developing economies.

3.3 Methodological issues

We can study now the links among our variables from equation (2); that is, output, government spending, money supply, credit rationing, foreign demand and the real exchange rate. To offer reliable econometric evidence on these links we estimate a macro econometric model. We must certainly ensure that the probabilistic structure of the data is fully accounted for. Specifically, we estimate a *cointegrated system (VECM)*. In what follows, we make a brief presentation of the relevant econometric theory and discuss the model estimation by FIML.

3.3.1 Econometric issues

To specify a proper macro econometric model we follow the so-called *probabilistic reduction* approach to econometrics. This approach emphasizes the use of statistically adequate models as the basis of drawing reliable inferences (Spanos; 1986, 1999, 2006a, 2006b). The foundation of this approach is a purely probabilistic construal of the notion of a statistical model, considered to be a set of internally consistent probabilistic assumptions aimed to capture the statistical information in the data (chance regularity patterns – see Spanos, 1999; Andreou, Pittis and Spanos, 2001). In other words, economic theory suggests the potential theoretical relationships and the relevant data, but the statistical model is specified by viewing the observed data as a realization of a generic vector stochastic process with a probabilistic structure that would render the observed data a truly typical realization thereof. That is, the structural model is based on substantive subject matter information, but the statistical model is chosen to reflect the systematic statistical information contained in the particular data. The way the two sources of information can be blended harmoniously is to embed the structural model into a statistically adequate statistical model.

The importance of statistical adequacy arises from the fact that the ultimate aim of empirical modeling is to learn from the data about the phenomenon of interest. However, no learning can take place unless the inference procedures used in drawing those inference are reliable in the statistical sense: their actual error probabilities coincide (or approximately equal) to the nominal error probabilities, and statistical adequacy ensures that. When the estimated statistical model is misspecified, the actual error probabilities are likely to be very different from the nominal ones and any inference based upon such a model is likely to be unreliable. For instance, the modeler might apply a 5% significance level thinking that such inference will rarely be wrong, but if the actual type I error probability is 98% (due to some misspecification), such an inference will be erroneous considerably more often than assumed; that's how unreliability can creep into the inference (See Spanos, 2005a, 2005b).

Hence, when an estimated model is found to be statistically inadequate (misspecified) for the data in question, one needs to respecify (choose a different statistical model) which will account for the systematic information that the original model did not. As a result, the success of econometric modeling (in the sense of learning from the data) depends on how appropriate the postulated assumptions are in capturing the statistical information in the data. Thus, in this approach, misspecification testing plays a fundamental role, to ensure the statistical adequacy of the model and the reliability of the inferences based on such a model.

Another aspect of empirical modeling that plays an important role in what follows is the use of recent developments in system-based cointegration methods. These methods allow us to deal with the nonstationary nature of economic time series and endogeneity problems, in order to provide a more appropriate and effective analysis of the relevant macroeconomic links among the variables of interest.

To summarize our approach, we can start from a VAR (p) model of the form.

$$(3) \qquad Z_t = \alpha_0 + A_1 Z_{t-1} + ... + A_p Z_{t-p} + u_t, \quad t = 1, 2, \ldots, T,$$

Where Z_t is a nx1 vector of I (1) variables, A_i, I = 1,…, k, are nxn matrices of unknown parameters, α_0 is a nx1 vector of unknown deterministic terms, u_t is an nx1 vector of i.i.d. (0, Ω) disturbances. We can get a Vector Error Correction Model (VECM) by reparameterizing model (3) as follows[5]:

$$(4) \qquad \Delta Z_t = -\Pi Z_{t-1} + \Sigma_{i-1}^{p-1} \Gamma_i \Delta Z_{t-i} + \alpha_0 + u_t \qquad t = 1,2 \ldots\ldots,T$$

The rank of the matrix Π gives us the equilibrium properties of model (4). When the elements of Z_t are I (1) and cointegrated with rank (Π) = r, we can decompose Π into two nxr full column rank matrices α and β, where $\Pi = \alpha\beta'$. This implies that there are $r < n$ stationary linear combinations of Z_t. The Johansen (1988) reduced rank procedure allows us to estimate such matrices.

At this point, two problems arise. First, there is an identification problem since the matrices α and β are not uniquely identified without extra information. A practical solution to this problem consists in including r restrictions per cointegrating vector to reach exact identification (Pesaran, Shin and Smith 2000). A second problem is the well-known over-parameterization problem associated to VAR models. That is, the problem of a severe lack of degrees of freedom often implied by the need to estimate an

[5] See appendix B for a discussion on the stability properties of the VAR and VECM models.

excessive number of VAR parameters. A way to address this problem is by testing and imposing weak exogeneity assumptions. Such restrictions allow us to reduce the number of parameters we need to estimate (Hall, 2001).

A general system model (VECM) including exogenous I (1) variables derived from (4) is as follows:

$$(5)\quad \begin{aligned} &\Delta Y_t = c_y - wc_x + w\Delta X_t + (\alpha_y - w\alpha_x)\beta' Z_{t-1} + \Sigma_{i=1}^{k-1}(\Gamma_{yi} - w\Gamma_{xi})\Delta Z_{y-i} + \varepsilon_{yt} - w\varepsilon_{xt}, \\ &\Delta X_t = c_x + \alpha_x \beta' Z_{t-1} + \Sigma_{i=1}^{k-1}\Gamma_{xi}\Delta Z_{t-i} + \varepsilon_{xt}, \\ &where \quad w = \Omega_{yx}\Omega_{xx}^{-1} \end{aligned}$$

As we can see, in this case, model (5) includes a conditional model for Y_t and a marginal model for X_t. In general parameters in the conditional and marginal models are interrelated and a full system analysis is required. Nonetheless, whenever X_t is weakly exogenous with respect to β the conditional model contains the same information as the full system so analysis of the conditional model alone is efficient.

We can simplify the VECM to reduce it to a more parsimonious representation by using four types of restrictions (Doornik and Hendry, 2001),

Restrictions on the rank of the long run matrix (Π)

Restrictions on the short run dynamic coefficients (Γ)

Restrictions on the long run cointegrating vectors, β;

Restrictions on the loading parameters, α.

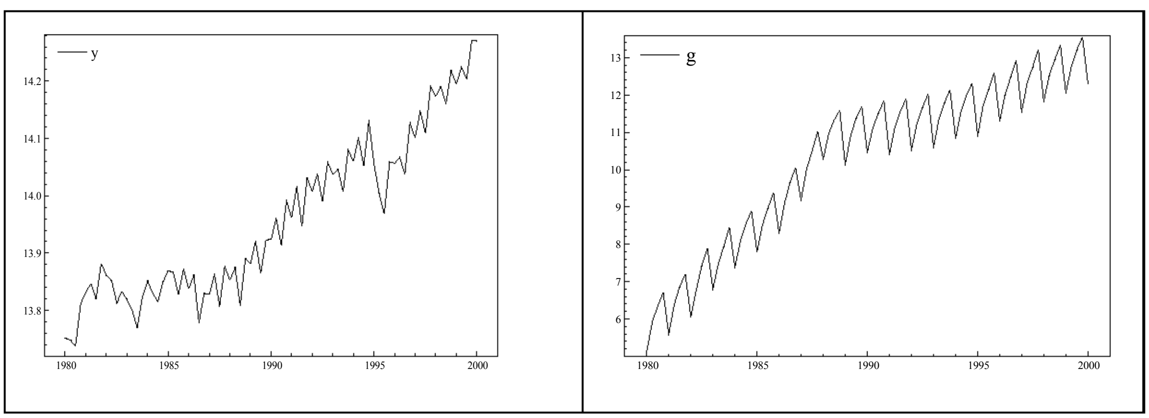
Finally, according to our econometric approach, the reliability of all the described techniques and of any statistical inference procedure depends on the statistical adequacy of the multivariate models.

3.3.2 Estimating the model by FIML

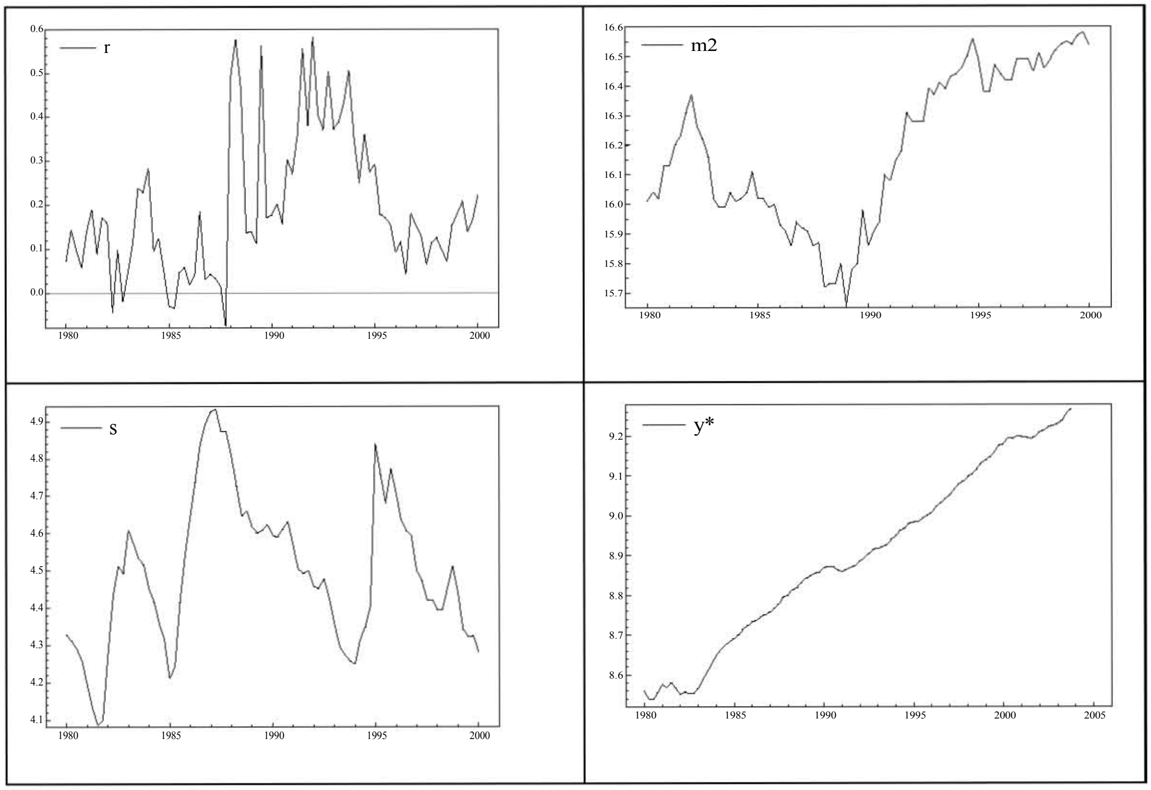
To model the macroeconomic effects of interest we first assume that output (y) depends on public spending (g), the real exchange rate (s) and foreign demand, which in our exercise corresponds to the US real GDP (y*)[6]. There is not a generally accepted measure of the degree of liquidity or of credit rationing, and here we include two variables with which we try to approximate that notion. One is broad money, m2. This variable gives a certain measure of liquidity; but we are conscious that m2 is also influenced by credit demand. This is why, following Wolfson (1986) we use also the difference between the active interest rate (that it, the rate at which banks lend money), and the passive rate (that is, the one at which they borrow), to capture the degree of credit rationing in the economy. We acknowledge that these are only proxies for liquidity or credit-rationing, which is the concept we really want to measure.

Our data consist of non-seasonally adjusted quarterly observations for the period 1980 to 2000. The graphs shown in figure 1 describe the behavior of all the variables.

Figure 1



[6] Over 90 percent of Mexican exports go to the US.



Inspection of the first graph suggests that during the last two decades output growth has shown three distinct stages. In the years prior to 1982 output grew at high rates; however, a severe crisis in 1982 changed the trend. It is worth mentioning that during that period the state ran liberal public spending and monetary policies, since oil prices and production were high and external loans were easily available. From 1983 to 1987 the economy stagnated with ups and downs, with an important fall of output that took place in 1986. During this second stage, first hesitantly and then at full speed, structural reforms were undertaken that led to a retrenching of the economic role of the state. Under the new economic perspective, monetary and fiscal policies were considered as useless, or indeed nefarious, to promote economic growth. Therefore, government expenditure was persistently reduced and money supply was used only as an instrument to reach inflation targets. The last stage is the one which begun in 1988. This period can be divided into two sub periods. The division line can be drawn by a new crisis that erupted at the end of 1994; which provoked a fall in output of about 7 per cent in 1995. Again, during these two sub periods, fiscal and monetary policies were not focused to promote growth but they were aimed at ensuring price stability. Finally, our graphs show that, in the whole period from 1980 to 2000, an increasing exchange rate has been normally associated with a decreasing output's growth rate (Kamin and Rogers, 2000).

From the modeling standpoint, the previous graphs also convey statistical information that can be assessed by temporarily ignoring the substantive variable each of these series represents, and treating the plots as realizations of stochastic processes with a certain probabilistic structure that would render these plots truly typical of that structure; see Spanos (1999, 2006). Our series exhibit trends, seasonal effects, outliers and cycles. These data features provide us with some useful information on the probabilistic features of the data, and suggest some assumptions that we can adopt to specify our VAR models. In short, our graphical analysis suggests that the model ought to include not only the lagged values of the series but also some components as a constant, a trend and seasonal or intervention dummies.

To proceed with the graphical analysis and get a more adequate insight into the statistical features of our variables, we need to detrend and dememorize our data using generic ways [7]. Simple inspection allows us to infer that normality is not an inappropriate assumption to maintain for output and m2; and suggests that the real exchange rate, real government expenditure and real exchange rate exhibit certain forms of non-Normality. We confirm this inference when we perform the skewness-kurtosis

7 We subtract memory from the variables by regressing the detrended variables against their own lags.

normality test χ^2 (2) to all variables[8]. However, the rejection of Normality for the real exchange rate is probably due to outlying values in the first half of 1995, when Mexico's financial crisis broke off. Non-normality of public expenditure may be the result of large changes in government spending in 1982-I and 19802-III, and a (downward) shift in the mean starting in 1989-III. These changes were the result of revisions in the public spending policies after Mexico's 1982 crisis which led to big budget cuts during the 80s and 90s. Finally, non-normality of the US GDP can be due the volatile period in the first half of the 80s (Stock and Watson, 2002).

As a second step in the statistical analysis of data, we must examine the presence of unit roots to find out their stationary properties. We report in Table 1 below two different types of unit root tests[9]. The first is the standard Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1981). The second is a unit root test developed by Spanos (2000). The latter test is based on a heterogeneous autoregressive process. It can be used to nest the unit root hypotheses and overcomes the lack of power of the Dickey-Fuller type tests, for alternatives close to the unit root.

Table 1

Unit Root Tests	
Augmented Dickey-Fuller[1]	Har(p)[3]

8 The computed statistics and p-values of the asymptotic X^2 (2) normality tests are: 2.2576 [0.3234] for Mexico's GDP, 1.9266[0.3816] for m2, 107.04 [0.0000] for government spending, 397.80 [0.0000]** for the real exchange rate and 16.384 [0.0003] for US GDP.

9 It is worth to point out that as any other inference procedure this type of tests must be based on statistically adequate models in order to guarantee its validity (Andreou and Spanos, 2003). In other words, the reliability of the Augmented Dickey Fuller (ADF) and Perron (1989) unit root tests depends on the validity of the underlying assumptions of the auxiliary regressions used for the tests. Any departure from the appropriate lag length, order of the deterministic trend or absence of structural stability can affect the reliability of the test even asymptotically and introduce biases. Therefore, the natural way to proceed is to establish the statistical adequacy of the autoregressive models used for the Dickey Fuller (1978) and Spanos HAR(p) tests before using them for unit root testing purposes.

(using First Differences of the data)			(Heterogeneous Autoregressive Model)
Variable	ADF	K[2]	Λ
Y	-5.98	2	0.56
G	-37.11	1	0.73
R	-2.89	2	-0.01
M2	-5.69	2	-0.01
S	-6.5	3	0.27
Y*	-5.21	1	-0.04

Notes: Where (y) is output, (g) is public spending, (r) is credit rationing, m2 is money supply, (s) is the real exchange rate and y* is US real GDP.

[1] The regressions include trend and intercept and are performed in deviation from seasonal means.

[2] k is the degree of augmentation in the AR(k) models used to: test the unit root hypothesis, the choice of k was based on statistical adequacy grounds.

[3] To test whether a series contains a unit root, we compare λ statistics to the critical values from a Chi^2(1). The critical values are 7.87 and 10.83 to the 5 and 10 per cent confidence levels respectively.

The statistical analysis in table 1 suggests that all variables are integrated of order one, I(1); which implies that modeling them in levels may lead to misleading conclusions. However, this problem does not appear if the variables cointegrate.

For the econometric analysis, as a first step we estimate a statistically adequate VAR(2) model with two lags in all variables, and including a linear trend (t), two seasonal dummies and a crash dummy that captures the effects of the 1995 financial crisis[10]. This dummy takes the value of minus one at 1995-II, one at 1995-I and zero otherwise. It is worth mentioning that this model also assumes weak exogeneity for public expenditure (g), credit rationing (r) and foreign demand (y*). Economic theory and intuition suggest that we can make this assumption. Moreover, further statistical analysis, following the methodology described in Hall and Grenslade (2000), confirms

[10] The number of lags was chosen based on statistical adequacy grounds. None of the equation and vector misspecification tests rejected. All estimates and tests are available from the authors upon request.

that these variables might be realistically viewed as weakly exogenous[11]. Nevertheless, according to our tests, the real exchange rate is not a weakly exogenous variable; thus suggesting that it is necessary to estimate a cointegrated system (VECM), (see table 2).

Table 2

Weak Exogeneity Test

Variable	$X^2(2)$	p-value
S	31.824	[0.000]**

Notes: Column 1 refers to the variable tested. The second column provides the $\chi2$ statistic and column three is the associated p-value. Two asterisks indicate significance at 5% level.

We now proceed to test for the cointegrating rank using Johansen's reduced rank methodology. Table 3 shows the test statistics with three exogenous variables. From the table we can see that the trace statistic suggests the existence of two cointegrating vectors. We therefore conclude that the estimated system has two long-run relationships (Johansen, 1988).

Table 3

[11] A weak exogeneity test shows that those three variables are truly exogenous. The LR test of over-identifying restrictions has value 0.10 and a p-value of 0.74 for a $\chi2(1)$ distribution, which indicates that exogeneity restrictions are data acceptable.

Cointegration Rank Statistics

Ho: Rank(Π)=r	Trace test	p-value
r = 0	82.252	[0.000]
r ≤ 1	34.776	[0.002]
r ≤ 2	4.9380	[0.612]

Notes: Column 1 refers to the null hypotheses of zero, at least one, two cointegrating vectors.

Column 2 lists the trace statistic and the last column list the associated p-values.

Given the purpose of this work, we want to identify an output equation. However, since we have found an extra cointegrating vector, we can also identify a real exchange rate equation. Now, exact identification, in a system with cointegrating rank two, requires two restrictions in each of the cointegrating vectors (Pesaran, Shin and Smith, 2000). In this case, exact identification was accomplished by three exclusion restrictions and two normalization restrictions. Specifically, we exclude m2 and the linear trend from the real exchange rate equation and the constant in the output equation. Finally, we introduce two normalization restrictions; one on output and the other on real exchange rate[12]. Thus, the two final identified cointegrating vectors were an output equation and the exchange rate equation. They are shown below (asymptotic standard errors are provided in parentheses).

$$y = -0.38s + 0.32m2 + 3.79y^* - 0.14r + 0.29g - 0.015t$$

$$\quad (0.03) \quad (0.06) \quad (1.19) \quad (0.07) \quad (0.08) \quad (0.00)$$

$$s = -2.44y + 2.95y^* - 0.30r + 0.59g + 29.3$$

$$\quad (0.34) \quad (2.10) \quad (0.13) \quad (0.16) \quad (2.71)$$

[12] The LR test of over-identifying restrictions has value 0.110 and a p-value of 0.73 for a $\chi^2(1)$ distribution, which indicates that the restrictions are data acceptable.

Where (y) is output, (g) is public expenditure, (r) is credit rationing, m2 is money supply, (s) is the real exchange rate and y* is US real GDP. It is well known that the cointegrating vectors correspond to the long run equilibria of the system, and that the dynamic adjustment to the equilibria is given by lagged differences in each equation. Then, the next step of the econometric analysis consisted of estimating a cointegrated system[13], with differences of the variables (Dx is the difference of variable x in logs) and the cointegration vectors, denoted as y and s. We use the full information maximum likelihood method (FIML). The final parsimonious model gave the following results in table 4 below[14].

Table 4
The present sample relates to the period 1980(3)-2000(1)

Equation for Dy

Variable	Coefficient	SE	t-value	t--prob.
Dy_1	-0.354466	0.08907	-3.98	0.000
Ds_1	-0.177173	0.02744	-6.46	0.000
y_1	-0.001671	0.00019	-8.54	0.000
Dg_1	0.0235776	0.00358	6.59	0.000
Dy*_1	-0.109665	0.2594	-0.42	0.674
Dr_1	-0.0394206	0.01516	-2.60	0.012
D951	-0.0220676	0.01400	-1.58	0.120
Seasonal1	-0.0388244	0.01084	- 3.58	0.001
Seasonal2	-0.0984908	0.00808	-12.2	0.000

Notes: Standard deviations of residuals = 0.0172507
y_1 is the lagged cointegrating vector for output
Dx is the difference of variable x in logs
D951 is a dummy variable which captures 1995 Mexico's financial crisis effect.
Seasonal1 and seasonal 2 are seasonal dummy variables.

[13] Estimating a system is advantageous since it let us deal with endogeneity problems and it allows a more satisfactory analysis of the macroeconomic interactions of interest.
[14] The model was reduced to a parsimonious system by eliminating redundant variables.

Equation for Ds

Variable	Coefficient	SE	t-value	t--prob.
Dy_1	-0.450330	0.2107	-2.14	0.036
Ds_1	0.567476	0.08390	6.76	0.000
Dg_1	-0.00458728	0.009523	-0.482	0.632
Dy*_1	-0.966324	0.6823	-1.42	0.162
Dr_1	-0.0451574	0.04581	-0.986	0.328
D951	0.403234	0.04270	9.44	0.000
Seasonal1	0.0115222	0.02120	0.543	0.589
Seasonal2	0.0242549	0.01592	1.52	0.133

Notes: Standard deviations of residuals=0.0527602
Dx is the difference of variable x in logs
D951 is a dummy variable which captures 1995 Mexico's financial crisis effect.
Seasonal1 and seasonal 2 are seasonal dummy variables.

Equation for Dm2

Variable	Coefficient	SE	t-value	t--prob.
Ds_1	-0.240000	0.07356	-3.26	0.002
s_1	-0.00206188	0.00043	-4.71	0.000
Dg_1	0.0294652	0.00886	3.32	0.001
Dy*_1	-0.165035	0.6975	**-0.237**	**0.814**
Dr_1	0.0969880	0.04108	2.36	0.021
D951	0.00191262	0.03732	0.051	0.959
Seasonal1	0.0979565	0.01500	-6.53	0.000
Seasonal2	-0.0701209	0.01633	-4.30	0.000

Notes: Standard deviations of residuals=0.0467856
s_1 is the lagged cointegrating vector for real exchange rate
Dx is the difference of variable x in logs
D951 is a dummy variable which captures 1995 Mexico's financial crisis effect.
Seasonal1 and seasonal 2 are seasonal dummy variables.
no. of observations 79
no. of parameters 25

The estimated system seems to be an adequate model since the over-identifying restrictions are valid[15] and none of the misspecification tests rejected at a10% level (see Appendix A).

In conclusion, since our model is adequate from a statistical point of view, it constitutes a good basis to obtain reliable inferences regarding the long and short run behavior of our variables. Next we provide an interpretation of our econometric model.

3.4 Discussing the empirical results

In this section we analyze the main results from our macro econometric model. For the time being we discuss only the plausibility and rationale for our findings. Later on we take up the economic policy implications. We discuss first the long and short run effects of changes in government policies and changes in world economic conditions on output. Specifically, we discuss the effects of shocks in monetary, fiscal, credit, and exchange rate policies, and on world (i.e. US) output. We reproduce below the estimated cointegrating vector normalized as an output equation.

$$y = -0.38s + 0.32m2 + 3.79y^{*} - 0.14r + 0.29g - 0.015t$$

Let us consider each one of the relevant variables in turn. Our estimated equation shows, firstly, that the effect of external (i.e. US) output, on Mexico's output is very strong (Garcés, 2003). Our long run equation suggests that a ten per cent increase of US GDP would produce an increase of almost 40 per cent in Mexico's GDP. This result may appear strange at first sight. However, we should remind the reader that in 2000, Mexico's GDP was a mere 6 percent of US's GDP; and US total imports were about 10 times larger than Mexico's total exports. Therefore, even a modest rate of

[15] LR test of over-identifying restrictions: Chi^2(20)= 31.229 [0.0522]

growth of output and imports of the former, implies a tremendous potential additional demand for exports of the latter.

Moreover, we must take into account two relevant peculiarities of the country. On the one hand, the government owns the oil industry. Now, when there is a business upswing in the US, the price and volume of Mexico's oil exports rise and fiscal revenue swell[16]. The government is thus able to expand its expenditure without incurring in a budget deficit. However, the expansionary effect on aggregate demand of government expenditure –i.e., the multiplier of the government expenditure-- is large, similar to the effect of a budget deficit, because government spending has grown without levying higher taxes from the domestic private sector (Huerta, 2007). The second peculiarity is the significance of remittances of Mexicans working in the US. This is also a very weighty item in the balance of payments. Now, remittances are mostly perceived by low-income groups of the population, whose propensity to consume is high.

Secondly, our econometric estimate show that monetary and credit policies have a positive effect on output in the long run. Specifically, a 10 per cent less of credit rationing (i.e., a fall in the interest rate differential) would produce a 1.4 per cent growth of GDP. That is, more credit rationing in the economy would discourage private demand and growth. This fact supports the view that the state of credit, and the degree of "credit rationing", affects output level in the long run.

Thirdly, and in the same vein, we find that a 10 per cent growth of money supply (m2) would produce a 3.2 per cent growth of GDP. Such empirical result supports the post-Keynesian view that monetary policy can positively affect output throughout its effects on aggregate demand.

[16] The case when there is a downswing is symmetrical and need not be discussed separately.

Fourthly, we find that fiscal policy may have a positive effect on output; with an output long-run elasticity to public expenditure of about 0.28. This estimate would imply that a 10 per cent increase of public spending could produce a 2.8 per cent increase on output, controlling for other factors. Thus, empirical evidence supports the Keynesian idea about the expansionary effects of government expenditure.

Finally, we found a negative elasticity of output with respect to the real exchange rate, of about -0.38. It appears that in Mexico, a higher –i.e., a more competitive—real exchange rate tends to improve the trade balance[17]. But it also tends to negatively affect other components of demand. Our finding suggests that in Mexico the net effect of currency depreciation on demand and on output is Contractionary, which is in line with some other author´s conclusions such as Garcés (2003), Bergoeing (2002), Kamin and Rogers (2000). This result agrees with the view originally proposed by Kalecki (1939), and more recently by Krugman and Taylor (1978). However, it runs counter the conventional wisdom, which normally assumes that a higher real exchange rate brings about an expansion of demand and of employment[18].

Next, we continue with the short-run analysis of the econometric model. The relevant estimated equation is the following one:

Dy= -0.35Dy_1 -0.18Ds_1 +0.02Dg_1 -0.11Dy*_1 -0.04Dr_1 -0.02D951 -0.001671y_1 -0.04 Seasonal1 -0.09Seasonal2

Analysis of our short-run model suggests that credit rationing (Dr_1) and the exchange rate (Ds_1), negatively affect output in the short run (Garcés, 2003) . However, only exchange rate movements have a large impact in the short run output's behavior; while credit rationing has a minor effect. On the other hand, government

[17] See especially Loria (2003), and the reference given therein.

[18] This finding however is not new. In fact, the point has been tested and verified for the Mexican economy. See for example Kamin and Rogers (2000), Kamin and Klaun (1997), and the references therein.

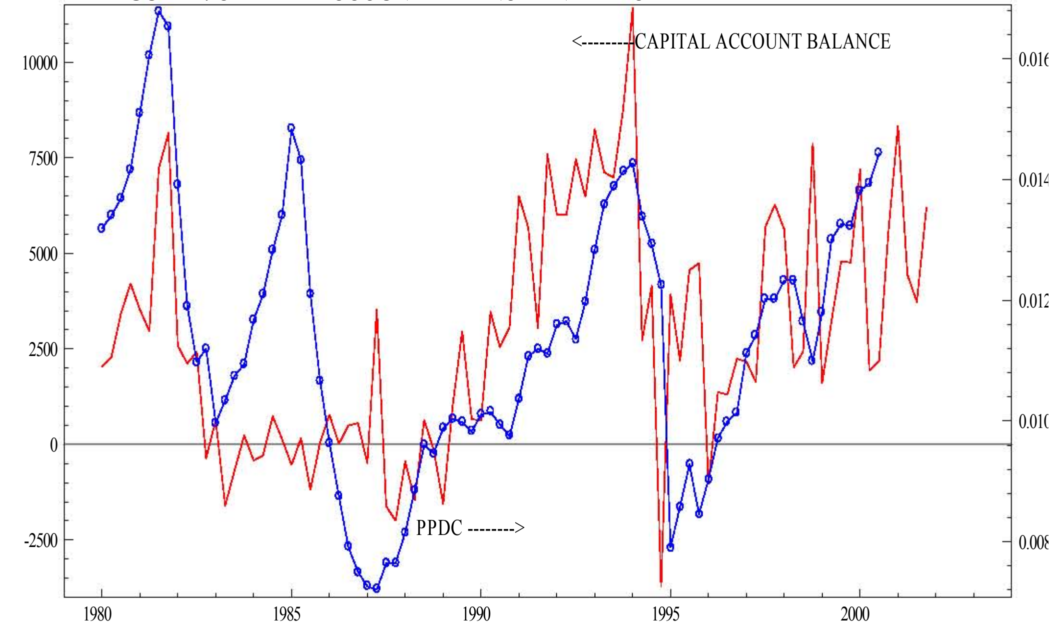
spending (Dg_1) has a small positive impact in the short run and US-GDP variations (Dy*_1) do not have a statistically significant coefficient in the short run (Huerta, 2007).

We continue with an analysis of the second cointegrating vector, normalized as a real exchange rate equation. As we pointed out previously, our main objective has been to model Mexico's output. However the exchange-rate equation offers some interesting points of debate, which are worth discussing here. We warn the reader, though, that a thorough study of the long-run determinants of Mexico's real exchange rate is beyond the scope of the present paper. It would need a different type of study and most likely a different dataset. What we can offer here are brief observations based on our estimated equation.

To motivate the discussion, it is useful to start with the following graph. In the graph we contrast the evolution of the inverse of the real exchange rate, i.e., what we call the Purchasing Power of the Domestic Currency (PPDC), with the capital account balance[19].It can be easily seen that the capital account balance plays an important role in connection to the real exchange rate level.

[19] Using the Purchasing Power of the Domestic Currency, rather than the real exchange rate, facilitates the graphical inspection.

FIGURE 2. CAPITAL ACCOUNT BALANCE AND PPDC



The association between the two variables in Figure 2 is not exact but its general feature is clear. Namely, it appears that the capital account balance and the Purchasing Power of the Domestic Currency are strongly associated. This is a very important point in itself. Furthermore, we can see that the two variables move in the same direction. Or, what amounts to the same, the real exchange rate moves in opposite direction with the capital account balance. We take this association as a point of departure to the analysis that follows.

To start with, we reproduce below the real exchange rate long-run estimated equation:

$$s = -2.44y + 2.95y^* - 0.30r + 0.59g + 29.3$$

First, according to this equation the income elasticity of the exchange rate is around -2.4. In words, when output grows 10 per cent, the real exchange rate depreciates 2.4 per cent; in other words, the Purchasing Power of the Domestic Currency appreciates. How could we possibly rationalize this association? We suggest the following interpretation. Foreign investors sense a better economic performance as a sign of good health of the economy. Therefore, foreign capital comes in, the balance of payments improves, and peso appreciates in real terms.

Let us see now what happens when the economic situation abroad improves. Controlling for other factors, we find that faster economic growth abroad (a rise in y^*) would induce an exchange rate depreciation. Why? We would propose that capital outflows tend to take place when investors sense better economic conditions abroad. Mexico's capital account balance deteriorates, and the Purchasing Power of the Domestic Currency follows suit.

On the other hand, let us consider now the positive association between the interest rate differential and the real exchange rate in our estimated equation. We would suggest the following pattern of evolution. When the interest rate differential increases, a capital inflow may occur, because banks can offer better conditions to foreign investors. This explains that a rise in the interest rate differential appreciates of the US-Peso real exchange rate.

Finally, according to the estimated model the public expenditure elasticity of exchange rate is around 0.59; that is, a real depreciation of the peso is associated with a rise in public expenditure. How can we understand this kind of association? We conjecture that increases in public expenditure are seen as a bad sign by foreign investors. Thus, an increase in public expenditure would stimulate capital outflows, the Purchasing Power of the Domestic Currency would decline, which would bring about a currency depreciation.

3.5 Conclusion

There are several implications that follow form our empirical modeling above. In the first place, we found that the influence of the US on the Mexican economic evolution is substantially bigger than has been traditionally assumed. It would be naïve to expect that the latter economy could grow without taking into consideration its external situation; mostly conditioned by the US economy, Garcés(2003). However, the degree of dependency of Mexico with respect of that country appears to be overly large. A new growth strategy should certainly look for a greater degree of diversification of its external trade and finance, and also for a certain degree of national autonomy.

On the other hand, we found that in spite of its external economic dependence, the Mexican government can exert a certain degree of influence on economic development. In particular, expansionary fiscal and monetary policies can contribute to stimulate economic growth. Now, it is known that, when carried too far, these policies negatively affect the trade balance and the balance of payments. This suggests that they should be accompanied with policies that improve competitiveness. Such policies in conjunction with adequate management of the exchange rate appear to be fundamental. According to our finding, a currency depreciation, by itself, has a negative impact on the level of output, Borgoeing(2002), Garcés(2003) and Kamin and Rogers(2000). However, if it is combined with adequate fiscal and monetary policy, it can help to sustain a growth resumption strategy in conditions of balance of payments equilibrium. However, in the long run other measures to improve competitiveness would be required.

In conclusion, we would like to emphasize that during the last two decades Mexico’s economic authorities have faithfully followed the recommendations endorsed by the so-called “Washington Consensus”, which are supported by the economic mainstream. The results so far achieved with this economic strategy have not been satisfactory; to say the least. Other schools of thought criticize the recommendations of conventional thinking. This is notably the case of Keynesian economics, and of Latin American Structuralism. According to our results, their criticisms appear to be justified.

Appendix A

VAR(1) Model: single equation diagnostic checks 1980(3)-2000(1).

Variable	Autocorrelation F(5,56)	Normality $\chi^2(2)$	ARCH (1) F(4,59)	Heteroskedasticity F(16,50)	Hetero-X test $\chi^2(44,22)$
DLPIB	3.3948 [0.0095]**	1.5187 [0.4680]	0.86700 [0.4892]	1.1436 [0.3441]	0.69097 [0.8537]
DLITCR	1.8324 [0.1213]	10.526 [0.0052]**	0.39496 [0.8114]	0.56104 [0.8976]	0.43373 [0.9909]
Dm2	3.2961 [0.0112]*	0.59995 [0.7408]	1.3082 [0.2775]	0.86481 [0.6102]	1.2529 [0.2889]

VAR(1) Model: joint diagnostic checks 1980(3)-2000(1).

Ho	Autocorrelation F(45,149)	Normality $\chi^2(6)$	ARCH (1) F(96,261)	Hetero-X test $\chi^2(264,110)$
Joint Tests	1.1287 [0.2911]	13.067 [0.0420]*	0.69424 [0.9807]	0.62762 [0.9987]

Appendix B

A brief discussion on the stability of VAR (P) models and their VECM representations.

As we have discussed in the first chapter of this dissertation a VAR (P) can be seen as a linear dynamic system with its associated stability conditions as follows.

(1) $Z_t = \sum_{i=1}^{p} \Pi_i Z_{t-i} + U_t$

Which is stable if

$\det(I - \Pi_1 y - .... - \Pi_p y_p)$

has no roots in and on the complex unit circle.

A simple but useful linear transformation of system (1) which can facilitate the interpretation of a VAR model, in the presence of cointegrated non-stationary variables, is the so called VECM model. Such representation does not consist in just taking first differences of all the variables in the VAR but it implies a mapping from Z_t, Z_{t-1}, Z_{t-2} to ΔZ_t, ΔZ_{t-1} Z_{t-1}, where the first lag of the model remains in levels. We can then say that a VECM model[20] is just a re-parameterization of the original VAR model which preserves the mathematical structure of the latter.

In order to clarify the nature of such linear transformation lets discuss two examples. First, assume that we have an autoregressive-distributed lag model as follows:

(2) $Y_t = \beta_1 Z_t + \beta_2 Y_{t-1} + \beta_3 Z_{t-1} + \xi_t$

Letting $\Delta Y_t = Y_t - Y_{t-1}$ and mapping (Z_t, Z_{t-1}) to $(\Delta Z_t, Z_{t-1})$ we obtain a linear transformation the so-called general equilibrium-correction model which is isomorphic to the autoregressive-distributed lag model (2) when $\beta_2 \neq 1$:

(3) $\Delta Y_t = \beta_1 \Delta Z_t + (\beta_2 - 1)(Y - K_1 Z)_{t-1} + \xi_t$

Where $K_1 = (\beta_1 + \beta 3)/(1 - \beta_2)$

[20] A VECM model is the system estimated in this chapter.

Second, this type of stable re-parameterizations can be extended to systems of equations. In fact, Engle and Granger (1987) established the isomorphism between cointegration and equilibrium-correction models (ECMs). Let X_t be an n X 1 vector of I(1) time series, so that ΔX_t ~ I(0). Then the components are cointegrated if $\beta' X_t$ is I(0) for some β. For n elements in X_t, when β is an n X r matrix there are r linearly-independent, cointegrating relationships between the Xs, and n – r combinations which are I(1). If r=n, then X_t must be I(0), so we exclude that case as X_t is I(1); similarly, if r=0, there is no cointegration. When r > 0, the { X_t } process can be expressed in I(0) space in terms of r cointegrating combinations $\beta' X_t$ and n –r first differences, denoted $\Delta X_{at} = \beta'_{\perp} \Delta X_t$ where $\beta_{\perp}$ is an nx(n – r) matrix of rank (n – r) orthogonal to β. In effect, we map X_t to ($\beta' X_t : \beta'_{\perp} X_t$) = GX_t (say) where G is non-singular n x n. The first block are I(0) and the second I(1), so need to be differenced to become I(0). This formalizes the fact that there are other ways to remove unit roots than differencing.

The simplest case is when X_t is generated by the first-order vector autoregression (VAR):

(4) $X_t = \delta + AX_{t-1} + e_t$ where $e_t \sim | N_n[0, \Sigma]$.

Since linear models are invariant to linear transformations, and lag functions of levels of X_t can be transformed to differences and a single levels vector, the VAR can be reparameterized as:

(5) $\Delta X_t = \delta + (A - I)X_{t-1} + e_t = \delta + \pi X_{t-1} + e_t$.

When r = 0, no levels combinations of X_t are I(0) and since ΔX_t and e_t are I(0), then π must be 0. Similarly, when r = n and X_t is I(0), then π must be full rank n. Otherwise, π has rank r for n > r > 0, and so π can be expressed as the product of two n X r matrices of rank r, denoted by α, β so $\pi = \alpha\beta'$. Thus, the system in (5) can be written as:

(6) $\Delta X_t = \delta + \alpha\beta' X_{t-1} + e_t$,

Where $\beta' X_{t-1}$ are the I(0) cointegrating combinations, or ECMs, so (6) provides a generalized ECM stable representation.

4. Modelling the peso-us exchange rate movements and their volatility: non-linear dependence and thick tails

4.1 Introduction

It is widely known that the evolution of nominal exchange rates affects not only to the dynamics of financial markets but also to the workings of the economic activity through very different channels (Taylor, 1995). For instance, high exchange rate variability affects import and export prices which might induce a significant output fall at an aggregate level. Even more, erratic exchange rate fluctuations have been often associated with the emergence of financial crisis, the weakening of economic growth and the redesigning of monetary and fiscal policies at a worldwide level.

Therefore, it is of paramount importance to reach some consensus regarding appropriate models of exchange rate changes, which provide sensible theoretical explanations of the underlying economic behavior shaping such variations and at the same time account for the stylized facts present in the data (*probabilistic features of the data*[1]). In other words, we need to determine not only a statistical characterization of the distribution of exchange rate changes, but also an adequate theoretical description of the workings of a market which could account for such distribution (Pesaran, 1993). In order to do so, we need to study the economic behavior of speculators –technical

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[1] When we talk about probabilistic features of the data, we are referring to the statistical distribution, patterns of probabilistic dependence and heterogeneity of the data.

analysts- since appreciations and depreciations, and the probabilistic features of exchange rate changes, must be explained as the outcome of the economic behavior of such market participants.

Thus, the main objective of this chapter is to provide a reasonable theoretical explanation of exchange rates' behaviour and specify an appropriate statistical model of the Peso-US exchange rate variations. In other words, we want to provide a simple explanation of the underlying economic mechanism which governs exchange rate movements over time and a congruent statistical model of them. We show that the student's t autoregressive model with dynamic heteroskedasticy, *Star (l,p,v),* proposed by Spanos (1992), is an adequate specification of exchange rate dynamics from the statistical and economic points of view. Such econometric model constitutes an alternative to the ARCH-type specifications for modelling "speculative prices". It has the advantage that it takes into account all the "stylized facts", widely accepted in the quantitative financial literature, such as: bell shape symmetry, leptokurticity, non-linear dependence and second-order stationarity (Kendall, 1953; Mandelbrot, 1963; Engle, 1982 and Bollerslev, 1994).

This chapter is structured as follows. The second section briefly discusses our theoretical framework. The third section includes an overview on the probabilistic features of the Peso-US exchange rate variations. The arguments of this section lead us to choose the *Star (l,p,v)* model as a reasonable econometric model which accounts for all the stylized facts about exchange rate changes. The fourth section discusses the specification and estimation issues regarding the *Star(l,p,v)* model. The fifth section reports the estimates of our model and we associate them to the behavior of exchange rate changes. The last section reports our conclusions on the topic.

4.2 Theoretical framework

In this section we briefly describe our economic theory on exchange rates´ behavior, which is based on some Post-Keynesian ideas about the workings of exchange rate markets. This framework will provide us with some useful insights on the appropriate econometric specification for modeling exchange rate changes.

The following discussion is based on conjectures from the work of many economists about the underlying economic mechanism governing exchange rates behavior, including Keynes' work. The originality of the following theoretical argument resides in that our theory not only accounts for the underlying economic behavior of agents in the speculative markets but also accounts for the probabilistic structure of the data (stylized facts) as we will see later on.

An initial assumption of our theory is that exchange rate dynamics are mostly shaped by the behavior of the participants of the market. Specifically, we are talking about market speculators, known as technical analysts[2]. That is, we postulate that appreciations and depreciations are the outcome of the economic behavior of such market participants.

We also assume that in a Keynesian world individuals have to make decisions under true uncertainty[3] and they do so by making use of conventions. For example, a good convention will be the use of other agent's expectations, about exchange rate

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[2] For excellent arguments supporting this assumption, see Frankel and Froot, (1986); Schulmeister (1988) and Pesaran (1993).

[3] See Keynes (1936), especially chapters 5, 12, 15 and 17. See also Crotty (1991) for a complete discussion on the concept of uncertainty from a Keynesian point of view. In a Keynesian world individuals can never have complete knowledge of the future since economic outcomes depend on current and future agent choice as well as the future pattern of institutional change, both of which are inherently unpredictable.

returns, to forecast such returns. In other words, we hypothesize that in the real world agents make use of a simple rule rather than use a more complex model to face uncertainty. If that is the case, then the main task of every agent is to try to predict the expectations and future actions of other agents who can be considered as opinion leaders (Steindl, 1956; Crotty, 1997). Then, in the real world agents expectations might be considered dependent of each other.

On the other hand, we also assume that the leading technical analysts are not capable of assessing the true effect of news in the market so that the effect of new information on the level of transactions and the market price may under-or-overshoot. For example, if some economic or political news arrive, the leading dealers might suddenly change their expectations on the new equilibrium level of the returns by an amount that exceeds the real change in the value of the assets.

In consequence, a sudden change in expectations might generate an unexpected change in the number of transactions and, given our assumption of dependence of agent's expectations, that will provoke that new dealers join to the buying and selling trends reinforcing the dependence of changes through time. This trend might give rise to a non uniform number of transactions over time.

In few words, our theory states that the existence of conventions helps generate an atmosphere of confidence among agents. However, such confidence can be suddenly undermined since the prevailing opinion is unstable, and is subject to unexpected and violent changes (Keynes, 1936; Steindl, 1956).

Even more, the degree of confidence regarding the adequacy of the previous rule may weaken soon; and ends when a majority of agents lose faith in the conventions that sustain the expectations-generating process. We can say that conventions are unstable since opinion shifts to new leaders after some time, leading to sudden new changes in transactions and prices. That is the moment when a market bubble bursts giving rise to a new dependent pattern of exchange rate changes. In the next section we discuss the stylized facts and their implications for postulating an adequate economic theory on the dynamics of exchange rates.

4.3. Probabilistic features of exchange rate variations (the stylized facts)

As a preliminary step to propose an appropriate conditional model for exchange rate changes, we first discuss the stylized facts which have been influencing the development of different volatility models in the last century. This discussion is useful since in selecting our model we will take into account not only a theoretical model but also the probabilistic structure of the data on hand.

Such preliminary analysis can be performed by using a set of graphical techniques which are useful guide to choose an appropriate model of exchange rate returns, Spanos (1986).

Below we show a t-plot of the standardized log difference of the weekly spot rate of the Mexican peso vis-à-vis the US dollar[4], recorded every Wednesday over the period November 1993 through April 2005[5] (T=2995). We also show the kernel estimate of the univariate density of returns (Silverman, 1986) and a graph of the recursive variance of exchange rate changes.

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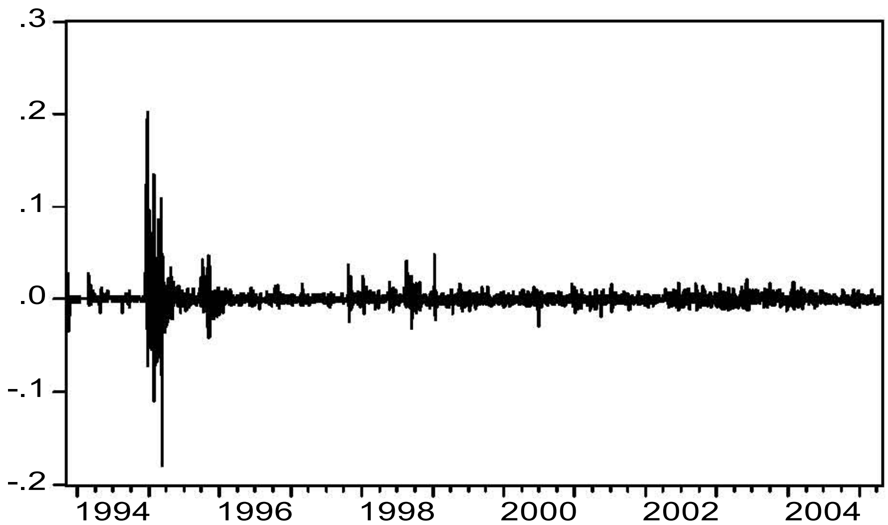
[4] The exchange rate differences are standardized by making use of the sample standard deviation.
[5] Source: Board of Governors of the Federal Reserve System.

Graph 1

Standardized t-plot of the Peso-US dollar exchange rate changes

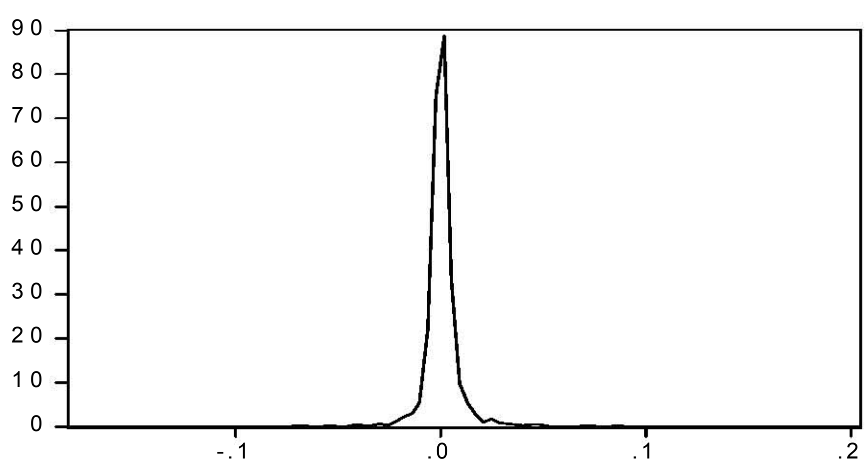
(1993:11:08-2005:04:29)



Graph 2

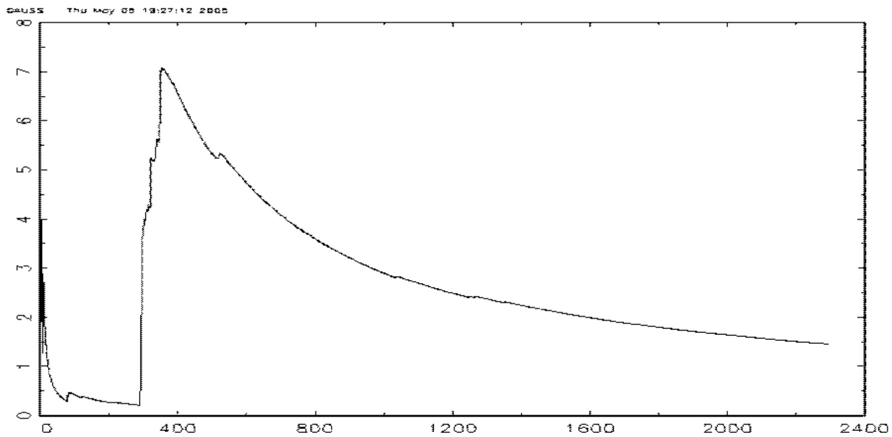
Univariate kernel Density estimate of the Peso-US dollar exchange rate changes

(1993:11:08-2005:04:29)



Graph 3

Recursive variance of the Peso-Us dollar exchange rate changes



An analysis of the stylized facts in the previous graphs allows us to confirm the existence of the following probabilistic features of the data:

The data exhibits symmetry and leptokurticity: According to graph 1, there is a concentration of observations close to the sample mean and the tails of the distribution, Mandelbrot (1963). The kernel estimate of the density of exchange rate changes confirms that the data do not seem to correspond to a normal distribution given the high degree of leptokurticity of the series.

The exchange rate data exhibit second-order temporal dependence: the t- plot exhibits clusters of small and large changes, which are associated to the presence of non-linear probabilistic dependence (Kendall, 1953; Cowles, 1960; Moore, 1962).

Second order stationarity: the sample mean and variance do not appear to change systematically over time (Kendall, 1953).

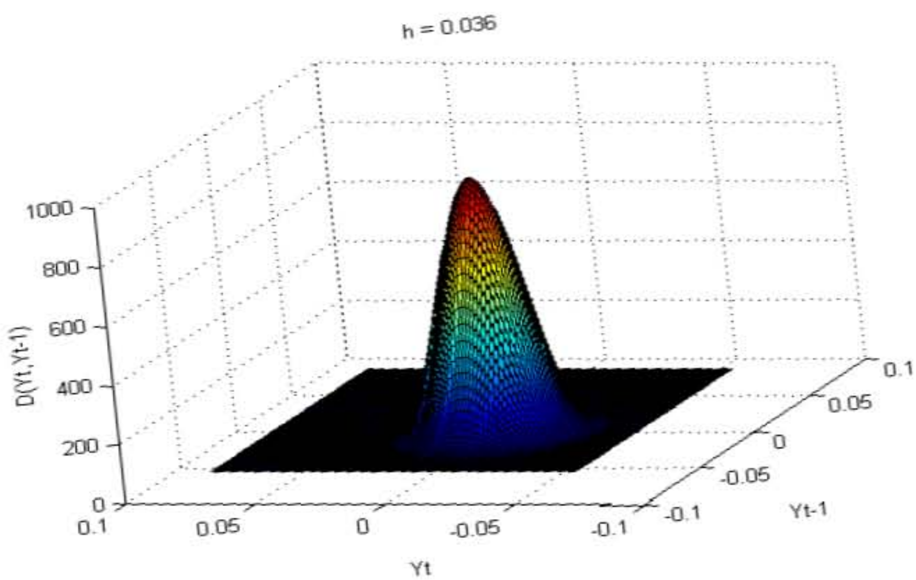
The recursive sample variance seems to be infinite: Mandelbrot found that recursive estimates of the sample variance of speculative prices do not converge. This characteristic is always associated to the existence of volatility clustering and heavy tails.

From this evidence, we are able to conclude that exchange rate changes are stationary since the mean seems to be constant over time, although the variation around the mean is not always constant along the time span (Werner, 1997). On the other hand, the data exhibits non-linear temporal dependence as large and small changes in returns tend to be clustered over time. Besides, the t-plot suggests that the data exhibits bell-shaped symmetry given that there seems to be the same number of points above and below the mean line. However, the normal distribution would not fit well our data since there is a larger concentration of points around the mean and many outliers which are associated to leptokurtosis.

In addition to the previous features we can get more information relating to the joint distribution of exchange rate changes by looking at the bivariate kernel estimates of the density function shown in graph 4 below.

Graph 4

Bivariate normal kernel density estimate for exchange rate changes (y_t , y_{t-1})



At this point, we can infer that the joint distribution is also bell shaped, and exhibits leptokurticity and second order dependence in the form of clusters. Such characteristics make the distribution of the data closer to a Student's t distribution rather than the normal distribution.

In addition to the graphical evidence we report several descriptive statistics regarding exchange rate returns in table 1 below.

Table 1

Sample Statistics for Exchange Rate Returns

Sample Statistics(T=2995)	
	y_t
Mean	0.0004
Variance	0.0001
Skewness	4.2052
Kurtosis	130.393
P-value for the BDS Test	
BDS(1,4)	0.0000
BDS(1,6)	0.0000

The statistics of table 1 show that the sample kurtosis and skewness coefficients reinforce the evidence of non-normality of our data. On the other hand, the p- values of the BDS test (Brock, Dechert, and Scheinkman (1987), for temporal dependence, provide strong support to the hypothesis that our data might exhibit second order dependence. It is worth to mention that such a form of non linear dependence is not compatible with the assumption of normality of returns.

To sum up, we can say that an adequate model of exchange rate changes should account for the *leptokurticity* and *second order dependence* exhibited by the data. We can also conclude that these probabilistic features of the data are not compatible with an economic model based on the typical Normal Random Walk formulation for speculative prices. The latter formulation implies that exchange rate returns should be normal, independent and identically distributed as follows.

$$(1) \quad P_t = P_{t-1} + y_t, \qquad y_t \sim \textbf{NIID}\ (0, \sigma^2) \qquad t \in \mathrm{T}$$

Where P_t is the stock price and y_t is the change in the stock price (exchange rate changes). The random walk model states that the returns have a zero mean and constant variance which might imply that returns follow an ergodic stochastic economic model. That is, a model where future outcomes (exchange rate fluctuations) are independent of any previous pattern of current agent choice. "A World in which agents' decisions do not create the future", where the future path of the asset prices is pregiven and independent of agent forecasting errors (Crotty, 1997).

On the contrary, the stylized facts reveal that exchange rate returns or the conditional forecast error of such variations might have the following probabilistic structure.

$$(2) \quad P_t = \beta_0 + \sum_{i=1}^{l} \beta_i P_{t-i} + y_t, \qquad y_t \sim \textbf{St}\,(0, \omega_t^2, \upsilon) \qquad t \in \mathrm{T}$$

Where ω_t^2 is the conditional variance of y_t given that we know all its past values, and St refers to the student's t distribution. This stochastic formulation (2) is very different from the previous one (1). Indeed, (2) states that exchange rate returns have zero mean, a time changing conditional variance (ω_t^2) and numerous sudden large changes and small changes in returns. These probabilistic features suggest that market players are facing a non-ergodic, ever changing economic and social environment. That is, economic outcomes follow a stochastic model whose future depends on current agents' choice as well as on uncertain institutional changes.

4.4. Student's t autoregressive model with dynamic heteroskedasticity

From the previous analysis we can conclude that the probabilistic features of exchange rate changes data suggest the specification and estimation of a conditional model from the family of non-normal/linear/heteroskesdastic distributions. We propose this type of models because the t-plots and bivariate plots reveal that the data exhibits symmetry, leptokurticity, stationarity and the t-plots show the presence of second order dependence in the form of clusters of small and large changes (Spanos, 1993). More specifically, the student's t AR model with conditional heteroskedasticity (Spanos; 1990, 1994) results appropriate given the nature of our data. These types of models imply to model not only the conditional mean of the stochastic processes behind the data but also the conditional variance, which is often associated to uncertainty in the econometric literature.

The student's t Autoregressive model takes the form:

$$y_t = \beta_0 + \sum_{i=1}^{l} \beta_i y_{t-i} + u_t, \quad l > 0, t \in N$$

$$\omega_t^2 = [\nu / \nu + t - 3]\sigma^2 + \left[1 + \sum_{i=1}^{t-1} \sum_{j=-p}^{p} q_{|j|} (y_{t-i} - \mu)(y_{t-j-i} - \mu)\right]$$

Where $u_t = y_t - E[y_t / \Im_{t-1}]$ is distributed St$(0, \omega_t^2, \upsilon)$, ω_t^2 is the conditional variance, $\mu \equiv E(y_t)$, υ>2 is the degrees of freedom , $\Im_{t-1} = \sigma(Y_{t-1}^0)$ is the conditioning information set generated by the past history of y_t, $Y_{t-1}^0 = (y_{t-1}, \ldots, y_1)'$, l is the highest lag in the conditional mean, and [-p,p] is the window of the local "smoothing" in the conditional variance (l≥ p).

From the previous equations we can conclude that the conditional mean of the Student's t model is linear in the conditioning variables; and the conditional variance is a quadratic function of all past conditioning information, but it is parameterised with only p+1 unknown $q_{j's.}$ We could say that the conditional variance is simply a sequentially smoothed version of the unconditional variance.

Under stationarity, the log-likelihood function for the Student's t Autoregressive model can be written in terms of a recursive decomposition of the density function D(y;ϕ,υ) (Spanos, 1993) and is given by (ignoring the p initial conditions):

$$ln \propto -\frac{T}{2} ln(\pi) + ln\left[\Gamma\left(\frac{1}{2}(\upsilon+T)\right)\right] - ln\left[\Gamma\left(\frac{\nu}{2}\right)\right] - \frac{T}{2} ln\left(\upsilon\sigma^2\right) - \frac{1}{2}\sum_{t=p+1}^{T} ln\left(c_t^2\right) - \frac{1}{2}\sum_{t=p+1}^{T}(\upsilon+t) ln\left(\gamma_t^2\right)$$

where $\gamma_t^2 = \left[1+\left(\frac{u_t^2}{\upsilon\sigma^2 c_t^2}\right)\right]$, $c_t^2 = \left[1+\left(Y_{t-1}^0 - 1_{t-1}\mu\right)' Q_{t-1}\left(Y_{t-1}^0 - 1_{t-1}\mu\right)\right]$, Q_{t-1} is a p-banded persymmetric matrix, being the inverse of the temporal "covariance" matrix of $Y_{t-1,}$ denoted Vt-1. Vt-1 is a (t-1) dimensional positive definite, symmetric Toeplitz matrix, and if its elements die out "sufficiently quickly" with $|t\text{-}s|$, the model will be operational for small values of p and l.

Some issues arise while estimating the Student's t model. First, the mean and conditional variance must be estimated jointly as they are related through the parameters of the joint distribution. Second, the sample unconditional moments should be used as the starting values for the estimation algorithm, since the unconditional moments and the coefficients of the conditional distributions are related. Third, the choice of l, p and ν[6], must be guided by the search of the model that accounts for all the probabilistic features of the data.

[6] There is no Maximum Likelihood estimator for the parameter ν of the Student's t distribution.

4.5 The empirical evidence and the economics of exchange rates fluctuations

The main objective of this section is to model and explain the financial speculative gains' dynamics in the foreign exchange rate market. In order to do so, we estimate the *star (l, p,v)* model for the Peso-US exchange rate changes. Taking stock of our estimated model, we then propose a very simple theoretical construct, about the workings of the foreign exchange market. Our theoretical construct is consistent with the stylized facts of the second section, and supports Keynes's view of decision-making under uncertainty. We find that a model like the Student's t autoregressive model, proposed by Spanos, is a sensible specification that captures both the economic and probabilistic behavior of returns in the exchange rate market.

First, we proceed to estimate the star(l,p,v) model for the exchange rate changes. This model was estimated using the weekly spot us-peso exchange rate for the period for the period 1996-2004[7]. Table 2 shows the Maximum Likelihood estimates of the Student's t autoregressive model, STAR(3,3,9). Where Δspot_1, Δspot_2, Δspot_3 refer to the lagged exchange rate changes and Lij's refer to the parameters of the conditional variance. It is worth to say that the STAR model makes a good fit of the actual values.

7 The estimation was carried out using a GAUSS routine.

Table 2

Star(3,3,9) model of Exchange Rate Returns
(3 lags in the conditional mean, 3 lags conditional variance and 9 degrees of freedom)

Parameters	Estimates	Standar error.	P-values
Δspot_1	0.0250	0.0246	0.3089
Δspot_2	-0.0026	0.0243	0.9158
Δspot_3	-0.0618	0.0247	0.0122
mu	0.0010	0.0053	0.8423
sigma	0.4281	0.0080	0.0000
L11	2.3230	0.0432	0.0000
L21	-0.0204	0.0286	0.4754
L31	0.0021	0.0285	0.9411
L22	2.3202	0.0432	0.0000
L32	-0.0176	0.0287	0.5390
L33	2.3265	0.0432	0.0000

The results of the star (3,3,9) model can be summarized as follows. According to the statistical tests we have that: (a) the third lag (Δspot_3) of the conditional mean is statistically significant, and b) the model has very significant dynamic heteroskedasticity effects, the coefficients of (L11), (L22) and (L33). These two facts may indicate that the simple random walk and martingale explanations of exchange rates are inappropriate for the data on hand, see equation (1) of section 2. On the whole, our estimates confirm that leptokurticity and second order dependence are two empirical patterns present on exchange rate changes.

Let us now consider the underlying economic mechanism in relation to our estimated statistical model. As we have already said, the use of other individual's expectations, about exchange rate returns, to forecast our own returns is probably a good convention. Then, our finding of significant lagged exchange rate changes seems reasonable from an economic point of view given that in the real world agents expectations might be considered dependent of each other. The leptokurtic distribution can be associated to the fact that the leading technical analysts are not capable of assessing the true effect of news on the level of transactions and, as a consequence, the market price may under-or-overshoot, Fujihara and Park (1990).

Even more, the second order probabilistic dependence pattern might be associated to the abrupt change in the number of transactions, in the same direction, resulting from the dependence of agent's expectations that will provoke that new dealers join to the buying and selling trends (within some hours) reinforcing the dependence of changes through time, Osborne (1962).

4.6 Final Remarks

We can conclude with the following remarks. First, the exchange rate returns setting process is shaped by speculators who with their actions generate the leptokurtic and dependent pattern of exchange rate dynamics (Wermer, 1997). Second, this pattern can be captured by the star(l,p,v) model. Third, the main hypothesis is that the participants in the forex market are interested in future appreciation or depreciation and have dependent expectations on the direction in which prices are going to change and their speculative activity generates the probabilistic patterns of the data. Fourth, the existence of different expectations is in fact needed to ensure the maintenance of equilibrium in the market plus the existence of a long run equilibrium value (or set of equilibrium values).

Conclusion

In this dissertation we have investigated the workings of some key macroeconomic variables of the Mexican economy and the interactions among them, based on a Keynesian-Structuralist framework. We do so by applying a relatively novel econometric methodology which allows us to "learn from the data" increasing our chances of improving our empirical knowledge of economic phenomena (Spanos, 1986).

Three are the main contributions of this study. First, we provide reliable evidence supporting the validity of some of the main hypothesis of the Keynesian-Structuralist school of economic though for Mexico. We explain, for instance, the economic and empirical behavior of variables such as the nominal exchange rate, nominal wage and output and describe some of the associated transmission mechanisms in terms of a Keynesian-Structuralist perspective.

The second contribution of this work is in terms of the econometric methodology used. We show that the PR approach to empirical modeling constitutes a useful framework to reach reliable inferences about economic phenomena. In chapter one of this dissertation we show the advantages, in terms of reliability of inferences, of this approach compared to the textbook approach to econometrics.

The third contribution is the application of a system approach to model the evolution of Mexico's macroeconomic variables. Specifically, we refer to the use of cointegrated systems of equations (VECH-M) and SVAR models to capture the interdependencies of the data for the applied work. The use of such models for applied work on Mexico has been scarce although a promising way to attack empirical problems.

Regarding our main specific findings, in chapter one we show that a misguided econometric methodology may affect the reliability of all inference procedures that are performed with econometric models such as the VAR model: forecast, Granger causality testing, cointegration analysis, impulse response analysis and variance decomposition. Therefore, we propose the use of the PR approach (Spanos, 1986) as a good practice to ensure that the final result of the modeling process is an adequate model from the empirical and economic points of view.

In the second chapter, we want to identify the factors that govern the behavior of money wages in the manufacturing sector and in the maquila industry in Mexico. Such objective was accomplished by using modern econometric techniques, with specific emphasis on the use of congruent econometric models from statistical and theoretical viewpoints and the SVAR methodology. Our main empirical findings show that money wages are jointly determined in both industries, and that a relatively similar set of conditioning variables determines their dynamics (López, 2006; Carrillo, 2003; Herrera, 2000). More particularly, it is found that money wages in both sectors depend on shocks to underemployment and on the specific conditions of the sector, the latter summarized by output growth in the manufacturing sector and by productivity growth in the maquila industry (Bendesky, Godínez and Salas, 2004). Such results let us conclude that wage behaviour in those two industries in Mexico can be successfully explained by theories of wage determination that emphasize the institutional aspects of the labor market, and that take into account the dual or segmented structure of the labor market in today's capitalism, in conjunction with some of the ideas proposed by Keynes in his General Theory.

Our econometric results show, first, that US economic growth is dramatically important for Mexico's long-run evolution. This finding validates the emphasis that the Latin American Structuralist school of though, as well as the Post Keynesian approach, put on the external constraint on growth (Loría, 2003). Second, money and government spending have a positive impact on output. Third, we find that rationing of credit plays a negative role on output (López, 2003). These last two results are compatible with the principle of effective demand supporting our research and with the post Keynesian and new Keynesian views about the expansionary effects of liquidity and money on output (Minsky, 1975, 1982; Davidson, 2002; Blinder, 1987; Greenwald and Stiglitz, 1988). They also contradict alternative visions. Most importantly, they discard the macroeconomic outlook whereby government intervention would have harmful consequences for the economy (Barro, 1974), and money would not have any real effects on output (Lucas, 1972). A fourth important finding of our work shows the existence of an inverse association between the real exchange rate and output (Kamin and Rogers, 2000; Garcés, 2003). In other words, currency depreciation would depress output when it is not accompanied with complementary policy measures. This result supports the contractionary devaluation hypothesis, which has given rise to a long debate, mostly in Latin America (Diaz-Alejandro, 1963; Krugman and Taylor, 1978). It also runs counter the supposed expansionary effect of currency depreciation, assumed in conventional macroeconomic thinking (Dornbusch and Werner, 1994).

Finally, in chapter four we discuss the dynamics of exchange rate determination and estimate a model of the dynamics of the Peso-US dollar exchange rate variations.

We can conclude with the following remarks. First, the exchange rate returns setting process is shaped by speculators who with their actions generate the leptokurtic and dependent pattern of exchange rate dynamics, which can be captured by the star(l,p,v) model (Werner, 1997). Second, the main hypothesis is that the participants in the forex market are interested in future appreciation or depreciation and have dependent expectations on the direction in which prices are going to change and their speculative activity generates the probabilistic patterns of the data. Third, the existence of different expectations is in fact needed to ensure the maintenance of equilibrium in the market plus the existence of a long run equilibrium value (or set of equilibrium values)

A final remark on the empirical aspects of this work is the following. One of the oldest uses of econometrics has been to provide empirical evidence on the theoretical economic relationships postulated by economic theory. That is econometrics has been understood as an instrument which allows us to test the validity of economic theory. However, nowadays the usefulness of econometrics to reach such an objective is far from being reached given the huge amount of econometric conflicting evidence which do not allows us to learn from data and use it to verify our assertions. Does this imply that econometrics can be seen as a tool which do not allow us to have improvements or that it can not played the role of giving support to theories? The answer is NO, what it is needed is the use of appropriate econometric methodology that help us to close the gap between theoretical concepts and data, allowing us to reach real empirical knowledge on the workings of economic phenomena.

References

Andreou, E. Pittis, N. and Spanos A., (2001) “On Modeling Speculative Prices: the empirical literature.” Journal of Economic surveys. Vol. 15. No. 2.

Bendesky, L., de la Garza, E., Melgoza, J. and Salas, C. (2004) “La industria maquiladora de exportación en México: mitos, realidades y crisis", Estudios Sociológicos. Vol. XXII, núm. 65, mayo-agosto, 2004.

Bergoeing, R., P. J. Kehoe, T. J. y R. Soto. (2002). “A Decade Lost and Found: Mexico and Chile in the 1980s and 1990s”, NBER Working Papers Series, WP 8892.

Bollerslev, T and M. Melvin., 1994b. “Bid-ask Spreads and Volatility in the Foreing Exchange Market: an Empirical Analysis”. Journal of International Economics.

Bollerslev, T., (1986) “Generalized Autoregressive Conditional Heteroskedasticity” Journal of Econometrics 31, 307-327.

Brock, William, Davis Dechert, Jose Sheinkman & Blake LeBaron (1996). "A Test for Independence Based on the Correlation Dimension," Econometric Reviews, August, 15(3), 197-235.

Buitelarar, R. and Padilla, R. (2000) “Maquila, economic reform and corporate strategies”, World Development, 28(9):1627-1642.

Burdett, K., and D.T. Mortensen (1998) “Wage differentials, Employer Size and Unemployment,” International Economic Review, 39, 257-273.

Campos, J., N.R. Ericsson and D.F. Hendry (2005), Editors' Introduction to General to Specific Modelling, Edward Elgar. Forthcoming

Carrillo, J. and De la O, M. (2003) “Las dimensiones del trabajo en la industria maquiladora de exportación en México”, in E. De la Garza and C. Salas (Eds.), La situación del trabajo en México, 2003, Plaza y Valdéz, México City

Commendatore, Salvatore D´Acunto, Panico, Pinto, (2002). “Keynesian theories of growth”, Edwar Elgar.

Cowles, A. (1933). “Can Stock Market Forecasters Forecast”. Econometrica, 1, 309-324.

Dickey, D.A., Fuller, W.A.,(1981), “Likelihood ratio statistics for autoregressive time series with a unit root”. Econometrica 49, pp. 1057-1072.

Doeringer, P. and Piore, M. (1971) “Internal labor markets and manpower analysis”. Lexington, Mass., D.C. Heath.

Doornik, J. And Hendry, D. (2001) “Modelling dynamic systems using PcGive 10”. Timberlake Consultants Ltd. London.

Enders, W., “Applied Econometric Time Series”, John Wiley and Sons Inc, 1995.

Engle, R.F. 1982., “Autorregresive Conditional Heteroskedasticity With Estimates of the Variance of the United Kindongm Inflation”, Econometrica 50, 987-1008.

Fairris, D. and Levine, E. (2004), “La disminución del poder sindical en México”, El Trimestre Económico, vol LXXI(4), num. 284, pp. 847-876.

Frankel, J. (2000). "Assessing the Efficiency Gains from Further Trade Liberalization." Harvard University.

Fujihara, R. and Park, H., (1990). “The Probability Distribution of Futures Prices in the chance rate market”

Garcés, D. (2003). “La relación de largo plazo del PIB mexicano y de sus componentes con la actividad económica en los estados unidos y con el tipo de cambio real”. Documento de investigación, No. 2003-4, Banco de México.

González, M.L. (2005), “Mercados laborales y desigualdad salarial en México”, El Trimestre Económico, Vol. LXXII(1), num. 285, pp.133-178.

Greene, W., “Econometric Analysis”, Prentice Hall, 2000.

Hall, S. G., S. Henry and J. Greenslade (2002) “On the Identification of Cointegrated Systems in Small Samples: a modeling strategy with an application to UK wages and prices”. Journal of Economic Dynamics and Control 26, 1517-1537.

Hamilton, J. D., “Time Series Analysis”, Princeton, Princeton University Press, 1994.

Hendry., (2003), Sargan and Origins of LSE methodology, Econometric Theory, 19

Hoover and Perez (2000), “Three attitudes towards data mining”, Journal of Economic Methodology, 7(2), 195-210.

Hendry, *D.F.* (2001) Econometrics: Alchemy or Science? 2nd Edition. Oxford: Oxford University Press. (ISBN 0-19-829354-2)

Hendry, *D.F.* (1995). Dynamic Econometrics. Oxford: Oxford University Press. (ISBN 0-19-828317-2)

Hernández, Laos (2000) “Políticas de Estabilización, Ajuste y Distribución Funcional de Ingreso en México”, Comercio Exterior, February.

Herrera, F. and Melgoza, J. (2003) “Evolución reciente de la afiliación sindical y la regulación laboral”, in E. De la Garza and C. Salas (Eds.), La situación del trabajo en México, 2003, Plaza y Valdéz, México City.

Huerta, R. Y López, J. (2007). “Restricción externa, ventajas comparativas y crecimiento económico de México”. Mimeo.

Johansen, S. (1988), "Statistical Analysis of Cointegration vectors", Journal of Economic Dynamics and control, 12, pp. 231-254.

Johansen, S. and Juselius, K. (1990) "Maximum Likelihood Estimation and Inference on Cointegration With Application to the Demand for money". Oxford Bulletin of Economics and Statistics 52, pp. 169-210.

Kamin, S. and Klaun, M. (1997) "Some Multi-country Evidence on The Effects of Real Exchange Rates on Output," BIS Working Papers No 48, Bank of International Settlements, Besle

Kamin, S. and Rogers, J., (2000) "Output and the Real Exchange Rate in Developing Countries: an application to Mexico." Journal of Development Economics, Vol. 61, 85-109.

Kendall, M., (1953). "The Analysis of Economic Time Series, Part I: Prices", Journal of the Royal Statistical Society.

Krugman, P. and Taylor (1978), "Contractionary effects of devaluation", Journal of International Economics November.

Laidler, D., "La demanda de dinero", Antoni Bosh, 1985.

Lindbeck, A. and Snower, D. (2001) “Insiders versus Outsiders”, Journal of Economic Perspectives, 15,1, Winter 2001, 165-188

Lindbeck, A. and Snower, D. (1986) “Wage Setting, Unemployment and Insider Outsider Relations”, American Economic Review, 76, 235-239

López, A and López J; (2006) “Manufacturing Real Wages in Mexico: The Role of Macroeconomic factors”. Mimeo.

López, J. (1999): “The Macroeconomics of Employment and Wages in Mexico”, Labour, 13,4, 859-878.

Loría, E. (2003) “The Mexican Economy: Balance of Payment Constrained Growth Model. The importance of the exchange rate, 1970-1999”, en Journal of Post Keynesian Economics. Vol. 25, Núm.4.

Loría, E. (2003) “A Disaggregate Analysis of the External Constraint to Growth for the Mexican Economy 1980-2000: A post Keynesian Approach”, International Journal of Development Issues. The University of Sydney. Vol. 2, No. 1. June 2003. Pp. 105-126.

Mandelbrot, B. (1963), “The Variation of Certain Speculative Prices”. The Journal of Business, Vol. 36, No. 4, 394-419

Marshall, A. (1999) "Wage determination regimes and pay inequality: A comparative study of Latin American countries", International Review of Applied Economics, 13(1): 23-39.

McGuirk, A., Robertson, J and Spanos A., (1993). “Modelling Exchange Rate Dynamics: Non-linear Dependence and Thick Tails”. Econometric Reviews 12, 33-63.

Meza L. (1999) “Cambios en la estructura salarial de México en el periodo 1988-1993 y el aumento en el rendimiento de la educación superior”, El Trimestre Económico, No 262: 189-226.

OECD (1996) “Mexico”, OECD Economic Surveys, Paris: OECD.

Mortensen, D.T., (2003), “Wage Dispersion: Why are Similar Workers Paid Differently”. Cambridge MA. Press.

Moore, A., (1962). “Some Characteristics of Changes in Common Stock Prices. In P. Cootner (ed.), 1964. “The Random Character of Stock Market Prices”. Cambridge Mass: MIT Press.

Osborne, M., (1962). “Periodic Structure in the Brownian Motion of Stock Prices” Cambridge Mass: MIT Press.

Pagán, J. and Tijerina, J. (2000) “Increasing wage dispersion and the changes in relative employment and wages in Mexico’s urban informal sector:1987-1993”, Applied Economics, 2000 (32):335-347.

Pesaran, B; Robinson, G.; (1993); “The European Exchange Rate Mechanism and the Volatility of the Stearling-Deustschemark Exchange Rate”; The Economic Journal 421, 1418-1431.

Pesaran, M.,Y. Shin, and R. Smith (2000), “Structural Analysis of Vector Error Correction Models with exogenous I(1) variables”. Journal of Econometrics 97, 293-343.

Phillips, P.C.B., Perron, P., (1988). “Testing for unit roots in time series regression”, Biometrika 75, pp. 335-346.

Ramírez, M.D. (2004), “Desigualdad salarial y desplazamientos de la demanda calificada en México 1993-1999”, El trimestre económico, Vol. LXXI(3), num. 283, pp. 625-680.

Salas, C. and Zepeda, E. (2003) “Empleo y salarios en el México contemporáneo”, in E. De la Garza and C. Salas (Eds.), La situación del trabajo en México, 2003, Plaza y Valdéz, México City

Salvadori, N. and Panico C, (2004) “Keynesian theories of growth and distribution.” Edward Elgar

Silverman, B. (1986). “Density Estimation for Statistics and Data Analysis”. Chapman and Hall, London.

Sims, C. A. (1972), “Macroeconomics and reality, Econometrica 48, pp.1-48.

Seccarecchia, M. (2003) “Wages and labour markets”, in J. King (Ed.) The Elgar companion to Post Keynesian Economics, Edward Elgar, Cheltenham.

Spanos, A., (2006b) “The Curve-Fitting Problem, Akaike Type Model Selection, and the Error Statistical Approach”, Virginia Tech Working Paper.

Spanos, A. (2006a) "Econometrics in Retrospect and Prospect," pp. 3-58 in Mills, T.C. and K. Patterson, New Palgrave Handbook of Econometrics, vol. 1, MacMillan, London.

Spanos, A. (2005a), "Misspecification and the Reliability of Inference: the t-test in the presence of Markov dependence," Virginia Tech Working Paper.

Spanos, A. (2000b) “Revising Data Mining: hunting with or without a lecense”, Journal of Economic Methodology, 7, pp.231-264.

Spanos, A. (2000a), “Testing for a unit root in the context of a heterogenous AR(1) model”, Processed, Virginia Polytechnic Institute and Technical University, Department of Economics.

Spanos, A. (1999), “Probability theory and statistical inference: econometric modeling with observational data”, Cambridge University Press.

Spanos, A., (1999) “Time Series and Dynamic Models”, Unpublished paper, V.P.I.

Spanos, A. (1995b) “On Theory Testing in Econometrics: Modeling with Non-experimental Data”, Journal of Econometrics, 67, pp. 189-226.

Spanos, A. (1995a) “On Normality and the Linear Regression Model”, Econometric Reviews, 14(2), pp.195-203.

Spanos, A. (1994). “On Modelling Heteroskedasticity: The Student’s t And Elliptical Linear Regression Models”, Econometric Theory 10, 286-315.

Spanos, A. (1993). “The Student´s t Autorregressive Model with Dynamic Heteroskedasticity”. Mimeo.

Spanos, A. (1992). “The Student´s t Autorregressive Model with Dynamic Heteroskedasticity”. Mimeo.

Spanos, A. (1990) “The Student´s t Autoregressive Model with Dynamic Heteroskedasticity”, unpublished paper, VPI.

Spanos, A. (1986), “Statistical Foundations of Econometric Modeling”, Cambridge University Press.

Steindl, S., 1956. “Economic Papers 1941-88”

Stock, J and Watson, M. (2002), "Has the business cycle changed and why?", NBER Working paper 9127.

Taylor, M., 1995, "The Economics of Exchange Rates", Journal of Economic Literature, Vol. XXXIII, 13-47

Thirlwall, A.P. (1979) "The Balance of Payments Constraint as an Explanation of International Growth Rate Differences", Banca Nazionale del Lavoro.

Verner, D. (1999) "The macro- wage curve and labor market flexibility in Tanzania", Processed, The World Bank, Washington.

Watson, M. W., and Stock, J. H., "Vector Auto regressions", Journal of Economic Perspecticves, 15, Number 4, 2001, pp. 101-115.

Werner, A., (1997) "Un Estudio Estadistico Sobre el Comportamiento de la Cotización del Peso Mexicano Frente al Dólar y de su Volatilidad", BANXICO.