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How Long is the Long Run? A Dynamic Analysis of the Spanish Business Cycle

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Abstract

This paper studies the sources of Spanish business cycles. It assumes that Spanish output is affected by two types of shocks. The first one has permanent long-run effects on output and it is identified as a supply shock. The second one has only transitory effects on output and it is identified as a demand shock. Spain seems to have long business cycles, of about 15 years. As restrictive demand policies to control the inflation rate could prove painful and disappointing, supply side policies aimed at reducing rigidities in the product and labor market would be a better way to achieve the same objective.

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SUMMARY

This paper analyzes the sources of business cycles fluctuations in Spain over the last 40 years. The analysis assumes that the economy is driven by two shocks, the first having permanent effects on output and the second having only transitory effects on output. On the basis of the statistical evidence and with the help of a dynamic macroeconomic model, the first is interpreted as a supply shock and the second as a demand shock. Applying this structure to Spanish annual data on output and inflation for 1951-1994 shows that the length of the Spanish business cycle--the period of transition after a shock to a new equilibrium--could be of approximately 15 years. This implies that business cycle research that uses short sample sizes or instruments computed over less than this span could lead to misleading results.

The quantitative analysis shows that the Spanish business cycle, dominated in the short run by demand disturbances, and in the long run by supply disturbances, conforms to the traditional view of economic fluctuations. An historical analysis of the last three periods of recession, concludes that while the first two recessions, 1973 and 1979, were the result of a combination of supply and demand components, the recession of the 1990s was due almost entirely to demand factors. The data suggest that inflation is mainly supply-driven, and although the demand component of inflation was driving inflation down during the last recession, the supply component was increasing steadily. The main policy implication of this paper is that strong disinflationary demand policies could prove both inefficient and very painful for Spain, and that more active supply polices oriented to product and labor market reforms may be needed.

I. INTRODUCTION

The last two decades have seen a sort of revolution in business cycle research. The traditional Keynesian interpretation of macroeconomic fluctuations suggested that in the short run, supply shocks would move output and prices in opposite directions, while aggregate demand shocks would move them in the same direction. Short-run output movements would be dominated by demand shocks while long-run output movements would be dominated by supply shocks, and active demand policies would be the right tools for stabilization purposes. In the long run output would tend to reflect the effects of supply shocks, since the effect of demand shocks would be mostly reflected in prices.

This traditional view of the business cycle was challenged by the influential paper of Nelson and Plosser (1982), who found that US real GNP and numerous other US series were consistent with a stochastic growth model. Their result had fundamental implications for macroeconomics, because standard analyses would have overstated the importance of demand disturbances for business cycle fluctuations. Indeed, Nelson and Plosser argued that a major proportion of US business cycle fluctuations should be assigned to supply shocks. Subsequent research by Watson (1986) and Campbell and Mankiw (1987) reported also similar results. The empirical findings of Nelson and Plosser were contemporaneous to the birth of a new methodology for the study of business cycles, the so-called "real business cycle methodology" (Kydland and Prescott (1982) and Long and Plosser (1983)). This new methodology argued that technology shocks alone could explain the main part of output fluctuations, at least in the United States, and that business cycles were not undesirable but rather the result of the optimizing behavior of agents following technology innovations.

Clearly, issues of central importance to policy makers are under discussion. If output fluctuations are undesirable and demand disturbances are largely responsible for them, there may be a role for government policies trying to mitigate these fluctuations. If instead output fluctuations can be explained by real factors, then the government should try to reduce uncertainties about its policies rather than trying to stabilize the economy. Therefore, a particular policy stance could lead to undesirable results if the source of the fluctuations is different from the one assumed by the policy maker.

In this paper we address the issue of the source of output fluctuations in Spain. Spain is an interesting country because of the distinctive features of its economy. It is the country with the highest rate of unemployment in the developed world, has an important public sector and a very rigid labor market. However, it is also a country which has experienced an intense "technological revolution" after 40 years of isolation during the Franco's dictatorship and the process of European integration. Therefore, one could expect Spain to be a country where both demand and supply policies should have played a role in economic fluctuations.

Research in this area favors the hypothesis of demand disturbances being the main responsible for recent Spanish economic fluctuations. On the one hand, Ortega (1994) finds that an open economy real business model driven by technology shocks is unable to reproduce the main stylized facts of the Spanish business cycle. On the other hand, Dolado and Jimeno (1995), Dolado and Lopez-Salido (1996) and Lopez, Ortega and Ubide (1996), suggest that in the last 20 years Spanish output fluctuations would have been mainly demand driven. Indeed, Dolado and Jimeno assert: "As regards technology and labor supply shocks, they do not seem to have mattered much...". Dolado and Lopez-Salido estimate that demand shocks could account for about 50 percent of output fluctuations in the short run and could be responsible for about 40 percent of the fluctuations of the secular component of output. Lopez, Ortega and Ubide argue that demand shocks alone could explain reasonably well the evolution of the Spanish economy from 1976 to 1994.

A more striking feature of the Spanish economy is that, contrary to the conventional wisdom, these demand disturbances could have had permanent effects on output, due mainly to the hysteretic behavior of the labor market. Hysteresis in the labor market seems to be a general feature of European countries (see Alogoskoufis and Manning (1989)) and is particularly intense in Spain due to factors such as demography, labor market regulation and insider-outsider structures (see Lopez, Ortega and Ubide (1996) for a detailed analysis).

However, the fact that demand policies can have long-run effects on the level of output remains an unusual result deserving further testing. In this paper we want to carry out a detailed analysis of the Spanish business cycle. In order to do so, we want to accomplish three tasks. The first one would be to determine the relative importance of demand and supply disturbances for the fluctuations of output and inflation in Spain. The second one, related to the first one, would be to answer the following question: how long is the long run in Spain? Because all the previous studies, while using very different approaches and econometrics techniques, share a common feature: they use quarterly data for the after-Franco period, or less than 20 years of data. This should be enough to perform business cycle analysis for the U.S. economy, where a cycle lasts normally 6-8 years, but perhaps not for the Spanish economy, where the average cycle identified using a NBER-like method (see Artis *et al.* (1995) and Lopez, Ortega and Ubide (1997)) lasts 15 years! This implies that using short sample sizes, econometric analyses possibly consider a long run which is too short, and the result that demand shocks have a long-run effect may be just due to the fact that the cycle is not completed. In this paper we follow an alternative approach to previous studies and use a longer data span. We use annual data on output and inflation for the period 1951-1994 and specify demand shocks such that they have no long-run effect on output. In doing so we follow the traditional wisdom regarding the distinction between demand and supply shocks, but by using a long data span we allow for the possibility of long cycles. Finally, we perform a historical analysis of the last three recessions to understand the idiosyncracies of each episode.

The main conclusions of the paper are that the length of the Spanish business cycle, defined as the period of transition after a shock to a new equilibrium, could be of approximately 15 years. This implies that business cycle research that uses short sample sizes or instruments, such as impulse response functions computed over less than this period, could lead to misleading results. The quantitative analysis shows that the Spanish business cycle is dominated in the short run by demand disturbances, whereas in the long run supply disturbances play a dominant role, and thus conforms to the traditional view of economic fluctuations. The historical analysis shows that while the first two recessions, 1973 and 1979, were the result of a combination of supply and demand components, the recession of the 1990s was due almost entirely to demand factors, probably caused by the tight monetary policies that followed the process of joining the ERM. In terms of inflation, the data suggest that inflation is mainly supply-driven, and that disinflationary polices relying mainly on demand polices could be ineffective and costly, with a sacrifice ratio over 1.5. We also check for the relationship of these supply and demand components with other variables, finding that the money growth rate causes the demand components, but not the supply ones, and that the growth rate of wages causes the supply components, but not the demand ones.

The rest of the paper is organized as follows. In Section 2, we review the econometric methodology used to identify the shocks. Section 3 carries out the empirical analysis. Section 4 studies the demand and supply components of output and inflation and their relationship with other variables of the Spanish economy. Finally, Section 5 presents our conclusions.

II. Econometric Identification

In this section we review the econometric methodology used for the identification of structural shocks in a bivariate model of output and inflation. The methodology we use is essentially that of Blanchard and Quah (1989). Consider a 2x1 vector $X_t = [Y_t \; \pi_t]$, where Y_t represents output and π_t represents inflation, and assume that it admits the following representation in first differences:

$$\Delta X_t = C(L) e_t \qquad (1)$$

where e_t is a bivariate white noise process with zero mean and variance Σ, and $C(L)$ is a matrix polynomial in the lag operator L, $C(L)=I-C_1L-C_2L^2-....$, satisfying standard regularity conditions.

Equation (1) is a reduced form relation for X_t. However, what is of interest for us are the structural relations leading to (1), and we will discuss below the way of restricting this set of structural relations and how they can be used to draw inference about the structural relations from $C(L)$ and Σ. To be more specific, consider the following structural model:

$$\Delta X_t = D(L) u_t, \qquad (2)$$

where now $D(L)=D_0-D_1L-D_2L^2-....$, and $u_t=[\, u_{st} \; u_{dt} \,]$ is again a vector white noise process with covariance matrix Ω. The main identifying assumption is that one of the shocks, say u_{st}, will have permanent long-run effects on output, whereas the second shock, will have only transitory effects on output. Thus, the matrix of long-run multipliers D(1) will take the form

$$D(1)=\begin{bmatrix} d_{11} & 0 \\ d_{21} & d_{22} \end{bmatrix} \tag{3}$$

Notice that we have not imposed any restriction on the effects of the shocks on inflation. In particular, d_{11} will be the long-run effect of u_{st} on output, d_{21} will be the long run effect of u_{st} on inflation and d_{22} will be the permanent effect of u_{dt} on inflation. Thus, both shocks could have a priori permanent effects on inflation.

The second identifying restriction that we use is that u_{st} and u_{dt} are uncorrelated (i.e. Ω is a diagonal matrix). These two identifying restrictions are enough to recover the two structural shocks, u_{dt} and u_{st}, from the vector e_t. However, it is worthwhile to explore further the possible effects of u_{dt} and u_{st} on inflation. There are three possible cases, depending on the rank of C(1) (notice that the rank of C(1) is equal to the rank of D(1)). The first one is when C(1) is a full rank matrix, which means that there is no cointegration between output and inflation. In that case d_{22} will be different from zero and d_{21} will be either equal or different from zero. Defining P to be the lower triangular square root of $C(1)\Sigma\ C(1)'$, such that $PP'=C(1)\Sigma C(1)'$, then we can recover u_t as $u_t = P^{-1}\ C(1)\ e_t$ and D(L) as $D(L) = C(L)\ C(1)^{-1}\ P$. Clearly, in order to use this decomposition a necessary condition is that C(1) is a full rank matrix (i.e.rank C(1) = 2). However, if cointegration exists between the variables, the rank of C(1) will be 1, and this opens two other possibilities. The first one is when $d_{22} = 0$ and $d_{21} \neq 0$. In this case, only u_{st} will have permanent effects on inflation. The second case is when both d_{22} and d_{21} are equal to zero, in which case neither u_{st} nor u_{dt} will have permanent effects on inflation. Notice that these are not a priori restrictions imposed on the system, but rather the range of possibilities that can be obtained from the statistical properties of the data. It is easy to show that if cointegration exists, then defining $\beta\perp = [d_{11}\ d_{21}\ ]'$, the cointegration vector β will be given by the eigenvector corresponding to the unit eigenvalue of $(I_2 - \beta\perp\ (\beta\perp'\beta\perp)^{-1}\ \beta\perp')$ (see Johansen (1995)). Notice also that $d_{21} = 0$ implies a cointegration vector of the form $\beta = [0\ 1]$ (i.e., inflation is stationary), whereas if $d_{21} \neq 0$ then $\beta = [1\ -\beta_1\ ]$ (i.e., inflation is I(1) but cointegrated with output).

The next question is how to recover u_t and D(L) from e_t, Σ and C(L) in the presence of cointegration. We will not review here the estimation and inference in cointegrated systems and refer the reader to Johansen (1995). We will proceed by assuming that X_t admits a vector error correction representation. That is, if X_t is cointegrated and there is one cointegration vector then it is possible to write

$$(I-A_1L-A_2L^2\ldots-A_{p-1}L^{p-1})\Delta X_t=\alpha\beta' X_{t-p}+e_t \tag{4}$$

where A_i is a 2 x 2 matrix and both α and β are $2x1$. The vector β above is the cointegration vector and α is the loading factor vector. If we define the orthogonal complements of α and β as $\alpha_\perp$ and $\beta_\perp$, Johansen (1995) shows that the long-run impact matrix C(1) can be expressed as,

$$C(1)=\beta_\perp(\alpha_\perp'\Psi\beta_\perp)^{-1}\alpha_\perp', \tag{5}$$

where $\Psi=I-A_1-\ldots-A_{p-1}$. The vector $\beta_\perp$ can be defined as the eigenvector associated with the unit eigenvalue of the matrix $(I-\beta(\beta'\beta)^{-1}\beta')$.

Define also the partitioned matrix

$$D_*=\left[\alpha_\perp(\alpha_\perp'\Psi\beta_\perp)\quad\alpha\right] \tag{6}$$

and the lower triangular square root P of $D_*^{-1}\,\Sigma\,(D_*^{-1})'$ such that

$$PP'=D_*^{-1}\,\Sigma\,(D_*^{-1})' \tag{7}$$

Then we can recover both u_t and D(L) as $u_t = P^{-1}D_*^{-1}e_t$ and $D(L) = C(L)\,D_*P$.

Hence, we have seen that by restricting $d_{12} = 0$ we impose that one of the shocks has no long run effect on output. The sign and value of the remaining elements of D(1) is left unrestricted and will be estimated in the next section. Then, depending on the results of the estimation an economic interpretation will be given to each of the shocks.

III. Empirical Analysis

We use data on per-capita GDP (in logs) and inflation rate for Spain over the 1951-1994 period. The sample consists of annual observations and the source is Prados de la Escosura (1993) for the 1951-1990 period and the *International Financial Statistics* of the IMF for the 1991-1994 period. The first step towards analyzing these series is the evaluation of their stationary characteristics. We have performed Dickey Fuller tests, where the number of lags for the autoregression has been chosen using a general to specific approach. Looking at the plots of the series of per-capita output and inflation (figures 1 and 2), we have considered stationary around a deterministic trend as the relevant alternative hypothesis for output. For inflation a more sensible alternative seems stationary around a constant, given that it does not seem to trend up over time. The test results indicate that there is little evidence against the unit root hypothesis in the levels of output. The t-statistic is -0.85 and the critical value is -3.49. For inflation, the test rejects the null hypothesis in favor of stationary. The t-statistic is -3.76 and the critical value is -2.91. Notice that this result is consistent with the predictions of our model economy. Table 1 reports some descriptive statistics for the real growth rates (x 100) and for the levels of inflation (in percentage) with consistent standard errors.

Inspection of Table 1 reveals that the Spanish economy has displayed a per-capita average growth rate slightly above 3 percent over the last 40 years, with years growing at rates close to 9 percent. Table 1 also indicates that the Spanish economy has experienced high inflation. The average inflation has been around 9 percent, and for some years above 20 percent. During the last 35 years the inflation rate has never been below 2.5 percent.

We next move to the multivariate analysis, starting by performing Johansen cointegration tests. Notice that on the basis of the univariate unit root tests performed above, we could proceed to estimate a bivariate VAR with the imposition of a trivial ([0 1]) cointegration restriction. However, and as an additional check on the validity of our restrictions, we will test the same hypothesis in the multivariate framework. The number of lags for the VAR model on which the cointegration test are based has been chosen so that it minimizes the multivariate version of the Hannan and Quinn (1979) criterion. The selected specification on the basis of this criterion is a VAR(2), and the residuals do not present any problem of serial correlation. The univariate Box-Lung statistics, which under the null of independent residuals are distributed as a $X^2(12)$ (c.v. 21.03), take values of 4.49 and 12.20, respectively. The multivariate Box-Lung statistic, which under the same null hypothesis is distributed as a $X^2(80)$ (cv 101.4), takes a value of 81.76 and therefore we cannot reject the null hypothesis. Table 2 reports the results of the Johansen Trace and Lambda tests.

Inspection of Table 2 suggests that, as expected from the results of the univariate unit root tests, one can reject the null hypothesis of no cointegration in favor of the alternative hypothesis of one cointegration restriction. The estimated cointegration vector (normalized so that the parameter of output is 1) is [1 38.21]. Next we test the hypothesis of stationarity of inflation (notice that with only two variables this test is equivalent to a test of exclusion for output). The test statistic, which under the null hypothesis of stationarity of inflation is distributed as a $X^2(1)$ (c.v.=3.84), takes a value of 1.456 and hence we cannot reject the hypothesis that inflation is I(0).

Recall from Section 2 that there were three different possibilities for the value of the parameters of the matrix D(1) depending on the rank of the matrix. We have found in the data that one variable is I(1) and the other is I(0), and hence there exists a cointegration vector between the two variables. Therefore, the data suggests $d_{22} = d_{21} = 0$ for the Spanish case, and hence none of the structural shocks will have permanent effects on inflation. These two shocks can be interpreted, by means of a simple economic model (see Appendix I), as demand and supply shocks, where the supply shock would have permanent effects on output but not on inflation and the demand shock would have only temporary effects on both variables.

An issue to take into account in this exercise is the possibility of structural breaks, because we are considering a long period of time in which the Spanish economy suffered many transformations. In order to control for these facts we have tested for the presence of outliers and structural breaks. The normality statistics of the residuals do not indicate any serious problems of outliers. The univariate Jarque and Bera (JB) statistics take values of 0.44 and 3.92 and under the null hypothesis of normal errors is distributed as a $X^2(2)$ (cv 5.99). The multivariate JB statistic takes a value of 4.37 and under the same null is distributed as a $X^2(4)$ (cv 9.84), not rejecting in any case the null hypothesis. Regarding the presence of structural breaks, we have considered the possibility of a structural break associated with the death of Franco and the change of political regime in 1975. The statistics, which under the null of no structural break are distributed as a F(4,34), take values of 0.74 for the output equation and 0.93 for the inflation equation, not rejecting the null of no structural break.

Once we have determined the stochastic structure of the series, we proceed to compute the response of output and inflation to impulses in supply and demand shocks. Previously we have transformed the reduced form model into a structural model, as described in the previous section, in order to recover the structural disturbances. Figure 3 plots the impulse response functions together with one standard deviation bands computed using 1000 bootstrapping replications according to the method proposed by Runkle (1987).

Several results emerge from the impulse response functions. Firstly, a positive supply shock produces an immediate increase in output and a decrease in inflation. Instead, a positive demand shock produces a positive impact in both output and inflation. Therefore, the impact responses to both shocks seem to follow the traditional Keynesian paradigm. Given our econometric restrictions, only supply shocks have a permanent effect on income, whereas none of the shocks have permanent effects on inflation. It is also important to observe the speed of adjustment of the economy towards the new equilibrium after the shock. Following a supply shock leading to a 1 percent permanent increase in output, the impact effect is 0.17. Output then increases steadily for a period of around 5 years to 0.7 and after 12 years the adjustment has been completed. Inflation also reacts strongly during the first years. The impact effect is a decrease in inflation by 0.6 points; after 5 years the effect on inflation is -0.1 (15 percent of the impact effect) and after 12 years the adjustment has been completed.

The response of output to a demand shock takes place at a slower pace than to a supply shock. The impact effect is higher than in the previous case (0.30 against a previous 0.17). After 5 years the effect is still 0.20 (around 66 percent of the impact effect), after 10 years 0.02 (around 5 percent of the impact effect) and after 12 years there is still a small adjustment to take place. The response of inflation to a demand shock is smaller than the response to a supply shock. The impact effect is 0.24 (against a previous 0.61) and after 5 years it still remains 50 percent of the adjustment to take place (0.11). After 10 years most of the adjustment has been completed. Notice that, on the basis of these results, a Spanish business cycle, defined as the transition between old and new equilibria, would last between 12 and 15 years. This result confirms the findings of Artis *et al.* (1995) who, using the conventional definition of the business cycle as the distance between two consecutive peaks, find the average Spanish business cycle to last 15 years. Hence our exercise, by using an alternative definition of the business cycle, serves also as robustness analysis of the results obtained in more conventional studies. Notice also that our conjecture regarding the length of the long run was correct: an impulse response function computed over less than 60 quarters may find a long-run effect of demand shocks, although the right interpretation would be that the cycle is still to be completed.

Once we have seen the dynamic effects of supply and demand disturbances the next step is to quantitatively evaluate the contribution of each of the shocks to the fluctuations of output and inflation. We do this in two ways. The first one examines the forecast error variance decomposition of output and inflation in demand and supply disturbances at various horizons, giving an idea of the average contribution of each of the disturbances over the sample. The second one analyzes the evolution of the historical time series of the demand and supply components of output and inflation according to the description of turning points of the Spanish business cycle of Artis *et al.* (1995) (see also Lopez, Ortega and Ubide (1997) for an alternative dating of the Spanish business cycle).

The first issue is addressed in the left panel of Table 3, which shows the percentage of the forecast error variance attributed to each of the innovations (bootstrapping standard errors in parentheses). Notice that the identifying restrictions only imply that the contribution of the supply disturbance to the variance of output will tend to 1 as the horizon increases, leaving all the remaining factors unconstrained. The results suggest that demand shocks play a dominant role in explaining the variance of GDP, while supply shocks explain a very important part of the variance of inflation. At short horizons (2 years) demand shocks explain around 75 percent of the variation in output. After 4 years, they still explain almost 50 percent and only when we consider a 10 year horizon, supply shocks account for a 90 percent. Instead, fluctuations in inflation are dominated by supply disturbances in the short run (more than 80 percent after 2 years and about 75 percent after 10 years).

It seems from these results that demand policies aimed at reducing inflation could be both painful in terms of output (because of their very long lasting effects) and not very effective in terms of reducing inflation (notice that the demand component explains only 22 percent of the variance of inflation). This can be quantitatively evaluated by computing the sacrifice ratio, the cost in terms of GDP of reducing one percentage point in inflation. Since after a negative demand shock the dynamic responses of output and inflation will differ, we compute the sacrifice ratio making use of the dynamics of the system. We define the sacrifice ratio of the economy as the accumulated response of output to a demand shock over the accumulated response of inflation to the same shock. Thus, we take into account the period of adjustment, very important for Spain, and this ratio would be an average measure of the responses of output and inflation over time. The results suggest a ratio above 1.5: the point estimate is 1.52 and the 90 percent confidence interval computed with bootstrapping techniques is (0.5, 2.7). It means that reducing a percentage point of inflation would cost more than 1.5 percentage points of GDP. Notice that the sacrifice ratio will be larger the more sensitive is output to demand policies and the less sensitive is inflation to the same policies.

There is the possibility that the results would have been influenced by the sample period adopted, because in the immediate post civil war period the Spanish economy was dominated by the autarkic policies of the Franco governments. In order to control for this fact, we have performed some sensitivity analysis on the results, rolling the first observation to 1961, just after the *Plan de Estabilizacion* of the Spanish economy started and the autarkic policies were abandoned. The results remain essentially unchanged. The lags in the VAR model are the same as for the long sample size and the residuals do not present problems of serial correlation. The univariate Box-Lung statistics are now 4.38 and 5.90 and the multivariate version of the same statistic is 64.4. Figure 4 plots the impulse response functions and Table 4 reports the results of the forecast error variance decomposition. In this case, the impact responses and the shapes of the functions are very similar to the 1951-1994 sample. The only relevant difference could be that the speed of adjustment is now slower: 5 years after a supply shock the response of output is 0.62 against a previous 0.72 while after 15 years is 0.95, against a previous 1. Ten years after a demand shock there still remains 30 percent of adjustment for output and 20 percent of adjustment for inflation. Thus, the cycles of the Spanish economy are even longer if we only consider this shorter sample period.

As we have indicated, the second quantitative analysis consists in the computation of the supply and demand components of output and inflation, which are shown in Figure 5. These are the time paths of each of the variables had the other component been set equal to zero. Given our identification restrictions, in which only supply shocks have a permanent effect on output, the demand component of output and the supply and demand components of inflation are stationary. In order to analyze its evolution during the different turning points, we have superimposed the turning points of the Spanish business cycle computed by Artis *et al.* (1995). Notice that by the end of 1994 the end of the recession had not been attained yet.

We can see that the supply component of output trends up over time, with a slowing down corresponding to the first oil crisis. This is followed by a period of stagnation which lasts until the end of the second oil crisis, when it starts increasing again, accelerating from 1986 onwards. The demand component shows two different parts, slightly increasing until 1974 and decreasing afterwards. This negative contribution is particularly important in the last recession, starting in 1989, and at the end of 1994 the recovery was not on sight yet. Thus, there are indications that the first two recessions were a combination of demand and supply components whereas the last one was caused solely by the demand component, probably owing to the strong disinflationary policies that followed the process of joining the ERM. The picture of the last recession is completed with the fact that whereas the demand component of inflation drives inflation strongly down after 1986-87, the supply component - probably reflecting the strong salary increases of the late eighties and early nineties - is driving inflation strongly up during the same period. Therefore, the very strong contractionary and disinflationary policies that were implemented in the second half of the eighties drove down both output and inflation, but the strong supply component of inflation made this major effort a relative failure.

IV. DOES THE PREVIOUS ANALYSIS MAKE SENSE?

In the previous section we have disentangled inflation and per-capita GDP into their demand and supply components. In this section we investigate the properties of such components. In fact, if the previous analysis makes sense, variables usually identified with the demand side of the economy, such as money or interest rates, should help in forecasting the demand components, whereas variables identified with the supply side, say wages, oil prices, etc., should help in forecasting the supply components. In econometrics terms, demand side variables should cause the demand components whereas supply side variables should cause the supply components.

As in the previous sections we use a VAR framework, but rather than relying in a structural VAR, we now work with the reduced form. The VAR methodology is useful in this context for two reasons: first, it allows us to specify models without endogeneity problems. Second, it allows us to test for causality between the different variables. The basic idea underlying the concept of causality is that if a variable y causes a variable x, the former should help improving the predictions of the latter. Assuming the following familiar representation

$$x_t = a(L)x_{t-1} + b(L)y_{t-1} \tag{8}$$

where $a(L)=a_0+a_1L+...+a_pL^p$ and $b(L)=b_0+b_1L+...+b_pL^p$, then variable y is said to cause variable x (in the sense of Granger) if $b(L)\neq 0$. Put in other words, past values of y should help in improving the forecasts of x. Notice that we are not trying to specify a behavioral model for the components obtained in the previous section but instead to test whether a set of variables explain the behavior, at least in part, of these components.

To avoid biases in our analysis related to prior beliefs about supply and demand, we will start with a general model where the explanatory variables include both demand and supply variables. Then we will reduce the model, following a general to specific approach, in order to get a parsimonious representation. Because of the unit root properties of the components we have extracted, we will consider the growth rates of the supply component of GDP and the levels of the demand component of output and of both components of inflation. Given data availability, we restrict our analysis to the 1961-1994 period, with the components extracted using the 1951-1994 period.

Clearly, one would expect that the most parsimonious model for the supply components includes among the explanatory variables, supply-related variables. Equivalently, for the demand components, one would expect the explanatory variables being variables affecting the demand. With this in mind, the explanatory variables we consider are the following: oil prices (o), wages (w), nominal money (m), exchange rate measured as Spanish pesetas per US dollar (e) (all variables in growth rates), and interest rates (r) in levels[1].

The equation we attempt to estimate is of the type

$$C_{it}=\mu+\beta_1 C_{it-1}+\beta_2 m_{t-1}+\beta_3 w_{t-1}+\beta_4 o_{t-1}+\beta_5 e_{t-1}+\beta_6 i_{t-1}+u_t \qquad (9)$$

where C_{it} is the component we are interested in and u_t is an error term. For the supply component of output one would expect a positive value for β_1, negative values for β_3, β_4 and β_5, and a zero or negative value for β_6. Finally, for β_2 one would expect a zero value. For the supply component of inflation, with the exception of β_1, one would expect the opposite signs. With respect to the demand components, the signs should be similar for both output and inflation: β_1 and β_2 should be positive, β_3 and β_4 zero, β_5 positive and β_6 either negative or zero.

Table 4 contains the results of the estimation of equation (9) for inflation and Table 5 presents the same results for output (t-statistics are in parentheses). We would like to point here that for the supply component of output, the initial estimation of the equation above produced autocorrelated residuals. Further exploration of the specification suggests considering wages with two lags rather than with one lag. Although the results are basically maintained the serial correlation problem vanishes. Therefore, for the supply component of output, the parameter β_3 makes reference to w_{t-2}. The column headed by $\chi2(1)$ contains the result of a LM test for first order serial correlation in the residuals.

Inspection of Tables 4 and 5 shows that the signs of the most general model including all the variables are as expected, although many of them are not significant. The reduction process is carried out by sequentially deleting the variable with the minimum t-statistic. The process continues until a final specification with all variables entering significantly is achieved. From a statistical point of view there are no problems of serial correlation among the residuals, and in general the R^2 are relatively high for a system involving stationary variables.

The final specifications are consistent with our previous analysis. The supply components are caused by wages and the demand components are caused by money growth. None of the other variables are significant in the final equations. These results support our explanation of the recession of the 90s, in which demand-compressing policies via contention of the monetary variables pushed down output, whereas the supply-related resistance of inflation to decrease was mainly due to increases in salaries. It is also interesting to note that, contrary to conventional wisdom, oil prices did not enter the inflation equation, something that can be explained by the fact that after the oil crisis prices have decreased whereas the price level in Spain has consistently increased. We have tried other specifications that could

[1] Unit root tests of these series are available upon request.

account for nonlinear responses. That is, we have tested the hypothesis that inflation and output react when the oil price increases, but do not when the oil price decreases. However, we have not found evidence of a significant relationship.

V. Conclusions

In this paper we have analyzed the sources of business cycles fluctuations in Spain over the last 40 years. We have assumed that the economy is driven by two shocks, the first one having permanent effects on income but not on inflation, and the second one having no permanent effects on any of the two variables. On the basis of a dynamic macroeconomic model we interpret the first one as a supply shock and the second one as a demand shock. We apply this structure to annual data for the period 1951-1994 and show that the length of the Spanish business cycle, defined as the period of transition after a shock to a new equilibrium, could be of approximately 15 years. This implies that business cycle research which uses short sample sizes or instruments such as impulse response functions computed over less than this span could lead to misleading results. The quantitative analysis shows that the Spanish business cycle is dominated in the short run by demand disturbances, whereas in the long run supply disturbances play a dominant role, and thus conforms to the traditional view of economic fluctuations. We have also performed a historical analysis of the last three periods of recession, and conclude that while the first two recessions, 1973 and 1979, were the result of a combination of supply and demand components, the recession of the 90s was due almost entirely to demand factors. In terms of inflation, the data suggest that inflation is mainly supply-driven. In fact, the data show that although the demand component of inflation was driving inflation down during the last recession, the supply component was increasing steadily. The main policy implication of this paper is that strong disinflationary demand policies could prove both inefficient and very painful for Spain, with a sacrifice ratio over 1.5, and that more active supply polices oriented to product and labor market reforms may be needed. These results are in agreement with previous work using completely different methodologies, and this is probably what science is about.

Table 1. Main Statistics of the Series

1951-1994	Mean	S.D.	Skew	Ekur	Min	Max
Δy	3.24	2.56	0.14	-0.82	-1.28	8.71
s.e	(0.64)	(0.27)	(0.46)	(0.83)		
π	8.82	5.11	0.57	-0.53	0.15	21.00
s.e.	(1.27)	(0.85)	(0.46)	(0.84)		
1961-1994	Mean	S.D.	Skew	Ekur	Min	Max
Δy	2.99	2.63	0.21	-0.91	-1.28	8.71
s.e	(0.79)	(0.42)	(0.59)	(1.04)		
π	9.36	4.69	0.64	-0.55	2.57	21.00
s.e.	(1.48)	(0.78)	(0.67)	(1.19)		

Table 2. Johansen Cointegration Tests

Ho	λ	Trace	λmax	Trace 5%cv	λmax 5%cv
$r \leq 1$	.05	2.35	8.18	8.18	8.18
r=0	.44	27.10	24.75	17.95	14.9

Table 3. Forecast Error Variance Decomposition due to Supply Shocks

	Supply shocks 1951-1994		Supply shocks 1961-1994	
Horizon	y	π	y	π
1	0.23 (0.22)	0.86 (0.19)	0.26 (0.30)	0.87 (0.28)
2	0.23 (0.21)	0.82 (0.19)	0.27 (0.29)	0.81 (0.26)
3	0.38 (0.19)	0.79 (0.19)	0.37 (0.26)	0.78 (0.26)
4	0.54 (0.16)	0.78 (0.19)	0.47 (0.23)	0.76 (0.25)
5	0.67 (0.12)	0.77 (0.19)	0.57 (0.20)	0.74 (0.25)
6	0.76 (0.09)	0.77 (0.19)	0.65 (0.17)	0.73 (0.25)
7	0.82 (0.07)	0.77 (0.19)	0.72 (0.14)	0.73 (0.25)
8	0.86 (0.05)	0.77 (0.19)	0.77 (0.12)	0.72 (0.25)
9	0.88 (0.04)	0.77 (0.19)	0.81 (0.11)	0.72 (0.25)
10	0.90 (0.04)	0.77 (0.19)	0.84 (0.09)	0.72 (0.25)
11	0.91 (0.03)	0.77 (0.19)	0.86 (0.08)	0.72 (0.25)
12	0.92 (0.03)	0.77 (0.19)	0.88 (0.07)	0.72 (0.25)
13	0.93 (0.02)	0.77 (0.19)	0.89 (0.07)	0.72 (0.25)
14	0.94 (0.02)	0.77 (0.19)	0.90 (0.06)	0.72 (0.25)
15	0.94 (0.02)	0.77 (0.19)	0.91 (0.05)	0.72 (0.25)

Table 4. Inflation Equations

Comp.	μ	β_1	β_2	β_3	β_4	β_5	β_6	R^2	$\chi^2(1)$
Supply	-0.00 (-0.19)	0.31 (1.79)	0.06 (0.57)	0.28 (2.42)	0.01 (0.97)	0.04 (0.85)	0.19 (1.45)	0.60	0.00
Demand	-0.01 (-1.2)	0.79 (5.66)	0.12 (2.78)	0.001 (.03)	-0.007 (-1.06)	0.017 (.96)	-0.068 (-1.45)	0.82	0.00
Supply	-0.00 (-.07)	0.32 (1.85)		0.32 (2.95)			0.19 (1.48)	0.56	0.00
Demand	-0.01 (-1.47)	0.74 (6.12)	0.13 (3.02)				-0.06 (-1.28)	0.81	0.55
Supply	0.01 (.24)	0.44 (2.84)		0.24 (2.44)				0.54	0.05
Demand	-0.01 (-3.49)	0.77 (6.25)	0.14 (3.32)					0.80	0.75

Table 5. Output Equations

Comp.	μ	β_1	β_2	β_3	β_4	β_5	β_6	R^2	$\chi^2(1)$
Supply	0.04 (2.71)	0.40 (2.44)	0.01 (.04)	-0.11 (2.43)	-0.01 (-.97)	-0.01 (-.25)	-0.08 (-1.38)	0.74	1.74
Demand	-0.01 (-1.4)	0.96 (8.15)	0.17 (3.11)	-0.02 (.36)	-0.01 (-1.3)	0.02 (1.16)	-0.08 (-1.43)	0.88	0.61
Supply	0.04 (2.83)	0.40 (2.50)		-0.12 (-2.81)			-0.08 (-1.42)	0.74	1.97
Demand	-0.02 (-1.96)	0.88 (8.84)	0.18 (3.42)				-0.07 (-1.17)	0.88	2.58
Supply	0.02 (2.45)	0.56 (4.54)		-0.08 (-2.38)				0.71	2.74
Demand	-0.02 (-4.2)	0.90 (8.99)	0.19 (3.72)					0.88	3.02

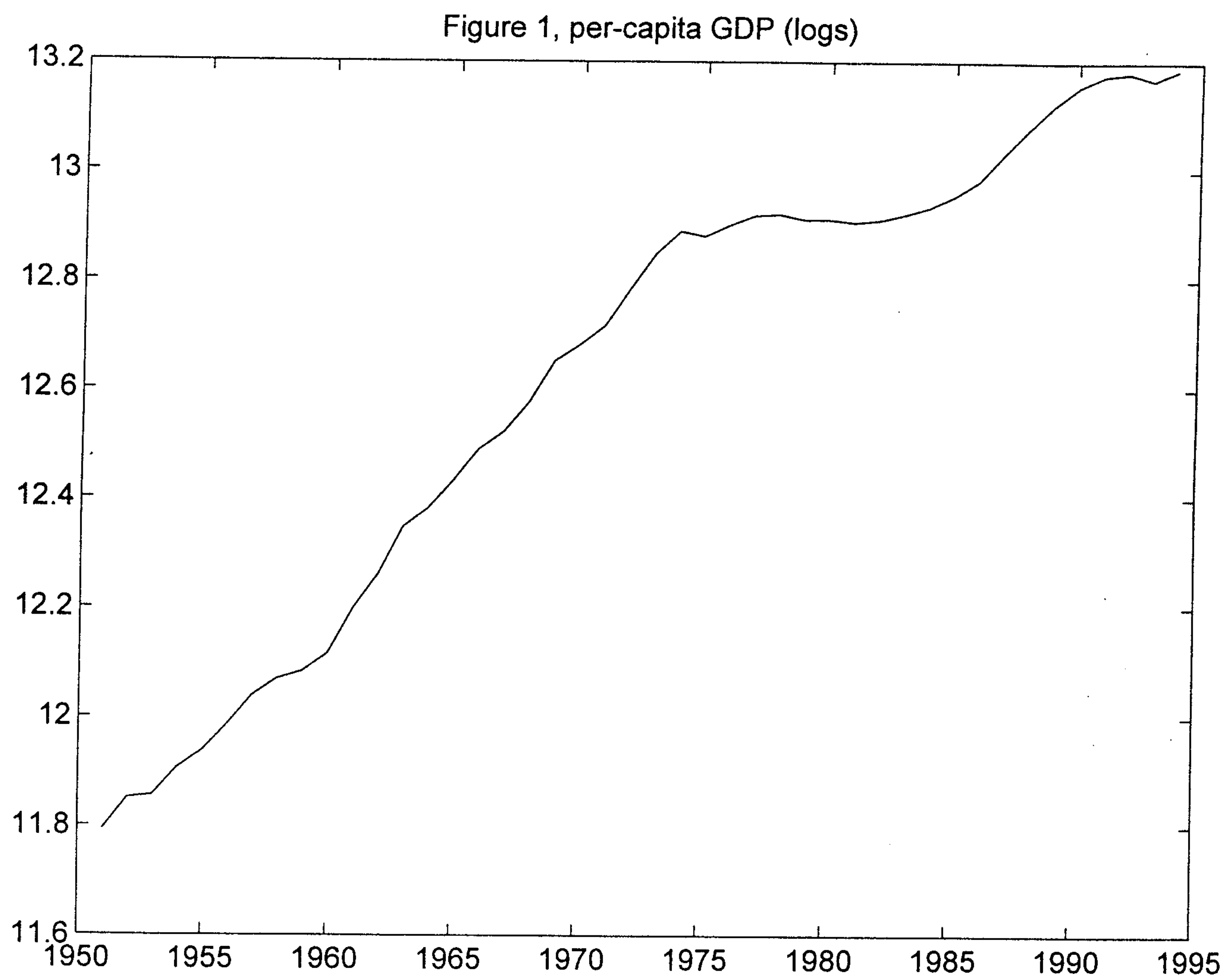


Figure 1, per-capita GDP (logs)
13.2
13
12.8
12.6
12.4
12.2
12
11.8
11.6
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

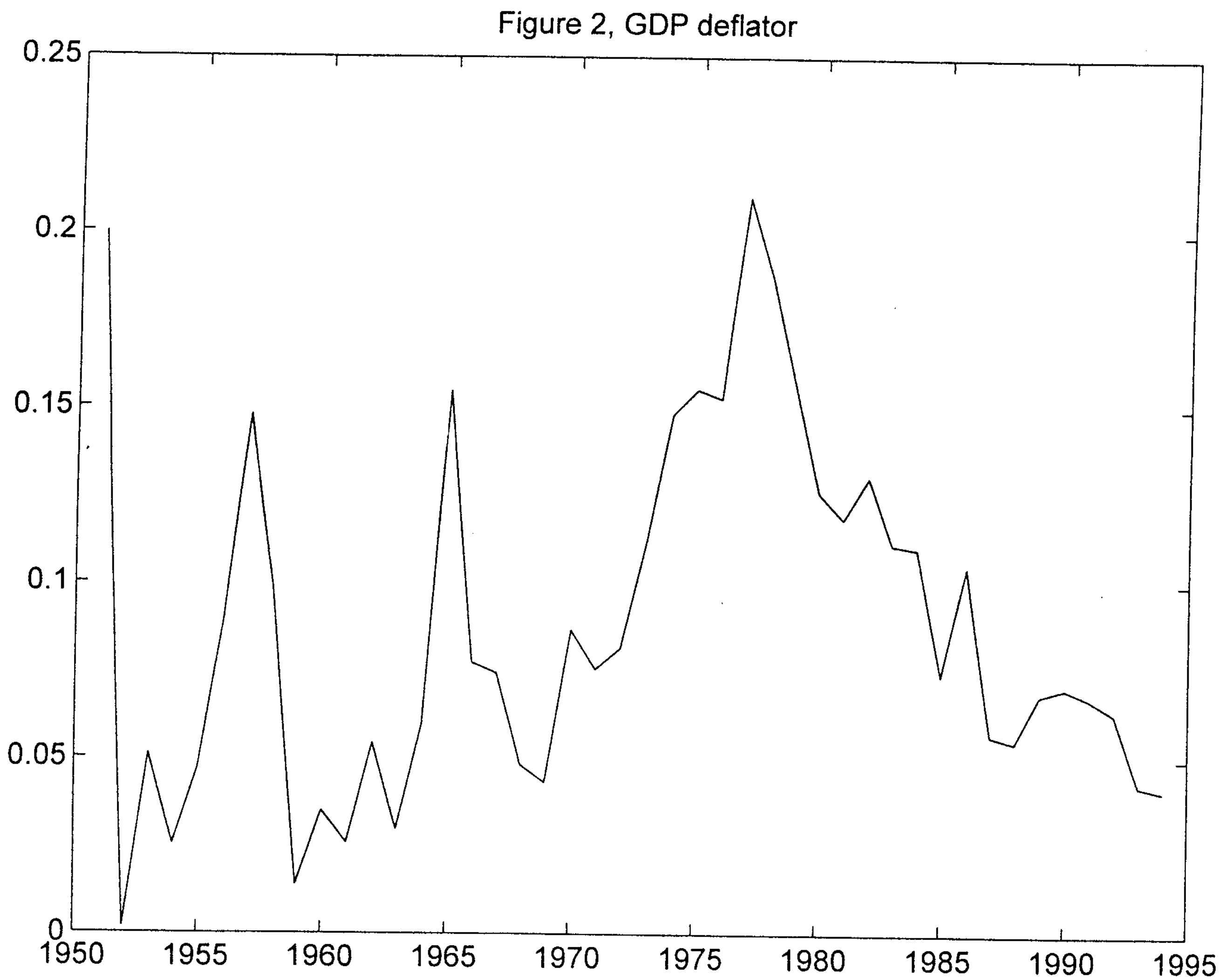


Figure 2, GDP deflator
0.25
0.2
0.15
0.1
0.05
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

Figure 3a, Output response to a supply shock, 1951-1994

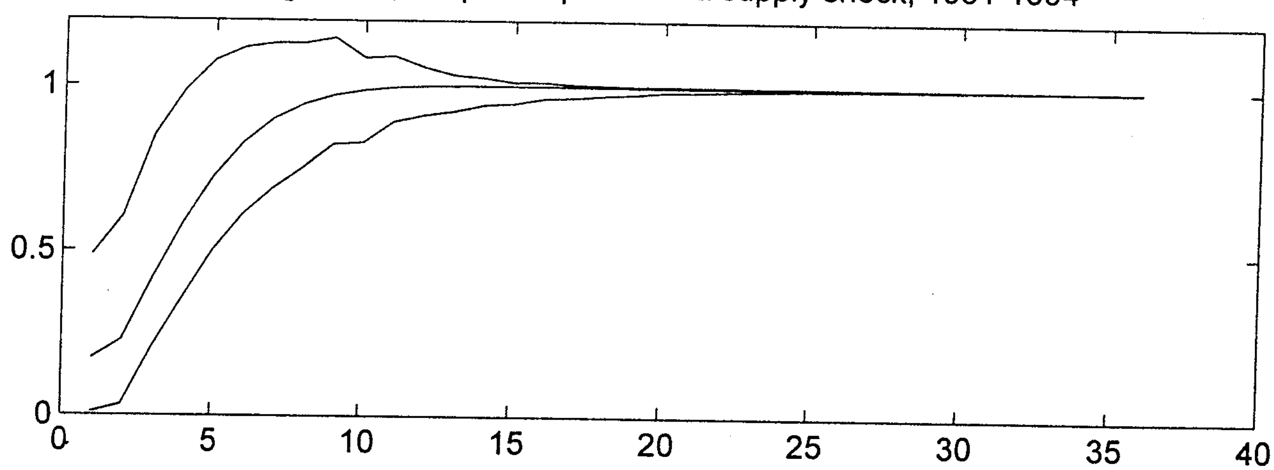


Figure 3b, Inflation response to a supply shock, 1951-1994

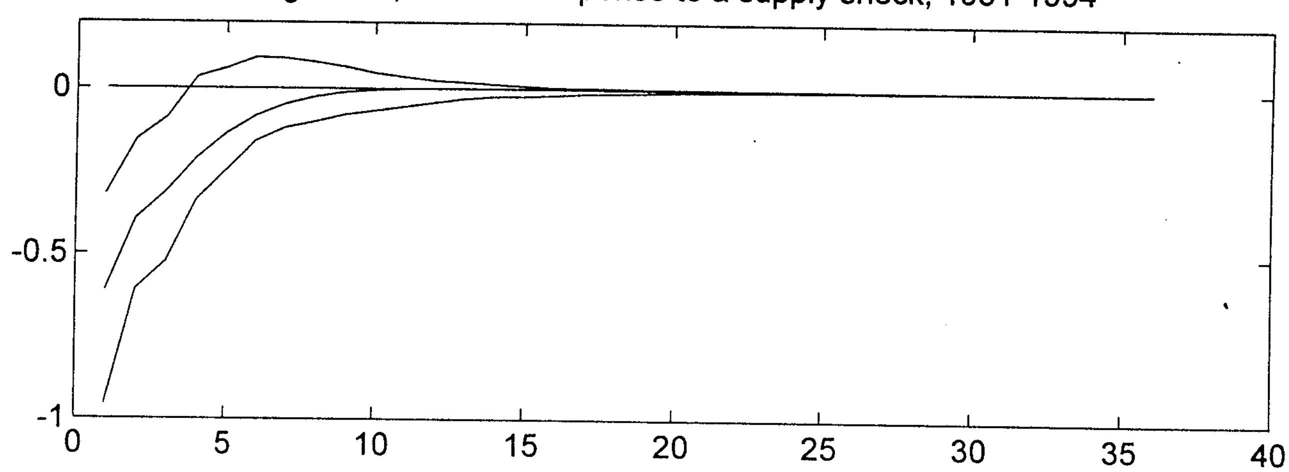


Figure 3c, Output response to a demand shock, 1951-1994

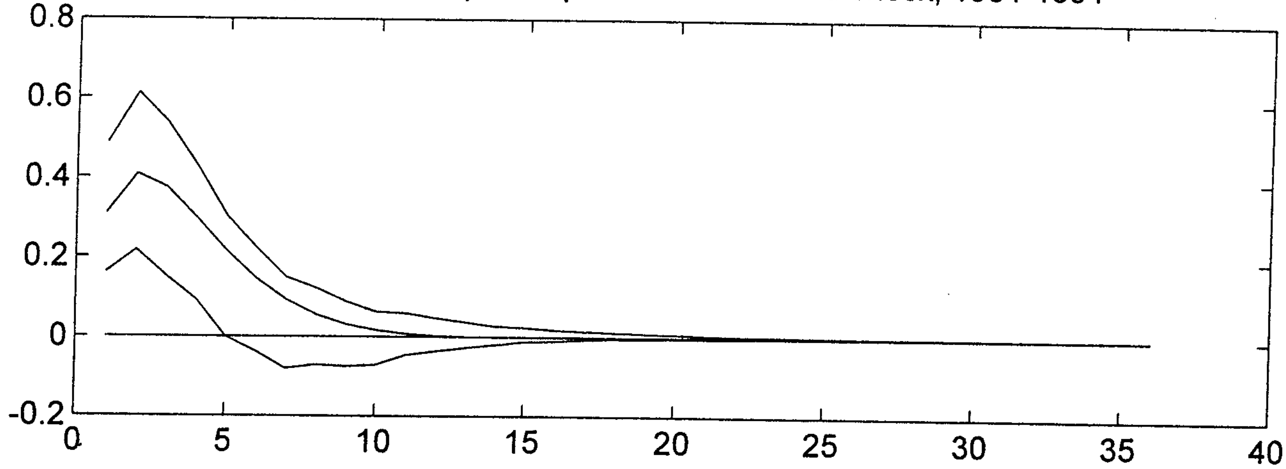


Figure 3d, Inflation response to a demand shock, 1951-1994

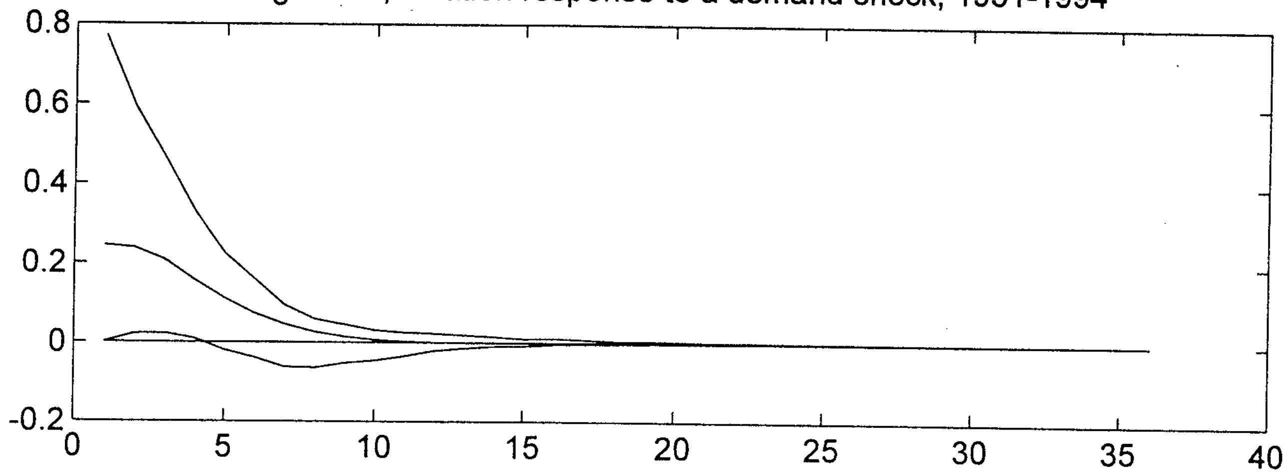


Figure 4a, Output response to a supply shock, 1961-1994

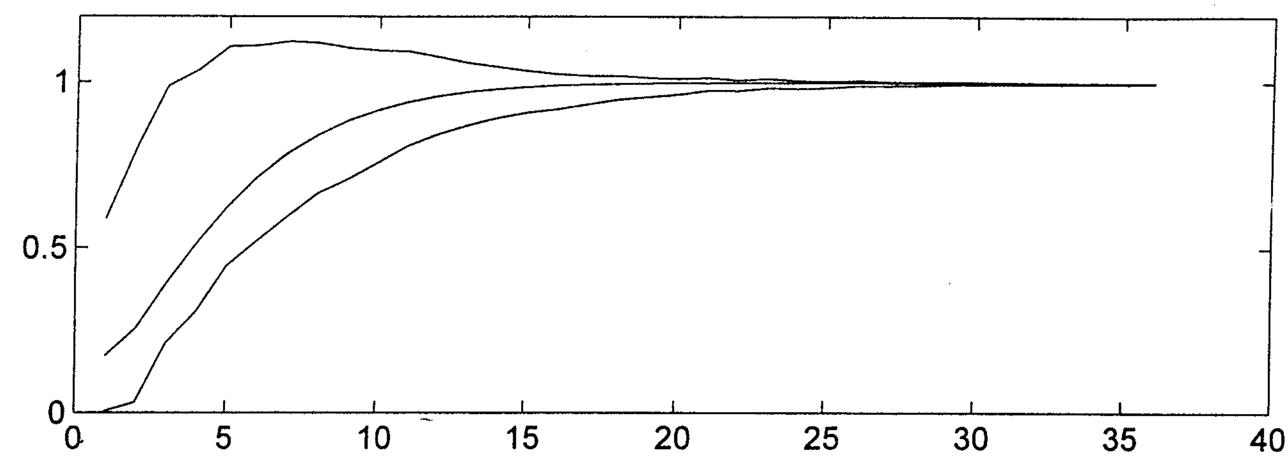


Figure 4b, Inflation response to a supply shock, 1961-1994

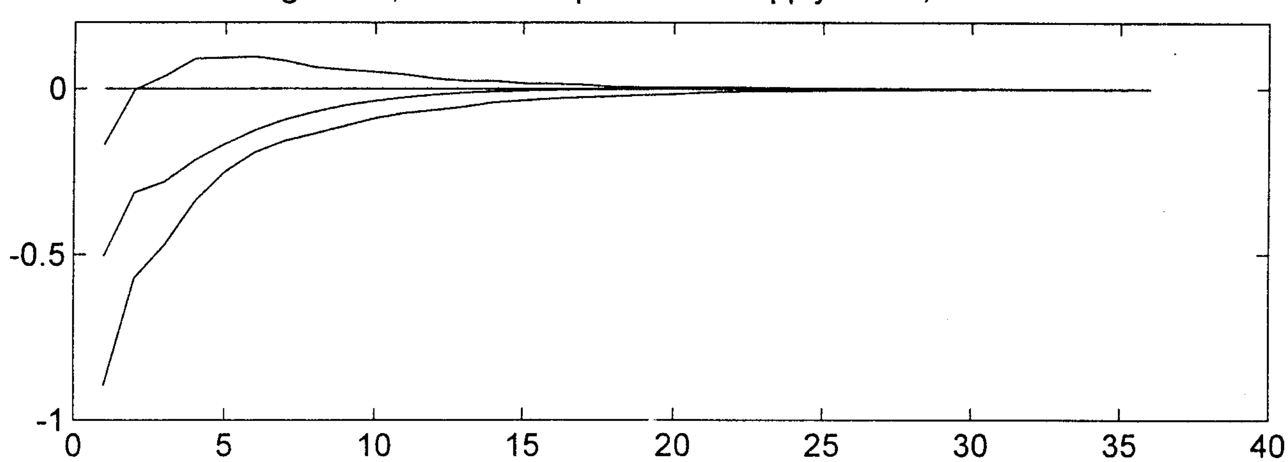


Figure 4c, Output response to a demand shock, 1961-1994

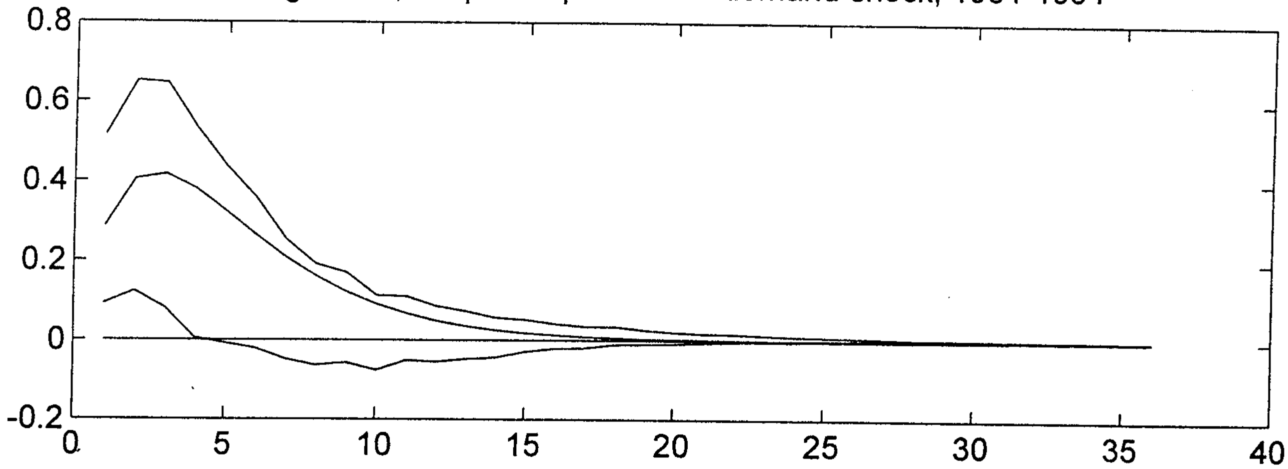


Figure 4d, Inflation response to a demand shock, 1961-1994

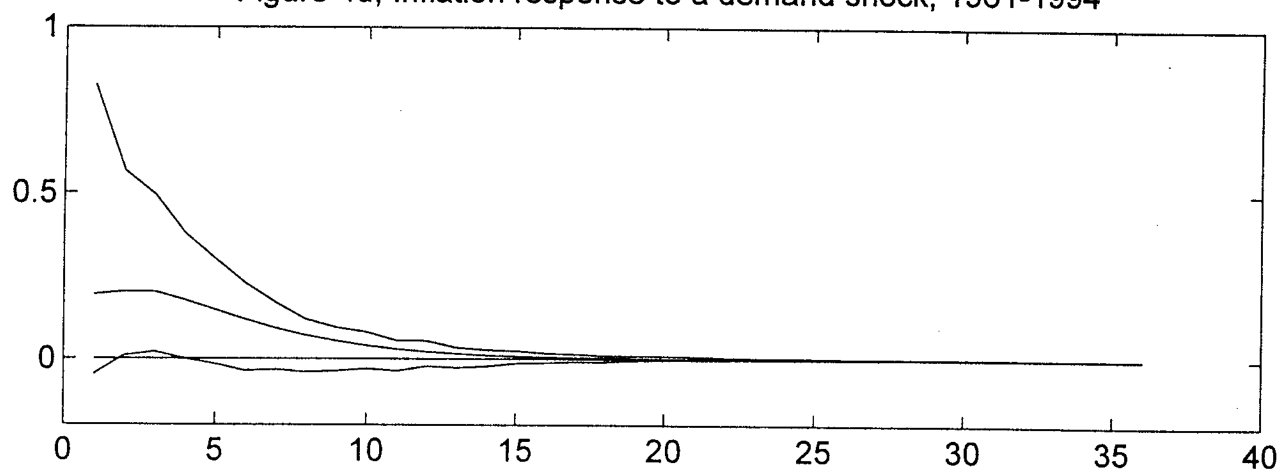


Figure 5a, Supply Component

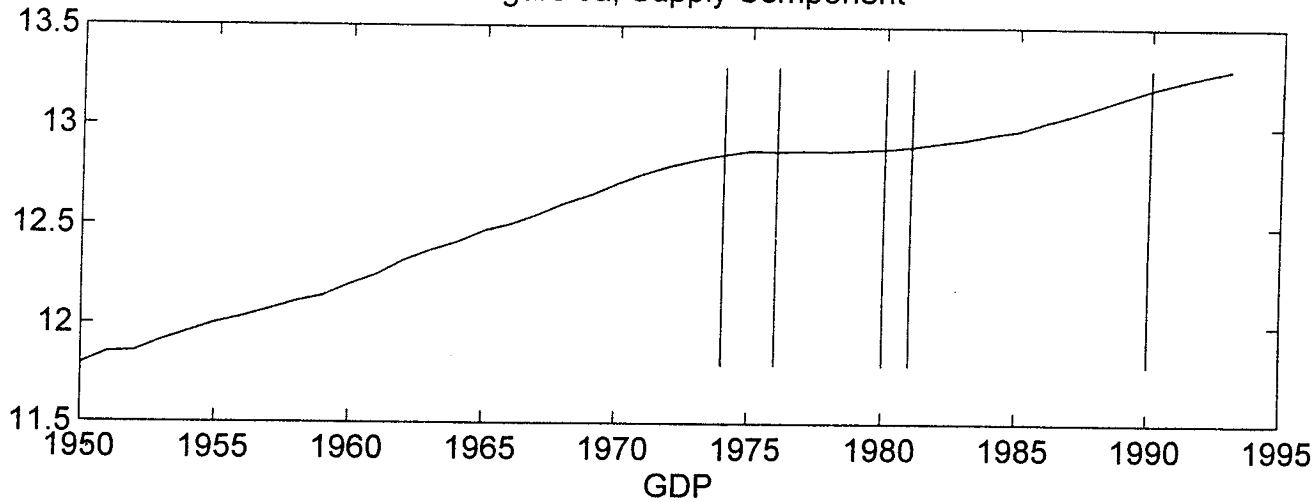


Figure 5b, Supply Component

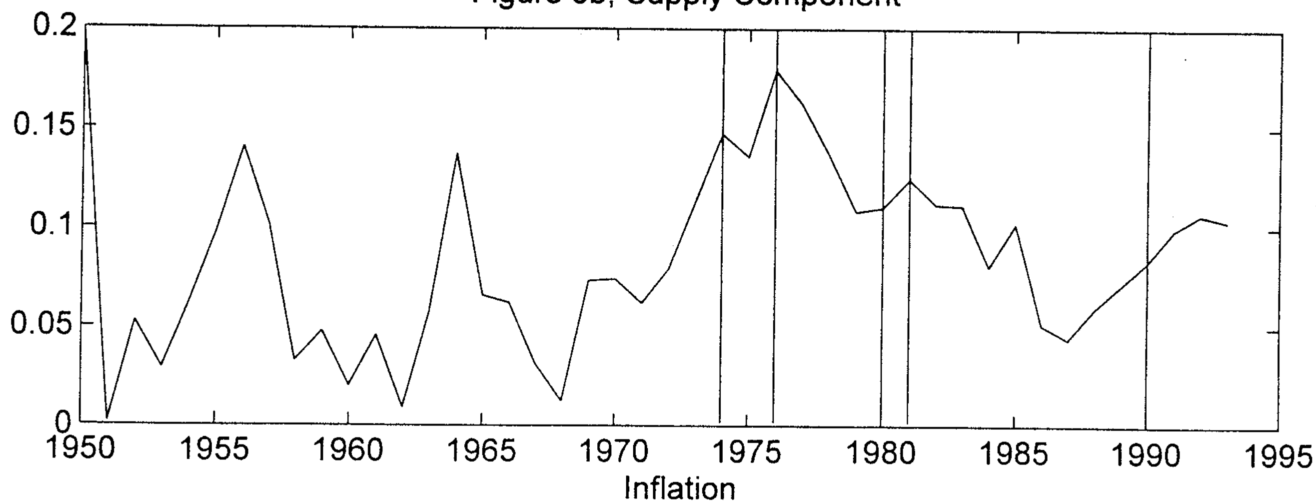
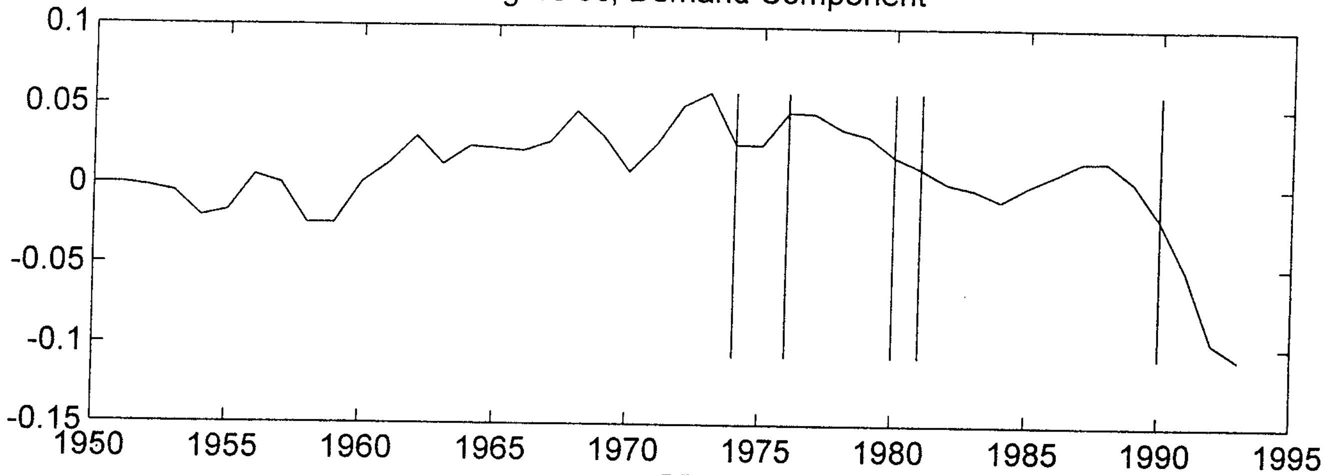
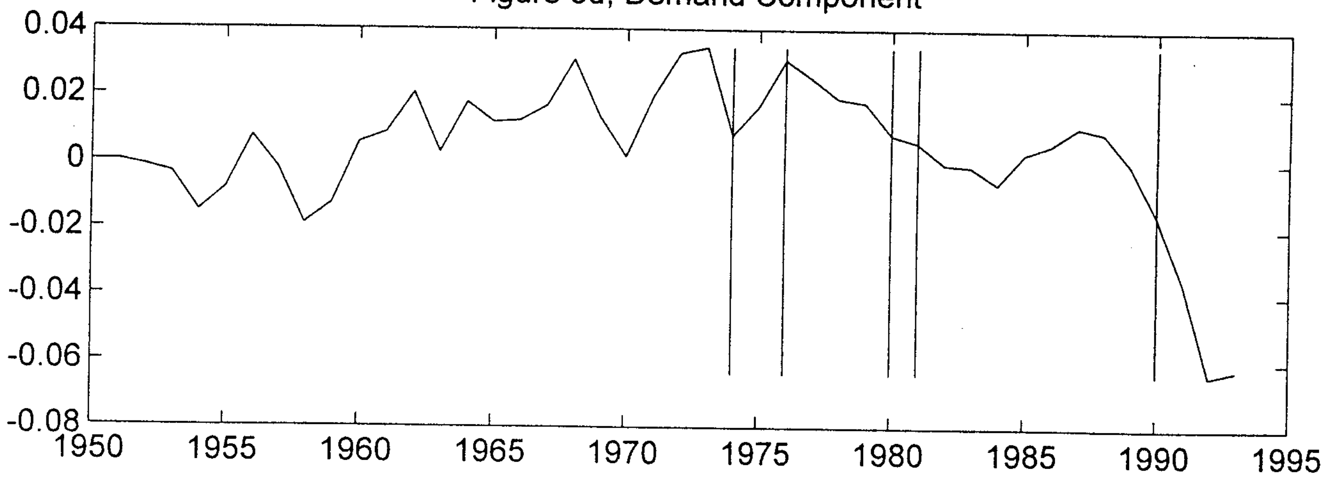


Figure 5c, Demand Component



GDP

Figure 5d, Demand Component



Inflation

A SIMPLE MACROECONOMIC MODEL

Our interpretation of disturbances with permanent effects as supply disturbances and of disturbances with transitory effects as demand disturbances is motivated by a monetarist-rational expectations view of fluctuations. To illustrate this issue we provide a simple economic model which delivers these implications. Assume that the economy is governed by the following model:

$$\begin{aligned} &(a)\quad y_t=a(p_t-p_t^e)+\theta_t, \\ &(b)\quad y_t=m_t-p_t+\epsilon_t, \\ &(c)\quad p_t^e=E_{t-1}p_t, \end{aligned} \qquad (10)$$

where y_t is the log of real per-capita GDP, p_t is the log of the GDP deflator, m_t is the log of the real money supply (in per-capita terms) and p_t^e is the individual expectations of the price level computed with all the information available at time t-1.

There are two disturbances in this economy. The first one is η_t, a technology shock, which fully characterizes θ_t, the technology of this economy. The dynamics of θ_t are assumed to be described by

$$\theta_t=\theta_{t-1}+\eta_t. \qquad (11)$$

The second one is ϵ_t and it is intended to capture demand disturbances. Both disturbances are zero mean white noise process and are independent between them. Equation (10a) is an aggregate supply schedule embodying the natural unemployment rate hypothesis since expected price increases will not boost supply. Equation (10b) is a demand function which depends on real balances, and finally (10c) assumes rational expectations. The monetary authority is assumed to follow the following policy rule:

$$\Delta m_t=h(L)\epsilon_{t-1}+g(L)\eta_{t-1}, \qquad (12)$$

with $h(L)=h_0-h_1L-h_2L^2-...$, and $g(L)=g_0-g_1L-g_2L^2-...$ Through the policy rule in (12) the monetary authority reacts to unexpected changes in the position of the economy due to the disturbances ϵ_t and η_t which completely describe this economy. However, we will assume that the monetary authority sets m_t at the beginning of the period without observing η_t and ϵ_t; this assumption explains why (12) only involves lagged values of ϵ_t and η_t. We will also assume that shocks occurred long time ago have no effect on the policy rule and that changes in money are bounded, or formally that

$$\lim_{j\to\infty} h_j = \lim_{j\to\infty} g_j = 0$$
$$\sum_{j=0}^{\infty} h_j^2 < \infty \qquad (13)$$
$$\sum_{j=0}^{\infty} g_j^2 < \infty$$

Solving the model, we can express output y_t and the inflation rate π_t as

$$y_t = \delta a \epsilon_t + (\delta + a\delta L)\theta_t$$
$$\pi_t = H(L)\epsilon_t + G(L)\eta_t \qquad (14)$$

where $\delta = 1/(1+a)$, $H(L) = H_0 - H_1 L - H_2 L^2 - \ldots, G(L) = G_0 - G_1 L - G_2 L^2 - \ldots$, and

$$H_0 = \delta \quad G_0 = -\delta \quad ,$$
$$H_1 = h_0 - \delta \quad G_1 = -(g_0 - a\delta) \quad , \qquad (15)$$
$$H_j = h_{j-1} \quad G_j = g_{j-1} \quad j > 2.$$

Taking the limits on (14) we can compute the long-run effect of each of the shocks on output and inflation

$$\lim_{j\to\infty} \partial y_{t+j} / \partial \epsilon_t = 0,$$
$$\lim_{j\to\infty} \partial y_{t+j} / \partial \eta_t = 1,$$
$$\lim_{j\to\infty} \partial \pi_{t+j} / \partial \epsilon_t = \lim_{j\to\infty} H_j = 0, \qquad (16)$$
$$\lim_{j\to\infty} \partial \pi_{t+j} / \partial \eta_t = \lim_{j\to\infty} G_j = 0.$$

Therefore, the model predicts that supply shocks will have permanent effects on output, but transitory effects on inflation, and that demand shocks will have transitory effects on both output and inflation. The impact effect of supply shocks on output will be positive, while the impact effect on inflation will be negative. The impact effect of demand shocks will be positive on both output and inflation. Notice that had we specified the model in terms of the price level instead of inflation, the effect of both shocks on prices would have been permanent and not transitory. Finally, observe that the model also predicts that output will have a unit root in its autoregressive representation (y_t will be I(1)), and inflation will be stationary (π_t will be I(0)). Notice that in econometric terms this will imply that output and inflation will be cointegrated with a cointegration vector [0 1].

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