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Resumen

Este artículo documenta las regularidades empíricas que caracterizan los ciclos de negocios de Chile a través de una gama amplia de actividades económicas. Mientras que en general los ciclos reales de Chile presentan algunas características típicas de los países de la OECD, mantienen algunas interesantes particularidades. El comercio representa una parte importante de la actividad económica, las exportaciones se mueven contemporáneamente con el producto y los términos de intercambio tienden a liderar muy anticipadamente el ciclo. Por otro lado, las políticas públicas juegan un rol significativo en las fluctuaciones de corto plazo: el gasto público y las variables asociadas a la política monetaria lideran el ciclo en 2 a 3 trimestres. El "mito monetario" de Kydland and Prescott (1990) se encuentra vivo en Chile.

Abstract

This paper documents the empirical regularities characterizing business cycles in Chile in a wide range of economic activities. While the country presents many of the typical features of business fluctuations in OECD countries, Chilean cycles present some striking peculiarities. Trade represents an important part of economic activity as exports move contemporaneously with output and the terms of trade lead the cycle long in advance. Besides, public policies play a significant role in short-run economic fluctuations: government expenditures and monetary policy variables lead the cycle 2 to 3 quarters in advance. Kydland and Prescott's (1990) ``monetary myth'' is alive in Chile.

We thank K. Schmidt-Hebbel and R. Valdés for comments and suggestions. The views expressed in the paper are those of the authors and do no necessarily reflect those of the Central Bank of Chile.

Empirical Regularities of the Chilean Business Cycle

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May 1998

Abstract

This paper documents the empirical regularities characterizing business cycles in Chile in a wide range of economic activities. While the country presents many of the typical features of business fluctuations in OECD countries, Chilean cycles present some striking peculiarities. Trade represents an important part of economic activity as exports move contemporaneously with output and the terms of trade lead the cycle long in advance. Besides, public policies play a significant role in short-run economic fluctuations: government expenditures and monetary policy variables lead the cycle 2 to 3 quarters in advance. Kydland and Prescott's (1990) "monetary myth" is alive in Chile. (JEL E32).

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1 Introduction

Over the past ten years only, a period of economic stability in Chile, the 7:7% average annual growth rate is swamped by the year-to-year variations. A plus or minus two standard deviation interval uncovers a growth rate ranging between 3 and 13% per year. A question we want to ask is why the economy experiences such large short-term °uctuations along its long-run growth path. Business cycles, the recurrent °uctuations in aggregate economic activity, have been a property of all economies for as long as there has been data, and di®erent theories have emerged to attempt to explain the cycle as a natural outcome of an economic system. Modern real business cycle theory defends the view that cycles arise as the equilibrium outcome of the activities of rational economic agents. It takes the approach of testing competing assumptions about the sources and propagation mechanisms of business cycles by comparing how well di®erent models mimic important aspects of the cyclical behavior through time of actual economies. Therefore, as a ¯rst necessary step in applying this line of research to the case of Chile, the present paper provides a theory-free documentation of the empirical regularities characterizing Chilean business cycles. These facts constitute a benchmark against which possible explanations of the sources and mechanisms of cyclical °uctuations in Chile can be confronted to. In a ¯rst stage, we use data available annually since 1960 to o®er a historical perspective on the properties of economic °uctuations in Chile. Then, we use higher-frequency quarterly data, available since 1986, to pin down the \stylized facts" of business cycles in a wide range of economic activities over a phase of stability of the Chilean economy.

To study the features of Chilean business cycles, we follow the standard methodology of Kydland and Prescott (1990). Since °uctuations concern not only a single variable, like GDP, but a wide range of economic activities, we examine the cyclical patterns of various components of national income. We disaggregate GDP into its demand-side elements, or expenditure components: personal consumption expenditures, gross investment in ¯xed capital, government spending, and net exports, and its supply-side elements, or inputs components: labor and capital stock. To provide a reference to the study of economic policy, we also document the properties of °uctuations in monetary policy variables, the money stock and the policy interest rate, as well as of variables often examined in many analysis of the Chilean economy, such as prices, the real wage, and the terms of trade. The regularities we want to shed light on are of two types: the volatility of each macroeconomic variable, in particular relative to the one of GDP, and the comovement of this variable with GDP over the course of the cycle. Two characteristics of this comovement are important for our

discussion of business cycle facts. The first is the direction in which a macroeconomic variable moves, relative to the direction of aggregate economic activity. A variable that moves in the same direction is procyclical, one that moves oppositely is countercyclical. Variables that do not display a clear pattern over the cycle are acyclical. The second one is the timing of a variable's turning point relative to the turning point of the business cycle. A leading variable tends to move in advance of aggregate economic activity, a lagging one sees its peaks and troughs occur later than those of the business cycle, those of a coincident variable occur at the same time as those of output.

Some interesting facts about Chilean business cycles come out of their analysis over the 1960-1997 period. First, the high volatility of fluctuations characterizing the 1975-1985 \reform" period decreases enormously in the following decade. Particularly remarkable is the fall in the volatility of government expenditures and variables related to monetary policy that takes place from the 60s to the 90s. This reduction in volatility reaches 80% for prices, 70% for the money stock, 35% for public consumption, and 12% for public investment. Taken as revelators of a move towards a higher underlying economic stability, these results lead us to study the features of economic fluctuations in the 1986-1997 period as an as-best-as-possible approximation of those that would be displayed by a \standard" Chilean business cycle. This characterizes Chilean cycles as lasting an average of 3 years, half this time of expansion, the other half of recession, with both phases symmetric, displaying an amplitude of fluctuation of 3% on average in each direction. It appears that, over this period, Chile presents many of the regularities characterizing business fluctuations in OECD countries. Consumption and investment are very procyclical, investment is also very volatile, net exports are countercyclical, the volatility of employment explains most of the volatility of the labor input and prices are countercyclical. However, the analysis sheds light on some original traits of the Chilean business cycle. First, trade plays a large role in the short-run fluctuations of a small open economy like Chile: exports unusually move contemporaneously with output, while turning points in terms of trade fluctuations lead the cycle long in advance. Second, government variables { whether public expenditures in consumption and investment goods or monetary variables like base money, M1 and the intervention rate managed by the Central Bank { all lead the cycle. Government expenditures are found procyclical, while monetary policy, through its intervention rate, is countercyclical. The \monetary myth" of the leading role of money on output, that gave its title to Kydland and Prescott's (1990) paper establishing the stylized facts of American business cycles, is alive and well in Chile.

The growing literature documenting the evidence on business cycles has mainly concentrated on industrialized countries. After Kydland and Prescott's (1990) reporting of the US business cycle facts[1], many authors undertook to apply this a-theoretical methodology to document the evidence on business cycles in their countries. Backus and Kehoe (1992) gather and develop many of these country-specific results in a long and detailed study of century-long data for 10 OECD countries, establishing a more general evidence on business cycles features for this group of countries.[2] However, whether for lack of economic or political stability, lack of data, or any other reason, Latin American countries have been mostly left aside from this line of research. Recently, Kydland and Zarazaga (1997) apply this methodology to document the properties of business cycles in Argentina. They are however confronted to the problem of data availability and have to use two non-consolidated versions of National Accounts covering overlapping periods of time. The business cycles facts obtained are not often robust over databases, which makes it hard to draw clear conclusions about the stylized features of Argentinian business cycles. More recently even, Agenor, McDermott and Prasad (1998) include Chile, Colombia, Mexico and Uruguay in a group of 11 middle-income countries to investigate the existence of a set of business cycle facts typical to this income group. Because of lack of data and emphasis of the paper on the comparison of business cycle facts among the countries of the group, the paper does not provide a systematic report of the cyclical characteristics of each country. In fact, in the case of Chile, their paper concentrates on the cycles in an index of industrial production, not on those in total GDP, and does not systematically disaggregate output cycles into their expenditure nor input components. The present paper adds to this literature by presenting a comprehensive analysis of the features of business cycles in Chile. Building up a database going back to 1960, we document consistently the historical properties of the Chilean business cycle over 37 years of data. We divide this whole period into three sub-samples { consistent with successive stages in the stability and level of economic growth of the country { to analyze the changes in the features of the cycle. Because of the wide economic and political changes that characterize this long sample of data, we isolate next a period of economic stability, to report for Chile the features of cyclical °uctuations associated with an economy closer to its long-run \steady state". As will be explained later, we chose to begin this study in 1986, the date from which quarterly data is also consistently available.

[1] Even though it uses a different methodology, their work is a reactivation of the research agenda of Burns and Mitchell in the 40s at the NBER.

[2] See also this paper for a review of the literature.

This allows us to provide a more standard analysis of the comovements and timing of turning points of cycles in macroeconomic variables, comparable with international evidence.

The rest of the paper is organized as follows. Section 2 looks at the historical properties of aggregate °uctuations in Chile since 1960 using available annual data. Section 3 concentrates on the years 1986-1997 to document the features of business cycle-type °uctuations in GDP, its expenditure and input components, using higher-frequency quarterly data. Fluctuations in prices, money aggregates and terms of trade are also examined. Finally, section 4 concludes.

2 Historical Perspective on Chilean Fluctuations

As mentioned before, the objective of this paper is to pin down the empirical regularities characterizing business cycles in Chile. To do so, having access to a long sample of data with enough number of cyclical episodes would be ideal. In the case of Chile however, the economic history of the last 40 years is marked by drastic structural changes and periods of high economic instability. The structural changes that a®ected the economy resulted from radical shifts in economic policy implemented under di®erent political regimes. These regimes determine distinct economic phases, each of them associated with a speci¯c framework through which to understand the mechanisms underlying the behavior of macrovariables. This makes it hard to isolate a \standard" for business cycle-type °uctuations over the long-run. To deal with these di±culties, we ¯nd it useful to analyze the historical properties of business cycles in Chile over three sub-periods, homogenous in terms of economic and political environment. The section begins by reviewing brie°y these three phases, before documenting some interesting features of business cycles since 1960. It aims at o®ering an historical context in which to understand the features of business cycles that characterize the current, stable period of economic activity presented in the next section.

2.1 Sub-periods

It is not in the scope of this paper to provide a thorough description of the wide array of events marking the recent history of the Chilean economy. For that, we prefer to refer the reader to the vast literature describing the economic and political history of Chile and its main transformations during the last four decades, as proposed by Edwards and Cox (1986), Meller (1997), and Morandé and Schmidt-Hebbel (1988) for

example. From our own reading of this recent economic and political history, and with the risk of appearing arbitrary, we find it useful to analyze short-term fluctuations in Chile since 1960 across three distinct economic phases. First, the years 1960 to 1970 represent a decade characterized by a rather closed economy with a large role for public intervention and some controlled markets. 1975 to 1985 constitutes a second period of analysis, one of structural reforms and high economic instability. The years 1971 to 1974 are excluded from any sub-period analysis as, during those years, the presence of strong government control over the economy makes it irrelevant to analyze short-term fluctuations as the result of a natural adjustment process of the economy to the shocks affecting it.[3] Finally, 1986 to 1997 represents a stage of consolidation of market-oriented reforms and of stabilization.[4] To give a brief summary of the growth path of the Chilean economy in terms of its level and stability since 1960, table 1 reports the means, standard deviations and autocorrelation coefficients of output growth rates over the whole period and each sub-period cut described above.

Table 1: Output growth in real terms

	Mean (%)	Standard deviation (%)	First autocorrelation
1960-1997	4:3	5:79	0:26
1960-1970	4:3	2:76	¡ 0:33
1975-1985	2:1	8:36	0:19
1986-1997	7:7	2:42	¡ 0:28

Note: first-difference of the logarithm of real GDP, annual data:
Source: Central Bank of Chile

One of the striking features of table 1 concerns the difference in terms of the moments of growth between the mid-period and the other two. The years 1975 to 1985 represent definitely a period of high volatility and growth slowdown for the Chilean economy. Over these years, real growth decreases by half relative to the previous period, while its volatility triples. The subsequent and most recent decade is marked by a strong take-off of the economy, with a high average annual growth rate associated to a relatively low level of volatility, the lowest over the almost 40 years of study. This

[3] 1974 is also excluded from any sub-period as the economy was still undergoing hyperinflation, reaching its highest level in history { above 700% { in April 1974.

[4] Note that Schmidt-Hebbel (1998) extends the definition of the reform period up to 1989, according to the criteria that unemployment began to fall back to a level more consistent with its \natural" rate at that date. We will check in our description of business cycles facts, their robustness to this different sample cut.

observed negative correlation between volatility and growth is a common result in the recent empirical growth literature.[5] Note that the difference in the nature of growth between the mid-period and the first and last ones is also revealed by the change in sign and level of the coefficient of autocorrelation of GDP growth characterizing these periods.

2.2 Historical Evidence

We now turn to examine business cycle fluctuations per se, over the 1960-1997 period. Even though they are only available at an annual frequency, data going back to the Sixties are useful to evaluate the consistency of business cycles features in Chile over time and to provide a historical perspective on the properties of business cycles in this country. At this low frequency, examining the phase shifts of cycles in macrovariables does not appear meaningful so that, in this section, we limit our analysis to the study of the volatility and contemporaneous correlation of fluctuations in GDP with its components, as well as of prices and money. We now present the data we have available or construct for the analysis, and explain how they are transformed to extract their cyclical components. Then, we turn to presenting the salient regularities observed in Chilean business cycles since 1960, emphasizing how these regularities evolved over the different economic and political phases highlighted in the beginning of the section.

2.2.1 Data transformation

Most expenditure variables are available since 1960 at an annual frequency. Because the government variable reported in National Accounts includes only wages and salaries paid by the government, as well as the public consumption of final goods, we report separately public investment to account as accurately as possible for the pattern of cyclical behavior of government spending. Concerning input variables, only employment data is available since 1960, so that our analysis of fluctuations in the labor input is limited to the description of the behavior of this variable. National Accounts do not provide series for capital stock but for investment, disaggregated into its residential and non-residential components. It proves therefore delicate constructing capital series, as it involves aggregating different types of capital goods with different rates of depreciation. Since there is no consensus in the literature on Chile,

[5] See, for example, Ramey and Ramey (1995).

four possible hypothesis are made concerning depreciation, leading to as many capital series. It turns out that the different series differ more in their absolute levels than in their second moments or timing pattern along the course of the cycle. We therefore chose to report in the paper only the results obtained for one of them and comment on their robustness. Finally, to document the properties of fluctuations in nominal variables, we look at the Consumer Price Index and M2, as data on M1 is not available since 1960. A description of the variables used and their sources is given in Appendix A.

Following Lucas (1977), we then define business cycles as deviations of macroeconomic variables from trend. We use data expressed in real terms, except for money stocks, and take their natural logarithm. Since net exports can take negative values, we instead consider their ratio to nominal GDP. Throughout the rest of the paper, our working definition of business cycle fluctuations concerns properties of time-series that have been filtered by the Hodrick-Prescott (HP) method, which removes a smooth trend line from the data. In their study of business cycle facts in middle-income countries, Agénor, McDermott and Prasad (1998) use four different types of filters to compare their results. Their study shows, in fact, very little consistency of results across filters, so that such an exercise reveals necessary and informative for objectivity purposes when trying to extract information from data. Canova (1998) examines more in detail how alternative detrending filters extract different types of information from the data. However, although there are many ways to estimate a trend line and extract low frequency movements from the data, the HP filter has become a standard in the empirical literature on business cycles, so that we use it for comparability with the bulk of the research in the area.[6]

2.2.2 Cyclical properties

Table 2 presents the volatility of business cycles in some real and nominal variables since 1960 and over the three sub-periods introduced above, as well as their correlation with real output fluctuations over the same periods. Fluctuations in real GDP appear highly volatile during the 1960-1997 period, but this volatility comes mostly from the years 1975 to 1985. During this middle period, the standard deviation of output fluctuations was 3.8 times larger than during the previous decade and 3.6 times larger

[6] Along the same line of thought, Burnside (1998) argues that the use of a common method for testing business cycles simply means that economists coordinate to look through the same window to examine their models and data. For a discussion of the HP filter, see Baxter (1991) and Cogley and Nason (1995) for example.

than during the most recent one. These ratios compare to those measuring the relative volatility of growth over periods, as table 1 showed.

Since 1960, Chilean business cycles present the following general features. Similarly to what was observed for total output, the size of fluctuations in almost all variables increases by around 300% in the 1975-1985 period relative to the years 1960 to 1970, and decreases by a comparable amount from then to the following, most recent, period. The only exceptions to this pattern of volatility come from the capital stock, which cyclical fluctuations are overall smoother, and from nominal variables, which undergo the most significant change (a decrease) in their volatility over the ultimate period of investigation. In fact, the volatility of fluctuations ends up at a slightly higher level in the 1986-1997 period than what it was over the 60s, except in two notable cases. Fluctuations in the variables related to monetary policy and also to government expenditures see their volatility fall significantly over the last 86-97 period: volatility is reduced by 80% for prices, 70% for money, 35% for public consumption, and 12% for public investment. Finally, a strong comovement of fluctuations is in general associated with the high volatility of variables over the mid-period: except for nominal variables, all coefficients of correlation are above 0:60. The level of correlation of fluctuations in macrovariables with those of output remains high in the 1986-1997 period, and this feature also concerns nominal variables over that period.[7]

Variable per variable, the following patterns characterize their respective cyclical behavior over the long-run. Consumption expenditures remain highly procyclical over all periods. The correlation between consumption and output fluctuations ranges between 0:85 and 0:96 over all sample breaks. Its variability is about the same as that of output: the ratio of its standard deviation to that of output is close to 1 over all periods, with a small increase in the last decade. This feature points to the existence of credit constraints in the Chilean economy and will be examined more in detail in the next section using higher-frequency data.

Total investment is around 3 times more volatile than output between all periods. It has also been consistently procyclical over time. The private sector component of investment expenditures displays similar features, except that its volatility increases to be 4 times that of GDP in the last decade. Public investment presents striking differences. First, its variability has decreased in the last period relative to all periods, where it also becomes lower than that of private investment. Second, its correla-

[7] Note that residential capital presents such a correlation above 0:60 over the 1975-1985 period with a lag between one and two years. The strong correlation of employment with the cycle is also visible with a lag over 1986-1997.

tion with output °uctuations falls back to a low level after the 1975-1985 period. The coe±cient of correlation is in fact not statistically signi¯cant during 1960-1970, while it is just barely so during 1986-1997. In short, public investment expenditures follow in the last decade a smoother pattern than they have since 1960, with little contemporaneous relation to the cycle in aggregate economic activity.

Fluctuations in government consumption show little regularity over the periods examined. They behave procyclically and coincidentally (within a year time) in the last two periods, while °uctuations appear acyclical in the 1960-1970 period.[8] Moreover, the volatility of °uctuations in government consumption relative to the one of output falls from 1:3 to 0:8 between 1960-1970 and 1986-1997. Both the last two facts suggest that some aspects of government policies linked with public investment and consumption have changed over time.

The standard deviation of exports cycles varies 1 to 1 with that of output. Exports have come to comove more and more tightly with aggregate activity, from acyclicality in the 60s to a high procyclicality since 1986. This is linked to the gradual opening of the economy and points to the importance of trade in aggregate economic activity in the most recent period. Fluctuations in imports have been uniformly 3 times more volatile than those of output. They display a strong procyclicality over the years, with a coe±cient of correlation almost equal to 1 during the 1975-1985 period. Net exports appear countercyclical over the whole period as well as in each sub-period.

Turning to the cyclical behavior of input variables, we see that °uctuations in employment are smooth over all periods, with a standard deviation around 60% that of real GDP. However, their magnitude has been increasing over time, doubling from the ¯rst to the last sub-period, which may point to the relaxation of labor market rigidities in the most recent period. Employment varies procyclically with output over the whole 1960-1997 sample period, but its coe±cient of correlation becomes non-signi¯cant and negative in the last period, revealing the possibility of a phase shift in employment cycles. Their timing pattern will be examined more in detail in the next section. Cycles in capital are 40% smoother than those in aggregate economic activity on average and procyclical over the whole 1960-1997 period. Their volatility has however increased regularly over time, reaching approximately the same level as that of output. This is due to the variability of non-residential capital, which increases strongly in the third period. More generally, cycles in non-residential capital are

[8] If anything, the negative sign may reveal a phase shift of more than a year relative to GDP cycles. Cross-correlation coe±cients do not however reveal any clear leads or lags of the variable at this frequency.

much more variable and procyclical than those in residential capital over all periods, although their degrees of procyclicality converge over the last decade.

We now turn to the properties of °uctuations in price levels and the money stock. Over the more than 35 years of data, °uctuations in prices are 9 times larger than those in output. This single ¯gure hides the tremendous decrease in the magnitude of price °uctuations that has taken place over time. Between the ¯rst and the last period of analysis, the size of these °uctuations has been divided by 5: Note that when year-to-year changes are important, using annual data to compute price volatility makes the ¯gures more dramatic. The next section will mitigate this problem using higher frequency data. The correlation of price °uctuations with output changes sign over the sub-periods, but is negative over the whole period.

Fluctuations in M2 are 8 times more variable than those in output over the 1960-1997 period. When broken over sub-periods, the standard deviation of °uctuations in M2 shows the same decrease as the one characterizing prices: between the ¯rst and the last periods, its value gets divided by 3: Fluctuations in the broad money aggregate appear acyclical over the whole period, but display a strong positive correlation over the 1986-1997 period. The examination of the details of the timing pattern of these variables is left for the next section.

3 \Steady State" Business Cycles

Having in mind the historical perspective in which to understand the evolution of cyclical °uctuations in Chile, we concentrate in this last part of the paper on the most recent decade, from 1986:1 to 1997:4, to draw the portrait of business cycles over a period of stability of the economy. Another advantage of restricting our analysis to this period is to be able to use consistent series published by the National Accounts at a quarterly frequency[9], thanks to which a standard study of business cycles \facts" can be developed, comparable with the bulk of research in this area. To assess the properties of Chilean business cycles, in terms of volatility and cross-correlations of macroeconomic variables over the course of the cycle, we compare as much as we can our results with the stylized facts characterizing two other economies of interest. The ¯rst one is Colombia, another Latin America country which economic conditions are comparable with those Chile. We use data from the Central Bank of Colombia

[9] The data is seasonally adjusted using the X-11 procedure.

between 1980:1 and 1996:4 to replicate our analysis for this country.[10] Second, we also report in the tables the properties of US business cycles documented by Kydland and Prescott (1990), a standard benchmark for business cycles facts to contrast the results obtained for Chile with.

Figure 1: Deviations from trend of real GDP, 1986:4{1997:4.

Figure 1 introduces the business cycles that have taken place in Chile over the period of study. Three full cycles, peak to peak, mark the decade. The ¯rst goes from 1986:4 to 1989:2. A second, more profound, one lasts from 1989:2 to 1992:4 and coincides with the strong contractionary monetary policy implemented by the central bank at the beginning of 1990. The third cycle begins in 1992:4 and lasts until 1995:3. From then on, a phase of contraction takes place until 1997:1, after which the economy begins expanding.[11] The average duration of a cycle over this period is approximately of 3 years (exactly 35 months, with a standard deviation of 6 months). Expansion and contraction phases lasted an irregular number of months, so that it is hard to generalize a typical length for them. They both, however, have an average length of 19 months (with a standard deviation of 8 months for expansions, 4 for contractions). For reference, in postwar US data, Moore and Zarnowitz (1986) using

[10] These results will be presented separately in a forthcoming paper comparing Latin American business cycles.

[11] Note also that the ¯lter will adjust better to the last observations as the time-series get updated.

the same detrending procedure as in this paper ¯nd that expansions lasted an average of 50 months, recessions one of 11. Finally, upturns and downturns have been rather symmetric in size, with slightly larger downturns if anything. Upturns represent, on average, a deviation from trend of 2:5%; downturns one of 3% (with standard deviations of 0:7% and 1% respectively). We now turn to document the properties of °uctuations in a wide range of economic activities. These properties are summarized by two types of statistics: the standard deviation of the cyclical component of each type of variable, expressed as a ratio to that of output for normalization, and the cross-correlation in time of this variable with °uctuations in output. We examine ¯rst the behavior of the expenditure components of national income (consumption, investment, government, and trade variables), follow with input variables (labor and capital), and end with monetary aggregates and di®erent types of prices.

3.1 Cyclical properties of GDP and expenditure variables

Table 3 reports the statistics summarizing the cyclical behavior of real GDP and its expenditure components. Note that given the size of the data sample, a correlation coe±cient given in the table is signi¯cant with a 5% probability of error if it is larger than 0:14: Between parenthesis are reported the equivalent moments documented by Kydland and Prescott (1990) for the US economy.[12] The ¯rst striking feature of the table comes out to be, as a matter of fact, the comparability of the size of °uctuations in Chile and in postwar US around their own respective trend. The volatility of cycles in real GDP in Chile is 1:84% (i.e., their standard deviation are, on average, 1:84% above or below the growth trend in GDP), close to the 1:71% displayed by US real GDP. This does not imply that the two countries undergo the same type of business cycles dynamics, whether referring to impulses or propagation mechanisms. Data shows that the contemporaneous correlation between cycles in US and Chile, over the 1986-1996 period, is only 0:12. Rather, it gives a reference through which to assess the relative stability of the Chilean economy along its growth path over the last decade. Comparing with other Latin American countries, we ¯nd that Colombia presents a lower variability of output °uctuations than Chile (1:29%). For Argentina, Kydland and Zarazaga (1997) document a volatility of output °uctuations 3 times

[12] Note that the period of time covered in their analysis di®ers from the one in this paper, since it concerns the years 1954 to 1989. However, in the same way as the post-war period was selected as the representative one to extract stylized facts for US business cycles, we believe our sample period to be an informative one for the Chilean economy, as motivated in section 2.1. Other papers, like Kydland and Zarazaga (1997) for the case of Argentina, undertake the same type of comparison.

higher than those in Chile, revealing structural di®erences between the two economies that make a comparison between the two business cycles less informative. We now review the characteristics of °uctuations in expenditure variables.

Figure 2: Cyclical °uctuations in real output and consumption, 1986:1{1997:4.

Consumption As ¯gure 2 shows, Total private consumption is highly procyclical, contemporaneous, and about as volatile as real GDP. Consumption does not vary smoothly over the cycle in Chile, as it does in the US, or as theory would predict. All the reasons why Friedman's (1957) Permanent Income Hypothesis would not hold are therefore candidates for providing an explanation to the \excess sensitivity of consumption" in Chile: presence of credit constraints, lack of rational expectations, etc. International evidence shows that Chile is not alone in this case. In Colombia, we ¯nd that consumption is 60% more volatile than real GDP. Among OECD countries, Japan and the U.K. present a volatility of consumption respectively 25% and 26% larger than that of GDP (Backus and Kehoe, 1992). However, in Kydland and Prescott's (1990) study, the smoothness of consumption result originates more speci¯cally from the pattern of consumption of non-durable goods.[13] Unfortunately,

[13] Durables have a volatility around 3 times that of real GDP in the US, while the volatility of non-durables and services is only half that of real GDP.

in the case of Chile, the series available from National Accounts is not disaggregated between durable and non-durable consumption, so that we cannot investigate further the features of consumption in Chilean data.

Investment In Chile, the government participates in a non-negligeable way to the investment process. Between 1986 and 1996, public investment represented an average of 10% of total investment per year. Because of this, we report the behavior of total investment in fixed capital as the sum of its private and public components, as well as the properties of each component separately. Since public investment is not available from National Accounts data, we use a series constructed using data from the Office of the Controler (Contraloría General de la Republica). As figure 3 shows,

Figure 3: Cyclical fluctuations in real output and investment, 1986:1–1997:4.

fluctuations in total investment are very volatile (more than 3 times the volatility of output) and procyclical. They are also found to lag the cycle by up to 2 quarters. These properties reflect the ones of its larger private sector component, about 4 times more volatile than GDP and procyclical with a 2-quarter lag. In the US, this timing pattern characterizes non-residential fixed investment, whereas residential investment leads the cycle. Whether this decomposition is true in Chile is not possible to say.

National Accounts do not disaggregate at a quarterly frequency residential and non-residential investment. Turning to public investment cycles, the table reports its high volatility, more than 7 times that of output.[14] Public investment is found to lead the cycle by 2 quarters. However, caution has to be taken in interpreting this series, as it originates from a different source than the National Accounts, which do not report it separately (see Appendix A for more details).

Government purchases Government consumption varies smoothly over the course of the cycle, with a volatility 65% the one of real GDP. This is low relative to OECD countries where, in the postwar period, the variability of government spending relative to output ranges between 1:2 in Japan to 3:3 in Norway (Backus and Kehoe, 1992). Moreover, the government variable in Chile shows a significant and positive contemporaneous correlation with the cycle. This correlation is of the same strength one quarter before the turning point in GDP, giving public spending a slightly leading pattern. This result differs from the findings of Agenor et al. (1998), who report a slightly countercyclical pattern for government expenditures (but with respect to industrial production). In international evidence, government fluctuations are generally found acyclical. Our result could be explained by the fact that National Accounts report as government consumption only salaries paid to government employees and final goods and services bought by the government. We use data from the Contraloría to obtain the series for government transfers, which, added to the public investment series, allows to construct a variable representing total government expenditures. The problem with this exercise is that the data series for government consumption taken from the two sources do not match. For consistency, we therefore prefer to present in a separate table the properties of government expenditures and their components, as originating from the Controlaría. Table 4 summarizes the results.

[14] The standard deviations of public and private investment do not sum up to the standard deviation of the total, as the two components are negatively correlated.

Table 4: Cyclical Behavior of Government Expenditures and its Components

Variable X	Std. Dev.	Cross Correlation of X_{t-i} with GDP_t, where i =								
	relative to	-4	-3	-2	-1	0	1	2	3	4
	GDP's		(leads of X)					(lags of X)		
Total Gov.	3.91	0.11	0.27	0.19	0.10	0.17	0.28	-0.07	-0.14	0.02
Consumption	2.91	0.14	0.19	0.22	0.45	0.38	0.22	0.20	-0.05	-0.26
Transfers	4.33	0.05	0.20	0.01	-0.05	0.00	0.14	-0.16	-0.14	0.09
Investment	7.47	0.18	0.25	0.34	0.19	0.30	0.33	0.06	-0.03	-0.12

Note: % deviations from trend (H-P filtered logarithms), quarterly data, 1986:1-1997:1. 5% significance level for correlation coefficients: 0.14.

Source: Contraloría

The aggregated series for government expenditures appears this time very volatile, as it is 4 times more volatile than real GDP. If this is in the range reported by Kydland and Zarazaga for Argentina, it is also higher than for most OECD countries in the postwar period, as reported above, as well as higher than in Colombian data (even though measurements of government expenditures differ widely across countries). All series appear in fact very volatile, including government consumption which shows more than 4 times more volatility than does its equivalent measure given by the National Accounts. These numbers should therefore be taken with caution. The patterns of comovements and time-shifts of cycles are however more consistent with the results available from National Accounts. The Contraloría data confirms in fact the 1-quarter leading pattern of cycles in government consumption. It is interesting to note that total government expenditures appear not very significantly correlated with the cycle and, if anything, lag it slightly. This result is more consistent with US and other international experiences: there has been hardly any evidence that government expenditures display any consistent pro- or countercyclical pattern. The timing pattern of this aggregate variable is strongly influenced by its public transfers component, which displays very little correlation with the cycle at any lead or lag. Interestingly, this variable is however found, at a statistically significant level, to move contracyclically with real GDP at a 2 quarter lag.

Trade Exports and imports are respectively about 2 and 3 times more volatile than output. In the US, imports and exports are both 3 times more volatile than GDP. The comparatively low volatility of exports when measured relative to GDP can be explained by the large share of exports in the GDP of a small open economy like Chile where exports represent around 40% of GDP, for an equivalent 13% in the US. Similarly, in Colombian data, the high variability of exports and imports, about 6

and 7 times larger than the volatility of output respectively, is associated with a lower size of exports relative to national GDP, around 19% over the period of analysis.
In terms of comovement, we ¯nd imports to be more procyclical than exports, as well as still strongly correlated with the cycle 1 quarter later. Both of these facts also hold in the US. What does not appear in Chilean data is the lagging pattern of exports. Indeed, whereas in the US exports lag the cycle up to a year later, in Chile they behave coincidentally with aggregate economic activity. This reveals the di®erence of economic structures between the two countries, shedding light on the large role played by exports in the short-run °uctuations of a small open economy like Chile. Finally, net trade recovers some of the standard features known for the US and most OECD countries: it is found to vary countercyclically with aggregate economic activity, even if it display much more volatility than in the US.

3.2 Production Inputs

Table 5 reports statistics concerning °uctuations in the labor and capital input components of national income. Data on hours worked for Chile is only available until 1995:4. The equivalent moments documented by Kydland and Prescott (1990) for the US economy are given in parenthesis.

Hours Total hours displays cyclical variations smoother than those of output. It varies procyclically, although °uctuations in hours are still strongly correlated with those in GDP after 2 to 3 quarters. To examine more closely the timing pattern of hours, we restrict the sample to the years 1989-1995, a period of lower unemployment in the Chilean economy and more stable labor market[15]. Over this period, the labor input appears clearly lagging the cycle by 3 quarters. This result remains valid when starting the sample period a few quarters later too.
Total hours can be decomposed into number of people working (employment) and hours worked per person (hours/worker). As reported in the table, employment °uctuates procyclically, while hours per worker is essentially uncorrelated contemporaneously with real GDP. The timing patterns of these two variables di®er particularly. Turning points in employment appear to lag the cycle up to 3 quarters, while those of hours per worker lead the way 3 quarters ahead. Both of these phase shifts are also a characteristic of US business cycles, even though the leading pattern of hours

[15] The consequence of the 1982 crisis on the level of unemployment can be felt long until the end of the Eighties. From a rate of 20% in 1982 { which does not include the population employed in special government programs {, unemployment began to fall slowly down, reaching a level close to 10% between 1986 and 1988. Since 1989, average unemployment has been around 7%.

per worker is much stronger in Chile. This fact reveals that hours per worker tend to increase 3 quarters in advance of an upturn in real output. We do not have data on the labor input for Columbia to contrast our ¯ndings with. More generally, the present study shows that, in Chile, labor input variables are much less correlated contemporaneously with real GDP over the cycle than in the US. This fact may point to the existence of labor market rigidities in Chile. Finally, in terms of variability, both variables °uctuate smoothly over the course of the cycle, relative to real output. The US also display this smooth pattern of °uctuations. It is interesting to note that more of the volatility in total hours appears to come from changes in employment rather than in hours per worker.[16] The \indivisibility of labor" hypothesis (Hansen, 1985) may then provide a helpful framework to understand labor °uctuations in Chile, as it does in the US.

Figure 4: Cyclical °uctuations in real output and labor productivity, 1986:1{1996:2.

[16] Kydland and Prescott (1990) note that if these two variables were perfectly correlated, the sum of their standard deviations would be equal to the standard deviation of total hours. Because this correlation is close enough to one in the US, they infer that employment accounts for 2/3 of the volatility in hours and hours/workers 1/3. In Chile, this correlation is close to zero: employment and hours per worker do not appear correlated. It is not possible, then, to infer the share in total hours variability of each of its components.

Labor productivity Hours is a variable that aggregates all types of skills present in the labor force and therefore provides a poor measure of labor input. Only as a first approximation, we compute an index of labor productivity as the ratio of GDP to hours. Fluctuations in labor productivity (figure 4) display a volatility equal to that of real GDP, a high figure relative to the US benchmark. They are also strongly procyclical (around 20% more than in the US) and coincident. Procyclicality is consistent with the idea that labor demand shifts in response to changes in the production function, a fact weighting in favor of a supply-side interpretation of the Chilean business cycle. However, this interpretation really holds when talking about the marginal productivity of labor. Being able to measure only average productivity, we defer deriving such conclusions until examining the cyclical behavior of the real wage, as is done later. Finally, note that the negative and significant correlation of labor productivity lagged 3 and 4 quarters with current output suggests the existence of labor hoarding, where labor adjusts with time to changes in productivity.

Capital Investment data is not available disaggregated into its residential and non-residential components at a quarterly frequency from National Accounts, contrary what is available at an annual frequency. We then only examine the features of fluctuations in total capital. As was explained in section 2.2.1., three series of this variable are constructed, following different assumptions on a depreciation rate for the aggregate capital stock. Robustly across series, we find, consistently with international evidence, that cycles in total capital stock are smooth in Chile. Their variability ranges between 35 and 50% the one of output for all capital series. Capital cycles tend to lag aggregate economic activity by 3 to 4 quarters, which means that it takes one year to the capital stock to adjust to the business cycle. This feature, also robust over all capital series we construct, is the reason why past changes in capital stock are negatively correlated with the current phase of GDP cycle. As mentioned above, a capital series is not available disaggregated into its residential and non-residential components at a quarterly frequency. We cannot therefore assess the possibility of a higher volatility of one of the two capital series. The analysis done at annual frequency in the previous section showed that a large source of fluctuations in the capital stock came from the variability of non-residential capital, particularly over the 1986-1997 period. This contrasts with the well-known large volatility of residential capital in the US, a variable also taken as a leading indicator of the business cycle in that country. It would be interesting to check if the construction boom Chile has been undergoing in the 90s[17] has brought additional variability to fluctuations in

[17] Construction has grown at an average rate of 11% per year between 1991 and 1996.

the capital stock.

3.3 Prices, Money and Interest Rates

We now turn to examining the behavior of prices, money stocks and interest rates. As an introduction, Table 6 summarizes some sample statistics for the growth rates of prices and a broad money aggregate (M2) over the 1986-1997 period.

Table 6: Properties of In°ation and Money Growth Rates, annualized.

	Mean (%)	St. dev. (%)	Autocorrelation	Cross-correlation with output growth
In°ation Rate	13.9	5.45	0.91	-0.29
M2 Growth	26.1	4.94	0.82	0.21

Note: fourth-di®erence of logarithms; based on quarterly data, 1986-1997.
Source: Central Bank of Chile.

The large ¯gure reported in the table for average in°ation per year does not provide a good representation of the dramatic decrease in in°ation that has taken place in the course of the past years in Chile. It however does when associated with its second moment: both ¯gures de¯ne a range of in°ation rates in the [3; 25] percent interval over the period. In fact, coming from above 20% in 1990, annual in°ation fell towards single-digit levels four years later, and still presents a declining slope until today. The persistence in in°ation is high, consistently with international evidence that in°ation persistence has been higher in the postwar period in OECD countries than before (Backus and Kehoe, 1992).[18] According to that paper, the ¯gure for Chile is comparable with the one of Italy over the postwar period (0:91). For Canada, Denmark, the UK and the US, the equivalent moment ranges between 0:74 and 0:79. Comparing with Colombia, the Chilean ¯gure appears twice as large. Edwards and Lefort (1997) explain that the high level of indexation of the Chilean economy creates a strong persistence in price changes, and that the gradual desindexation of the economy carries with it a fall in the persistence of in°ation. Money growth is persistent and positively correlated with output growth rate, in agreement with the disputed monetarist ¯ndings of Friedman and Schwartz (1982) for the US. We will return to this result later in this section.

[18] Following Cagan (1986), the high persistence of in°ation can be interpreted as coming from government policies, which opposed more credibly than before severe price movements.

Let us now investigate the statistical properties of the business cycle components of monetary aggregates, prices and interest rates. Table 7 summarizes the evidence, and gives the corresponding benchmark moments for the US in parenthesis.

Money Cycles in high-powered money are volatile, 1:5 larger than those in output, the triple of their amplitude in the US. A high volatility also characterizes M1 and re°ects the interest rate-oriented monetary policy followed by the Central Bank. This has for consequence to endogenize completely changes in the money supply, as it adjusts to changes in the central rate. Money demand is generally also found very unstable. Consistent with this fact is the strong leading pattern of M1 (and the base), which °uctuations lead by up to 2 quarters the output cycle.[19] This supposed leading role of money was the \monetary myth" that gave its title to Kydland and Prescott's (1990) paper when they only found M1 to be coincident with the cycle in US data. This myth appears however a reality in Chile's experience. M2 °uctuations lag the cycle 1 quarter, as found in Agenor et al. (1998), while time deposits, the di®erence between M2 and M1, lag the cycle by 2 quarters more. This is also di®erent from US evidence where M2 leads the cycle, revealing the role of credit arrangements in the US economy. To give some benchmarks related to other Latin American countries, we look at the patterns of °uctuations of monetary aggregates in Colombia. The results are similar to those of Chile, but the time-lag is shorter: we ¯nd M1 to lead the cycle by only 1 quarter, as well as M2 and the di®erence between M2 and M1. Kydland and Zarazaga (1997) report completely di®erent results for Argentina: they ¯nd M1 and M2 to move countercyclically with output, both with lag.[20] The absence of clear pattern in the international business cycles of money aggregates reveals di®erences in the type of monetary policy implemented by each country, and in its channel of transmission to the economy.

Prices Fluctuations in the consumer price index are 1:4 more volatile than those in output. This is almost double than in the US, but similar to the amplitude of price °uctuations in Colombia. As before, Argentina reveals here less comparable with Chile in economic terms, as price °uctuations there are 17 times larger than those of real output. Strikingly conform with international evidence, we ¯nd prices to move countercyclically to output. Greenwood, Hercowitz and Krussel (1994) give an

[19] It would be possible to re¯ne this timing pattern using monthly data for the real rate and GDP. The latter series does not exist at this frequency, but Herrera, Caputo and Pastene (1998) use data on the Monthly Index of Economic Activity (IMACEC) and, with a VAR system, ¯nd that a 1% shock to M1 creates a 0:1% increase in economic activity 5 months later.

[20] However this ¯nding is not robust across national accounts estimates, so that it should be taken with caution.

intuitive explication for countercyclical price movements: technological improvements in the process of production, more prone to occur in upturns of the cycle, are likely to generate negative price movements. This result plays in favor of a supply-side interpretation of the sources of business cycles. Chadha and Prasad (1994) have argued that such an interpretation may be invalidated by the cyclical behavior of in°ation. In particular, their ¯nding of a procyclical in°ation rate associated with countercyclical prices in the group of G-7 countries makes it impossible to discriminate between alternative theories of the business cycle on the basis of these stylized facts for this group of countries. We check this for Chile by examining the behavior of in°ation over the course of the cycle.[21] As ¯gure 5 illustrates, in°ation behaves countercyclically with output, similarly to prices, two results therefore consistent with the predictions of supply-determined models of the business cycle.

To examine °uctuations in the terms of trade, we use the ratio of an export to an import price index constructed by Valdes (1997). Relative to the one available from National Accounts, this series has the advantage to be built using a set of relevant prices for Chile, those of the goods that account for the main exports and imports of the country (see Appendix A for more details). Fluctuations in the terms of trade are found to be 4 times more volatile than output °uctuations. This is slightly higher than the values found for Japan (3:5) and France (3:9) by Backus, Kehoe and Kydland (1994) over the 1955-1990 and 1970-1990 periods respectively. As can be seen in ¯gure 6, terms of trade are found procyclical, consistently with the idea that higher export prices (say, or lower import prices) generate a wealth e®ect and an increase in national income. Cyclical movements in the terms of trade lead the ones in GDP by 2 quarters. This result also holds if we use the wider terms of trade series given in National Accounts, and is consistent with the a-typical stylized fact characterizing exports °uctuations in Chile: Exports were found to move without lag with the cycle, at di®erence with international evidence. The last price we document the properties of is the real wage. Its °uctuations are smoother than those of output and occur with a 3-quarter lead over those of GDP. This variable is predicted to be countercyclical in traditional Keynesian interpretations of the cycle and procyclical in equilibrium models of the business cycle. In Chile, the real wage varies procyclically, as also found in Agenor et al. (1998), and this ¯nding, together with the one of the procyclicality of labor productivity, plays again in favor of a supply-side interpretation of the driving force of business cycles in the country.

[21] As in°ation is non-stationary in level, we detrend it with the Hodrick-Prescott ¯lter ¯rst.

Figure 5: Cyclical °uctuations in output and in°ation, 1986:1{1997:4.

Figure 6: Cyclical °uctuations in output and the terms of trade, 1986:1{1997:4.

Figure 7: Cyclical °uctuations in output and the 3-month real interest rate, 1986:1{1997:4.

Interest Rates We look at the properties of the central rate used for monetary policy. The intervention rate is very smooth, displaying half the volatility of real GDP. As the instrument used by the Central Bank to monitor the economy, this rate varies countercyclically with output. Short-term °uctuations in the policy rate lead the ones in output by up to 2 to 3 quarters.[22]

4 Summary of Results and Conclusions

This paper presents some salient \facts" of the business cycle in Chile, using the standard a-theoretical methodology proposed by Kydland and Prescott (1990). It ¯nds, not that surprisingly, that the historical behavior of business cycles in Chile is strongly in°uenced by the economic and political developments that have taken place in the country over the past four decades. The volatility of °uctuations has decreased over the years, in particular since the highly volatile \reform" period, between 1975 and 1985, and this decrease concerns speci¯cally government expenditures and variables related to monetary policy. This excepted, we ¯nd a great deal of regularity in the features of business cycles over the 1960-1997 period. Consumption and investment remain highly procyclical, private investment is very volatile, net trade varies countercyclically, and input °uctuations are smooth and tend to lag the cycle.

We concentrate on the patterns of business °uctuations over the most recent and stable decade, from 1986 to 1997, as providing a \standard" for business cycles-type °uctuations in the Chilean economy. This allows to characterize cycles as having an average length of 3 years, with symmetric phases of expansion and recession of half this length each, and an amplitude of °uctuations of 3% on average in each direction. Our principal results and avenues for future works are summarized in the following points:

- Over the course of the cycle, consumption is found to display an \excess sensitivity" to output °uctuations, which may reveal the presence of credit constraints in the economy.
- As mentioned earlier, private investment is very volatile, about 4 times more than output, and it lags the cycle by up to 2 quarters.
- Exports are not very volatile compared to output °uctuations, as they represent a large share of GDP. Added to the unusual ¯nding that exports comove

[22] With monthly data, Herrera, Caputo and Pastene (1998) ¯nd, using a VAR model, that a 25 basis point shock to the central rate leads to a 0:5% shock to the IMACEC after 10 months.

contemporaneously with the cycle, this fact sheds light on the important role played by exports in the determination of short-run °uctuations for a small open economy like Chile. This is con¯rmed by the striking 2-quarter lead found to characterize phase shifts in the terms of trade along the course of the cycle.

- The behavior of input °uctuations reveals the presence of rigidities on the factor markets. Fluctuations in employment, total hours worked and capital all lag the cycle by up to 3 quarters. Besides, the higher volatility of employment °uctuations relative to that of hours per worker suggests that Hansen's (1985) \indivisibility of labor" hypothesis may provide a helpful framework to understand labor °uctuations in Chile. In turn, the real wage °uctuates smoothly over the cycle, and does so with a surprising 3-quarter lead. While the goal of this paper is not to defend a theory about the nature of shocks a®ecting the Chilean economy, this last fact plays in favor of a supply-side interpretation of the business cycle.

- This idea is reinforced by the ¯nding of countercyclical price movements over the course of the cycle.

- Government policies are found to play a signi¯cant role in short-term °uctuations. Public investment and consumption are procyclical and leading the cycle. This leaves only to government transfers a countercyclical role with a lag with respect to the cycle in aggregate economic activity. Monetary policy variables are found highly volatile. Fluctuations in M1 are strongly procyclical and lead the cycle by up to 2 quarters. This leading role of money, that Kydland and Prescott (1990) uncovered as a \monetary myth" in US data, is a reality in Chile's experience. As another evidence of the impact of monetary policy on the economy, the study ¯nds that the intervention rate varies countercyclically with output cycles and its °uctuations lead the ones in output by 2 to 3 quarters.

These facts, characterizing the short-term economic °uctuations around the 7:7% average annual growth rate of the Chilean economy in the past 10 years, constitute a basis for interpreting economic data and evaluating the state of the economy. They also provide guidance and discipline for the development of economic theories and models towards a better understanding of the Chilean business cycle.

Appendix A: data description

GDP: Gross Domestic Product, annual and quarterly. Source: Central Bank of Chile.

Consumption: Personal consumption expenditures, annual and quarterly. Source:Central Bank of Chile.

Total Investment: Gross investment in ¯xed capital, annual and quarterly. Source: Central Bank of Chile.

Public Investment: Spending on physical capital by central government, annual and quarterly. Source for annual data: Own estimations, based on data published by the Ministry of Finance; Source for quarterly data: Series constructed by B. Piedrabuena (Ministry of Finance), using data from the Contralor¶a General de la Republica.

Private Investment: Spending on physical capital by private sector. Estimated as a residual between Total Investment and Public Investment. Annual and quarterly.

Government Purchases: Consumption of goods and services by the government plus wages and salaries, annual and quarterly. Source: Central Bank of Chile.

Transfers: Pension payments and current transfers to the private sector by the government. Source for annual data: National Accounts (Central Bank of Chile); Source for quarterly data: Series constructed by B. Piedrabuena (Ministry of Finance), using data from the Contralor¶a General de la Republica.

Employment: Average number of workers occupied, annual and quarterly. Source: National Institute of Statistics (INE).

Hours: Total number of hours worked, annual and quarterly. Source: INE.

Capital Stock: since the series is not available at any frequency from national statistics, we constructed it as

$$K_t = K_0 + \sum_{i=1}^{t} (I_i - \pm K_{i-1}),$$

where K_t is the capital stock in period t, I_i is gross investment (in machinery and equipment concerning the series for non-residential capital) in period i and ± is the depreciation rate. The initial year is 1959 for annual data and 1985 for quarterly data, and the capital stock that year is calculated as:

$$K_0 = \frac{I_0}{\pm + \hat{y}},$$

where $\hat{y}$ is output growth at t = 0 (see Harberger, 1976). We compute capital series for di®erent assumptions on ± at an annual frequency, and infer their quarterly value

thereafter. The first series uses an annual depreciation rate of 5% for residential capital, and 10% for non-residential. This is equivalent to assuming that buildings depreciate fully in 20 years, while machines do so in 10 years. This hypothesis is also the one adopted by Rojas, Lopez and Jimenez (1997). The second scenario follows R. Fuentes and E. Haindl (1986), who find that depreciation rates of 6:7 and 2:5% for non-residential and residential capital respectively fit the case of Chile. The third case proposes to use a standard unique 10% depreciation rate for both types of capital. Finally, a fourth series was constructed using a measure of the value of depreciated capital per period published in the National Accounts. Note that the series reported in the paper use a depreciation rate of 10% for Machinery and Equipment and 5% for Construction concerning annual data, and 1:6% for the quarterly aggregate capital data.

CPI: Consumer Price Index, annual and quarterly. Source: own estimation using monthly data from INE.

M1: Money in circulation plus non-financial deposit accounts of the private sector, annual and quarterly. Source: Central Bank of Chile.

M2: M1 plus time deposits of the private sector, annual and quarterly. Source: Central Bank of Chile.

Real Short-term Interest Rate: Corresponds to the quarterly average real interest rate on 3-month PRBCs (\Pagaré Reajustable del Banco Central") between 1986:1 and 1995:2, and to the quarterly average overnight real rate from then on, following the change in instrument used for monetary policy. Source: Central Bank of Chile.

Terms of Trade: Ratio of the export price index to the import price index constructed by Valdés (1997). The goods and their respective weights included in the export price index are copper (58%), fish meal (23%) and wood pulp (19%). The import price index consists in machinery (94%) and petroleum (6%). For more details, see the cited reference.

Real Wages: Average quarterly real wages. Source: INE.

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Table 2: Properties of cyclical °uctuations, annual data, 1960-1997

	1960-1997	60-70	75-85	86-97
Volatility of Output, Expenditure, Input and Nominal Variables (%)				
Real GDP	5.73	2.50	9.48	2.61
Consumption	8.20	2.85	12.23	3.51
Investment	13.93	8.25	22.92	7.50
Private Investment	15.71	8.54	20.60	10.46
Public Investment	17.22	10.61	24.37	9.30
Government Consumption	3.99	3.30	4.57	2.13
Exports	8.69	2.55	9.79	3.27
Imports	16.45	8.31	28.20	8.11
Net Exports/output	4.23	2.15	6.82	2.17
Employment	3.61	1.04	5.70	2.09
Capital Stock	2.32	1.35	2.39	2.99
Non-residential	4.57	2.43	6.42	4.72
Residential	1.66	1.39	1.36	1.83
Prices	53.45	42.98	53.82	8.06
M2	46.55	42.28	47.24	13.37
Correlation of Expenditure, Input and Nominal Variables with GDP				
Private Consumption	0.90	0.85	0.96	0.96
Investment	0.85	0.62	0.94	0.73
Private Investment	0.71	0.62	0.90	0.69
Public Investment	0.59	0.28	0.67	0.29
Government Consumption	0.48	-0.11	0.60	0.79
Exports	0.19	0.22	0.57	0.79
Imports	0.95	0.64	0.99	0.91
Net Exports/Output	-0.86	-0.49	-0.95	-0.70
Employment	0.77	0.63	0.87	-0.13
Capital Stock	0.44	0.48	0.36	0.64
Non Residential	0.65	0.62	0.67	0.75
Residential	0.19	0.26	-0.20	0.59
Prices	-0.48	0.76	-0.33	0.66
M2	-0.18	0.76	0.24	0.86
Approx. Standard Error	(0.16)	(0.30)	(0.30)	(0.29)

NOTE: Absolute standard deviations in % and contemporaneous correlation with real GDP; variables are deviations from trend using the Hodrick-Prescott ¯lter.
Given the respective sample size of each period, a coe±cient of correlation is signi¯cant at a 5% level of error if it is superior to the number given in parenthesis in its column.
SOURCE: Central Bank of Chile.

Table 3: Cyclical behavior of output and expenditure components, quarterly, 1986:1{1997:4.

Variable X	Volatility	Cross correlation of GDP_t with X_{t+i}, for i =								
	(relative to GDP's)	-4	-3	-2	-1	0	1	2	3	4
			(leads of X)					(lags of X)		
1. Real GDP	1.85 (1.71)[1]	-0.22	0.04	0.28	0.58	1	0.58	0.28	0.04	-0.22
2. Expenditures										
Consumption	0.99 (0.73)	-0.29	0.03	0.38	0.63	0.78	0.60	0.42	0.10	-0.24
Total Investment	3.40	-0.51	-0.34	-0.05	0.26	0.64	0.67	0.65	0.40	0.13
Private Invest[2]	3.95 (4.85)	-0.56	-0.41	-0.12	0.22	0.56	0.63	0.67	0.45	0.12
Public Invest[2]	7.47	0.18	0.25	0.34	0.19	0.30	0.33	0.06	-0.03	-0.12
Govt Consumption	0.65 (1.21)	-0.07	0.16	0.39	0.48	0.48	0.31	0.16	-0.07	-0.06
Exports	1.89 (3.23)	-0.14	-0.06	0.12	0.07	0.46	0.28	-0.02	-0.16	-0.13
Imports	2.70 (2.88)	-0.41	-0.16	0.08	0.36	0.77	0.65	0.47	0.21	-0.14
Net Exports/GDP	1.78 (0.45)[1]	0.32	0.12	-0.01	-0.32	-0.47	-0.43	-0.45	-0.29	0.05

NOTE: Variables are deviations from trend of logged data (except for the ratio of net exports) using the Hodrick Prescott ¯lter. In parenthesis, are equivalent statisticsfor the US. The 5% signi¯cance level for correlations is 0.14.
[1]:absolute level, in percentage; [2]:1986:1-1997:1 due to data availability.
SOURCE: Central Bank of Chile

Table 5: Cyclical behavior of production inputs, quarterly, 1986:1{1997:4.

Variable X	Volatility	Cross correlation of GDP_t with X_{t+i}; for i =								
	(relative to GDP's)	-4	-3	-2	-1	0	1	2	3	4
			(leads of X)					(lags of X)		
1. Labor Input										
Hours[1]	0.86 (0.86)	-0.15	0.02	0.08	0.15	0.34	0.26	0.35	0.33	0.20
Employment	0.64 (0.62)	-0.40	-0.24	-0.02	0.21	0.38	0.41	0.45	0.46	0.31
Hours/Worker[1]	0.50 (0.32)	0.35	0.40	0.21	0.02	0.11	-0.15	-0.12	-0.15	-0.21
GDP/Hours[1]	1.07 (0.50)	-0.09	0.04	0.23	0.45	0.66	0.37	0.02	-0.20	-0.37
2. Capital Input										
Capital Stock	0.41 (0.36)	-0.40	-0.37	-0.33	-0.22	-0.16	-0.02	0.14	0.27	0.34

NOTE: Variables are deviations from trend of logged data using the Hodrick-Prescott ¯lter. In parenthesis, are equivalent statistics for the US. 5% signi¯cance level of correlation: 0.14.
[1]:Based on 1986:1-1995:4, due to data availability. SOURCE: Central Bank of Chile.

Table 7: Cyclical behavior of money, prices and interest rates, quarterly, 1986:1{1997:4.

Variable X	St. Dev.	Cross correlation of GDP_t with X_{t+i}; for i =								
	(relative	-4	-3	-2	-1	0	1	2	3	4
	to GDP's)		(leads of X)					(lags of X)		
1. Money Stock										
Monetary Base	1.49 (0.51)	0.25	0.43	0.50	0.39	0.36	0.19	-0.19	-0.33	-0.46
M1	2.66 (0.98)	0.27	0.50	0.65	0.65	0.52	0.41	0.28	0.18	0.02
M2	1.49 (0.88)	0.01	0.15	0.20	0.22	0.27	0.41	0.28	0.18	0.02
M2-M1	1.88 (1.12)	-0.14	-0.13	-0.17	-0.14	0.02	0.30	0.35	0.39	0.27
2. Prices										
CPI	1.40 (0.82)	0.20	0.02	-0.12	-0.26	-0.34	-0.27	-0.17	-0.09	-0.07
In°ation	1.79	-0.20	-0.44	-0.56	-0.61	-0.56	-0.33	-0.09	0.13	0.28
Terms of Trade	4.00	0.19	0.32	0.40	0.23	0.02	-0.03	-0.19	-0.31	-0.26
Net Real Wages	0.69 (1.58)	0.29	0.40	0.30	0.28	0.14	-0.09	-0.18	-0.21	-0.18
3. Real Interest Rate										
Short-term Rate	0.49	-0.47	-0.57	-0.60	-0.44	-0.26	0.08	0.39	0.56	0.57

NOTE: Variables are deviations from trend using the Hodrick-Prescott ¯lter. In parenthesis,are equivalent statistics for the US. Money variables are in nominal terms; the CPI is 100 in 1986.

5% signi¯cance level of correlation: 0.14.

SOURCE: Central Bank of Chile

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