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SECTORAL GROWTH IN CHILE: 1962-82

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FOREWORD

To understand the time path of agricultural development, the causes for the variability in sectoral outputs must be examined as part of the general process of economic growth. Such an examination is the focus of this report by Juan Eduardo Coeymans and Yair Mundlak, which appears at a time when there is a great deal of interest in the ability to sustain agricultural as well as general economic growth.

This research extends beyond previous studies of agricultural growth at IFPRI by Mundlak and his associates by looking at the economy as consisting of five sectors that vary in their degree of tradability as well as in other attributes that caused differential response to the rapidly changing economic conditions in Chile from 1960 on. The study uses an input-output table to structure the flow of intermediate products between agriculture and the other sectors of the economy and shows how developments outside agriculture affect agricultural ability to compete for resources and to change its productivity.

One of the many findings of the study is that it was only when a stable macro environment was achieved that agriculture, and the economy at large, started to grow. IFPRI has pursued the study of the effects of macro and trade policies on agriculture in the context of other developing-country experiences. *The Bias Against Agriculture: Trade and Macroeconomic Policies in Developing Countries*, a book published jointly with the International Center for Economic Growth, contains eight country studies and three regional surveys undertaken by IFPRI researchers and their collaborators.

Per Pinstrup-Andersen
Director General

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Juan Eduardo Coeymans
Yair Mundlak

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SUMMARY

On the whole, agricultural share in total output declines in the process of economic growth. The major reason for this is the small income elasticity for food. However, a small open economy can overcome the demand constraint to the growth of agricultural production by expanding its net exports. Chile serves as a good example; its share of agriculture in total output averaged 9.46 percent in the period 1986-90, as compared with an average value of 9.66 percent in 1960-64. The relative long-term constancy of this share in Chile is a sharp departure from the experience of most countries. The option of maintaining such a constant share is not open to all countries of the world combined because that would be inconsistent with income-inelastic demand. Furthermore, this share was not stable; it fluctuated over the 30-year period and reached its lowest level of 7 percent in 1973, the last year of the Allende government.

The time path of the agricultural share in total output is determined by the differential growth rates of agriculture and nonagriculture, and these varied considerably over time in Chile as elsewhere. This study examines the causes for this variability in sectoral outputs and the relative long-term constancy of the share of agriculture by studying the broader issue of the determinants of sectoral growth. It is believed that such broadening of the framework for the analysis of the performance of agriculture is essential for understanding the trajectory of agricultural development. The Chilean economy is a very interesting case for such a study in view of the various policies that have been tried out in a short time span. Most studies of the consequences of such policies have concentrated on the short-term macro aspects, but little has been said about their long-term effects on overall and sectoral growth.

Economic growth is achieved through the accumulation of physical and human capital and changes in the available technology. By and large, the literature on theoretical growth concentrates on the long-run aspects of the growth process and so takes no account of the prevailing economic environment. Does this provide a good guideline for empirical analysis? A review of the Chilean experience shows that during 1936-70, per capita income grew at a relatively steady rate of 1.6 percent per year. This growth was interrupted as a result of the shocks to the economy introduced initially by the Allende government (1970-73) and the difficulties of returning to normality, and later by the recessions of 1975 and 1982 that were triggered mainly by unfavorable external conditions. Basically, there have been two periods of catching up: 1976-81, which was followed by a deep recession in 1982, and the subsequent period of continuous growth through 1992. Both the fall and the subsequent rise of output are results of government policies—some, of course, with negative effects. Such policies, in part specific to agriculture and in part general, affected the economic environment and thereby affected the growth performance. The economic environment affects sectoral growth through its effects on factor productivity and resource allocation.

For the purpose of this study the economy is decomposed to five sectors, listed in decreasing order of their degree of tradability: mining, agriculture (including fisheries), manufacturing, services, and government. The product of each sector consists of intermediate inputs purchased from other sectors and the value added of the sector produced by capital and labor, and also land in the case of agriculture.

The available technology at any point in time provides producers with more than one technique of production of which they use only a subset. The choice of the techniques to be used, referred to as the implemented technology, is determined by the incentives that affect their profitability and by the constraints to their use. The empirical production functions that relate sectoral outputs to inputs represent the implemented technology, and as such they depend on the economic environment. To capture this dependence, the empirical analysis allows the coefficients, and therefore the factor productivity and factor shares, to vary in response to the prevailing economic environment. This framework makes it possible to evaluate the changes in productivity that are associated with changes in economic variables and thereby to decrease the unexplained residual of total factor productivity.

Different techniques have different factor requirements and therefore their implementation at any time depends on the prevailing factor supply at the sectoral level. Given the total factor supply, the intersectoral allocation of resources depends on the differential returns, and these in turn are affected by the product and factor prices. An empirical off-farm labor-migration equation is obtained to quantify the response of labor migration to changes in the differential income between agriculture and the nonagricultural sectors. The migration was larger when the income differential was relatively high and the unemployment rate in nonagriculture was low. Accordingly, the deterioration of economic conditions in the 1970s reduced the rate of off-farm migration and thereby increased the agricultural labor supply.

The study period (1962-82) includes years with very high unemployment rates, indicating that wages were not market-clearing. Wages in nonagriculture were determined by a bargaining process with government guidelines during the volatile years of the 1970s. With wages given, employment in nonagriculture was determined by labor demand, and when this was low a large unemployment resulted.

The sectoral investment was determined by the rate of return and institutional factors. An improvement in the sectoral incentives increased the rate of return, thereby increasing the investment and the capital stock; this facilitated the introduction of new techniques that were more capital-intensive than the prevailing ones.

The output of each sector consists of three types of products: importable, exportable, and nontradable. The sectoral prices are weighted averages of the prices of these components. The prices of the tradable components are world prices, whereas the prices of the nontradable products are determined by the domestic supply and demand. Changes in policies, as well as in the external conditions, affect the prices of the various components differentially. Such changes in the relative prices affect the intersectoral allocation of resources as well as the choice of techniques.

The model allows quantitative evaluation of the effects of the various determinants of sectoral growth within the Chilean economic environment of 1962-82. In general, sector-specific policies affect sectoral prices and thereby sectoral outputs. The strength and the nature of such effects are examined by simulating the response of the economy to price changes. The various experiments investigated indicate that the sectoral composition of the simulated economy is strongly influenced by changes in the relative prices across sectors. The response is gradual and may take a long time to complete. It is therefore important to distinguish in the discussion of supply response between the magnitude and the speed of the response.

The response of agricultural output to a 1.0 percent increase in its price results in a 0.3 percent increase in agricultural output in 3 years and a 1.0 percent increase after 10 years. This corresponds to implicit supply elasticities of 0.3 and 1.0 after 3 years and 10 years, respectively. The weak response of agriculture in the short run explains the pessimism of the structuralists regarding the effect of price policy on agricultural output. The essence of these results is that the response is rather sizable but requires time to materialize. This distinction between magnitude and speed is extremely important in that it highlights the importance of having persistent economic policies.

The reason for the gradual response is that changes in the structure of the economy require reallocation of resources, and this is time-consuming. The sluggishness in resource mobility is a reflection of the nature of factor supply and is not specific to changes instigated by price changes. A similar pattern is expected to exist in response to other changes in the economic environment. This means that there are no shortcuts for changing the structure of the economy—a point that is often overlooked in the discussion of policy.

A comparison of the adjustments made by labor and capital to changing prices shows that the capital stock on the whole is more technique-specific than labor. Therefore, the adjustment in the sectoral composition of the capital stock is carried out largely through new investment and requires more time than adjustment of the composition of the labor force. The slow speed of factor response to prices explains the differences in factor prices that prevail persistently across sectors.

For part of the study period, manufacturing was protected to improve its profitability. The response of manufacturing to a price change is much stronger than that observed in agriculture. An increase in the price of manufacturing by 1 percent leads to a 4 percent increase in output after 10 years, implying a supply elasticity of four. The expansion comes mainly at the expense of services, with mining contributing to the expansion of manufacturing capital. This illustrates that the development of manufacturing need not be at the expense of agriculture, as is often implied in the development literature that proposes taxing agriculture as a means of developing manufacturing.

The main event in the study period was the outcome of general, rather than sector-specific, policies. Such policies affect the level of domestic prices and thereby the real exchange rate; the price of the tradable goods in terms of the nontradable goods. The index of the real exchange rate varied in the study period from 77 to 131 and climbed to still higher levels in the post-study period, reaching a level of 147 in 1985. A change in the real exchange rate affects sectoral prices according to the sector's degree of tradability; the more important is the tradable component in sectoral output, the more susceptible is the sectoral price to changes in the real exchange rate. The strength of the effect is directly related to the degree of openness of the economy. Indeed, a simulated increase in the real exchange rate causes a strong increase in output of mining and agriculture, the more tradable sectors. The resources needed for the expansion of these sectors are provided by services, which constitute the least tradable sector. The long-run effect of an increase in the real exchange rate on agriculture is to reduce the off-farm migration and thereby increase employment in agriculture at the expense of nonagriculture. Wages increase in all sectors and this leads to an increase in the share of wages in total income. The importance of the real exchange rate for agriculture has been shown by the actual growth of agriculture in the 1980s, which is largely outside the study period.

The political and economic volatility in the study period cannot be considered as a steady-state situation, nor for that matter can it be assumed that there was no gap between the available and implemented technology. Thus two fundamental premises of the theoretical discussions of growth are not maintained. A key variable, the investment-output ratio, fluctuated over the period 1960-90 in the range of 13-23 percent, implying fluctuations in the rate of capital accumulation. Changes in the capital stock affect output directly as well as indirectly, through the effect on the choice of techniques.

Simulating the economy with an increase of one percentage point of the investment-output ratio over and above its historical path results in a considerable increase of output. When such a simulation is carried out with wages maintained at their historical levels, output increases by 7.7 percent after 10 years, and 19.8 percent after 20 years. An increase in capital has a substitution and expansion effect on labor demand. The simulation indicates that the expansion effect dominated and labor demand grew considerably with the increase in investment, leading to a decline of unemployment by 11 percentage points in 1982, a year with an unemployment rate of 18 percent. This exercise also shows the importance of physical capital for growth—a point that has often been lost in recent discussions of growth.

The main decline in the investment-output ratio was caused by the policies of the early 1970s, and it took a long time for this ratio to return to its level of the 1960s. To evaluate the cost of the political instability of the 1970s, the economy is simulated under the assumption that the ratio is maintained at a 20 percent level, which was typical for the 1960s. The simulation begins in 1974 and the effect is dramatic; in 1982, eight years after this change is introduced, output increases by 14.5 percent with endogenous wages and by 20 percent when keeping the wages at their historical level. Unemployment in 1982 would have declined by 5.1 and 11.2 percentage points in these two cases, respectively.

An extremely important feature of the Chilean economy in the study period is the resiliency of the real wages in nonagriculture. Any simulated improvement in the economy that leads to an increase in labor demand has a stronger effect on wages than on employment. This result reflects the empirical wage equations and shows how institutional arrangements that interfere with market performance can choke up the growth process.

Chile, being a small economy, depends greatly on its relationships with the world economy. External terms of trade affect its economy and historically have been the cause of business cycles. An improvement in the terms of trade has a favorable effect on the volume of trade and therefore on the introduction of new techniques that cause an irreversible technical change. A similar effect is obtained by keeping the economy open to trade and to capital flow.

The cyclical variations affected growth. It is found that during recessions there was less incentive to expand technology. Favorable external conditions affected positively the productivity of manufacturing and services. To a great extent, the effect of the external conditions comes from its impact on the productivity of sectoral nontradable components of output. Although the elasticity of productivity with respect to the external conditions is positive for the two sectors, it is anticyclical in manufacturing and procyclical in services, the least tradable sector.

The long-term bias of technology is labor-saving in agriculture and labor-using in manufacturing and services. It is suggested that restrictions on import of machinery prevented the country from taking advantage of the capital-intensive techniques.

The agrarian reform that was carried out throughout a good part of the study period had a slight positive effect on agricultural output in its beginning and a negative effect in the final years.

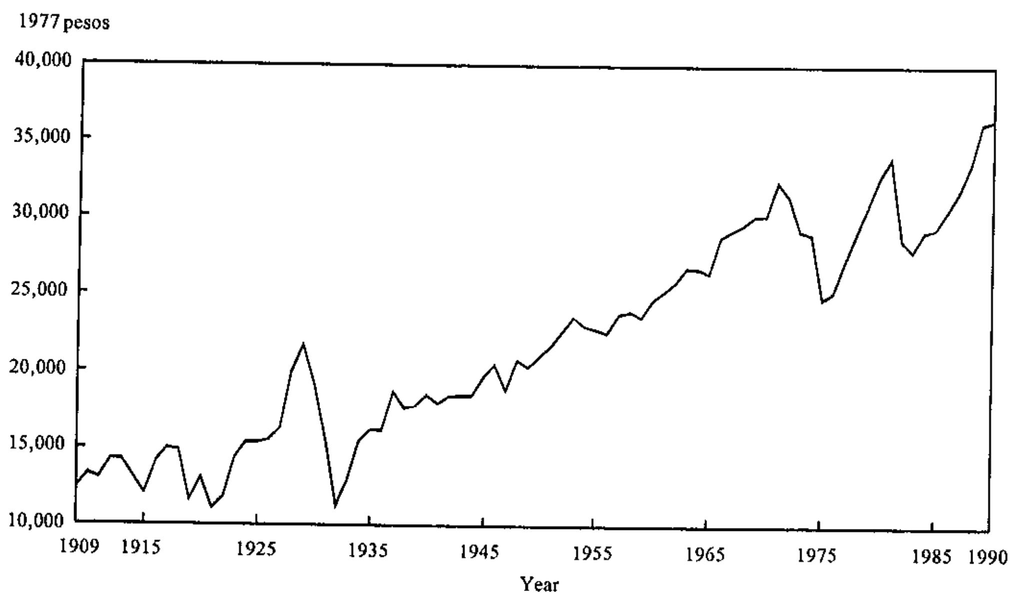
2

INTRODUCTION

The 1962-82 study period falls within four very different administrations in Chile: Alessandri (1958-64); Frei (1964-1970); Allende (1970-73), who tried to implement a socialist regime; and the military regime of Pinochet (1974-90). Their widely different economic policies, combined with changing, and at times volatile, external events—particularly the terms of trade and international rates of interest—strongly affected the performance of the economy. The outcome is well illustrated in Figure 1, which shows the per capita gross domestic product (GDP) in the period within a historical perspective. Coming out of the Great Depression of the early 1930s, the country enjoyed a continuous growth with relatively small interruptions up until 1971. This was followed by a sharp decline climaxed by the recession of 1975. A short period of recovery, beginning in 1976, culminated in the recession of 1982. The subsequent post-study period (effective through 1992) has been a period of vigorous and stable growth.

To provide a background of the prevailing economic environment pertinent to the study, some of the important events that took place during this relatively short period of 20 years are listed below. Some of these developments are reviewed later in more detail in connection with the discussion of specific subjects.

Figure 1—Per capita gross domestic product, 1909-90



1. Large changes in the fiscal and public deficit: reduction of the deficit at the end of the 1960s; a huge increase during the Allende period that led to inflation of the order of 700 percent; decrease of the deficit beginning in 1974; and declining inflation since 1975 to levels below 15 percent in 1992.

2. Fluctuations in exchange rate policies: fixed exchange rate up to 1962; passive crawling peg during the Frei period; exchange rate controls and multiple exchange rates during the Allende period; a mixture of passive crawling peg and sudden changes in the 1974-77 period; an active crawling peg since 1977-78; fixed exchange rate in 1979-82; and abandonment of the fixed rate in mid-1982.

3. Important changes in trade polices: a foreign exchange crisis at the end of 1961 that led to import controls; a decline in controls since 1965 and modest liberalization of trade at the end of the 1960s; a reversal of this attempt during the Allende period; and a massive trade liberalization since 1975—as a result of this, and other policies, exports have grown at a high rate since then.

4. Price controls during the 1960s: a substantial increase in controls during the Allende period and complete liberalization under Pinochet.

5. Controls of interest rates during the first three administrations and complete liberalization of interest rates and financial markets, leading to a boom in financial markets during the Pinochet period.

6. Liberalization of the capital account in 1979, which led to huge flows of external credits, but these have been severely reduced since 1982.

7. Huge fluctuations in the terms of trade, especially in copper price, which varied in the range of US$0.67-US$2.08 per pound. Copper constituted more than half of total export value during the study period.

8. High international liquidity, which, together with overoptimistic expectations of growth and fixed exchange rate policy, led to high external flows of capital at the end of the 1970s; a rise in international rates of interest in 1981 that imposed a substantial increase in the cost of servicing the climbing foreign debt; a severe cut in the external flows of capital in 1982 that triggered a severe recession in that year.

9. Uncertainty about property rights and direct public control of production: nationalization of big copper mines from the mid-1960s to early 1970s; an agrarian reform that began in 1965, accelerated at the end of the 1960s and early 1970s—affecting about 50 percent of the irrigated land—and was partially reversed at the beginning of the military regime; nationalization of over 500 of the largest private enterprises of manufacturing and services during the Allende period; reversal of these nationalizations under Pinochet, and privatization of additional public firms during this same administration, a process that still continues.

The recessions of 1975 and 1982, which were in part triggered by external events, are the most important turning points in the evolution of the economy. Thus, per capita income in 1981, prior to the recession of 1982, was only 4.9 percent higher than that of 1971, whereas that of 1988 was lower than that of 1981 and only 3.6 percent higher than in 1971. The low growth rates implied by these figures affected the labor market; real wages in 1980 and 1990 were still at the 1970 level. Unemployment increased dramatically in 1974-75 and stayed at much higher levels than the historical average until 1988.

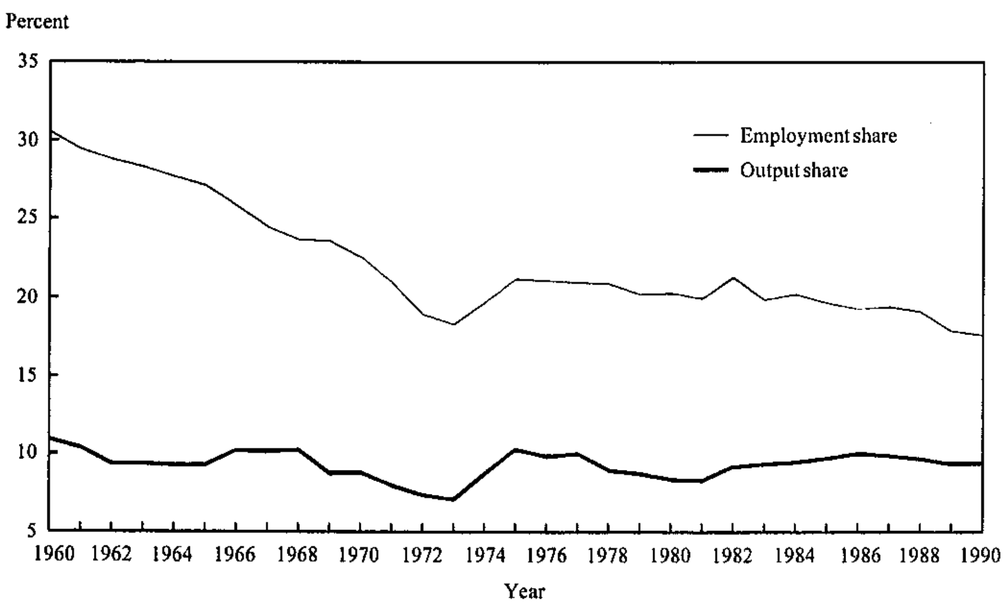
It is not surprising, therefore, that the Chilean economy has attracted the attention of economic researchers. A description of the macro events and policies during the 1960s appears in Ffrench-Davis (1973), Behrman (1977), and Corbo (1974). The events of the 1970s are discussed by Barandarián (1974), Corbo (1983, 1985b), Corbo and Solimano (1991), Ramos (1984), Harberger (1982, 1985), Edwards and Cox (1987), de la Cuadra and Hachette (1991), Arellano (1988), and Fontaine (1989). Largely, these studies describe the policies and most important events and provide an interpretation of the facts. The quantitative studies deal mainly with the short-term macro changes.

There is a big question as to how and to what extent changes in the economic environment affect growth. This is an extremely important subject that is not well understood by economists. Much of the emphasis in the growth literature is placed on human capital, the role of which is evaluated within a framework of a competitive economy in a steady-state equilibrium. The level of education in Chile did not fluctuate much during the study period; therefore, this variable cannot account for the changes in output. Thus, relating changes in growth to the economic environment is a challenging task, and this study is an attempt in that direction.

The main interest here is in sectoral growth, which, unlike the assumption made in some of the theoretical studies, is not balanced in that the various sectors need not grow at the same rate. Thus, in this study the analysis is carried out at the sectoral level. Changes in the economic environment have a differential effect on the various sectors, and this is reflected in changes in the sectoral resource allocation and productivity growth, which lead to changes in the sectoral composition of output, employment, and capital.

This framework allows an understanding of the major developments in agriculture that result from changes not specific to agriculture. A first impression of the development of Chilean agriculture is given in Figure 2. The decline in the share of

Figure 2—Share of agriculture in total value added and total employment, 1960-90



agricultural output in the late 1960s and the beginning of the 1970s is related to the relatively low agricultural prices, which in part reflect price controls, and the agrarian reform. However, the price effect was in part compensated for by the low farm wage. The high unemployment in the cities in the late 1970s and the first half of the 1980s contributed to retention of labor in agriculture and thereby to depression of agricultural wages. The comeback of the share of agriculture in total output in the 1980s is related to a reversal of the situation. The favorable conditions in agriculture in this period also affected off-farm migration, thereby stopping the steep decline in the agricultural share in the labor force that was observed during 1960-73 in many other countries. These and related developments are better understood within the broad view taken in this study.

In Chapter 3 an overview of the model is provided, and the main relationships, which are studied in more detail in subsequent chapters, are introduced. The reader may want to read Chapter 3 superficially and return to it after reading Chapters 4-7, which are devoted to the empirical analyses, including the specification of the various equations. In Chapter 4 the approach taken in the analysis of both factor productivity and its response to the changes in the economic environment is described and estimates of the sectoral production functions are provided. The behavior of the labor markets is analyzed in Chapter 5 by analyzing the off-farm labor migration and the determination of sectoral wages in nonagriculture. The intersectoral allocation of investment and its dependence on the differential rates of return are dealt with in Chapter 6. An analysis of the behavior of sectoral prices and their dependence on international prices and the macro policies is provided in Chapter 7. In Chapter 8 the various components of the model are assembled to simulate the economy and to examine its response to changes in relative prices including changes in the real exchange rates. The growth aspects of the model are discussed in Chapter 9, and some general conclusions are given in Chapter 10.

The study is based on a great deal of data. The major series are reported in Appendix 1. A supplementary publication, available upon request, describes the data and the sources and explains the construction of the variables used in the study. The figures in the report are based on these data and on results of the calculations, as explained in detail throughout the discussion.

3

THE MODEL

The study deals with sectoral growth in Chile in the period 1962-82. This is not the ideal period for which to study growth in the way that economists think about growth as a long-term process. Not only is the study period short, but it also covers some very unstable years as a result of some shocks that one would like to think are not recursive. However, the economic volatility offers an interesting case for examining some effects that such shocks have on the growth process.

The model assumes that the economy consists of four sectors aside from government: agriculture, mining, manufacturing, and services. Explicit account is taken of the intermediate inputs, or intersectoral flow of outputs. This calls for a distinction between sectoral prices of value added and prices of gross output, or simply product prices. Output decisions are taken in response to value-added prices. The value-added price in one sector changes when the product price of this sector changes and also when there is a change in the product price in any of the sectors that provide intermediate inputs to that particular sector. The model is similar in some respects to the supply side of some computable multisectoral general equilibrium models for an open economy (see Dervis, De Melo, and Robinson 1982). This resemblance is largely of form and not of substance. Several features distinguish this study from the majority of such models; the more important ones are the treatment of technology and treatment of the factor markets.

First, the technology of each sector is endogenously determined by economic variables. Producers decide simultaneously on the techniques of production to be used and on the intensity of their utilization as determined by the inputs allocated to them. Second, the behavior of the factor markets is strongly influenced by dynamic considerations that prevent the markets from maintaining the conditions of static equilibrium.

In these respects the study is similar to the two-sector model of Cavallo and Mundlak (1982) and Mundlak, Cavallo, and Domenech (1989) for Argentina. However, the extension to more sectors, and particularly the introduction of intermediate inputs, adds additional important aspects. Besides, there is an important difference between the two economies. During a large part of the study period, the Chilean economy had a considerable rate of unemployment, whereas that was not an important problem in Argentina. The persistence of unemployment in the 1970s influenced the formulation of the behavior of the nonagricultural, or urban, labor markets. The prevailing wages in the urban sectors were not necessarily market clearing. They were affected largely by the macro environment, unemployment, and the institutional settings. This is in contrast to the wages in agriculture, which basically clear the market. Wage differences between agriculture and nonagriculture are a major determinant of off-farm migration, which in turn determines the labor supply in agriculture and nonagriculture.

A general description of the structure of the model follows. The details and the empirical analysis are discussed in subsequent chapters. The data base for the study is provided in Appendix 1.

Technology

Gross Sectoral Output

Output. Sectoral output consists of value added and intermediate inputs flowing from other sectors. The sectoral production function is assumed to be additive in these two components. Intermediate inputs are related in fixed proportions to the sectoral output. The sectoral labels are 1 for agriculture; 2 for mining; 3 for manufacturing; 4 for the rest of the economy, exclusive of government, to be referred to as "services"; and 5 for government. The real quantities are valued at 1977 prices, which is the base year of the National Accounts. Real prices, unless indicated otherwise, are nominal prices deflated by the consumption deflator, *PC*.

$$X_j = \sum_i A_{ij} X_j + V_j, \quad i, j = 1,...,5, \tag{1}$$

where X_j is gross output, A_{ij} is an input-output coefficient indicating the level of input originating in sector i needed to produce a unit of product in sector j, and V_j is real value added. All quantities, including the input-output coefficients, are measured in 1977 prices.

Ideally, the input-output coefficients should be endogenized, but this would require a time series of input-output tables that does not exist. There are only two input-output matrices for Chile and those are not easily comparable because of changes in definitions.

Value Added. The formulation of the production function of sectoral value added follows the approach of endogenous productivity as explained in Chapter 4. The available technology consists of more than one production function. The subset of the functions that are actually used at any time, referred to as the implemented technology, is determined by state variables. The frontier of the implemented technology provides the implemented production function. This frontier changes with the state variables, and this is taken explicitly into account in formulating the production function. The production system is approximated by a system consisting of two identities and two stochastic equations. In writing the system, the competitive equilibrium conditions are utilized where factor shares are equated to the production elasticities. The production system for a given sector is

$$\ln v_j = \Gamma_j(.) + B_j(.) \ln k_j, \tag{2}$$

$$B_j(.) = S_j - (1/2)\, \pi_{kj} \ln k_j, \tag{3}$$

$$S_j = \pi_{01j} + s_j' \pi_{11j} + \pi_{k1j} \ln k_j + \varepsilon_{kj}, \text{ and} \tag{4}$$

$$\Gamma_j(.) = \pi_{00j} + s_j' \pi_{10j} + s_j' \pi_{20j} s_j + \varepsilon_{0j}, \tag{5}$$

where, unless indicated otherwise, the variables are for year t;

v = V/L,
L = employment,
K_{t-1} = real capital stock at the end of year t-1,

k_t = capital-labor ratio for year t defined as K_{t-1}/L_t,
S = share of nonwage income in value added,
s = a vector of state variables,
ε = stochastic term,
$B(.)$ = slope of the function,
$\Gamma(.)$ = intercept of the function, and
π = parameter to be estimated.

The function has the form of a Cobb-Douglas function, but it is more general in that the coefficients depend on the inputs and the state variables. The dependence of the production elasticity on ln k makes the function quadratic in ln k, as in the translog function. A similar system was estimated for Argentina by Cavallo and Mundlak (1982) and Mundlak, Cavallo, and Domenech (1989).

A major consideration in the empirical application of this approach is the choice of state variables. In general, the state variables consist of the available technology, constraints, and incentives. This is discussed in detail in Chapter 4.

This approach was applied successfully to agriculture, manufacturing, and services. For reasons discussed in Chapter 4, a different approach had to be applied to mining.

Inputs

Labor Demand

The demand for labor in agriculture, manufacturing, and services is determined from the value marginal productivity of labor. Using the adding-up property, the labor share for each of these sectors is $(1 - S_j)$, determined from the production function, and the definition of the labor share is used to determine labor demand:

$$(1 - S_j) = W_j L_j / (V_j - T_j) P_{vj}, \qquad j = 1,3,4, \tag{6}$$

where W_j is the sectoral real wage or cost per unit of labor, T_j is real indirect taxes paid by the sector, and P_{vj} is the real price of value added.

In accordance with the specification of the production process in mining, it is assumed that the employment is proportional to output. The employment in government is exogenous in the empirical analysis and in some simulations, whereas in others it is endogenized by assuming that the government value added constitutes a constant proportion of output; that the value added is equal to the product of the government wage and employment; and that the government wage varies in the same proportion as the average nonagricultural wages.

Labor Supply

The overall labor supply is assumed to equal the historical values. The allocation of labor between agriculture and nonagriculture is determined by the migration equation. Assuming a constant participation rate in the labor force, the labor supply in agriculture at time t is obtained by adjusting the labor force at t–1 by the natural growth rate and subtracting from it the off-farm migration:

$$L_1 = L_{1t-1}(1 + n) - M, \tag{7}$$

where M is the number of off-farm migrants, and n is the natural rate of population growth. The migration is an outcome of an economic decision, summarized by the migration function, written in a general form as

$$m = M(d, u, RL), \tag{8}$$

where

- m = M/L_1, which is the proportion of the agricultural labor force that migrates to nonagriculture,
- d = income differential between agriculture and nonagriculture,
- u = unemployment rate in nonagriculture, and
- RL = ratio of the labor force in nonagriculture to that in agriculture.

It is assumed that agricultural wages are market-clearing and therefore there is no unemployment in that sector.

It is expected that migration increases with the income differential and with the share of nonagriculture in the labor force and declines with unemployment.

The flow of migrants is obtained from

$$M = m L_1. \tag{9}$$

Nonagricultural Wages

Wages in the nonagricultural sectors were affected by market and institutional forces, taking the form of official guidelines for wage determination. These were based on the overall macro environment as well as the specific conditions of the particular industries. The actual contracts differed from the guidelines, reflecting the influence of economic conditions and bargaining power of labor unions.

The sectoral wage equations are of the augmented Phillips curve type. Under the assumption of price homogeneity, a constant inflation rate leaves real wages unchanged. Changes in inflation rates affect real wages in the short run. The other determinants are unemployment and the rates of change of past real wages. It is expected that higher unemployment levels reduce the bargaining or market power of labor to increase wages. Real wages are obtained by deflating nominal wages by the National Accounts consumption deflator (PC).

For the purpose of estimation and simulation, the function has the following general form:

$$w_{jt} = W(u, \Delta p, w_{jt-1}, w_{jt-2}), \qquad j = 2,3,4, \tag{10}$$

where w is the ln of real wage, and Δp is the inflation rate. This subject is discussed in detail in Chapter 5.

Urban Unemployment

The rates of nonagricultural unemployment and nonagricultural labor force (L_{na}) are determined by the following identities:

$$u = \left(L_{na} - \sum_i L_i\right) / L_{na}, \qquad i = 2,3,4,5, \text{ and} \tag{11}$$

$$L_{na} = L_T - L_1, \tag{12}$$

where L_T is the overall labor force in the economy, exogenously determined.

Capital

The sectoral capital stock is obtained from the following identity:

$$K_{jt} = K_{jt-1} + I_{jt} - D_{jt}, \qquad j = 1,2,3,4, \tag{13}$$

where I_j is the gross real investment in fixed capital and D_j is the depreciation of real capital in sector j, determined by using exogenous sectoral depreciation rates.

Sectoral Investment

The sectoral investment is determined conditional on overall investment:

$$I_j = \theta_j I, \qquad j = 1,2,3,4, \tag{14}$$

where θ_j is the share of sector j in total investment. It is assumed that the government has no investment. However, public firms are treated as private firms and their investment is included in the sectoral investment, and specifically, the investment in infrastructure is attributed to services. The share of sector j in total investment is assumed to be determined by the competitive position of the sector as determined by its rate of return compared with that of other sectors. Rates of return are decomposed into expected and transitory components. The expected and current rates of return are determined inside the model.

Omitting time subscripts when unnecessary, a sectoral investment share equation is written in general form as

$$\theta_j = H(R^e, R_j^t, I/K, \theta_{jt-1}, z), \tag{15}$$

where

R^e = a vector of the expected rates of return in the sectors under consideration,

R_j^t = transitory component of the actual rate of return,

I/K = ratio of the total investment in year t to the total capital stock in year t–1, and

z = a vector of exogenous variables.

Rates of Return

The rate of return of each sector is obtained as the ratio of nonwage income, net of taxes and depreciation, to the capital stock:

$$R_j = \frac{S_j(V_j - T_j)P_{vj} - D_j P_{kj} - T_{kj}}{K_{jt-1} P_{kjt-1}}, \tag{16}$$

where P_{kj} is the real price of capital in j, T_{kj} is the real tax on profits in j, and all of these are deflated by PC.

In analyzing the productivity in agriculture, the measure of capital includes the value of land at constant prices. In the case of agriculture, for some purposes the relevant measure of the rate of return should also include land in the denominator. This provides another measure for the agricultural rate of return, labeled RA_1, where the denominator of equation (16) has an additional term, the value of land, deflated by PC.

Prices

In a small open economy the domestic prices of tradable goods are determined by international prices, the nominal exchange rate, commercial policies (tariffs in the case of importables and subsidies for exportables), and internal marketing margins. On the other hand, the prices of nontradables are determined by the domestic supply and demand. This distinction between tradables and nontradables is difficult to apply empirically because all sectors have both traded and nontraded components in their output. In reality, each sector can be thought of as an aggregate of three components: importable, exportable, and nontraded. The nontraded component can reflect either nontradability or a decision not to trade.

Viewing the sectoral output as an aggregate output implies that the sectoral price is an aggregate of the prices of its three components. Using a geometric average, the sectoral price is written as

$$P_j = \alpha_0 P_{ej}^{\alpha_1} P_{mj}^{\alpha_2} P_{hj}^{1-\alpha_1-\alpha_2}, \tag{17}$$

where P_{ej} and P_{mj} are the domestic prices of exportables and importables defined below, and P_{hj} is the price of the nontraded component.

The elasticities indicate the relative weight of the components in the sectoral output. The price of the nontraded component is assumed to equal its average cost. Equation (17) is used to determine the real prices of agriculture, mining, and manufacturing. As the analysis is conducted conditional on PC, the price of services is determined from the identity of the consumption deflator:

$$1 = \sum_j \rho_j P_j, \quad j = 1,\ldots,5, \tag{18}$$

where the price of the government sector, P_5, is exogenous in most of the simulations. The weights in equation (18), ρ_j, vary over time.

Under the small-country assumption, import and export prices at user (or retail) level in domestic currency of the base year are derived from

$$P_{ej} = P_{ej}^{*}(1 + t_{ej})\, E/PC, \qquad j = 1,2,3, \text{ and} \tag{19}$$

$$P_{mj} = P_{mj}^{*}(1 + t_{mj})\, E/PC, \qquad j = 1,2,3, \tag{20}$$

where

P_{ej}^{*} = f.o.b. dollar price of sector j exports,

t_{ej} = rate of subsidy on exports,

E = nominal exchange rate,

P^*_{mj} = c.i.f. dollar price of sector j imports, and

t_{mj} = sum of the tariff rate and trade margins on sectoral imports; tariffs and subsidies are exogenous.

Other Identities

Value-added Prices

The decisions taken by producers are based on the price of value added. These prices are obtained by subtracting the cost of intermediate goods from the product prices. For this, two identities are used, one in nominal terms and the other in 1977 prices, the same as equation (1):

$$X_j NP_j = \sum_i A_{ij} X_j NP_{ij} + V_j NP_{vj}, \quad \text{and} \tag{21}$$

$$X_j = \sum_i A_{ij} X_j + V_j, \tag{22}$$

where NP_{ij} is the nominal price of input from sector i used in sector j. Using these two identities the nominal price of value added is

$$NP_{vj} = \frac{NP_j - \sum_i A_{ij} NP_{ij}}{1 - \sum_i A_{ij}}. \tag{23}$$

The real prices of value added are obtained by replacing the nominal prices in equation (23) with the prices deflated by PC.

$$P_{vj} = \frac{P_j - \sum_i A_{ij} P_{ij}}{1 - \sum_i A_{ij}}, \tag{24}$$

where $P_{vj} = NP_{vj}/PC$, $P_j = NP_j/PC$, and $P_{ij} = NP_{ij}/PC$.

Price of Government Output

Due to the peculiarities of this sector, the nominal price of its value added is assumed equal to its average cost, which consists of wages only:

$$V_5 \, NP_{v5} = NW_5 \, L_5. \tag{25}$$

Then,

$$NP_{v5} = NW_5 \, L_5 / V_5, \tag{26}$$

and the real price of value added is obtained by dividing this equation by PC to yield

$$P_{v5} = W_5 \, L_5 / V_5 \,. \tag{27}$$

The productivity and employment of government, and therefore output, are taken as exogenous. Once the price of government value added is determined, the nominal price of government output is solved by using equations (21) and (22) and the definition of value-added price, similarly to equation (23):

$$NP_5 = NP_{v5}\left(1 - \sum_i A_{i5}\right) + \sum_i A_{i5} NP_{i5} \,, \qquad (i = 1,2,3,4,5). \tag{28}$$

The real price of the sector is obtained by dividing equation (28) by the consumption deflator to obtain

$$P_5 = P_{v5}\left(1 - \sum_i A_{i5}\right) + \sum_i A_{i5} P_{i5} \,. \tag{29}$$

Prices of Intermediate Inputs

The number of sectors of the input-output matrix used in the computation of National Accounts is 64. The practice used in the computation of the National Accounts is to assume that the proportional changes through time of the price index of any given sector of the 64 sectors is independent of the output destination. However, this property is not fulfilled in the model due to its level of aggregation. Instead, the prices of intermediate inputs used by the different sectors of the model are specified as simple linear functions of the corresponding product price of the sector of origin. The coefficients that link the product and intermediate prices are the historical ratios between them:

$$NP_{ij}/NP_i = \text{historicallevels}, \qquad (i, j = 1,2,3,4,5). \tag{30}$$

Deflating the prices by PC, the equation used in the model is obtained.

Prices of Sectoral Capital Stocks

Capital stocks are valued at replacement cost. Therefore, the prices of sectoral capital stocks are determined from the prices of investment goods, and those in turn are related to the prices of the sectors of origin:

$$NP_{kj} = \sum_i \lambda_{ij} NPI_i \,, \qquad (i, j = 1,2,3,4), \text{ and} \tag{31}$$

$$NPI_i/NP_i = \kappa_i \,, \tag{32}$$

where λ_{ij} is the historical ratio of investment goods originating in sector i used in real gross investment in sector j, both quantities are in 1977 prices, κ_i is the historical value of the ratio in equation (32), and NPI_i is the nominal price of investment goods originating in sector i. Deflating the nominal prices by PC, the real price of capital is obtained:

$$P_{kj} = \sum_i \lambda_{ij} \kappa_i P_i , \qquad (i, j = 1,2,3,4). \tag{33}$$

In the case of agriculture, capital is used in two forms, with and without land. The amount of land was assumed to be fixed, but its value is allowed to vary. The value of land is obtained by multiplying the area by the price of land and deflating by *PC*.

Miscellaneous

The stock of capital in agriculture, including land in 1977 pesos, can be written as

$$K1A = K_1 + A, \tag{34}$$

where *A* is the cultivated land valued at 1977 prices.

Overall value added is

$$V_T = \sum_j V_j , \qquad (j = 1,2,3,4,5). \tag{35}$$

Let *POP* be total population, then the overall productivity is determined as

$$y = V_T / POP. \tag{36}$$

Real indirect taxes on sectoral output are determined under the assumption that the tax rates are exogenous:

$$T_j = t_j V_j , \qquad (j = 1,2,3,4). \tag{37}$$

Similarly, real direct taxes on profits are determined by assuming exogenous tax rates:

$$T_{kj} = t_{kj} RK_j , \qquad (j = 1,2,3,4), \tag{38}$$

where RK_j is real sectoral profits, obtained by

$$RK_j = (V_j - T_j) P_{vj} - W_j L_j - D_j P_{jk} , \qquad (j = 1,2,3,4). \tag{39}$$

The real depreciation of the capital stocks is determined by assuming exogenous rates applied to lagged capital stocks:

$$D_j = d_j K_{jt-1} , \qquad (j = 1,2,3,4). \tag{40}$$

The share of total wages in total income is determined as

$$S_L = \frac{\sum_j W_j L_j}{\sum_j (V_j - T_j) P_{vj}} . \tag{41}$$

Finally the peak of the overall productivity lagged one year, used as a state variable in the production functions, is obtained from the following identity:

$$PEAK_t = \frac{1}{2} [| \ln y_{t-1} - PEAK_{t-1} | + (\ln y_{t-1} - PEAK_{t-1})] + PEAK_{t-1} . \tag{42}$$

The determination of the other state variables of the production functions is explained in Chapter 4.

Empirical Analysis

The empirical analysis, described in Chapters 4-7, consists of estimating equations (2)-(6), (8), (10), (12), (15), and (17). Although the model is largely recursive, several variables are determined simultaneously. Because of its size, the system was estimated by blocks. The empirical results and the various identities are used for the simulations that are discussed in Chapters 8 and 9.

The Working of the Model

It is useful to summarize the working of the model with reference to the above equations by reviewing the response to a change in product prices. Total resources and the available technology are held constant. The system is recursive, and at time t the lagged values of the endogenous variables as well as the lagged and current values of the exogenous variables are known.

The change in product prices affects the price of intermediate inputs, and as a result the price of value-added changes according to equation (24). The prices are state variables in the production function, and consequently the factor shares as well as total output are affected directly, as seen from the production block in equations (2)-(5). The change in value-added price and the factor shares changes the rate of return, as seen from equation (16). The change in the rates of return affects the expectation for future values of these variables and thereby, according to equation (15), the sectoral allocation of investment and in turn, by equation (13), the sectoral capital stock.

The change of the production functions also affects the labor demand as implied by equation (6). In agriculture, where the wage rate clears the labor market, this change causes a change in the wage rate. In nonagriculture, a change in labor demand changes the sectoral employment and hence the total employment in nonagriculture. Unemployment in nonagriculture is determined by equation (11) as the difference between total supply and demand for labor at the ongoing wages and thus is affected from the demand side.

According to equation (10), unemployment affects the nonagricultural wages and thereby the farm/off-farm income differentials, whether measured by wages or average labor productivity. The changes in the income differential, unemployment, and the sectoral labor composition affect the off-farm migration, according to equation (7), and consequently the labor supply in agriculture and nonagriculture. This change in the labor supply also contributes to the change in unemployment.

The changes in sectoral employment and capital stock affect the sectoral capital-labor ratios, and given the state variables, value added is obtained from the production function, equations (2)-(5). Sectoral outputs are obtained from equation (1). The value added is aggregated, as in equation (35), and *PEAK* is updated using equation (42). The various identities are used to update all the other variables in the system.

4

PRODUCTIVITY

In most economic analyses it is assumed that at any time a product can be produced by a single technique. The input-output relationship associated with the technique is described by a production function. Technical change is perceived as a change of this function and the scope for agents' decision is limited to the choice of the optimal level of inputs. Is this a good assumption? Looking at any sector of the economy, one can find various methods of producing a given product that cannot be described by a given production function. In such a case, the choice of techniques becomes an economic problem in that the techniques implemented at any time reflect the prevailing economic environment at that time, as well as its history. Incorporating this choice in the analysis adds another channel through which market conditions can influence productivity, whereas neglecting this simple fact leads to a distorted view of the production process.

This view of production is applied here in the estimation of the sectoral production functions. The derived functions have the form of a Cobb-Douglas function, but their coefficients are allowed to vary in response to the economic environment and to factor utilization. The economic environment is characterized by three groups of state variables: incentives, constraints, and technology. The dependence of the implemented technology on the economic environment allows an evaluation of the changes in the productivity associated with changes in the state variables and thereby a considerable decrease in the unexplained productivity residual.

The path of sectoral outputs in the Chilean economy in the study period of 1962-82 shows large cyclical variations that cannot be attributed solely to input variations along a given production function. The analysis shows how the sectoral factor productivity was affected by macro and external shocks as well as by policies such as land reform. Moreover, the analysis retrieves the cyclical nature of productivity to the economic environment. It is this extension that causes a reduction in the unexplained productivity residual in this framework.

The approach, based on Mundlak (1988), is summarized in the next two sections. This is followed by a discussion of the state variables used in the analysis and the presentation of the results. The last section of the chapter summarizes some of the substantive results, further explaining the content of the study.

The Choice of Techniques

The production of a given commodity or service can be decomposed into a set of elementary activities or techniques. A technique is described by a production function. The degree of disaggregation, or refinement of the definition of a technique, depends on the purpose of the analysis. The available technology, AT, is defined as the collection of all possible techniques. In symbols,

$$AT = \{F_j(x)\}, \tag{43}$$

where $F_j(x)$ is the production function associated with the jth technique.

A distinction is made between the available technology and the implemented technology. The latter is a subset of AT and is determined by the firms subject to their constraints and the economic environment. The corresponding optimization problem calls for a choice of the variable (a_j) and the fixed (k_j) inputs to be assigned to technique j so as to maximize profits. The Lagrangian equation for this problem is

$$L = \sum_j p_j F_j(a_j, k_j) - \sum_j wa_j + \lambda\left(k - \sum_j k_j\right), \tag{44}$$

subject to $F_j(.) \varepsilon AT; \quad a_j \geq 0; \quad k_j \geq 0,$

where p_j is the price of the product of technique j, w is the price vector of the variable inputs, a, and k is the upper bound constraint on the allocation of fixed inputs. The equation is written so as to allow for product choice as well as for a method of production to produce the product. The Kuhn-Tucker necessary conditions for a solution are

$$L_{aj} = p_j F_{aj} - w \leq 0, \tag{45}$$

$$L_{kj} = p_j F_{kj} - \lambda \leq 0, \tag{46}$$

$$\sum_j (L_{aj} a_j + L_{kj} k_j) = 0, \tag{47}$$

$$a_j \geq 0; \quad k_j \geq 0, \tag{48}$$

$$L_\lambda = k - \sum_j k_j \geq 0, \text{ and} \tag{49}$$

$$\lambda L_\lambda = 0, \tag{50}$$

where L_{aj}, L_{kj}, F_{aj}, F_{kj}, and L_λ are vectors of the first partial derivatives. Let $s = (k,p,w,AT)$ be the vector of state variables and write the solution as $a_j^*(s)$, $k_j^*(s)$, $\lambda^*(s)$ so as to emphasize the dependence of the solution on the available technology, on the constraints, and on prices. The optimal allocation of inputs a_j^*, k_j^* determines the intensity of implementing the jth technique. This also includes the decision not to use the technique, as can be seen by rearranging equations (45)-(47):

$$0 = \sum_j (p_j F_{aj} - w)\, a_j + \sum_j (p_j F_{kj} - \lambda)\, k_j\,. \tag{51}$$

When equation (45) or (46) is negative, then a_j^* *or* k_j^*, respectively, is equal to zero. To the extent that the implementation of a technique requires positive inputs, then when the optimal levels of these inputs are zero, the technique is not implemented. The implemented technology (IT) is defined by

$$IT(s) = \{F_j(a_j, k_j) \mid F_j(a_j^*, k_j^*) \neq 0,\ F_j \varepsilon T\}. \tag{52}$$

It is important to note that the implemented techniques are determined simultaneously with the level of inputs conditional on the constraints and the available technology. Consequently, holding prices constant and changing either the constraints or the available technology will change the product mix. The aggregate production function, as commonly used, is perceived as an aggregation of outputs produced by a *given* set of micro production functions. In the present framework such an aggregate is not uniquely defined, because the set of functions over which the aggregation is performed is endogenous. For the same reason, prices are insufficient statistics for identifying the implemented technology. The same set of prices leads to a different choice of techniques when the available technology or the constraints change. The results of time-series analysis of production that does not take this into account will depend on the combination of prices, constraints, and available technology that exists at each point in time. The implication of this assertion for empirical analysis is discussed in the next section.

Aggregation of Techniques

This framework requires knowledge of production by techniques. In general, when dealing with sectors or the whole economy, the data are not reported by techniques, and it is therefore impossible to estimate the production functions associated with individual techniques. Therefore, the implication of this framework for the estimation of a production function using aggregate data is traced here. This requires some lengthy manipulation, and the final outcome may appear too remote from the original formulation and therefore may not reflect the validity of the approach. For this reason it is desirable to try the approach on more disaggregated data. This is done in the study of the "green revolution" in the Punjab by McGuirk and Mundlak (1991). The results indicate that the choice-of-techniques approach has been useful and instructive.

Turning to the examination of the aggregate production function,

$$\sum_j p_j v_j^*(s) \equiv F(x^*; s) \equiv \varphi(s), \tag{53}$$

where x is the vector of inputs, and $x^* = x(s)$ is its optimum level. The production function in equation (53) is defined conditional on s, and changes in s imply changes in x^* as well as in $F(x^*, s)$. It is therefore meaningless to think of changes in x that are not instigated by changes in s, so it is impossible to trace a stable production function.

The empirical aggregate production function can be thought of as an approximation to equation (53) in a specific way. For equation (53) to be a production function in the usual sense, x should be disjoint from s. Such a separation requires a discrepancy between x and x^* that will allow the observed output to be written as

$$\sum_j p_j v_j \approx F(x,s). \tag{54}$$

A second-degree approximation of this function yields the production function in equation (2). The function has the form of a Cobb-Douglas production function, but there is a major modification in that the coefficients themselves are functions of the state variables and the actual inputs used as described by equations (3)-(5).

To emphasize a salient property of this formulation, the production elasticity can be written

$$\begin{aligned} \partial \ln v/\partial \ln k &= B(.) + \ln k(\partial B(.)/\partial \ln k) \\ &= B(.) + \ln k(\pi_{k1} - \pi_k/2) \\ &= S + \ln k(\pi_{k1} - \pi_k), \end{aligned} \tag{55}$$

where the last term is obtained by using equation (3). The discrepancy between the factor share and the production elasticity depends in this formulation on the difference $\pi_{k1} - \pi_k/2$. When this term is zero, the production elasticity is equal to the factor share. A discrepancy between the two is an indication of a distortion in the factor market. In the present formulation, such a distortion is attached to k and its relevance can be tested empirically by restricting the values of the coefficients to be the same.

Turning to the factor share, it is noted that it is a function of the input, ln k, which makes the production function quadratic in ln k as in the translog function (Christensen, Jorgenson, and Lau 1971). At the same time, the factor share depends also on the state variables, and this is a major deviation from the translog model.[1] It should be emphasized that in the translog model the variations in the factor shares are caused by variations in the input combinations, whereas in the present case the factor shares can vary as a result of variations in the state variables that lead to changes in the composition of techniques. This difference has very important consequences for the empirical estimates.

Variations of this system were estimated for Argentina by Cavallo and Mundlak (1982) and Mundlak, Cavallo, and Domenech (1989) and for U.S. agriculture by McMillan (1990).

State Variables

As a way of organizing the thinking about the state variables, they are classified into four groups: constraints, incentives, available technology, and the political environment. The following sections give a brief description of the variables used here in each group.

Constraints

Constraints to the implementation of the available technology are represented by the vector k in equation (44). The main constraints are the level and composition of the capital stock. The overall level of the capital stock matters when the new techniques are more capital-intensive than the existing ones. Other things being equal, an increase in the capital-labor ratio is expected to result in more capital-intensive techniques. That is, the pace of implementation of new techniques is affected by *net* investment. The

[1]Basically, the translog function is a quadratic equation in the log of the inputs. The reference to the translog model, rather than function, implies here that the function is considered as a description of the production process with all the implications thereof.

composition of the capital stock matters when the new techniques require a different mixture of capital items than the existing ones. An example is the heterogeneity of capital goods suggested by Solow's (1962) embodiment hypothesis. The composition is important in the short run, and with time it converges to the desired one through *gross* investment. The foregoing considerations pertain to all forms of capital, including human capital. The empirical analysis deals directly with the sector-specific physical capital and indirectly, through the variable *PEAK* described below in the section on available technology, with the remaining forms of capital.

The discussion suggests that investment is expected to affect the change, rather than the level, of output. However, the role of the investment variable in an empirical analysis is somewhat more complex in that it represents other effects as well. The cost-of-adjustment argument (Lucas 1967; Gould 1968; Treadway 1969) postulates that the larger the rate of investment per unit of time, the more costly it is in terms of the ongoing output. The expected outcome is a negative effect of investment on productivity.

There is another consideration of a different nature that is related to the information about the market conditions embedded in investment. Loosely speaking, the better the market prospects, the higher the investment. Ideally, if the incentives are measured correctly, there is no scope for this variable. But if this is not the case, the investment can be viewed as a measure, subject to error, of incentives. This measure is of course imperfect and cannot replace the more direct measures of incentives discussed below.

Thus it follows that the expected effect of investment on productivity cannot be signed a priori and has to be determined empirically. The discussion pertains to a given economy, and as the economy changes in size over time an adjustment is made in the empirical analysis by employing the ratio of investment to the capital stock.

In most of the period under consideration, foreign exchange allocation was controlled by the government and thus constituted a constraint. The level of this constraint is related to the shocks in the external market; therefore, this variable is discussed below with the incentives.

Constraints can also be of an institutional nature. Of particular interest in this study is the land reform that was implemented during the period of analysis. This variable is specific to agriculture and is discussed below in the section on political environment.

The off-farm migration produced changes in the labor quality. It has been observed that the off-farm migrants in Chile tended to concentrate in low-paying jobs in the service sector. In part this reflects their lower level of human capital, implying that their contribution to output is lower than that of the average worker. To account for such changes in the average quality of labor, a variable, *ACM,* is constructed to measure the ratio of the accumulated off-farm migration to the sectoral employment, lagged one year. More on this variable is found in the discussion of the empirical analysis of the service sector.

Incentives

Incentives determine the relative profitability as well as the risk of the various techniques and thereby the degree of their implementation. Naturally, the immediate variables for measuring incentives are prices. However, when dealing with an important sector of the economy, the prices should be replaced with product demand and factor supply. To do this would require a detailed structure that is avoided in this study. Instead, two summary measures are used: the rate of return and a measure of the external shocks.

The rate of return summarizes the effects of the various prices. It is measured as the ratio of nonwage income to the value of the capital stock. This rate has a permanent and a transitory component. The permanent component is more relevant to the choice of techniques that require investment. Without going into refined analysis of expectation formation, the first order autoregression of the rate of return is taken here as a proxy for the permanent component, and the difference between the actual value and the computed one is considered to be the transitory one.

The second measure is related to the particular importance of the foreign sector in the Chilean economy. The Chilean economic history of the last 60 years reveals that most recessions have been triggered by crises in the balance of payments (Cortes and de la Cuadra 1984).[2] During the sample period, the recession of 1975 was triggered by a sharp fall in the terms of trade, and the recession of 1982 was instigated by the combination of a fall in the terms of trade, a sudden cut in the external capital inflows, and a substantial increase in the rate of interest on external debt. On the other side, favorable external conditions have been associated with expansions. This was the case in the expansion of 1966, when the real price of copper was at its peak for the sample period and overall output grew by 11 percent, and in the recovery after the 1975 recession and up to 1981, when large capital inflows took place.

An improvement in the terms of trade causes an expansion in the aggregate demand, which in turn affects sectoral demand. Indirectly, a similar effect is generated by a decline in the international rate of interest in that it reduces the burden of servicing the debt. The response of sectoral demand to such shocks depends on the sector's degree of tradability and on its income, or absorption, elasticity.[3] An expansion in sectoral demand causes an increase in net import of tradables, whereas for nontradable goods the demand can be met only by an increase in domestic production and therefore in their prices. This effect is particularly important in manufacturing and services, which are the sectors with larger nontradable components, 40-50 percent for manufacturing and more than 80 percent for services. The differences in income elasticities of products within a given sector imply changes in the composition of output and therefore in the aggregate production function of that sector.

The external flows of capital had a direct effect on the level of foreign exchange. Until 1979, international capital mobility was centrally controlled, so the level of imports was subject to a foreign exchange constraint. This also had a differential effect on the sectors according to their use of imported inputs.

To capture the two effects of the external shocks, expansion and import constraint, a variable, *FEC* (foreign exchange constraint), was constructed to provide a measure of the capacity to import in any given year. It is defined as the ratio to GDP (lagged one year) of the sum of exports, autonomous capital movements, and international reserves at the end of the previous year less financial services. All these items

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[2]A similar observation for other Latin American countries was made by Ffrench-Davis and Marfan (1989).

[3]For a discussion of the effects of an expansion of aggregate demand on sectoral incentives, see Mundlak, Cavallo, and Domenech 1990.

are deflated by a price index of overall imports.[4] The main determinants of this variable are foreign prices and foreign interest rates, and these are largely exogenous to Chile.

Available Technology

Conceptually, available technology is the most difficult group to measure empirically because technology is an abstract concept rather than an observable quantity. One can speak of, and evaluate in one form or another, the consequences of major inventions such as improved crop varieties, electricity, radio, transistors, and so on. This, however, does not lead to a compact representation of the technology. The evidence on technology, particularly at the aggregate level, is circumstantial, as it is derived from observations on outputs and inputs. Once this is recognized, indirect methods of measurement can be developed. Mundlak and Hellinghausen (1982), relate the technology to an aggregate measure of comprehensive, physical and human, capital. Following and extending this approach, the aggregate production function is written as $y_t = F(k_t, h_t, s_t, u_t)$, where y is the average labor productivity, k is the vector of ratios of physical capital goods to labor, h is a similar vector for human capital, s is a vector of other state variables, and u is a random disturbance.

For the purpose of the discussion, h is interpreted as the unobserved component of capital. Given k, s, and u, y is monotonic, increasing in h so that one can write $h = H(k, y, s, u)$, $\partial h/\partial y > 0$. As h does not fluctuate much over short time periods, past values can be used to substitute for its current value. The past values of h can be extracted from the past values of output, after allowing for the effects of the other variables in the production function. Let $x = (k, y, s, u)$ and let x_τ be some function of lagged values of x to be defined below, then $h_\tau = H(x_\tau)$. The idea is to substitute h_τ for h_t in the production function to get $y_t = F(k_t, h_\tau, s_t, u_t)$.

The value of h_τ depends on u_τ, s_τ, and k_τ and thus is subject to error that has to be eliminated. The fluctuations in u are by far larger than those in the capital stock and they can be reduced by taking a moving average for y and assuming away the effect of this term. The effect of k_τ and s_τ can be eliminated by introducing these variables explicitly into the analysis. Building on the fact that a regression coefficient represents the effect of a variable, net of the (linear) effects of the other explanatory variables in the equation, one can write, in a generic form, an empirical version that replaces equation (54):

$$y_t = F(y_\tau, k_\tau, s_\tau, k_t, s_t, u_t). \qquad (56)$$

In empirical analysis, k_τ is likely to be omitted because it is likely to be highly correlated with k_t and thus will have little to contribute. A similar argument follows for s_τ, but here the correlation is not as strong. Particularly, the incentives are subject to secular variations. In times of low profitability, output declines, but this is not a reflection of a decline of h. To take this into account, the historical peaks of y are used. Define

$$y_\tau = \max_i (y_{t-i}), \qquad i < t, \qquad (57)$$

[4]For a detailed description of this variable, see Coeymans 1990.

and label y_τ as *PEAK*. The *PEAK* coefficient represents the net effects of the various forms of human capital, institutions, and organization that are referred to as technology and cannot be measured directly. Indeed, the captured technology effect is lagged, rather than current, but this is inevitable in this approach and constitutes a small price to pay.

The function that is actually estimated, in its general form, is

$$y_t = F(y_\tau, k_t, s_t, u_t). \tag{58}$$

The effect of s_τ on y_τ is asymmetric in that it can only cause *PEAK* to increase. Therefore, a decline in y_t is attributed to state variables other than *PEAK*, and these are random in nature with possible cyclical components. To reduce the effects of such variations on *PEAK*, per capita output is used in the empirical analysis instead of average labor productivity. The reason is that the population is a more stable variable than employment.

Briefly, an indirect measure of productivity is used, and in this sense the measure is similar to Solow's residual. The difference is, first, that the effect of this measure on productivity is estimated jointly with the production function, and second, the measure affects not only the intercept but also the slope of the function and so allows for a shift in factor intensity.

Political Environment

Productivity is affected by the political and institutional environment. The main changes of interest for this study are the land reform and the large shocks of the Allende regime (1970-73).

A land reform that eventually covered 50 percent of the irrigated land of the country was implemented during 1965-73. A study done at the Universidad Católica de Chile suggested that the reform had a positive effect on productivity during the early period of the reform, ending in 1968-69. At that time the inefficiency in farm operation was used as a criterion for expropriation of farms, and this induced an improvement in productivity.[5] As the reform progressed, the procedures used to expropriate had less to do with efficiency considerations and more with the sole objective of land redistribution. The landowners in the commercial farm sector began to lose interest in improving productivity and instead tried to minimize their losses in case of expropriation. This increasingly aggressive expropriation generated farm labor unrest in its attempt to take over the farms on which the laborers worked, disregarding the original criterion of efficiency. The process eventually led to quasi paralyzation of the commercial farm sector in 1973, the last year of the Allende government. The uncertainty generated by the reform is measured by the proportion of land expropriated in a given year, labeled *UAR*, and the change in the criterion is represented by a dummy variable for the period 1969-73. In addition, a stock variable that measures the proportion of the cumulative expropriation in total land was

[5]To quote, "the fear of expropriation (and the fact that the inefficiency and underutilization of land was one of the causes for expropriation) caused a favorable reaction of the private commercial sector, which was stimulated by a plentiful supply of low cost credits" (Universidad Católica de Chile 1979).

constructed to represent the effect of land reform on productivity. This variable was not significant and was omitted from the regressions.

The Allende regime generated drastic shocks in the economy that cannot be perceived as normal economic shocks; therefore, in several instances, dummy variables had to be used to prevent these changes from distorting the empirical analysis.

Estimation

Estimates of the production functions for three sectors—agriculture, manufacturing, and services—are presented here. For each sector, the system of equations (2)-(5) is collapsed to two equations with value added and the share of capital as dependent variables. The estimates were obtained, using three-stage least squares (3SLS), within somewhat larger systems, as explained in Appendix 2.

Because of the small sample size, only a few state variables are actually used in the empirical analysis. The complete system was solved using dynamic simulation. The reported R^2 are computed from the fitted values obtained from this simulation. There is no easy way to summarize the empirical results because each state variable appears in two equations, one for the share and one for the intercept. Also, and more important, the state variables may not be independent. A change in one state variable may affect the values of the others as well as the value of the capital-labor ratio. All this should be taken into account in evaluating the impact of the state variables on output. This is illustrated by evaluating the elasticity of average labor productivity with respect to a given state variable (say s_i):[6]

$$\partial \ln y/\partial s_i = \sum_h \{\partial \Gamma/\partial s_h + \ln k[\partial B(s)/\partial s_h] + B(s)(\partial \ln k/\partial s_h)\}\,\partial s_h/\partial s_i. \quad (59)$$

The first two terms in the brackets show the response of the implemented technology to a change in the state variables, whereas the last term in the brackets shows the output response to a change in inputs, under constant technology. The elasticities in equation (59) have a t index, which is suppressed here, indicating that they vary over the sample points. The innovation in the present formulation lies in the response of the implemented technology. This is evaluated here under the assumption that $\partial s_h/\partial s_i$ is equal to zero for $h \neq i$, yielding the elasticities

$$E_i = \partial \Gamma(s)/\partial s_i + \ln k[\partial B(s)/\partial s_i]. \quad (60)$$

The effect that is captured by equation (60) is part of the unexplained productivity residual in the standard productivity analysis under the assumption of constant technology. The actual values obtained are discussed below.

The effect of s on factor bias is indicated by the sign of $\partial B(s)/\partial s_i$. It is capital (labor) saving when this derivative is negative (positive).

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[6]When s is not in log form, the derivative in equation (59) is semi-elasticity, but for simplicity it is referred to as elasticity as well.

Results

The regressions are reported in Table 1. The capital-labor ratio, the investment-capital ratio, and the rate of return are sectoral values, whereas *PEAK* is computed for the economy as a whole. Variables for which coefficients are not reported were highly nonsignificant and were therefore omitted. The estimates were obtained under the restriction of equality of the factor shares and the production elasticities, $\pi_{k1}=\pi_k$ in terms of equation (55). This equality was not rejected in all three sectors. The various elasticities are summarized in Table 2 and their annual values are plotted in Figures 3-8.

Table 1—Estimates of the production function

	Agriculture		Manufacturing		Services	
Explanatory Variable	**Output**	**Share**	**Output**	**Share**	**Output**	**Share**
R^2	0.95	0.85	0.95	0.97	0.97	0.91
D.W.	2.07	2.02	1.52	1.56	1.77	1.74
Constant	20.82	−1.735	86.106	12.20	−261.35	34.373
	(2.4)	(2.5)	(4.7)	(5.6)	(2.7)	(3.2)
Capital-labor ratio	. . .	. . .	0.724	−0.724	2.118	−2.118
			(3.5)	(3.5)	(4.2)	(4.2)
PEAK output	−1.942	0.243	3.525	−0.270	8.452	−0.614
	(2.3)	(3.6)	(1.7)	(1.6)	(1.5)	(1.4)
Investment-capital ratio	. . .	. . .	15.029	−1.101	. . .	. . .
			(2.6)	(2.4)		
Rate of return	14.440	−1.038	. . .	. . .	8.207	−0.595
	(2.7)	(2.5)			(1.7)	(1.5)
Foreign sector *(FEC)*	. . .	. . .	−22.637	1.974	21.61	−1.622
			(3.7)	(4.0)	(5.0)	(4.8)
$(FEC)^2$	. . .	. . .	41.196	−3.485	. . .	. . .
			(3.7)	(3.9)		
10^{-3} agrarian reform *(UAR)*	5.5	−0.34	. . .	. . .	. . .	. . .
	(4.8)	(3.4)				
10^{-3} *(UAR)D6973*	. . .	−0.14	. . .	. . .	. . .	. . .
		(3.4)				
Labor quality *(ACM)*	. . .	. . .	. . .	. . .	−13.44	1.038
					(2.2)	(2.2)
D71	. . .	. . .	1.964	−0.153	. . .	. . .
			(4.6)	(4.5)		
D72	. . .	. . .	3.348	−0.259	3.196	−0.248
			(6.5)	(6.3)	(3.8)	(3.8)
D73	−1.109	−0.066	. . .	. . .	. . .	. . .
	(3.5)	(2.7)				
D82	. . .	−1.91	. . .	. . .	. . .	. . .
		(7.7)				

Notes: Numbers in parentheses are *t*-ratios expressed in absolute values. *PEAK* is the highest historical level attained by the output variable; *FEC* is the foreign exchange constraint; *UAR* serves as a measure of the intensity of the land reform; and *ACM* is the proportion of workers who migrated from agriculture in the total employment in services.

Table 2—Summary results of output elasticities

Variable	Mean	Low	High
Capital			
Agriculture	0.666	0.553	0.742
Manufacturing	0.590	0.427	0.660
Services	0.582	0.474	0.680
PEAK[a]			
Agriculture	1.144	1.069	1.193
Manufacturing	0.175	0.117	0.210
Services	0.584	0.507	0.675
Rate of return			
Agriculture	1.264	1.053	1.586
Services	0.573	0.498	0.660
Investment			
Manufacturing	1.340	1.110	1.480
FEC[b]			
Manufacturing	0.826	0.071	1.477
Services	0.811	0.608	1.051
Land reform			
Agriculture	...	−0.00064	0.00129
Labor quality			
Services	−0.126	−0.279	−0.004

Note: The elasticities are calculated according to equation (18), where inputs are held constant.
[a]*PEAK* is the highest historical level attained for per capita output.
[b]*FEC* is the foreign exchange constraint.

Figure 3—Share of capital in agriculture, manufacturing, and services, 1962-82

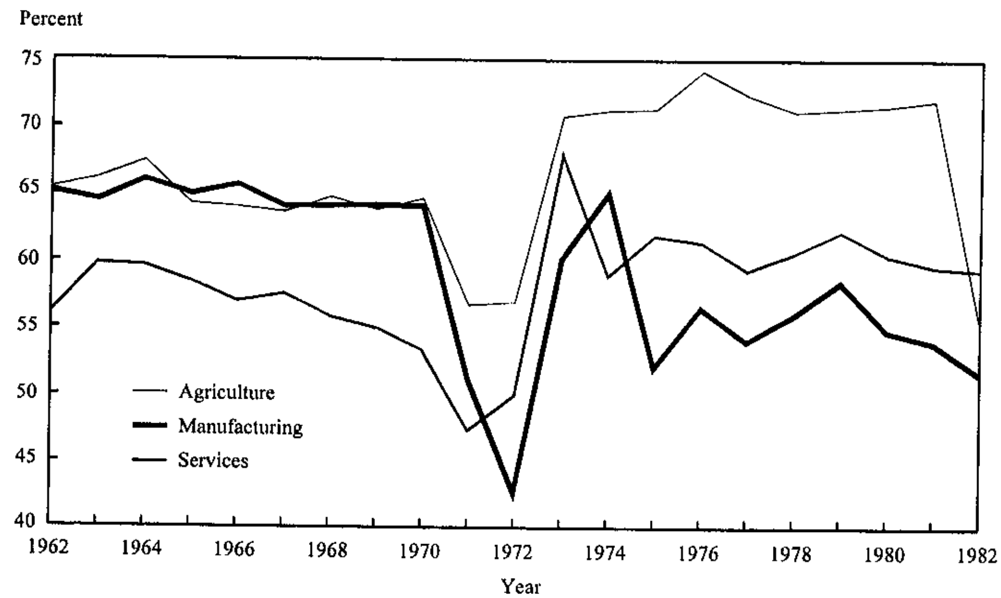


Figure 4—Output elasticity with respect to the peak of overall productivity, 1962-82

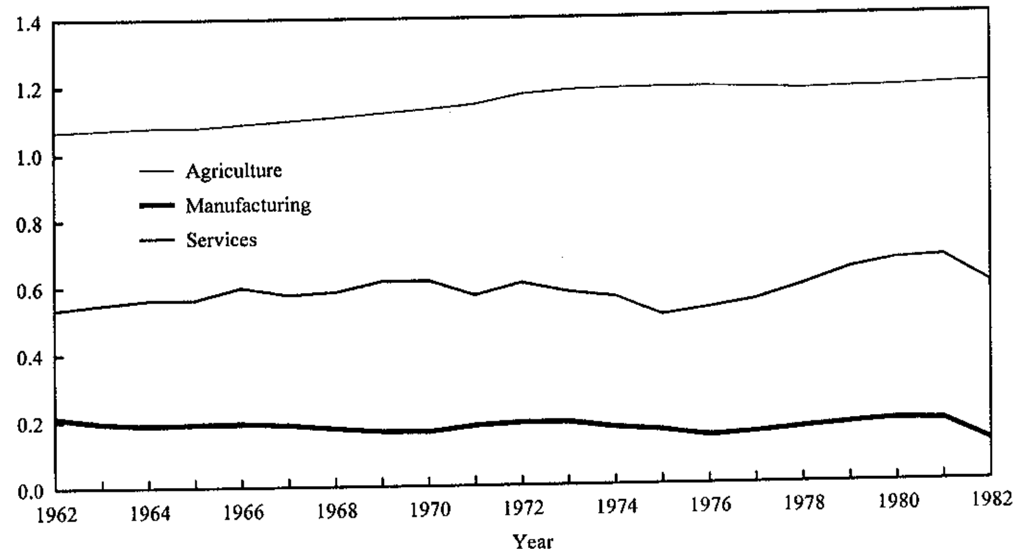


Figure 5—Output elasticity with respect to the investment-capital ratio, 1962-82

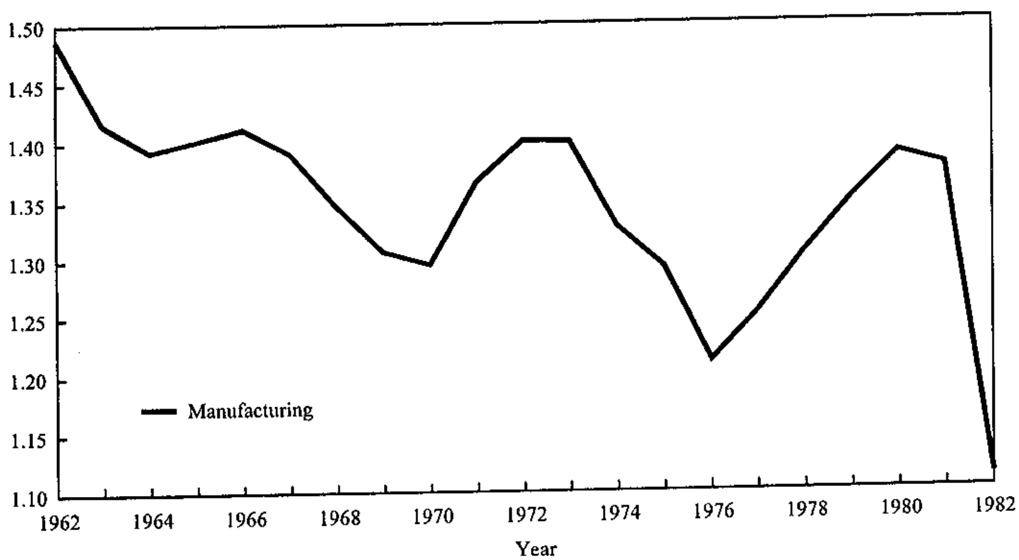


Figure 6—Output elasticity with respect to the rate of return, 1962-82

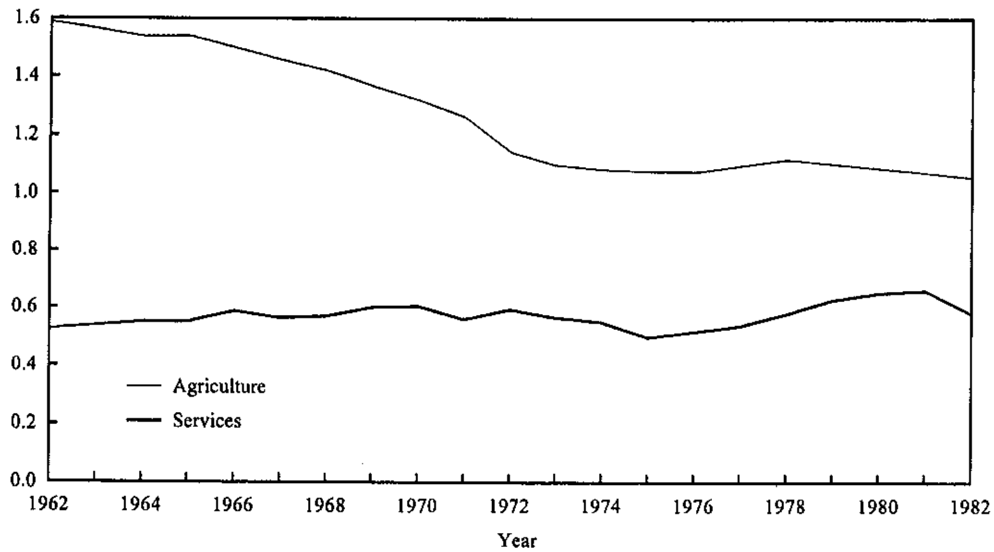


Figure 7—Output elasticity with respect to the foreign exchange constraint, 1962-82

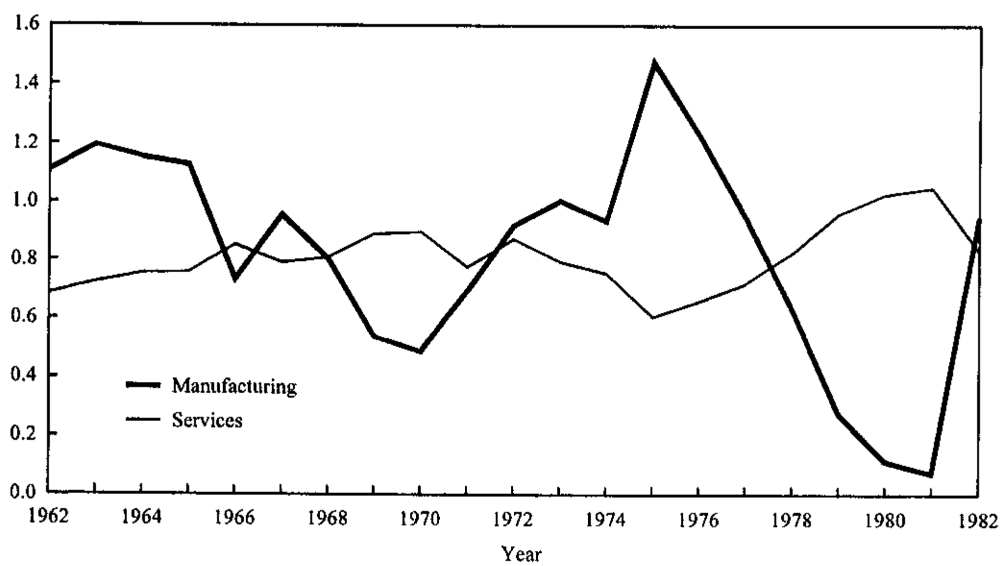
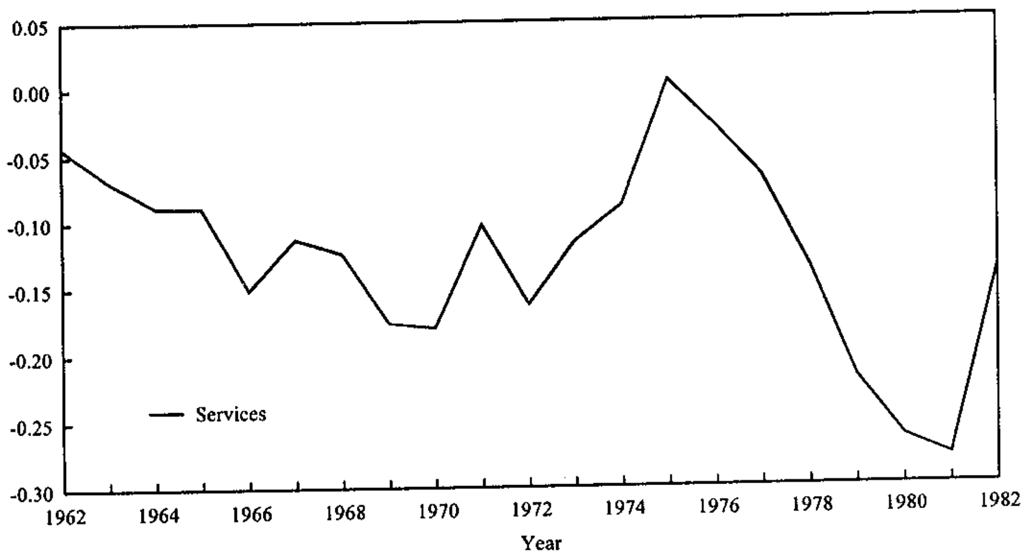


Figure 8—Output elasticity with respect to the labor force composition, 1962-82



The capital share in agriculture was independent of k (the value of π_{kl} and π_k was zero). This implies that the function is of the Cobb-Douglas form in the inputs. This was not the case in manufacturing and services, where the production function contains the quadratic term of ln k. The computed values of the capital share are plotted in Figure 3. Aside from the big jumps during the Allende period, the shares are higher in the 1970s than in the 1960s in agriculture and services and lower in manufacturing. This is consistent with the slow recovery in manufacturing in the 1970s.

The negative sign of π_{kl} indicates that the labor share increases with k, and this is consistent with the elasticity of substitution, between capital and labor, being smaller than one. The value of the elasticity of substitution depends on the level of the factor share, thus it varied over the sample with a mean of 0.25 for manufacturing. The absolute value of π_{kl} is larger in services than in manufacturing, implying a lower elasticity of substitution in services. In agriculture, the elasticity of substitution between capital and labor is not statistically different from one, and thus is considerably larger than in the other sectors.

It is instructive to compare these results with other studies for Chile. Behrman (1972), using time-series data for manufacturing for the period 1945-65 and a different specification, obtained estimates for the elasticities of substitution that are considerably smaller than one. These findings are at variance with cross-section estimates obtained with firm data. Corbo and Meller (1979) report a value close to one. Such a difference is not uncommon and can be accounted for in terms of the choice-of-technique framework. Different firms make their investment decisions in different times conditional on different sets of state variables, including available technology. Thus the differences in the capital-labor ratios reflect variations in technology in addition to variations in the intensity of input utilization. The situation is different for sector aggregates where most of the capital stock is predetermined and therefore the response of technology to changes in the state variable is slow.

This explanation is also consistent with the fact that a lower value was obtained for the elasticity of substitution in manufacturing than in agriculture, where the elasticity of substitution is one. There is a broader scope for changing the composition of output, and therefore of techniques, in agriculture than in manufacturing. For instance, land or tractors can be reallocated to crops that differ in their labor requirements. It is this flexibility that is missing in manufacturing in the short run, where capital goods are more product-specific.

The effect of *PEAK*, the residual carrier of technology, is positive in all sectors; it is strongest in agriculture, with an average elasticity of 1.144, and weakest in manufacturing, with an average elasticity of 0.175, whereas services is in between. The elasticity is smaller in manufacturing because in that sector the production function includes investment, which also serves as a carrier of technology, whereas the other sectors do not include investment in the production function.

Turning to the share equations, the coefficient of *PEAK* is positive for agriculture, indicating that the trend of the implemented technical change was capital-using or labor-saving. As the elasticity of substitution in agriculture is one, the observed changes in the factor shares are not caused by changes in factor ratios. Such changes are attributed to changes in the implemented techniques where the new techniques are more capital-intensive than the existing ones. On the other hand, a negative coefficient of *PEAK* in manufacturing and services shows a trend of capital-saving or labor-using techniques. This may be accounted for by the restrictions on import of machinery that prevented the country from taking advantage of capital-intensive techniques during the 1960s. The situation changed from 1974 on, but during that period considerable unemployment prevailed and there was no incentive to introduce labor-saving techniques in these two sectors.

The output elasticities of *PEAK* are plotted in Figure 4. As seen from equation (60), the output elasticities depend on k; therefore, variations in k induce variations in these elasticities. For instance, the elasticity in manufacturing is $3.525\text{-}0.27(\ln k)$. The variations in k are largely cyclical; a decline in the level of activity results in a decline in employment, whereas the capital stock is fairly stable, hence k increases in recessions and declines in years of high activity. The same pattern is observed in services. That means that this elasticity has a procyclical pattern; it is positively related to the level of activity, and specifically, sectoral "recessions" are not favorable to the introduction of long-run technical progress. The situation is different in agriculture, where there is no unemployment and the labor market clears by changes in the wage rate. As the level of activity of nonagriculture declines, the off-farm migration declines and therefore the labor force in agriculture behaves in an opposite direction from that in nonagriculture.

The investment-capital ratio was important only in manufacturing, where on average a one percentage point increase in the investment-capital ratio resulted in an increase of 1.34 percent in average labor productivity. The positive effect of this variable on productivity indicates that in manufacturing, the possible negative effect of the cost of adjustment was dominated by the positive effects of investment. The lack of significance of this variable in the other two sectors may be the outcome of the theoretical ambiguity with respect to the sign of the effect of investment on productivity. More likely, it reflects the collinearity between investment and the other state variables, particularly the rate of return and *FEC*. The elasticity of the investment-capital ratio is 15.03-1.101(ln k), and thus it is also procyclical. The annual values are plotted in Figure 5. The variable itself has a labor-using effect.

The expected rate of return was significant in agriculture and services. The values of the elasticity, $\partial \ln v / \partial R$, plotted in Figure 6, are on average 1.1 in agriculture and 0.573 in services. Apparently, in the case of manufacturing, most of the information contained in the rate of return is better reflected in the investment variable and *FEC*. However, it is important to note that, as will be seen in Chapter 6, the sectoral rates of return affect sectoral investment in all sectors, so that a decline in the manufacturing rate of return will decrease the investment in that sector and thereby will have an indirect effect on sectoral productivity. This is also discussed in Chapter 9.

The sign of the coefficient of the rate of return in the share equations is negative for both sectors, showing that the set of techniques becomes more labor-intensive when there is an increase in the expected rate of return. Thus, an increase in the agricultural price, which leads to a higher rate of return, will have a positive effect on the share of labor in value added. This is explained in part by the changes in the composition of output, which became more labor-intensive when output prices and the rate of return increased. The same relationship was observed also in the post-study years, when a sizable real devaluation took place. The devaluation improved agricultural profitability, which in turn increased the demand for labor, leading to higher wages and employment and to a change in the composition of output in favor of fruits and other export products that are labor-intensive.

In services, the behavior of the elasticity with respect to the rate of return is procyclical. During the recessions of 1975 and 1982, the capital-labor ratio in services increased and the elasticity fell. This implies a lower sectoral supply response to prices during recessions. In addition, a positive relation between the share of labor, on the one hand, and utilization of capital and other inputs, on the other, may also contribute to the explanation of the result.

The effect of the external shocks, as measured by *FEC*, is observed in manufacturing and services with similar mean elasticities, around 0.8 (Figure 7). In manufacturing, the function has a quadratic term that causes the elasticity to vary over the sample. The results indicate that when the value of *FEC* is low, as is the case in times of external crisis, the elasticity is high. For instance, during the great recession of 1975 that was triggered by the fall in the copper prices, *FEC* declined from 0.228 in 1974 to 0.112 in 1975, and the interpolated elasticity (between 1974-75) of *FEC* was 1.206. This resulted in a decrease of computed manufacturing output by 13.9 percent. The actual reduction of output in 1975 was 25.2 percent. The rest of the reduction in output is explained by the fall in employment and investment, which are also affected by *FEC*. In the severe recession of 1982, manufacturing output dropped 21.0 percent and *FEC* declined from 0.436 in 1981 to 0.239 in 1982. The direct effect of *FEC* explains about one-half of this decline, quite similar to the 1974-75 recession.

The effect of *FEC* on services is consistent with the hypothesis that foreign shocks spill over to the nonprimary sectors. The mean value of this elasticity in services is similar to that in manufacturing, but the annual values are more stable. The numerical reason for the higher stability is the exclusion of a quadratic term of *FEC* from the production function of services, because the coefficient was insignificant.

The annual values of the elasticity of agricultural output with respect to the agrarian reform variable are not reported here. These values are positive, of the order of magnitude of 1.3 percent, for the first period of the reform, 1965-68, and slightly negative for the second period, 1969-1973. This pattern is consistent with the description of the process given above. In either case the value is relatively small. The effect of the agrarian reform was labor-using. This can be related to the uncertainty of property rights created by the reform, which led to the implementation of techniques less intensive in capital to avoid their being expropriated. This explanation is also applicable to the coefficient of the dummy of 1973 in the share equation for agriculture.

The estimated elasticity of the labor quality variable in services, *ACM*, is plotted in Figure 8. It has the expected sign: an increase in the proportion of labor drawn from agriculture implies a fall in services productivity. The estimate makes it possible to compute the differential productivity of "migrant" as compared with the average labor productivity of "nonmigrant" in services. The result is equal to 0.74. The mean of the ratio of the average rate of real wages in agriculture to the average rate of real wages in services is approximately 0.27. Assuming the agricultural wage to be equal to the marginal productivity of labor in agriculture, it is concluded that the marginal productivity of a migrant increases when he moves to nonagriculture but not to the extent given by the wage differences between the two sectors.

The dummy variables for some years of the Allende period capture some of the shocks. The dummy variable for 1982 in the share equation for agriculture is introduced to capture what seems to be data error.

Another way of looking at the results of this analysis is to compare the residuals with those obtained by standard methods. Equation (18) summarizes the effect of the state variables on output with the inputs held constant. In the standard analysis, such variations in output appear in the unexplained residuals. Thus, the present analysis should have smaller residuals. This is indeed the case, as can be seen from Figures 9-11, which compare the Solow residuals with those obtained in the present analysis. The interpretation is that, in part, the residuals constitute changes in outputs caused by changes in the composition of techniques in response to variations in the state variables.

Mining Production Function

The endogenous productivity approach used in the other three sectors did not yield satisfactory results for mining. There were large discrepancies between the factor shares and the production elasticities that could not be accounted for in a meaningful way by economic variables. This finding is attributed to institutional and technological features of this sector (Coeymans 1990). The mining sector, in which copper is most important, was largely foreign owned up to 1965. Thereafter it was gradually nationalized, a process that began in the Frei administration and was pursued aggressively by the Allende administration. The nationalization had been anticipated for some time, and the fear of it during the 1960s might have led foreign owners to minimize labor conflicts (Lira 1974). The labor unions in mining were on the whole very strong and effectively resisted reduction in employment, which remained stable during the 1960s in spite of the large fluctuations of copper production.

Since 1971 most copper has been in the public sector. The decisions by the public firms took into account "social" and political considerations rather than following strictly the consequences of market prices. This is the reason that a sizable increase

Figure 9—Unexplained productivity in agriculture, as share of output, 1962-82

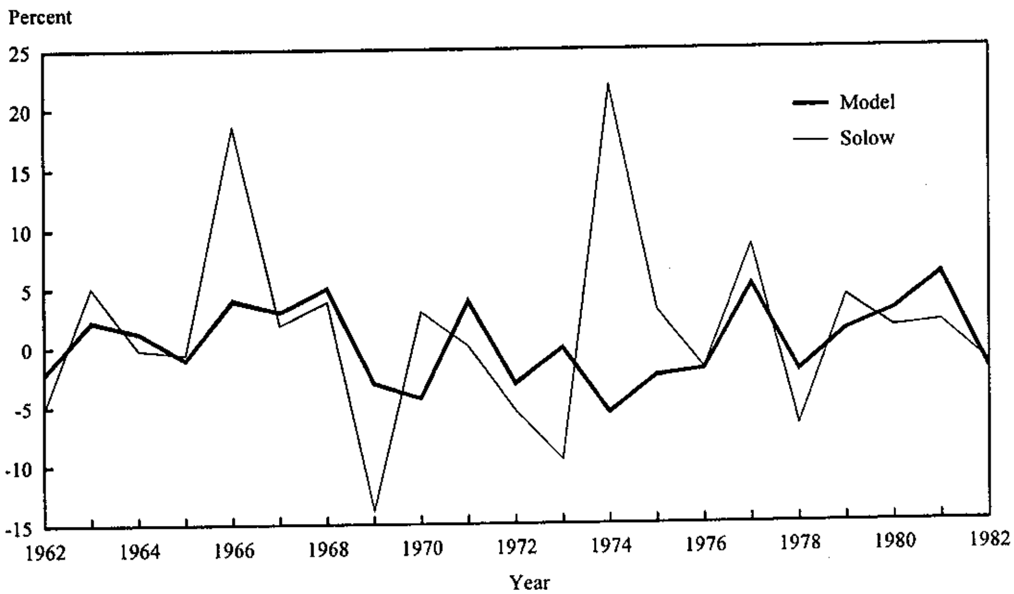


Figure 10—Unexplained productivity in manufacturing, as share of output, 1962-82

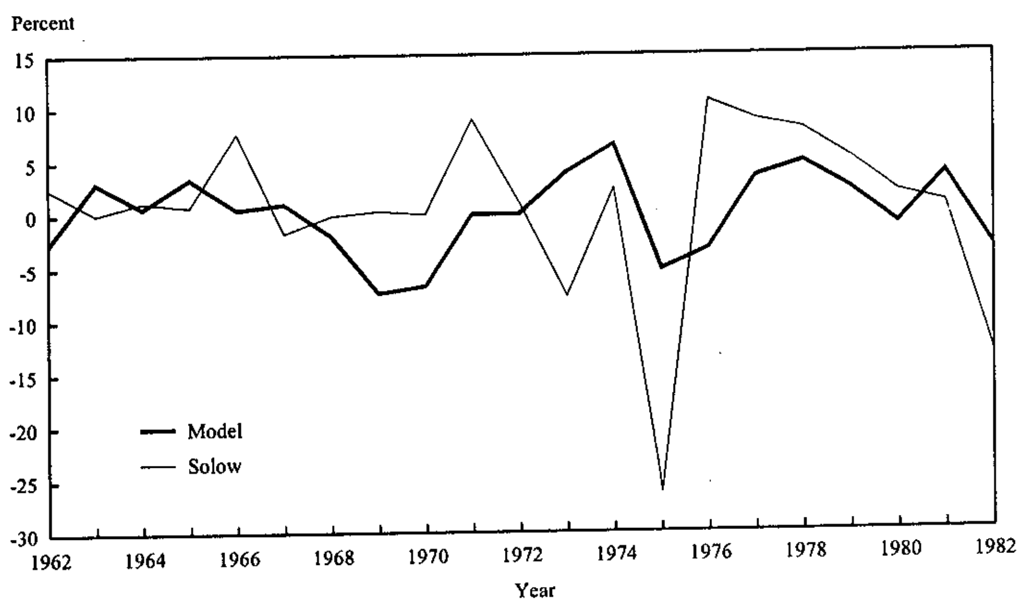
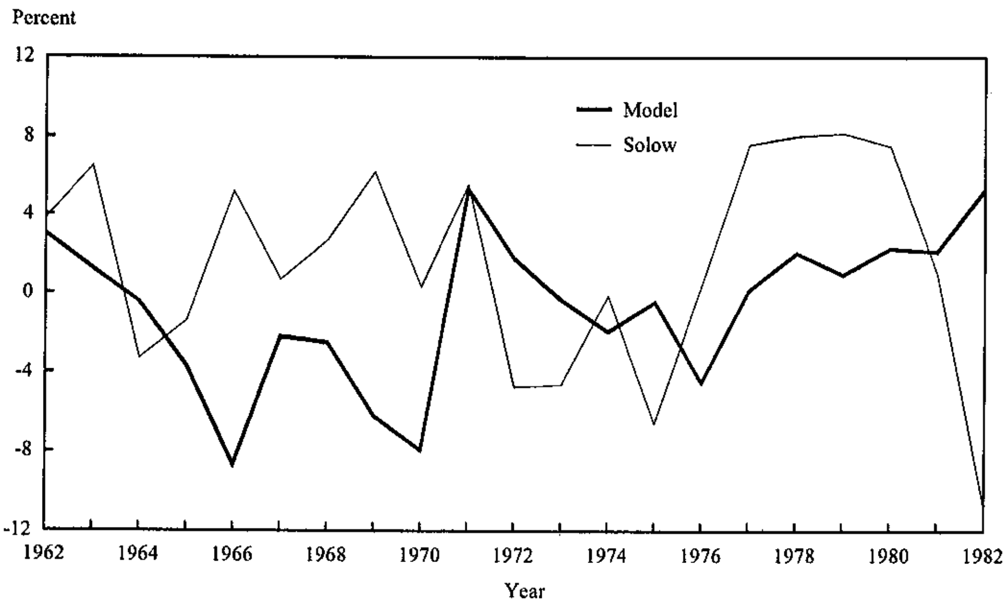


Figure 11—Unexplained productivity in services, as share of output, 1962-82



in employment, unjustified by economic reasons, occurred during the Allende administration. After the military coup, the unions suffered a loss in their bargaining power, and in spite of the significant declines in real wages during some years, not a single strike took place. As a consequence, employment declined by 28.6 percent from the end of 1973 to the end of the study period, whereas output increased by 60 percent.

To complete the model, a production function is fitted for mining in terms of capital alone, allowing for structural changes as explained below. This function means a perfectly inelastic supply in the short run. The long-run supply response is positive and its magnitude depends on the response of investment to prices. The estimated equation is

$$\underset{(7.8)}{V = 9008} - \underset{(7.1)}{24748}(D7582) + \underset{(8.1)}{0.13506}(K_{t-1}) + \underset{(6.4)}{0.20779}(K_{t-1})D7582 - \underset{(4.3)}{1111}\ (ALLEN); \qquad (61)$$

$R^2 = 0.977$, D.W. = 2.06.

The equation includes a variable (*ALLEN*) for the Allende period, when important strikes and severe labor unrest occurred. The effect of labor unrest, similar to that of the agrarian reform in the case of agriculture, was not constant but had an increasing dynamic. To save degrees of freedom, the variable is a time trend for the three years of the Allende regime. This variable is strongly correlated with the number of working days lost in strikes.

D7582 is a dummy for the years 1975-82 that intends to capture the changes introduced in this period, mainly the nationalization and the military regime. The nationalization eliminated the uncertainty about the property rights of the copper mines prevailing since the early 1960s and also allowed for better coordination of the copper mines (Tironi 1974), which might have led to an increase in productivity. The fact that this was a period of labor discipline might have contributed as well.

The slope of the function is a gross marginal product of capital in the sense that it also includes the contribution of labor. The results are 0.135 for the first period and 0.342 for the second one. *PEAK* was insignificant and was not included. It is postulated that much of technical progress is embodied in capital.

In the policy simulations it is assumed that the average labor productivity is constant. The share of mining in total employment averaged 3.3 percent for the study period, so the assumption on the labor requirement in mining has little repercussion for the computation of unemployment.

Conclusions

The foregoing results differ from results obtained from sectoral aggregate production functions. Aside from the numerical differences, the approach presented here allows the coefficients, and therefore the factor productivities, to vary in response to the prevailing economic environment. For instance, the factor shares varied greatly over the study period. The common approach in studying production functions is to relate such differences to differences in inputs used. On the contrary, the approach presented here relates such variations, largely but not exclusively, to variations in the implemented technology. One of the benefits of this approach is that it provides a channel for evaluating the effect of policy, as well as business cycles, on productivity and on factor demand.

More specific results indicate that there is a larger factor substitution across techniques than along a given production function. The indirect measure of technology has positive effects in all the three sectors. Its elasticity is procyclical, so during recessions there is less incentive to expand technology. Favorable external conditions affect positively the productivity of nonprimary sectors. The elasticity with respect to the external conditions is anticyclical in manufacturing and procyclical in services. The effects of the expected rate of return in services and of the investment-capital ratio in manufacturing are procyclical, implying a lower response in recessions.

The long-term bias of the technology, as measured by *PEAK*, is toward labor-saving in agriculture and labor-using in manufacturing and services. It is suggested that restrictions on import of machinery prevented the country from taking advantage of techniques that are capital-intensive.

The agrarian reform in agriculture had a slight positive effect in its beginning years and a negative effect in the final years.

5

LABOR

In this study, the total labor force is exogenously determined. The allocation of labor between agriculture and nonagriculture is summarized by the migration equation, which is the first subject of this chapter. The employment in each of the nonagricultural sectors is determined by the labor demand, which is derived from the production function and the price equations, and the prevailing wages. The wages are determined largely by the macro environment and, most significant, are not market-clearing, as can be verified by the considerable unemployment that existed during most of the study period. This is the second subject of the chapter.

Off-Farm Migration

Background

The analysis follows the approach taken in Mundlak 1979, Cavallo and Mundlak 1982, Coeymans 1982, and Mundlak and Cavallo 1989. It is therefore sufficient to outline the approach in general terms as a background for the specific application of this study.

The labor supply of an individual is determined as a choice between leisure and consumption. Consumption is financed, in full or in part, by income derived from work. However, work is not a homogeneous option. Ordinarily, there are several possible occupations, some of which require investment in learning or a change of location, and a choice has to be made among the various alternatives. These alternatives differ in both the level and the variance of the income stream that they generate. Location has two dimensions: work and residence. Residence affects the consumption choice in terms of the availability of goods and services, their quality, and their prices. For instance, housing and food may be cheaper in rural areas, whereas the quality and accessibility of health and education may be better in the urban area.

To put all of these in an optimization framework, imagine that the individual is maximizing his or her remaining lifetime utility derived from consumption and leisure, subject to the market opportunities and the investment in learning he or she makes for each of the discrete alternatives available to that individual. The outcome of this optimization is summarized in terms of the indirect utility function for each of the alternatives. The indirect utility function expresses utility in terms of the various variables that determine the earning and the consumption. The choice is then clear: select the alternative with the highest utility level.

This framework is applied here specifically to the choice between farm and off-farm employment. This choice is influenced by the intersectoral income differential used here to measure the earning alternatives. Other things being equal, when income in nonagriculture is higher than in agriculture, labor will move to nonagriculture. Such off-farm migration contributes to the closure of the income differential between the two sectors. Will it lead to a complete closure of the gap? The answer is probably no, at least not until the economy is fairly well developed. First, other things are not equal, so the income differential is not the only consideration in the choice, and there may be compensations to lower income such as the price of the consumption goods. Whether this is quantitatively important is an empirical question and there is not much evidence that it is. As optimization is concerned with lifetime income and is affected by the cost of migration, it is likely that migration will be an optimal option for some people, say the young, and not for others, say the old. There may be other attributes, such as gender, that differentiate between people.

It is thus possible that the market will be in a dynamic equilibrium, even with prevailing intersectoral wage or income differentials that are identified with disequilibrium in the comparative static sense. The important fact to note is that the off-farm migration lasts for a long period of time. This can happen only if some of the state variables that determine the choice are also changing continuously. Why then would the state variables be changing continuously? One reason is related to the fundamentals that affect agriculture, namely, declining terms of trade and labor-saving technical change. Another reason, not specific to agriculture, is related to demography. As the migration pays off for the young and not for the old, every year brings a new group of people for whom it pays to migrate. However, with time, this stock of potential migrants gradually diminishes, and therefore the migration eventually slows down, as can be observed in countries where the agricultural labor force constitutes only a small fraction of the total force.

In general, the intersectoral labor migration in most countries is in one direction, out of agriculture, until the proportion of the labor force in agriculture stabilizes. In this respect, the Chilean experience is interesting in that the off-farm migration changed direction in the late 1970s and early 1980s, when unemployment in nonagriculture reached high levels. This migration to agriculture had a suppressing effect on agricultural wages.

The utility is unobserved, but the arguments entering the indirect utility function are observable and so is the outcome. It is then possible to make inferences about the quantitative importance of the various variables in making the choice. The choice can be expressed in terms of an index function that assigns a value of one to the chosen alternative and a value of zero to all the other alternatives. When the index function is summed over all the individuals, the total number of people who chose the particular alternative is obtained. Applying this to the decision of people in agriculture on whether or not to stay in agriculture, the off-farm migration is derived. The number of migrants is a function of the variables that enter into the decision of the individual. The quantitative importance of these variables is determined by estimating a migration equation.

Empirical Analysis

Occupational migration is defined here as the net flow of agricultural labor to nonagriculture. It is computed using the following identity:

$$L_{1t} = (1 + n)L_{1t-1} - M_t, \qquad (62)$$

where L_{1t} is the agricultural labor force in year t, n is the natural rate of growth of the labor force, and M is the net outflow of workers from agriculture to nonagriculture. It is assumed that the participation rate of the population in the labor force is constant and that there is no unemployment in agriculture.[7]

The dependent variable in the migration equation is the ratio of migration to the agricultural labor force, $m_t = M_t/L_{1t-1}$. The short time series and the aggregate nature of the data restrict the number of explanatory variables in the regression, and the more important determinants of migration are concentrated on here:

- Intersectoral income differential (d). The intersectoral income differential can be represented by the ratio of sectoral wages or total income, approximated by average labor output. Empirically, the wage rate performed better for nonagriculture, and the average labor productivity performed better for agriculture.
- Unemployment rate in nonagriculture (u). It is assumed that the smaller the unemployment, the higher the probability of obtaining a job in nonagriculture, and consequently, the higher the migration rate (Todaro 1969).
- The composition of the labor force (RL). The composition is measured as the ratio of the labor force in nonagriculture to that in agriculture. The probability of a migrant's getting a job depends also on the size of the market. The larger the market, the easier it should be to get a job. Also, it follows from the framework of the analysis as outlined above that for any given level of income differential and of the other state variables, the *number* of migrants increases with the size of the labor force in agriculture. These two considerations are taken into account by expressing the migration, measured as a proportion of the agricultural labor force, as a function of the ratio of the labor force in nonagriculture to that in agriculture.
- Real price of agriculture (P_1). This variable is introduced to capture the differential effect of *changes* in the cost of living. A *constant* difference in the cost of living between the two sectors is absorbed in the intercept of the equation. The sectoral incomes (or wages) are deflated by a cost-of-living index obtained as a weighted average of the prices of food and nonfood components. The price of agriculture is used as a proxy for food price, and the overall consumption deflator is used for the cost-of-living index. Simple arithmetic shows that this effect can be summarized by introducing the price of agriculture, deflated by the consumption deflator, P_1, as a separate variable into the regression. The effect of this variable depends on the relative weight of food in total consumption in the two sectors. The coefficient of this variable will be zero when the weights are the same.

Preliminary empirical results showed a large positive residual for 1972. This residual is attributed to the turbulence of the Allende period, specifically the agrarian reform discussed in Chapter 4. To avoid a bias in the estimated coefficients of the other variables, a dummy variable, $D72$, is used for this year.

As migration takes on negative values, the dependent variable is in a linear form and not in logs, as is the case for the other variables. For statistical reasons, the migration equation is estimated jointly with the agricultural production function using 3SLS.[8] The empirical equation is

[7]The labor surveys for the study period show some unemployment in agriculture. This is interpreted here as job-searching in nonagriculture (Coeymans 1982).

[8]The disturbance in the migration equation affects the agricultural employment, the nonagricultural labor force, and the unemployment at time t. It is also likely to be correlated with the disturbances of the production block in agriculture.

$$m = -0.052 + 0.051 \ln RL_{t-1} + 0.116 \ln d_{t-1} + 0.238 \ln(1 - u_t)$$
$$\quad (1.5) \quad (2.2) \quad (3.3) \quad (2.6)$$

$$+ 0.050 \ln P_{1t-1} + 0.056\, D72; \qquad (63)$$
$$\quad (1.2) \quad (3.2)$$

$R^2 = 0.72$, D.W. = 1.9, n = 21.

Numbers in parentheses are *t*-ratios expressed in absolute values. The reported R^2 corresponds to a dynamic simulation of the agriculture block as described in Chapter 3. The fit of the migration equation, as indicated by the R^2, is satisfactory. This is especially true if one considers the method used to obtain the migration flow. Relatively small deviations of agricultural employment with respect to its trend imply large changes in migration. The signs of the coefficients of the labor ratio, income differential, and rate of employment are as expected. The price coefficient is not significantly different from zero. This suggests that there is no significant difference in the relative weight of food in the two sectors. As food prices are lower in the country than in town, the result is consistent with an inelastic demand for food.[9]

There is a significant difference between the coefficients of the unemployment and the income differential.[10] This is inconsistent with the Todaro (1969) formulation that migrants respond to the expected income differential where the expected income is the product of the income and the probability of being employed. In terms of the formulation here, where the variables are measured in logs, this assumption implies the same coefficient for the two variables in the migration equation. The coefficient of the probability of being employed, measured here by $\ln(1 - u)$, is larger than that of the income differential. Such an outcome is consistent with risk aversion behavior.

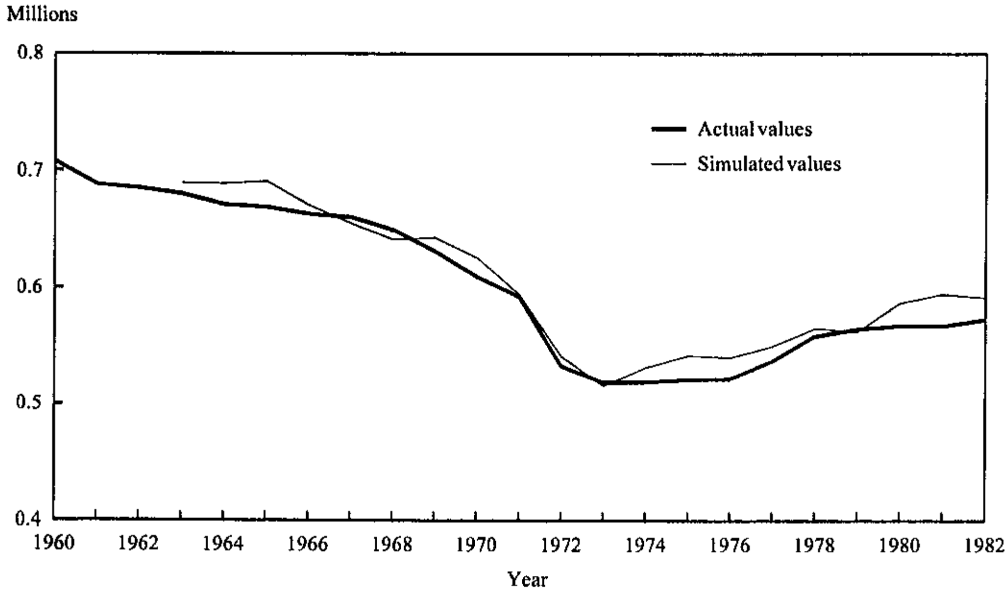
The agricultural labor force is presented in Figure 12. The results of the estimated migration equation explain the variability in this labor force, which declined from 707,000 workers in 1960 to 515,000 in 1973, a fall of 27.16 percent. The average rate of migration for the period was 3.86 percent. Thereafter, between 1973 and 1982, agricultural employment increased from 515,000 workers to 591,000, an increase of 14.76 percent. The average rate of migration for the post-1974 period was 0.39 percent. This rate is smaller than the natural population growth rate, and as a result, agricultural employment increased. The fall in the migration rate is the result of a large increase in nonagricultural unemployment and of the fall in the income differential. Unemployment increased from an average annual rate of 7.8 percent during 1960-73 to 15.8 percent during 1974-82. This change contributes 2.28 percentage points to the fall in the migration rate. The fall in the income differential contributes 2.38 percentage points. These two effects add up to 4.66 percentage points, whereas the total fall is only 3.47 percentage points. The difference is accounted for by the positive effect of the labor ratio, the dummy, and regression residuals.

Because agricultural labor constitutes a relatively small proportion of the labor force, the off-farm migration is quantitatively more important for agriculture than for

[9]The elasticity is unitary if the expenditure on food is independent of the food price and the income is held constant. As the income is larger in nonagriculture, the implied demand elasticity is smaller than one.

[10]A likelihood ratio test rejected the null hypothesis of equal parameters at the 10 percent level of significance.

Figure 12—Labor force in agriculture, 1960-82



nonagriculture. This is different in countries where agriculture accounts for a large proportion of the labor force. Nevertheless, the accumulated effect of migration on the nonagricultural labor supply is important in the longer run. In the shorter run, the main effect of the off-farm migration is on the unskilled labor segment of the market. Specifically, the migrants concentrate in the lowest income bracket of services.

As explained in Chapter 3, it is assumed that agricultural wages are market-clearing. Figure 13 presents real wages in agriculture. Their trend is very different from that of wages in nonagriculture, as will be seen in the next section. This is particularly the case for the 1960s, when agricultural employment was declining, whereas wages show an upward trend.

Nonagricultural Wages

The behavior of the labor market is of great importance in understanding the performance of the economy in the study period. The main feature of the labor market in that period was the covariation of real wages and employment in spite of the considerable unemployment that prevailed during part of the period. This suggests that shocks positively affecting labor demand had a strong wage effect, which in turn prevented a sharp decline of unemployment. This relationship between employment and real wages was affected by the volatility in the inflation rates.

The study period can be divided into three subperiods, the 1960s, the post-1975 recession, and the period in between that covers the Allende period and its immediate consequences. The general developments of the nonagricultural labor market can be observed by reviewing the data as plotted in Figures 14-16 for wages and in Figures 17-19 for employment.

Figure 13—Real wages in agriculture, 1960-82

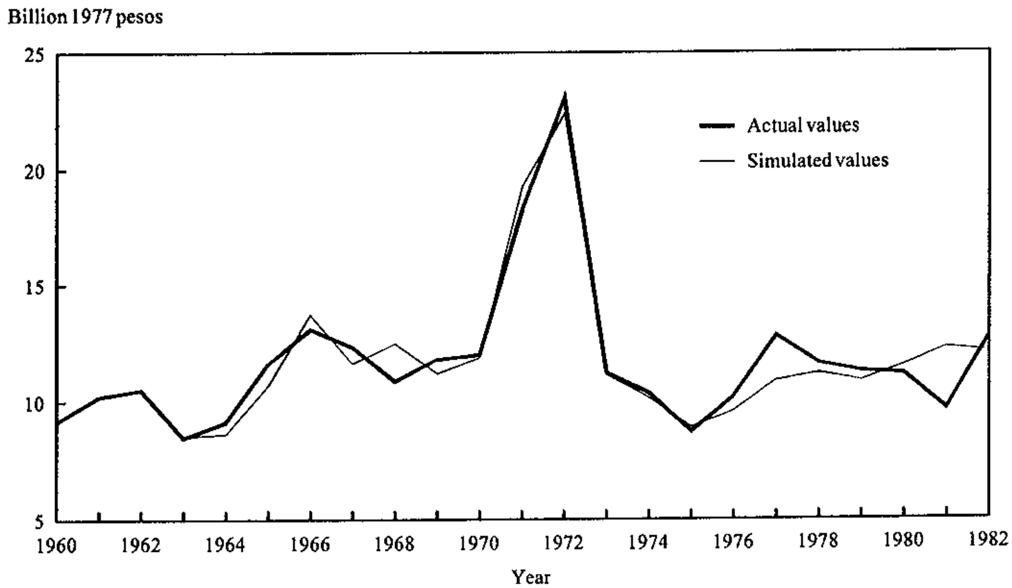


Figure 14—Real wages in mining, 1960-82

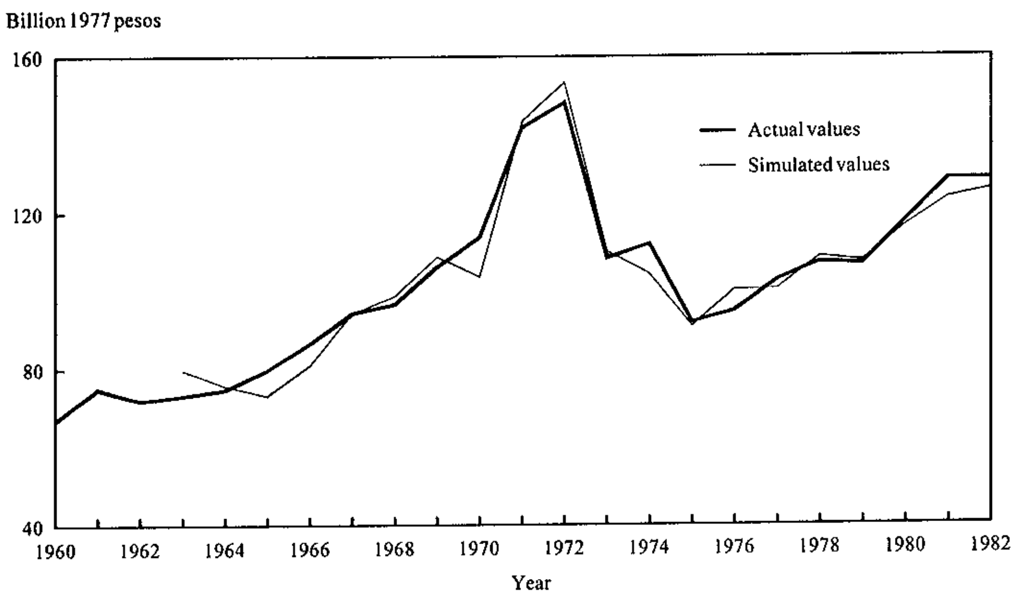


Figure 15—Real wages in manufacturing, 1960-82

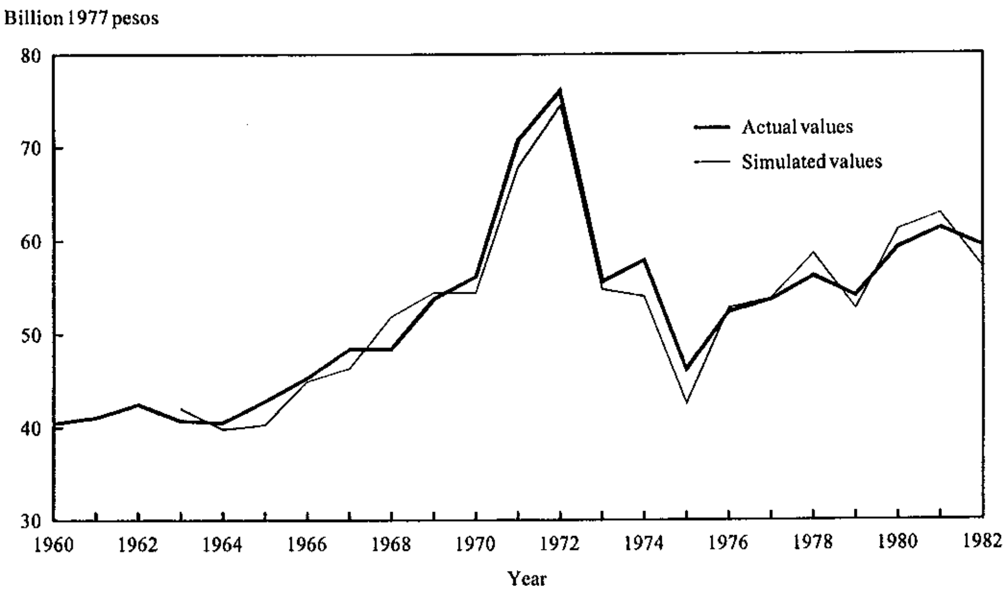


Figure 16—Real wages in services, 1960-82

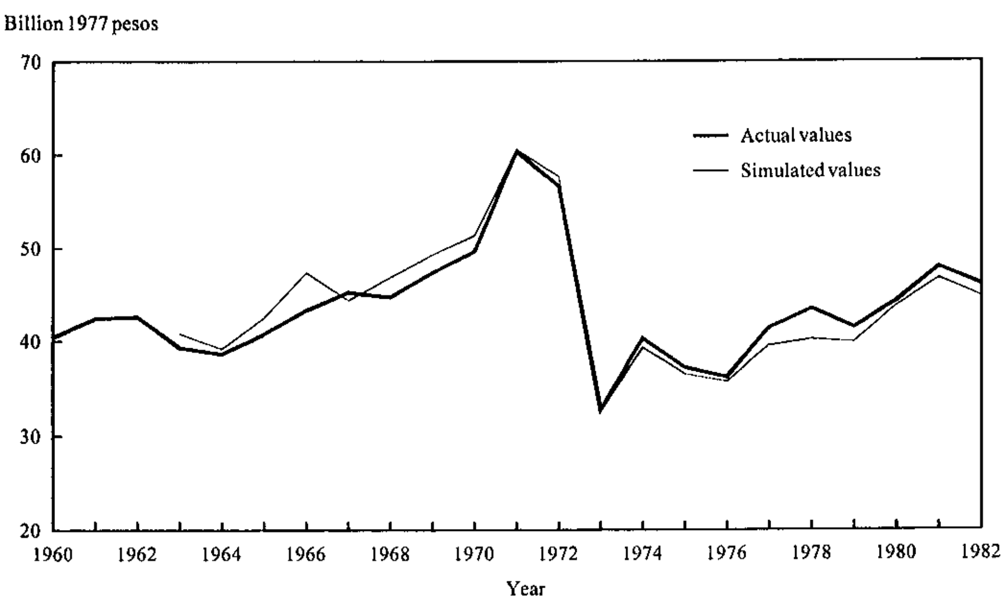


Figure 17—Employment in mining, 1960-82

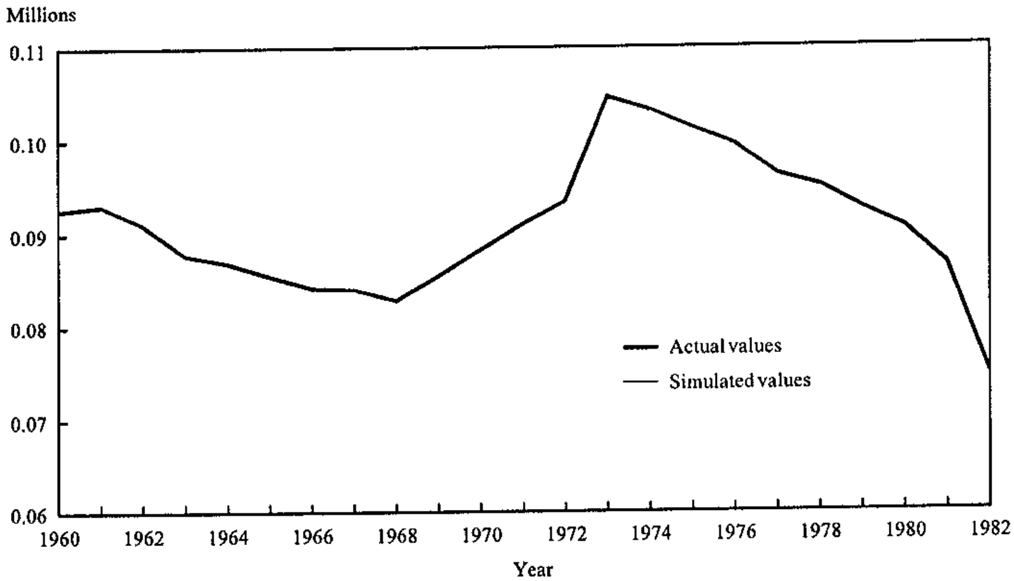


Figure 18—Employment in manufacturing, 1960-82

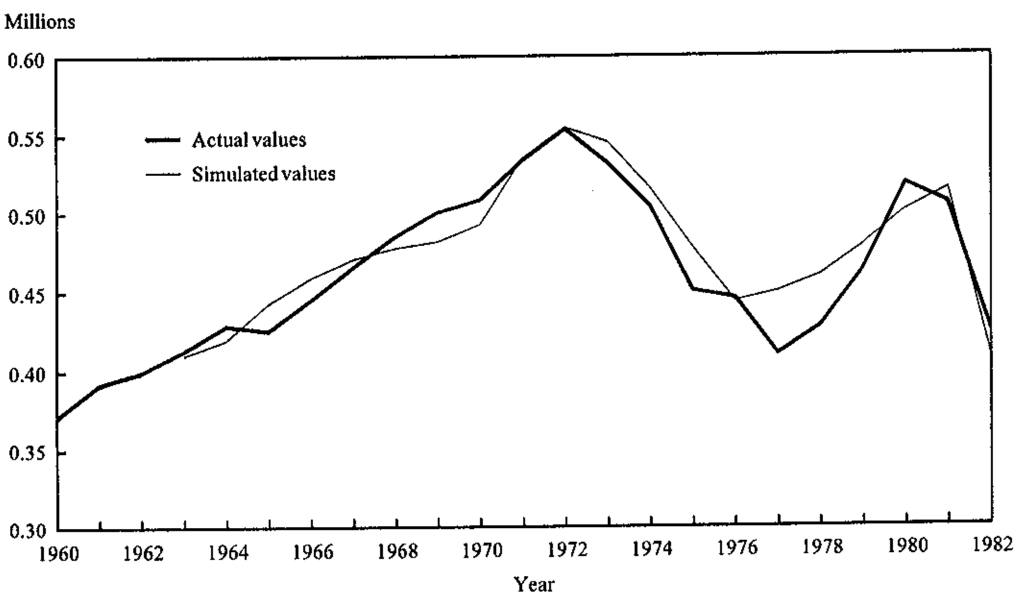
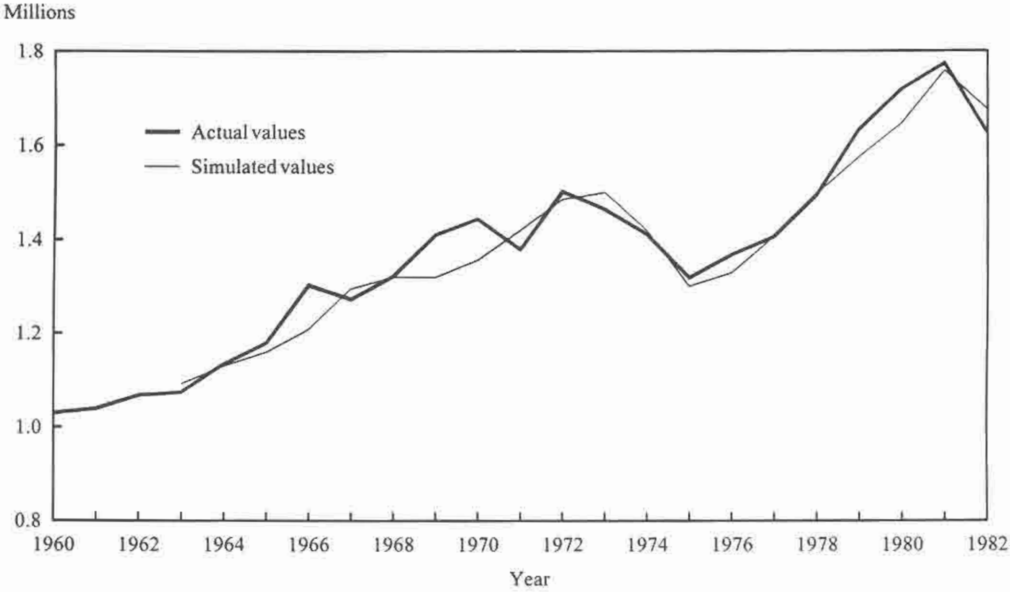


Figure 19—Employment in services, 1960-82



The decade of the 1960s was a stable period, the rate of unemployment was low and declining, and inflation was relatively low. Per capita output, real wages, and employment were increasing. This was all changed at the end of 1970 by the incoming Allende government, which introduced expansionist policies. Nominal wages were drastically increased and price controls were imposed. Initially, these steps had a positive effect on real wages, which continued to increase and peaked around 1972 for manufacturing and mining and around 1971 for services. However, the policy was unsustainable, and inflationary pressure was building up. The inflation started to accelerate in mid-1972 and this led to a decline in real wages. The price liberalization in October 1973, at the beginning of the new government, caused an additional deep fall in real wages and an increase in unemployment that helped to further suppress real wages. Briefly, this period of mid-1972 through 1975 was characterized by high inflation, a decline in real wages and employment, and an increase in unemployment that reached high levels of 15 to 20 percent. There are some differences in wage behavior between services and manufacturing; nevertheless, the general pattern is similar.

The recovery began in 1976 and continued until 1981. Employment started to increase but not enough to reduce unemployment substantially. Wages were increasing again, but did not return to the pre-Allende level. The growth came to an end in 1981, giving way to the recession of 1982, with a deep decline in the real wages in manufacturing and services. Real wages in mining held for another year and started their decline in 1983.

To place the analysis within a broader time perspective, updated data for the economy as a whole for the period 1960-90 is presented in Figures 20-22. These data are revised to take into account the census of 1980, and in this respect they differ

Figure 20—Rate of total unemployment, 1960-90

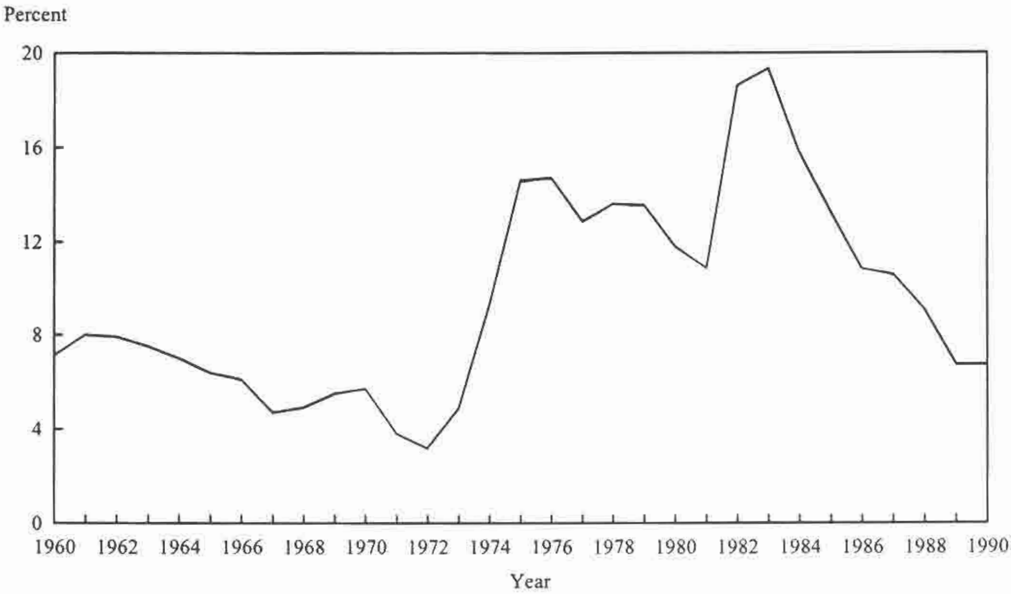


Figure 21—Total employment, 1960-90

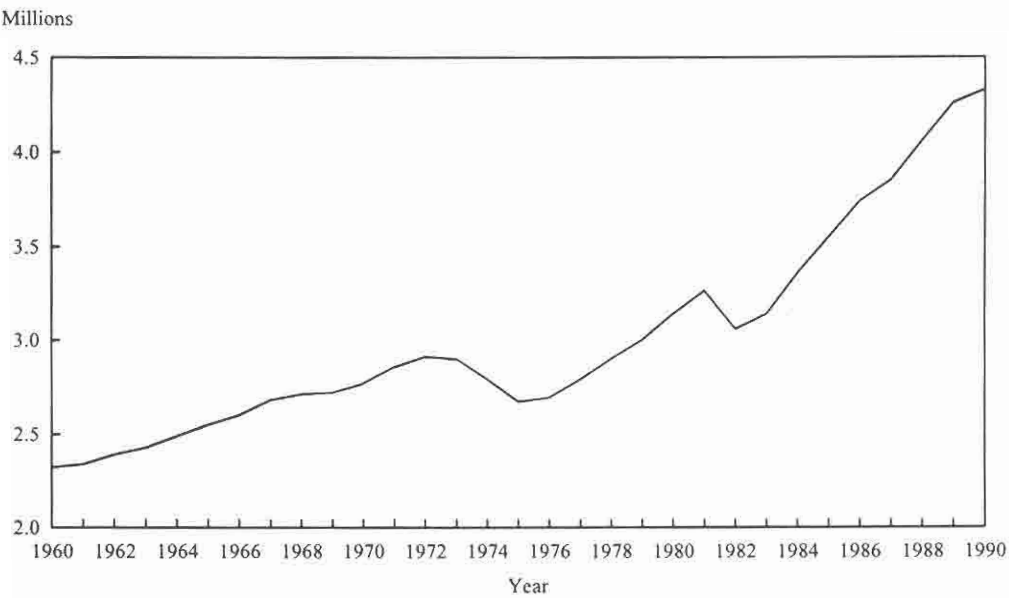
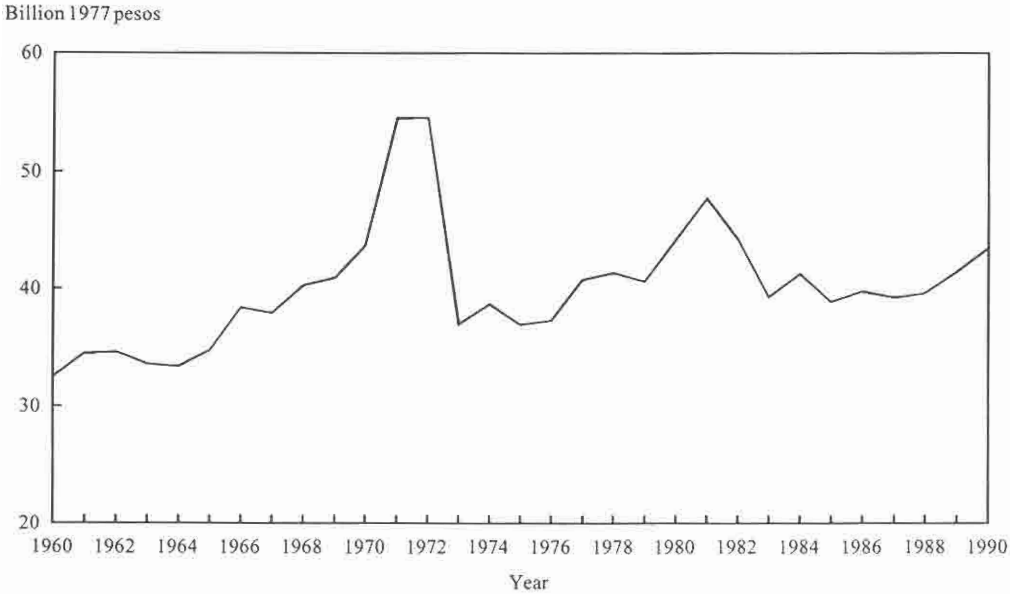


Figure 22—Rate of aggregate wages, 1960-90



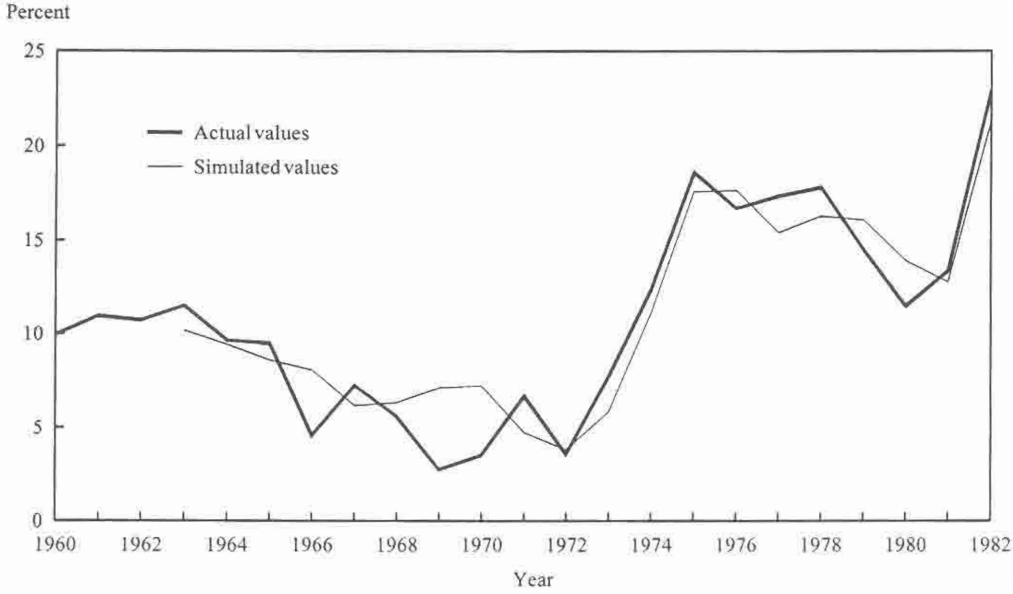
slightly from the data used in the model. Also, the unemployment rate is for the total labor force, whereas unemployment shown in Figure 23 is for nonagriculture only. These differences do not change the overall picture. In 1984 the aggregate wage began a mild gradual growth, with some fluctuations, which has continued through 1992. Unemployment reached its peak in 1983 and has declined since. The striking difference between the recovery in the 1970s and that in the 1980s is that in the later period the inflation was considerably lower, the increase in employment was stronger, the rate of unemployment was decreasing faster, and the rise in the average wage was milder.

In brief, it appears that when unemployment and inflation were relatively low, as in the 1960s, real wages were steadily increasing. As the inflation accelerated and unemployment increased in 1973-75, real wages declined. The recovery of the real wages thereafter is associated with a decline in unemployment and reduction in the inflation rate. In the following analysis an effort is made to evaluate the consequences of all this for the determination of real wages. A description of sectoral differences is given first, followed by the empirical analysis. A brief historical review of events and institutions is given in Appendix 3.

Sectoral Attributes

The three nonagricultural sectors differ in some important attributes that affect wage behavior, namely, factor intensity, the demand for the final products, and the power of the labor unions. Mining is a highly tradable sector and is the main exporter. The most important industry in this sector is copper. The large copper mines were fully nationalized in 1971, ending a nationalization process that began in 1966. As a largely publicly owned industry, it had to follow the wage guidelines more closely

Figure 23—Unemployment in nonagriculture, 1960-82



than other industries. Copper is the main export industry and the strikes there are very costly. These attributes make the labor unions very powerful. Unions are also strong in the oil industry, which is very capital-intensive and depends on skilled labor. The situation is somewhat different in coal and iron, where much of the employment in mining is concentrated. These industries are more labor-intensive and pay lower wages than other industries in this sector.

Manufacturing is more heterogeneous in its product composition and is less tradable than mining. Public firms are less important; therefore, wages are less affected by public wage policy than in mining. There is a relatively large number of unions, and their bargaining power is lower than in mining. The services sector is the least tradable; some of the industries require but little skill and capital and are therefore easy to enter.

The foregoing overview suggests that the macro shocks, as reflected by unemployment and inflation, were major determinants of real wages. The effect of sector-specific factors, if any, was of secondary importance. The empirical wage equations are specified accordingly.

Review of Literature on Wage Determination in Chile

Empirical estimates of wage equations for the Chilean economy along the lines of an augmented Phillips curve using quarterly data can be found in Corbo 1974, Behrman and García 1973, and Corbo 1985a. Similar models using annual data are found in Corbo 1974 and Behrman 1977.

Cortázar (1983a) presents a critical review of the studies to date and an econometric analysis of wages using quarterly data. Cortázar considers the institutional framework with the official guidelines to be the main determinant of wages. His empirical analysis shows no effect of unemployment on wages. A possible reason for this finding is that the sample is divided into three subperiods, 1964-71, 1974-79, and 1980-81, and thereby the spread of unemployment is greatly reduced. The unemployment in the first period followed a declining trend with little variation around it; therefore, its effect may be difficult to capture in an empirical equation with other trended variables. The second subperiod had a larger variance in unemployment, largely because of 1974, which had a low rate compared with the other years in this group. However, the effect of this year was erased by using a dummy variable in the equation that was estimated from quarterly data. The last period is very short.

There is another pertinent element that is related to the role of the official readjustment policy (for details, see Appendix 3). The frequency of the official readjustment declarations depended on the rate of inflation and varied between one and four times a year. The guidelines themselves are affected by the overall macroeconomic environment, specifically by the rate of inflation and the prevailing unemployment rate. The timing of the major jumps in nominal wages was determined by the timing of the official readjustment declarations, and this creates a strong correlation between the official readjustment variable and actual wages. Therefore, when the official readjustment is included as a variable in a regression with monthly or quarterly data, as in Cortázar (1983b), it accounts for most of the variations and dominates the contribution of the annual explanatory variables.

Corbo (1985a) estimates wage functions for manufacturing and nontradables as a part of a short-run quarterly model of inflation for the Chilean economy during 1976-82. The relative wage changes are determined by lagged inflation, the reciprocal of unemployment, the change in unemployment, and growth in productivity. An alternative version replaces lagged inflation with a measure of expected inflation constructed from the model. Corbo concluded that lagged, rather than expected, inflation was the pertinent variable. The equations were not homogeneous of degree one in prices. He found that the change in unemployment was significant only at the 10 percent level in the case of manufacturing, when imposing some restrictions on other parameters of the model, but was not significant in the case of services. This study is subject to the same limitations of Cortázar's study in that the variance of unemployment is relatively small and a dummy variable for 1982 was needed to explain the sharp decline in wages at the precise time when there was a sharp increase in unemployment.

These studies suggest that the wage determination was strongly affected by the wage adjustment policy, that it was not responsive to unemployment, and that the homogeneity property of the wage equation was rejected.

The Wage Equations

The dynamics of sectoral wages reflect changes in the overall economic environment, so-called macro shocks, and sector-specific factors. The macro shocks were the main event in the study period and therefore serve as a natural starting point for the discussion. Wages are largely determined for a period of time and are subject to a contract, which specifies the effect of inflation on wages. The literature contains a taxonomy of contracts, depending on the way inflation is treated. Backward-looking contracts are based, in principle, on past inflation. However, some backward-looking contracts allow for within-year adjustments to inflation; therefore, the nominal wages of such contracts are also affected by current inflation. Forward-looking contracts are guided by price expectations, agreed upon by labor and employers. Such expectations are formed on the basis of the available information, which also includes past inflation. In practice, with high inflation rates, all contracts were subject to some implicit or explicit indexation mechanism that allowed for a discrepancy between the current and expected inflation; thereby, current inflation had some effect on the current nominal wages. As explained in Appendix 3, the income policy of the government institutionalized this element of ongoing adjustments of wages according to past inflation. Although the taxonomy is widely used in the discussion of wage determination under inflation, its usefulness is of limited importance because the contract types may change in response to the changing economic conditions. This is particularly the case when the economy is very volatile.

As a starting point, it is useful to assume that the change in nominal wages depends on lagged, current, and expected inflation rates. Under forward-looking contracts, current inflation is replaced by the expected inflation, which is obtained conditional on the available information. The effect of these variables on nominal wages, *nw*, is summarized by an aggregate measure, P^a, referred to as the adjustment price and defined as a geometric average of lagged and expected prices. Let lower-case letters denote the natural logarithm, ln, of the variables in question; then $p_t^a = \lambda p_t^e + (1 - \lambda) p_{t-1}$ is the ln of current adjustment price, p_t^e is the ln of the expected price, and p_{t-1} is the ln lagged price. The measure of the price level used here is the consumption deflator, *PC*, so that $p_t = \ln P_{ct}$. The expected inflation rate was derived from a regression of inflation on the change in the money supply, rate of nominal devaluation, and three lagged inflation rates. The coefficients were allowed to change for the post-1975 period in order to capture the effect of the opening-up of the economy. Without real changes in the economy, nominal wages are expected to change at the same rate as the price level. This is the homogeneity hypothesis.

Under the assumption that employment in nonagriculture is demand determined, unemployment may exist when labor supply exceeds demand at the ongoing wages. *In this case, unemployment is likely to depress real wages. To allow for this effect,* the wage equation includes a measure of the nonagricultural-unemployment rate, $u_{nt} = \ln(0.02 + 0.5\, u_t + 0.5\, u_{t-1})$.[11] In addition to inflation and unemployment, the equation includes lagged changes in real wages to allow for a gradual adjustment to the changing environment.

In the absence of macro shocks, the changes in the wage rate are expected to reflect changes in demand and supply. The changes in demand are caused largely by changes in productivity as well as by changes in the final demand and the supply of intermediate inputs. Productivity shocks on the whole have an upward trend and thus generate an expansion effect on labor demand. The net effect depends also on the substitution effect, which may be negative if the technical change is labor-saving. Taking a long historical view, it is expected that the productivity shocks generate an upward positive trend in real wages. Such shocks generate a correlation between current and lagged wages, and this is captured by the lagged wages in the wage equation.

[11]In dealing here with the log of unemployment, a constant of 0.02 is added to avoid numerical problems when iterations of the solution of the model have unemployment values that are close to zero.

Taking the above considerations into account, the sectoral wage equation is written in a general form, with the sectoral subscript omitted, as

$$\Delta nw_t = \beta_1 + \beta_2 u_{nt} + \Delta p_t^a + a_3 \Delta w_{t-1} + a_4 \Delta w_{t-2} + \varepsilon_t, \qquad (64)$$

where Δ is the difference operator, for instance, $\Delta p_t = p_t - p_{t-1}$, w = ln real wage, obtained by deflating the nominal wage (nw); $w = nw - p$. The coefficient of Δp_t^a is one, reflecting the price homogeneity assumption, which implies that the inflation is fully transmitted to nominal wages. For the purpose of estimation and simulation, the equation is rewritten with the ln real wage as the dependent variable. Rearrange and use the definition of p^a to obtain

$$w_t = \beta_1 + \beta_2 u_{nt} + \beta_3 w_{t-1} + \beta_4 w_{t-2} + \beta_5 w_{t-3} + \lambda \Delta p_t^e - \Delta p_t + (1 - \lambda)\Delta p_{t-1} + \varepsilon_t, \qquad (65)$$

where $\beta_3 = 1 + a_3$, $\beta_4 = a_4 - a_3$, and $\beta_5 = 1 - \beta_3 - \beta_4$. Equation (64) was estimated for each of the three sectors by maximum likelihood.

Dummy variables were added for 1972 and 1973.

Statistical Results

The estimates of equation (65) for the three sectors appear in Table 3. The estimates were obtained by restricting the weights of all the inflation coefficients to add up to one in order to impose price homogeneity in the long run. This restriction

Table 3—Nonagriculture wage equations

	Sector		
Variable	Mining	Manufacturing	Services
Constant	−0.100 (1.0)	−0.196 (2.1)	−0.182 (3.0)
u_{nt}	−0.069 (1.5)	−0.102 (2.4)	−0.090 (3.3)
w_{t-1}	1.0	0.749 (6.6)	0.902 (14.7)
w_{t-2}	...	0.344 (2.3)	...
Δp^e_t	0.862 (12.5)	0.775 (14.1)	0.674 (21.6)
D72	...	0.151 (3.3)	...
D73	−0.271 (2.7)	...	−0.237 (6.2)
R^2	0.904	0.914	0.944
D.W.	2.28	2.13	2.67

Note: Numbers in parentheses are *t*-ratios expressed in absolute values.

was tested and not rejected. The table does not report estimates for coefficients of lagged wages for mining, which were highly nonsignificant.[12] In the case of services, pretesting led to the exclusion of β_4, implying that wages of services are affected by lagged changes of wages in t–1 and t–2 with equal weights, $a_3 = a_4$. In the case of manufacturing, both β_3 and β_4 are included, meaning that the two lagged changes in wages have different weights.

Clearly, unemployment had a negative effect on the change of real wages. This result is basically the same when using current or lagged unemployment separately. Given the nonlinearity of the unemployment variable, the effect depends upon the level of unemployment; the lower the unemployment, the larger its effect on wages. This is illustrated in Table 4. For instance, a reduction of unemployment by one percentage point increases the rate of change of real wage in manufacturing by 0.89 percent when the unemployment is 10 percent and by 1.58 percent when the unemployment is 5 percent. Therefore, when the rate of unemployment is relatively low, an increase in the demand for labor was translated largely to higher real wages, which in turn reduced the quantity demanded and made it difficult to further reduce unemployment. This result is of prime importance and will be discussed further in Chapter 9.

Equation (65) is a second-order-difference equation in the rate of change of real wages. Thus, even though the effect of unemployment on the current wage may appear to be small, this effect accumulates with time to reach a substantial magnitude. To illustrate the implication of the numerical result, consider for example a permanent decline in unemployment of one percentage point from a level of 10 percent. This has a cumulative effect, causing wages to climb in 20 years by 12.8 percent in mining, 19.4 percent in manufacturing, and 16.8 percent in services. This is a somewhat artificial exercise because unemployment is not exogenous and in general cannot be kept constant at a given level with real wages climbing. The purpose of the exercise is to point to the difficulty that the economy had at the time in reducing the unemployment rate. This subject will be addressed again in Chapters 8 and 9.

There are intersectoral differences in the strength of the response to unemployment: manufacturing is most sensitive, and mining is least sensitive. The weaker response in mining may be in part a reflection of the strength of the labor unions, which insulated the sector from labor-supply pressures.

Table 4—Response of wages to a fall of one percentage point in unemployment

Unemployment Level	Sector		
	Mining	Manufacturing	Services
(percent)		(percentage points)	
5	1.071	1.577	1.384
10	0.605	0.890	0.781
15	0.421	0.620	0.544
20	0.323	0.476	0.418

[12]Specifically, pretesting did not reject the null hypothesis that β_3 is equal to one and β_4 is equal to zero in the case of mining. This implies that a_3 and a_4 are equal to zero. This is the specification most commonly used for the augmented Phillips curve.

The value of λ, the parameter of the expected inflation, summarizes the nature of the dependence of real wages on changes in inflation. A value of one reduces the three inflation terms in equation (65) to $\Delta(p_t^e - p_t)$, implying that lagged inflation has no effect and that real wages are affected only by the discrepancy between expected and current inflation rates, not by *changes* in the rates. This is the case when indexation operates as it is intended to. A value of λ smaller than one implies that when inflation increases, even if expected, real wages fall and thus indexation is not fully effective. The estimates of this parameter for the three sectors are significantly lower than one; the largest is that of mining, and the lowest is that of services, indicating that indexation was most effective in mining and least effective in services. These sectoral differences can be attributed to the specific features of each sector discussed above.

The changes in real wages produced by inflation changes are self-correcting through the functioning of the labor market. To illustrate, an increase in unexpected inflation causes an immediate fall in real wages; as a result, the demand for labor will rise, unemployment will fall, and wages will recover. If this change in inflation is of a more permanent nature it will be included in the expected price and will affect wages directly. A similar argument follows for changes induced by other shocks such as those captured by the dummies.

The effect of the level of unemployment on the changes in the sectoral real wages is summarized in Table 5. The table shows that when the level of nonagricultural unemployment is 20 percent, the change of wages is negative in manufacturing and services and is slightly positive in mining. This rate of unemployment is not sustainable, because under normal conditions the productivity growth is positive. For instance, during 1960-90 the total labor productivity grew at an annual average rate of 1.3 percent. The decline in the real wage due to the high unemployment rate, along with the increase in labor demand due to the rise in productivity, would increase employment by more than the increase in labor supply and therefore unemployment would decline. On the other hand, a rate of 3 percent unemployment is not sustainable, either, as it would require a productivity growth in the range of 8.7-10.8 percent to maintain the unemployment at that level.

These results reflect the economic conditions in the sample period, and the question is to what extent they are robust. A partial answer can be obtained by referring to a study that used a similar wage equation for the aggregated economy for a longer period, 1960-90, which includes the recovery of the 1980s that was obtained under lower

Table 5—Change in real wages under different nonagricultural rates of unemployment and constant inflation rate during 1962-82

Nonagricultural Unemployment	Wage Change		
	Mining	Manufacturing	Services
	(percent)		
20	0.51	−4.07	−4.60
15	2.31	−1.43	−2.28
10	4.73	2.13	0.84
8	5.99	4.00	2.48
7	6.72	5.08	3.43
3	10.81	11.09	8.70

inflation than that observed in the 1970s (Coeymans 1992). The unemployment variable used by Coeymans is for the economy as a whole and not for nonagriculture as in the present study. In both cases the unemployment figure is the same, but this figure is divided by the total labor force for the economywide measure, whereas it is divided by the nonagricultural labor force in the present study. The latter rate is, on average, 2 percent higher than that of the economywide rate. The relationship between the unemployment level and the change in the real wage obtained from the present study is given in Table 6. The results of Table 6 are quite similar to those in Table 5.

It is interesting to confront the results with some recent data. Preliminary estimates for 1992 indicate that the unemployment rate was around 5.0 percent, real wages increased by about 4.5 percent, total employment increased by 4.0 percent, and total output increased by 9.0 percent, considerably higher than the 6.0 percent growth rate for 1991. This amounts to total productivity growth of 5.0 percent. These values are consistent with the values of Table 6. Of course, the question arises as to how long a productivity growth of 5.0 percent can last. Part of the growth in output is attributed to the growth in employment, which was made possible by the high unemployment rate and also by an increase in the labor force. The growth rate of the labor force declined from 2.9 percent per year in most of the 1980s to 2.0 percent in 1988-92. With unemployment reaching low values, further decline will be associated with an increase in real wages that will slow down the growth.

To examine the dynamic behavior of the wage equations, they were solved and simple regressions between the dynamically simulated wages and actual wages were estimated. These regressions are summarized in Table 7.

The constants are not significantly different from zero and the slopes are not significantly different from one, thus revealing the absence of dynamic drifts. The values of the R^2 of the three regressions indicate a good fit to the data. In Chapter 8, dynamic simulations are presented for the complete model, where unemployment is endogenous and the results are similar to those presented here.

Conclusions

The wage equations summarize the behavior of wages during the sample period, which was very unusual, and its applicability to different economic environments is

Table 6— Change in aggregate real wage under constant rate of inflation during 1962-90

Rate of Overall Unemployment	Change in Aggregate Real Wage
(percent)	
15	-2.658
13	-1.649
10	0.149
8	1.619
6	3.417
4	5.736

Source: Based on data from J. E. Coeymans, "Productividad, salarios y empleo en la economía chilena: Un enfoque de oferta agregada," *Cuadernos de Economía* 29 (87): 229-263.

Table 7—Dynamic simulation of nonagricultural wages: a measure of precision

Coefficient	Mining	Manufacturing	Services
Constant	0.16	−0.80	−0.60
	(0.22)	(1.22)	(0.99)
Slope	0.99	1.08	1.06
	(16.02)	(17.90)	(18.80)
R^2	0.93	0.95	0.95

Note: Numbers in parentheses are *t*-ratios expressed in absolute values.

not straightforward. The most important result of this chapter is the statistical significance of the unemployment variable for the explanation of annual real wages. This result is in contrast to some previous empirical studies for the Chilean economy and other Latin American countries.

Another important result of this chapter is the empirical existence of price homogeneity in the longer run, meaning the absence of a long-run trade-off between inflation and unemployment. In spite of price homogeneity in the longer run, changes in the rate of inflation during the period of analysis had important effects on real wages in the three sectors, particularly in services. Accelerations of inflation experienced during the sample period led to declines in real wages, and conversely, a decline in the inflation rate resulted in a rise of real wages. This short-run effect was largest in services and smallest in mining.

The analysis supports the hypothesis that the behavior of wages is procyclical if inflation is not correlated with the cycle. During booms, unemployment tends to decline and, consequently, wages rise. However, if booms are accompanied by sudden increases in inflation, the rise in real wages may be delayed.

6

CAPITAL

The sectoral stock of capital is built from sectoral investment. The decisions on investment are postulated to take place in two stages: first, total investment is determined, and second, the total is allocated to the various sectors. The behavior of total investment over the sample period is plotted in Figure 24. Investment was increasing during the 1960s and it peaked in 1970-71, the beginning of the Allende government. It then declined rapidly and reached a trough in 1976. From then on it showed a strong recovery, and finally in 1980 it surpassed the level of investment of the 1960s. The recession of 1982 interrupted this growth.

Figures 25-28 show the sectoral pattern of investment. All the sectors suffered from the recession in the early 1970s; however, the sectoral patterns are not the same. Mining investment seems to be the most autonomous, or the least correlated with the investment of the other sectors. It thus appears that the general shocks in the economy affected the various sectors differently. This can best be seen from the behavior of the sectoral shares in total investment shown in Figures 29 to 32. The discussion here aims at explaining these patterns.

The discussion deals with the allocation of total investment among the various sectors. This allocation is assumed to be driven by the competition between sectors for existing resources. The overall investment reflects the resource availability to the economy as determined by saving behavior, in the household and public sectors, as well

Figure 24—Total investment, 1961-82

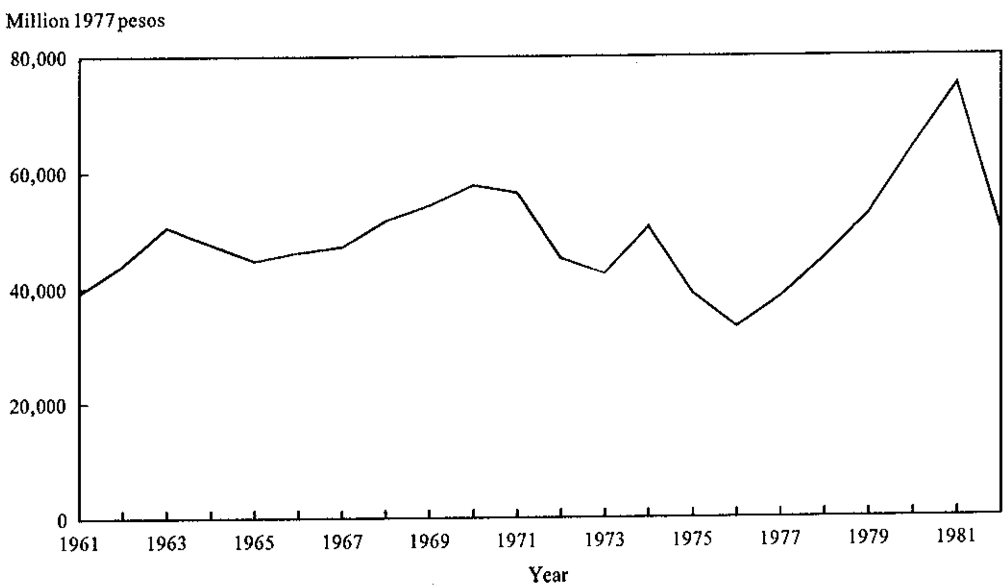


Figure 25—Investment in mining, 1961-82

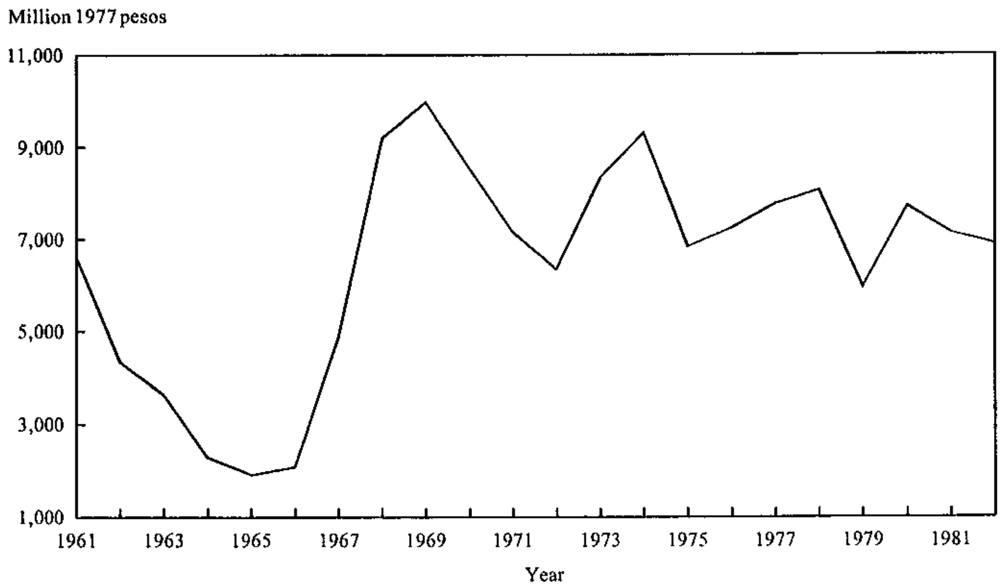


Figure 26—Investment in agriculture, 1961-82

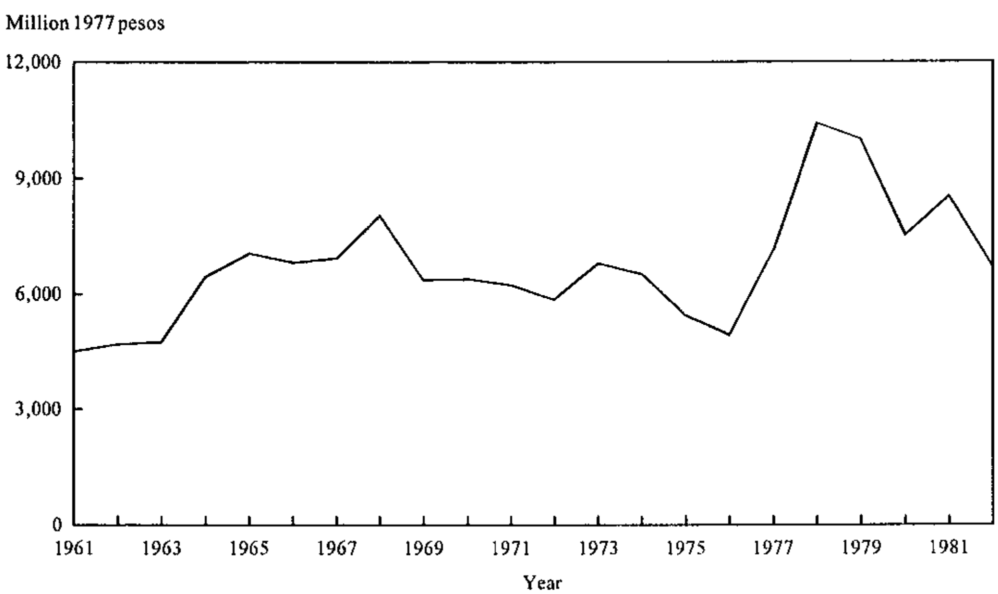


Figure 27—Investment in manufacturing, 1961-82

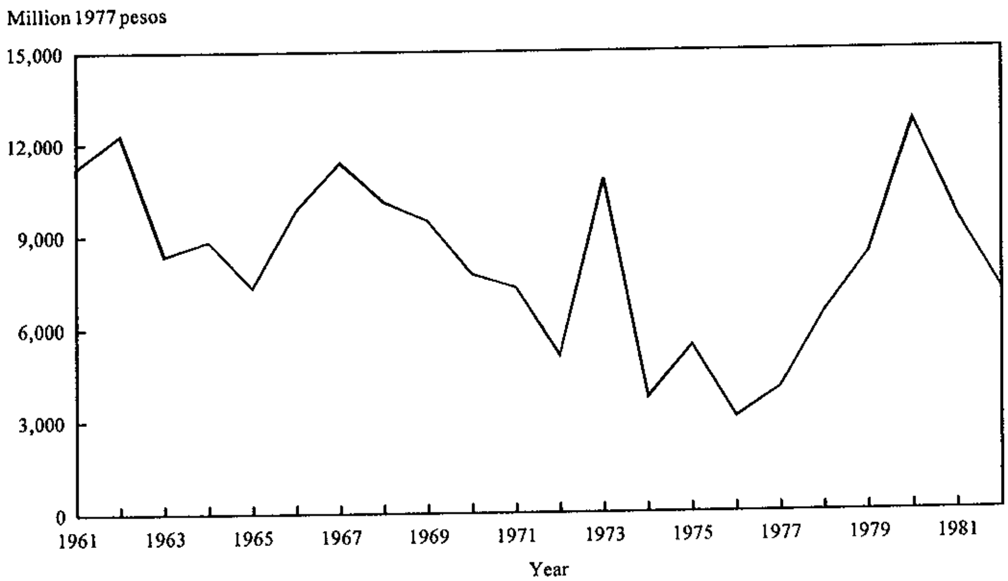


Figure 28—Investment in services, 1961-82

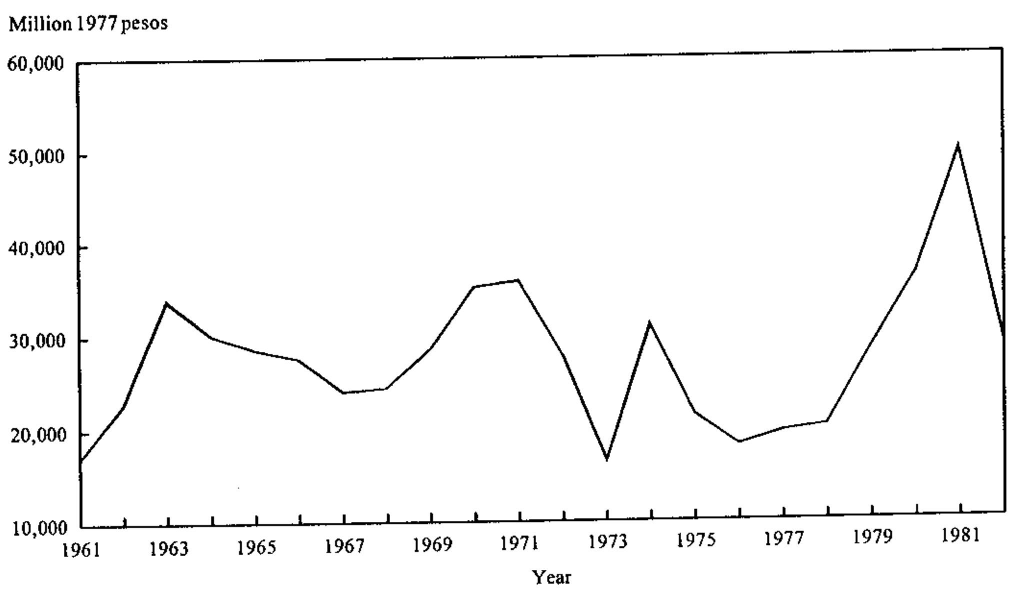


Figure 29—Share of investment in services, 1961-82

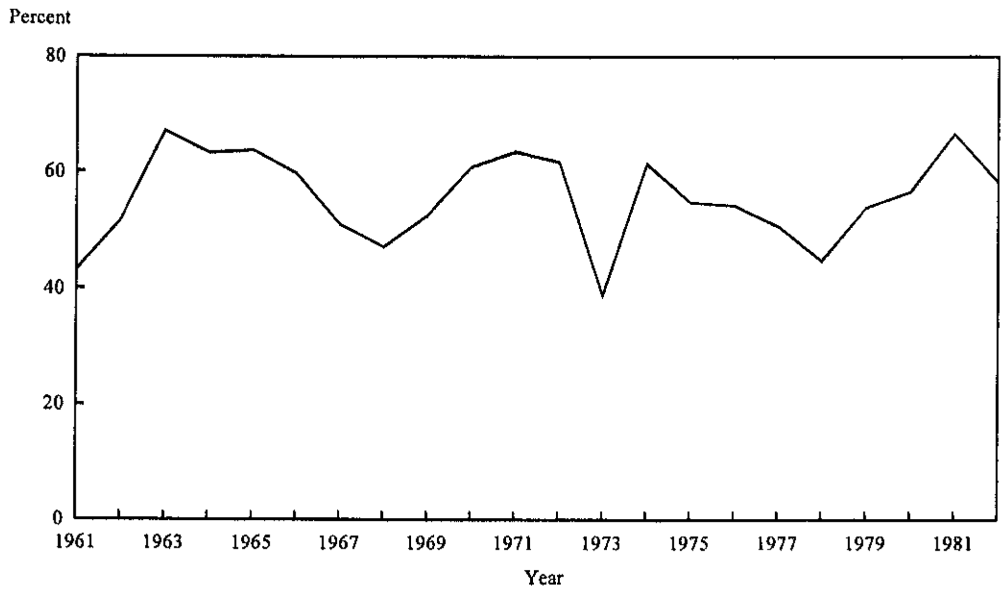


Figure 30—Share of investment in mining, 1961-82

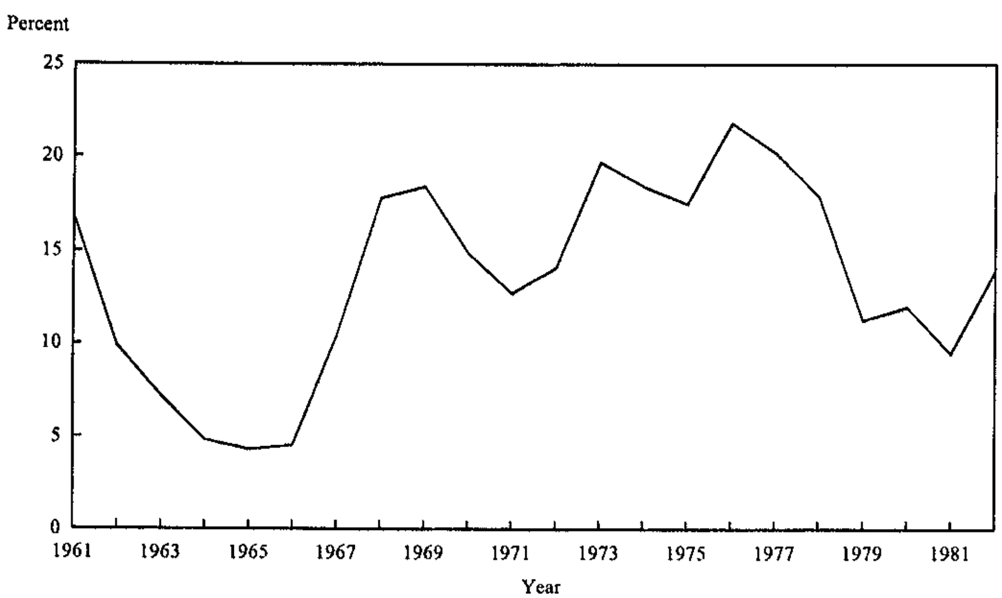


Figure 31—Share of investment in manufacturing, 1961-82

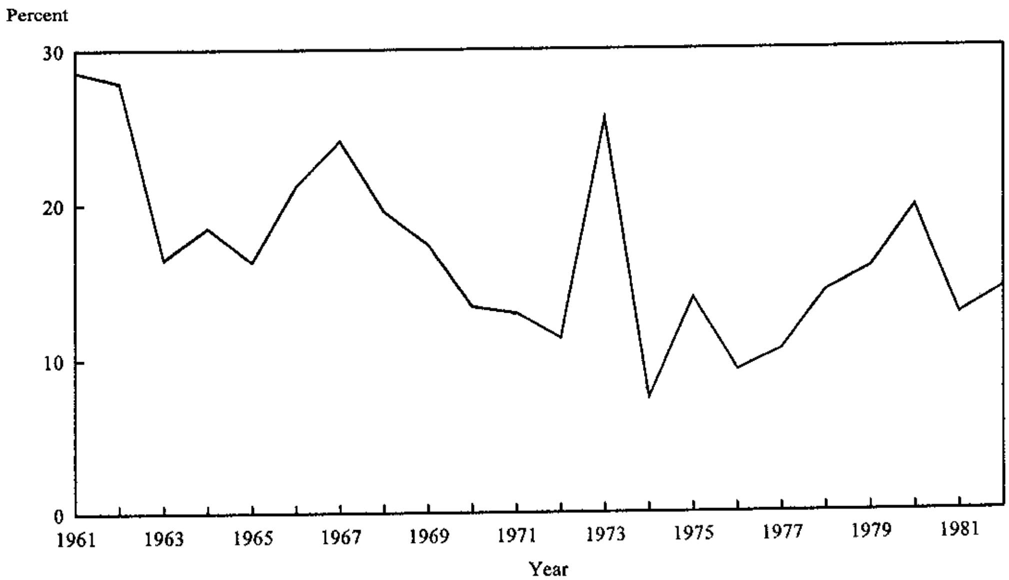
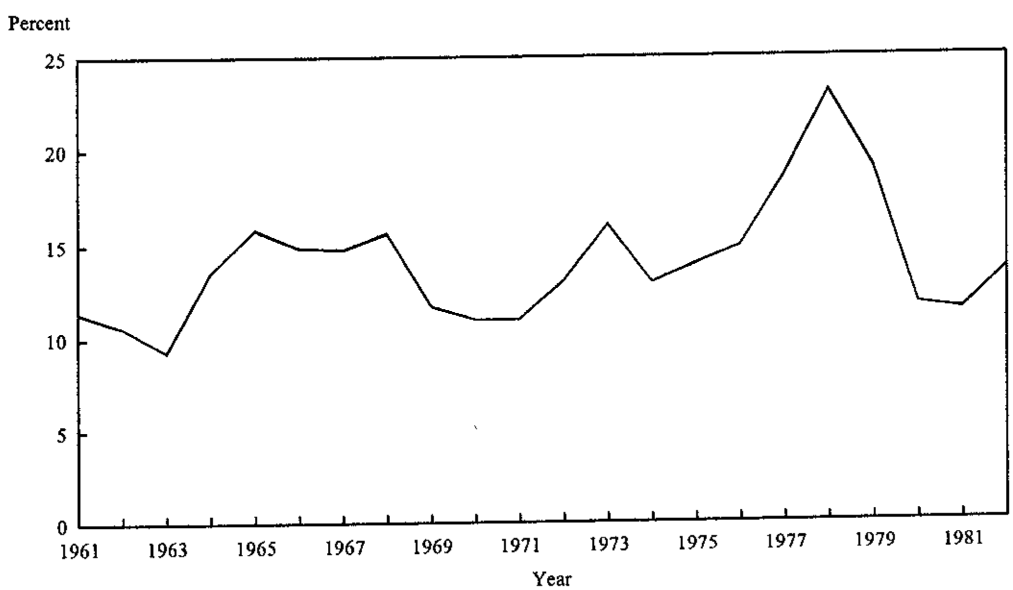


Figure 32—Share of investment in agriculture, 1961-82



as international mobility of capital. These are not very responsive to sectoral investment decisions and can therefore be considered exogenous in the present analysis. As a consequence, similar to the analysis of intersectoral allocation of labor, the allocation of investment will depend on the intersectoral differential rates of returns.

The Model

To outline the framework that leads to the empirical analysis a competitive firm is considered, choosing the time path of inputs so as to maximize the present value of its income flow. Output is produced with variable and durable inputs, referred to as capital. To simplify the presentation, a single-technique production function is assumed. The supply of the variable input a is perfectly elastic at the price w. The supply price of the capital good is labeled by q, and the net cash flow, G, at time t is written

$$G(t) = p(t)F[a(t), k(t)] - w(t)a(t) - q(t)[\dot{k}(t) + \delta k(t) + c(\dot{k})], \tag{66}$$

where $\dot{k} = dk/dt$, c is the internal cost of adjustment, and δ is the depreciation rate. Let i be the interest rate, invoke certainty equivalence, and the problem is that of selecting a time path for the inputs:

$$\underset{k(t), a(t), \dot{k}(t)}{\text{Maximize}}\, E_0 \int_0^{\infty} e^{-it} G(t)dt, \tag{67}$$

subject to the initial condition $k(0) = k_0$; the definition of investment, $I = \dot{k} + \delta k$; the transversality condition; and where $E_0(X)$ is the expected value of X conditional on the information set at $t = 0$.

The first order conditions are

$$\frac{\partial G(t)}{\partial a(t)} = 0, \text{ implying that at any } t, \frac{\partial F}{\partial a} = w/p, \tag{68}$$

and the Euler equation,

$$\frac{\partial G(t)}{\partial k} - \frac{d}{dt}\left[\frac{\partial G(t)}{\partial \dot{k}(t)}\right] = 0. \tag{69}$$

The condition in equation (68) is extremely important for empirical analysis. It states that along the optimal path, the use of the inputs that do not affect revenue or cost in subsequent periods is determined by equating their marginal productivity to their real prices in each period. This leads to a recursive system. First, at each period the optimal levels of the variable inputs are determined as functions of the state variables of that period, $s(t)$ and $k(t)$. The outcome is the restricted or short-run factor demand that is substituted in $G(t)$ to replace the inputs. This results in the restricted profit function, which, for the present discussion, can be condensed on $k(t)$, $\pi[k(t), s(t)]$. Second, $k(t)$ is determined so as to maximize

$$L[k(t), \dot{k}] = \int_0^{\infty} e^{-it}\{\pi[k(t), s(t)] - q(t)[\dot{k}(t) + \delta k(t) + c(\dot{k})]\}dt, \tag{70}$$

subject to the conditions in equation (67).

The solution of this problem provides the optimal time path of $k(t)$:

$$k^{*}(q, \hat{q}, \delta, i, c, w, p, AT), \tag{71}$$

where $\hat{q}$ is the rate of change of q. Heuristically, at the optimal level, the value marginal productivity of k is equal to the user cost of capital, allowing for the appreciation of the price of the capital good and the cost of adjustment. All the variables in equation (71) are functions of time. Obviously, the decision on the optimal time path of k requires knowledge of the time path of all the state variables, and within this framework they are replaced by expectations. How to incorporate the process of expectation formation in the analysis is a major topic of current research in this area. The possible gain from simultaneous treatment of expectation and investment decisions in the study sample was not thought to justify further complicating the analysis. The introduction of the expectation is explained in the empirical part that follows.

In a small sample it is impossible to include empirically all the variables that appear in the argument of equation (71). Therefore, the prices and other state variables that affect the profits, such as the available technology, AT, are replaced by the rate of return, R. The higher the expected rate of return, the higher the investment demand. The investment demand is obtained as the difference between $k^*(t)$ and the available capital, $k(t)$:

$$I_i^d(q, R, i, t) = k_i^*(q, R, i, t) - k_i(t). \tag{72}$$

Summing the investment demand over all firms in the industry, the industry demand is obtained:

$$I^d(q,.) = \sum_i I_i^d(q,.), \; \partial I^d(q,.)/\partial q = \partial k^*(q,.)/\partial q < 0. \tag{73}$$

The following discussion concentrates on q; therefore $(q,.)$ is used to represent the argument in equation (72).

The expression in equation (71) includes the cost of adjustment, an idea developed to account for the fact that firms close the gap between the existing and the optimal stocks of capital gradually rather than in one step (Eisner and Strotz 1963; Lucas 1967; Gould 1968; and Treadway 1969). It postulates that investment requires diversion of resources away from production so that there is a trade-off between output of the final product and buildup of the capital stock of the firm. When dealing with the industry as a whole there is another important force that dictates a gradual adjustment of the capital stock—the availability of resources as reflected in the supply of capital goods. This represents limitations that are external to the firm and are referred to as the external cost of adjustment. External cost of adjustment was recognized in the original work of Eisner and Strotz (1963).

The overall resource constraint is the source for the sectoral competition for existing resources, and as such it is the main force that drives the intersectoral allocation of investment. The resource limitation reflects saving behavior by the household and public sectors as well as international mobility of capital. These are not very responsive to sectoral investment decisions and are therefore considered to be exogenous in the present analysis. As a consequence, similar to the analysis of intersectoral allocation of labor, the allocation of investment will depend on the intersectoral differential rates of returns.

The supply price of the capital good is postulated to increase with the rate of investment. To normalize the investment for the size of the economy, the measure of the intensity of investment is taken as its ratio to the capital stock:

$$q^s(I/k,t), \qquad \partial q^s/\partial(I/k) > 0. \tag{74}$$

Write the inverse function, $I^s/k = I(q,t)$, then q is determined by equating

$$I^d(q,.,t) = I^s(q,t,k). \tag{75}$$

Substituting the price that solves this equation back in equation (74), the investment function for sector j can be written as

$$I_j(I/k,\ R_j,i,t). \tag{76}$$

Let θ be the share of sector j in total investment, and use equation (76) to write

$$\theta_j = \frac{I_j}{\sum_j I_j} \approx \theta_j\left(\frac{i}{k},R,i,t\right), \tag{77}$$

where R is the vector of the sectoral rates of return, R_j. This analysis shifts the gradual response of investment to scarcity of capital. The scarcity simply reflects the fact that, at any time, resources are finite, and if more of them are demanded in one industry they have to be bid away from another industry, a process that requires adjustment in price to equate supply with demand. The price, so determined, allocates the investment goods among all producers. The essence of this analysis is that there is a difference between the price of the investment good perceived by the firm to be constant and the supply price to the industry, which varies with the level of investment. A similar equation was estimated by Cavallo and Mundlak (1982) and Mundlak, Cavallo, and Domenech (1989) for Argentina. The results show that the share of agriculture in total investment increases with the relative profitability of agriculture.

Variables

The empirical equation is a linear version of equation (77). The vector R is decomposed to an expected component, R^e, and to a transitory component of the actual rates of return in the sector under consideration.

Expected Rates of Return

The actual rates of return used in this study, defined by equation (16), are nominal profits after taxes, divided by the nominal value of fixed capital.[13] These values, referred to as "actual," are plotted in Figures 33 to 37. For agriculture, two measures

[13]More precisely, as the capital stock is for the beginning of the year, it is deflated by PC_{t-1}, whereas the profits are deflated by PC_t.

Figure 33—Rate of return to capital in agriculture, including land, 1960-82

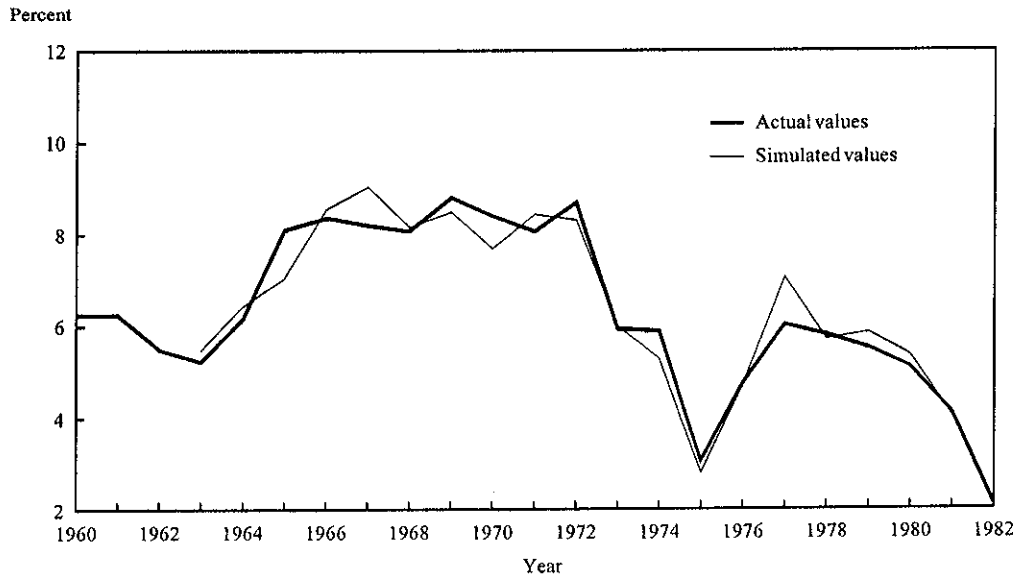


Figure 34—Rate of return to capital in agriculture, not including land, 1960-82

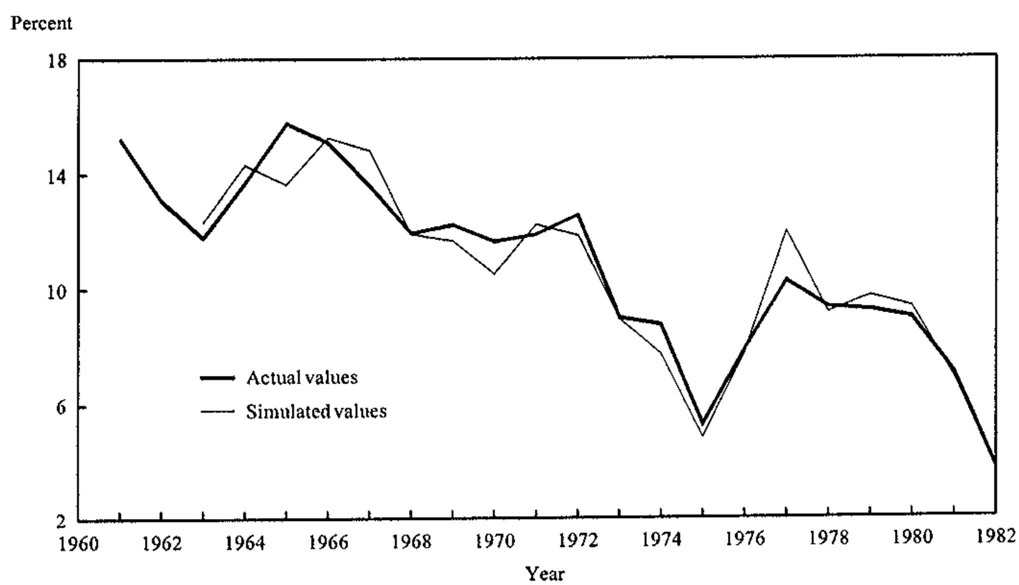


Figure 35—Rate of return to capital in mining, 1960-82

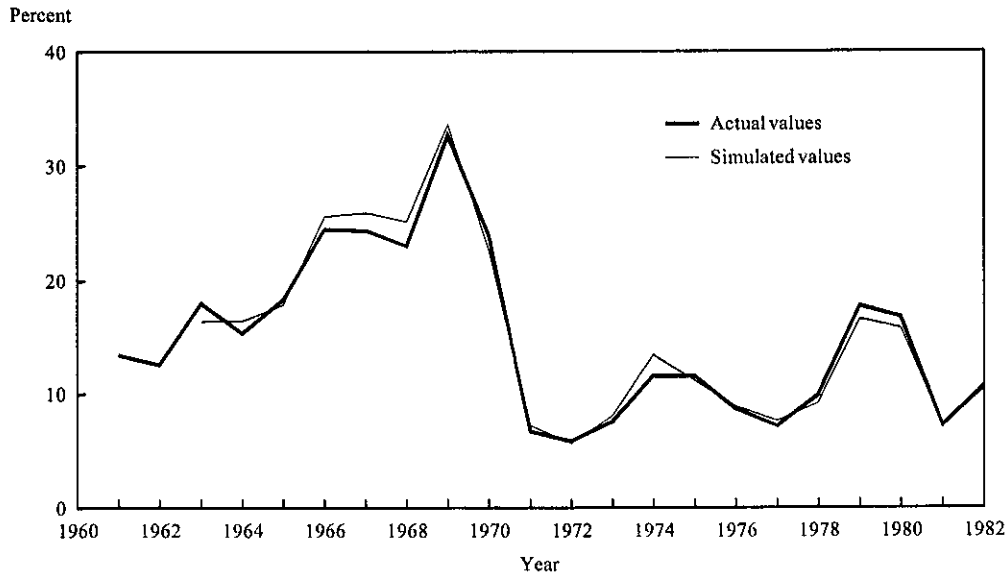


Figure 36—Rate of return to capital in manufacturing, 1960-82

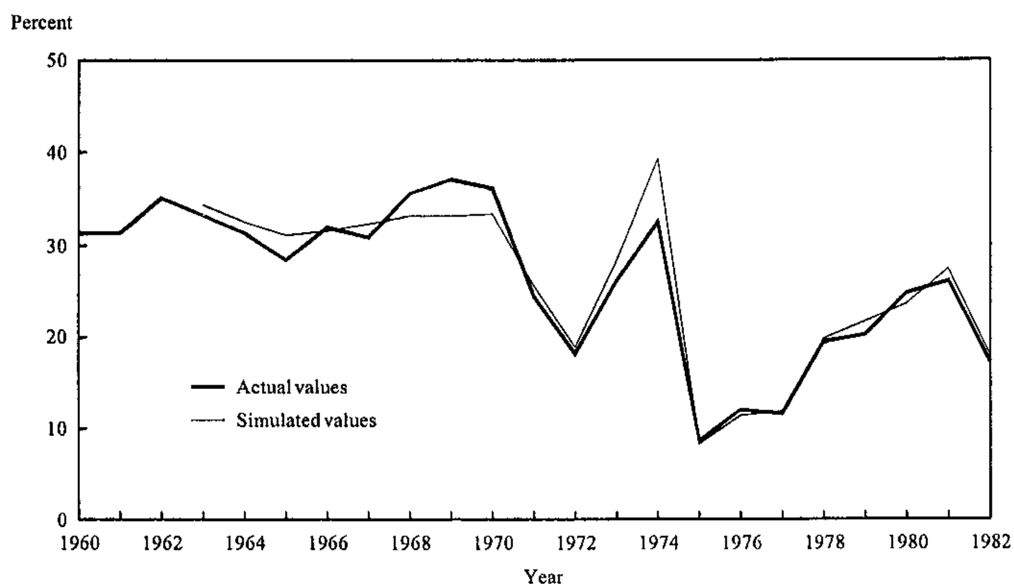
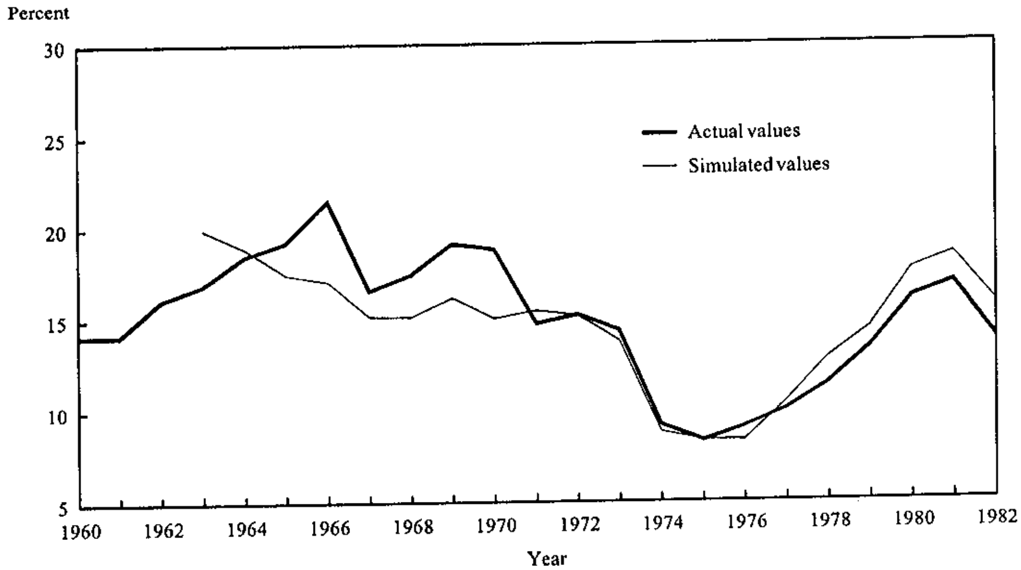


Figure 37—Rate of return to capital in services, 1960-82



of capital are used: with and without land. The rates of return of all sectors reflect the decline in profitability in the early 1970s and the recession of 1982, but at the same time they show somewhat different patterns. Agriculture suffered from a declining profitability after the mid-1960s, as can be seen from Figure 33. Because of the declining land prices, this declining trend in profitability is not detected when the rate of return is computed from a capital series inclusive of land.

The expected rate of return is obtained from a regression of the current rate on three lags, AR(3), with the sum of the coefficients equal to one. The regressions of manufacturing and services also contain the change in the foreign exchange constraint (*FEC*) discussed in Chapter 4. This variable summarizes the "news," not contained in the AR(3), related to sudden changes in expectations on future growth and returns caused by external shocks. It has been previously indicated that most recessions in the Chilean economy have been triggered by external shocks, summarized by *FEC*, and that these shocks affected mainly manufacturing and services.

The transitory component is computed as the difference between the actual and the expected rate.

The Interest Rate

There is no good time series of interest rates for the period as a whole. Prior to the liberalization of the capital market in 1975, interest rates were fixed and credit was rationed. For this reason, published interest rates previous to the liberalization of the capital market in the Chilean economy (1975) do not properly reflect the alternative cost. There is a dramatic change in the published rates following the liberalization. Therefore, the published figures were included here only for the post-1975 period, and a constant value of 16 percent was used for the years before 1975.[14]

Quantitative Restrictions on Imports

During some of the sample period there was an acute scarcity of foreign exchange, and quantitative import restrictions were imposed. These restrictions affected the supply of new machinery. Ffrench-Davis (1973) developed an index of the quantitative import restrictions, which is quoted in Table 8. The index is inversely related to the degree of restrictions; the higher the index, the weaker the restrictions.

The import restrictions affected more the sectors with a relatively high import component in investment. There is a strong negative association between the Ffrench-Davis index and the ratio of imported machinery to the total capital stock in machines. Following the foreign exchange crisis in 1962, there was a large increase in quantitative restrictions in 1963. To capture the effect of this change in regime, a dummy variable, ($D63$), was introduced. It turns out that this variable is significant only in manufacturing, a sector highly intensive in imported machinery.

Political Environment

During the Allende administration (November 1970 to September 1973), direct and indirect interventions in the price system were abundant, and property rights were seriously affected. The nationalization of copper mines was completed in 1971, and as discussed in Chapter 4, the agrarian reform that had started as a gradual process in the previous administration went out of control and an arbitrary wave of expropriations exploded. The nationalizations during this period were also extended to manufacturing, banking, and wholesale trade. The growing importance of the public sector in the various industries is presented in Table 9 for three selected years.

The first year in the table, 1965, represents the situation during the 1960s. Most of the increase in the degree of public involvement observed in comparing the first two columns of the table occurred during the Allende administration. Information on

Table 8—Index of quantitative import restrictions, 1960-65

Year	Ffrench-Davis Index	Year	Ffrench-Davis Index
1960	15	1966	10
1961	20	1967	12
1962	16	1968	11
1963	7	1969	12
1964	8	1970	13
1965	7	1971	n.a.

Source: Based on data from R. Ffrench-Davis, *Políticas Económicas en Chile 1952-1970*, Ediciones Nueva Universidad (Santiago: CEPLAN, 1973).
Note: n.a. means not available.

[14]The value of the interest rate for years before 1975 is somewhat arbitrary; it was chosen empirically by pretesting.

Table 9—Share of public firms in gross sectoral output, selected years

Sector	1965	1973	1981
Mining	0.13	0.85	0.83
Manufacturing	0.03	0.40	0.12
Utilities	0.25	1.00	0.75
Transport	0.24	0.70	0.21
Telecommunications	0.11	0.70	0.96
Financial services	. . .	0.85	0.28

Source: Based on data from L. F. Rojas, "State, Industrialists, and Class Alignments: A Study of the Social Obstacles to Capital Formation, Chile 1964-1986" (Ph.D. diss., Duke University, Durham, N.C., U.S.A., 1990).

the agrarian reform shows a similar trend. The crowding out of the private sector was accompanied by increasing the share of the public sector in total investment, which, according to Rojas (1990), exceeded 80 percent during the Allende period. These events can blur any relationships between the sectoral rates of return and investment; to account for them, dummy variables were used for this period.

The incoming military government in September 1973 lost no time in reversing previous nationalizations. The wave of privatization did not, however, include mining firms or some services activities. As a consequence, there was a transition period of uncertainty in the public firms about their future, and this reduced the incentives for that sector to continue to invest. In addition, the announcement in 1974 of trade liberalization paralyzed investment in manufacturing, the sector with the highest proportion of import-substitution activities. This year is also represented by a dummy variable.

Empirical Results

The model involves a large number of parameters. To avoid a substantial loss of degrees of freedom for the estimation, homogeneity and symmetry restrictions were introduced. Homogeneity, as defined here, implies that an equal increase in the expected rates of return in all sectors will leave the investment allocation unchanged. If h_{ij} is labeled to be the coefficient of the expected rate of return of sector i in θ_j, the share of sector j in total investment, then symmetry implies that $h_{ij} = h_{ji}$. Also, to save degrees of freedom, a pretesting was applied to eliminate the coefficients with low t-ratios. Since the system allocates a given amount of investment among sectors, it fulfills the adding-up restriction, $\sum_j \theta_j = 1$. Therefore, one of the four sectors had to be excluded from the estimation. The omitted sector is services, and the coefficients for the services equation are obtained from the adding-up identity and the other two restrictions.[15] The sectoral equations were estimated simultaneously, using seemingly unrelated regression method. The results are reported in Table 10.

The coefficients with an asterisk (*) were not estimated directly but were obtained by using the above restrictions. Numbers in parentheses are the absolute values

[15]The final form of the system involves 21 free coefficients.

Table 10— Intersectoral investment allocation

Variable	Agriculture	Mining	Manufacturing	Services
Constant	0.182 (5.6)	0.187 (4.9)	0.397 (5.3)	0.234*
R_1e	0.403 (2.3)	. . .	−0.091*	−0.312*
R_2e	. . .	0.359 (4.1)	−0.196*	−0.164*
R_3e	−0.091 (1.3)	−0.196 (2.8)	0.443 (2.4)	−0.156*
R_5e	−0.312*	−0.164*	−0.156*	0.631*
R_3t	. . .	. . .	0.406 (2.0)	−0.406*
I/K_{t-1}	−1.063 (2.5)	−1.723 (3.5)	−1.965 (2.8)	4.751*
i	. . .	. . .	−0.116 (3.6)	0.116*
$\theta_{1,t-1}$	0.373 (2.9)	. . .	. . .	−0.373*
$\theta_{2,t-1}$	. . .	0.507 (4.9)	. . .	−0.507*
D63	. . .	. . .	−0.047 (1.9)	0.047*
D71	. . .	. . .	−0.040 (1.8)	0.040*
D72	. . .	. . .	−0.086 (3.3)	0.086*
D73	. . .	0.054 (2.5)	. . .	−0.054*
D74	. . .	0.041 (1.7)	−0.209 (6.0)	−0.168*
R^2	0.559	0.834	0.776	. . .

Notes: The dependent variable is the sectoral shares in total gross investment; numbers in parentheses are t-values expressed in absolute values; and R^2 is obtained from dynamic simulation. See the glossary of symbols for definitions of variables.

*The coefficient was not estimated directly but was obtained by using the restrictions $h_{ij} = h_{ji}$ and $\sum_j \theta_j = 1$.

of the t-ratios, which are reported only for the coefficients that were estimated directly. The values of R^2 are obtained from the regressions between the observed and fitted values of dynamic simulations conditional on rates of return. Results of dynamic simulations obtained by using the complete model, where rates of return are endogenous, are reported in Chapter 8.

The coefficients of the own expected rates of returns are positive and significant in all sectors. The responses of the first three sectors to their own expected rates are fairly similar, that of mining being the lowest. The most responsive sector to its own rate of return is services. The cross effect between agriculture and mining was not significant and was discarded. The remaining cross effects are all negative, indicating competition among the sectors. The strongest observed substitutions are between agriculture and services and between manufacturing and mining. In all four sectors the own rate of return is more important than individual cross effects.

The transitory component of the rate of return was relevant only in manufacturing. The lagged share of investment was not significant in manufacturing and therefore was omitted. These two results suggest that manufacturing investment had less inertia than the other three sectors. This may reflect technological conditions, but it may also be because the equation for manufacturing has the largest number of dummy variables, which, empirically, can break any appearance of inertia.

The partial effect of a decrease in the rate of interest in the post-1975 period is positive in manufacturing and negative in services. But as a decline in the rate of interest has a positive effect on total investment and thereby on I/K, it also affects sectoral investment shares through the variations in I/K. Total investment is biased toward services in that an increase in I/K is associated with an increase in the share of services at the expense of the other three sectoral shares. Taking this effect into account, the response of services investment to a decline in the interest rate is positive. The lack of direct response of agriculture and mining to changes in the interest rate shows that these sectors benefited from sector-specific credit programs, and therefore were greatly detached from variations in the interest rate.

The effect of import restrictions of 1963 are detected only in manufacturing and services. The dummies for the Allende period were significant mainly in manufacturing and services. The dummy for 1974 was significant in all sectors except agriculture.

The equation for agriculture has the simplest final form. It does not have dummy variables. On the other hand, among the three estimated equations, manufacturing was the most perturbed by exogenous shocks not captured by the explanatory variables of the model other than the dummies.

In order to evaluate the effects of changes in the rates of return on the stocks of capital, simulations of exogenous increases of five percentage points in rates of return, in one sector at a time, are performed.[16] The increase is maintained for the period as a whole. The percentage changes of the sectoral capital stocks after a given number of years are presented in Table 11.

The expansion of the stock of capital in agriculture is made at the expense of manufacturing and services. Considering the relative sizes of the sectoral stocks, the contribution of services is much more important. The expansion of mining capital is at the expense of manufacturing and services. Again, due to the sizes of the sectoral stocks, it is services that provides more resources. The expansion of manufacturing is made at the expense of agriculture and mining. The expansion of services is "financed" by the other three sectors, with manufacturing paying the lowest cost, both in terms of percentage change of the stock and in terms of the amount of resources involved.

The exercise shows that even though investment is responsive to changes in the rate of return, it takes a long time to obtain a substantive change in the capital stocks. Therefore, the slow intersectoral mobility of capital implies that intersectoral differentials in the rates of return can prevail for long periods.

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[16]For instance, if the observed rate is 0.15, it is increased to 0.20.

Table 11—The response of sectoral capital to an increase of five percentage points in a sectoral rate of return

Sector	Year 2	5	10	15
	(percent)			
	Increase in Agricultural Rate of Return			
Agriculture	1.1	4.7	11.0	14.6
Mining	0.0	0.0	0.0	0.0
Manufacturing	−0.2	−0.7	−1.5	−2.5
Services	−0.2	−0.8	−2.1	−3.1
	Increase in Mining Rate of Return			
Agriculture	0.0	0.0	0.0	0.0
Mining	1.2	7.0	15.2	18.9
Manufacturing	−0.4	−1.4	−3.3	−5.3
Services	−0.1	−0.6	−1.8	−2.8
	Increase in Manufacturing Rate of Return			
Agriculture	−0.2	−1.0	−2.4	−3.2
Mining	−0.5	−3.5	−8.0	−10.1
Manufacturing	2.0	4.3	8.4	13.0
Services	−0.3	−0.4	−0.1	0.1
	Increase in Services Rate of Return			
Agriculture	−0.9	−4.2	−8.9	−11.7
Mining	−0.7	−3.7	−7.3	−9.0
Manufacturing	−0.4	−1.3	−2.7	−4.4
Services	0.4	1.7	3.9	5.7

The simulations show that an increase in the own rate of return leads to an increase in the own sectoral capital stock. The response of services is the weakest of all sectors in spite of its having the largest coefficient of expected rate of return. The reason is that this sector accounts for more than one-half of the overall capital stock. Thus, the same amount of additional investment implies a smaller percentage change in services than in other sectors.

The empirical equations are used to simulate the sectoral capital stocks. This is done within the framework of the complete model as described in Chapter 8. The results are summarized in Figures 38 to 41.

Concluding Remarks

The main result of the foregoing discussion is the revealed response in the allocation of investment and, through it, of capital to sectoral profitability as measured by the rate of return. Sectoral investment is responsive to the own rates of return as well as to the rates of the other sectors. The cross effects reveal the existence of competitive relationships among sectors.

Figure 38—Capital stock in agriculture, not including land, 1960-82

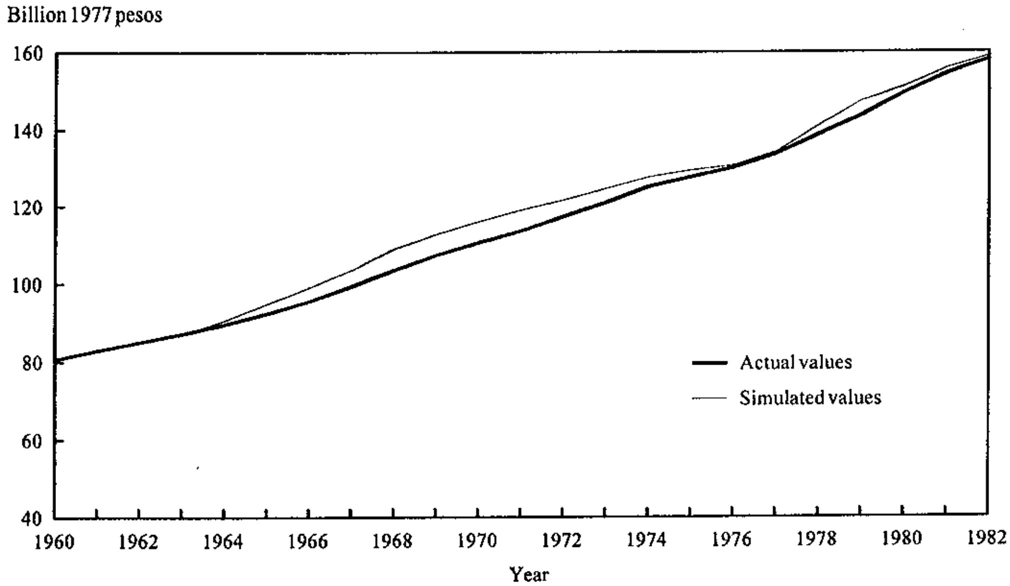


Figure 39—Capital stock in mining, 1960-82

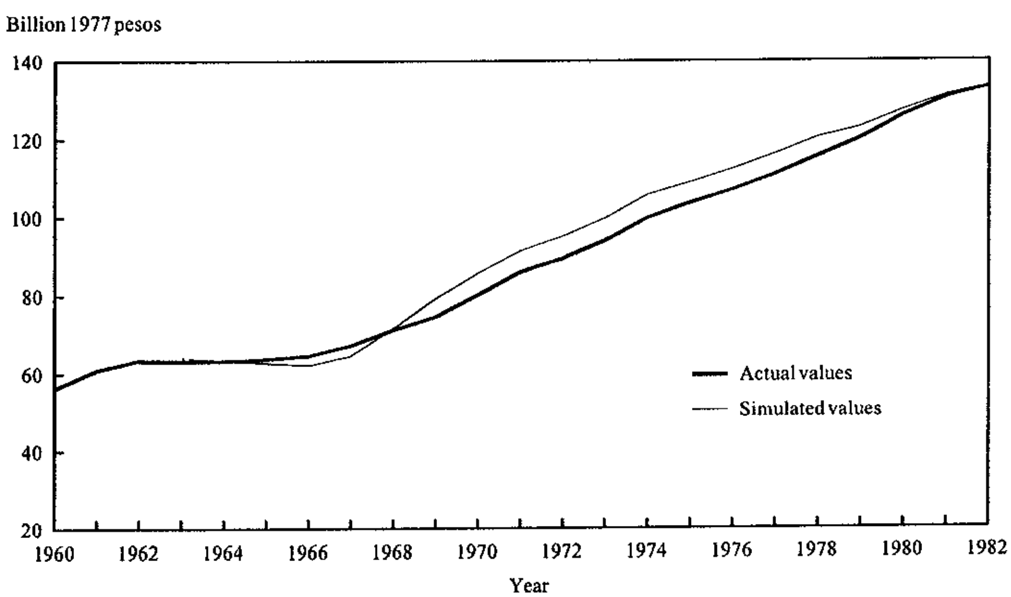


Figure 40—Capital stock in manufacturing, 1960-82

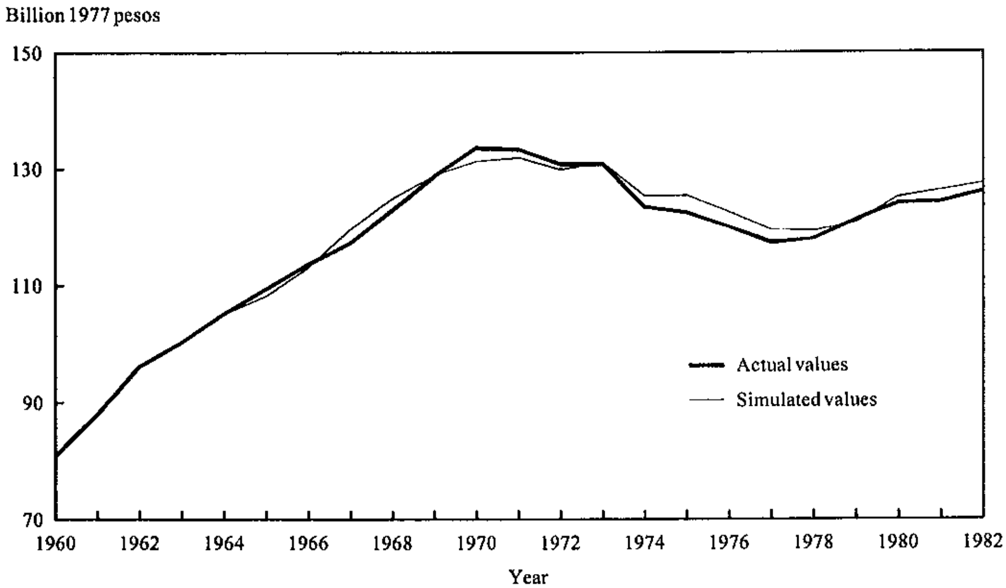
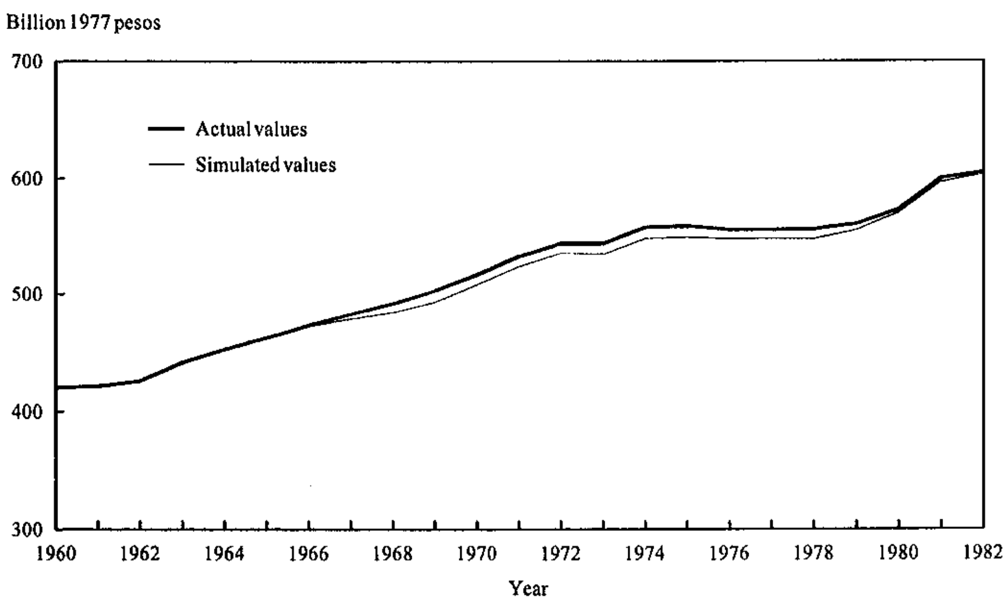


Figure 41—Capital stock in services, 1960-82



The share of services investment is the most responsive to its own rate of return and the share of mining is the least responsive. However, due to the relative sizes of the stocks of capital, the stock of mining has the largest reaction and that of services the smallest.

The allocation of capital in response to market signals is far from being instantaneous and it accumulates with time. For this reason, intersectoral differences in the rates of return can prevail for long periods.

Finally, the parameters of the system reflect the past structure of the economy during a very turbulent period and should be used with care for prediction purposes.

7

PRODUCT PRICES

The sectors under consideration are heterogeneous in that their output consists of three types of goods, importable, exportable, and nontradable. As a result, the sectoral price (at user or retail level) is a weighted average of the prices of these goods. This approach, taken by Mundlak, Cavallo, and Domenech (1989), is introduced in Chapter 3, and here it is shown how it was implemented empirically. For this, equation (17), which serves as a point of departure, is rewritten as

$$P_j = \alpha_0 P_{ej}^{\alpha_1} P_{mj}^{\alpha_2} P_{hj}^{1-\alpha_1-\alpha_2}, \tag{78}$$

where P_{ej} and P_{mj} are the domestic prices of the exportable and importable goods defined in equations (19) and (20).

The purpose of the empirical analysis is to estimate equation (17). However, this is impossible because the price of the nontradable good, P_{hj}, is unobserved; it is simply impossible to identify an important sector of the economy that is completely nontradable. The production of every product has a tradable component, and the various products differ only by their degree of tradability. Still, it is possible to approximate the price equation under some reasonable assumptions. In Mundlak, Cavallo, and Domenech 1989, P_h is expressed as a function of the macro and trade variables. In turn, this function replaces P_h in the sectoral price equation, such as equation (78).

Here, a different approach is taken. It is assumed that the price of the nontradable product is equal to the average cost of its production. Assuming constant returns to scale, the average cost can be viewed as the value of the average cost function. This function is written as a geometric average of the wage rate and the consumption deflator as representing the other prices that should enter the function. Writing this in nominal terms,

$$NP_{hj} = b_0 (NW_j)^{b_1} (PC)^{1-b_1}. \tag{79}$$

Deflating by PC,

$$P_{hj} = b_0 W_j^{b_1}. \tag{80}$$

Combining equations (17) and (80),

$$P_j = c_0 P_{ej}^{\alpha_1} P_{mj}^{\alpha_2} W_j^{b_1(1-\alpha_1-\alpha_2)}, \tag{81}$$

where $c_0 = \alpha_0 b_0^{1-\alpha_1-\alpha_2}$. The sum $\alpha_1 + \alpha_2$ is viewed as a measure of the sector tradability.

The overall price level, as measured by the consumption deflator, reflects the wages, but it also reflects the prices of traded products, and the two may be strongly correlated. In this case, the value of b_1 in the empirical analysis may be close to zero. In fact, the wage appears to be empirically relevant only in manufacturing.

In preliminary work, b_0 was allowed to vary with a measure of the excess demand for the sector output and with labor productivity. This formulation was not supported by the data and was ignored, and the coefficient is taken to be a constant.

Agriculture

Agricultural commodities are in principle largely tradable, and their prices are strongly influenced by the world prices. However, the link between the world and domestic prices can be completely distorted by domestic policies. This indeed was the case during a great part of the study period. The agricultural policies during this period were studied by Hurtado, Muchnik, and Valdés (1990). It appears that all means of interventions were used, depending on the time and the commodities, such as direct price controls, export and import quotas, interventions in the marketing process, and use of a public agency to sustain prices. In fact, it is suggested that until 1974 the prices for the bulk of agricultural output can be seen more as policy variables than as an outcome of market forces. As indicated by Hurtado, Muchnik, and Valdés, the price and trade liberalization process that started in 1974-75 in the economy at large was not immediately applied to agriculture. It was implemented only gradually, and as late as 1977 the government was still intervening in the determination of prices of wheat, sugar beets, and oilseeds. The liberalization in agriculture reached its high point by 1981, but, interestingly, a new wave of direct intervention, although much more moderate than the one that had previously prevailed, started after the study period.

In view of this record it is expected that the role of world prices in influencing domestic prices would vary over the period in accordance with the changing policies. To take this into account, the empirical analysis is conducted by subperiods. This reduces the number of observations considerably; therefore, it is necessary to keep the number of parameters to a minimum. Thus, the exportables and importables are aggregated, using their relative weights in trade, to obtain a price index of the traded component, P_{1T}. This price is deflated by *PC*. The log of the domestic prices is then regressed on the log of the price of tradables. The elasticity of the tradable price was not significantly different from zero for the period 1962-74, nor was it significant for the whole study period of 1962-82. However, the results are different for the period of liberalization, as can be seen in Table 12.

The value of the elasticity changes from 0.25 when computed for 1975-82 to 0.68 for 1977-82. Thus the importance of the tradable price increases as the years of strong

Table 12—Agricultural price equation

Coefficient	1975-82	1976-82	1977-82
Constant	−0.136 (4.3)	−0.128 (4.7)	−0.112 (4.7)
p_{IT}	0.251 (1.9)	0.409 (3.0)	0.677 (3.7)
Adjusted R^2	0.28	0.56	0.72
D.W.	1.08	1.52	1.78

intervention are dropped. Of course, the exercise of eliminating observations cannot go much further due to the small sample size.

What then is the relevant value of the elasticity of the tradable price? This is a legitimate question, considering the fragile nature of the results. The answer is somewhat indirect because of the reference here to a similar study for Argentina for a much longer period, 1913-84, by Mundlak, Cavallo, and Domenech (1989, 41). To be exact, the large sample for Argentina facilitated a more elaborate analysis, which, among other things, allowed the elasticity of the tradable price to vary with the degree of openness. The average value of this elasticity for the period as a whole was 0.67. This provides support to accept the value of 0.68 that is obtained for the six years 1977 through 1982 as a measure of tradability for the period with relatively little intervention.

Mining

Mining is the most tradable sector. The empirical price equation obtained for the period 1962-82 is

$$\underset{}{p_2} = \underset{(2.0)}{-0.020} + \underset{(22.2)}{0.753\,p_{e2}} + \underset{(12.4)}{0.086\,p_{m2}} - \underset{(2.3)}{0.075\,D71} + \underset{(3.2)}{0.111\,D74}; \qquad (82)$$

$R^2 = 0.976$, D.W. = 1.7,

where lowercase letters represent logarithms. As expected, the price of the exportables with a weight of 0.753 dominates the price of the mining sector. Aggregating the exportables and the importables, whose elasticity is 0.086, an elasticity of 0.84 is obtained for the tradable component of mining. This is a measure of tradability of mining. The wage rate was not found significant. Reference to equation (82) shows that the high degree of the sector tradability would make the wage coefficient close to zero. The dummy variables show the effect of the Allende policies in 1971, the structural change related to the trade liberalization, and the overshooting in prices due to the liberalization of prices in 1974.

Manufacturing

As manufacturing was also subject to changing levels of protection, the degree of tradability is expected to change accordingly. The greater the protection, the more insulated the sector, and the smaller the effect of the price of the tradable components on the domestic prices. To capture this effect, the elasticities are allowed to vary with the degree of openness in the economy. This is done by using the ratios of exports and of imports in total manufacturing output. It turned out that only the ratio of exports was empirically relevant. The empirical equation also includes two dummies to account for turbulence during the Allende period and also a dummy for the overshooting in manufacturing prices due to the liberalization of prices in 1974. The estimated equation is

$$p_3 = \underset{(1.9)}{-1.033} + \underset{(3.0)}{1.978}(X_{3et-1}/X_{3t-1})p_{e3} + \underset{(7.4)}{0.195}\,p_{m3}$$

$$+ \underset{(1.9)}{0.097}\,w_3 - \underset{(3.6)}{0.103}\,D72 + \underset{(3.4)}{0.086}\,D74; \qquad (83)$$

$R^2 = 0.91$, D.W. = 1.8.

The elasticity of the exportable price varied between 0.026, when the economy was more closed, and 0.198 at the end of the sample period when the economy was more open. The elasticity of the importable price is constant at 0.2, and the combined elasticity, which is the elasticity of the tradable component, varied correspondingly between 0.22 and 0.39. As expected, the weight of the traded component is much lower than that obtained for agriculture (for the late 1970s) and mining. As distinct from the price equations for agriculture and mining, the estimated final equation for manufacturing also includes the real wage of the sector. To avoid simultaneity bias, the equation was estimated using lagged wage as an instrumental variable for the current wage. The coefficient of the real wage can be used to get an estimate of b_1 in equation (81). Assume an average value of 0.3 for the degree of the sector tradability, then b_1 is nearly 0.097/0.7 = 0.15.

8

SIMULATIONS OF CHANGES IN RELATIVE PRICES

This chapter presents several simulations that examine the response of the economy to various changes in relative prices. The results of such changes are compared with a base run, which is the first topic of discussion. The discussion of the simulation results is presented with reference to the working of the model. As this entails some detailed discussion, the substantive results are summarized at the end of the chapter.

Base Run

The empirical equations are now assembled and the model is used to obtain a numerical solution for the sectoral growth in Chile during 1963-82.[17] The solution is obtained conditional on sectoral product prices; thus it summarizes the production side of the economy. The solution for the endogenous variables is then confronted with the actual data.

To judge the performance of the model a static simulation is obtained where all the lagged variables are considered to be predetermined because they are all known at the time the decisions for the current period are taken, or, more technically, they belong to the current information set. A simple way to summarize the performance of the model is to compute a regression of the actual observations, x, on the simulated values, x^s, $x = a + b x^s$ + error, where x stands for any endogenous variable. The value of R^2 indicates the goodness of fit of the model. The simulation is said to be unbiased when the intercept is zero and the slope is one. The estimates of these coefficients are reported in Table 13. The values in parentheses are the t-ratios for testing individually the hypotheses of $a = 0$ and $b = 1$. The results indicate no drift from the actual values for all the variables under consideration.

The model is applied to derive the response of the economy to changes in the time path of some exogenous variables, referred to as policy simulation, even though some of the contemplated changes are not related to policies. The results of the simulation are summarized by comparing the time paths of the endogenous variables of the base run. However, there is a question of a choice of a base run. For the very same reason that the static simulation is a good representation of the quality of the fit of the model, it cannot be used as a base run for the policy simulations because the lagged values of the endogenous variables change in response to the change in the exogenous variables. As such, the historical values of the endogenous variables are not part of the information set that agents would have had in the simulated environment. Therefore, the pertinent base run requires a solution for the lagged values of the endogenous

[17]The model is solved using the Newton procedure of the SAS/ETS program.

Table 13—Summary results of the static simulation

Sector	Constant	Slope	R^2
		Variable	
		Rate of Return	
Agriculture	0.000 (0.0)	1.006 (0.1)	0.933
Mining	−0.002 (0.3)	1.014 (0.4)	0.982
Manufacturing	0.005 (0.3)	0.987 (0.2)	0.929
Services	0.019 (1.3)	0.864 (1.4)	0.812
		Wages	
Agriculture	557.8 (0.6)	0.949 (0.7)	0.910
Mining	700.4 (0.1)	0.996 (0.1)	0.907
Manufacturing	1,227.8 (0.4)	0.979 (0.3)	0.928
Services	−34.6 (0.0)	1.003 (0.1)	0.957
Total Labor Share	0.0 (1.1)	0.915 (1.1)	0.878
		Value Added	
Agriculture	−513.3 (0.3)	1.023 (0.3)	0.917
Mining	328.3 (0.4)	0.986 (0.4)	0.975
Manufacturing	3,130.3 (0.7)	0.954 (0.7)	0.921
Services	−6,447.1 (0.9)	1.042 (0.9)	0.964
Total	−8,617.2 (0.7)	1.031 (0.8)	0.972
		Investment	
Agriculture	1,252.3 (1.0)	0.821 (1.0)	0.554
Mining	374.5 (0.5)	0.945 (0.5)	0.786
Manufacturing	1,014.7 (1.2)	0.873 (1.2)	0.797
Services	637.8 (0.4)	0.976 (0.4)	0.947

(continued)

Table 13—Continued

Sector	Constant	Slope	R^2
		Variable	
		Capital	
Agriculture	1,368.2 (1.0)	0.989 (1.1)	0.998
Mining	556.0 (0.5)	0.994 (0.5)	0.998
Manufacturing	2,467.0 (0.6)	0.979 (0.6)	0.981
Services	−809.7 (0.2)	1.001 (0.2)	0.999
		Capital Share	
Agriculture	0.018 (0.3)	0.975 (0.3)	0.845
Mining	0.011 (0.2)	0.981 (0.2)	0.895
Manufacturing	0.000 (0.0)	0.996 (0.0)	0.851
		Employment	
Agriculture	0.001 (0.0)	0.999 (0.0)	0.968
Manufacturing	0.057 (1.4)	0.879 (1.5)	0.861
Services	0.082 (1.1)	0.940 (1.1)	0.943
Migration	0.001 (0.2)	0.943 (0.4)	0.692
Nonagricultural labor force	−0.008 (0.5)	1.003 (0.5)	0.999
Unemployment	0.010 (1.0)	0.918 (1.0)	0.872

Note: Numbers in parentheses are *t*-ratios expressed in absolute values.

variables, conditional on the simulated environment, and this is achieved by a dynamic simulation.

The comparison of the dynamic simulation and the data is summarized by the regressions in Table 14. It is seen that most variables are still simulated without a drift. The exceptions are agricultural capital, value added in mining, unemployment, and rate of return in services. The magnitudes of the drifts are not quantitatively important, and the fit of the system is good, as seen in the various plots discussed below.

The Chilean economy in the study period was very turbulent as a result of shocks from the international markets, political instability, and economic policies. Neverthe-

Table 14— The base run: summary of dynamic simulation

Sector	Variable		
	Constant	Slope	R^2
		Rate of Return	
Agriculture	0.001	0.983	0.930
	(0.2)	(0.3)	
Mining	−0.001	1.020	0.982
	(0.3)	(0.6)	
Manufacturing	0.010	0.980	0.935
	(0.6)	(0.3)	
Services	0.031	0.772	0.735
	(1.9)	(2.1)	
		Wages	
Agriculture	365.7	0.964	0.915
	(0.4)	(0.5)	
Mining	137.1	0.992	0.954
	(0.0)	(0.2)	
Manufacturing	928.3	0.972	0.950
	(0.3)	(0.5)	
Services	−1,663.5	1.040	0.941
	(0.6)	(0.7)	
		Value Added	
Agriculture	−854.2	1.052	0.920
	(0.5)	(0.7)	
Mining	1,639.1	0.933	0.973
	(2.1)	(1.9)	
Manufacturing	4,628.6	0.939	0.932
	(1.2)	(1.0)	
Services	−9,523.7	1.049	0.947
	(1.0)	(.08)	
Total	−9,963.9	1.033	0.964
	(.07)	(0.7)	
		Investment	
Agriculture	1,255.8	0.833	0.527
	(1.0)	(0.9)	
Mining	266.4	0.973	0.645
	(0.2)	(0.2)	
Manufacturing	1,276.5	0.847	0.769
	(1.4)	(1.4)	
Services	−218.7	0.997	0.955
	(0.1)	(0.1)	

(continued)

Table 14—Continued

Sector	Variable Constant	Slope	R^2
		Capital	
Agriculture	5,505.3 (2.4)	0.977 (1.2)	0.993
Mining	–927.1 (0.4)	1.039 (1.4)	0.988
Manufacturing	3,716.7 (0.8)	0.975 (0.6)	0.971
Services	9,134.0 (1.1)	0.972 (1.8)	0.995
		Capital Share	
Agriculture	0.022 (0.3)	0.969 (0.3)	0.849
Mining	0.022 (0.6)	0.970 (0.5)	0.935
Manufacturing	–0.025 (0.3)	1.036 (0.2)	0.715
		Employment	
Agriculture	0.027 (1.1)	0.972 (0.7)	0.971
Manufacturing	0.063 (1.6)	0.877 (1.5)	0.861
Services	0.039 (0.5)	0.961 (0.7)	0.943
Migration	0.001 (0.3)	0.881 (0.7)	0.624
Nonagricultural labor force	0.009 (0.6)	0.992 (1.3)	0.999
Unemployment	0.020 (2.3)	0.825 (2.5)	0.883

Note: Numbers in parentheses are *t*-ratios expressed in absolute values.

less, the model is able to reproduce the main changes and turning points in the endogenous variables. It is somewhat remarkable to get such a good fit with very few empirical equations. This achievement is attributed to the recursive structure of the model and its dependence on the state variables at any point in time.

Some of the results of the dynamic simulation are briefly reviewed below.

Value Added

As indicated in Figures 42-45, there are some distinct differences in the cyclical pattern of sectoral outputs. The 1960s were a period of growth in manufacturing and services and, for part of the period, in agriculture. The expansionary policies of the Allende government stimulated growth in manufacturing, and somewhat less in services, until 1972. The decline of agricultural output during 1969-73 reflects the negative effects of the land reform, as discussed in Chapter 4. The level of agricultural output of 1968 is regained only several years later. The abrupt change in policies introduced by the incoming military government produced a strong contraction in manufacturing and services that bottomed out in 1975. From then on, the economy recovered and grew until the recession of 1982.

All these turns are captured well by the model. Manufacturing was the most volatile sector. However, the recovery from the 1975 recession is strongest in services, which is the biggest sector, constituting 54 percent of total output during the study period. The average annual rate of growth in services during 1975-81 was 8.4 percent, as compared with 6.7 percent in manufacturing, 5.7 percent in mining, 3.1 percent in agriculture, and a decline of 0.16 percent in government. To some extent this strong growth reflects a high "income elasticity" of the activities included in the services sector. But for the main part, this growth is an outcome of the trade liberalization and external capital inflows, which are reviewed later in this chapter. The growth rates for the more responsive subsectors are commerce, 12.7 percent; building, 9 percent; and financial activities, 18 percent.

Mining output is influenced largely by external events and therefore shows a somewhat different cyclical pattern, which is also captured accurately. Finally, the fit of total value added as shown in Figure 46 is very close.

Capital

The fit of the model is shown in Figures 38 to 41. The model tends to overestimate the increase in agricultural capital during 1964-68, and it tends to underestimate the

Figure 42—Value added in agriculture, 1960-82

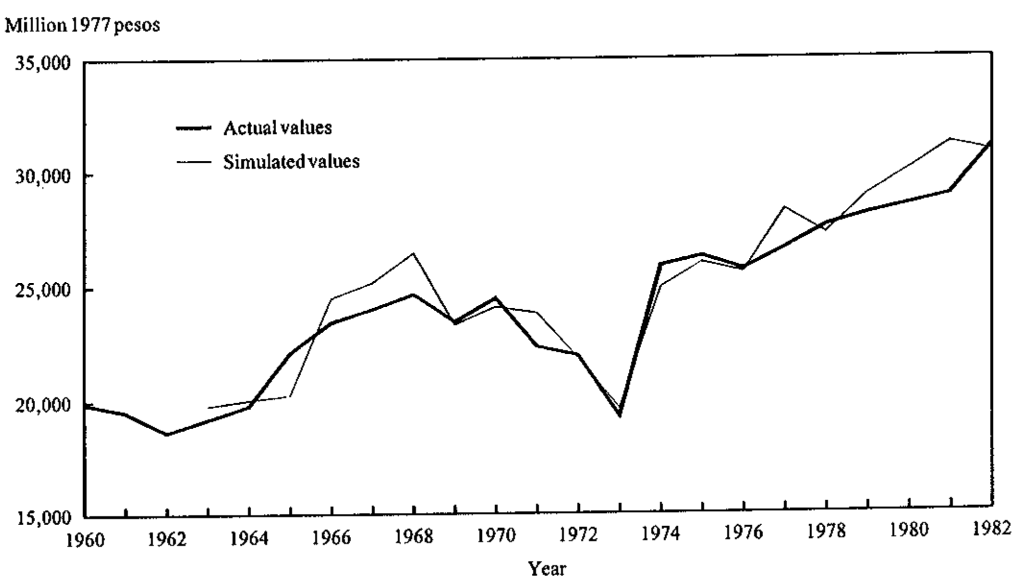


Figure 43—Value added in mining, 1960-82

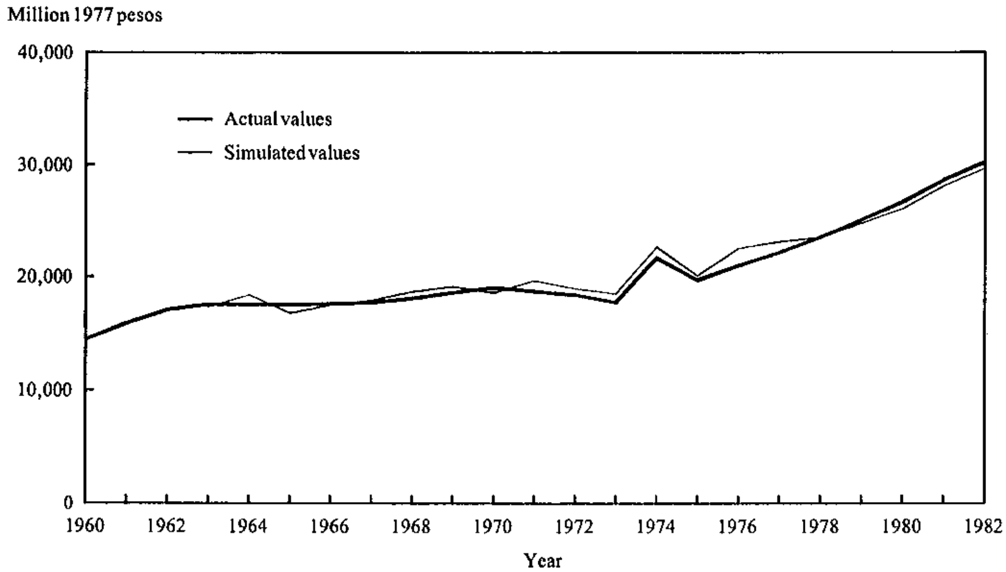


Figure 44—Value added in manufacturing, 1960-82

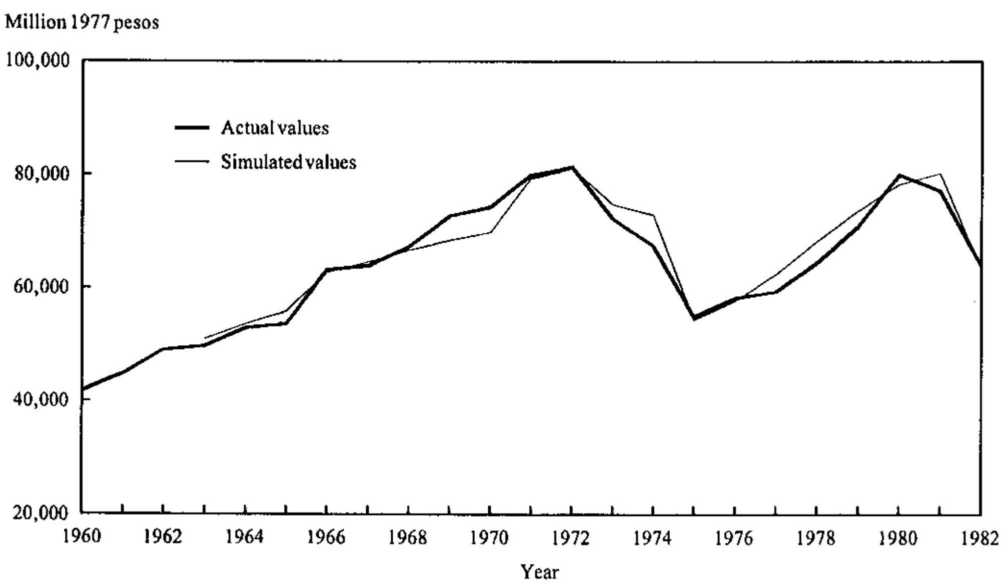


Figure 45—Value added in services, 1960-82

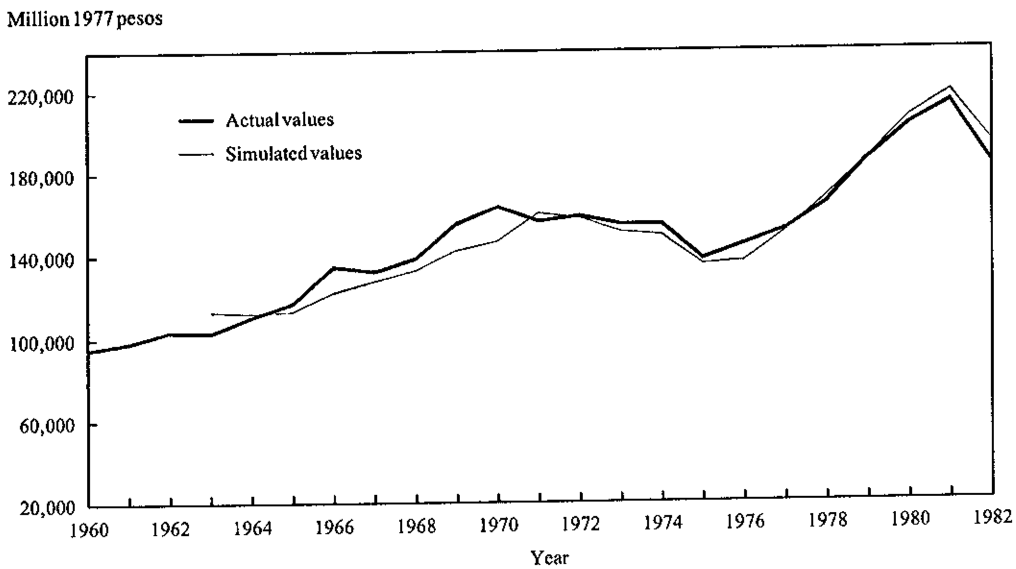
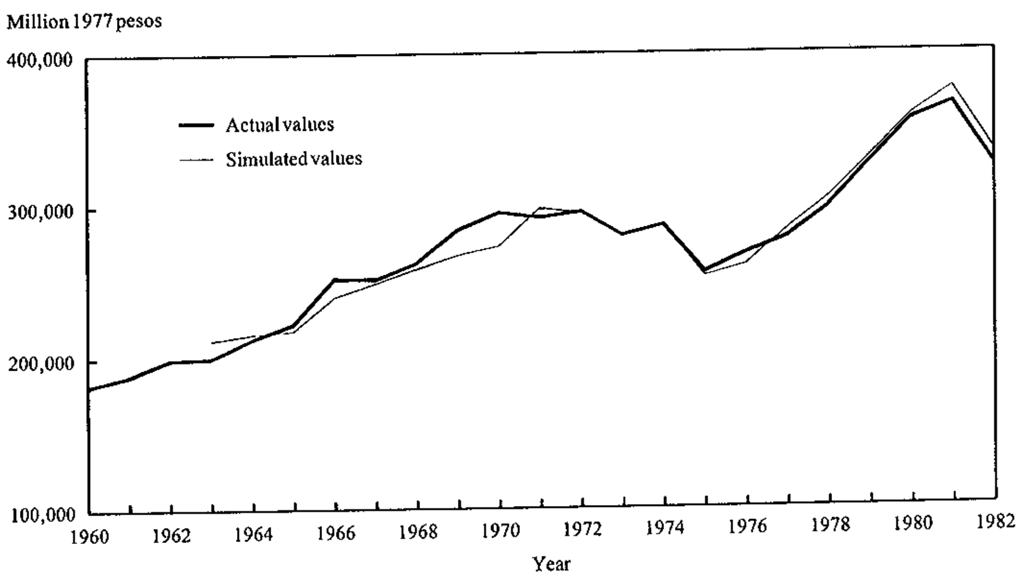


Figure 46—Total value added, 1960-82



investment and capital accumulation during 1972-73. These discrepancies may be the result of the role played by the public sector in agricultural investment, which is not taken into explicit account in the analysis. However, the model tracks very well the main trend in capital accumulation since 1974, when the role of the public sector was less important. It reproduces well the slowdown in capital accumulation in agriculture during 1975-76, and reflects accurately the strong recovery since 1977.

The model describes well the major change in the growth of the capital stock in mining after 1968 as a consequence of the big expansion in investment in copper mines since 1967 and in iron mines since 1972.

Manufacturing capital shows the widest fluctuations. It grew at an annual rate of 3.7 percent during the 1960s, nearly stopped growing during the Allende period, fell at an annual rate of 2.3 percent during 1973-77, and started growing again thereafter. This is the only sector that shows a decline in the stock of capital for some years. The variations in the sectoral capital stocks reflect the variations in the sectoral investment shares as well as those in total investment, which contributed largely to the fall of manufacturing capital during 1974-78.

The capital stock of services is also well described by the model, which traces the steady growth during the 1960s, the stagnation during 1974-78, and the recovery in growth rate during 1979-81. This recovery, which was fueled in great part by the high external capital inflows, had a strong effect on services investment.

Labor

The fit of the model is presented in Figures 12, 18, and 19. The main trends and turning points of employment in manufacturing and services, including the recessions of 1975 and 1982, are well traced by the model (even though capital, wages, and technology are endogenous). The model also captures the slowdown in off-farm migration and its effects on agricultural employment. While employment in manufacturing and services is cyclical, this is not the case in agriculture.

As indicated in Chapter 4, the attempt to derive a labor demand function for mining was not successful; therefore, the employment in mining is considered to be exogenous. During the study period, the employment in mining constituted on average only 3.3 percent of the total labor force.

More important, the model traces very well unemployment in nonagriculture (Figure 23), which is obtained endogenously as the difference between urban supply and demand of labor. As such, it is very sensitive to small errors in the estimates of total labor demand and supply. Unemployment was low during the 1960s and early 1970s, increased radically from 1974, declined somewhat starting in 1977, and jumped up again in 1982.

Policy Simulations—An Overview

Before the more substantive and complex results are presented, it will be useful to review the working of the model in response to a change in relative prices, holding total resources and, to a large extent, technology constant. In the simulation, product prices are changed. This change immediately affects the price of intermediate inputs, and as a result, the price of value added changes in accordance with the input-output relationships. This in turn changes the ratios of wages and rates of return to value-added prices. The changes in the rates of return affect sectoral allocation of investment and thereby the sectoral capital stocks. The changes in the rates of return and investment also affect sectoral productivity.

The change in the sectoral wage-price ratios changes the sectoral employment in nonagriculture and, consequently, the sectoral capital-labor ratios. Unemployment in nonagriculture is determined as the difference between total demand and supply of labor at the prevailing wages. The unemployment affects the nonagricultural wages. In agriculture, the wage rate clears the labor market. The farm and off-farm income differentials and the unemployment conditions affect the off-farm migration and, consequently, the labor supply in agriculture and nonagriculture. The changes in sectoral capital-labor ratios affect the marginal productivity of capital and rates of return and thus the investment in the next period. Although the model is largely recursive, several variables are determined simultaneously.

The simulations of supply response to changes in relative prices are done conditional on the historical values of overall supplies of labor and capital, and thus they capture mainly the substitution effect. The scope for expansion is limited here to changes in unemployment and to the possible response of productivity to prices through the mechanism discussed in Chapter 4. The substitution is generated by intersectoral allocation of resources, but as factor prices are not equal between the various sectors, the reallocation of resources may lead to some expansion or contraction of total output.

Increasing the Agricultural Price

In the first simulation the response of the economy to a 1 percent increase in the agricultural price is examined. The existence of supply response is often questioned on the ground of lack of substitution between agricultural and nonagricultural output. This simulation is addressed to an examination of this question. In a multisector economy there are alternative ways to change sectoral prices. In this experiment the overall price level is kept constant. The increase in the agricultural price is compensated for by a decrease in the price of services. The increase in the agricultural price can be interpreted as an elimination of tax on agriculture, which is often imposed in Latin America as well as in other developing countries. The compensating decline in the price of services, which represents the most nontradable sector, has an element of a real devaluation in the sense that the price ratio of tradable to nontradable increases.

Results

The results are summarized in Table 15 in terms of response elasticities for selected time spans. The response is measured relative to the base run obtained by dynamic simulation.

Prices. Some of the changes in product prices are imposed exogenously and thus describe the simulation. The price of services is reduced by 0.21 percent at the beginning of the period and by 0.35 percent at the end of the period. The price changes affect wages, and therefore, through the price equation, the manufacturing price changes as well. As wages do not appear in the price equation for mining, the price of mining is unchanged in this exercise.

Output decisions depend on value-added prices, which are the product prices net of the cost of intermediate inputs. Thus, the 1.0 percent increase in the agricul-

Table 15—Impact of a 1 percent increase in agricultural price

Sector	1963	1967	1972	1977	1982
			Product Price		
Agriculture	1.000	1.000	1.000	1.000	1.000
Mining	0.000	0.000	0.000	0.000	0.000
Manufacturing	0.000	0.004	0.056	0.076	0.099
Services	−0.209	−0.214	−0.289	−0.315	−0.347
			Value-added Price		
Agriculture	1.726	1.726	1.745	1.753	1.760
Mining	0.045	0.044	0.037	0.034	0.031
Manufacturing	−0.269	−0.257	−0.080	−0.014	0.063
Services	−0.280	−0.288	−0.399	−0.438	−0.486
			Rate of Return		
Agriculture	0.242	0.228	0.207	0.182	0.088
Mining	0.018	−0.012	−0.091	−0.056	−0.063
Manufacturing	−0.148	−0.189	−0.287	−0.134	−0.224
Services	−0.093	−0.101	−0.232	−0.150	−0.250
			Wages		
Agriculture	1.718	2.126	1.730	1.310	0.912
Mining	−0.011	0.170	0.508	0.658	0.809
Manufacturing	−0.015	0.223	0.724	0.936	1.154
Services	−0.014	0.209	0.621	0.807	0.991
Labor Share	0.147	0.373	0.705	0.791	1.099
			Value Added		
Agriculture	0.004	0.576	1.011	1.046	1.180
Mining	0.000	0.064	0.240	0.298	0.363
Manufacturing	−0.032	−0.204	−0.528	−0.484	−0.585
Services	−0.018	−0.050	−0.274	−0.239	−0.375
Total	−0.017	−0.016	−0.205	−0.113	−0.183
			Capital Stock		
Agriculture	0.000	0.331	0.771	0.904	1.072
Mining	0.000	0.184	0.416	0.422	0.470
Manufacturing	0.000	−0.105	−0.230	−0.289	−0.309
Services	0.000	−0.067	−0.171	−0.222	−0.280
			Labor		
Agriculture	0.012	0.658	1.395	1.900	2.270
Mining	0.000	0.064	0.240	0.298	0.363
Manufacturing	−0.093	−0.313	−0.719	−0.722	−0.858
Services	−0.043	−0.020	−0.240	−0.200	−0.359
Total	−0.032	0.106	0.004	0.171	0.118
Unemployment	0.040	−0.112	0.009	−0.111	−0.024

Note: The figures are percentage changes from the base run except those for rates of return and unemployment, which are percentage-point deviations from the base run.

tural price results in about a 1.7 percent increase in its value-added price. The value-added price of services falls between 0.28 percent and 0.49 percent. The fall in the price of services also affects slightly the value-added prices of manufacturing and mining.

Output. There is a substantial increase in agricultural output, capital, and labor that builds up with time. Output increases by 0.58 percent in the fifth year and by 1.01 percent after 10 years. This amounts to a 10-year supply elasticity of unity. Thus, if for example the average price distortion in Chilean agriculture were 20 percent, its correction would imply an increase in sectoral output of approximately 20 percent. The initial response is weaker, and it takes 10 years to reach this level. This response is substantial even though it represents only the substitution effect. It is obtained by allowing the various markets to respond to the changing environment.

The results demonstrate that policy measures biased against agriculture can have important allocation effects in the long run. The difference between short- and long-run response emphasizes the importance of persistence in economic policy. Usually, policymakers cannot wait long for visible results of their own policies and therefore tend to neglect such policies. This exercise shows that such political decisions are costly in terms of sectoral growth.

Where does the agricultural expansion come from? It comes at the expense of manufacturing and services output, while the mining output increases a little. Inasmuch as the declines in the output in manufacturing and services are significant, they are relatively small when compared with the change of agriculture. This simply reflects the relative size of the sectors in question.

The simulation is conducted conditional on overall resources and, to a large extent, on technology; therefore, as indicated above, overall output, properly measured, should be largely unaffected by the price change. Table 15 shows a slight decline, which builds up with time and reaches 0.2 percent after 20 years. This is considered as an index number problem in the sense that the aggregation of sectoral outputs is done in terms of the actual 1977 prices and not in terms of the new simulated prices.

Capital. The allocation of investment flows and the paths of capital stocks depend on the relative rates of return. The rates of return in this study are basically nonwage income divided by the value of the capital stock. As such they approximate the realized value marginal productivity of capital. They depend on the implemented technology, the capital-labor ratio, the value-added price, and the price of the capital stock. In this simulation, the agricultural rate of return increases with respect to the historical levels by about 0.2 percentage points.[18] This increase is caused by the rise in the value-added price and the decline in the sectoral capital-labor ratio.[19] Similar reasons account for the declines in the rates of return in manufacturing and services. The results indicate an expansion of capital in agriculture at the expense of manufacturing and services.

[18]Changes in rates of return contained in Table 15 are percentage-point deviations from the base run and not percentage changes. The average rate of return to capital in agriculture without land was 10.8 percent. The percentage changes in the same agriculture rates of return with respect to the base run were 2.1, 1.7, 1.7, 1.8, and 2.2 percent for the years 1963, 1967, 1972, 1977, and 1982, respectively.

[19]The resulting increase in the price of agricultural capital (not reported in Table 15) was a deterrent to the increase in the rate of return along the whole period.

Labor. The expansion of agricultural output is achieved largely by the expansion in employment, which grows by 0.66 and 1.4 percent in 5 and 10 years, respectively. The corresponding changes in the capital stock are 0.33 and 0.77 percent, respectively. Hence, agriculture becomes more labor-intensive, and on the whole, nonagriculture becomes more capital-intensive. The declining sectors that provide the labor and capital are manufacturing and services.

It appears that labor is more mobile than capital because capital is more sector-specific. Consequently, capital is allocated across sectors mainly, though not only, through the allocation of investment, and this takes time to accumulate. It should be recalled that this simulation is conducted conditional on the existing overall capital stock in the economy. If an expansion of total investment were allowed for, the adjustment in the capital stock would have been faster. This will be discussed further in Chapter 9.

The rise in agricultural price increases the demand for labor in agriculture, and since the short-run labor supply is fairly inelastic, the agricultural wages rise by about 2 percent during the first 10 years. This rise produces a jump in the wage differential between agriculture and nonagriculture, causing a reduction in the rate of off-farm migration and an increase in the agricultural labor force relative to the base run.

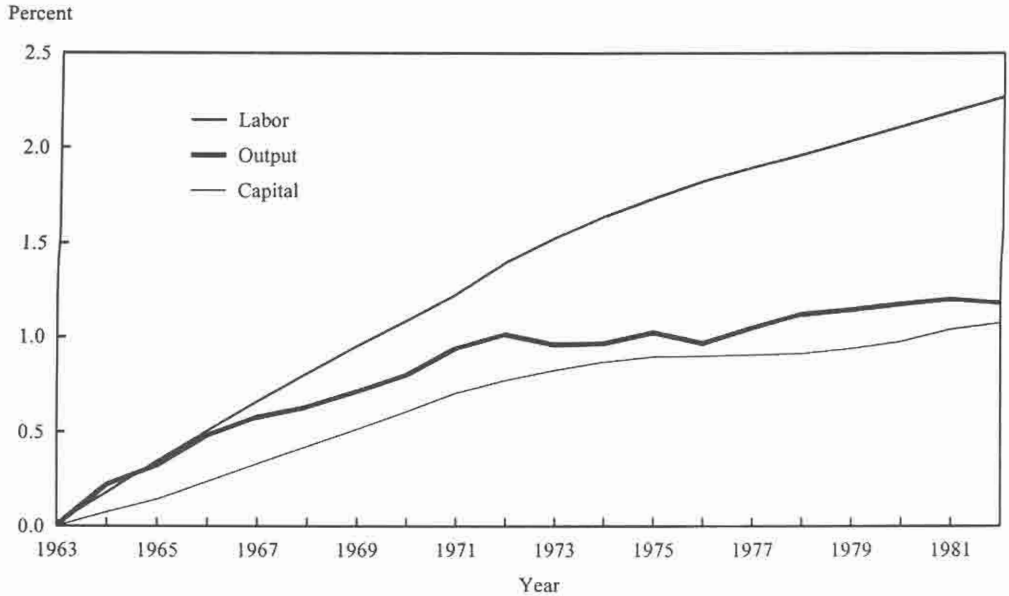
The reduction in the off-farm migration reduces the labor supply in nonagriculture relative to the base run. This reduction should have reduced unemployment, but this is hardly the case. The reason for this weak response of unemployment is the outcome of the strong response of wages to unemployment. Thus, as soon as unemployment declines, wages rise and cause a reduction in the quantity demanded of labor. The increase in total employment would have been larger had wages not been so responsive to unemployment. This result reflects the behavior of the labor market in Chile during the period studied—a subject discussed in Chapter 5. Finally, it is noted that the price change initially caused a considerable effect on the wage differential between agriculture and nonagriculture, but eventually, due to factor mobility, the final increase in wages was similar in all sectors.

Income Distribution. The effect of the price change on labor and capital income is measured in terms of the share of total wages to total income. Table 15 shows that the labor share rises considerably with time, reflecting the rise in wages discussed above. The rise in agricultural wages favored mostly agricultural workers, who are the lowest-paid workers in the economy. This result shows that policies biased against agriculture, motivated by the intention of helping workers and low-income people, may lead to opposite results.

Policy Implications

The supply response of agriculture is summarized in Figure 47. The response builds up gradually rather than being observed immediately, and this is likely to be the reason some policymakers do not believe in its existence. Thereby they commit several errors. First, their view of no supply response is based on variations in actual prices, which in part are perceived by producers as being transitory and thus not justifying a response. The present experiment deals only with price changes that can be perceived as permanent. Therefore, when dealing with policy one should consider only price changes of a permanent nature. Second, the slow response is related to the behavior of labor and capital, whose sectoral allocation is based on intertemporal considerations and whose adjustment is subject to costs. In general, policies that tax agriculture are not transitory;

Figure 47—Impact of a 1 percent increase in agricultural price, 1963-82



they are long-lasting and, therefore, if based on the wrong view as to how the economy is working, they cause a distortion that builds up over time. Finally, the results, whether one likes them or not, represent the working of the system, and the message, when considering alternatives, is that there are no shortcuts.

There are some other negative effects to taxing agriculture that are not taken into account in this exercise. The increase in the agricultural price causes a decline in the off-farm migration to the cities. To a large extent, such migration contributes to unemployment in the short run, and to city congestion and pressure on the public services. Higher labor demand in agriculture, which follows the elimination of its taxation, reduces these effects and also saves the costs that accompany migration.

Increasing Manufacturing Price

In contrast to the common disbelief in aggregate supply response in agriculture, the common view is that the supply response in manufacturing is substantial. This view underlay, at least implicitly, the promotion of the development strategy of import substitution in Latin American and other less-developed countries. This policy led to high import barriers that resulted in high domestic prices for manufactured goods.

The response of the economy to a 1 percent increase in the price of manufacturing while holding *PC* (National Accounts consumption deflator) and the prices of agriculture and mining constant is examined in this simulation.[20] The services price is

[20]The price of manufacturing is introduced exogenously, and the price equation for manufacturing is eliminated in this simulation.

adjusted in order to keep the *PC* at the historical level.[21] This simulation may be viewed as somewhat unrealistic in that it assumes a considerable change in the price ratio of manufacturing to services. The fundamental policy question is how to implement such a change in the price ratio. The usual protection of manufacturing or, more generally, import-substituting industries, causes a rise in the price of nontradables and thereby in the prices of the other sectors according to their degree of tradability. Consequently, the desired protection level is not achieved, and the level of protection is further increased, leading to an additional appreciation of the domestic currency. To prevent this outcome, the protection should be accompanied by a contraction policy to prevent the increase in the overall price level. It is in this context that the following results are pertinent. The results are summarized in Table 16.

Results

Prices. The price specification of the simulation is described in the first block of Table 16. The decline in the price of services is larger than the increase in the price of manufacturing because the weight of services in consumption, and therefore in *PC*, is smaller than that of manufacturing. As a result, the ratio of manufacturing price to that of services increases by 2.4 percent. The corresponding changes in the prices of value added are more pronounced; a rise of 3.4 percent for manufacturing and a decline of 2.1 percent for services. The value-added prices of agriculture and mining, whose product prices remain constant, are also affected because of the change in the prices of the intermediate inputs. The change is positive for agriculture and negative for mining, but in both cases it is relatively small.

Capital. The rates of return respond strongly to the increase in value-added price. In manufacturing, the rate increases by about 1.9 percentage points until 1967. This amounts to a 6.5 percent increase over the base run. The relative increase is still 8.9 percent in 1972 and 7.1 percent in 1982. In services, the rate of return declines by about 0.7 percentage points in 1967, or 4.4 percent compared with the base run, whereas the change in the rates in mining (negative) and agriculture (positive) are small.

The change in the rates of return has a considerable effect on the composition of investment, leading to a high growth in the capital stock in manufacturing, 1.3 percent at the end of 1967 and 3.5 percent at the end of 1982. The source for this increase is mining and services. The decline in mining indicates a strong cross effect with manufacturing in the investment function. The cross effect between agriculture and manufacturing is weak, there is none with mining, and it is negative and strong with services. As a result, the agricultural capital stock increases moderately.

Labor. The relative response of employment in manufacturing is stronger than that of capital. In 10 years the employment increases by 4.7 percent, as compared with an increase of 2.8 percent in the capital stock, leading to a decline in the capital-labor ratio in manufacturing. A similar result was obtained for agriculture in the first simulation and indicates that the price response of employment is stronger than that of capital. This is attributed to the speed of adjustment of labor and capital and indicates that the marginal activities in agriculture and manufacturing are labor-intensive. This result may indicate a fuller utilization of the existing capital during the

[21] Also, the real wage in the government and real prices of government are kept at their historical levels, and the transitory component of manufacturing rates of return is exogenous.

Table 16—Impact of a 1 percent increase in manufacturing price

Sector	1963	1967	1972	1977	1982
			Product Price		
Agriculture	0.000	0.000	0.000	0.000	0.000
Mining	0.000	0.000	0.000	0.000	0.000
Manufacturing	1.000	1.000	1.000	1.000	1.000
Services	–1.436	–1.436	–1.436	–1.436	–1.436
			Value-added Price		
Agriculture	0.320	0.320	0.320	0.320	0.320
Mining	–0.133	–0.133	–0.133	–0.133	–0.133
Manufacturing	3.373	3.373	3.373	3.373	3.373
Services	–2.142	–2.142	–2.142	–2.142	–2.142
			Rate of Return		
Agriculture	0.051	0.041	0.052	0.034	0.011
Mining	–0.066	–0.086	–0.080	–0.038	–0.004
Manufacturing	1.932	1.865	1.665	0.732	1.315
Services	–0.731	–0.710	–0.870	–0.501	–0.720
			Wages		
Agriculture	0.314	0.460	0.490	0.893	0.782
Mining	–0.009	0.022	0.520	0.612	0.402
Manufacturing	–0.013	0.028	0.722	0.883	0.592
Services	–0.012	0.028	0.637	0.753	0.495
Labor Share	0.222	0.180	0.635	0.782	1.076
			Value Added		
Agriculture	0.003	0.204	0.223	0.218	0.273
Mining	0.000	–0.289	–1.261	–1.661	–1.607
Manufacturing	0.305	2.111	4.010	3.927	4.321
Services	–2.130	–1.014	–1.533	–1.115	–1.443
Total	–0.034	–0.023	0.248	0.140	–0.063
			Capital Stock		
Agriculture	0.000	0.311	0.480	0.501	0.649
Mining	0.000	–0.891	–2.131	–2.234	–2.130
Manufacturing	0.000	1.332	2.810	3.405	3.510
Services	0.000	–0.265	–0.455	–0.490	–0.593
			Labor		
Agriculture	0.010	0.175	0.116	–0.167	–0.146
Mining	0.000	–0.289	–1.261	–1.661	–1.607
Manufacturing	1.014	2.834	4.660	4.650	5.155
Services	–0.454	–0.970	–1.530	–1.410	–1.502
Total	–0.027	0.045	0.096	–0.079	–0.127
Unemployment	0.034	–0.051	–0.112	0.076	0.116

Note: The figures are percentage changes from the base run except those for rates of return and unemployment, which are percentage-point deviations from the base run.

period of transition; thus it does not necessarily imply that the new techniques are on average labor-intensive.

During the sample period, actual sectoral employment (in thousands) varied within the following ranges: mining, 75-100; manufacturing, 400-600; and services, 1,000-1,300. The labor needed for the expansion of manufacturing comes largely from services, where at the end of the period employment declines by 1.5 percent. There is also a considerable decline in employment in mining, but because the employment there is small, its contribution to the employment in manufacturing is relatively unimportant.

The simulation illustrates that industrialization need not take place at the expense of agriculture, as is assumed in traditional development models. The results indeed reflect the assumptions of the simulation, but they nevertheless depend on the historical state variables and the parameters that are assumed to describe the Chilean economy.

The most striking result is that in spite of the expansion in the demand for labor in nonagriculture, which exceeds the small increase in supply, unemployment changes only a little. This is an outcome of the strong response of wages to changes in unemployment, a subject discussed in Chapter 5. Wages in all sectors, including services whose demand declines, respond positively to the increase in the labor demand, leaving total employment almost unchanged.

The demand for labor in agriculture increases in direct response to the increase in the value-added price, and indirectly through the response of the production function to the change in the rate of return. As the labor supply in agriculture is inelastic in the short run, the increase in demand causes an increase in wages at a rate similar to that of nonagriculture. As a result, there is only a small change in the off-farm migration and in the sectoral labor supply.

Income Distribution. The rise in wages in all sectors of the economy results in an increase of the ratio of factor shares, in favor of labor, from 0.2 percent in the first year to 1.1 percent in the final year.

Output. The simulation indicates a very strong supply response in the economy. At the end of the period, a 1 percent increase in the price of manufacturing causes an increase of 4.3 percent in manufacturing output and a decline of 1.6 and 1.4 percent in mining and services output, respectively. The cross effect on agricultural output, though modest, is positive. Total output is affected very little. As in the previous case, this modest response in total output is a direct result of holding constant levels of investment and growth of total labor force and thereby preventing expansion effects.

Conclusions and Implications. There is a strong response to the change in the price ratio of manufacturing to services. In relative terms it is stronger than that observed for agriculture. As before, the response takes time to build up. The simulation shows that industrialization need not take place at the expense of agriculture. The labor and capital for the development of manufacturing can be found in nonagricultural sectors.

The Real Exchange Rate

The real exchange rate is endogenously determined by macro and trade policies and by other variables affecting the domestic price level, such as institutional constraints. In the long run it is also affected by technical change in the production of tradable and nontradable goods and by changes in tastes and in sectoral composition that affect the demand for these two goods.

The following section is a review of major changes of macro policies and their association with changes in the real exchange rate that will help to place the results of the simulation in an appropriate perspective.

Background Review

The real exchange rate is measured here as the nominal rate times an index of U.S. wholesale prices, taken as a measure of foreign prices, divided by the consumption price deflator *PC*. This measure differs from the one used in the base run, where the actual historical foreign prices are used. The past values of the real exchange rate are presented in Table 17 and in Figure 48. Clearly, the rate fluctuated widely, between 77 and 131 in the study period, and increased to a level of 147 in 1985.

The pertinent macro events and policies during the 1960s are discussed by Ffrench-Davis (1973), Behrman (1977), and Corbo (1974). Those of the 1970s are discussed by Barandarián (1974), Corbo (1983), Ramos (1984), Harberger (1985), Edwards and Cox (1987), de la Cuadra and Hachette (1991). The main events are summarized below.

The developments in the early 1960s were influenced by the policies that the Alessandri administration had put in place in 1958-59. The policies included devaluations in December 1958 and January 1959 that depreciated the peso by 25.5 percent, a fixed nominal exchange rate, and a substantial reduction in trade restrictions. The fixing of the nominal exchange rate reduced the inflation rate from 39 percent in 1959 to 8 percent in 1961. However, with the nominal rate being fixed, the inflation caused the real exchange rate to decline during this period. Expenditures were not sufficiently restrained; in real terms they were 8.8 percent higher in 1962 than in 1960. Private consumption increased by 10 percent in the two years. Public consumption

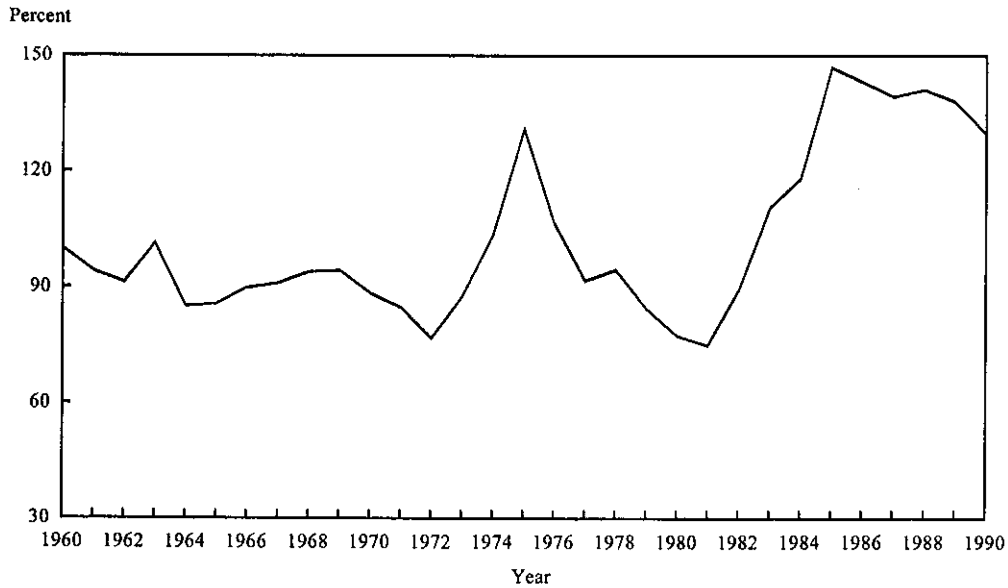
Table 17— Real exchange rate, 1960-90

Year	Real Exchange Rate	Year	Real Exchange Rate	Year	Real Exchange Rate
1960	100.00	1971	84.63	1981	74.90
1961	94.05	1972	76.70	1982	89.19
1962	91.06	1973	87.71	1983	110.39
1963	101.25	1974	103.37	1984	118.02
1964	85.06	1975	130.67	1985	146.86
1965	85.62	1976	106.58	1986	143.08
1966	89.94	1977	91.66	1987	139.30
1967	90.99	1978	94.34	1988	141.19
1968	93.88	1979	84.44	1989	137.92
1969	94.09	1980	77.31	1990	129.54
1970	88.50				

Sources: Authors' computations based on data from Banco Central de Chile, *Indicadores económicos y sociales de Chile, 1960-1988* (Santiago: Banco Central de Chile, 1989); and Banco Central de Chile, *Cuentas nacionales de Chile, 1960-1982* (Santiago: Banco Central de Chile, 1983).

Note: The real exchange rate is computed as the nominal exchange rate times an index of U.S. wholesale prices deflated by the consumption price deflator.

Figure 48—Real exchange rate, 1960-90



increased as well and raised the fiscal deficit gradually from 2.6 percent of GDP in 1959 to 5.6 percent in 1962. This deficit was financed with external credit and by drawing on the foreign exchange reserves, which were also suffering from the deteriorating terms of trade at the time.

The lack of control of the fiscal deficit, combined with the low price of copper, led to an acute foreign exchange crisis at the end of 1961. This crisis initially prompted quantitative restrictions to imports, but the loss of foreign reserves continued and the government was forced to devalue. In the last three months of 1962, the currency, using the commercial rate, was devalued by 47 percent, and this was followed by another devaluation of 30 percent in 1963, leading to an increase of the real exchange rate in 1963.

The Frei administration (September 1964-September 1970) introduced some important changes in the economic policy: it replaced the fixed exchange rate with a sliding peg. The fiscal deficit was steadily reduced during five of the six years of this administration.[22] The quantitative restrictions to trade, especially between 1968 and 1970, were reduced as well. All these contributed to an increase in the real exchange rate in the first five years. The increase in the deficit in the last year of the Frei administration resulted in a decline of the real exchange rate in that year.

The Allende government (November 1970-September 1973) marked a major change in policies, which destabilized the economy for some time. From its outset, expenditures were increased considerably, and the fiscal deficit jumped from 2.7 percent of GDP in 1970 to 10.7 percent in 1971, 13 percent in 1972, and 24 percent in

[22]The fiscal deficit increased mildly from 3.9 percent of GDP in 1964 to 4.1 percent in 1965 but was lowered gradually thereafter to 0.4 percent in 1969 before increasing again to 2.7 percent in 1970.

1973. This expansionary policy caused a heavy loss of reserves, which was reinforced by the declining copper prices in 1971 and 1972. Thus, in spite of the high level of reserves at the beginning of this administration, the country suffered from lack of foreign exchange in 1973. To overcome this shortage, devaluations at increasing rates were implemented together with an intensification of controls of all sorts. The currency was devalued by 104 percent between September 1970 and December 1972 and by 240 percent between January and September of 1973. The foreign exchange crisis was amplified by the decline in production by 5.5 percent in 1973, largely due to strikes, general uncertainty about property rights, and disorders in production.

The incoming military regime in September 1973 introduced fundamental changes in the economic policies aiming at freeing the economy from controls. It reduced quantitative controls on imports, liberalized the badly distorted price system, and privatized government-owned firms. It abolished the land-reform law, distributed the expropriated land—which in 1973 was collectively held—to the peasants, freed the land market, and more. A large devaluation was implemented, and the nominal exchange rate at the end of 1973 was 303 percent higher than that in September of the same year. The rate would have probably increased even more if it were not for the recovery of the copper price in 1973. These measures resulted in a drastic increase of prices—87 percent in the first month of the new regime.[23] Nominal wages were not adjusted accordingly and real wages declined. The acceleration of inflation during 1973 and the reduction in real wages caused a fall of 6.2 percent in real expenditure of the private sector. This decline in expenditure contributed to the recovery of the real exchange rate in that year.

The nominal devaluations of 1974 and the world inflation, triggered by the shock of oil prices, caused tradable prices to rise. Import prices increased more than export prices, and as a result, a deterioration of nearly 5 percent of GDP in the terms of trade was observed. Real private consumption fell by 18 percent in one year. At the same time, the fiscal deficit was reduced from 24.7 percent of GDP in 1973 to 10.5 percent in 1974, and the annual growth of domestic credit fell from an annual growth rate of 714 percent to 315 percent. This decline in real expenditure and the deterioration in the terms of trade were followed by an increase in the real exchange rate.

The large deterioration in the terms of trade caused by a reduction in the copper price by one-half, on top of the increase in oil prices and the continuation of inflation, prompted more drastic anti-inflation policies at the beginning of 1975.[24] The fiscal deficit was reduced from 10.6 percent of GDP in 1974 to only 2.6 percent in 1975. This reduction was complemented by a large devaluation: the average nominal rate of exchange in 1975 was 490 percent higher than that of 1974. These policies resulted in a fall of 13 percent in overall real expenditure in that year, leading to an increase in unemployment in 1974-75 and a drastic fall in real wages, which in turn contrib-

[23]These annual inflation figures are derived from the *PC* series, which is unavailable on a monthly basis. Therefore, monthly inflation figures are based on the data published by the National Institute of Statistics (INE). The INE series reports considerably lower values for the annual inflation rates in 1973 and 1974 than those derived from the *PC*.

[24]The rate of inflation, December to December, as computed by the National Institute of Statistics, was 22.1 percent in 1971, 163 percent in 1972, 508 percent in 1973, 375 percent in 1974, 340 percent in 1975, and 174 percent in 1976.

uted to further decline in expenditures. To overcome this contraction, a modest revaluation was implemented in the middle of 1976.

The trade liberalization that began in 1974 continued with a gradual reduction of tariffs, and by 1979 all tariffs except for cars were fixed at 10 percent. Initially, the effect of the trade liberalization on the real exchange rate was not important, because at the time the economy was in a deep recession and a large part of the tariffs was redundant (Coeymans 1978; de la Cuadra and Hachette 1991). However, the redundancy diminished in subsequent years, and the liberalization started to have its effect. The recovery of the economy, beginning in 1976 and continuing to 1981, was accompanied by an increase of external credit and debt, beginning in 1977 and gaining impetus from 1979 on. The flow of external credit prevented a real devaluation that could be expected to accompany tariff reform. The augmented foreign credit caused a rise in the prices of nontradables and thus caused a real appreciation of the domestic currency. During this period real expenditures increased and the current account deteriorated, but the balance of payments showed a surplus due to the external credits. However, the fiscal deficit remained low and even showed small surpluses in 1979-81.

The external capital inflow, especially from 1979 on, was a major event that affected the economy for some time. Several explanations are given for the inflow. On the demand side, (1) the fixing of the exchange rate and the inertia of inflation, caused in part by indexation of labor contracts, implied a lower expected cost of external borrowing; (2) expectations of high future growth contributed to the expansion of private real expenditure; and (3) the liberalization of internal financial markets implemented since 1975 raised domestic interest rates (McKinnon effect), which made lending to the Chilean economy very attractive. On the supply side, (1) the foreign banks overestimated the growth potential of the Chilean economy; (2) low international real rates of interest prevailed up to 1980; and (3) the liberalization of the capital account in mid-1979 eliminated the quantitative constraints to external credits.

The rise in the international interest rates in 1981 increased the cost of servicing the growing foreign debt. It also had a negative effect on the expected international level of activity and, consequently, on the price of copper. The external shocks were considered to be transitory and the response to them was delayed. Thus, in 1981 the deficit in the current account reached a record, mainly due to a further increase in imports and to higher interest charges on the accumulated debt.[25] However, the copper price continued falling in 1982 by an additional 16.7 percent, whereas the international interest rates remained high. These external events plus bankruptcies in some domestic financial institutions precipitated a sudden cut in external capital inflows in 1982. This cut was supplemented by an anticipation of a devaluation, which was eventually implemented together with a mild and short-lived increase in tariffs on imports. The reduction in the external capital flow contributed to the serious deterioration of the economy. The nominal exchange rate, which was fixed in July 1979 at 39.00 pesos per U.S. dollar, was raised to 43.02 pesos in June 1982, and climbed gradually to 72.39 pesos in December 1982.

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[25]Cost of servicing the external debt, in millions of U.S. dollars, increased from 930 in 1980 to 1,428 in 1981 to 2,050 in 1982. The last figure is approximately 11 percent of GDP.

In the period from 1982 (the year of the crisis) to 1987, access to the voluntary credit market was restricted by foreign suppliers, and the macro policy was designed in agreement with the International Monetary Fund and the World Bank, a condition considered to be important for a successful renegotiation of the foreign debt. Beginning in 1983 (except for a short period in 1984), the macro policy was directed toward a reduction of the deficit in the current account through a restraint in government expenditures and a foreign debt conversion scheme that implied subsidy to private savings. Investment responded slowly to this change, due to the high idle stock of capital that still existed at the time, and this helped the success of the policy in restraining overall real expenditures. The prevailing high unemployment had a suppressing effect on real wages and therefore on domestic prices. At the same time, the peso was continuously devalued, and with the price level under control, the real exchange rate was increasing. The situation started to change in 1988 with a gradual recovery of access to the voluntary credit market and an increase of the rate of growth of private consumption and investment, leading to an inflow of capital. These events caused some decline in the real exchange rate, which nevertheless remained at high historical levels, as can be seen in Figure 48.

A Parametric Change in the Real Exchange Rate

The simulation evaluates the effect of a 1 percent change in the real exchange rate. The change is imposed on the model without discussing the underlying policies needed to achieve such a real devaluation. The change in the real exchange rate affects sectoral prices through the sectoral price equations discussed in Chapter 7.[26] Such price changes are normalized by *PC*, so that the simulation can be evaluated as if *PC* were held constant. The remaining assumptions are similar to those of the previous exercises.[27] The results of the simulation are summarized in Table 18.

Prices. The response of sectoral prices to the change in the real exchange rate depends on two important attributes: degree of tradability and degree of openness. The price of mining, the most tradable sector, increases by 0.8 percent and that of agriculture by 0.7 percent. The price equations for these two products were not responsive to the degree of openness. This is not the case for the response of manufacturing price, which increases with the degree of openness from 0.2 percent in the first year to 0.4 percent at the end of the period. Manufacturing is less tradable than mining and agriculture; therefore, its price is less responsive to the change in the real exchange rate. The change in the real price of services needed to keep the *PC* constant is lower than that observed in the previous simulation.

The cost structure of each sector and the changes in sectoral product prices determine the changes in the value-added prices. The value-added prices of agriculture and mining increase more than the price of manufacturing, but the relative differences diminish with time.

Inputs. The changes in value-added prices have an immediate effect on the rates of return; the rates in the more tradable sectors increase, and those in services decline. The percentage changes of the rates in the first year are 1.5 for agriculture, 2.7 for

[26]In the case of agriculture, the equation is that of the period 1977-82 (see Table 12).

[27]Total labor force, investment, *PEAK*, real wage, and real price of government are held at their historical levels. The transitory component of manufacturing rates of return and *FEC* are also exogenous here.

Table 18— Impact of a 1 percent increase in the real exchange rate

Sector	1963	1967	1972	1977	1982
			Product Price		
Agriculture	0.677	0.677	0.677	0.677	0.677
Mining	0.838	0.838	0.838	0.838	0.838
Manufacturing	0.226	0.242	0.265	0.368	0.396
Services	−0.469	−0.494	−0.524	−0.666	−0.707
			Value-added Price		
Agriculture	1.230	1.235	1.244	1.277	1.286
Mining	1.422	1.420	1.417	1.403	1.399
Manufacturing	0.377	0.433	0.513	0.865	0.960
Services	−0.683	−0.720	−0.765	−0.975	−1.035
			Rate of Return		
Agriculture	0.174	0.163	0.159	0.146	0.072
Mining	0.483	0.476	0.280	0.174	0.215
Manufacturing	0.213	0.182	0.147	0.152	0.291
Services	−0.233	−0.223	−0.294	−0.220	−0.356
			Wages		
Agriculture	1.224	1.521	1.190	0.879	0.487
Mining	−0.008	0.057	0.248	0.344	0.415
Manufacturing	−0.012	0.072	0.353	0.486	0.591
Services	−0.011	0.070	0.304	0.421	0.507
Labor share	0.073	0.223	0.504	0.561	0.888
			Value Added		
Agriculture	0.003	0.455	0.828	0.863	0.994
Mining	0.000	0.208	0.750	0.841	0.904
Manufacturing	0.049	0.097	0.165	0.203	0.488
Services	−0.048	−0.287	−0.568	−0.532	−0.783
Total	−0.012	−0.070	−0.147	−0.096	−0.168
			Capital Stock		
Agriculture	0.000	0.323	0.654	0.732	0.878
Mining	0.000	0.595	1.254	1.197	1.186
Manufacturing	0.000	0.037	0.083	0.120	0.328
Services	0.000	−0.157	−0.359	−0.433	−0.533
			Labor		
Agriculture	0.009	0.520	1.152	1.594	1.985
Mining	0.000	0.208	0.750	0.841	0.904
Manufacturing	0.142	0.183	0.195	0.297	0.562
Services	−0.116	−0.239	−0.522	−0.531	−0.736
Total	−0.025	0.054	0.007	0.117	0.076
Unemployment	0.031	−0.052	0.003	−0.065	0.005

Note: The figures are percentage changes from the base run except those for rates of return and unemployment, which are percentage-point deviations from the base run.

mining, 0.6 for manufacturing, and –1.3 for services. The allocation of investment responds to these changes in the rates of return, and this is reflected in the sectoral growth of the capital stocks. In 10 years, capital grows by 0.65 percent in agriculture, 1.25 percent in mining, and 0.08 percent in manufacturing, whereas capital in services declines by 0.36 percent.

The immediate response in wages was strongest in agriculture, 1.2 percent in the first year and over 1.5 percent in the subsequent four years. This reflects the increase in demand as well as the largely predetermined labor supply in the short run. With time the agricultural labor supply increases, through the growth of the labor force associated with population growth and a decline in off-farm migration, to 2.0 percent at the end of the period, thereby reducing the wage increase to 0.5 percent.

This simulated response of wages to a real devaluation resembles the observed pattern in recent, post-study, years, when a high real rate of exchange has prevailed. Although there are no official data on agricultural wages for the post-study period, there is the general view that in recent years agricultural wages have increased more than wages in other sectors. Some experts claim that wages in fruit production have increased at least 40 percent. Also, in spite of 10 percent urban unemployment, labor for agriculture is becoming scarce in some regions.

The actual expansion in agricultural employment is 12,000 workers in the final year. A 0.73 percent decline in services employment amounts to 12,200 workers, who are in part absorbed in mining and manufacturing. All this takes place with only minor changes in the rate of unemployment. As seen in the previous simulation, this rigidity in response of employment to the increased demand for labor is the result of the strong reaction of wages to unemployment.

It is concluded, therefore, that the policy produces a substantial reallocation of employment from nonagriculture to agriculture. As in the previous exercises, the overall labor share increases, indicating that the increase in the real exchange rate is capital-saving.

Output. The strongest output response is observed in agriculture, even though its value-added price increases less than that of mining. The strength of the response can be quantified by computing the implicit supply elasticities as a ratio of the percentage change in value added to the percentage change in its price. The results for 1972 are services 0.74, agriculture 0.67, mining 0.53, and manufacturing 0.32. The values for 1982 are somewhat higher, but they maintain the same sectoral rankings.

The Importance of Openness

The degree of openness appears explicitly as a variable in the price equation of manufacturing. With time, the economy became more open, and this affected its response to changes in the economic environment. To examine the impact of openness in terms of the model, the last experiment of real devaluation is repeated with one change, imposing for the period as a whole the maximum value of 0.38 for the share of tradables observed in 1981. This change calls for a new base run. The changes for this new run are summarized in Table 19.

The change in the degree of openness amplifies the response of manufacturing price to the real devaluation. It now increases by 0.38 percent in the first year, compared with the 0.20 percent shown in Table 18. The difference from the previous

Table 19—Impact of a 1 percent increase in the real exchange rate with an increase in openness

Sector	1963	1967	1972	1977	1982
			Product Price		
Agriculture	0.678	0.678	0.678	0.678	0.678
Mining	0.832	0.832	0.832	0.832	0.832
Manufacturing	0.382	0.380	0.415	0.431	0.444
Services	−0.756	−0.725	−0.771	−0.758	−0.743
			Value-added Price		
Agriculture	1.270	1.273	1.286	1.297	1.307
Mining	1.397	1.395	1.389	1.384	1.380
Manufacturing	0.847	0.861	0.985	1.081	1.174
Services	−1.142	−1.082	−1.147	−1.111	−1.074
			Rate of Return		
Agriculture	0.183	0.166	0.164	0.146	0.069
Mining	0.470	0.447	0.256	0.163	0.215
Manufacturing	0.551	0.460	0.405	0.183	0.306
Services	−0.354	−0.335	−0.442	−0.267	−0.401
			Wages		
Agriculture	1.257	1.625	1.278	1.034	0.586
Mining	−0.016	0.030	0.322	0.418	0.483
Manufacturing	−0.023	0.036	0.459	0.598	0.697
Services	−0.020	0.036	0.395	0.515	0.594
Labor share	0.086	0.183	0.564	0.602	0.977
			Value Added		
Agriculture	0.006	0.495	0.874	0.930	1.045
Mining	0.000	0.156	0.548	0.576	0.713
Manufacturing	0.084	0.405	0.718	0.729	0.856
Services	−0.109	−0.462	−0.818	−0.688	−0.870
Total	−0.034	−0.076	−0.122	−0.072	−0.156
			Capital Stock		
Agriculture	0.000	0.367	0.725	0.815	0.966
Mining	0.000	0.443	0.922	0.850	0.918
Manufacturing	0.000	0.243	0.487	0.623	0.692
Services	0.000	−0.198	−0.423	−0.510	−0.597
			Labor		
Agriculture	0.017	0.543	1.179	1.610	2.013
Mining	0.000	0.156	0.548	0.576	0.713
Manufacturing	0.277	0.584	0.824	0.846	0.967
Services	−0.230	−0.410	−0.777	−0.700	−0.833
Total	−0.047	0.055	0.009	0.116	0.080
Unemployment	0.059	−0.054	0.001	−0.065	0.004

Note: The figures are percentage changes from the base run except those for rates of return and unemployment, which are percentage-point deviations from the base run.

experiment remains high throughout the period. The value-added price of manufacturing was affected by more than the product price. It increases by 0.85 percent in the first year, as compared with 0.38 percent shown in Table 18. This difference declines somewhat with time. Even so, the change in manufacturing price is smaller than that of the more tradable sectors, agriculture and mining.

The effect is considerably stronger when it comes to the rate of return in manufacturing. It increases by 0.55 percentage points in the first year, as compared with 0.2 percentage points in the previous simulation. Consequently, the capital stock in manufacturing increases now by 0.5 percent in 10 years, as compared with 0.08 percent in the previous case. This larger increase is at the expense of mining and services, while there is only a slight increase in the capital stock in agriculture. Similar changes are observed in employment. With the increase in openness, the employment in manufacturing increases in 10 years by 0.82 percent, as compared with 0.19 percent before. This growth is mainly at the expense of a lower expansion of employment in mining and a larger decline in services. The increase in the demand for labor translates itself to higher wages rather than a decline in unemployment. This helps to increase the overall labor share somewhat, as compared with the previous case.

The changes in the sectoral inputs are well reflected in the output changes. The change in manufacturing output is now considerably higher than in the previous case. The response in 10 years is 0.72 percent, as compared with 0.16 percent in the previous case. The expansion of manufacturing is at the expense of a larger reduction in services and a lower increase in mining. The increase in openness augments considerably the supply elasticity in manufacturing, which takes on a value of 0.73 for 1972, as compared with 0.32 before. At the same time, mining and services decline, and agriculture remains basically the same. Agriculture continues to be most responsive to the real devaluation. The change in overall output is not much different from the previous case.

The comparison of the results of the two simulations indicates that a real devaluation provides a stronger incentive to manufacturing when the economy is more open. This result provides an empirical support for policies that combine devaluations with the elimination of trade restrictions. The supply response of the three more-tradable sectors to the real devaluation become more similar as the economy is opening up.

Summary and Conclusions

The various experiments reported in this chapter indicate that the sectoral composition of the simulated economy is strongly influenced by changes in the relative prices. Because the response takes time to build up, there are two aspects of the response to price variations: magnitude and speed. For instance, in the case of the response of agriculture to changes in its terms of trade, the implicit supply elasticity is 0.3 after 3 years and reaches 1.0 after 10 years. The weak response of agriculture in the short run explains the pessimism of the structuralists regarding the effect of price policy on agricultural output. The essence of the results in this study is that the response is rather sizable but requires time to materialize. This distinction between magnitude and speed is extremely important in that it highlights the importance of having persistent economic policies.

The supply response evaluated in these simulations assumes away uncertainty in that the contemplated price change is taken to be permanent. The reason for the gradual response is that changes in the structure of the economy are carried out by resource allocation, and this process is time-consuming for reasons discussed in Chapters 5 and 6. This sluggishness in resource mobility is a reflection of the supply of labor and capital and is not specific to changes instigated by price changes. A similar pattern is expected to exist in responding to other changes in the economic environment. This means that there are no shortcuts for changing the structure of the economy.

Adjustment in the sectoral composition of the capital stock is carried out through investment and therefore requires more time in responding to price changes than that of labor. The slow speed of factors' response to prices seems to be insufficient to eliminate differences in relative factor prices across sectors during the time span of the simulations.

As the simulations were conducted conditional on total factor supply and technology, changes in relative prices have shown no important effect on overall output of the economy. This is an interesting result in view of the high rate of unemployment that prevailed during much of the period. The lack of a significant improvement in sectoral employment in response to price improvement reflects the behavior of the labor market at the time that translated an increase in labor demand into an increase in wages rather than an increase in employment. A rise in the terms of trade in favor of agriculture leads to an increase in the labor demand in agriculture and therefore to a decline in the labor supply in nonagriculture and to higher wages in all sectors of the economy, with agricultural workers gaining the most. Consequently, policies biased against agriculture, with the intention of favoring workers and low-income people, seem to be producing the opposite results.

The protection of manufacturing by increasing its real price generates a much stronger change in relative prices and resource allocation than that realized by increasing agricultural prices by the same rate. An increase in the price of manufacturing by 1 percent leads to a strong supply response of this sector—4 percent after 10 years, implying an elasticity of 4. The expansion comes mainly at the expense of services, with mining contributing to the expansion of manufacturing capital. This illustrates that development of manufacturing need not be at the expense of agriculture, as is often implied in the development literature that proposes taxing agriculture as a means of developing manufacturing.

An increase in the protection of manufacturing also leads to an increase in wages in all sectors. The increase in wages is much smaller than what is obtained in the case of an increase of agricultural prices in the same percentage.

A change in the real exchange rate affects sectoral prices according to their degree of tradability, with mining being the most tradable, and services the least. The strength of the effect is directly related to the degree of openness. The supply response is stronger in mining and agriculture, which are the more-tradable sectors. The resources needed for the expansion of these sectors are provided by services, the least tradable sector. The long-run effect on agriculture is to reduce the off-farm migration and thereby increase employment in agriculture at the expense of that in nonagriculture. The wage rates rise in all sectors and this leads to an increase in the share of wages in total income.

9

SIMULATIONS OF GROWTH

The discussion in the previous chapter indicates that changing the relative prices while holding resources constant has a strong effect on the composition of the economy but not on growth. The reason is that resources and technology in these experiments are held constant. The growth attributes of the model will now be examined by allowing resources to change while holding product prices at their historical level.

The Role of Capital

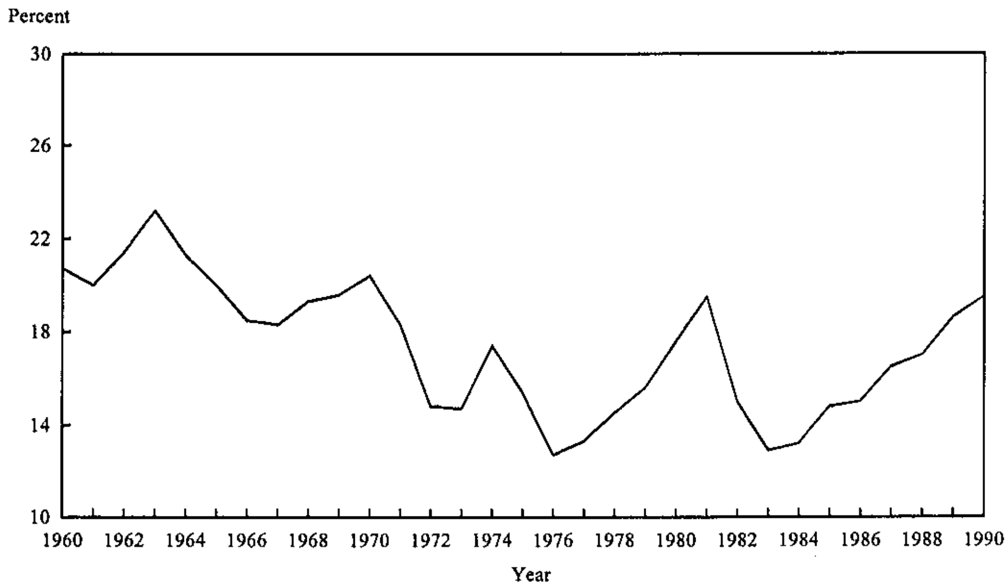
The role of capital in growth is an important topic on which there is no clear and conclusive view. Current theoretical discussion views human capital as the engine of growth (see Lucas 1988).[28] The empirical implication of this view is not immediate. The framework for this theoretical discussion has two pertinent aspects for the present discussion: it evaluates the economy in a steady state position, and it does not distinguish between the implemented and available technology—whatever is known is immediately used. The empirical implication of these two assumptions is rather limited. In terms of the present analysis, it is not helpful to think of Chile in the study period as an economy in a steady state, and it is definitely misleading to assume that there was no gap between the available and implemented technology.

The empirical problem is that of allocating growth to the various potential contributors. This is related to the discussion of productivity in Chapter 4. The evaluation of the effect of capital on productivity in the general equilibrium setting is rather complex in that, in addition to the direct effect, changes in the capital stock also influence wages, and therefore employment; off-farm migration, and thereby labor supply; and unemployment. Also, the capital stock affects the rates of return and investment, which are state variables in the production function.

In what follows, the net effect of capital is evaluated by simulating the response of the economy to an increase in the capital stock. This is done by increasing the investment-output ratio. Figure 49 shows the investment-output ratio for the period 1960-90. In the 1960s this ratio fluctuated in the range of about 18-23 percent. With a few exceptions, it was considerably lower for the 1970s and most of the 1980s. This ratio reflects the prevailing economic environment, but this aspect is not explicitly studied here. For the purpose at hand, the historical ratio is changed exogenously by one percentage point. Thus, for example, when the historical ratio was 0.18, it is now set at 0.19. This increase is imposed, beginning in 1963, for the whole period.

[28]In this discussion it becomes important to qualify the type of capital under consideration. Thus, when the word "capital" is used without further qualification, it refers to physical capital.

Figure 49—Investment-output ratio, 1960-90



In this exercise the government sector is also explicitly brought into the analysis. This is done under the following assumptions: (1) the ratio of government to total output remains at the historical level; (2) government output consists of wages only (this is in line with the discussion in Chapter 3); (3) government employment is obtained from the ratio of output to the wage rate; and (4) the government wage rate increased at the same rate as the average wage in nonagriculture.

Summary results for the impact of increasing the investment-output ratio by one percentage point are presented in Table 20. As the experiment controls the investment-output ratio, the level of investment depends on output, which is endogenous in the model. To isolate the effect of capital from that of the implemented technology, as measured by the *PEAK* variable, in the first simulation *PEAK* is maintained exogenously at the historical level. As a result of the augmented investment rate, the overall capital stock increases gradually, by 1.6 percent in 1967, the fourth year of the change, and by 5.6 percent in 1982, 15 years later. The corresponding values for output are 1.1 and 3.3 percent. The ratio of the proportionate increase in output to that of capital is 0.7 in 1967 and 0.6 in 1982.

The increase in nonagricultural employment is considerably smaller, only 0.43 percent in 1967, and it weakens in the later years. Consequently, unemployment is reduced for the period as a whole only by roughly half a percentage point. The effect of changing the capital stock on labor demand consists of a substitution and an expansion component. The substitution effect should reduce the labor demand. In this case, wages will be pressed downward. However, the expansion effect will cause wages to rise. Table 20 shows the changes in the manufacturing wage, which increases by 1.8 percent in 1967 and 7.5 percent by 1982. From this it can be inferred that the expansion effect was dominating. Thus it is concluded that the increase in

Table 20—Impact of augmenting investment-output ratio by one percentage point, beginning in 1963

Simulation	1967	1972	1977	1982
		Total Capital Stock		
1	1.60	3.05	4.32	5.59
2	1.67	3.56	5.17	6.94
3	1.70	4.22	6.70	10.38
		Total Output		
1	1.12	1.40	2.77	3.35
2	1.76	3.13	4.71	7.09
3	2.11	7.71	9.94	19.84
		Total Employment		
1	0.43	0.10	0.28	0.18
2	0.66	0.32	0.52	1.01
3	1.20	4.57	5.98	11.22
		Unemployment		
1	−0.54	−0.15	−0.45	−0.45
2	−0.82	−0.40	−0.69	−1.25
3	−1.48	−5.34	−6.30	−10.98
		Manufacturing Wages		
1	1.83	4.49	5.99	7.53
2	2.19	8.29	11.04	13.76
		Labor Share		
1	1.17	2.99	3.71	4.83
2	1.12	4.32	5.78	6.88

Notes: The historical values are imposed in simulation 1 on *PEAK* (the highest historical level attained by the output variable) and in simulation 3 on wages. The figures are percentage changes from the base run except those for unemployment, which are percentage-point deviations from the base run.

labor demand caused by the increase in the capital stock is reflected largely by an increase in nonagricultural wages.

The growth rate of output falls between the rates of capital and labor. It can be thought of as a weighted average of the growth rates of these two factors, with weights of 0.59 and 0.41 for capital and labor, respectively. This implies an implicit value of 0.59 for the capital share, which is in line with the values plotted in Figure 3.

In the second simulation the *PEAK* variable is endogenized in order to capture the effect of the change in the capital stock on the implemented technology. *PEAK* appears in all the production functions, and its strongest effect is in agriculture. This modification increases output considerably over the first alternative. As the investment-output ratio is fixed, an increase in output causes investment, and therefore the capital stock, to increase over the first alternative. As seen in Table 20, simulation 2, the capital stock increases by 1.7 percent in 1967 and by 6.9 percent in 1982; employment increases by 0.66 and 1.01 percent for the two years, respectively, whereas the corresponding increase in output is 1.8 and 7.1 percent.

When output increases by more than all inputs, there is an unexplained residual. This situation can also be interpreted as increasing returns to scale. However, this interpretation is neither meaningful nor revealing. The quoted figures are obtained by aggregating the results of the individual sectors. One possibility is that the result is due to aggregation. However, this is not the case, as it is also observed at the sectoral level for some sectors, while the sectoral production functions maintain constant returns to scale. The interpretation of this residual in terms of the framework is that the increase in the capital stock makes it possible to move to new techniques that are both capital-intensive and more productive. Such moves generate the productivity gain, and the time path of output is generated by changing the implemented technology as determined by the factor supply and the other conditions of the model.

The second simulation has a somewhat stronger positive effect on employment than the first one, and unemployment declines by slightly less than one percentage point for most of the period. However, the increase in wages was more sizable, 2.2 percent in 1967 and 13.8 percent in 1982. The importance of wages in deterring growth is underlined in simulation 3, which repeats simulation 2 but keeps wages at their historical levels. The outcome is dramatic. Employment increases gradually from 1.2 percent in 1967 to 11.2 percent in 1982, whereas unemployment declines by 1.5 percentage points in 1967. This decline increases to 11 percentage points in 1982, a year with an unemployment rate of 18 percent. In this alternative, the capital stock and output increase by 10.4 and 20.0 percent, respectively, in 1982. Thus, output increases twice as fast as capital.

Labor Markets

The foregoing simulations indicate that wage rises hindered the growth of the economy in response to various stimuli. To shed more light on this specific point, the response of the economy to a 1 percent increase in the nonagricultural real wages will now be evaluated. The results are summarized in Table 21. When the rise is introduced in 1963, employment declines by nearly 0.3 percent in 1967 and unemployment increases in that year by about 0.34 percentage point. The response accumulates somewhat in later years. The decline in output is similar in rate to that of employment.

Table 21—Impact of a 1 percent increase in wages

Variable	1967	1972	1977	1982
Increase begins in 1963				
Employment	–0.28	–0.43	–0.35	–0.40
Unemployment	0.34	0.50	0.36	0.39
Output	–0.25	–0.42	–0.30	–0.42
Increase begins in 1975				
Employment	. . .	. . .	–0.21	–0.33
Unemployment	. . .	. . .	0.21	0.31
Output	. . .	. . .	–0.14	–0.28

Note: The figures are percentage changes from the base run except those for rates of return and unemployment, which are percentage-point deviations from the base run.

Thus, on average, a 1 percent increase in wages increases the unemployment rate by about 0.30 percentage point. This result is also consistent with the model simulations that are summarized in Tables 20, 22, and 23. The response is nearly the same when the change is introduced in 1975.

The simulations show what the cost was in terms of growth of the strong response of wages to an increase of labor demand to the extent that most of the increase in such demand was translated into wages rather than employment. It is not suggested here that real wages should have been kept constant. This exercise indicates the importance of understanding the behavior of the labor market and its role in facilitating growth.

Cost of Political Instability

The volatility in the economy that began in late 1970 with the Allende government and subsequent political events had a serious impact on output and on the variables related to growth. As seen in Chapter 5, unemployment increased from a level of 5-7 percent in the 1960s to a level of roughly 15 percent in the 1970s. At the same time, investment declined considerably. As shown in Figure 49, the investment-output ratio fluctuated between 18 and 23 percent in the 1960s, reached 20.4 percent in 1970, and started to decline thereafter, reaching a trough of 12.7 percent in 1976. In 1971 the decline in the ratio was largely due to an increase in output, and the decline in investment was relatively small. Thereafter, as indicated in Figure 24, total investment declined sharply until 1976. From then on, the investment-output ratio and total investment started a gradual recovery, with the ratio reaching a level of 19.5

Table 22—Impact of augmented investment beginning in 1974

	1 Percent Increase		Investment-Output Ratio Kept at 20 Percent	
Simulation	**1977**	**1982**	**1977**	**1982**
		Capital Stock		
2	1.20	2.96	6.32	12.57
3	1.20	3.05	6.31	13.34
		Output		
2	0.88	3.27	4.54	14.53
3	0.94	4.04	4.81	20.08
		Unemployment		
2	−0.56	−1.38	−2.91	−5.06
3	−0.70	−2.40	−3.52	−11.24
		Manufacturing Wage		
2	0.49	2.95	2.14	16.00

Notes: The historical values of wages are imposed in simulation 3. The figures are percentage changes from the base run except those for rates of return and unemployment, which are percentage-point deviations from the base run.

Table 23— Impact of a one percentage point increase in the foreign exchange constraint

Simulation	1967	1972	1977	1982
		Capital Stock		
2	0.46	1.13	1.54	2.09
3	0.50	1.72	2.75	4.43
		Output		
2	2.30	2.80	3.15	3.98
3	2.70	6.75	7.14	12.05
		Employment		
2	0.55	0.04	0.05	0.16
3	1.18	3.57	3.99	6.50
		Unemployment		
2	−0.70	−0.06	−0.16	−0.32
3	−1.45	−4.18	−4.23	−6.44
		Manufacturing Wages		
2	2.48	6.52	7.25	8.27

Notes: The historical values of wages are imposed in simulation 3. The figures are percentage changes from the base run except those for rates of return and unemployment, which are percentage-point deviations from the base run.

percent in 1981, only to be interrupted again by the recession of 1982, and finally returning to that level only in 1990.

The decline in output affected labor and capital differently. Figures 33 to 37 show that, with minor exceptions, the rate of return in the various sectors declined in the early 1970s and had not fully recovered by the end of that decade. On the other hand, real wages were initially raised by the Allende regime but could not be sustained at that new level and had to retreat somewhat. However, their decline was short-lived, and they were increasing during the recovery period beginning in 1975-76 and in most cases reached the pre-Allende level in the late 1970s. Most of the adjustment in the labor market during this period was made by the increase in unemployment. In this sense the adjustment behaved differently from that observed for the rates of return.

In looking back at this period the question is, What are the important policy measures that should have been contemplated? This is a natural question to ask about a normal period, where marginal adjustments in policies can be evaluated, but it is not very meaningful when asked in connection with a set of policies that should not have been implemented in the first place. One possible way to assess the cost of this period is to evaluate the potential performance of the economy under the investment rates typical for the 1960s. This is done here by simulating the economy in the post-Allende period, beginning in 1974, under the assumption that the investment-output ratio remained constant at the pre-Allende level of 20 percent. By keeping the investment level of the 1960s, it is implicitly assumed that alternative economic policies would have been pursued in order to maintain the profitability needed to sustain such investment rates.

The contemplated change in the investment rate is more drastic than the one considered in the previous exercise, as reported in Table 20. In order to evaluate the full impact of this difference, the simulations of Table 20 are repeated, that is, the investment-output ratio is increased by one percentage point, except that the change is now first introduced in 1974. The results appear in the first two columns of Table 22. The last two columns of the table present simulations with the investment-output ratio held at 20 percent. In each case, the last two simulations of Table 20 are presented, namely, simulations with endogenous *PEAK* and endogenous wages (simulation 2) or alternatively, endogenous *PEAK* and exogenous wages (simulation 3). The results for 1977 and 1982 are for the cumulative effect of the fourth and ninth year, respectively, after the beginning of the process.

Starting with the one percentage point change, it can be seen that the effects on capital accumulation of the two alternatives are quite similar. However, the effect on unemployment is substantially different. When wages are allowed to increase, they increase by almost 3 percent in 1982 and unemployment declines by 1.4 percentage points in 1982. When wages are kept at their historical levels, unemployment declines by 2.4 percentage points, almost twice as much. However, even if wages were kept constant, an increase of one percentage point in the investment ratio would not be sufficient to produce dramatic results. In this respect, this result is different from the corresponding result in Table 20. The difference is in the starting date; the latter is obtained when the change is introduced in 1963. The capital accumulation in the 1960s was sufficient to make a difference. This is not the case when the change is introduced in 1974, where the investment level was low and there is not sufficient time to produce a significant effect. A more drastic change was needed to lift the economy from its depressed position.

Turning to the last two columns of Table 22, where the investment ratio is kept at 20 percent, the results look considerably different. The capital stock increases in 1982 by about 13.0 percent for the two alternatives, whereas output increases by 14.5 and 20.1 percent with endogenous and exogenous wages, respectively. Unemployment declines by 5.1 and 11.2 percentage points in the two alternatives, respectively. If wages were allowed to increase, they would have increased by 16 percent in 1982. Thus, there is a trade-off between an increase in wages by 16 percent and a decline in unemployment by about six percentage points (11.2 minus 5.1) in a year with 18 percent unemployment.

Integration with the World Economy

The response of the system to changes in capital and technology depends on the degree of openness. The more open is the economy, the stronger are the competitive pressures for an improvement in efficiency, and also the easier it is to import capital goods, which are the carriers of new technology. The model does not include a direct measure of the effect of openness on productivity, but the *FEC* can be used to represent its effect. A larger degree of openness leads to larger trade, and this will be reflected in larger *FEC*.

The *FEC* is a composite variable that changes not only with the opening of the economy but also with changes in the external terms of trade or with the world interest rates. Thus the experiment of changing the *FEC* can represent more than one scenario. Keeping this in mind, the effect of increasing the historical values of the *FEC* by one percentage point is examined. In this, domestic prices are maintained at their historical levels. The implication is that if the change in the *FEC* is caused by changes in the external terms of trade, these changes are compensated for by taxes in order to maintain the internal terms of trade intact. Nevertheless, there is a wealth effect that increases the stock of foreign exchange.

The *FEC* variable has a strong direct effect on the productivity in manufacturing and a lesser one in services, whereas it has no such effect on the productivity in agriculture and mining. The results are reported in Table 23 for the historical price levels and for endogenous and exogenous wages.

The immediate effect of an increase in the *FEC* is to increase the productivity in manufacturing and services, and therefore to increase their output. As output increases, investment increases so as to maintain the historical investment-output ratios. Thus, in the first simulation, output increases by 2.3 percent in 1967 with only 0.46 percent increase in the capital stock. The growth of capital then picks up, showing an increase of 2.1 percent in 1982, whereas the output growth is almost 4.0 percent. The effect on employment is not significant, whereas wages in manufacturing increase rapidly at a higher rate than employment, reaching a level of 6.5 percent in 1972 and 8.3 percent in 1982.

Restricting wages to remaining at their historical level gives a completely different result. Output in 1972 is almost 7 percent higher than that of the base run, and this difference grows to 12 percent in 1982. Employment in nonagriculture grows at about half the rate of output, from 1.2 percent in 1967 to 6.5 percent in 1982. Unemployment declines drastically, from 1.5 percentage points in 1967 to 6.4 percentage points in 1982.

Growth and Sectoral Composition

The foregoing discussion dealt with the response of the aggregate values to the imposed changes. To see the effect of sectoral composition, refer to Table 24, which presents detailed results of simulation 3 in Table 20. This simulation is obtained by increasing the investment ratio by one percentage point with endogenous *PEAK* and historical wages and prices.

When capital is allowed to increase, the sectoral capital-labor ratios increase as well. With a constant production function, such a change should result in a decline in the rates of return. This is not the case in this simulation, as the sectoral rates of return increase for all sectors except mining. The reason is that in the present study the implemented technology is not invariant to such a change. Changes in the rates of return affect the sectoral competitive position for new investment, which in turn affects the sectoral pattern of growth in the capital stock. Manufacturing responds most strongly to the changes in investment, but the sectoral differences are not large. The increase in the capital stock, in investment, and in the rate of return change the implemented technology so that output and the demand for labor increase. Consequently, unemployment declines (Table 20), and this in turn increases the off-farm migration and decreases the agricultural labor force. The effect of the decline in unemployment on migration is strong enough to overcome the increase in agricultural income as measured by the average labor productivity. The decline in agricultural

Table 24— Impact of a one percentage point increase in investment ratio on the composition of the economy

Sector	1967	1972	1977	1982
		Rate of Return		
Agriculture	0.06	0.64	0.51	0.87
Mining	−0.12	−0.08	−0.04	0.12
Manufacturing	0.45	0.85	0.36	1.38
Services	0.21	1.30	0.81	2.84
		Output		
Agriculture	1.23	5.76	8.23	18.64
Mining	0.41	1.70	4.94	8.78
Manufacturing	3.10	7.94	9.60	17.69
Government	2.11	7.71	9.94	19.84
Services	2.03	8.59	11.11	22.63
		Labor		
Agriculture	−0.87	−3.43	−6.00	−10.40
Mining	0.41	1.70	4.94	8.78
Manufacturing	3.00	7.56	9.79	17.82
Government	2.11	7.71	9.94	19.84
Services	1.56	5.98	8.74	15.74
		Capital		
Agriculture	1.50	3.40	6.10	8.77
Mining	1.21	3.04	5.96	8.42
Manufacturing	2.29	5.12	7.43	11.91
Services	1.66	4.37	6.84	10.91

Note: The figures are percentage changes from the base run except those for rates of return and unemployment, which are percentage-point deviations from the base run.

labor and the rise in its capital stock increase the capital-labor ratio in agriculture, whereas this ratio declines for most other sectors, as can be seen by comparing the proportionate increments in capital and in employment. Finally, except for mining, output increases considerably more than capital.

The behavior of the government sector reflects the assumptions on its relationship to total output.

Discussion

Although growth is an economic phenomenon, it is not insulated from political developments. This study shows that major political shocks have a strong effect on the forces that generate economic growth. Such shocks may change agents' expectations for the probability distribution of future values of the pertinent economic variables and, consequently, their decisions. The political shocks may be influenced by the economic situation in the country, but they may also be completely independent of it and be, for instance, driven by ideology. Whatever the case, it is clear that such shocks are a factor that has to be reckoned with. The main implication of this point is for economic research. It is not very illuminating to assume that events such as the Allende period in Chile are a realization of a random variable generated by a stable probability distribution that can be retrieved from the sample data.

The other point that comes out from the analysis is the importance of the market organization. The study shows the importance of the behavior of the labor market in the determination of the growth performance. Noncompetitive markets may be generated by a variety of forces. It seems that the instability generated by the high inflation rates contributed to this behavior. In any case, growth affects factor markets, and, in turn, the performance of such markets has a feedback effect on growth.

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CONCLUSIONS

Many economic discussions differentiate between short-term variations and long-term growth. This is a convenience that cannot be enjoyed in empirical analysis for the simple reason that the data are not dichotomized accordingly. Investment is a key variable in the discussion of growth, and, at the same time, variations in investment are strongly associated with short-term variations in total output. The data are always determined in the context of short-run equilibria, and one of the more challenging tasks of empirical analysis is to distill the long-run processes from the data. This work is an attempt in that direction. However, the task is somewhat difficult because the study period of 1962-82 covers a very turbulent environment in Chile's history, caused by internal political events and external shocks. There are several studies dealing with the economic volatility in this period and its relationships to economic policies and external shocks. The emphasis of these studies is on the short-term variations, whereas the growth effect of these policies and external shocks is not dealt with.

The importance of understanding the Chilean experience goes beyond academic interest. The post-study period from 1983 through 1992 has been a period of vigorous growth in Chile, and there is an ongoing discussion in the country as to whether the current growth performance is sustainable. The public discussion of this issue is in part political and emotional, and it lacks a quantitative framework. Yet it has important repercussions. An overestimation of the growth rate may lead to overspending and debt accumulation, with all the negative consequences such as those observed in the 1970s when the medium-term growth was overestimated.

Growth is not a mysterious process detached from current events. Changes in the economic environment, such as external terms of trade, flow of capital, government expenditures, and finance or sector-specific policies such as subsidies to agriculture or the protection of manufacturing, all affect the performance of the economy through the price mechanism and the resource availability for production. Differences in product prices also affect factor prices and their sectoral allocation. The introduction of new and more productive techniques of production requires a profitable environment as well as capital. In an open economy the flow of capital depends on domestic profitability and stability relative to the rest of the world and on the degree of openness of the economy.

By its very nature, the response to a changing environment involves costly resource mobility, and it is therefore carried out only if the observed changes are expected to be permanent. Transitory price or policy variations cannot be expected to have an important effect on such resource mobility. Consequently, the response to a changing environment is time-consuming for two reasons: first, the change has to be perceived as permanent, and second, time is needed to implement the changes once they are decided on. This is logical, but can it be empirically substantiated? The study shows very clearly that there is a distinct supply response in sectoral output and resource allocation to a changing economic environment and that the response is accumulated over time.

The study of intersectoral resource allocation and productivity changes in response to the economic environment is pertinent for any topic related to the supply side of the economy. Specifically, it is essential for evaluating the effect of trade liberalization or free trade agreements such as NAFTA (North American Free Trade Agreement) between Mexico and the United States or MERCOSUR (Mercado Común del Sur) in the southern cone of Latin America. The welfare *flow* of such agreements is determined by the direction as well as by the speed of the adjustments in resources and productivity.

The difference between short- and long-run response emphasizes the importance of persistence in economic policy. Usually, policymakers do not want to wait long for results of their own policies to become visible, so they tend to neglect policies with much-delayed results. The present analysis shows that such political decisions are costly in terms of sectoral growth. This applies to all sectors, agriculture included.

All the exercises done in this work indicate clearly that the expansion in production was closely associated with an increase in the capital stock, at both the sectoral and aggregate levels. This is also consistent with the association of the decline of economic growth in the 1970s with a sharp decline in the investment rate. This outcome illustrates the importance of physical capital for growth, a point often neglected in the "new growth" literature with its emphasis on human capital.

The performance of the economy was strongly affected by the external conditions; this highlights the importance of trade in Chile. The measure used in this study to represent the external conditions is positively related to the degree of openness and the terms of trade. An improvement in both contributes to improvement in factor productivity.

The importance of competitive factor markets is illustrated by the functioning of the labor market. During the study period, a large and persistent unemployment prevailed with only a relatively small decline in real wages, suggesting a low response of wages to unemployment. At the same time, simulated growth-promoting changes—such as increasing the investment ratio or the real exchange rate or an improvement in the external conditions—increased the demand for labor, and this was translated mostly to a rise in wages and only in small part to a decline in the unemployment rate. This is an outcome of the strong response of wages, rather than employment, to an increase in labor demand. Such a peculiar behavior, leading to high and persistent unemployment, is attributed to the magnitude of the macro shocks that distorted the ordinary functioning of the labor market.

The most important lesson learned from the Chilean experience, as well as from the experience of other countries, is that economic policies should be sustainable and persistent. Myopic policies, whether carried out for reasons of political opportunism, ideology, or ignorance, are very costly in terms of growth, and because they are not sustainable they are also costly in terms of the adjustments that are called for to reverse their negative effects.

APPENDIX 1: THE DATA BASE

This appendix presents, in Tables 25-39, the more important data used in the study. The main source is the National Accounts published by the Central Bank. More detailed data and an explanation of the construction of all the data used in the study appear in a supplement that is available upon request from IFPRI's Information Program.

Table 25— Gross output

Year	Agriculture	Mining	Manufacturing	Services	Government
			(millions of 1977 pesos)		
1960	37435	26252	136858	130168	15671
1961	38700	28763	147079	140997	15125
1962	37500	31235	162637	145957	16116
1963	40157	31925	168142	159922	15629
1964	41363	33778	176814	167953	15954
1965	39012	32055	179792	168554	17568
1966	43964	33518	203811	194256	19974
1967	45975	33426	211402	200296	19879
1968	48476	34769	219554	206864	20391
1969	43452	35857	225790	222601	22018
1970	47289	35309	225961	226397	23662
1971	47822	36802	257811	249117	26790
1972	47470	35097	265710	240146	27668
1973	45676	34568	247610	229156	27962
1974	52325	40711	235237	253927	32411
1975	50685	38179	182555	201273	27517
1976	48988	42092	192970	203657	28075
1977	52159	42553	207146	225851	28871
1978	53371	43010	226134	256952	32159
1979	56007	45648	239101	278021	35375
1980	58757	48335	250898	299734	31686
1981	60605	52256	257436	316898	30795
1982	59882	53132	208792	286901	29913

Table 26— Real value added

Year	Agriculture	Mining	Manufacturing	Services	Government	Total
			(millions of 1977 pesos)			
1960	19876	14432	41649	95155	10839	181950
1961	19511	15865	44743	98006	10725	188850
1962	18622	17122	48967	103400	11032	199141
1963	19777	17314	50895	113085	10896	211968
1964	20033	18393	53479	112227	11875	216008
1965	20257	16800	55839	112973	12537	218406
1966	24489	17504	62867	122288	13223	240371
1967	25163	17924	64669	127654	13623	249032
1968	26439	18709	66763	132892	13689	258492
1969	23325	19162	68555	142380	13814	267236
1970	24071	18595	69912	146660	14027	273265
1971	23806	19714	79404	160349	14535	297808
1972	21825	18974	81180	157855	15029	294863
1973	19647	18532	74906	151108	15393	279586
1974	24904	22642	72994	149432	16432	286404
1975	25993	20095	54405	135222	16740	252455
1976	25574	22544	57678	136665	17688	260149
1977	28289	23161	62574	150867	18041	282932
1978	27241	23529	68374	167570	17476	304189
1979	28922	24792	73777	186521	16997	331009
1980	30031	26077	78332	207022	16864	358326
1981	31168	28084	80336	219327	16578	375494
1982	30803	29680	63500	194216	16108	334308

Table 27—Real sectoral profits

Year	Agriculture	Mining	Manufacturing	Services
		(millions of 1977 pesos)		
1960	11232	7614	21497	35867
1961	11514	6283	22973	45211
1962	10085	6498	27330	48630
1963	9392	8631	29077	55483
1964	10792	9380	30722	54664
1965	10569	9481	30178	53896
1966	13041	14203	33047	58244
1967	13720	14483	35033	58039
1968	11159	15080	39275	57248
1969	11041	21503	40120	61244
1970	10367	15828	41206	57048
1971	12132	5416	32057	60846
1972	12902	4501	24038	70570
1973	10980	7094	37974	78493
1974	8938	11612	48747	54665
1975	6711	12010	12562	56632
1976	11531	12639	22896	51764
1977	16906	9915	19797	61794
1978	12459	10719	26336	74421
1979	13317	21479	29838	89824
1980	13150	18977	30020	101494
1981	10500	8697	32194	107452
1982	5692	12506	20992	93752

Table 28—Real indirect taxes

Year	Agriculture	Mining	Manufacturing	Services
		(millions of 1977 pesos)		
1960	108	72	2617	8630
1961	102	–54	2743	9311
1962	69	–24	2851	8517
1963	80	73	2961	8842
1964	242	78	3517	8745
1965	312	53	3941	9211
1966	300	45	3407	10958
1967	378	31	3886	13119
1968	624	–67	3997	13296
1969	402	–85	4330	14812
1970	394	–102	4390	15876
1971	405	–364	7201	14851
1972	44	1655	8116	9256
1973	238	4166	6427	9954
1974	667	7632	7261	16251
1975	1235	–45	11439	13947
1976	2122	–33	7835	16221
1977	1646	–135	11572	14246
1978	2098	–1463	10273	15889
1979	2050	–1147	10618	13009
1980	2860	–1432	9840	12972
1981	3233	–1853	11794	16413
1982	3489	–1128	12253	15217

Note: Computed as nominal indirect net taxes deflated by nominal price of value added (NP_{vj}).

Table 29— Real depreciation

Year	Agriculture	Mining	Manufacturing	Services
		(millions of 1977 pesos)		
1960	2735	1928	3617	22612
1961	2174	1707	4092	15711
1962	2604	1913	3899	18373
1963	2837	2923	3943	19336
1964	2725	2969	4251	18435
1965	2851	2663	4415	18050
1966	2534	2520	4827	16899
1967	2394	2469	4876	18001
1968	2655	2146	4794	19274
1969	2523	2364	5411	19547
1970	2976	2145	5325	19598
1971	3319	1511	6689	20526
1972	3289	2625	7129	15978
1973	3838	3569	9530	17568
1974	3586	3317	9478	17642
1975	3639	3804	5376	19701
1976	3595	3912	5979	19682
1977	3755	3741	7029	19172
1978	3574	3818	6678	20386
1979	3728	3325	6940	21034
1980	3811	3462	8204	21633
1981	3763	3527	8378	22622
1982	3601	4468	5970	22094

Note: Computed as the nominal figures of depreciation of the National Accounts deflated by the corresponding price indexes of capital.

Table 30— Gross real investment in fixed capital

Year	Agriculture	Mining	Manufacturing	Services	Total
			(millions of 1977 pesos)		
1960	...	...	...	...	...
1961	4491	6619	11207	16910	39226
1962	4678	4344	12280	22738	44040
1963	4721	3635	8353	33833	50541
1964	6447	2273	8838	30103	47661
1965	7066	1909	7315	28491	44781
1966	6822	2072	9817	27510	46221
1967	6922	4903	11365	24020	47210
1968	8042	9192	10085	24356	51675
1969	6355	9988	9462	28477	54282
1970	6382	8536	7735	35133	57786
1971	6220	7153	7271	35802	56446
1972	5854	6340	5101	27810	45105
1973	6799	8337	10797	16454	42387
1974	6522	9309	3726	30932	50489
1975	5423	6839	5402	21329	38992
1976	4918	7230	3058	18009	33215
1977	7128	7763	4010	19444	38346
1978	10406	8058	6443	20102	45009
1979	9998	5944	8327	28324	52593
1980	7532	7705	12649	36220	64105
1981	8536	7125	9523	49663	74848
1982	6703	6884	7145	28717	49448

Table 31— Capital stocks

Year	Agriculture	Agriculture with Land	Mining	Manufacturing	Services	Total
			(millions of 1977 pesos)			
1960	80602	161681	56044	80709	420187	637542
1961	82918	163997	60956	87824	421386	653084
1962	84991	166070	63388	96205	425750	670334
1963	86875	167954	64099	100615	440248	691837
1964	90597	171676	63403	105201	451916	711117
1965	94812	175891	62649	108101	462357	727919
1966	99100	180179	62201	113092	472968	747361
1967	103628	184707	64636	119580	478988	766832
1968	109015	190094	71682	124871	484071	789639
1969	112847	193926	79306	128922	493001	814076
1970	116253	197332	85697	131332	508535	841817
1971	119154	200233	91339	131914	523812	866219
1972	121719	202798	95054	129885	535644	882302
1973	124680	205759	99822	131153	534530	890185
1974	127615	208694	105813	125400	547820	906648
1975	129399	210478	108849	125426	549448	913122
1976	130722	211801	112166	122505	547775	913168
1977	134095	215174	116189	119487	548047	917818
1978	140928	222007	120428	119252	547763	928371
1979	147197	228276	123048	120640	555052	945937
1980	150919	231998	127292	125084	569639	972934
1981	155692	236771	130890	126230	596680	1009492
1982	158794	239873	133307	127404	603303	1022808

Note: The capital series were derived by accumulating the annual investment figures. In most cases there is a known value for the capital stock for a given year and that was used as an anchor value.

Table 32— Real taxes on profits

Year	Agriculture	Mining	Manufacturing	Services
		(millions of 1977 pesos)		
1960	89	26	1091	1250
1961	91	21	1166	1576
1962	80	22	1387	1695
1963	74	29	1476	1934
1964	115	50	1251	2622
1965	50	171	2476	2641
1966	54	105	2493	2659
1967	40	86	2370	2429
1968	37	52	1974	2761
1969	60	354	2651	3375
1970	15	48	2899	3393
1971	19	29	2644	2618
1972	20	22	2163	3133
1973	17	32	3701	3593
1974	84	23	3876	7645
1975	552	269	2014	4533
1976	265	537	4238	4119
1977	306	253	2829	4178
1978	164	93	2652	4142
1979	239	792	2851	5486
1980	246	286	2813	6695
1981	234	626	2409	6303
1982	210	609	1508	4187

Note: Obtained by dividing sectoral nominal direct taxes by the National Accounts consumption deflator. Nominal taxes figures were obtained from the Internal Revenue Service.

Table 33— Rates of return

Year	Agriculture	Agriculture with Land	Mining	Manufacturing	Services
1960	...	...	...	...	...
1961	0.153	0.062	0.134	0.313	0.142
1962	0.131	0.055	0.126	0.350	0.161
1963	0.123	0.055	0.164	0.343	0.199
1964	0.143	0.064	0.165	0.325	0.189
1965	0.136	0.071	0.179	0.311	0.174
1966	0.153	0.086	0.256	0.316	0.171
1967	0.148	0.090	0.259	0.324	0.152
1968	0.119	0.082	0.252	0.331	0.152
1969	0.117	0.085	0.336	0.331	0.162
1970	0.105	0.077	0.227	0.334	0.150
1971	0.122	0.084	0.072	0.256	0.155
1972	0.119	0.083	0.056	0.189	0.152
1973	0.090	0.060	0.081	0.283	0.138
1974	0.078	0.053	0.134	0.393	0.088
1975	0.048	0.028	0.112	0.083	0.083
1976	0.078	0.047	0.089	0.114	0.083
1977	0.120	0.071	0.076	0.119	0.104
1978	0.092	0.057	0.091	0.198	0.128
1979	0.097	0.059	0.166	0.217	0.144
1980	0.094	0.054	0.158	0.236	0.176
1981	0.069	0.040	0.071	0.274	0.184
1982	0.037	0.021	0.103	0.179	0.157

Note: Rates were obtained by using equation (16) of the model. The capital stock with land included uses the real price of land (P_L). The anchor value for land in 1977 is 81079 (in millions of pesos). This value was calculated by using the price of land series and the estimate reported in a study for 1979 that was carried out by the Internal Revenue Service.

Table 34— Real wages

Year	Agriculture	Mining	Manufacturing	Services	Government
			(millions of 1977 pesos)		
1960	9130	66959	40426	40382	78861
1961	10200	74810	41091	42426	78573
1962	10500	71898	42458	42647	74208
1963	8509	79720	42036	40819	61830
1964	8602	75593	39809	39215	61193
1965	10649	73106	40269	42529	68993
1966	13746	80995	44872	47360	76749
1967	11625	94206	46355	44406	80392
1968	12475	98481	51912	46862	74173
1969	11198	108678	54447	49294	72062
1970	11840	103490	54472	51320	83847
1971	19243	143445	67837	60533	102094
1972	22404	153386	74463	57662	107922
1973	11151	110162	54790	32530	82421
1974	10132	104291	54047	39284	96457
1975	8871	90729	42465	36518	63865
1976	9581	100067	52806	35716	58049
1977	10878	100258	53771	39609	67065
1978	11186	108639	58514	40281	68227
1979	10861	107624	52755	39980	68042
1980	11503	116630	61116	43790	62744
1981	12288	123773	62789	46722	70134
1982	12097	125929	57054	44836	71762

Note: Obtained by dividing the sectoral nominal wage by the National Accounts consumption deflator. Sectoral nominal wage, in turn, was computed as the ratio between the sectoral total wage bill (including social security) and employment.

Table 35— Employment

Year	Agriculture	Mining	Manufacturing	Services	Government	Total
			(millions of persons)			
1960	0.708	0.093	0.370	1.029	0.118	2.317
1961	0.688	0.093	0.392	1.038	0.126	2.337
1962	0.685	0.091	0.399	1.067	0.139	2.381
1963	0.689	0.088	0.410	1.093	0.154	2.433
1964	0.689	0.087	0.420	1.131	0.162	2.488
1965	0.691	0.086	0.443	1.160	0.168	2.547
1966	0.670	0.084	0.459	1.208	0.177	2.597
1967	0.655	0.084	0.471	1.295	0.175	2.679
1968	0.641	0.083	0.478	1.320	0.189	2.710
1969	0.642	0.085	0.482	1.319	0.195	2.723
1970	0.626	0.088	0.492	1.357	0.203	2.766
1971	0.594	0.091	0.535	1.419	0.217	2.857
1972	0.542	0.093	0.554	1.486	0.233	2.908
1973	0.516	0.105	0.545	1.500	0.226	2.891
1974	0.532	0.103	0.515	1.418	0.216	2.785
1975	0.542	0.101	0.477	1.300	0.240	2.661
1976	0.541	0.100	0.444	1.328	0.270	2.682
1977	0.550	0.096	0.450	1.405	0.269	2.770
1978	0.566	0.095	0.460	1.496	0.263	2.880
1979	0.563	0.093	0.478	1.575	0.267	2.975
1980	0.587	0.091	0.501	1.646	0.290	3.114
1981	0.595	0.086	0.514	1.757	0.285	3.238
1982	0.591	0.075	0.407	1.674	0.287	3.035

Note: The figures are for June 30 of each year.

Table 36— Labor force

Year	Nonagriculture Labor Force	Total Labor Force	Rate of Nonagriculture Unemployment	Rate of Off-farm Migration	Natural Rate of Growth of the Labor Force	Ratio of the Labor Force in Nonagriculture to That in Agriculture
	(millions of persons)					
1960	1.694	2.494	0.099	a	0.012	2.394
1961	1.759	2.540	0.110	0.029	0.013	2.558
1962	1.809	2.585	0.107	0.012	0.013	2.642
1963	1.854	2.630	0.102	0.005	0.014	2.691
1964	1.900	2.676	0.094	0.010	0.014	2.759
1965	1.945	2.721	0.086	0.008	0.014	2.817
1966	2.012	2.766	0.080	0.031	0.015	3.001
1967	2.072	2.811	0.061	0.025	0.015	3.164
1968	2.126	2.849	0.063	0.025	0.016	3.319
1969	2.153	2.881	0.071	0.008	0.016	3.352
1970	2.218	2.932	0.072	0.027	0.016	3.546
1971	2.283	2.969	0.047	0.042	0.017	3.842
1972	2.366	3.001	0.038	0.063	0.017	4.367
1973	2.417	3.037	0.058	0.035	0.017	4.685
1974	2.432	3.067	0.111	−0.007	0.018	4.576
1975	2.468	3.112	0.176	−0.001	0.018	4.551
1976	2.500	3.140	0.176	0.012	0.019	4.624
1977	2.528	3.174	0.154	0.001	0.019	4.595
1978	2.669	3.329	0.163	−0.005	0.019	4.719
1979	2.781	3.436	0.160	0.014	0.020	4.943
1980	2.846	3.523	0.139	−0.013	0.020	4.851
1981	2.943	3.624	0.128	0.004	0.020	4.946
1982	3.030	3.695	0.213	0.016	0.021	5.124

[a] Not applicable.

Table 37— Population

Year	Inhabitants	Year	Inhabitants
1960	7580000	1972	9700000
1961	7760000	1973	9860000
1962	7950000	1974	10030000
1963	8140000	1975	10200000
1964	8330000	1976	10370000
1965	8510000	1977	10550000
1966	8680000	1978	10730000
1967	8850000	1979	10920000
1968	9030000	1980	11104300
1969	9200000	1981	11294100
1970	9370000	1982	11504826
1971	9530000		

Table 38— Real prices

Year	Agriculture	Mining	Manufacturing	Services	Government
1960	0.969	0.931	1.008	1.089	0.820
1961	0.951	0.819	0.976	1.104	0.867
1962	0.982	0.804	0.946	1.084	0.918
1963	0.874	0.898	0.955	1.065	0.837
1964	0.910	0.851	0.954	1.001	0.802
1965	0.994	0.998	0.944	1.038	0.862
1966	1.023	1.157	0.921	1.018	0.952
1967	0.902	1.123	0.920	1.014	0.937
1968	0.806	1.129	0.946	1.017	0.910
1969	0.864	1.343	0.960	0.994	0.899
1970	0.822	1.167	0.957	0.962	0.991
1971	0.974	0.918	0.930	1.006	1.129
1972	1.228	1.042	0.889	1.055	1.200
1973	1.164	1.270	1.013	0.963	0.959
1974	0.923	1.586	1.103	0.915	1.136
1975	0.888	1.306	1.119	1.062	1.023
1976	0.977	1.230	1.090	1.007	0.956
1977	1.000	1.000	1.000	1.000	1.000
1978	0.920	1.031	0.981	1.005	1.015
1979	0.897	1.183	0.976	0.992	0.993
1980	0.924	1.125	0.980	0.962	0.988
1981	0.833	0.837	0.959	0.947	1.091
1982	0.729	0.885	0.910	0.992	1.122

Note: Nominal prices (NP_j) are National Accounts deflators of gross production, and the real prices are obtained by deflating with the consumption deflator, NP_j/PC.

Table 39— Real prices of value added

Year	Agriculture	Mining	Manufacturing	Services	Government
1960	1.024	1.073	1.014	1.086	0.859
1961	1.058	0.922	1.012	1.129	0.926
1962	1.056	0.853	1.031	1.114	0.936
1963	1.898	1.056	1.040	1.076	0.873
1964	0.962	1.004	1.021	1.073	0.837
1965	1.027	1.079	1.001	1.117	0.925
1966	1.018	1.333	0.974	1.154	1.024
1967	0.948	1.379	1.011	1.126	1.031
1968	0.831	1.338	1.090	1.115	1.023
1969	0.892	1.707	1.108	1.101	1.015
1970	0.858	1.435	1.109	1.080	1.215
1971	1.137	0.985	1.028	1.128	1.526
1972	1.301	1.227	0.985	1.161	1.672
1973	1.043	1.511	1.112	1.027	1.208
1974	0.740	1.710	1.311	0.980	1.270
1975	0.631	1.287	0.928	1.029	0.914
1976	0.875	1.196	1.069	0.989	0.886
1977	1.000	1.000	1.000	1.000	1.000
1978	0.882	1.000	1.036	1.032	1.028
1979	0.853	1.335	0.977	0.998	1.069
1980	0.870	1.186	0.989	1.002	1.079
1981	0.765	0.752	1.046	1.041	1.206
1982	0.593	0.845	0.969	1.067	1.280

Note: Nominal value-added prices (NP_{Vj}) are National Accounts deflators of value added, and the real prices are obtained by deflating with the consumption deflator, NP_{Vj}/PC.

APPENDIX 2: SUMMARY OF STOCHASTIC EQUATIONS

Production Functions

Agriculture Production Function

$$\ln(V_1) = \underset{(2.4)}{20.82} + \underset{(2.7)}{14.440} \cdot RA1_{t-1} - \underset{(2.3)}{1.942} \cdot PEAK_t + \underset{(4.8)}{0.0055} \cdot UAR - \underset{(3.5)}{1.109} \cdot D73$$

$$+ \underset{(7.7)}{0.1907^*} \cdot D82 \cdot \ln(K1A_{t-1}/L_1) + S_1 \cdot \ln(K1A_{t-1}/L_1) + \ln(L_1);$$

$R^2 = 0.95$, D.W. = 2.07, n = 21, and

$$S_1 = -\underset{(2.5)}{1.735} - \underset{(2.5)}{1.038} \cdot RA1_{t-1} + \underset{(3.6)}{0.243} \cdot PEAK - \underset{(3.4)}{0.00034} \cdot UAR$$

$$-\underset{(3.4)}{0.00014} \cdot UAR \cdot D6973 - \underset{(2.7)}{0.0665} \cdot D73 - 0.1907^* \cdot D82;$$

$R^2 = 0.85$, D.W. = 2.02, n = 21.

(*) Restricted coefficient across equations.
Numbers in parentheses are t-ratios expressed in absolute values.

These two stochastic equations were estimated, using 3SLS, jointly with the migration equation. The reported R^2 correspond to a simultaneous dynamic simulation of the agricultural subsystem that includes, in addition to these two equations, the migration function (equation 8), the identities of the supply and demand for labor (equations 6, 7, 9, and 12), urban employment (equation 11), and (lagged) rates of return (equation 16). The following variables of the production function were considered predetermined in the estimation: $RA1_{t-1}$, $PEAK_t$, UAR, $UAR \cdot D6973$, D73, D82, $K1A_{t-1}$, L_1.

Manufacturing Production Function

$$\ln(V_3) = -\underset{(4.7)}{86.106} + \underset{(2.6)}{15.029} \cdot \ln(I_3/K_{3t-1}) - \underset{(3.7)}{22.637} \cdot FEC + \underset{(3.7)}{41.196} \cdot FEC^2$$

$$+ \underset{(1.7)}{3.525} \cdot PEAK + \underset{(4.6)}{1.9638} \cdot D71 + \underset{(6.5)}{3.3485} \cdot D72$$

$$+ (1/2) \cdot \underset{(3.5)}{0.724^*} \cdot [\ln(K_{3t-1}/L_3)]^2 + S_3 \cdot \ln(K_{3t-1}/L_3) + \ln(L_3);$$

$R^2 = 0.94$, D.W. = 1.52, n = 21, and

$$S_3 = \underset{(5.6)}{12.20} - \underset{(2.4)}{1.101} \cdot \ln(I_3/K_{3t-1}) + \underset{(4.0)}{1.974} \cdot FEC - \underset{(3.9)}{3.485} \cdot FEC^2 - \underset{(1.6)}{0.270} \cdot PEAK$$

$$-\underset{(4.5)}{0.153} \cdot D71 - \underset{(6.3)}{0.259} \cdot D72 - 0.724^* \cdot \ln(K_{3t-1}/L_3);$$

$R^2 = 0.97$, D.W. = 1.56, n = 21.

(*) Restricted coefficient across equations (implying that factor shares are equal to production elasticities).

These two stochastic equations were estimated using 3SLS. The reported R^2 correspond to a simultaneous dynamic simulation of the manufacturing subsystem, which also includes the identity of the demand for labor (equation 6). The variables of the production function considered predetermined for the estimation were (I_3/K_{3t-1}), FEC, $PEAK$, $D71$, $D72$, K_{3t-1}.[29]

Services Production Function

$$\ln(V_4) = -\underset{(2.7)}{261.35} + \underset{(1.7)}{8.207} \cdot R_{4t-1} + \underset{(5.0)}{21.61} \cdot FEC - \underset{(2.2)}{13.44} \cdot ACM + \underset{(1.5)}{8.452} \cdot PEAK$$

$$+ \underset{(3.8)}{3.196} \cdot D72 + (1/2) \cdot \underset{(4.2)}{2.118}^*[\ln(K_{4t-1}/L_4)]^2 + SK_5 \cdot \ln(K_{4t-1}/L_4) + \ln(L_4);$$

$R^2 = 0.97$, D.W. = 1.77, n = 21, and

$$SK_4 = \underset{(3.2)}{34.373} - \underset{(1.5)}{0.595} \cdot R_{4t-1} - \underset{(4.8)}{1.622} \cdot FEC + \underset{(2.2)}{1.038} \cdot ACM$$

$$-\underset{(1.4)}{0.614} \cdot PEAK - \underset{(3.8)}{0.248} \cdot D72 - 2.118^* \cdot \ln(K_{4t-1}/L_4);$$

$R^2 = 0.91$, D.W. = 1.74, n = 21.

(*) Restricted coefficient across equations.

These two stochastic equations were estimated using 3SLS. The reported R^2 correspond to a simultaneous dynamic simulation of the services subsystem, which also includes the identity of the demand for labor (equation 6). The variables of the production function considered predetermined for the estimation were R_{4t-1}, FEC, ACM, $PEAK$, $D72$, K_{4t-1}.[30]

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[29] A fitted value of employment was also used as an instrument. This was obtained form a simultaneous simulation of the manufacturing subsystem, which was preliminarily estimated by the full information maximum likelihood estimator (FIML). Detected errors in the computation of FIML t-ratios made the results of 3SLS preferable.

[30] See footnote 29.

Mining Production Function

$$V_2 = \underset{(7.8)}{9008} - \underset{(7.1)}{24748} \cdot D7582 + \underset{(8.1)}{0.13506} \cdot K_{2t\text{-}1}$$

$$+ \underset{(6.4)}{0.20779} \cdot K_{2t-1} \cdot D7582 - \underset{(4.3)}{1111} \cdot ALLEN;$$

$R^2 = 0.977$, D.W. = 2.06, n = 22.

The equation was estimated by OLS.

Off-Farm Migration

$$m = \underset{(1.5)}{-0.052} + \underset{(2.2)}{0.051} \cdot \ln RL_{t-1} + \underset{(3.3)}{0.116} \cdot \ln d_{t-1} + \underset{(2.6)}{0.238} \cdot \ln(l-u_t)$$

$$+ \underset{(1.2)}{0.050} \cdot \ln(P_{1t-1}) + \underset{(3.2)}{0.056} \cdot D72;$$

$R^2 = 0.72$, D.W. = 1.9, n = 21.

The R^2 corresponds to a dynamic simulation of the agriculture block. The migration equation was estimated jointly with the agriculture production function using 3SLS. In the estimation $RL_{t\text{-}1}$, $d_{t\text{-}1}$, u_t, $P_{1t\text{-}1}$ were considered predetermined.

Nonagricultural Wages

Each of the sectoral wage equations was estimated using maximum likelihood. The expected rate of inflation (Δp_t^e) was derived from a regression with instruments indicated in the main text.

Dummy variables are included for the most turbulent years of the Allende administration (1972-73) and for 1974, the first year after the price liberalization. During 1972, public firms followed income policies reflected in higher wages. Also, private firms feared nationalization that gave a strong negotiation power to their workers. Therefore, the coefficient of the dummy for 1972 is expected to be positive. On the other hand, the unexpected price liberalization after September 1973 (prices nearly doubled in the last three months of 1973), when most of the wage contracts were already made, justifies the exclusion of 1973 by the dummy. Thus the coefficients of the dummies for 1973 were expected to be negative. The year 1974 was also turbulent; the percentage change of the annual average price level was 660 percent, and the effects of price liberalization on relative prices were still not completed. The number of dummies for these three turbulent years was reduced by pretest. For these reasons, the dummies appearing in the equations were included. In the case of manufacturing, after pretest, the effect of the dummy for 1972 was restricted to disappear in 1973. In services, the effect of the dummy for 1973 was restricted to disappear in 1974. In summary, wages during these three years cannot be explained by the economic variables appearing in the equations, and the dummies just measure the effects of other forces at play.

Mining Wages

$$w_{2t} = 1.0^{*} \cdot w_{2t-1} \underset{(1.0)}{-0.100} \underset{(1.5)}{-0.069} \cdot u_{mt} \underset{(12.5)}{+0.862} \cdot \Delta p_t^e + (1 - 0.862^{**}) \cdot \Delta p_{t-1} - \Delta p_t \underset{(2.7)}{-0.271} \cdot D73;$$

R^2 = 0.904, D.W. = 2.38, n = 20.

(*) Restricted coefficient: pretesting led to the conclusion that lagged changes in real wages do not affect current changes in wages. This is the specification most commonly used for the augmented Phillips curve.
(**) Restricted coefficient implying price homogeneity.

Manufacturing Wages

$$w_{3t} = \underset{(2.1)}{-0.196} \underset{(2.4)}{-0.102} \cdot u_{mt} \underset{(6.6)}{+0.749} \cdot w_{3t-1} \underset{(2.3)}{+0.344} \cdot w_{3t-2} + (1 - 0.749^{*} - 0.344^{*}) \cdot w_{3t-3} \underset{(14.1)}{+0.775} \cdot \Delta p_t^e + (1 - 0.775^{**}) \cdot \Delta p_{t-1} - \Delta p_t \underset{(3.3)}{+0.151} \cdot (D72 - D73);$$

R^2 = 0.914, D.W. = 2.13, n = 20.

(*) Restricted coefficient due to specification.
(**) Restricted coefficient implying price homogeneity.

Services Wages

$$w_{4t} = \underset{(3.0)}{-0.182} \underset{(3.3)}{-0.090} \cdot u_{mt} \underset{(14.7)}{+0.902} \cdot w_{4t-1} + (1 - 0.902^{*}) \cdot w_{4t-3} \underset{(21.6)}{+0.674} \cdot \Delta p_t^e + (1 - 0.674^{**}) \cdot \Delta p_{t-1} - \Delta p_t \underset{(6.2)}{-0.237} \cdot (D73 - D74);$$

R^2 = 0.944, D.W. = 2.67, n = 20.

(*) Restricted coefficient due to specification.
(**) Restricted coefficient implying price homogeneity.

Intersectoral Investment Allocation

This block includes three stochastic equations corresponding to the shares in investment of agriculture, mining, and manufacturing, and one identity corresponding to the share of services. Homogeneity and symmetry restrictions were introduced. Homogeneity, as defined here, implies $\sum_i h_{ij} = 0$, where h_{ij} is the coefficient of the expected rate of return of sector i in θ_j. Symmetry implies $h_{ij} = h_{ji}$. The identity for the share of services is obtained using the adding-up $\left(\sum_j \theta_j = 1\right)$ and the other constraints. The sectoral equations were estimated simultaneously using seemingly unrelated regressions method.

Agriculture Investment

$$\theta_1 = \underset{(5.6)}{0.182} + \underset{(2.3)}{0.403} \cdot R_1^e - \underset{(1.3)}{0.091} \cdot R_3^e - 0.312^* \cdot R_4^e - \underset{(2.5)}{1.063} \frac{I}{K_{t-1}} + \underset{(2.9)}{0.373} \cdot \theta_{1,t-1};$$

$R^2 = 0.559$, D.W. = 1.92, n = 20.

(*) Restricted coefficient.

Mining Investment

$$\theta_2 = \underset{(4.9)}{0.187} + \underset{(4.1)}{0.359} \cdot R_2^e - \underset{(2.8)}{0.196} \cdot R_3^e - 0.164^* \cdot R_4^e - \underset{(3.5)}{1.723} \frac{I}{K_{t-1}}$$

$$+ \underset{(4.9)}{0.507} \cdot \theta_{2,t-1} + \underset{(2.5)}{0.054}\, D73 + \underset{(1.7)}{0.041} \cdot D74;$$

$R^2 = 0.834$, D.W. = 1.69, n = 20.

(*) Restricted coefficient.

Manufacturing Investment

$$\theta_3 = \underset{(5.3)}{0.397} - 0.091^* \cdot R_1^e - 0.196^* R_2^e + \underset{(2.4)}{0.443} \cdot R_3^e - 0.156^* \cdot R_4^e + \underset{(2.0)}{0.406} \cdot R_3^t$$

$$- \underset{(2.8)}{1.965} \frac{I}{K_{t-1}} - \underset{(3.6)}{0.116} \cdot i - \underset{(1.9)}{0.047} \cdot D63 - \underset{(1.8)}{0.040} \cdot D71 - \underset{(3.3)}{0.086} \cdot D72 - \underset{(6.0)}{0.209} \cdot D74;$$

$R^2 = 0.776$, D.W. = 1.75, n = 20.

(*) Restricted coefficient.

Services Investment

The equation for this sector was not estimated. The reported parameters of the equation were obtained from the restrictions introduced to the system:

$$\theta_4 = 0.234^* - 0.312^* \cdot R_1^e - 0.164^* R_2^e - 0.156^* \cdot R_3^e + 0.631^* \cdot R_4^e$$

$$-0.406^* \cdot R_3^t + 4.751^* \frac{I}{K_{t-1}} + 0.116^* \cdot i - 0.373^* \cdot \theta_{1,t-1} - 0.507^* \cdot \theta_{2,t-1}$$

$$+ 0.047^* \cdot D63 + 0.040^* \cdot D71 + 0.086^* \cdot D72 - 0.054^* \cdot D73 - 0.168^* \cdot D74.$$

(*) Restricted coefficient.

Prices

Agriculture Price

Price equations for three different periods were estimated for this sector using OLS. As explained in the text, the last equation was the one used in some simulations:

Period 1975-82:

$$p_1 = \underset{(4.3)}{-0.136} + \underset{(1.9)}{0.251} \cdot p_{1T};$$

adjusted $R^2 = 0.28$, D.W. = 1.08.

Period 1976-82:

$$p_1 = \underset{(4.7)}{-0.128} + \underset{(3.0)}{0.409} \cdot p_{1T};$$

adjusted $R^2 = 0.56$, D.W. = 1.52.

Period 1977-82:

$$p_1 = \underset{(4.7)}{-0.112} + \underset{(3.7)}{0.677} \cdot p_{1T};$$

adjusted $R^2 = 0.72$, D.W. = 1.78.

Mining Price

$$p_2 = \underset{(2.0)}{-0.020} + \underset{(22.2)}{0.753} \cdot \ln p_{e2} + \underset{(12.4)}{0.086} \cdot \ln p_{m2} - \underset{(2.3)}{0.075} \cdot D71 + \underset{(3.2)}{0.111} \cdot D74;$$

$R^2 = 0.976$, D.W. = 1.7, n = 21.

The equation was estimated by OLS.

Manufacturing Price

$$p_3 = \underset{(1.9)}{-1.033} + \underset{(3.0)}{1.978} \cdot (X_{3et-1}/X_{3t-1}) \cdot p_{e3} + \underset{(7.4)}{0.195} \cdot p_{m3} + \underset{(1.9)}{0.097} \cdot w_3$$
$$- \underset{(3.6)}{0.103} \cdot D72 + \underset{(3.4)}{0.086} \cdot D74;$$

$R^2 = 0.91$, D.W. = 1.8, n = 21.

This equation includes the current wage. To avoid simultaneity bias, it was estimated by instrumental variable method, using lagged wage as an instrument for the current wage.

APPENDIX 3: REVIEW OF POLICIES AND INSTITUTIONS AFFECTING LABOR

This appendix contains a brief review of public policies and institutions affecting the labor market in Chile. For the purpose of understanding the behavior of wages, the most important policies were the official readjustment, indexation, and minimum wages. For a more complete description of labor market institutions, a brief summary of public policies regulating strikes, collective bargaining, and severance payments is also provided.

Wage Policies

General Review

Chile had already had a long experience of inflation before the period of analysis. For this reason, indexation of labor contracts based on previous inflation was an important institutional feature. Public policy also played a role in the labor market by establishing minimum wages, by changing the rules on automatic indexation, and by fixing floors for the readjustment of wages. Indexation and readjustments affected directly the whole range of wages. Minimum wages, especially the *sueldo vital*—which was applicable only to white-collar workers in the public and private sectors—were used as a reference in readjustments for bargaining on nonminimum wages. This intervention in the labor market was not constant through time.

The *sueldo vital*, created in 1937 for white-collar workers, was the first minimum wage. Two additional minimum wages were introduced later: the first, for agricultural workers, was created in 1953, and the minimum wage for industrial blue-collar workers, in 1956. The amount of these wages, their readjustments, and, if they had any, their indexation mechanisms, were determined by the government periodically. Since 1974, only one minimum wage has been determined by the government.

Period from 1960 to 1964. This period corresponds to the Alessandri administration, which began in 1958. Very heterogeneous wage policies were implemented in these years. The policies for the public sector were different from those ruling the private sector. Minimum-wage changes varied across and within sectors. There were several lump-sum bonuses, and some automatic indexation mechanisms applied. The years 1963 and 1964 are remarkable. In 1963 neither the public sector nor the private sector received official readjustments of wages, and in the next year only the public workers could readjust their wages.

During the first part of Alessandri administration, when a stabilization plan was implemented, average real wages increased.[31] After the failure of this stabilization plan, between 1962 and 1964, real wages fell (data on inflation rates are given in Table 40).

Period from 1965 to 1970. This period corresponds to the administration of Eduardo Frei, a Christian Democrat. This administration strongly emphasized income-redistribution goals. Besides the agrarian reform, wage policies and the strengthening

[31]The average real wages were measured as the total real wage bill of national accounts divided by total employment. Real values are obtained by dividing nominal values by the consumption deflator.

Table 40— Inflation during 1960-82

Year	Inflation, December-December, INE[a]	Annual Inflation, INE[a]	Annual Inflation, National Accounts
1960	5.5	11.6	. . .
1961	9.6	7.7	6.50
1962	27.7	13.9	12.74
1963	45.3	44.3	46.31
1964	38.5	46.0	50.81
1965	25.8	28.8	34.16
1966	17.0	22.9	24.83
1967	21.9	18.1	26.03
1968	27.9	26.6	34.22
1969	29.3	30.7	36.93
1970	34.9	32.5	42.83
1971	22.1	20.1	17.63
1972	163.4	77.8	80.30
1973	508.1	352.8	444.04
1974	375.9	504.7	661.60
1975	340.7	374.7	401.22
1976	174.3	211.9	240.86
1977	63.5	92.0	106.06
1978	30.3	40.1	54.14
1979	38.9	33.4	47.62
1980	31.2	35.1	30.72
1981	9.5	19.7	13.72
1982	20.7	9.9	12.22

Source: The INE data is from Banco Central de Chile, *Boletín Mensual* (Santiago: Banco Central de Chile, various issues); and the National Accounts data is from Banco Central de Chile, *Cuentas nacionales de Chile, 1960-1982* (Santiago: Banco Central de Chile, 1983).

[a]INE is the Chilean National Institute of Statistics.

of the union movement were envisaged as major tools to achieve redistribution. Unemployment and inflation were relatively low, and some success in reducing inflation was obtained during the first three years. On average, real wages of both the private and public sectors experienced substantial increases between 1965 and 1970. The annual rate of growth of real wages obtained from National Accounts was 5.6 percent.

Period from November 1970 to September 1973. This period corresponds to the administration of socialist Salvador Allende and can be divided into two subperiods. The first was from November 1970 until July 1972 and the second was from August 1972 until September 1973. In the first subperiod, the expansionist policies of expenditure and wages along with price controls were successful in controlling inflation, increasing real wages and employment at the same time. Minimum salaries were increased by 66.7 percent, while the rate of inflation computed by the National Institute of Statistics between December 1970 and December 1971 was 22.1 percent. The private and public sectors received obligatory readjustments equal to or even higher than the variation of the official consumer price index. During 1972, public firms followed income policies of higher wages. Private firms, fearing nationalization, had to make wage concessions as well.

The second subperiod is the "collapse." The increase in the fiscal deficit, monetary expansion, and wage hikes made since the first year of the administration accelerated the inflation, which jumped from a rate of 80 percent in 1972 to 444 percent in 1973, according to the National Accounts consumption deflator. Due to the acceleration of inflation, real wages started to fall. Since price controls continued, shortages appeared and black markets developed.[32] In spite of this, the data of the labor market does not show a break in the second subperiod, presumably because workers were not fired due to fear of intervention (nationalization).[33]

Period from September 1973 to end of 1981. This period corresponds to part of the Pinochet administration, which started in September 1973. The first step of the new regime was the abolishment of all price controls established during the socialist administration. This produced a big jump in the price level at the end of 1973. The unexpected price liberalization after September 1973 had its effect on wages. Prices nearly doubled in the last three months of 1973, but most of the wage contracts had already been made. Inflation between annual average price indexes continued to increase in 1974, reaching a level of 660 percent.[34] However, inflation between December and December started to decline in 1974 and continued falling until 1981.[35]

Important changes in laws and policies directly affecting the labor market were implemented. Two subperiods can be distinguished: from 1973 to June 1979, and from July 1979 onward. In the first, the most important characteristics were the absence of collective bargaining and the elimination of all automatic indexation systems. In the second subperiod, when the so-called "Labor Plan" was implemented, the administration fixed the minimum readjustments of wages for blue-collar and white-collar workers. The Labor Plan reinstated collective bargaining, but with an important modification; negotiations had to take place at firm level according to a schedule determined by the government. Before 1974, negotiations at a sectoral level were possible for unions of white-collar workers. This Labor Plan fixed a "wage floor" to the result of the negotiation consisting in indexation of 100 percent of the previous inflation. Workers not subject to negotiations or not affected by them had a minimum wage equal to the readjustments decreed by the government.

Period from 1982 onward. The year 1982 was one of crisis. Indexation was eliminated in June of that year, and readjustment laws began to apply only for the public sector. With these changes, the private sector was liberated of all regulation except minimum wages.

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[32]In this subperiod, the stock market began (in August 1972) a deep fall in real terms that would end with the beginning of the Pinochet regime.

[33]Allende not only mismanaged the economy, he also had bad luck; the average real price of copper (in June 1984 dollars per pound of copper) decreased from US$1.81 in 1970 to US$1.35 in 1971 and US$1.27 in 1972. This price recovered in March 1973 to reach an average for 1973 of US$1.87. The expansionist policies of 1971 could succeed despite the fall in copper only because international reserves were still high. When they were exhausted, in mid-1972, the collapse began.

[34]Inflation measured according to the National Accounts consumption deflator.

[35]There are no data of monthly inflation according to National Accounts, only according to the National Institute of Statistics (INE). This institution recorded the following rates of inflation between December of year $t-1$ and December of year t: 34.9 percent in 1970; 22.1 percent in 1971; 163.4 percent in 1972; 508.1 percent in 1973; 375.9 percent in 1974; 340.7 percent in 1975; 174.3 percent in 1976; 63.5 percent in 1977; 30.3 percent in 1978; 38.9 percent in 1979; 31.2 percent in 1980; 9.5 percent in 1981; and 20.7 percent in 1982.

Specific Review of Official Readjustments

Official readjustments of wages were among the most important instruments of public policy because of their broad application and their mandatory character—as a minimum change of wages—generally for both private and public sectors.

The official readjustments were determined in frequency, amount, and coverage by the government. For this purpose, the government explicitly considered the rate of inflation and the overall wage policy of the moment. The frequency of the readjustments varied between one and four times a year. The higher the inflation, the higher the frequency. Thus, during the 1960s and until 1971, when the rates of inflation and unemployment were relatively low, there was only one readjustment per year. During 1972-74, both inflation and the frequency of readjustments increased (two during 1972, two during 1973, and four during 1974). During 1975-82, the rate of inflation started to fall and the number of readjustments tended to decrease.

Also, although not officially recognized, fiscal policy and labor-market tightness were important considerations for the definition of this policy. During the 1960s, when unemployment was relatively low, the amount of the official readjustment was very similar to the previous inflation. However, when the rate of unemployment was high, the amount of the readjustment tended to be lower than the previous inflation. Thus, in 1974 and 1975, when the rate of unemployment increased, the accumulated readjustments within each year were much lower than the previous inflation. The same occurred in 1982, when unemployment increased and there was no readjustment.

Besides the endogeneity of the frequency and amount of official readjustments of wages according to inflation and labor-market tightness, it is important to show that these readjustments were not binding in the medium term. They indeed determined the short-term path of wages, but not their medium-term or longer-run behavior. In fact, the changes in nominal wages had only minor differences with respect to the readjustments in the months when the readjustments were decreed. However, in between the dates of the readjustments there were additional changes in wages that were relatively small on a monthly base, but were important when accumulated throughout the year. These changes plus the small differences between official readjustments and wage changes in the months of readjustments implied at the end that the readjustment policy was not binding for the determination of annual wages. Wages were determined more by market forces and relative negotiating power than by the official readjustments.

To evaluate the proposition that official readjustments of wages were not binding in the medium term, the actual path of wages is compared with the hypothetical behavior of wages had they followed the official readjustments. It is convenient to restrict the comparison to the period since April 1976. Before that month, the description of the readjustments is less clear because there were differences between readjustments applying to the public and private sectors. Also, before April 1976, the wage index was on a quarterly base and not on a monthly base.

Since the comparison should be made on a monthly base and the National Accounts implicit rate of wages is computed on an annual base, the Monthly Wage Index of the National Institute of Statistics is used. Although the evolution of both wage indices is not the same, since the coverage of firms included is different, the comparison well illustrates the point, because if the readjustment policy was binding for the determination of wages in general, it should also have been binding for the wages paid in those firms included in the index used here.

The coverage of the official readjustments is summarized in Table 41. Figure 50 shows the plots of a monthly index of the actual nominal wages and an index of wages if they had strictly followed the legal minimum readjustments for the period April 1976-December 1982. See Table 42 for the data of these indexes and the readjustments and changes in actual nominal wages as recorded by the National Institute of Statistics during the last six years of the study period.

Other Policies

Strike Policies

The description of strike legislation can be divided into two periods, 1932-79 and 1979-82.

The first global legislation for strikes was approved in 1932. The decree established the right to strike, but only in case of failure of a conciliation procedure. The law did not allow for the replacement of the strikers. No legal limits were imposed on the strike duration. The decree did not contemplate the possibility of the workers abandoning the strike or their individual bargaining for self-reincorporation. After the strike had begun, the employer could declare a lockout with a maximum duration of 30 days. The government could decide the end of strikes or lockouts if it considered it necessary given the "country's economic conditions."

The Labor Plan implemented in 1979 established a limit of 60 days for strike duration. With the new legislation, firms could replace the strikers, and workers could negotiate individually for their reincorporation after 30 days of strike. As earlier, the conciliation procedure was the first recourse in case of a collective conflict; if it failed, a strike could be declared, and if it was declared, the employer could begin a lockout with a maximum duration of 30 days.

Collective Bargaining Policies

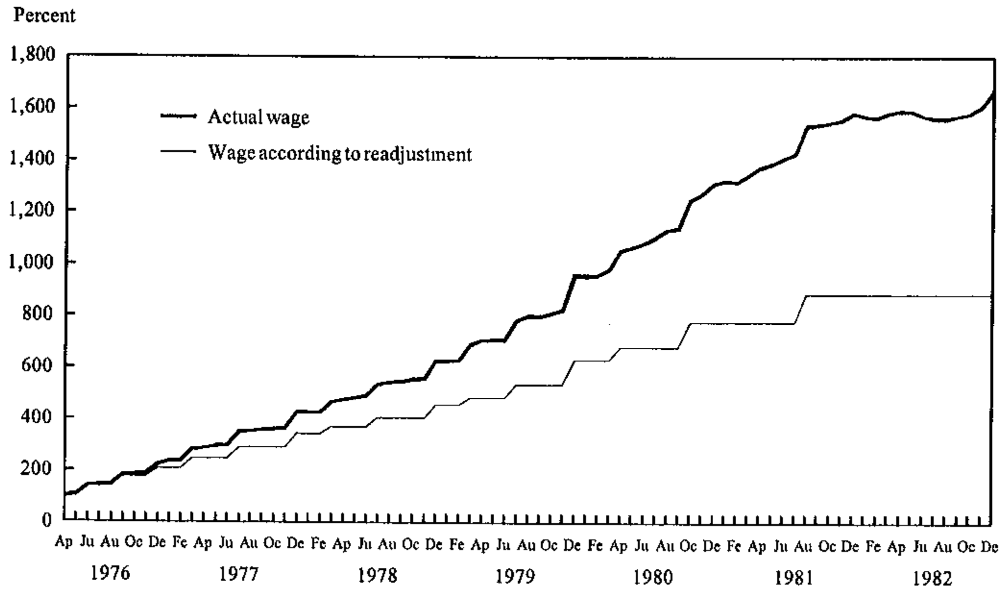
During 1931-73 all unions could negotiate within their firms. Bargaining at the sectoral level was also possible for white-collar unions. Collective bargaining was prohibited with the beginning of the Military Government, but it was reinstated with

Table 41— Coverage of official readjustments, 1953-82

Period	Coverage
1953-55	Public sector
1956-62	Private and public sectors
1963	None
1964	Public sector
1965-66	Private and public sectors
1967	Public sector
1968-81	Private and public sectors
1982 onward	Public sector

Source: For data until 1981, R. Saez, "Evolución de la indexación en Chile," *Notas Técnicas CIEPLAN* 49 (Santiago: Corporación de Investigaciones Económicos para América Latina, 1982); for data from 1982, A. Solimano, "Política de remuneraciones en Chile: Experiencia pasada, instrumentos y opciones a futuro," *Colección Estudios CIEPLAN* 25 (December 1988): 159-190.

Figure 50—Nominal wage index according to official readjustments and actual wage index, April 1976-December 1982



Source: Data on official readjustments were obtained from A. Mizala and P. Romaguera, "¿Es el sector público un sector líder en la determinación de los salarios? Evidencia para la economía chilena," *Colección Estudios CIEPLAN* 33 (December 1991): 59-93.

the implementation of the Labor Plan in 1979. Only negotiations at firm level were possible in the new legislation. Not only unions could participate in collective bargaining but also groups of workers associated with that purpose. It is important to note that since 1932, agreements have applied only for those workers who have participated in the negotiation. A rough dimension of the importance of unions and collective bargaining processes is given in Table 43.

Severance Payment Policies

Four stages of severance payment policies can be identified since 1931. From 1931 to 1966, the employer had to make a severance payment in case of termination or when an agreement to continue with the workers' services could not be reached. The severance payment corresponded to one month's wages for each year of work.

An important modification was introduced with the "Unremovability Law" in 1966; the employer could not terminate the contract without a justified cause. The court could ask for the reincorporation of the worker to the firm if it considered that the layoff was not justified. If the employer did not agree, he had to give a severance payment of a minimum of one month's wages per year of work. A second modification introduced in 1966 was that the employer could immediately terminate the contract without severance payment if the needs of the firm could be justified in the court.

Table 42—Official readjustments of wages and behavior of actual nominal wage rate, 1976-82

Year/Month	Official Readjustment	Change in Actual Wage	Wage Index According to Official Readjustment	Actual Wage Index
	(percent)			
1976				
April			100.00	100.00
May		2.74	100.00	102.74
June	39	36.09	139.00	139.82
July		1.35	139.00	141.71
August		2.91	139.00	145.83
September	26	25.33	175.14	182.77
October		1.35	175.14	185.24
November		1.05	175.14	187.18
December	18	19.41	206.67	223.52
1977				
January		5.24	206.67	235.23
February		0.21	206.67	235.73
March	19	19.63	245.93	282.02
April		1.30	245.93	285.68
May		3.32	245.93	295.18
June		0.67	245.93	297.16
July	18	17.40	290.20	348.86
August		1.02	290.20	352.41
September		1.60	290.20	358.06
October		0.80	290.20	360.94
November		0.78	290.20	363.76
December	18	18.10	342.44	429.58
1978				
January		−0.50	342.44	427.43
February		−0.27	342.44	426.28
March	8	9.51	369.83	466.84
April		1.86	369.83	475.53
May		1.56	369.83	482.93
June		1.46	369.83	489.96
July	10	9.47	406.81	536.38
August		1.25	406.81	543.11
September		0.83	406.81	547.59
October		1.52	406.81	555.91
November		0.47	406.81	558.54
December	12	12.56	455.63	628.68
1979				
January		0.03	455.63	628.86
February		0.05	455.63	629.18
March	6	9.90	482.97	691.46
April		2.55	482.97	709.07
May		0.31	482.97	711.27
June		−0.14	482.97	710.28
July	11	10.79	536.09	786.94
August		2.02	536.09	802.82
September		−0.05	536.09	802.45
October		1.48	536.09	814.35
November		1.02	536.09	822.63
December	18	17.00	632.59	962.45

(continued)

Table 42—Continued

Year/Month	Official Readjustment	Change in Actual Wage	Wage Index According to Official Readjustment	Actual Wage Index
	(percent)			
1980				
January		−0.54	632.59	957.23
February		0.38	632.59	960.83
March		2.30	632.59	982.91
April	8	7.40	683.20	1,055.66
May		1.07	683.20	1,066.96
June		1.59	683.20	1,083.94
July		2.02	683.20	1,105.86
August		2.56	683.20	1,134.14
September		0.63	683.20	1,141.28
October	14	9.54	778.85	1,250.11
November		1.79	778.85	1,272.54
December		3.27	778.85	1,314.21
1981				
January		0.92	778.85	1,326.30
February		−0.54	778.85	1,319.15
March		2.06	778.85	1,346.33
April		2.07	778.85	1,374.17
May		1.03	778.85	1,388.30
June		1.75	778.85	1,412.64
July		1.09	778.85	1,428.10
August	14	7.68	887.89	1,537.75
September		0.26	887.89	1,541.68
October		0.49	887.89	1,549.24
November		0.55	887.89	1,557.70
December		1.74	887.89	1,584.76
1982				
January		−0.82	887.89	1,571.77
February		−0.29	887.89	1,567.17
March		1.16	887.89	1,585.40
April		0.60	887.89	1,594.84
May		−0.21	887.89	1,591.56
June		−1.12	887.89	1,573.73
July		−0.62	887.89	1,564.02
August		0.01	887.89	1,564.20
September		0.63	887.89	1,574.10
October		0.60	887.89	1,583.56
November		1.78	887.89	1,611.80
December		3.37	887.89	1,666.08

Sources: Figures of Official Readjustment were obtained from A. Mizala and P. Romaguera, "¿Es el sector público un sector líder en la determinación de los salarios? Evidencia para la economía chilena," *Colección Estudios CIEPLAN* 33 (December 1991): 59-93; figures on Actual Wage Index were obtained from Banco Central de Chile, *Boletín Mensual,* various issues.

There was an important change in 1978. The severance payment due to eviction could be used to finish the labor contract. Therefore, workers could not resort to the court in case of eviction if the firm gave a severance payment equal to one month's wages (the last wage) per year of service.

Table 43— Unions, collective bargaining, and strikes, 1960-1982

Period	Unionized Workers		Workers Involved in Collective Bargaining		Workers Involved in Strikes per Year	
	Number	Percent of Total Employment	Number	Percent of Total Employment	Number	Percent of Total Employment
1960-64	268,195	11.4	196,850	8.3	111,485	4.4
1965-70	464,118	17.1	349,316	13.4	330,004	12.5
1971-73	818,949	29.0	318,696	11.3	459,336	16.3
1980-82	361,930	12.1	89,839[a]	3.0[b]	12,246	0.4

Source: Based on data from G. Campero and R. Cortázar, "Actores sociales y la transición a la democracia en Chile," *Colección Estudios CIEPLAN* 25 (December 1988): 115-158.

[a]The figure is an average for the period August 1981-May 1985. Before 1979 the length of collective contracts was one year. Since 1979 this length has been two years.

[b]The change of the length of collective contracts should be taken into account for the purpose of comparison with previous periods. If it is assumed that 50 percent of the workers bargain each year, the 3 percent negotiating every year under the new length means that 6 percent would have negotiated if the old length had remained unchanged.

Some modifications related to the case of termination were introduced in 1981. A maximum limit of 150 days was imposed on the severance payment for those workers who had been hired after August 14, 1981, and whose contracts had been signed at least one year before termination. No limit was imposed on contracts signed before August 14, 1981. Layoffs due to needs of the firm were also eliminated in this year.

GLOSSARY OF SYMBOLS OF VARIABLES USED IN THE EMPIRICAL ANALYSIS

The glossary symbols provide a short definition of the variables. The code j indicates that a variable corresponds to a sector j. The sectoral codes are 1, agriculture; 2, mining; 3, manufacturing; 4, services; 5, government.

A = cultivated land valued at 1977 prices.

ACM = ratio of accumulated off-farm migration to employment in services, computed as

$$ACM_t = \sum_{t=1960}^{t} MIG_t / L_{4t-1}.$$

A_{ij} = input-output coefficient indicating the level of input originating in sector i needed to produce a unit of gross product in sector j; both items are valued at 1977 prices.

$ALLEN$ = time trend for the three years of the Allende administration.

d = income differential between nonagriculture and agriculture, using nonagricultural wages and agricultural productivity, computed as WNA/Y_1.

D_j = depreciation of real capital stock, 1977 prices, equal to $d_j K_{jt-1}$.

d_j = rate of depreciation of the capital stock.

E = nominal exchange rate.

FEC = foreign exchange constraint, equal to the ratio to GDP (lagged one year) of the sum of the value of exports of goods and services, autonomous capital movements (including direct foreign investment) and transfers, international reserves at the end of the previous year less financial services, all these items divided by a price index of overall imports.

I = overall investment in fixed capital, 1977 prices.

i = rate of interest.

I_j = gross real investment in fixed capital, 1977 prices, sector j.

$K1A$ = real stock of capital in agriculture, including land. at the end of the year, in 1977 prices.

K_j = real capital stock of sector j at the end of the year, in 1977 prices.

K_t = overall real stock of capital at the end of the year, excluding land, in 1977 prices.

k_j = capital-labor ratio, computed as $\frac{K_{jt-1}}{L_{jt}}$, sector j.

L_j = employment in sector j, in millions of persons.

L_{na} = nonagricultural labor force, in millions of persons, computed as $L_T - L_1$.

L_T = overall labor force in the economy, in millions of persons.

M = number of off-farm migrants, between June of year t–1 and June of year t, in millions of persons.

m = proportion of the agricultural labor force that migrates to nonagriculture, computed as M/L_1.

n = natural rate of population growth in period t.

NW_j = nominal wage rate of sector j, computed as National Accounts wage bill (including social security) divided by employment.

$NWNA$ = weighted average of nonagriculture nominal wages, computed as

$$\sum_j NW_j \cdot L_j / \sum_j L_j \qquad j = 2,3,4,5.$$

$NY1$ = nominal agricultural average labor productivity net of indirect taxes, computed as

$$\frac{(V_1 - T_1)\,NP_{vj}}{L_1}.$$

P^*_{ej} = f.o.b. dollar price of sector j exports, computed as the National Accounts deflator of exports in domestic currency, at f.o.b. level, divided by the nominal exchange rate.

P^*_{mj} = c.i.f. dollar price of sector j imports, computed as the National Accounts deflator of imports in domestic currency, at c.i.f. level, divided by the nominal exchange rate.

P_1 = real price of agriculture, computed as NP_1/PC.

P^a_t = current adjustment price, equal to $\lambda p^e_t + (1 - \lambda)p_{t-1}$.

PC = National Accounts consumption deflator, equal to one in 1977.

$PEAK_t$ = peak of overall productivity lagged one year, defined by equation (42).

P_{ej} = domestic price of exports at user level, in 1977 pesos, computed as National Accounts deflator of exports at user level divided by PC, equal to one in 1977.

p^e_t = natural log of expected PC.

P_{hj} = price of nontraded component in sector j at user level, in 1977 pesos (deflated by PC).

P_{ij} = real price of input from sector i used in sector j, equal to NP_{ij}/PC.

P_j = real price of sector j, computed as NP_j/PC.

P_{kj} = real price (replacement cost) of capital stock in sector j, equal to NP_{kj}/PC.

P_{mj} = domestic price of the import component in the sector j product at user level, in 1977 pesos, computed as National Accounts deflator of imports at user level divided by PC, equal to one in 1977.

P_{1T} = real price index of the traded component in agriculture, computed as a weighted average of agricultural import and export prices (by using their shares in trade), deflated by PC.

NP_1 = nominal price of agriculture, computed as National Accounts deflator of gross output, equal to one in 1977.

NPI_i = nominal price of investment goods originating in sector i, equal to one in 1977.

NP_{ij} = nominal price of input from sector i used in sector j, equal to one in 1977.

NP_j = nominal price of sector j, computed as National Accounts deflator of gross output, equal to one in 1977.

NP_{kj} = nominal price (replacement cost) of capital stock in sector j, equal to one in 1977.

NP_{vj} = nominal price of value added of sector j, computed as National Accounts deflator of sectoral value added (nominal value added divided by real value added), equal to one in 1977.

POP = total population, in millions of persons.

p_t = natural log of PC.

PV_j = real price of value added of sector j, computed as NP_{vj}/PC.

$RA1$ = rate of return of agriculture capital stock, including land.

R_j = rate of return in sector j, computed as

$$\frac{(V_j - T_j)\,P_{vj} - W_j\,L_j - D_j\,P_{kj} - T_{kj}}{K_{jt-1}\,P_{kjt-1}} = \frac{S_j(V_j - T_j)P_{vj} - D_j\,P_{kj} - T_{kj}}{K_{jt-1}\,P_{kjt-1}}.$$

R_j^e = expected rate of return in sector j, computed from auxiliary regression as explained in Chapter 6.

R_j^t = transitory component of rate of return in sector j, computed as residual of auxiliary regression as explained in Chapter 6.

RK_j = real sectoral profits, defined in equation (39).

RL = ratio of the labor force in nonagriculture to that of agriculture, computed as L_{na}/L_1.

S_j = share of nominal nonwage income in nominal net value added of sector j, computed as

$$\frac{(V_j - T_j)\,NP_{vj} - NW_j\,L_j}{(V_j - T_j)\,NP_{vj}}.$$

S_L = share of total wages in total income, defined in equation (41).

t_{ej} = rate of subsidy on exports.

T_j = real indirect taxes paid by sector j, computed as nominal indirect taxes deflated by NP_{vj}, also equal to $t_j V_j$.

t_j = tax rate of indirect taxes paid by sector j.

T_{kj} = real direct tax on profits, computed as nominal tax deflated by PC, equal to $t_{kj}RK_j$.

t_{kj} = tax rate on profits.

t_{mj} = sum of tariff rate and trade margins on sectoral imports.

u = rate of nonagricultural unemployment, computed as

$$\left(L_{na} - \sum_i L_i\right) / L_{na} \qquad i = 2,3,4,5.$$

UAR	=	amount of land, quality adjusted, expropriated during a given year.
u_{nt}	=	ln $(0.02 + 0.5u_t + 0.5\,u_{t-1})$.
V_j	=	real value added of sector j, 1977 prices.
V_T	=	overall value added at 1977 prices.
W_j	=	real wage of sector j computed as NW_j/PC.
WNA	=	weighted average of real nonagricultural wages, computed as $NWNA/PC$.
X_j	=	real gross output of sector j, 1977 prices.
X_{jet}	=	real exports of sector j in year t, 1977 prices, obtained from National Accounts.
y	=	overall productivity, equal to V_T/POP.
Y_1	=	real agricultural average labor productivity net of indirect taxes, computed as $NY1/PC$.
θ_j	=	share of sector j in total investment in fixed capital, equal to I_j/I.

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