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by:

Antonio Saravia

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The Chilean agricultural transformation during the second half of the twentieth century: A story of institutional change

Antonio Saravia[a],

[a]*Department of Economics, American University of Sharjah, Sharjah, UAE*

Abstract

The second half of the twentieth century witnessed a dramatic transformation of the Chilean agricultural sector. From accounting for only five percent of the value of Chile's total exports in the late 1960s, agricultural exports grew to account for more than 30 percent of this value in the mid 1990s. Using a modified neoclassical growth formulation, we show that the transformation of the Chilean agricultural sector can be associated with *institutional changes* or modifications to the sector's basic functioning structure. In particular, our historical review shows that changes in the definition of property rights over land, caused by the Chilean agrarian reform first and the general economic reform later, seem to have greatly caused the changes in the sector's levels of investment and production.

Key words: Institutional Economics, Property Rights, Land Tenure, Agricultural Economics, Chile
JEL Classification: N56; O13; Q11; Q15

Email address: `asaravia@aus.edu` (Antonio Saravia).

1 Introduction

The performance of the Chilean agricultural sector during the second half of the twentieth century is considered one of the most successful and miraculous growth stories in Latin America. From accounting for only five percent of the value of Chile's total exports in the late 1960s ($ 27 million), agricultural exports grew to account for more than 30 percent of this value in the mid 1990s ($ 1.5 billion). [1]

While the Chilean agricultural transformation during this period has been explained as the result of macroeconomic (Larrañaga (1991), Muñoz and Ortega (1990), and Sanfuentes (1987)), microeconomic (Pietrobelli (1993)), and social policies (Kay (2002) and Cox, Niño de Zepeda, and Rojas (1990)), we believe that its underlying story can be better understood as a story of institutional change. As we argue below, the stagnation and posterior growth of the Chilean agricultural sector were the result of not only different public policies but also of the different structural frameworks or *institutions* under which these policies were implemented.

Institutions determine the basic functioning structure of an economic system and, therefore, the way in which agents interact and change the rules of their interaction. [2] In the case of the agricultural sector, a fundamental institution is given by the definition of property rights over land as this definition highly determines the appropriation of the returns on physical and human capital investments. Public policies such as credit subsidies or state funded technology, therefore, will have little effect changing agents' incentives if the definition of property rights over land remains constant.

As we show in our historical review, the definition of property rights over land in Chile did change in dramatic proportions during the second half of the twentieth century. From 1965 to 1973, the process of agrarian reform expropriated a startling 69 percent of Chile's basic irrigated land from large landowners and transferred it to peasants and small farmers. From 1974 to 1978, the *general economic reform* completely reversed this process and restituted the land to its original owners. Although several public policies simultaneously affected the agricultural sector, the expectations generated by the changes in the definition of property rights over land had a large effect on the performance of the sector.

Indeed, the rapid transformation of Chile's agricultural sector provides a valuable opportunity to analyze the combined effects of public policies and severe

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[1] Data in dollars of each year (Braun, et al. (2000)).
[2] A comprehensive survey of the literature on new institutional economics can be found in Williamson, O. (2000).

institutional changes implemented in a relatively short period of time. We perform this analysis in two steps. First, following a standard neoclassical growth formulation, we build a model that characterizes the transitional dynamics of the sector's saving-investment equilibrium under the realization of exogenous institutional and policy shocks. Second, we match the predictions of our model with available historical evidence.

Section two describes our model and visits the implications of changing key parameters associated with the definition of property rights over land, prices (including tariffs, exchange rates, wages, and credit), and technological progress. This section follows the classic continuous version of the neoclassical growth formulation as in Abel and Blanchard (1983).

Section three presents a historical review of the Chilean agricultural sector dividing our period of study in three subperiods: 1965 - 1973 (the process of agrarian reform), 1974 - 1981 (post general economic reform), and 1982 - 1994 (the new agricultural sector). Section four interprets the previous historical analysis in terms of our theoretical model and contrasts its predictions with available historical evidence. Section five concludes.

2   A simple model of partial equilibrium

Using the standard neoclassical growth formulation, our model characterizes the transitional dynamics of the saving-investment equilibrium in the Chilean agricultural sector under the presence of adjustment and transaction costs for investment. These costs are given, in turn, by the agents' valuation of the definition of property rights over land.

The agents are a mass of infinitely-lived consumers and a mass of value-maximizing firms. The firms produce the agricultural good which can be used for consumption or investment. All variables have been defined in units of labor and land.

2.1   Utility maximization by consumers

We assume that the representative consumer inelastically supplies one unit of labor and receives a wage w in each period, t. She chooses a sequence of consumption that maximizes the present value of utility,

$$\int_0^\infty U(c_t)e^{-\beta_t}d_t \tag{1}$$

where c is the consumption level and β the discount factor. [3]

Consumers own both factors of production and receive dividends from the firm (which, given the competitive characteristics of the model, are zero). The budget constraint is, therefore:

$$c_t + i_t\left[1 + h\left(\frac{i_t}{k_t}, \phi_t\right)\right] = w_t + r_t k_t \qquad (2)$$

where i is the level of capital investment, k is the stock of capital, ϕ represents the agent's valuation of property rights over land, w is the nominal wage in the agricultural sector, and r is the payment for capital.

The function h captures the presence of adjustment and transaction costs for capital investment. It depends positively on the amount invested in relation to the stock of capital (adjustment or installation costs) and negatively on the agent's valuation of property rights over land (transaction costs). [4] This assumption is at the core of our argument. A context of land expropriation that generates high investment uncertainty decreases ϕ (increases transaction costs for investment) and, other things equal, decreases i. The parameter ϕ can also be interpreted as representing the possibility of offering land property as credit collateral. A context of land expropriation would reduce this possibility, increase transaction costs for investment, and decrease i. [5]

The stock of capital grows following the rule,

$$\dot{k}_t = i_t - \delta k_t, \qquad k_0 = \bar{k}_0 \qquad (3)$$

where δ is a constant depreciation rate and the initial stock of capital is given by $\bar{k}_0$.

2.2 Profit maximization by firms

Profits for the representative firm can be written as:

$$\Pi_t = p_t y_t - w_t - r_t k_t \qquad (4)$$

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[3] Interior solutions are guaranteed by assuming $U'() > 0$, $U''() < 0$, and $U'(0) = \infty$.
[4] The formalization of adjustment costs is based on the classic work of Eisner and Strotz (1963) and Lucas (1967).
[5] Formally, h satisfies: $h(0, \infty) = 0$, $h_{\frac{i}{k}}() > 0$, $h_\phi() < 0$, $h_{\frac{i}{k}\frac{i}{k}} = h_{\phi\phi} = h_{\frac{i}{k}\phi} = h_{\phi\frac{i}{k}} = 0$.

where y_t is the agricultural product per unit of labor and land, and the exogenous agricultural price is defined as:

$$p_t = Pa_t^\theta[(1+\tau_t)Pa_t^*e_t]^{1-\theta} \tag{5}$$

where Pa is the internal agricultural price level, Pa^* is the international agricultural price level, τ is the effective nominal rate of protection received by the sector, e is the real exchange rate, and θ is a positive parameter less than 1.

The representative firm maximizes profits in each period subject to its production technology:

$$y_t = f(k_t) \tag{6}$$

We assume that y exhibits decreasing marginal returns to k.[6]

2.3 Equilibrium in the agricultural sector

The competitive equilibrium condition requires:

$$p_t y_t = c_t + i_t \left[1 + h\left(\frac{i_t}{k_t}, \phi_t\right)\right] \tag{7}$$

Notice that, for the purposes of our analysis, this equation is not to be interpreted as a general equilibrium but as a partial equilibrium condition for the agricultural sector.

2.4 The central planning problem

The absence of tax distortions allows us to solve the model as a social planner maximization problem:

$$\underset{c_t}{Max} \int_0^\infty U(c_t)e^{-\beta_t}dt \tag{8}$$

subject to:

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[6] Additionally, f satisfies $f'(\infty) > 0$, $f''(\infty) < 0$, and $f'(0) = \infty$.

$$p_t f(k_t) = c_t + i_t \left[1 + h\left(\frac{i_t}{k_t}, \phi_t \right) \right] \tag{9}$$

$$\dot{k}_t = i_t - \delta k_t, \qquad k_0 = \bar{k}_0$$

and the conditions:

$$
\begin{aligned}
U'() &> 0, & U''() &< 0, & U'(0) &= \infty \\
f'(\infty) &> 0, & f''(\infty) &< 0, & f'(0) &= \infty \\
h(0, \infty) = 0, \quad h_{\frac{i}{k}}() &> 0, & h_\phi() &< 0, & h_{\frac{i}{k}\frac{i}{k}} = h_{\phi\phi} = h_{\frac{i}{k}\phi} = h_{\phi\frac{i}{k}} &= 0
\end{aligned}
$$

The Hamiltonian is:

$$e^{-\beta t} \left[U\left(p_t f(k_t) - i_t \left(1 + h\left(\frac{i_t}{k_t}, \phi_t \right) \right) \right) + m_t (i_t - \delta k_t) \right] \tag{10}$$

where m_t is the shadow price of an additional unit of capital in period t. Following Abel and Blanchard (1983) we define:

$$x_t \equiv \frac{i_t}{k_t} \qquad \text{and} \qquad H(x_t, \phi_t) \equiv 1 + h(x_t, \phi_t) + x_t h_x(x_t, \phi_t) \tag{11}$$

The first order conditions can then be written as:[7]

$$U'(c_t) H(x_t, \phi_t) = m_t \tag{12}$$

$$\dot{m}_t = (\beta + \delta) m_t - U'(c_t) [p_t f'(k_t) + x_t^2 h_x(x_t, \phi_t)] \tag{13}$$

$$\lim_{t \to \infty} e^{-\beta t} m_t k_t = 0 \tag{14}$$

These conditions are easy to interpret. Equation (12) requires the marginal opportunity cost of investment to be equal to the shadow price of capital (a measure of the value of a unit of capital in terms of utility units), m. A decrease

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[7] These conditions are necessary and sufficient as the problem satisfies the conditions of the Weitzman (1973) theorem.

in ϕ would imply a higher marginal cost of investment and, in equilibrium, require a higher m.

In equation (13), given that $x_t^2 h_x(x_t, \phi_t)$ is the reduction in the opportunity cost of investment when adding a unit of capital, $p_t f'(k_t) + x_t^2 h_x(x_t, \phi_t)$ is the total marginal product of capital. Combining equations (13) and (14) we get:

$$m_t = \int_t^\infty U'(c_s)[f'(k_s) + x_s^2 h_x(x_s, \phi_s)]e^{-(\beta+\delta)(s-t)}ds \qquad (15)$$

This equation implies that the shadow price of capital must equal the discounted value of the total marginal product of capital measured in utility units. Equations (12) and (15) generate the equilibrium condition for the competitive firm in each period: value of the marginal product equals marginal cost.

2.4.1 Steady state

In steady state (ss) $\dot{m} = \dot{k} = 0$, the investment capital ratio is equal to the depreciation rate, $x_{ss} = \delta$, and the capital stock is given by a *modified golden rule*:

$$pf'(k_{ss}) + \delta^2 h_x(\delta, \phi) = (\beta + \delta)(1 + h(\delta, \phi) + \delta h_x(\delta, \phi)) \qquad (16)$$

This rule implies $pf'(k_{ss}) > \delta + \beta$. Notice that this is the result of increasing the opportunity costs of investment in relation to the standard neoclassical growth model where $pf'(k_{ss}) = \delta + \beta$.

The system of equations (3), (12), and (13) form a dynamic system in (k, m, x) that we characterize for (k, x) for a given value of m. The theoretical movements of these variables after institutional or policy shocks can be obtained from the phase diagram in Figure 1. An additional advantage of this characterization is that k and x can be empirically observed. Section 4 below provides this analysis.

Combining equations (10) and (12), and differentiating equation (12) with respect to time and combining it with equation (13),
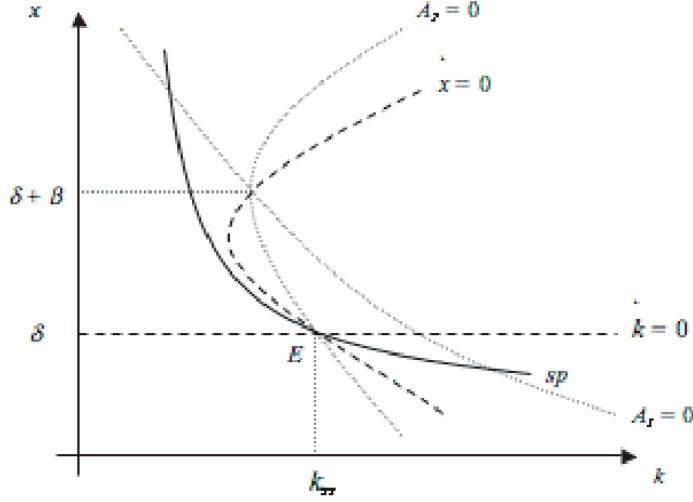
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Fig. 1. Phase diagram

$$\left[H_x(x,\phi) - \frac{U''(c)}{U'(c)}H^2(x,\phi)k\right]\dot{x}$$
$$= \left[(\beta+\delta)H(x,\phi) - x^2hx(x,\phi) - pf'(k)\right]$$
$$- \frac{U''(c)}{U'(c)}H(x,\phi)\left[pf'(k) - x(1+h(x,\phi))\right]\dot{k} \quad (17)$$

which can be simplified as $A_1\dot{x} = A_2 + A_3\dot{k}$ with obvious definitions for $A_{1,2,3}$. This equation together with $\dot{k} = k(x-\delta)$, which results from applying equivalence (11) to equation (3), characterize the equations of motion.

The loci of points $A_2 = 0$, $A_3 = 0$, and $\dot{k} = 0$ in Figure 1 represent the combinations of x and k that keep these expressions equal to zero. These curves delimit the areas in which $\dot{x} = 0$. Notice also that the steady state saddle path equilibrium is given by the intersection of $A_3 = 0$ and $\dot{k} = 0$. The transversality conditions ensure that this equilibrium is stable. Convergency of x and k to their equilibria values is monotonous. The Appendix shows a detailed construction of the phase diagram.

The prices that solve the profit maximization by firms are:

$$r_t = p_t f'(k_t) \quad (18)$$

$$w_t = p_t f(k_t) - r_t k_t \quad (19)$$

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The equations of motion and the prices given by equations (18) and (19) characterize the competitive (partial) equilibrium of the model.

2.4.2 Change in the definition of property rights

Interpreting the parameter ϕ as the investor's valuation of property rights over land allows us to study the effects on investment, capital, and production levels, of exogenous institutional shocks that affect this parameter.

Given our assumptions about the function h, $h_\phi() < 0$ and $h_{\phi\phi}() = h_{\frac{i}{k}\phi} = 0$, and the presence of decreasing marginal returns to k, the loci $A_2 = 0$ and $A_3 = 0$ shift to the left when ϕ decreases. Both curves also decrease their slope in absolute value (see the appendix). As a result, the steady state saddle path equilibrium shifts backwards while also decreasing its slope.

When investors in the agricultural sector lower their valuation of property rights (after an exogenous institutional shock), therefore, the investment level, the stock of capital, and the production level in equilibrium, all fall. Figure 2 shows the transition of k_{ss}.

Notice that the smaller slope of the saddle path determines a slower conversion. Furthermore, the transition from E_0 to E_1 depends on the formation of expectations by the agricultural producer. In a context of rational expectations, the model determines an instantaneous jump to the new saddle path as shown by the straight arrow. If, on the contrary, expectations are formed adaptively, the reaction is slower as shown by the curved arrow. The conversion to the new steady state point can be understood as the passive attitude of letting the stock of capital to naturally depreciate.

Additionally, given that $H_\phi(x, \phi) < 0$, and using equations (10) and (12), we can see that a decrease in ϕ increases the shadow price of capital, m.

The results are symmetrically opposite if ϕ increases.

2.4.3 Change in the price level

The model also allows us to study the effects of a change in the price level, $p_t = Pa_t^\theta[(1 + \tau_t)Pa_t^* e_t]^{1-\theta}$, faced by the agricultural producer. An increase in p generated by, for example, an increase in τ or e, shifts $A_2 = 0$ and $A_3 = 0$ to the right while increasing their slopes. The steady state saddle path equilibrium also shifts to the right and the shadow price of capital decreases. Figure 3 shows this analysis.

As we will see in the next section, the evolution of the Chilean agricultural
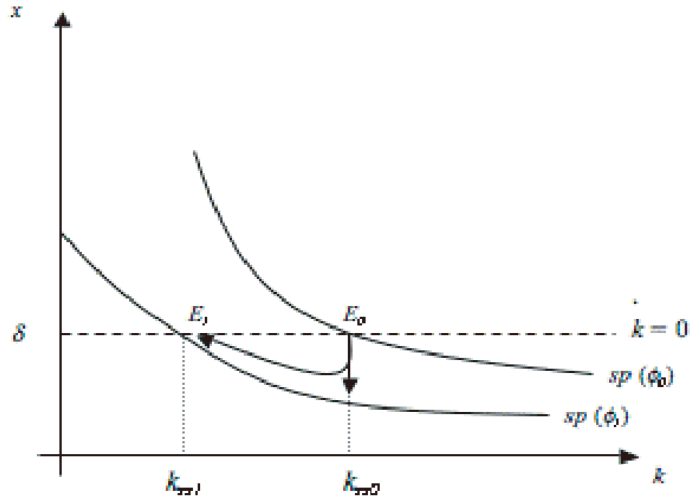
Fig. 2. A decrease in ϕ
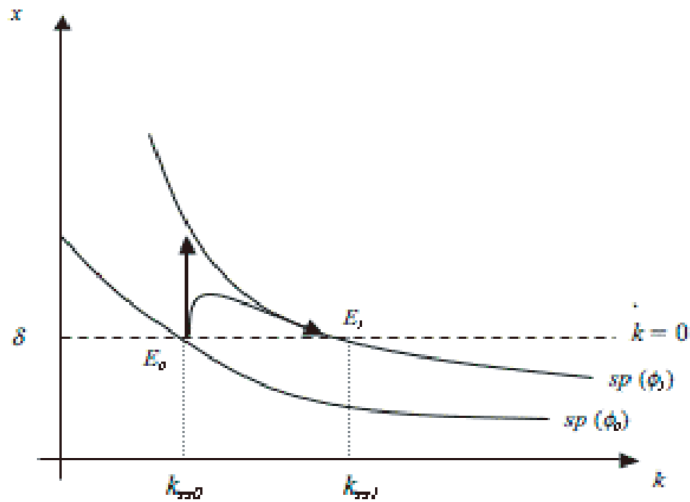

Fig. 3. An increase in p

sector was partially the result of price incentives and protective measures during the period of analysis.

2.5 Technological progress

The model also allows us to study long-run growth by introducing the effects of exogenous technological progress in the production function. Let $f(k)$ be defined now as:
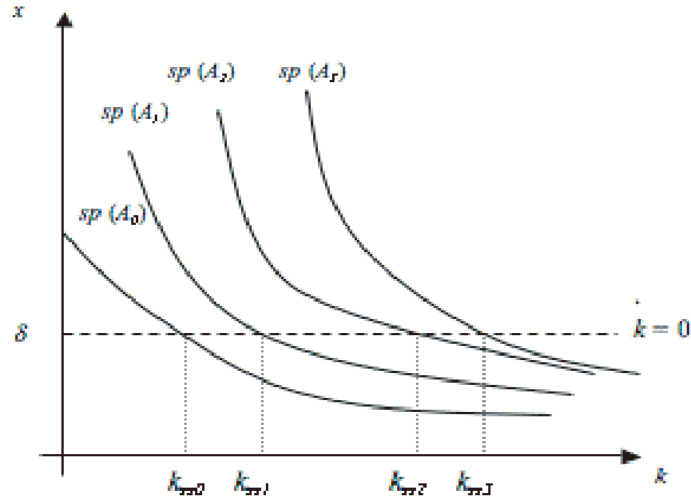
$$f(k_t) = A_t k_t^\alpha \tag{20}$$

Fig. 4. A continuos increase in A

where A is the coefficient of technological progress and follows an autoregressive process, $A_t = A_{t-1} + v_t$, where v_t is white noise.

An increase in A shifts all the curves in the phase diagram to the right increasing, in turn, the stock of capital and production level in steady state. Depending of the realization of the autoregressive process, the variables in steady state could increase in every period as in Figure 4.

Finally, it is easy to verify that these results also hold when assuming increasing marginal returns, $f''(k) > 0$. The curves in the phase diagram, however, would be a mirror image of the original ones and the steady state equilibrium would no longer be stable. [8]

The next section reviews the history of the Chilean agricultural sector from 1965 to 1994 in terms of the parameters emphasized by our model.

3   The Chilean agricultural sector from 1965 to 1994

3.1   A brief historical background: The import-substitution-industrialization strategy

The Chilean Law of Agrarian Reform was enacted in 1962 during the administration of Jorge Alessandri. Its general objectives were to increase production

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[8] Given the typical heterogeneity of an agricultural sector, this assumption may be a more appropriate formulation for the production technologies of particular agricultural products.

and productivity at all levels while incorporating peasants and small producers into land ownership (ODEPLAN (1968)).

The history of the agrarian reform started, however, several years before its implementation. The great depression of the 1930s had severely affected the Chilean economy - which was heavily dependent on mineral exports - leading to an overall crisis and restructuring process. The crisis not only decreased exports revenue for most industries, but also increased their production costs as most of their physical capital was imported.

The response of the Chilean state, as in most South American countries, consisted in the implementation of inward-looking development strategies in order to develop the manufacturing sector and protect the national economy from the volatility of international markets. The new economic paradigm, known as the import-substitution-industrialization (ISI) strategy, comprised a package of policies that included import tariffs, exchange rate controls, extensive industrial regulation, public investment in infrastructure, and the provision of public credit.

The combination of protectionist policies and the active participation of the state in the economy, did result in a local industrial boom. Industrial production grew at an annual average of 5.1 percent between 1937 and 1964 and, by the end of this period, accounted for 25 percent of the Chilean GDP (Muñoz (1971)).[9]

As it is usually the case when protectionist policies are implemented, however, while some sectors expand, others tend to lag behind. In Chile, the success of the industrial sector during this period, sharply contrasted with the poor performance of the agricultural sector. As industrial production increased and the urban sector expanded, the agricultural sector increasingly failed to cover the local market for food. Agricultural production grew at an annual average of 1.8 percent from 1930 to 1964 while the population grew at an average of 2.2 percent and the demand for agricultural products increased by 3 percent (Kay (1992)). Furthermore, during the same period, the percentage of agricultural production in the GDP fell from 15 to 10 percent while the percentage of agricultural labor in the total labor force fell from 35 to 20 percent (Kay (1977)).

The government of Jorge Alessandri deemed that the reasons behind this poor performance were not only the relative neglect of agriculture as the state concentrated in the industrial sector, but also the unequal land tenure structure. As a result, it was argued, the sector was unable to accumulate physical and human capital, generate technological progress, and increase the general level

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[9] By 1964, government expenditure had reached 40 percent of GDP and public investment accounted for half of total investment (Muñoz (1971)).

of production (ODEPLAN (1968) and Coeymans and Mundlack (1989)).

The distribution of land was indeed extremely unequal. In 1965, small peasant landowners or *minifundistas* accounted for 37 percent of the farms but had only 1 percent of the arable land. Large-landed estate owners or *latifundistas*, on the other hand, accounted for 7 percent of the farms but owned 65 percent of the arable land (CIDA (1966)). While *minifundistas* had too much labor and not enough land, the opposite was the case for *latifundistas*. As a result, land productivity (labor productivity) was low (high) for the former and high (low) for the latter.

Given that the country had a relative surplus of labor but a relative shortage of land, it was considered important to prioritize increases in land productivity rather than in labor productivity. The government considered, therefore, that a more equalitarian land ownership would yield higher rates of agricultural growth while improving living conditions for peasants and *minifundistas*.

The government's relative neglect of agriculture, in turn, translated not only in less public spending and investment for the sector, but also in unfavorable exchange rate and trade policies. The active participation of the state in the economy, including the ISI strategy, contributed to trigger an inflationary process that the government tried to control by keeping the domestic currency overvalued (with exceptions made for "key" industrial products). The overvaluation of the Chilean currency, together with the shortage of local agricultural products, encouraged imports and discouraged food exports (Valdés (1973)). [10]

In practice, the process of agrarian reform concentrated in redistributing the land tenure structure and did little to compensate the government's relative neglect of the sector. Although land expropriation was not strongly enforced from 1962 to 1965, [11] it progressively accelerated its pace after the latter year reaching its most intensive period from 1970 to 1973. In September of 1973, however, the military government of Augusto Pinochet began to reverse the process.

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[10] Although Valdés, Muchnik, and Hurtado (1990) points out that taxation and credit policies were relatively beneficial to agriculture, on balance "it is fair to say that agriculture was discriminated against by public policy" during this period.
[11] The opposition parties came to call it *"reforma de macetero"* (or "flowerpot reform") given its little significance and enforcement.

The Law of Agrarian Reform, implemented in the context of the ISI strategy, radically changed the institutional set of the agricultural sector. We organize our analysis by separately looking at the three parameters emphasized by our model: land reform, price incentives faced by the agricultural producer, and technological progress.

3.2.1   Land reform

As we mentioned before, although the Law of Agrarian Reform was enacted in 1962, the redistribution of land was not fully implemented until 1965. The process started by encouraging *latifundistas* to become modern and efficient or else suffer expropriation, and progressively transformed itself into forceful *tomas* or seizures by peasants' settlements.

During the first years, only farms above 80 basic irrigated hectares (BIH) were expropriated.[12] Under certain conditions, however, landlords were able to retain a farm of up to 80 BIHs as a "reserve."[13] From 1965 to 1970, an annual average of 236 farms were expropriated particularly in the central part of the country (regions V and VII). By 1970, a quarter of all farms above 80 BIHs had been expropriated and reassigned to peasants and small farmers (Kay (2002)).

During the government of Salvador Allende (1970 - 1973), land reform rapidly accelerated as the agrarian question became a political instrument of proletarian empowerment. Farms above 80 BIHs (and in some cases smaller) were now expropriated regardless of how well they were farmed. As Table 1 shows, 4,691 farms were expropriated during the 1970 - 1973 period. To put this number in context, 1118 farms were expropriated during the 1965 - 1969 period. By 1973 almost 6,000 farms had been expropriated and latifundia had ceased to exist (Kay (1978), ODEPLAN (1968)).

Additionally, Table 2 shows the number of hectares expropriated as a percentage of total productive land. As we mentioned in our introduction, 69 percent of total BIHs were expropriated between 1965 and 1973.

The institutional change generated by this severe attack on property rights

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[12] As Kay (2002) defines it, a BIH is a unit of "good" quality land use for standardizing land quality. For example, a farm of 500 ha. of poor quality could measure less than 80 BIH.

[13] Some landlords avoided expropriation by dividing their land into several farms smaller than 80 BIHs (Kay (2002)).

Table 1
Number of farms and hectares expropriated by land quality, 1965 - 1973

		Number of hectares				
Year	Farms (#)	BIH	Arable	Non arable	Total	Average size
1965	99	41,300	21,463	476,960	539,723	5,451
1966	265	57,800	38,724	428,647	525,721	1,981
1967	217	50,600	32,269	202,020	284,889	1,312
1968	223	44,700	36,773	574,394	655,867	2,941
1969	314	54,300	86,451	728,097	868,848	2,767
1970	297	41,600	398,339	778,410	1,218,349	4,102
1971	1,374	177,600	378,377	1,472,622	2,028,599	1,476
1972	2,189	211,800	308,735	2,488,711	3,009,246	1,374
1973	831	49,800	199,769	585,639	835,208	1,005
Total	5,809	729,500	1,500,900	7,735,500	9,965,900	1,715

Source: Garrido (1988).

Table 2
Hectares expropriated as a percentage of total productive land, 1965 - 1973

	BIH	Arable	Non arable	Total
Productive land	1,055,349	2,277,580	24,829,962	28,162,891
Expropriated land	729,500	1,500,900	7,735,500	9,965,900
Percentage	69	66	31	35

Source: Garrido (1988).

over land raised the transaction costs of capital investment in the sector. At least two factors point in that direction:

Risk and uncertainty

A process of land expropriation naturally generates high investment uncertainty. Landowners and large agricultural producers were not only *asked* to leave the industry but their compensation payments hardly ever reflected the value of their farms.

On average, only 10 percent of the value of the expropriated farm was paid in cash (5 percent if the farm expropriated was deemed not have been efficiently used) while 90 percent was promised to be paid in 25 years (Echenique (1970)). As we mentioned above, the repayment value hardly ever coincided with the market value of the farm and, starting in 1967, it was not adjusted

for inflation.[14]

The investment environment was not better for landowners that managed to keep their land or at least a reserve of it. The co-existence with neighboring peasants' settlements was always difficult and uncertain. The two groups had, of course, antagonistic objectives and their relationship was first based on distrust and then purely confrontational. During Allende's government, many peasants took the law into their own hands and began violent *tomas* under a tolerant political climate and the influence of left-wing parties.

Additionally, labor relationships between salaried peasants who remained in the reserve and landowners were also difficult and uncertain. The number of workers belonging to unions increased from about 2000 in 1965 to more than 140,000, or over a third of all agricultural workers, in 1970. Strikes also increased from 648 in 1968 to 1580 in 1970 (Silva (1992)).

Misuse of economies of scale

- Land atomization

Most of the land expropriated was distributed to atomized peasant organizations that not only faced physical obstacles to integrate but also had economic incentives to develop private individual farms rather than collective plots. As we will see below, the government controlled most agricultural prices keeping them artificially below their market value. As black markets flourished, peasants preferred to sell from their household plot rather than from a collective land plot at the official price.

- Lack of physical capital, managerial capacity, and economic incentives

Peasants' settlements did not usually have physical capital and technology for large or industrial scale production. As Garrido (1988) points out, landowners would usually choose their reserve in the portion where the basic infrastructure and machinery was set. Although some landowners would, ex-post, sell their capital to the settlements, these organizations still lacked the managerial capacity to take advantage of economies of scale.

The government policy of *anticipos* (or advance payments) also contributed to the reduction of incentives for large scale and efficient production. As part of the reform, the government paid the peasants a monthly advance to be deducted at the end of the agricultural year from profits. Given the poor performance of the sector, however, peasants accumulated large debts with the government. As the latter did not enforce the repayment of these debts -

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[14] The annual inflation average from 1967 to 1970 was 28.5 percent (Banco Central de Chile (1998)).
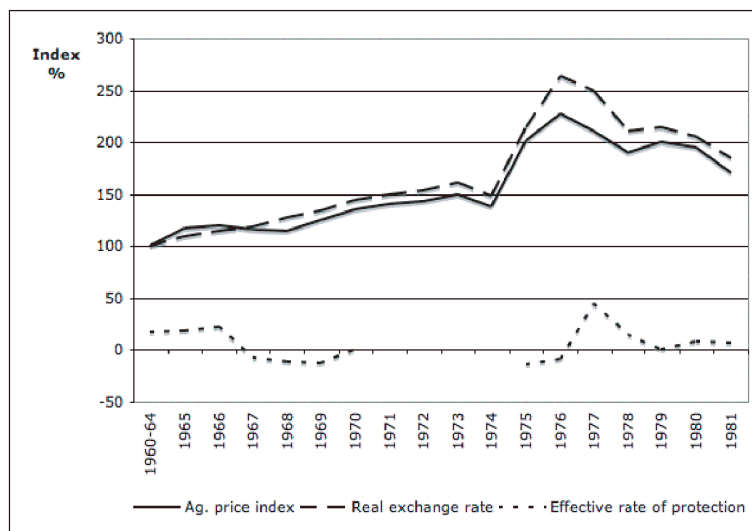
Fig. 5. Agricultural price index, real exchange rate, and effective rate of protection 1964 - 1981 (base year 1960-1964 average)

Source: Barahona, Quiroz, and Valdés (1990)

so as to keep the political support of the sector - peasants came to view the *anticipo* as a right: a fixed salary that did not change according to performance.

The incentive's structure motivated peasants, therefore, to run "unofficial" individual small farms (and sell on the black market) while "officially" being part of a collective plot receiving *anticipos*. The misuse of economies of scale implicitly raised the costs per unit of investment.

3.2.2 Price incentives faced by the agricultural producer

Price controls

From 1965 to 1973, the government exercised "buying and selling power" with which it controlled the prices of the most important agricultural products. Prices were generally kept below their market levels (especially until 1969) as the government considered agricultural products to be strategic or basic in the productive chain.

Figure 5 shows the evolution of the agricultural price index, the real exchange rate, and the effective rate of protection. As we have mentioned before, the average general annual inflation rate from 1967 to 1970 was 28.5 percent.

Effective rates of protection

Although the use of import tariffs was a central part of the ISI strategy, agricultural products did not benefit from their protection. In fact, high import tariffs for industrial products represented a higher cost of imported agro-industrial

Table 3

Effective rate of protection for selected products, 1965, 1967, 1970, 1974

	1965		1967		1970		1974	
	A	B	A	B	A	B	A	B
Intermediate consumption	-2	-32	-19	-62	-31	-52	-64	-75
Sunflower	-18	-43	-39	-120	-50	-68	-76	-83
Rapeseed	-11	-38	-13	-55	-54	-68	-92	-95
Wheat	4	-27	-11	-53	-19	-43	-21	-45
Corn	7	-25	13	-19	-12	-38	-84	-89
Sugarbeet	7	-25	–	–	-21	-45	-81	-87
Final consumption	-8	-36	-2	-44	-26	-48	-35	-49
Rice	-70	-79	-13	-55	-77	-84	-83	-55
Potatoes	10	-23	-21	-71	-62	-73	-61	-88
Eggs	–	–	–	–	–	–	-10	-73
Milk	12	-22	–	–	-1	-29	-26	-37
Pork	–	–	-18	-65	–	–	–	-50
Meat	17	-18	4	-32	36	-5	–	-31

A: Tariffs not adjusted by the overvaluation of the Chilean currency.

B: Tariffs adjusted by by the overvaluation of the Chilean currency.

Source: Cox (1983).

inputs. This effect may explain the reduction of the effective rate of protection for the sector in this subperiod (turning even negative from 1967 to 1970). See Figure 5. [15]

Exchange rate

As we mentioned before, in order to control the inflationary process, the government kept the exchange rate undervalued (see Figure 5). Naturally, net agricultural exports were discouraged and the effective rate of protection for the sector further lowered as Table 3 shows for a selection of products.

Wages

The Chilean agricultural sector was traditionally the most labor intensive of all. Wages were, therefore, one of the most important production costs. The unionization encouraged by the process of agrarian reform and the populist

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[15] Our original source lacks data for 1971 - 1974.

policies of the government increased real wages in the sector by 80 percent from 1965 to 1973 (Cox (1983)).[16] When possible, therefore, agricultural producers reduced their use of labor. As we mentioned before, the percentage of agricultural labor in the total labor force fell from 35 to 20 percent (Kay (1977)).[17]

Credit

Given that the production cycle is typically annual, credit was always an important factor in the Chilean agricultural sector. It allowed the producer to cover the gap between sowing and harvesting times. The uncertainty generated over the property of land, however, greatly increased the cost of credit by inhibiting the provision of a collateral. Moreover, the inflationary process and the high regulation of private banking reduced the credit supply.[18] These two effects made the cost of credit virtually prohibitive.

As a result, the government became the main source of credit for agricultural producers. From 1965 to 1970, the government offered 77 percent of the total credit received by the agricultural sector. As Table 4 shows, by 1973, only 8 percent of the credit received by the agricultural sector came from private sources.

Moreover, from 1965 to 1973, public credit became the only economic support of the sector. During these years, only 10 percent of the total credit financed capital investment while 90 percent was destined to cover operational costs (Cox (1983)).

3.2.3   Technological progress

The poor performance of the sector left little room for technological progress. The government, therefore, became the main source of this investment, covering 82 percent of its value. Several governmental institutions carried investment projects (National Company of Seeds, Vinex, National Sugar Industry (IANSA), etc.), direct technological transfer (Agrarian Reform Agency (CORA), Agricultural and Cattle Service (SAG), and the Institute of Farming Development (INDAP)), and scientific investigation (National Society of Agriculture (SNA) and public universities) (Cox (1983)).

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[16] Real wages increase 15 percent from 1964 to 1965, 14 percent in 1966, 20 percent in 1967, 1 percent in 1968, 13 percent in 1969, and 16 percent in 1970 (Cox (1983)).
[17] The capital/labor ratio for the sector increased from 7.28 percent in 1964 to 11.94 percent in 1974 for major fruits (*frutales mayores*) and from 15.5 percent to 20.71 percent for vineyards in the same period (see Figure 7).
[18] Among other measures, the Central Bank controlled the interest rate levels and increased the level of legal reserves (Echenique (1970)).

Table 4

Sources of credit as percentage of total credit, 1965 - 1974

Year	Banco del Estado	CORA[a] & INDAP[b]	CORFO[c]	Central Bank	IFICOOP[d]	Private banks	Total
1965	46	5	7	10	–	32	100
1966	44	9	10	10	1	26	100
1967	43	14	10	11	1	21	100
1968	44	16	7	11	2	20	100
1969	41	21	7	10	2	19	100
1970	38	25	6	11	2	18	100
1971	49	28	3	–	1	14	100
1972	53	25	5	–	1	14	100
1973	64	24	1	–	2	8	100
1974	65	16	9	–	1	9	100

a Agrarian Reform Agency

b Institute of Farming Development

c Corporation of Production Promotion

d Institute of Cooperative Financing

Source: Cox (1983).

Technological progress was, therefore, the result of an external effort rather than an endogenous development of the sector. As we examine below, the effect of this type of investment does not seem to have been very significant in terms of performance.

3.3 The general economic reform

The military government of Augusto Pinochet began in September of 1973. The new administration implemented a general and broad economic reform oriented toward the liberalization and openness of the economy. Its most important measures can be summarized as:

- Price liberalization
- Reduction of import tariffs
- Uniformity of exchange rates
- Privatization of several public companies including state banks
- Liberalization of interest rates and reduction of the level of minimum legal

reserves
- Reduction of public spending and subsidies
- Reestablishment and protection of property rights

These measures generated an *agrarian counter-reform* with the following characteristics:

Land

With the general objective of reducing the uncertainty over property rights, the government regularized the property of farms illegally expropriated during Allende's government, progressively expanded the maximum size of non-expropriable farms, and liberalized the market for land.

Additionally, the government dismantled the peasants' organizations and unions that carried the *tomas* and strikes.

Prices

Although the government kept control of some agricultural prices during the first years of the economic reform, it progressively liberalized them to follow the dynamic of international markets. The role of the government was ultimately reduced to guarantee market competition and to promote the development of financial instruments like *futures.*

Credit

Public credit for the agricultural sector was greatly reduced. By 1980 only INDAP and *Banco del Estado* kept special lines of short-term credit for medium and large producers (Cox (1983)).

3.4 Post general economic reform: 1974 - 1981

The performance of the agricultural sector was erratic during this period. Although overall agricultural exports increased, and some sectors greatly improved their performance (especially agro-industry and forestry), others were not able to succeed in a competitive and open economic environment (mostly basic annual traditional crops) (Echenique (1993)).

3.4.1 Restitution and regularization of property rights

The first step was to regularize the property of land that had been expropriated either through illegal *tomas* (mostly farms over 80 BIH) or because they were considered not efficiently exploited (mostly farms below 80 BIH). The majority

Table 5
Property regularization of agricultural farms, 1973-1978

Year	Farms (cumulative)	Hectares	Average size (ha.)
1973	2,858	1,500.000	52.4
1974	3,078	2,000,000	65.0
1975	3,483	–	–
1976	3,657	2,804,919	76.7
1977	3,714	2,867,463	77.2
1978	3,814	2,986,797	78.3

Source: Barahona, Quiroz, and Valdés (1988)

of these farms were returned partially or entirely to original landowners. The process rapidly accelerated and, by 1978, more than 50 percent of the total land expropriated by 1973 was regularized (Cox (1983)). See Tables 1 and 5.

The second step was to limit the scope of land expropriation. In December of 1973, farms of up to 40 BIH were declared non-expropriable and in 1974 all forestry land received this same protection independent of its size. Finally, in 1978, all legal dispositions regarding the determinants of expropriation were derogated and the process of agrarian reform formally ended (Cox (1983)).

The third step was to liberalize the market for land. The goal was to redirect this factor of production toward modern export-oriented entrepreneurs. A specific measure in this direction was to increase the possibility of subdividing plots for sale without the authorization of the SAG. At first, farms below 20 BIH required authorization to be subdivided. This limit then went down to 8 BIH, and finally, in 1980, any farm could be subdivided for sale (Cox (1983)).

The restitution, and regularization, of land together with the liberalization of its market, greatly reduced the uncertainty in the sector and brought a new class of *latifundistas* with incentives for large scale production. As a result, the average price of an hectare increased from $338 in 1975 to $549 in 1980 (Cox (1983)).

Finally, the remaining expropriated land was partially assigned to other public institutions (like the National Forestry Corporation (CONAF), SAG, the Chilean Corporation of Production Promotion (CORFO), and the Army),[19] to the general public through public auctions, and to the remaining settlements through soft sale contracts. By 1980, 37,000 farms were reassigned and about 50 percent of the beneficiaries of the agrarian reform ceased to own a plot of land either individually or collectively (Cox (1983)).

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[19] Most of these institutions leased the land, in turn, to private entrepreneurs.

Table 6
Land size distribution in percentages

Size categories	1965	1972	1976	1979	1986
Below 5 BIH	9.7	9.7	9.7	13.3	14
5-20 BIH	12.7	13	37.2	29	26
20-80 BIH	22.5	38.9	22.3	36.3	31
Over 80 BIH	55.3	2.9	24.7	16.9	26
Public agencies	0	0	0	4	3
Reformed sector	0	35.5	9.5	0	0
Total*	100.2	99.8	103.5	99.5	100

* Columns may not sum 100 due to rounding errors.

Source: Kay (2002) and Jarvis (1992).

The evolution of the land size distribution until 1986 can be seen in Table 6. Notice how latifundia, or farms above 80 BIH, had been practically eliminated until 1972 while the reformed sector became the most important one until that year (35.5 percent of total productive land). The growth of the 20-80 BIH farms, on the other hand, can be explained by the formation of reserves.

This situation, however, was reversed after the *counter-reform* was initiated in 1973 and, by 1979, the over 80 BIH sector regained almost a third of the land it possessed in 1965. It is also interesting to notice a parcellization process during this period, resulting in a more equal distribution of land, as the 5-20 and 20-80 BIH sectors became the largest. The liberalization of the land market, however, once again increased the importance of the over 80 BIH sector towards 1986.

3.4.2   Price incentives faced by the agricultural producer

Price controls

Price liberalization was progressive and differentiated. At first, in 1974, prices of "basic products in the typical Chilean diet" were kept in line with "medium run non-subsidized international prices." The government used "buying powers" to achieve this goal (Kay (2002)).

This policy was applied initially to wheat, corn, rice, cattle, and milk. Some other products were added in 1975 and 1976, but by 1977 the list only included wheat, corn, oleaginous, and wool. During this last year, the government abandoned its importing monopoly power and opened the market to private entrepreneurs (ODEPLAN (1968)).

In 1978 the government established price bands for wheat, oleaginous, and beet. This regulation, however, also lasted only a couple of years. In general, it is safe to say that the agricultural sector received strong price incentives between 1974 and 1981. This protection can be clearly seen by the sharp increase of the price index during these years in Figure 5.

Effective rates of protection

One of the goals of the general economic reform, the reduction of import tariffs, was not strictly followed in the case of the agricultural sector. The actual policy consisted of a typical countercyclical pattern: high tariffs when the international prices were low and vice versa. This may explain the erratic variation of the effective rate of protection during this period (see Figure 5).

Exchange rate

The general opening of the economy and the drastic fall of the terms of trade generated a strong depreciation of the real exchange rate particularly until 1979 as can also be seen in Figure 5. [20]

Cost of production

The reduction in the number of unions, together with the high urban unemployment rate during the period, stopped the increase of real wages in the sector experienced from 1964 to 1973. On the other hand, the international oil shocks caused a rise in the price of imported fertilizers and pesticides.

Credit

In 1974 the government cut most of the operational credit and privatized the estate banks that held credit lines with the agricultural sector. Additionally, the economic context, characterized by low international reserves and high fiscal deficit, resulted in an important increment in the real interest rate.

3.4.3 Technological progress

The government continued investing - although not as intensively as before - in technological progress during this period. Additionally, the restitution of land and the reform of the land market progressively brought about export-oriented producers who had more capacity to carry this type of investment. Vineyards and major fruits experienced particularly important technological advancements (Barahona, Quiroz, and Valdés (1988)).

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[20] The terms of trade, defined as the ratio of export prices over import prices, fell more than 60 percent from 1970 to 1981 (Barahona, Quiroz, and Valdés (1988)).

In summary, the post general economic reform period represented a typical transitional stage toward a market economy. The land *counter-reform* gave a new impulse to the sector reducing investment uncertainty and allowing new producers to take advantage of economies of scale. Additionally, as we have seen, despite the anti-statist stance of the new government, the agricultural sector benefitted from price bands or floors, countercyclical tariffs, and technological investment. The depreciation of the Chilean currency and the reduction in real wages also benefited the sector.

On the other hand, the increase in the cost of imported inputs, the increase in the cost of credit, and the general economic crisis (which accentuated toward 1981), had a negative impact on the sector - especially on traditional crops which were not protected by price bands.

3.5   A new agricultural sector: 1982-1994

The mediocre performance of the economy during the previous period (reinforced by unfavorable international conditions) ended in a general economic crisis during 1982 and 1983.

The crisis led to the establishment, during the 1984 - 1990 period, of an agrarian policy aimed at smoothing the effect of external shocks and stimulating a productive transformation and modernization of the capitalist farms (and to a lesser extent of the peasant farms considered "viable") (Kay (2002)). This *agricultural ISI* type of policy included protectionist measures for traditional crops such as import tariffs and price bands. Additionally, the market for land continued to develop, the government reduced its fiscal deficit, and the economy progressively recovered increasing the demand and price of agricultural products.

From 1991 to 1994, the general economic reform toward and open and liberalized economy consolidated and international conditions became more favorable. The investment uncertainty had dissipated and more investment, including foreign, was applied to the sector. An important characteristic of this period is the increase in technological progress that this new investment brought about (particularly in major fruits, vineyards, berries, and new varieties like kiwi). The Chilean agricultural sector became a dynamic and export-oriented industry penetrating the markets of Europe and Japan at first and of the USA at a later stage.

Table 7

Changes in key parameters and predictions of the model, 1965 - 1994

Years	ϕ	p	A	i, y
1965 - 1973	$\Downarrow$*	$\downarrow$?	$\uparrow$?	$\downarrow$
1974 - 1981	$\Uparrow$	$\uparrow$?	$\uparrow$?	$\uparrow$
1982 - 1983		*economic crisis*		
1984 - 1990	$\uparrow$	$\uparrow$	$\uparrow$	$\uparrow$
1991 - 1994	$\uparrow$	$\uparrow$	$\Uparrow$	$\uparrow$

* Double arrows represent large changes

4 The transformation of the Chilean agricultural sector in terms of our theoretical model

As we have emphasized before, the agricultural sector is a highly complex system in which very diverse technologies, productive processes, and government policies co-exist. Although this heterogeneity cannot be fully captured by our theoretical model, the historical analysis of the previous section suggests some generalities worth examining under its light.

Table 7 summarizes our historical analysis in terms of changes in the parameters emphasized by our model during each subperiod. Column five of the table shows the predictions of the model in terms of capital investment and production level (in equilibrium) due to these changes.

Our data provides general support for the aforementioned predictions. Figure 6 shows the evolution of both the agricultural and manufacturing GDP from 1964 to 1995. As we described in our historical analysis, the manufacturing sector benefited from an ISI strategy started in the 1940s and emphasized during the late 1950s and 1960s. The effects of this policy can be associated with the rapid growth of this sector until 1973 when the ISI strategy began to be progressively abandoned. The sector adjusted and recovered by 1976 and continued to grow despite a short fall during the 1982-1983 general crisis.

The poor performance and stagnation of the agricultural sector from 1964 to 1973, on the other hand, is also evident from Figure 6. As we described in our historical analysis, these were the years in which the institutional set was most negatively affected by the land expropriation process (hence the double down arrow in Table 7). Additionally, although credit policies were favorable for the sector, prices, effective rates of protection, exchange rates, and wages were not. We represent this contradictory combination of price incentives faced by the agricultural producer with a single down arrow and a question mark. Finally, although the sector benefited from government investment in technological
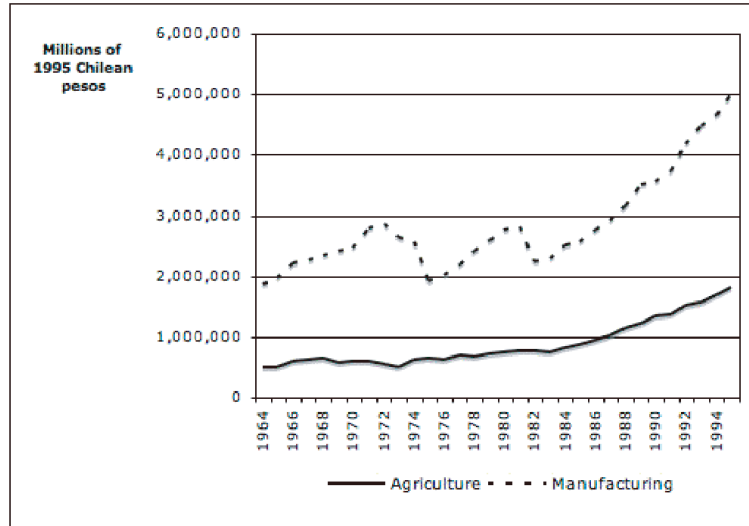
26

Fig. 6. Agricultural and manufacturing GDP, 1964 - 1995
Source: Braun, et al. (2000)

progress, it seems clear from Figure 6 that this investment did not have an effect large enough to counteract the previous two (hence the question mark in Table 7).

As our previous analysis shows, and Table 7 summarizes, after the agrarian counter-reform in 1973, the agricultural sector began to largely benefit from the restitution and regularization of property rights over land, and from a new structure of price incentives as the government actively protected the sector (increase in prices, increase in the effective rate of protection, depreciation of the exchange rate, and reduction of real wages). On the other hand, the liberalization of the financial market that made credit more expensive, and the higher cost of imported inputs, due to the depreciation of the Chilean currency, had negative effects on the performance of the sector. We interpret the slow performance improvement in the sector until 1981 as a result of these contradictory effects.

Our figure also shows the rapid improvement in the performance of the sector after the 1982-1983 crisis. We interpret this boom as the result of a complete restitution and regularization of property rights that dissipated investment uncertainty, an optimal international context, and the increase in endogenous technological investment especially from 1991 to 1994.

Annual data on agricultural investment levels is more difficult to find, compare, and interpret. Different agricultural products require different technologies, processes and investment patterns, which can be largely seasonal. Additionally, products considered "strategic" by the government did not represent the reality of the sector. One available exception is the subsector of major fruits or *frutales mayores*. Figure 7 shows the evolution of the investment (x) and
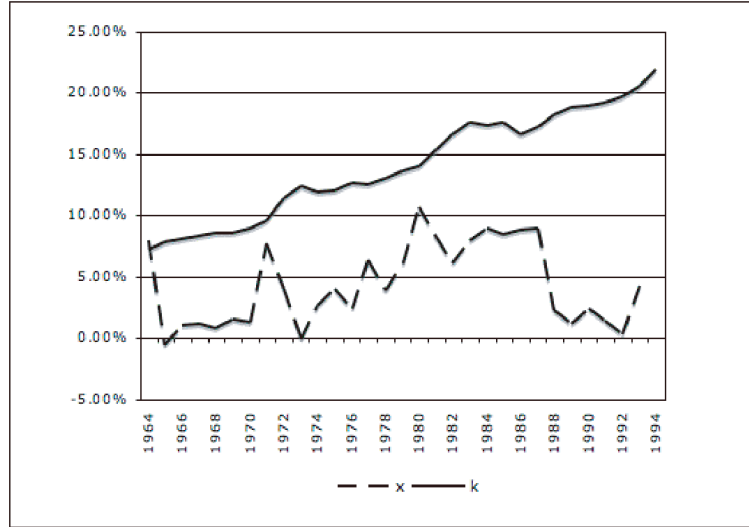
27

Fig. 7. Major fruits: Investment and capital per worker, 1964 - 1995
Source: Calculated from CORFO (1988)

capital (k) per worker for the period analyzed. The data displays a pattern similar to the previous figure. Although the investment level is very volatile, its trend clearly increases after the counter-reform of 1973. The accumulation of capital takes off around 1973, decreases briefly around the 1982-1983 crisis, and continues to increase thereafter.

Additional support for our results is given by variables that tend to be positively related to production levels. Figure 8 shows the employment level and labor productivity in the agricultural sector from 1965 to 1994. The patterns described before are also observable for these variables. An interesting observation is the structural break of labor productivity since the counter-reform (around 1975) that increases this variable by more than $ 10 thousand (1977 dollars) when compared to 1973.

The evolution of agricultural exports during the period analyzed provides the strongest support for the predictions of our model. As Figure 9 shows, this variable was practically nil until 1974. Again, we interpret this performance mainly as the result of the expropriatory process implemented by the agrarian reform. As our previous analysis shows, this process brought high investment uncertainty and the misuse of economies of scale of production which are crucial for an export-oriented sector.

After the counter-reform in 1974, exports rapidly accelerated largely caused by the restitution of land property and the depreciation of the exchange rate. Although the economic crisis of 1982 - 1983 shortly stopped this growth, exports continued accelerating after 1984 largely led by the performance of vineyards and fruits. The value of agricultural exports reached $1.5 billion in 1995.
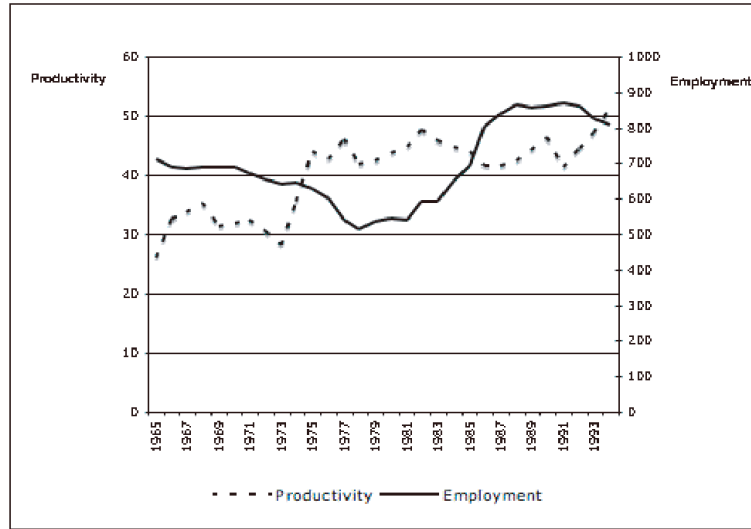
28

Fig. 8. Employment and productivity in the agricultural sector, 1965 - 1994
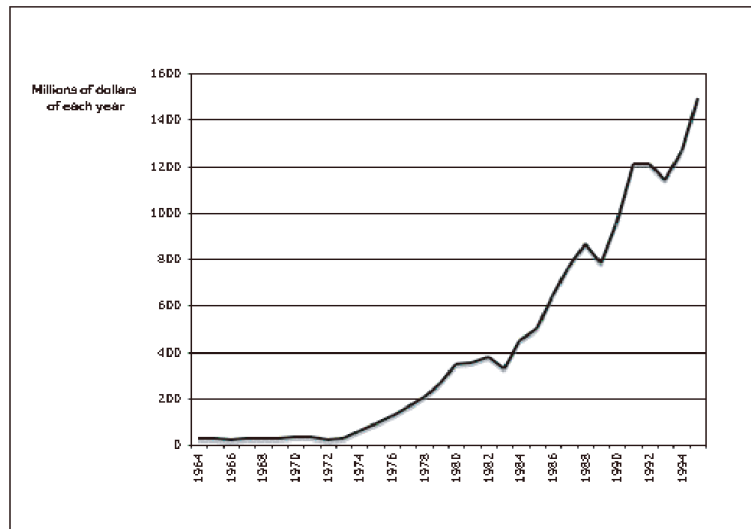Source: CORFO (1988)

Fig. 9. Agricultural exports, 1965 - 1995
Source: Braun, et al. (2000)

5   Conclusion

The story behind the remarkable transformation of Chile's agricultural sector in the second half of the twentieth century can be better understood as a story of institutional change. Indeed, as we have shown in our historical review, although the Chilean agricultural sector was indirectly or directly affected by several public policies during this period, its performance seems to have responded primarily to changes in the definition of property rights over land - a crucial agricultural institution that determines the appropriation of the returns on investments in physical and human capital.

We perform this analysis in two steps. First we build a model that characterizes the transitional dynamics of the sector's saving-investment equilibrium under the realization of exogenous institutional and policy shocks. Second, we match the predictions of our model with available historical evidence and aggregated data.

Our model follows the standard neoclassical growth formulation. In our modified version, however, the agents' valuation of the definition of property rights over land affects the households' capital investment decision by implicitly changing the transaction costs associated with it. Additionally, our formulation of profits for the agricultural firm allows us to study the effects of several public policies and the presence of technological progress.

Our historical review and data provide general support for the predictions of the model. The poor performance and stagnation of the Chilean agricultural sector from 1964 to 1973 can be associated with the strong attack on the definition of property rights over land generated by the agrarian reform. In terms of our model, the uncertainty and misuse of economies of scale generated by this institutional change increased the investment's transaction costs and, therefore, reduced production and investment in equilibrium.

The dramatic recovery from 1974 to 1981, on the other hand, can be associated with the restitution of property rights over land caused by the general economic reform implemented in 1973. These results become apparent despite the presence of contradicting price incentives faced by the producer (generated directly or indirectly by public policies), and exogenous technological investment carried out by the government.

As the definition of property rights over land became clear and stable during the 1980s and 1990s, the performance of the Chilean agricultural sector continued to improve to finally became the most modern and export-oriented agricultural sector in Latin America.

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6 Appendix: Construction of the phase diagram in Figure 1

The equations of motion in $\dot{x}$ and $\dot{k}$ are:

$$\left[H_x(x,\phi) - \frac{U''(c)}{U'(c)} H^2(x,\phi) k \right] \dot{x}$$
$$= \left[(\beta + \delta) H(x,\phi) - x^2 h x(x,\phi) - pf'(k) \right]$$
$$- \frac{U''(c)}{U'(c)} H(x,\phi) \left[pf'(k) - x(1 + h(x,\phi)) \right] \dot{k} \quad (21)$$

which can be simplified as $A_1 \dot{x} = A_2 + A_3 \dot{k}$ with obvious definitions for $A_{1,2,3}$, and

$$\dot{k} = k(x - \delta) \quad (22)$$

Consider first the locus of combinations of x and k for which $\dot{k} = 0$. From equation (22), this condition implies $x = \delta$. As indicated by the arrows in Figure 6, values of x greater than δ increase k and vice versa.
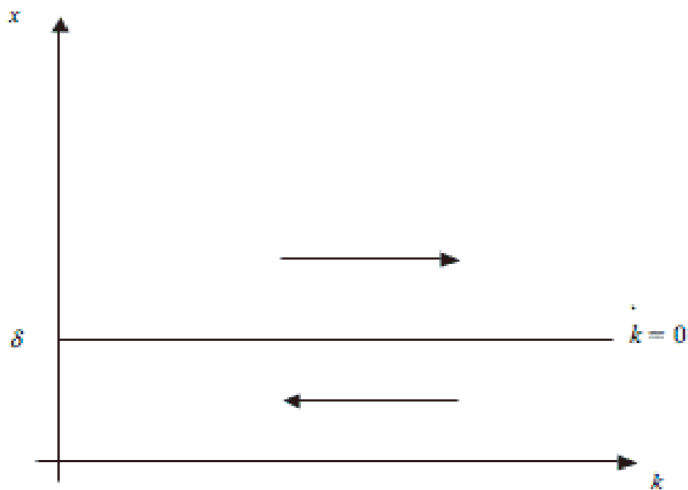

Fig. 10. Combinations of x and k that leave $\dot{k} = 0$

In order to construct the locus of combinations of x and k that leave $\dot{x} = 0$, we need the loci of points that leave A_2 and A_3 equal to 0. The slopes of the latter will be given by:

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$$\left.\frac{dk}{dx}\right|_{A_2=0} = \frac{(\delta + \beta - x)H_x(x,\phi)}{pf''(k)} \gtreqless 0 \quad \text{as} \quad x \gtreqless \delta + \beta \qquad (23)$$

$$\left.\frac{dk}{dx}\right|_{A_3=0} = \frac{H(x,\phi)}{pf''(k)} < 0 \qquad (24)$$

It is also easy to show that when $x = \delta + \beta$, A_2 and A_3 intersect. Figure 6 shows the loci of points that leave $\dot{k}$, A_2, and A_3 equal to 0. The three curves divide the diagram into seven regions that Table 8 summarizes in terms of the signs of A_2, A_3, and $\dot{k}$.
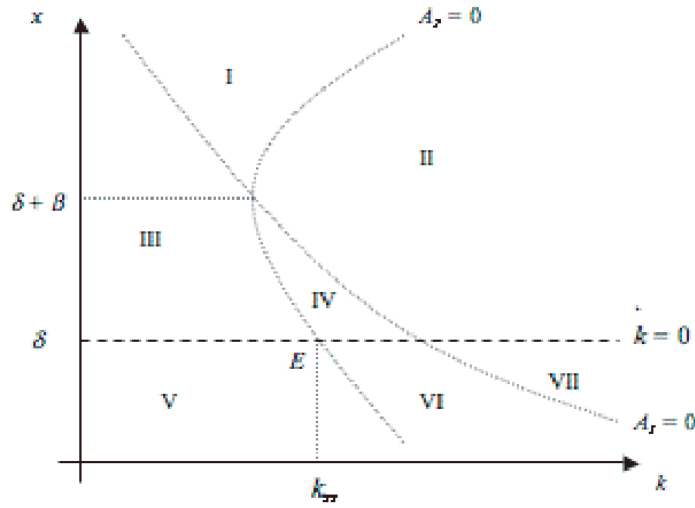

Fig. 11. Combinations of x and k that leave $\dot{k} = A_2 = A_3 = 0$

Table 8
Regions in Figure 6

Region	A_2 sign	A_3 sign	$\dot{k}$ sign
I	-	-	+
II	+	-	+
III	-	+	+
IV	+	+	+
V	-	+	-
VI	+	+	-
VII	+	-	-

Clearly, $\dot{x}$ will be negative in regions I and V, positive in IV and VII, but indeterminate in regions II, III, and VI. The vertical arrows in Figure 6 represent these directions.
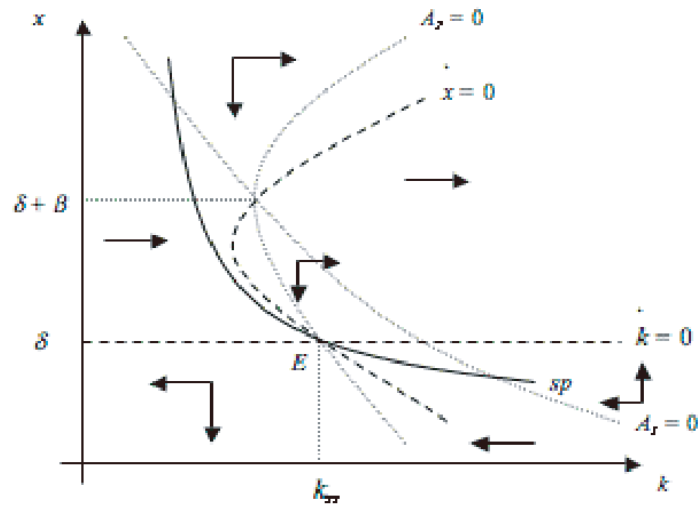
Fig. 12. The phase diagram

The system, therefore, possesses a unique stable saddle-path steady state equilibrium given by E.