# Social Security Privatization Reform and Labor Markets: The Case of Chile*

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## I. Introduction

In recent years policy makers, politicians, and academics have become deeply concerned about the future of social security. The specter of a massive insolvency crisis has generated, throughout the world, a frantic search for a solution to what the World Bank has called the "old age crisis." Conferences have been organized, wise men groups have been assembled, and blueprints for reform have been discussed. Throughout this process, and in an effort to learn from lessons of experience, many analysts have focused on Chile's pioneering social security reform. In 1980, Chile replaced an insolvent government-run social security system with a privately managed system based on individual retirement accounts. Almost 20 years after the launching of this privatization effort, the Chilean experience has become a required case study for anyone interested in reforming social security.[1] Most analyses of Chile's experience have concentrated on three aspects of this privatization program: (1) its effect on the fiscal accounts, including its effect on the public sector's contingent liabilities; (2) the effects of the new system on old-age pensions, including a comparison of replacement rates under the old and new regimes; and (3) the effects of the reform on aggregate national savings.[2]

Surprisingly, very few studies of the Chilean episode have dealt with the overall labor-market implications of the social security reforms. This, however, is not unique to the Chilean case. In fact, while a number of studies for a variety of countries have analyzed the way in which social security systems affect labor-market incentives for older individuals, very few authors have analyzed formally the way in which a major social security reform affects

overall labor-market outcomes.[3] Yet, it may be argued that a reform that (in principle) changes the rate of payroll taxes and affects the relationship between social security contributions and future earnings will have substantial effects on the aggregate (and sectoral) demand and supply for labor. This clearly would be the case if contributions to the pay-as-you-go system are considered (at least in part) a tax and contributions to individual retirement accounts are seen largely as deferred compensation.[4]

The privatization of social security—either partially or fully—is likely to have a particularly significant effect on overall labor-market outcomes in emerging economies, including those in former socialist nations. Segmented labor markets, where a modern and an informal labor market coexist, characterize most emerging countries. Under these circumstances, only those employed in the "modern" segment will be covered by labor-market regulations, including social security. Those employed in the so-called informal sector work without formal contracts, generally do not pay taxes, are not affected by minimum wage laws, and are excluded from the formal safety net.

The purpose of this article is to analyze the way in which a social security reform of the Chilean type affects labor-market outcomes in an economy characterized by a segmented labor market. Our main interest is to evaluate the way in which Chile's social security reform affected the country's level of employment, its rate of unemployment, and wages. To do this, we develop a model of the labor market in an emerging economy, and we simulate it using parameter values for Chile. We also use microsurvey data to investigate some key features, such as coverage, of Chile's privatized social security system.

The article is organized as follows: Section I is the introduction. In Section II, we provide a brief evaluation of Chile's social security reform. Section III deals with the effects of social security reform on wages, income distribution, employment, and unemployment. The section begins with a general discussion of Chile's labor-market reforms. We next develop a model of a segmented labor market to analyze the way in which policies aimed at reducing the tax component of social security contributions affect the key labor-market variables. In Section IV, we use microsurvey data to obtain an estimate of the "tax component" of social security contributions under Chile's privately managed social security system.[5] We then use, in Section V, the results from this empirical analysis to simulate our model and compute the effects of Chile's social security reform on employment, unemployment, and wages. The results from our simulation exercise suggest that the effect of the reform on Chile's aggregate employment was rather modest. The results also suggest that the reforms resulted in a small increase in average wages. Finally, in Section VI, we provide some concluding remarks.

## II. The Privatization of Chile's Social Security System
In late 1980, Chile's military regime privatized the country's traditional pay-as-you-go social security system.[6] Twenty years after Chile's social security reform, most observers agree that Chile's program was a true pioneer and

that there is much to learn from it. This section provides a brief discussion of the reform's main aspects.[7]

### A. The Old Pay-as-You-Go System

Chile's original social security system was designed in the 1920s as a collective capitalization fund. Accumulated funds, however, were poorly managed, and benefits—especially for the more well-to-do—escalated quickly. For all practical purposes, and despite the original intentions of its founders, by the 1970s the system had become an insolvent pay-as-you-go regime, characterized by very high contribution rates. In 1973, for example, total contributions to the retirement plan—by employers and employees—averaged 26% of wages. Once contributions to the national health system were included, total contributions exceeded, for some workers, 50% of wages. Worse still, there was almost no connection between retirement contributions and (perceived) benefits. Contributions largely were seen as taxes, while benefits received from the social security system were seen as entitlements.[8]

While in 1955 there were 12 active contributors per retiree, by 1979 there were only 2.5. As a result of this and a highly inefficient management, the Chilean system became increasingly unfunded. By the early 1970s, the system as a whole was already running a dramatic deficit. The gap between revenues and outlays—administrative costs plus pensions—was made up by the public sector. By 1971, the central government's contributions to the retirement system amounted to almost 3% of gross domestic product (GDP), and the present value of the system's contingent liabilities exceeded 100% of GDP.

### B. The Privatization of Social Security in Chile

In 1980, the military privatized the social security system. The core of Chile's new privately managed system comprises individual retirement accounts managed by private companies known as Administradoras de Fondos de Pensiones (AFPs). A key feature of the system is that it is mandatory for individuals working for a formal employer. Participants can decide freely which AFP will manage their retirement funds and are free to transfer them across the different management firms. When they reach the minimum pensionable age, individuals can choose to buy an annuity or to withdraw their funds according to a predetermined (actuarially fair) plan.[9] The system also has a survivor's term life insurance component and a disability program funded with an additional insurance premium. In the reformed system, the state continues to play an important role. It regulates and monitors the operation of the management companies and guarantees a minimum pension.[10] In an effort to increase the attractiveness of the new system, and in order to reduce political opposition, contribution rates under the new system were lowered; as a result, those individuals who joined the new system experienced an average increase of net take-home pay equal to 10%.[11] It was expected that, given the anticipated higher rates of return on the accumulated funds, the lower contributions would be enough to finance higher replacement rates for pensions.

Contributions to the retirement component of the system are equal to 10% of income, which is considerably lower then the 26% (on average) under the old system. Total contributions for retirement, health, and survivorship insurance add up to 20% of wages, with a cap equivalent to an annual wage rate of US$40,000 per year. A detailed regulatory framework—enforced by an institution especially created for this purpose, the Superintendency of AFPs—regulates investment portfolios and also ensures free determination of fees and commissions and free entry into the industry. Until 2000, each AFP could manage only one retirement fund; likewise, each participant could have only one retirement account.

Self-employed workers are not required to participate in the system. They have the choice, however, to set voluntary retirement accounts, which are (basically) subject to the same regulations as those of formal sector employees. In 1998, the percentage of active contributors—that is, those making deposits into their retirement accounts—stood at 58% of total employment, with an additional 4% of workers still contributing to the old system. This means, then, that in 1998 the total coverage of the Chilean retirement system amounted to 62% of employment. The 38% that is not covered by the social security system corresponds, largely, to those who work in the informal sector, or to the self-employed (for details on the actual characteristics of those not covered by the new system, see the discussion in Sec. III). At 62% of employment, the current coverage of the system is similar to that of the old pay-as-you-go system.

The volume of pension funds privately managed by the AFPs has increased dramatically. Between 1985 and 1997, they increased from 10% of GDP to almost 45% of GDP. Furthermore, recent simulations suggest that by 2010, the accumulated funds will represent 110% of GDP and by 2020, they will have reached 134% of GDP.[12] The types of assets in which the retirement funds can invest are tightly regulated. During the early years, funds were largely restricted to government securities, bank deposits, investment-grade corporate bonds, and mortgage bonds. At this time, however, a number of equities, both domestic and foreign, are allowed.

During the early years of the reform, the real (inflation adjusted) average rate of return of accumulated funds was very high, averaging, during 1982–95, 12.8% per annum. More recently, however, the real rate of return has declined significantly; between September 1994 and August 2000, the averaged (real) rate of return for the system was 4.9%. This rate is rather low and has raised some people's concerns about the system's ability to deliver pensions with a relatively high replacement rate in the future.

Existing regulations impose a floor on the return that individual AFPs pay to their members. In any given year, an AFP cannot pay a return lower than 2 percentage points of the system's average. If the actual return of a particular AFP falls below this minimum, the difference has to be made up by using funds from a specially set "reserve fund." The restriction on a minimum rate of return, coupled with the regulations that each AFP cannot have more than one fund and that individuals cannot distribute their funds

across funds, reduced the extent of competition of the system and resulted in the different AFPs holding extremely similar portfolios. Reforms introduced in 2000, however, have allowed each AFP to have a second fund.

The new system allows men to draw a pension at age 65, and women at 60, or earlier if they have accumulated enough funds to finance a pension of 70% of their (pensionable) salary. When an individual retires, he can choose between two systems: (1) he can use the accumulated funds to buy an annuity from an insurance company or (2) can choose to enroll in a "programmed withdrawal" scheme, in which the accumulated funds are drawn according to an actuarially determined schedule. By 1997, there were already 250,000 retirees receiving pensions under the new system. Of these, approximately one-half had opted for annuities while the other half opted for programmed withdrawal. Using a sample of 4,064 individuals, it has been estimated that the average replacement rate under the new system had amounted to 78%, which is significantly higher than under the old pay-as-you-go regime.[13]

The new system also establishes that, for those individuals who qualify, there is a minimum pension guaranteed by the state, which as of December 1998 was equal to 85% of the minimum wage. From an international comparative perspective, replacement rates have been quite high in Chile—indeed, higher than under most industrialized countries' systems.[14]

*C. Transitional Costs and Weaknesses of the New System*
Most proposals to privatize social security struggle with issues related to the transition. Chile dealt with this problem in a simple and costly manner. All transitional costs were borne by the government and were paid out of the general budget. Individuals who had been contributing to the old system received government bonds—the so-called recognition bonds. These bonds yielded per annum 4% in inflation-adjusted terms and were placed in each individual retirement account. The value of the bonds received by each person was determined using a formula that took into account their history of contributions to the old system. From a fiscal point of view, the transition was rather expensive, representing almost 5% of GDP in the peak year of 1983. It is estimated that by 2015 these costs would almost disappear.

The privatized Chilean system has exhibited two important weaknesses. First, at 62% of workers, the level of total coverage of the new system is low. This is explained by two basic factors: (1) the self-employed—who are not legally required to participate in the system—have limited incentives to make voluntary contributions; (2) the existence of a government-guaranteed (universal) minimum pension creates a moral hazard situation among low-income workers, many of whom are self-employed. For these individuals it pays to contribute only sporadically and only enough to obtain the minimum pension once they retire.[15] Second, the cost of running the private system—in terms of fees, commissions, and, especially, marketing costs—has been very high, tending to exceed, during the past few years, 10% of contributions. This has resulted in a significant reduction of the net rate of return accrued to participants.[16]

*D. Chile's Social Security and Labor-Market Reforms*

The reform of social security was only one component of a broad effort to transform Chile into a modern market economy. During the second half of the 1970s, the military government implemented a number of fundamental reforms, including a major overhaul of the tax system, the opening up of the economy to international competition, the privatization of most state-owned enterprises, and the creation of a modern financial market. In the early 1980s, the scope of the reforms was broadened to include labor markets and social security.

In 1979, under considerable international pressure, the military government initiated an effort to reform Chile's labor legislation. The main objectives of these policies were (1) to reform job security legislation by limiting the extent of severance payments (these were reduced from "one month per year of service, with no limit" to "one month per year of service, with a 5-month limit"), (2) to reduce unions' power by decentralizing collective bargaining and eliminating the old "close-shop" practice, and (3) reducing payroll taxes. This last measure was to be achieved, partially, by the social security reform discussed above.[17]

Between 1985 and 1997, Chile's labor markets performed well.[18] What makes this experience particularly interesting is that between 1983–85 and 1993–95, Chile went from rates of unemployment usually associated with some European countries to unemployment rates similar to those traditionally prevailing in the United States. While during 1983–85 the open rate of unemployment averaged 17.3%, by 1993–95 it had declined to 5.8%. All of this transpired while real wages experienced rates of growth in excess of 5% per year.[19] An interesting question is which of the components of the labor-related reforms—the reduced degree of job security, the reformed collective bargaining, or the social security reform—were more important in helping Chile improve its labor-market performance. Although providing a full answer to this question is beyond the scope of this article, in Section III we develop a model that allows us to quantify the effect of the social security reforms on some of the key labor-market variables. We proceed as follows: we first develop (in Sec. III) a model of a segmented labor market and investigate the way in which changes in taxes on labor in the "covered or modern" sector influence labor-market outcomes. Next, in Section IV, we use microsurvey data to analyze the extent to which participants considered the new system as a "deferred compensation" scheme. Finally, in Section V, we calibrate and simulate the model for the case of Chile. Our findings suggest that the social security reform had a modest effect on Chile's labor-market performance. This, however, need not be the case in other countries: the actual impact of a Chile-style social security reform on unemployment, wages, and income distribution will depend on the specific values of the relevant parameters.

### III. A Model of Social Security Reform and Labor Markets

In this section, we develop a two-sector model to analyze the effects of a social security reform on employment, unemployment, and wages. Labor markets in emerging economies in general—and in Chile, in particular—have a number of institutional features that set them apart from labor markets in industrial nations. The most important among these features are:

1. In emerging countries, labor markets are usually characterized by a rather large "informal" segment. This segment is, de facto, not directly affected by labor-market regulations, such as minimum wages, job security legislation, or social security. The informal sector coexists with a "modern" sector, for which labor-market regulations are fully in effect. The fact that in Chile the social security system covers only 62% of those employed provides some evidence of the existence of this segmented structure.[20]

2. Contributions to social security are often seen as a (partial) tax on labor rather than as deferred compensation or an insurance program. At the same time, individuals regard the benefits from these programs as an entitlement. The percentage of the contribution that is actually considered a pure tax depends on the nature of the social security system and, more specifically, on the perceived connection between contributions and benefits.[21]

Formally, assume that, as is the case in many developing and transitional economies, the labor market is segmented. There is a "modern" or "covered" sector subject to both a minimum wage and social security coverage and an "informal" or "unprotected" sector with no social security coverage and competitively determined wages. With other things equal, workers will rather be employed in the "protected" sector. The problem, however, is that there are not enough jobs in that sector; individuals who apply for a job in the modern sector face a probability $(p)$ of obtaining it and a probability $(1 - p)$ of being unemployed. In equilibrium, and under the assumption of risk neutrality, the wage rate obtained in the informal segment is equal to the expected (take-home) wage rate in the protected sector. We further assume that in every period employment in the modern sector turns over fully, so that the probability of getting a job in that sector is equal to the ratio of openings to applicants.[22]

We assume that, prior to the reform, workers in the protected sector were subject to a payroll tax—the purpose of which was to fund the social security system—equal to $T_1$. We also assume that there is a disconnect between social security contributions and benefits. More specifically, we assume that individuals fully consider social security contributions to be a tax. Notice, however, that the analysis that follows would not be affected by the assumption that only a fraction of the contribution was considered to be a tax. Workers employed in the modern sector receive a "take-home" wage rate equal to the minimum wage $(W_{\min})$. The cost of labor to firms operating in this sector is equal to the minimum wage plus the payroll tax. The social security reform

will result in a reduction of this tax. There are two sources for this reduction. First, as was the case in Chile, the reform itself may entail a reduction in the contribution. Second, the replacement of the old pay-as-you-go system by individual retirement accounts reduces the disconnect between contributions and benefits. In the postreform period, at least part of the contribution will be considered as deferred compensation (see Sec. IV for an estimate for the case of Chile).

Equations (1)–(4) describe the wage-determination process in this economy. Equation (1) establishes that, in equilibrium, the wage rate in the informal sector ($W_I$) is equal to the expected (net of taxes) wage rate in the modern sector $E(W_M^N)$. According to equation (2), the probability of finding a job in the modern sector is equal to the ratio of openings—that is, employment in that sector ($L_M$)—to applicants. The latter is given by the sum of openings ($L_M$) plus the total number of unemployed ($U$). It is assumed, for simplicity, that the unemployed received an income equal to $S$. Equation (3) says that the cost of labor in the modern sector is equal to the minimum wage inclusive of the payroll tax ($T_1$). In equation (4), we present the demand for labor equations in the modern and informal sectors. Expressions $P_M$ and $P_I$ are good prices in each sector, the functions $f(\ )$ and $g(\ )$ are physical marginal productivity of labor. Expressions $K_M$ and $K_I$ are the stock of capital used in the modern and informal sector, respectively:

$$W_I = E(W_M^N) = pW_{\min} + (1 - p)S, \tag{1}$$

$$p = [L_M/(L_M + U)], \tag{2}$$

$$W_M = W_{\min}(1 + T_1), \tag{3}$$

$$W_M = P_M f(L_M, K_M); \quad W_I = P_I g(L_I, K_I). \tag{4}$$

Equation (5) is the resource constraint in the labor market and establishes that employment in the modern sector plus employment in the informal sector plus unemployment has to be equal to total labor supply ($L_s$). According to equation (6), labor supply is a positive function of real wages; $O$ represents "other" factors affecting the supply of labor.[23] Equation (7) defines the aggregate price index and the aggregate wage rate as geometric means of sectoral prices and wages, respectively. To simplify the analysis, in equation (8) we have assumed that the modern sector corresponds to tradable goods and that, as a consequence, $P_M$ is given by international prices ($P_M^*$).[24] Equation (9) establishes that product prices in the informal sector are a positive function of wages in that sector. We further assume that an increase in $W_I$ will have a less-than-proportional effect on prices of goods produced in the informal

sector. That is, $d\log P_I < d\log W_I$.

$$L_M + L_I + U = L_S, \tag{5}$$

$$L_S = h(W/P, O); \quad h' > 0. \tag{6}$$

$$P = P_I^\beta P_M^{(1-\beta)}; \quad W = W_I^\theta W_M^{(1-\theta)}, \tag{7}$$

$$P_M = P_M^*; \tag{8}$$

$$P_I = z(W_I); \quad z' > 0; \quad d\log P_I < d\log W_I. \tag{9}$$

Equation (10) is the resource constraint for capital and says that the sum of capital used in each sector has to equal the total stock of capital. Equation (11) says that the allocation of the capital stock across sectors will depend on the relative product prices. Notice that in order to simplify the computations and focus on the issues at hand, we have assumed that there is no net investment.

$$K_M + K_I = K, \tag{10}$$

$$K_M = j(P_M/P_I); \quad K_I = v(P_M/P_I). \tag{11}$$

The initial (prereform) labor market is depicted in figure 1, under the simplifying assumption that the unemployed get no assistance ($S = 0$). Distance $O_M - O_I$ is total labor supply, $L_M$ and $L_I$ are the demand for labor schedules, and $yy$ is a rectangular hyperbola that satisfies the equilibrium condition in equation (1). The wage rate and the level of employment in the informal sector are determined by the intersection of the $yy$ and $L_I$ schedules. Expression $W_{\min}$ is the minimum wage, which, as stated above, is assumed to be set in net take-home bases. Expression $T_1$ is the payroll tax, and $W_M$ is the cost of labor in the modern sector. Expression $W_I$ is the wage rate in the informal sector. The initial level of employment in the modern sector is given by distance $O_M - L_M^1$; distance $O_I - L_I^1$ depicts initial employment in the informal sector. The total number of unemployed is equal to distance $L_M^1 - L_I^1$. As pointed out earlier, we consider the case in which the reform reduces the (perceived) tax component of social security contributions. That is, we assume that as a result of the social security reform, there will be a reduction of $T_1$ to some lower level, possibly even to zero. This would unleash a series of effects, including a higher demand for labor in the modern sector, a change in aggregate labor supply, and changes in wages and in employment in the informal sector.

Formally, the model given by equations (1)–(11) can be solved to obtain the effects of this type of social security reform, on a number of variables,
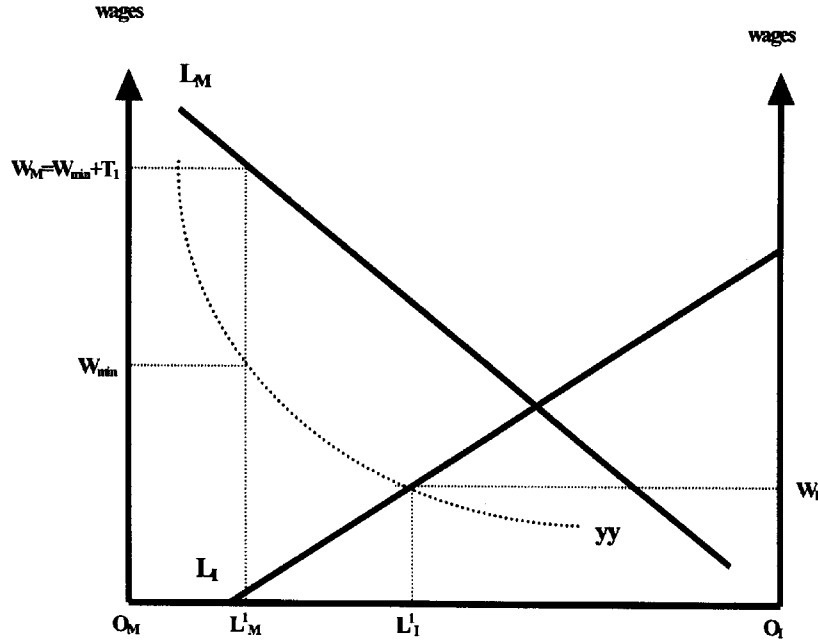
FIG. 1

including informal sector wages ($W_I$), the volume of unemployment ($U$), and product prices in the informal sector ($P_I$). In order to simplify the exposition, we follow a long tradition in international trade theory—the Ricardo-Viner approach—and we assume that capital is fixed in its sector of origin. We begin with the effects of changes in the tax component of the social security contribution ($d \log T$) on informal sector wages ($d \log W_I$):

$$d \log W_I = \Delta^{-1}(-\{\alpha_U[U/(L_M + U)](1/\eta_M)\}$$

$$- \{[U/(L_M + U)]\alpha_M(1/\eta_M)\})[T_1/(1 + T_1)]d \log T, \qquad (12)$$

where

$$\Delta = -\alpha_U - \{\alpha_I[U/(L_M + U)](1/\eta_I)(\mu - 1)\}$$

$$- \{[U/(L_M + U)\phi(\alpha_I + \mu\beta)\}. \qquad (13)$$

In equations (12) and (13), $\alpha_I$, $\alpha_M$, and $\alpha_U$ are the shares of employment in the informal sector, employment in the modern sector, and unemployment in the labor resources constraint (5), respectively. Variables $\eta_I$ and $\eta_M$ are the inverse of the elasticities of the demand for labor with respect to wages in the $I$ and $M$ sectors, respectively, and are negative.[25] Variable $\phi$ is the supply elasticity of labor and is positive; $\mu$ is the elasticity of the price of informal sector goods ($P_I$) with respect to the wage rate in that sector and is greater than zero and smaller than one. It follows from equation (13), then, that $\Delta$

is negative. Consequently, according to equation (12), the following result holds:

$$(d \log W_I / d \log T) < 0.$$

This means that a social security reform that reduces the payroll tax will unambiguously generate an increase in the wage rate in the informal sector *I,* the sector that is not covered by the social security system and that, prior to the reform, had the lowest wage rate. Notice that, by construction, net (take-home) wages in the modern sector are not affected by the reform. This is because we have assumed that the minimum wage is set in take-home bases and that the reform does not affect it. The more general case, in which the reform generates an increase in net wages in the *M* sector, is discussed below.

The effect of the reform on aggregate unemployment ($U$), is given by

$$d \log U = \Delta^{-1}((\alpha_I/\eta_I) - \{\alpha_I[U/(L_M + U)](1/\eta_I)(1/\eta_M)(\mu - 1)\}$$

$$- \{[U/(L_M + U)]\phi(\alpha_1 + \mu\beta)(1/\eta_M)\})[T_1/(1 + T_1)]d \log T. \quad (14)$$

The sign of equation (14) is undetermined. It follows from this that, within the framework developed in this article, a reduction in the payroll tax in the modern sector will have an ambiguous effect on the number of unemployed. Whether the level of unemployment will increase or decline will depend on two basic factors: the supply elasticity of labor in the economy—parameter $\phi$ in equation (14)—and the wage elasticity of labor demand in the informal sector. The more elastic is the supply for labor and the more inelastic is the demand for labor in the informal sector, the more likely it is that the reform will result in an increase in the level of unemployment.

Equation (15) gives the effect of the reform on product prices in the informal sector and is positive:

$$d \log P_I = \Delta^{-1}\{-[U/(L_M + U)](\alpha_M/\eta_M)$$

$$- \alpha_U[U/(L_M + U)](1/\eta_M)\}[T_1/(1 + T_1)]d \log T. \quad (15)$$

The working of the model is illustrated in figure 2, where it is assumed that the reform reduces the social security tax from $T_1$ to $T_2$. The new cost of labor in the modern sector is $W_M{}^2$. Distance $O_I - O_I'$ is assumed to be equal to the increase in the amount of labor supplied to the economy. Because of this increase in aggregate labor supply, the original demand for labor in the informal sector has to be redrawn as $L_I'$. Since the product price of *I* has increased, the demand for labor in the informal sector shifts up and is represented in figure 2 by $L_I'(P_I^1)$. The wage rate in the informal sector is now determined by the intersection of a new rectangular hyperbola $y'y'$ and a new demand for labor in sector *I* and is given by $W_I^2$. Employment in the informal sector has changed from distance $O_I - L_I^1$ to distance $O_I^1 - L_I^2$. Because of the reduction in $W_M$, employment in the modern sector has increased from $L_M{}^1$ to $L_M{}^2$. The new level of unemployment, which, as indicated by equation (13),
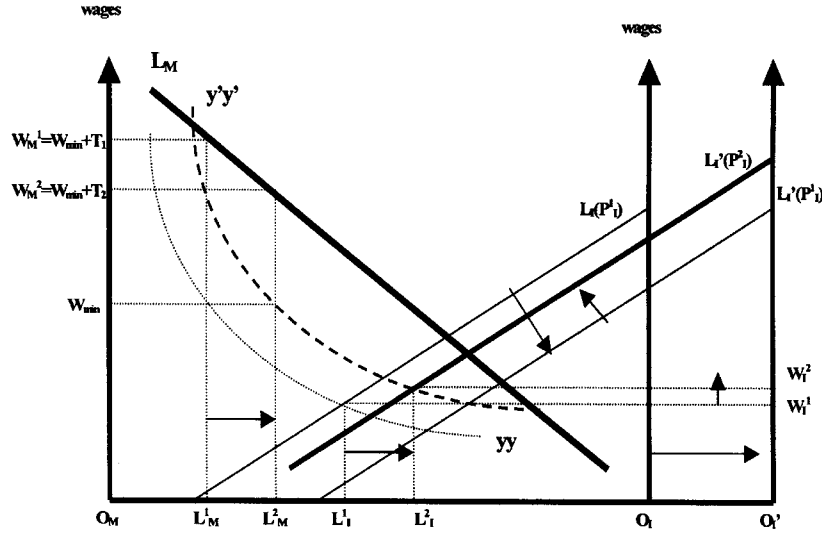
FIG. 2

could be either higher or lower than the initial level of unemployment, is given by distance $L_M^2 - L_I^2$ (see fig. 2).

The results in equations (12)–(15) assume that there is no change in the take-home wage in the modern sector. In Chile, however, the government mandated an increase in take-home wages equal to 10% for those who opted for the privatized regime.[26] In the context of the model developed in this article, an increase in the take-home wage in the sector covered by social security can be modeled as an exogenously determined increase in the minimum wage rate. Formally speaking, then, this more general policy package corresponds to a situation in which both the minimum wage ($W_{\min}$) and the payroll tax change (in opposite directions). In this case, the change in the wage rate in the informal sector will be given by

$$d \log W_I = \Delta^{-1}[(-\{\alpha_U[U/(L_M + U)](1/\eta_M)\}$$

$$- \{[U/(L_M + U)]\alpha_M(1/\eta_M)\})[T_1/(1 + T_1)]d \log T \qquad (16)$$

$$+ d \log W_{\min}].$$

The change in the level of employment, in turn, will now be given by

$$d \log U = \Delta^{-1}((\alpha_I/\eta_I) - \{\alpha_I[U/(L_M + U)](1/\eta_I)(1/\eta_M)(\mu - 1)\}$$

$$- \{[U/(L_M + U)]\phi(\alpha_I + \mu\beta)(1/\eta_M)\})\{[T_1/(1 + T_1)]d \log T \qquad (17)$$

$$+ d \log W_{\min}\}.$$

In this case, then, the final effect of the policy package will depend on the way in which the changes in the payroll tax and in the minimum wage are

related to each other. A reasonable assumption—and one that captures the case of the Chilean reforms—is that the increase in the take-home wage in the modern sector is equal to a fraction of the (percentage) reduction in the payroll taxes. Under these assumptions, the qualitative results derived above for the more simple version of the model still apply: a social security reform that reduces the tax component of social security contributions will (1) increase the wage rate in the informal sector, which is the sector with the lowest wages under the pay-as-you-go system, and (2) will have an ambiguous effect on the level of unemployment.

Notice, however, that because the effect on unemployment is ambiguous, it is not possible to say anything definitive with respect to the effects of the reform on income distribution. In fact, it is possible that income becomes more unequally distributed as a result of the privatization of social security.[27]

Although the model developed here is simple and has some limitations, it has enough structure to provide insights into some of the most important effects of a pension reform on labor markets.[28] In Section IV, we use micro-survey data for 1994 to analyze some important characteristics of Chile's privatized social security system. In Section V, we use the model developed here to simulate the effect of the social security reform on Chile's labor-market outcomes.

## IV. Chile's New Pension System: Who Is Covered? How Much Do Participants Value the System?

The model developed in the preceding section can be used to analyze empirically the effect of social security reform on labor-market outcomes. To calibrate and simulate the model, however, data on a number of key parameters are required. These include (1) the rate of coverage of the social security system (parameter $\alpha_M$); (2) the wage elasticities of demand for labor, in the covered and uncovered sectors—$(1/\eta_M)$ and $(1/\eta_I)$; (3) the wage elasticity of supply of labor ($\phi$); and (4) workers' perceptions of the tax component of social security contributions under both the old pay-as-you-go regime and the new privatized system.

In the case of Chile, some of these parameters (e.g., the labor elasticities) have been estimated in previous studies. Other key variables, however, are not readily available. In particular, there are no reliable calculations of the percentage of social security contributions that are considered to be a tax by labor-market participants. In principle, this implicit tax can be obtained by estimating a wage rate equation that includes a "compensating differential" for individuals who participate in the social security system. If social security contributions are considered to be a form of deferred compensation, individuals enrolled in the system would be willing to accept, for an equivalent job, a lower take-home (cash) wage than those individuals who do not participate in the social security system. If, however, social security contributions are considered fully as a tax, those enrolled in the system will demand, for an equivalent job, the same cash salary as those who are not in the system and, thus, are not subject to this tax.

The magnitude of the "compensating differential," for otherwise equivalent jobs will, then, provide an estimate of the proportion of the contribution that is actually perceived as a tax by labor-market participants.

In this section we use microdata to estimate the implicit tax component of social security contributions. Ideally one would like to use comparable data for the pre- and postreform eras. Unfortunately, however, detailed survey data have only been collected since 1990. For this reason, we pursue the following strategy. First, we use microdata from the postreform period to obtain a "base estimate" for the perceived tax component of the privatized social security system. Second, we make several alternative assumptions with respect to the perceived tax component of the old (prereform) system. This allows us to consider an interval of possible reductions of the tax stemming from the reform. Third, we combine this estimated range of tax reduction with parameters obtained from other studies to compute, using the model developed in Section III, the effects of Chile's social security's reform on the country's labor market.

Our basic data set is the CASEN (Caracterización Socioeconómica Nacional) national survey for 1994. Using 1994 data has a number of advantages. First, 1994 is a fairly "normal" year, when Chile was facing neither a recession nor serious disturbances from abroad. Second, it is a year when the democratic system was being consolidated, and thus the country was not subject to serious political disturbances. Third, in 1994, the privatized social security system had already been operational for some time and was entering into a mature phase. The CASEN survey collects information on demographics, education, type of dwelling, health care, occupation, employment, and income, among other variables. We are interested in two specific, and interrelated, questions:

  1. What is the coverage of Chile's privatized social security system? Or, in other words, what percentage of those who have paying jobs make contributions to the system? This is a key issue within the context of the model developed in Section III of this article, where it was assumed that only a fraction of those in the labor market—those employed in the "formal" sector—participate in the social security system actively.

  2. To what extent do participants in the system consider it a deferred compensation scheme? As mentioned, we deal with this issue by estimating "compensating differential" wage equations. The results from these estimates are used as the bases for a simulation exercise presented in Section V.

A. *Extent of Coverage of Chile's New Social Security System*
Table 1 presents summary data, for 1994, on the coverage of Chile's privately managed social security system. These data correspond to those individuals in the sample who had paying jobs at the time of the survey and have been organized by urban-rural sectors, age, and gender. The percentage of individuals in that particular group who made contributions to a privately managed retirement fund (an AFP) is referred to by "AFP." "Other" refers to the

TABLE 1

COVERAGE OF CHILE'S SOCIAL SECURITY SYSTEM, 1994: URBAN AND RURAL,
BY AGE AND GENDER

| | 16–39 Years | 40–59 Years | 60 Plus Years | Total |
|---|---|---|---|---|
| A. Urban: | | | | |
| Males: | | | | |
| AFP | 68.87 | 60.01 | 35.02 | 63.36 |
| Other | 3.09 | 9.84 | 18.95 | 6.58 |
| No | 28 | 30.15 | 46.04 | 30.03 |
| No answer | .04 | 0 | 0 | .02 |
| Total | 100 | 100 | 100 | 100 |
| Females: | | | | |
| AFP | 66.56 | 52.89 | 24.57 | 59.63 |
| Other | 2.46 | 9.27 | 16.72 | 5.57 |
| No | 30.98 | 37.6 | 58.71 | 34.72 |
| No answer | 0 | .24 | 0 | .08 |
| Total | 100 | 100 | 100 | 100 |
| B. Rural | | | | |
| Males: | | | | |
| AFP | 44.85 | 39.12 | 21.02 | 40.79 |
| Other | 2.65 | 11.33 | 13.47 | 6.41 |
| No | 52.49 | 49.56 | 65.51 | 52.8 |
| No answer | .01 | 0 | 0 | .01 |
| Total | 100 | 100 | 100 | 100 |
| Females: | | | | |
| AFP | 48.79 | 41.69 | 17.83 | 44.93 |
| Other | 1.59 | 6.25 | 13.63 | 3.64 |
| No | 49.62 | 52.06 | 68.54 | 51.44 |
| Total | 100 | 100 | 100 | 100 |

SOURCE.—Calculated by the authors using raw data from Caracterización Socioeconómica
Nacional national survey for 1994.
   NOTE.—Totals may not add up to 100 due to rounding errors.

percentage of individuals who made contributions to other retirement systems, including the old pay-as-you-go system and the armed forces retirement fund; "No" refers to those individuals who had not made contributions to any retirement system.

   Table 1 is rather self-explanatory and shows that as recently as 1994 Chile's system fell considerably short of universal coverage. Urban males have the highest coverage—defined as contributing to any retirement scheme—at 69.9%. The lowest coverage corresponds to males in the rural sector, with 47.2%. It may also be seen that, with the exception of rural males, those who are 16–39 years old have the highest degree of coverage. For the sample as a whole in 1994, the coverage rate of the formal retirement systems was 60.2%. Data from the CASEN survey also suggest that there is a very high degree of compliance with respect to required contributions. More than 95% of employees with an employment contract made contributions, as required by law, to a retirement system.

   Although there are no comparable survey data for the prereform period, existing estimates indicate that Chile's old pay-as-you-go system covered 58% of those employed. This means, then, that after the privatization reform there has been only a small increase in the coverage of the formal retirement system. The fact that younger workers exhibit a higher coverage ratio may indicate, however, a secular trend toward greater participation in the system.

### B. Deferred Compensation or Taxes?

The model developed here in Section III assumes that a reform of the social security system implies a reduction in the (implicit) tax on labor. More specifically, we assume that while under the pay-as-you-go system contributions are (largely) seen as taxes, under the privately managed regime contributions are seen (at least partially) as a deferred compensation scheme. In this subsection, we use data from the CASEN survey to investigate whether, on average, individuals indeed value the new privatized system and consider it as a component of their total compensation package.

   For an individual employed in the formal sector, total labor compensation will be equal to his take-home (cash) salary plus a proportion of his contribution to the retirement system. If contributions are seen fully as deferred compensation, that proportion will be equal to one. If on the other hand, contributions are seen fully as taxes, that proportion will be equal to zero, and the total compensation will be only equal to the take-home salary.[29] In principle, then, the value attached by individuals to the pension system can be estimated by comparing wages from jobs that are equivalent in all respects, except with regard to contributions to the retirement program. If individuals value being enrolled in the pension's program, we would expect that, for otherwise equivalent jobs, the take-home pay of those who participate in the system will be lower than that of individuals who do not make contributions. The actual difference in the (cash) take-home pay, for otherwise equivalent jobs, then, can be attributed to the value that individuals attach to being members of the retirement system.

   We use survey data for over 23,000 individuals to estimate a "treatment" model that combines a wage equation with an equation that captures the decision to contribute in the social security system:[30]

$$\log w_j = x_j\beta + \gamma C_j + \mu_j, \tag{18}$$

$$C_j = \begin{cases} 1, & \text{if } C_j^* > 0 \\ 0, & \text{otherwise} \end{cases} \tag{19}$$

$$C_j^* = y_j\alpha + \varepsilon_j. \tag{20}$$

Equation (18) is the wage equation. Log $w_j$ is the log of take-home wages for individual $j$; $x_j$ is a vector of traditional determinants of real wages that

include, among others, education, experience, size of firm, gender, and geographical location of the job; $C_j$ is an endogenous dummy variable (i.e., the treatment variable) that takes a value of one if individual $j$ participates in the retirement system and zero if he does not. Error term $\mu_j$'s properties are discussed below; $\beta$ and $\gamma$ are parameters to be estimated. The decision to contribute to the social security is assumed to be the result of an unobserved latent variable $C_j^*$, described in equation (20); $C_j^*$, in turn, is assumed to depend linearly on vector $y_j$; $\alpha$ is a parameters vector to be estimated; and $\epsilon_j$ is an error term. Error terms $\mu_j$ and $\epsilon_j$ are assumed to be bivariate normal, with a zero mean and a covariance matrix given by

$$\begin{pmatrix} \sigma & \rho \\ \rho & 1 \end{pmatrix}. \tag{21}$$

If the wage and contribution equations are independent, the covariance term $\rho$ in equation (21) will be zero.

Parameter $\gamma$ in equation (18) measures the (average) value that individuals attach to participating in the privatized social security system. We expect its estimated coefficient to be less than or equal to zero. If the (average) value attached to social security contributions is zero, that is, if contributions are fully considered a tax, the estimated coefficient should not be significantly different from zero. If, on the other hand, contributions were considered fully as a deferred form of compensation, we would expect the estimated coefficient $\gamma$ to be approximately equal to the rate of contribution.

The model given by equations (18)–(20) can be estimated simultaneously using a maximum likelihood procedure. Chile's specific institutional arrangements, however, complicate somewhat the task of interpreting the results obtained from the estimation of this system. The main difficulty stems from the fact that the social security law requires individuals to make contributions not only to the retirement system (at 10% of wages) but also to the health system (7%) and to a mandated life insurance program (3%). Total contributions for this "package," then, stand at 20% of wages. This means that the estimated value of parameter $\gamma$ is in the range of zero to $-20\%$.

In the wage equation (eq. [18]) the dependent variable is the log of net (take-home) wages; the notation used for the independent variables is provided in table 2. We control for the usual variables that explain wage differentials, including schooling, experience (which, as is customary, we proxy by age), experience squared, geographical location of the job, gender of the individual, and size of the firm where the individual is employed. The variable "Contri" is the endogenous dummy variable that indicates if the individual makes contributions to the system. In the estimation of equation (19), we assume that the decision on whether to make a contribution depends on schooling, age, industry where the individual is employed, size of the firm, gender, and whether the individual in question has a formal employment contract. Our data set consists of 23,198 civilian workers in the urban sector who held paying jobs and did not receive retirement benefits at the time of the survey.

TABLE 2

WAGES AND SOCIAL SECURITY CONTRIBUTIONS (Maximum Likelihood Simultaneous Estimation) NOTATION USED IN ESTIMATION OF TREATMENT MODEL

| Variable | Description |
| --- | --- |
| yschool | Years of schooling |
| ex (age) | Experience measured by age |
| exp2 (age2) | Experience (age)$^2$ |
| AGRI | Dummy for agriculture |
| MINI | Mining |
| INDU | Industry |
| UTIL | Utilities |
| CONS | Construction |
| COMM | Commerce |
| TRAN | Transportation |
| FINA | Financial services |
| GOV | Government |
| REG1 | Regional dummies ($i = 1 \ldots 3$). REG1 refers to the two largest metropolitan areas |
| Contri | Dummy that takes value of one if the individual has made a contribution to the social security system |
| FIRMj_k | Dummy that takes value of one if the firm where the individual is employed has $j$ to $k$ workers. FIRM_200 refers to firms with 200 or more workers |
| Part_ti | Dummy that takes value of one if individual works part time |
| dcontract | Dummy that takes the value of one if the individual has an employment contract |
| Woman | Dummy that takes a value of one if the individual is a woman |

Our sample excludes individuals with a household income below the indigent poverty line, or "extreme poverty line," as well as those with a salary that exceed the maximum subject to social security contributions.

The results obtained from the joint estimation, using a maximum likelihood procedure, of the model given by equations (18), (19), and (20), are presented in table 3. The Wald test statistic for independence of the two equations (for the covariance term $\rho$ being equal to zero) is equal to 111, strongly suggesting that both equations should indeed be estimated jointly. Panel A in table 3 corresponds to the wage equation (eq. [18]), while panel B contains the results for "treatment" equation (eq. [20]). As may be seen from panel A in table 3, the estimated coefficients for the traditional variables—schooling, experience, and experienced squared—are along the line of what is expected and are consistent with previous estimates for Chile and other emerging economies. Both schooling and experience have significant and positive coefficients; as expected, experience squared has a negative and significant coefficient. Women earn significantly less than men, and there are regional and firm-size significant wage differentials. The most important result, for our purpose, is that the estimated coefficient of the social security contribution variable is significantly negative, as expected. Its point estimate $-0.0885$ suggests that, on average and for equivalent jobs, individuals who contribute to the social security (cum health) system have a take-home wage

TABLE 3

WAGES AND SOCIAL SECURITY CONTRIBUTIONS
(Maximum Likelihood Simultaneous Estimation)

| | Coefficient | Robust Standard Error | $z$ | $P > |z|$ |
|---|---|---|---|---|
| | A. Wage Equation (Dependent Variable: Log of Take-Home [Net] Wages) | | | |
| yschool | .079173 | .0010154 | 77.97 | .000 |
| ex | .0217501 | .0007858 | 27.68 | .000 |
| ex2 | −.0001781 | .0000159 | −11.20 | .000 |
| Woman | −.1636414 | .0066837 | −24.48 | .000 |
| REGION1 | .0479687 | .0116115 | 4.13 | .000 |
| REGION2 | −.0120154 | .0125271 | −.96 | .337 |
| REGION3 | −.0427694 | .0129711 | −3.30 | .001 |
| FIRM6_9 | .0166319 | .0132469 | 1.26 | .209 |
| FIRM10_49 | .0554989 | .0089351 | 6.21 | .000 |
| FIRM50_199 | .1193046 | .0105452 | 11.31 | .000 |
| FIRM_200 | .2371546 | .0107323 | 22.10 | .000 |
| Contri | −.0885305 | .0129523 | −6.84 | .000 |
| _cons | 10.45468 | .019303 | 541.61 | .000 |
| | B. Treatment Equation (Dependent Variable: Dummy for Social Security Contributions) | | | |
| yschool | .0359285 | .0037132 | 9.68 | .000 |
| age | .0356025 | .0059522 | 5.98 | .000 |
| age2 | −.0003571 | .0000723 | −4.94 | .000 |
| FIRM6_9 | .0849724 | .0483861 | 1.76 | .079 |
| FIRM10_49 | .3225233 | .0344014 | 9.38 | .000 |
| FIRM50_199 | .4179108 | .0455909 | 9.17 | .000 |
| FIRM_200 | .5256829 | .0514504 | 10.22 | .000 |
| part_ti | −.2436089 | .0600502 | −4.06 | .000 |
| Woman | −.1087624 | .0288949 | −3.76 | .000 |
| AGRI | .2301454 | .1331833 | 1.73 | .084 |
| MINI | .286353 | .1472251 | 1.95 | .052 |
| INDU | .2978188 | .1297052 | 2.30 | .022 |
| UTIL | .2220377 | .1905074 | 1.17 | .244 |
| CONS | .2163195 | .1317592 | 1.64 | .101 |
| COMM | .2355087 | .128338 | 1.84 | .066 |
| TRAN | .1413476 | .1317512 | 1.07 | .283 |
| FINA | .4103262 | .139452 | 2.94 | .003 |
| GOV | .2871577 | .1284112 | 2.24 | .025 |
| dcontract | 1.93364 | .0283869 | 68.12 | .000 |
| _cons | −1.841414 | .1741268 | −10.58 | .000 |

NOTE.—Number of observations = 23,198; Wald $\chi^2$ (12) = 7,967.36; Prob $> \chi^2$ = .0000; log likelihood = −21,518.074; Wald test of independent equations: $(\rho = 0) : \chi^2(1) = 110.95$; Prob $> \chi^2$ = .0000.

that is almost 9% lower than those who do not contribute to the system. Since the mandatory (for retirement and health) contribution is 20%, this means that individuals who make contributions consider part of them as taxes. More specifically, these results suggest that individuals consider little over one-half of their contribution to be a tax.

A few words on the results from the treatment equation (panel B in table 3): the decision to contribute to the social security system is affected in a

TABLE 4

PARAMETER VALUES USED IN SIMULATION EXERCISES

| Parameter | Description | Value |
|---|---|---|
| $F$ | Total labor force (thousands of people) | 3,700 |
| $L_M$ | Employment in modern sector (thousands) | 1,850 |
| $L_r$ | Employment in "informal" sector (thousands) | 1,450 |
| $U$ | Unemployed (thousands) | 400 |
| $\mu$ | Wage "passover coefficient" in prices in informal sector goods | .3 to .5 |
| $\phi$ | Supply elasticity of labor with respect to wages | .3 |
| $\beta$ | Weight of informal sector prices in price level | .3 |
| $(1/\eta_I)$ | Demand elasticity for labor in informal sector | −.5 to −.7 |
| $(1/\eta_M)$ | Demand elasticity for labor in modern sector | −.4 to −.6 |
| $T_1$ | Initial implicit tax on labor | 26.0% |
| $T_2$ | Postreform implicit tax on labor | 5.6% |

SOURCE.—See text.

positive way by schooling, experience (although at a declining rate), and the size of the firm. Women tend to contribute less than men, and part-time workers tend to contribute less than those who work full time. Naturally, and as expected, those who have an employment contract (dcontra) have a (very) high probability of contributing. Some of the sectoral variables are also significant, suggesting that with other things given, the probability of making contributions to the private social security system is affected by the type of industry in which the individual works.

In order to investigate for the robustness of the results reported in table 3, we estimated earnings equations for alternative samples. The results obtained from these alternative estimations confirmed those reported in table 3 and are not presented here because of space considerations. In Section V, we use the estimates reported in table 3 as an input into our simulation exercises.

## V. Chile's Pension Reform and the Labor Market

This section presents the results from simulation exercises, based on the model derived in Section III, on the effects of the social security reform on Chile's labor market. We proceed as follows: we use values for the key parameters from previous studies of the Chilean economy, as well as from the econometric results presented in the previous section, to provide a "base case" calibration of the model. In order to test for the robustness of the results, we then consider alternative values for the key parameters. This procedure allows us to obtain a range of estimates for the effects of the social security reform on Chile's labor-market variables.

In table 4, we present the values of the parameters used in the simulation exercise. The elasticities were taken from previous studies on the Chilean economy.[31] The data on the labor force and the rate of unemployment were taken from Banco Central de Chile. The percentage of workers in the informal sector was taken from the analysis reported in Section IV. The parameter for

TABLE 5

CHILE'S PENSION REFORM AND THE LABOR MARKET: SIMULATION RESULTS
(Eqq. [12] and [14])

|  | Low-Case Scenario (%) | High-Case Scenario (%) |
|---|---|---|
| Percentage change in real wage in informal sector | 3.8 | 4.8 |
| Change in rate of unemployment (in percentage points) | −1.5 | −2.1 |

SOURCE.—Calculated by the authors on the bases of the model developed in Sec. III of this article.
NOTE.—This exercise assumes that there is no change in the net take-home pay for those in the "formal" segment of the labor market.

TABLE 6

CHILE'S PENSION REFORM AND THE LABOR MARKET: SIMULATION RESULTS
(Eqq. [16] and [17])

|  | Low-Case Scenario (%) | High-Case Scenario (%) |
|---|---|---|
| Percentage change in real wage in informal sector | 1.7 | 2.1 |
| Change in rate of unemployment (in percentage points) | −.7 | −1.0 |

SOURCE.—Calculated by the authors on the bases of the model developed in Sec. III of this article.
NOTE.—This exercise assumes that, at the time of the reform, there is a 10% increase in the net take-home pay for those in the "formal" segment of the labor market.

$\mu$ was taken from a number of studies on Chile's inflation. In our base-case analysis, we assume that under the traditional pay-as-you-go system, contributions to the social security system (at an average rate of 26% of wages) were fully considered to be a tax; as pointed out above, benefits during the prereform era were considered to be an entitlement. Finally, we assumed that in the postreform period, mandated contributions to the pension system had a tax component equal to 5.6% of wages. That is, we assume that individuals considered that slightly over one-half of the required contribution to the pension fund constituted a tax. This figure is based on the econometric results reported in the preceding section. More specifically, it was obtained by assuming that the perceived tax element of the contributions is equally distributed between the retirement component and the health component.[32]

In table 5, we present the simulation results for the case in which the reform reduces the (implicit) tax on labor but for which there is no increase in the take-home pay for those enrolled in the system. These results were obtained after calibrating equations (12) and (14) in Section III. Table 6, on the other hand, contains the results from a simulation exercise that assumes that the reform results in a 10% increase in net take-home pay for those enrolled in the system

and corresponds to equations (16) and (17). In both tables we have presented a "low" and a "high" case scenario. As may be seen, these results suggest that, by reducing the implicit tax on labor, Chile's pension reform had a positive (but small) effect on wages in the informal sector, at the same time as it contributed to a reduction in the rate of unemployment.

The results in table 6, which are based on assumptions that closely capture Chile's experience, suggest that the actual effect of the pension reform on labor-market outcomes was rather modest with respect to unemployment reduction. According to our simulation exercise, in the high case scenario, the reforms only contributed 1.0 percentage points to the reduction of the rate of unemployment. The total effect on net wages was more important, however: first, according to this simulation exercise, the reform contributed to an increase in net wages in the informal sector that ranged from 1.7% to 2.1%. Second, by design of the reform package, net (take home) wages in the formal sector increased by 10%.[33]

An important question is how sensitive are these results to the assumption that labor-market participants considered that under the old system the tax equivalent of contributions was 26% of wages, while under the privatized system it was 5.6% of wages. In order to deal with this issue, we performed a series of simulation exercises, under alternative values of the perceived tax component of contributions, both before and after the reform. More specifically, we made the following alternative assumptions: (1) under the old pay-as-you-go regime, half of the contribution was considered a tax ($T_1 = 13\%$). (2) With respect to the postreform era, we considered a range of values for the tax component of contributions. These values go from an estimated tax ($T_2$) of 6.2% of wages to 4.9% of wages.[34] The results obtained under these alternative parameter values are close to those reported in table 6. More specifically, this sensitivity analysis suggests the following lower bound for the estimated effects of Chile's social security reform: an increase in informal sector wages of 1.4% and a reduction in unemployment of 0.4 percentage points.

## VI. Concluding Remarks

In 1981, Chile reformed its social security system. An inefficient and insolvent pay-as-you-go regime was replaced by a system based on individual retirement accounts. Over the years Chile's reform has been widely praised and has been carefully studied by policy makers throughout the world. In this article we have focused on a neglected aspect of Chile's social security reform: its impact on labor-market outcomes, including unemployment and wages. We develop a model of the labor market where we assume that, as is the case in most emerging markets, a formal and an informal sector coexist side by side. According to our model, a social security reform that reduces the implicit tax on labor in the formal sector—as was the case in Chile—will result in an increase in the wage rate in the informal sector. The effect of this type of reform on aggregate unemployment is undetermined, however. Results from

simulation exercises suggest that in the case of Chile the reforms resulted in a rather modest increase in informal sector wages: approximately 2%. These results from the simulation exercise also suggest that the reforms made a positive, but modest, contribution to the reduction of Chile's aggregate of unemployment.

## Notes

* We are indebted to Manuelita Ureta for helpful discussions and to Alejandro Jara and Rajesh Chakrabarti for assistance.

1. World Bank, *The Old Age Crisis* (Washington, D.C.: World Bank, 1994). On Chile's reforms, see Sebastian Edwards and Alejandra Edwards, *Monetarism and Liberalization: The Chilean Experiment,* 2d ed. (Chicago: University of Chicago Press, 1991); Barry P. Bosworth, Rudiger Dornbusch, and Raúl Labán, eds., *The Chilean Economy: Policy Lessons and Challenge* (Washington, D.C.: Brookings Institution, 1994).

2. See, e.g., the discussion in Peter Diamond and Salvador Valdés-Prieto, "Social Security Reforms," in Bosworth, Dornbusch, and Labán, eds., pp. 114–37.

3. The papers collected in Jonathan Gruber and David A. Wise, eds. (*Social Security and Retirement around the World* [Chicago: University of Chicago Press, 1999]) analyze in great detail the way in which social security affects labor force decisions of older persons in 11 industrialized countries.

4. Horst Siebert, "Pay-as-You-Go versus Capital Funded Pension Systems: The Issues," pp. 3–34; Oliver Lorz, "Social Security and Employment," pp. 63–88; Sebastian Edwards, "Chile: Radical Change towards a Funded System," pp. 233–63, all in *Redesigning Social Security,* ed. Horst Siebert (Tubingen: Mohr Siebeck, 1998). These constitute some of the few papers that analyze the possible effects of social security reforms on labor markets.

5. This is equivalent to analyzing whether, as expected by the architects of the reforms, individual participants consider contributions into the new system as deferred compensation.

6. The decision to replace the government-run program by one based on privately managed individual retirement accounts was part of an ambitious program aimed at transforming Chile into a market-oriented economy.

7. See Peter Diamond, "Privatization of Social Security: Lessons from Chile," *Revista de Análisis Económico* 9 (June 1994): 21–34.

8. Alejandra Cox Edwards, "Economic Reform and Labor Market Legislation in Latin America" (California State University, Long Beach, 1992, mimeographed); Diamond and Valdés-Prieto.

9. There are no penalties for working while receiving a pension.

10. In case an accumulated fund does not provide for an annuity above the minimum pension, the state complements the funds, so long as the individual has made contributions for a minimum of 20 years.

11. Augusto Iglesias and Daniel Vittas, "The Rationale and Performance of Personal Pension Plans in Chile," Working Paper no. 867 (World Bank, Washington, D.C., 1992).

12. Roberto Fuentes Silva, "Evolución y resultados del sistema?" in *Quince años despues: Una mirada al sistema privado de pensiones,* ed. S. Baeza and F. Margozzini (Santiago: Centro de Estudios Públicos, 1995), pp. 73–99.

13. Sergio Baeza Valdés and Radl Burger Torres, "Calidad de las pensiones del sistema privado chileno?" in Baeza and Margozzini, eds., pp. 165–76.

14. On industrial countries replacement rates see, e.g., E. P. Davis, "Pensions in the Corporate Sector," in Siebert, ed. (n. 4 above), pp. 93–116; the papers in Gruber

and Wise, eds. (n. 3 above). Naturally, since this is a defined contribution system, future replacement rates may vary.

15. For details on the system's operative aspects, see Sebastian Edwards, "The Chilean Pension Reform: A Pioneering Program," in *Privatizing Social Security,* ed. M. Feldsrein (Chicago: University of Chicago Press, 1998); for the impact of the reform on women's income, see Alejandra Cox Edwards, "Pension Projections for Chilean Men and Women: Estimates from Social Security Contributions," working paper (World Bank, Washington, D.C., 2000).

16. This point has been forcefully made by Diamond and Valdés-Prieto (n. 2 above), among others.

17. See Sebastian Edwards and Alejandra Edwards, "Economic Reforms and Labor Market: Policy Issues and Lessons from Chile," *Economic Policy* 30 (April 2000): 183–229, for details on the labor reforms.

18. Strictly speaking, this improved performance began in 1985–86, after Chile recovered from the debt crisis.

19. The initial level of wages was, however, highly depressed; see Edwards and Edwards, *Monetarism and Liberalization* (n. 1 above).

20. M. Bach and Ricardo Paredes ("Are There Dual Labor Markets in Chile? Empirical Evidence," *Journal of Development Economics* 50 [August 1996]: 297–312) present microbased evidence for Chile that supports the view that the country's labor market is characterized by the coexistence of these two labor segments.

21. Diamond and Valdes-Prieto. In the case of Chile, A. Torche and Gert Wagner ("Prevision social: Valoracion individual de un beneficio mandatado," *Cuadernos de Economia* 103 [December 1997]: 363–90) have argued that, although the reform reduced the tax component of contributions to social security, it did not fully eliminated it. In Sec. III, we use microsurvey data to investigate this issue in detail.

22. This mechanism is similar to the one considered in migration models of the Harris-Todaro type. In our model, however, there is no migration. The assumption of risk neutrality is not essential; all the results will follow if individuals have a constant degree of risk aversion.

23. We have abstracted from intertemporal issues. Although our results will still go through in an explicit intertemporal context, the computations would become significantly more complex.

24. This simplification allows us to maintain product prices in the modern sector constant. An alternative assumption, and one that would not affect the basic aspect of the analysis, is that the modern sector comprises both tradable and nontradable goods. In this case, we would need a product market clearing condition for modern sector goods.

25. That is, $\eta_I = (d \log W_I)/(d \log L_I)$.

26. See S. Edwards, "The Chilean Pension Reform: A Pioneering Program" (n. 15 above).

27. There is some evidence that, in spite of poverty reduction, income distribution became more unequal in Chile during the 1980s and 1990s. See A. Valdes, "Poverty and Income Distribution in a High Growth Economy: Chile, 1987–95," in *Chile: Recent Policy Lessons and Emerging Challenges,* ed. G. Perry and D. M. Leipziger (Washington, D.C.: World Bank, 1999), pp. 111–29, for an analysis of the evolution of poverty and income distribution in Chile in the 1980–94 period.

28. Some of the limitations of the model include the fact that it does not consider all the channels through which the reform will feed back to the rest of the economy. Also, it does not consider explicitly the (possible) effect on the labor supply of the elimination of the expected future benefits of the entitlement component of the old system. This effect, however, is likely to be small and could be easily incorporated into the system by amending eq. (6).

29. This, however, is only a first-order approximation. The actual proportion of

the contribution will depend on the individual's rate of discount and the pension fund's rate of return, among other things.

30. G. S. Maddala, *Limited Dependent and Qualitative Variables in Econometrics* (Cambridge: Cambridge University Press, 1983).

31. J. E. Coeymans, "Productividad, salarios y empleo en la economía Chilena," *Cuadernos de Economía* 79 (August 1992): 221–44; J. E. Coeymans and Y. Mundlak, *Sectoral Growth in Chile: 1962–82,* Research Report, vol. 95 (Washington, D.C.: International Food Policy Research Institute, 1993).

32. The results in table 2 suggest that, after controlling for other factors, those individuals who are subject to mandated contributions (at a 20% rate), have a take-home pay that is on average 8.9% below that of individuals who do not participate in the system. The estimated perceived tax of the pension component is, then, calculated as $[.1 - (.089/2)] = .056$.

33. We also simulated the model under the assumption that the supply for labor is inelastic. In this case, the estimated increase in informal sector salaries is higher, ranging from 3.7% to 6.2%.

34. These bounds are derived from the point estimate, plus or minus one standard deviation.