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Pension Reform and Growth

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Replacing a pay-as-you-go pension system with a fully funded scheme could eliminate the incentives (under the pay-as-you-go system) to informalize production and employment. Simulations of an endogenous-growth model suggest that long-term growth could increase substantially by such a reform. Econometric evidence suggests that pension reform in Chile in 1981 may be a factor in the increase in Chile's private savings since 1980.

Summary findings

Corsetti and Schmidt-Hebbel review the qualitative macroeconomic and welfare implications of replacing a pay-as-you-go pension system with a fully funded scheme.

They summarize the typically small effects found in the simulations literature, based on exogenous-growth one-sector models. Much larger, and sustained, effects are obtained in the framework of an overlapping-generations model with endogenous growth and formal-informal production sectors — the model presented in this paper.

Model simulations using the overlapping-generations model suggest that replacing a pay-as-you-go system with

a fully funded system could substantially raise long-term growth rates by eliminating the incentives (under the pay-as-you-go system) to informalize production and employment.

A final look at Chile's reform experience suggests that a structural transformation toward formalization is taking place and that both private savings and growth have been rising substantially since 1980. Econometric evidence suggests that Chile's pension reform, in 1981, could be contributing toward Chile's large increase in private savings.

This paper — a product of the Macroeconomics and Growth Division, Policy Research Department — is part of a larger effort in the department to understand macroeconomic and financial aspects of pension systems. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Emily Khine, room N11-061, extension 37471 (35 pages). June 1995.

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PENSION REFORM AND GROWTH*

by

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INTRODUCTION

Pension system reform is at the forefront of policy discussions and changes in many developing and transition economies. Recent surveys, conferences, and specialized studies attest to this revival of interest in old-age saving arrangements by policy makers and academics (see Felderer 1993, Arrau and Schmidt-Hebbel 1994, and World Bank 1994). It is often argued that substituting state-run pay-as-you-go pension systems by private fully-funded schemes could raise saving and eliminate factor market distortions, increasing long-term growth and welfare levels. This paper evaluates these claims by surveying the existing literature, offering a new approach, and evaluating the empirical evidence limited to the Chilean pension reform experience.

This paper reviews first the simulation literature focused on macroeconomic and intergenerational welfare implications of adopting mandatory pension schemes and substituting a pay-as-you-go (PAYG) by a fully-funded (FF) system.^{1/} The existing literature provides a few results on the magnitude of the effects of pension systems and reforms. This paper compares the output and welfare results obtained in the traditional framework of exogenous growth and overlapping generations (OLG) by Auerbach and Kotlikoff (1987) for the U.S. and by Arrau and Schmidt-Hebbel (1993), Valdés-Prieto and Cifuentes (1993), and Cifuentes and Valdés-Prieto (1994) for representative economies. Typically, such effects turn out to be moderate at best: output and welfare are affected only in the very long run and by amounts that normally are not very large.

This paper shows that similar conclusions obtain in the framework of an OLG model of endogenous growth. As is well known, the long-run equilibrium of an endogenous growth model is characterized by stationarity in the rate of growth of output, capital and consumption. The pure intergenerational transfer-related effect of social security turns out to affect growth rates only slightly -- of course, the compounded long run impact on macroeconomic variables is very large.

In addition to the effect of intergenerational transfers, a PAYG-FF reform may also affect growth through efficiency improvements in both financial and labor markets. The potential efficiency gains are derived from reform-related incentives to liberalize financial markets or to reduce the magnitude of financial repression. Pension funds, the argument goes, provide particularly valuable financial resources in the process of reforming domestic markets, both

¹ An analytical review is offered by Arrau and Schmidt-Hebbel (1993), that discuss the macroeconomic literature of pension systems, initiated by the seminal work of Samuelson (1958) and Diamond (1965) and continued by Samuelson (1975) and Auerbach and Kotlikoff (1987), Breyer (1989), Homburg (1990), Breyer and Wildasin (1993), and Valdés-Prieto and Cifuentes (1993), among others.

because of their magnitude and their encouragement of the development of long-term investment instruments. Efficiency gains in labor markets work through changes in labor supply and resource allocation decisions in response to new incentives in factor and product markets.

This paper focuses on these mechanisms by making use of a stylized two-sector model of social security and capital accumulation developed in the tradition of the endogenous-growth literature. The productive structure of the economy responds to a pension reform as resources can be moved from a formal (taxed and regulated) sector to an informal (untaxed and unregulated) sector. On the one hand, the sectoral reallocation of production generates a Laffer curve, determining the financial sustainability of the pension reform. On the other hand, as efficiency levels of the two sectors differ, output levels and growth rates change with the magnitude of pension-related distortions. As a result, the model highlights conditions under which the long-run impact of the reform can be considerably higher than what is suggested by conventional models focused exclusively on intergenerational transfers. The issue of financial market liberalization is addressed by varying the mix of labor and capital income taxes financing a PAYG scheme. Such a mix affects growth through two channels. The first is the distortion in the intertemporal allocation of the accumulated factors; the second is the implicit transfer between people with different propensities to save (young and old).

Illustrative simulations based on this model show that intergenerational transfers caused by a PAYG-FF pension reform tend to have the least effect on stationary growth. More significant is the financial-market effect. The dominating growth gain may stem from reducing the incentive to evade PAYG contributions in the informal sector when substituting PAYG by FF.

Only one country has implemented a radical PAYG-FF reform and sufficient time has elapsed since its start to assess possible reform effects on economic structure, private saving and growth. This paper presents some evidence offered by the 1981 Chilean pension reform, focusing closely on the post-1980 changes in economic structure, saving, and growth. Regression analysis explores the evidence on the possible contribution of pension reform to the significant improvement of private saving in Chile.

Section 1 of the paper reviews the qualitative macroeconomic and welfare changes of a PAYG-FF pension reform and compares the simulation results of the existing literature. Section 2 introduces a new two-sector endogenous growth model and applies it to simulate stationary growth effects of pension reforms. Section 3 look at Chile's changes in economic structure, saving, and growth and reports regression results for saving. Section 4 concludes.

1. PENSION SYSTEMS, SAVING AND OUTPUT LEVELS

1.1 Pension Systems and Reforms

A PAYG scheme is a social contract of mandatory intra-temporal inter-generational transfers from workers to pensioners, backed by an implicit government debt or promise to contributing worker cohorts that they will benefit from future worker contributions once they retire. A PAYG system is said to be financially balanced when pension payments are exactly matched by worker contributions. This is seldom observed in practice. Immature (i.e. recently started) PAYG systems typically show surpluses which often turn into losses when the ratio of pensioners to workers reaches system maturity. Changing demographic conditions also impinge on PAYG balances: a rising old-age dependency ratio leads to increasing PAYG system losses when contributions and pension benefits remain unchanged. PAYG surpluses and deficits are typically absorbed by government budgets. Only when the PAYG system is mature, population growth is constant, and PAYG is financially balanced, pensioners are paid on average a real return on their contributions equal to the real rate of growth of the wage bill or the economy.

There are two reasons why the return on contributions differs from the market real interest rate. First, the growth rate of the wage bill is typically lower than the real return on capital -- a feature of dynamically-efficient economies à la Diamond (1965). Second, while the growth rate of the wage bill determines the average return on PAYG contributions, the return obtained by each individual worker is different from the average pensioner's return. The reason is that PAYG pensions often include a component -- unrelated to contributions -- that distributes income within cohorts. This distributional component favors (often only in theory) low-income workers or (often in practice) powerful worker groups who are able to secure generous pensions from the political establishment. Hence a PAYG scheme is in general actuarially unfair from the point of view of individual workers.

An alternative mandatory pension arrangement is an earnings-related fully-funded scheme which forces workers to save part of their wage income for old age. The average return on old-age saving depends on (domestic and international) market interest rates and rates of return. In principle, a FF system could also include distribution among groups of workers within a given generation, hence weakening the relation between earnings and pensions. As we abstract from this case, pensions in a FF system are actuarially fair for each individual.

A pension reform which substitutes PAYG by FF involves three changes: the link between worker contributions and benefits is strengthened, the previously hidden PAYG debt is made explicit, and the distributional function of the old PAYG system is separated from the new

FF scheme. The most generalized feature of PAYG systems in the real world are pension system losses that grow over time as a result of rising old-age dependency and/or increasing PAYG system maturity. The fiscal consequences of rising PAYG system losses are the single most important motivation for reforming PAYG schemes, typically more important than the potential efficiency and saving/output gains reaped from adopting a FF system (see World Bank 1994).

Many features determine how starting a mandatory pension scheme or substituting one scheme for another affects an economy's macroeconomic variables and (some appropriately defined criterion of) Pareto efficiency. While we refer the reader to a more extensive survey of the literature (Arrau and Schmidt-Hebbel 1993), in this paper we focus on three main features that determine the consequences of substituting PAYG by FF.^{2/}

(1) The distortionary nature of PAYG contributions. PAYG pension contributions are typically proportional to wage income and therefore can distort labor market decisions and employment levels. As mentioned above, the reason is that the link between worker contributions and benefits is weakened twice by a PAYG system: average rates of return on contributions differ from (are typically lower than) market interest rates, and rates paid to individual pensioners on their marginal contributions differ from average rates paid to their cohorts due to intra-generational income redistribution.

Workers attempt to reduce the excess burden of this pure tax by adjusting both the length of their working life and the quantity of labor supplied, or shifting into informal labor markets -- the latter response being more likely in developing countries -- where all taxes, including the pure tax component of PAYG contributions, can be avoided. Firms respond to higher PAYG labor costs by adopting less labor-intensive technologies or by shifting operations to informal markets as well. Overall, PAYG tends to raise gross labor costs in formal markets while depressing real net wages -- a labor market distortion which is avoided by a FF scheme, at least for those workers who are able to assess properly the link between their current contributions and future pension benefits. Loss in employment and economic efficiency due to the "pure" tax-component of PAYG contributions depends on the relevant supply and demand elasticities for labor and capital (saving and investment).

² Other structural features -- not considered here -- that determine the sign and size of macroeconomic and welfare effects of adopting a mandatory pension system or substituting it by a different scheme are the following: financial openness, inter-generational altruism, the size of mandatory saving relative to pre-system voluntary saving, consumer myopia, borrowing constraints, age structure, and incomplete insurance markets for sharing risk.

(2) Form of financing of system transition. The straightforward way to finance the reform transition deficit is by issuing new government debt. The old implicit PAYG debt is swapped for new explicit government debt so that the government's old PAYG debt is now explicitly reflected on government books.^{3/} Debt financing implies that national saving, the capital stock and the inter-generational distribution of welfare are only marginally affected, by magnitudes that depend on the net efficiency gains of the reform. A very different result is obtained when the transition deficit is financed using current budget surpluses, i.e. by raising taxes (and/or cutting public spending). A fully tax-financed transition reverts the initial PAYG transfer from workers to pensioners -- associated to the start of the initial PAYG scheme -- by fully paying off the implicit PAYG debt. This hurts tax-paying transition generations^{4/} and benefits non-taxed post-transition generations. Tax-financing of the transition -- as any restrictive fiscal policy which pays off government debt through taxes and hence shifts resources from current to future generations -- encourages higher saving and capital formation, therefore raising future per capita income and wage levels. These first-order effects on saving and capital formation, due to the inter-generational transfer embedded in tax financing, are added to potential second-order effects of the pension reform due to net efficiency changes.

Similar considerations apply to the case of spending cuts, to the extent that currently active workers enjoy less public or publicly-provided goods. Note that a reduction in public investment may also affect the path of capital accumulation as well as the efficiency of private capital.

(3) The distortionary nature of general taxation. A debt-financed transition deficit requires raising additional government revenue only to the extent that the interest bill increases when FF substitutes explicit new debt for implicit PAYG debt. A higher tax rate raises the magnitude of distortions due to general taxation -- independently of its underlying tax base. Hence a shift from PAYG to FF, while potentially eliminating labor market distortions, induces more widespread tax distortions, which could be permanent (if the transition deficit is debt-financed) or transitory (if it is tax-financed). If general taxation is at the margin less distortionary than payroll taxation, a pension reform brings positive net efficiency gains and can raise the economy's Pareto

³ Debt financing in a broad sense can be thought to refer to issuing any public liability or liquidating any public asset to finance the transition deficit. The latter option includes privatization of public enterprises and drawing from government holdings of international reserves or strategic commodity stocks.

⁴ These generations could include current pensioners retired under the initial PAYG system or could comprise only current and future working cohorts.

efficiency.^{5/} In case of a tax-financed transition -- equivalent to a debt-financed reform combined with a contractionary fiscal policy -- the new tax-induced distortion is temporary and lasts as long as taxes are required to pay off the initial PAYG debt. Nonetheless, the literature on tax-smoothing warns that increasing tax rates while shortening the period of contractionary fiscal policy may induce a more than proportional drop in output, labor supply, and welfare.^{6/}

In conclusion, the distortion-related effects on Pareto efficiency of the way the transition is financed are generally ambiguous. Only under lump-sum general taxation -- at least theoretically conceivable -- the PAYG-FF reform raises unambiguously Pareto efficiency by eliminating the distortionary effects of PAYG taxation.

1.2 Quantitative Long-Run Output and Welfare Effects of Mandatory Pension Systems and Reforms: a Look at the Literature

Few studies have assessed the short and long-run fiscal, output, and welfare effects of introducing or substituting mandatory pension systems. Here we discuss the findings of four simulation studies summarized in Table 1.1: one for the U.S. economy (Auerbach and Kotlikoff, 1987, denoted AK), the second for a representative economy (Arrau and Schmidt-Hebbel, 1993, denoted AS); and the third and fourth also for a representative economy (Valdés-Prieto and Cifuentes 1993, denoted VC, and Cifuentes and Valdés-Prieto 1994, denoted CV).^{7/8/}

⁵ On the relative efficiency of income taxation (which is the general tax considered by the simulations discussed in this paper below), Auerbach, Kotlikoff and Skinner (1983) conclude from second-best theory that income taxation will not always be more efficient than wage or payroll taxation; "rather, the relative efficiency of the two taxes will depend on the particular structure of preferences" (Auerbach and Kotlikoff, 1987, p. 80). Auerbach and Kotlikoff's (1987) simulation results for a switch from income to wage taxation (Table 5.7, p. 77) show efficiency losses for six and efficiency gains for one of their parameter combinations. This could suggest that efficiency gains are more likely than efficiency losses when substituting payroll by income taxation.

⁶ These considerations are also important, although for different reasons, in the presence of short-run price rigidities and liquidity constraints, when the contractionary fiscal policy implied by tax-financing the transition may run against short-run output stabilization policies. The presence of Keynesian market failures thus reinforces the argument in favor of gradualism in addressing the financial costs of the reform.

⁷ There are two similar dynamic simulation studies on PAYG-FF reforms for real-world economies, one for Mexico (Arrau 1990) and a second for Chile (Arrau 1992). However, they do not report long-run output and welfare effects of the reforms.

⁸ The four studies are based on OLG models aimed at assessing the effects on long-term output levels of intergenerational transfers and changes in market distortions. They all share AK's dynamic general equilibrium framework for a closed economy comprised by 55 optimizing overlapping cohorts. In all four models inter-generational voluntary transfers and intra-generational distribution are ruled out and mandatory saving always falls short of the amount consumers would

Starting PAYG shifts resources from future to current generations. For the U.S., the start of PAYG is estimated to reduce long-term output levels by figures close to 5%, with minor differences depending on how general taxes are raised -- either on general income, wage income, or consumption. The corresponding long-term welfare losses of future cohorts are 5 to 6%.^{9/}

The AS simulations for representative economies distinguish between two demographic scenarios (high and zero population growth) and how the transition deficit is financed (debt or taxes). Consider first the case of high population growth at 2% per year. When the fiscal transition deficit is financed by issuing explicit government debt (i.e., the case of a straightforward pension reform), the implicit PAYG debt is put on government books. Therefore the explicit government debt increases significantly, although this massive debt build-up does not crowd out private investment. The reason is that the reform raises both demand and supply of government debt, as new worker contributions to the FF system are invested in newly issued government debt during the 45 years of fiscal transition deficit.

While direct intergenerational transfers are ruled out by debt financing, higher income taxation imposes a slight but permanent efficiency cost. Hence long-run saving, capital, investment and output levels are slightly but negatively affected by debt financing. Output at year 110 is 1% lower than under the initial PAYG scheme, reflecting the full impact of the modest efficiency loss from higher income taxation. The welfare loss of future steady-state generations is 0.3%, derived from permanently higher income taxation. It is important to note that this loss could be a net gain when labor is supplied elastically and the associated labor market efficiency gain more than offsets the income-tax efficiency loss from higher income taxation.

voluntarily save in the absence of any pension scheme. Myopia and credit constraints are introduced by VC and CV but not considered in the AK and AS frameworks. The main difference between the AK model and the AS and VC frameworks is that both PAYG and general taxation are distortionary in the former but only general taxation is distortionary in the two latter models, where labor is supplied inelastically. AS report sensitivity analyses corresponding to alternative assumptions on critical parameter values -- the results are similar to the base-case results summarized here. AK, AS, and CV report impact, transition and steady-state effects on the main fiscal, macroeconomic and welfare variables. VC, however, is a model for steady-state equilibria. Here we focus only on long-run or steady-state results reported in the four papers, which often differ strongly from short or medium-term effects.

⁹ The welfare change is computed as the wealth compensation which would have been required to give each cohort to maintain its initial welfare level.

Table 1.1

LONG-RUN OUTPUT AND WELFARE EFFECTS OF PENSION SYSTEMS AND REFORMS1.1A Effects at Year 150 after Introducing PAYG in the U.S. Economy

	<u>Output Change</u>	<u>Welfare Change</u>
Under Income Taxation	-5.3 %	-6.0
Under Wage Taxation	-4.9 %	-6.3
Under Consumption Taxation	-4.5 %	-4.8

Source: Auerbach and Kotlikoff (1987), Tables 10.1 and 10.2. The long-run output change is calculated from the percentage changes in capital and labor at year 150 presented in table 10.1, weighted at a 0.25 capital share.

1.1B Effects at Year 110 after Substituting PAYG by FF in Representative Economies

	<u>Output Change</u>	<u>Welfare Change</u>
<u>High Population Growth</u> (n=2% per year)		
Debt-Financed Transition Deficit	-1 %	-0.3 %
Tax-Financed Transition Deficit	+3 %	+6.8 %
<u>Stationary Population</u> (n=0)		
Debt-Financed Transition Deficit	-4 %	-3.5 %
Tax-Financed Transition Deficit	+5 %	+12.5 %

Source: Arrau and Schmidt-Hebbel (1993), Tables 3, 4, and 9. Technical progress is 2% per year, hence stationary GDP growth is 4% or 2%, respectively.

1.1C Steady-State Effects of Substituting PAYG by FF in Representative Economies

	<u>Output Change</u>	<u>Welfare Change</u>
<u>Tax-Financed Transition Deficit</u>		
Without Credit Constraints	+1.9 %	+5.9 %
With Credit Constraints	+27.1 %	+13.5 %

Source: Valdés-Prieto and Cifuentes (1993), Table 10 and authors' calculations. Population growth is 2% and technical progress is 2%, hence stationary GDP growth is 4%.

1.1D Steady-State Effects of Substituting PAYG by FF in Representative Economies

	<u>Output Change</u>	<u>Welfare Change</u>
<u>With Credit Constraints</u>		
75% Debt, 25% Tax-financed Transition Deficit	+7.0 %	+3.4 %
Full Tax-Financed Transition Deficit	+21.8 %	+16.3 %

Source: Cifuentes and Valdés-Prieto (1994), Table 5, and authors' calculations. Population growth is 0.5% and technical progress is 0.5%, hence stationary GDP growth is 1%.

When the transition deficit is financed by taxes, the pension reform is actually combined with a contractionary fiscal policy. This combination hurts tax-paying transition generations and benefits post-transition cohorts. The transfer to future generations raises long-run saving, capital and output levels. However, long-run output gains of a fully tax-financed pension reform are modest. At year 110 after reform start, output exceeds the level it would have attained under the old PAYG system by only 3%. Future generations gain 6.8% of their wealth as a result of both the transfer from the tax-paying transition cohorts (which pay off the initial implicit PAYG debt) and a small efficiency gain due to slightly lower income taxes.

For a stationary population the qualitative results remain unchanged although their size is larger. The reason that the reform effects grow with the old-age dependency ratio is the larger initial PAYG debt, implying stronger efficiency effects and, in the case of tax financing, a larger transfer toward future generations.

The VC and CV papers introduce -- as opposed to the two preceding studies -- heterogeneous consumer groups with different degrees of myopia (that is, dissimilar subjective discount rates) in combination with the possibility of credit constraints. The latter hit consumers with high discount rates because of the additional restriction that non-human wealth has to be non-negative at any point in time.

The VC study allows to assess the important role played by the group of myopic and credit-constrained individuals when substituting PAYG by FF. Without binding credit constraints the long-term effects of a tax-financed pension reform are modest, similar to the results shown by AS. However, when widespread myopia-cum-credit-constraints is considered, the pension reform boosts (involuntary) saving significantly, so that the long-term output level gain rises 14-fold, from 1.9% to 27.1%. Welfare increases by significantly less because of the involuntary shift of consumption toward the future imposed on credit-constrained myopes. However, the large size of these effects -- and of those reported in the CV study discussed next -- is in part due to the assumption of both studies that FF savings are exempt from income taxation.¹⁰ This assumption -- not made in the two preceding studies -- provides an additional incentive to saving and hence capital formation when adopting a FF system.

¹⁰ The importance of this assumption is borne out by the comparison of steady-state output effects of the reform when pension fund income is and is not exempted from income taxation. This comparison can be inferred from the CV study (Table 6) for the case of 75% debt and 25% tax-financed transition deficits. With FF saving exemption from income taxation the steady-state output increase is 7.0% (as reported in our Table 1.1); it shrinks to only 4.5% without income tax exemption. One may infer that all other long-term output results reported by both VC and CV studies should be adjusted downward by roughly one third when evaluating a PAYG-FF pension reform without the provision of tax exemptions.

Finally consider the CV results, that allow to distinguish -- only for the case of binding credit constraints for a group of myopes -- between steady-state effects under two different financing options for the reform transition deficits. As this study solves for and simulates the entire transition path, its quantitative results are more reliable than those of the preceding VC study that is based only on comparisons across steady-state equilibria.

Even when debt-financing is large relative to tax financing (75% and 25%, respectively), the CV paper reports a significant long-term output gain of 7%. When the transition deficit is fully tax-financed, the long-term output gain rises to 21.8%. The latter figure is quite large, a result due in part to two important assumptions: FF savings exemption from income taxation and very low stationary GDP growth (1%). Without income tax exemption and with higher growth (say 4%, as in the AS and VC studies), long-term output gains of a tax-financed pension reform when credit-constraints myopes are present would be well below the reported 21.8%, possibly down to a single-digit figure.

In sum, the simulation results for the three models report modest to moderate long-term changes in output and welfare levels caused by a pension reform. And in the few cases where long-term percentage gains reach double-digit levels, these effects are only reaped decades after the reform has been initiated. Could larger effects be expected when the structure of production is allowed to respond to pension reform? To this question we turn next.

2. AN ENDOGENOUS GROWTH MODEL OF PENSION SYSTEMS AND THE SIZE OF THE INFORMAL SECTOR

This section analyzes growth and allocation effects of alternative pension systems within the framework of a stylized OLG model of endogenous growth where capital has an external effect on labor productivity. The structure of the model relates social security to the decision to allocate labor between two productive sectors, using different technologies. The first sector employ both capital and labor and is subject to social security regulation (the formal sector); a second, less efficient sector only employs labor and is totally unregulated (the informal sector). The goal is to provide a stylized model suitable to explore different ways in which pension reforms affect growth, with special reference to the size of the informal sector.

The two main features of the model are the following. First, the social return on capital is sufficiently bounded away from zero and does not decrease with the capital stock. Therefore the economy can never be dynamically inefficient due to excessive accumulation, as in the traditional OLG model (Diamond 1965 and Blanchard 1985). Nonetheless, because of the

external effect of capital on labor productivity, the social return on capital is not entirely appropriated by private investors. In a long-run equilibrium, the market capitalization rate may well be lower than the rate of growth of the economy. If this is the case, a PAYG system pays a higher average pension than a FF system at the current intertemporal price of consumption. Second, as labor moves from the informal to the formal sector in response to a pension reform, both productivity and the rate of return on capital increase. Because of conflicting income and substitution effects, the change in consumption and growth cannot be determined unambiguously. Nonetheless, our numerical simulations below show the potential importance of the effects under consideration.

The size of the informal sector is surprisingly large not only in developing economies but also in the industrialized world. In Italy, for example, the irregular sector is estimated to produce about 16% of aggregate value added in 1990 (70% in agriculture, 6% in manufacturing, 36% in the building sector, and 22% in services; Rey 1993). In developing countries, available estimates of informal-sector employment in urban areas vary between an average of 30% for a sample of relatively high-income countries and 50% for a sample of low-income countries (Turnham 1988). As social security contributions are one of the main components of labor costs, it is well understood that the informalization of production allows firms to reduce their costs substantially. In the case of Latin America, recent estimates point out that the tax wedge on labor costs imputable to social security is as high as 20% for small firms (Tokman 1992)¹¹.

The model focuses on the role of social security in the informalization of production from a macroeconomic perspective. The allocation of labor depends on the perceived marginal degree of appropriability of social security contributions capitalized at the market interest rate. The competitive equilibrium in an economy with a FF pension system provides the base scenario in our simulations. Vis-a-vis this benchmark, we will consider different degrees of appropriability in a PAYG system. In a world without uncertainty and credit constraints, social security contributions are a component of private saving in the base scenario, while they may be perceived as pure taxes in the other cases.

Section 2.1 briefly presents the model and provides a discussion of the basic features of OLG models of endogenous growth. The analytical model is summarized in the appendix; for a full analytical derivation see Corsetti 1994. Section 2.2 focuses on the quantitative impact of

¹¹ A theoretical assessment of the role of social security -- together with other forms of regulation -- in explaining the emergence of an informal economy is a promising direction of research but is not the purpose of this paper. All we require is that, at the margin, social security affects the choice to allocate labor between the two sectors.

different social security regimes by reporting simulations for different degrees of coverage and equilibrium tax rates.

2.1 The Model

2.1.1 Supply: a Stylized Two-Sector Model

Our model allows for two sectors, characterized by perfectly competitive markets with free entry. Production technology in the first sector requires both capital and labor while production in the second sector is carried out only with labor. Labor in the production functions is measured in efficiency units which do not coincide with labor time. In the tradition of the endogenous growth literature, we assume the presence of an external effect of the existing capital stock on labor efficiency (Sheshinski 1967, Romer 1986). Thus, under perfectly competitive markets, firms fail to see the link between their own investment and employment decisions and the efficiency of labor.

Technology in the formal sector is characterized by a standard constant-returns-to-scale production function, with capital and labor (in efficiency units) as productive inputs. Nonetheless, once the external effect of capital on labor is allowed for, aggregate sectoral production will be a linear function of capital (a typical AK model, as in Rebelo 1991), whereas the linear coefficient depends on the share of labor in the formal sector.

In the informal sector, the production function is linear in labor efficiency units, so that the productivity of informal employment determines the net wage rate for the whole economy. Because of the capital-related externality, the social production function in the informal sector is also linear in capital.

The existence of a competitive equilibrium requires the informal sector to be less efficient than the formal sector from the perspective of a social planner. As a result of this feature, shifting labor away from the formal to the informal sector reduces output and the return on capital by diverting the ultimately productive input -- embodied capital -- from the formal production process to a less efficient one.

2.1.2 Demand

The demand side of the model, which follows Buiter (1992), is derived from a Yaari-Blanchard OLG model, in a version which differentiates between birth and death rates (Weil 1989, Buiter 1988). The endogenous-growth version of this model may run into a problem similar to the one pointed out by Jones and Manuelli (1992) with respect to discrete-time OLG

models. They noticed that technologies which would generate sustained steady-state growth rates in a representative agent model may not do so in a OLG setting. The reason is that the endowment of the young generations may constrain the amount of saving that old generations are able to sell in order to finance consumption in their late days. The technological side of the model provides a strong engine for growth, i.e. persistently high productivity of accumulated factors of production. However, the same accumulation process rapidly dwarves the endowment of newly born people, which becomes a binding constraint on the rate of growth.

In the absence of a proper life cycle, a related issue arises in Yaari-Blanchard models from the fact that accumulated factors are the ultimate source of productivity. In our model, we assume that the capital stock has a positive external effect on labor productivity. If all externalities were internalized, both the social and the private marginal product of raw labor would be zero. In a competitive setting, capital income would exhaust output. Since in the absence of intergenerational bequest and gift motives the newly-born generations are endowed exclusively with raw labor, in such a scenario they would not be able to come into play. Each new generation would starve until death, the time of which, luckily enough, is by construction independent of people's diet.

The external effect of outstanding capital on individual productivity captures the idea that capital requires human skills and knowledge. To the extent that these goods are non-rival and non-excludable, and that they can be freely acquired in proportion to the level of economic activity, new generations see their endowment at birth increase with the size of the economy. Such a feature of OLG models of endogenous growth is often poorly understood. In a representative agent model, any reduction of the share in output of factors which are not productive from a social point of view increases growth and welfare. Thus, to the extent that the productivity of labor hinges on the external effect of capital, it is desirable to reduce the share of labor income.

In our OLG model, factor shares are strictly interwoven with the endowment of new generations at birth. Because of the external effect of capital on their productivity, young generations live out of "rents" from a social planner's perspective. Nonetheless, in early stages of their lives, they also have the highest marginal propensity to save out of labor income. The interaction of these two elements generates a much richer set of possible results than the monotonic relation between factor distribution and the rate of capital accumulation that characterizes the representative-agent version of our model.

2.1.3. Social Security and Equilibrium

The instantaneous flow of pension benefits is modelled after Saint-Paul (1992), including both an age-dependent and an age-independent component. Benefits are financed through a flat-rate tax on wage income, while the government is required to run a balanced net transfer (benefits minus taxation) budget.

While the net wage rate is technologically determined by productivity in the informal sector, the before-tax equilibrium wage rate in the formal sector depends on the perceived degree of future appropriability of current social security contributions, as determined by law, regulation and (implicit or explicit, private or political) contracts.

2.2 Simulation Results and Model Discussion

Section 1.2 has reviewed the literature on numerical simulations of OLG growth models, showing that, in general, the steady-state effects of reducing intergenerational transfers with a social security reform tend to be small. The question is therefore how much the long-run macroeconomic impact of pension reforms can vary, once different factors (in addition to the change in pension wealth) are taken into account. By way of example, this section provides a numerical simulation of our model, based on standard parameter values for both preferences and technology.

Endogenous-growth models are analytical tools which of course are biased toward our goal: growth rates are permanently affected by any change of parameters. Our exercise is therefore only aimed at capturing qualitative features of the response of economic systems to changing pension regimes, rather than providing a quantitative assessment of the effects under consideration. The simulation results, based on the model discussed in the appendix, are reported in Table 2.1.

The benchmark result is for the model under a FF pension regime (Simulation 2.1.0, Table 2.1). The following simulations reflect a PAYG regime which allows for an increase in pensions. In a first run of the model, the PAYG pension is financed by a lump-sum tax and hence there is no informal sector (Simulation 2.1.1). PAYG contribution rates vary between 6% and 20%. Then we let the magnitude of labor market distortions increase with the contribution or wage-tax rate (Simulation 2.1.2). Now the informal sector emerges as a consequence of the PAYG system, absorbing up to 47.5% of the labor force. In the next simulation (2.1.3), the individually perceived marginal appropriability of future social security benefits is raised from 0 (in simulations 2.1.1 and 2.1.2) to 20%. The final case (simulation 2.1.4) substitutes part of

the distortionary PAYG taxation by a distortionary tax on capital (at 0.5%), which lessens somewhat the informalization of the economy but reduces the incentives for capital accumulation.

Note that the simulations allow to distinguish between the inter-generational transfer effect and the distortionary labor market and production effect of PAYG. The former is reflected by simulation 2.1.1, which shows that long-run growth falls from 3.7% under FF to a range of 3.1%-3.5%, depending on the magnitude of lump-sum taxation and hence the size of the inter-generational transfer. However, when PAYG taxation is distortionary (simulation 2.1.2), growth declines very strongly at high PAYG contribution rates, as a result of a massive shift of labor from the formal to the informal sector. For instance, at a PAYG wage rate of 20% (and assuming that the degree by which workers relate current PAYG contributions to future pensions is 0), stationary growth reaches only 1.8%, much below the 3.1% growth rate achieved when PAYG is not distortionary. This is a striking result which reflects the much more significant role played by distortionary PAYG taxation in two-sector economies than by the PAYG transfer toward older cohorts.

Simulation 2.1.3 introduces a link between current worker contributions and future pension benefits. It shows that a relatively weak link of 20% can substantially lower the PAYG labor and production distortions induced by high PAYG contribution rates. At a 20% contribution rate, growth decreases only to 2.3% as compared to 1.8% in simulation 2.1.2.

The last simulation (2.1.4) is obtained by varying the combination of capital and labor taxation for a given pension rate. Introducing a tax on capital holdings -- at a very low rate of 0.5% -- allows to reduce the PAYG wage tax rate. Lower labor market distortions are matched by higher intertemporal distortions. The net effect (comparing simulation 2.1.4 to 2.1.2) is a further decline in growth rates by an average 0.3 percentage points.

In assessing these numerical results one should keep in mind that, in our model, the long-run impact of a pension reform can not be determined unambiguously because of the reform-related effects on the degree of labor market efficiency. As the inter-temporal price of consumption responds to the pension regime, people revise their saving plans accordingly.

Table 2.1

LONG-RUN MACROECONOMIC AND GROWTH EFFECTS
OF MANDATORY PENSION SYSTEMS

Steady-State Simulation Results with an Endogenous-Growth Model

2.1.0 A FF System

Wage Tax Rate	Formal- Sector Labor Share	Share of Labor in Income	Consump- tion to Capital Ratio	PAYG Pension Rate	Capital and Output Growth
Any	1	0.75	14.38%	0	3.7%

2.1.1 A PAYG System financed by Lump-Sum Taxation

Wage Tax Rate	Formal- Sector Labor Share	Share of Labor in Income	Consump- tion to Capital Ratio	PAYG Pension Rate	Capital and Output Growth
6%	1	0.75	14.46%	.11	3.5%
10%	1	0.75	14.56%	.17	3.4%
15%	1	0.75	14.68%	.25	3.3%
20%	1	0.75	14.81%	.34	3.1%

2.1.2 A PAYG System financed by Distortionary Taxation: Labor shifts from the Formal to the Informal Sector in response to Higher Tax Rates

Wage Tax Rate	Formal- Sector Labor Sector	Share of Labor in Income	Consump- tion to Capital Ratio	PAYG Pension Rate	Capital and Output Growth
6%	1	0.75	14.46%	.11	3.5%
10%	0.85	0.77	14.76%	.15	3.0%
15%	0.675	0.80	15.01%	.19	2.4%
20%	0.525	0.83	15.10%	.21	1.8%

Table 2.1

(Continuation)

2.1.3 A PAYG System financed by Distortionary Taxation: similar to 2.1.2 but at the margin the degree of appropriability of future pension payment at the current capitalization rate is 20%.

Wage Tax Rate	Formal-Sector Labor Share	Share of Labor in Income	Consumption to Capital Ratio	PAYG Pension Rate	Capital and Output Growth
10%	1	0.77	14.55%	.16	3.4%
15%	0.825	0.80	14.89%	.22	2.9%
20%	0.70	0.83	15.11%	.24	2.3%

2.1.4 A PAYG System financed by Distortionary Taxation on Both Labor and Capital: similar to 2.1.2 but in addition to the PAYG wage tax there is a 0.5% tax on capital

Wage Tax Rate	Formal-Sector Labor Share	Share of Labor in Income	Consumption to Capital Ratio	PAYG Pension Rate	Capital and Output Growth
9.7%	0.875	0.77	15.07%	.16	2.7%
14.6%	0.70	0.80	15.35%	.22	2.1%
19.6%	0.55	0.83	15.45%	.24	1.6%

Notes: The simulation model is discussed in the appendix. Parameter values for the simulation are the following: (a) Preferences: elasticity of marginal utility = 1.1, time preference = 0.02; (b) Technology: linear coefficients in the formal and informal sectors: $\alpha_1 = 0.2$, $\alpha_2 = 0.14$, the production function in the formal sector is Cobb-Douglas with a capital share of 0.25 and a depreciation rate of 0.02; (c) Demography: birth rate = 0.06, death rate = 0.03, aging rate = 0.03.

In our analysis, the indicator of labor market distortions is the size of the socially less productive informal sector. Are FF systems the least distortionary of pension systems? In an endogenous-growth model with an external effect of capital on labor, a distributional issue arises from the fact that a share of the return on investment goes to capital embodied in labor. Future wages increase with capital accumulation at some rate which may be higher than the market rate (without any adverse consequence for the dynamic efficiency of the economy). Therefore, it is possible that, once law, regulation, and contracts appropriately link contributions to benefits, income incentives to work in the formal sector be higher in a PAYG than in a FF system. Of course, this is typically not the case. While the link between current contributions and future benefits is clear in a FF actuarially-fair system, it must be carefully built in the design of the social security institutions of a PAYG scheme.

How are our results affected when allowing for credit constraints, uncertainty, and a PAYG-FF transition in which outstanding pension liabilities are honored by the government? Credit constraints give workers an incentive to resort to the informal sector in both FF and PAYG systems. The labor-market equilibrium condition includes an extra term where each additional unit of currently disposable income is weighted by its appropriate shadow price. In an uncertain environment, if workers cannot diversify their portfolio optimally because of missing markets or other inefficiencies, people may expect the government to provide some insurance (either explicitly or implicitly), within the framework of a FF system. To the extent that public insurance weakens the link between contributions and pensions, the (inter or intra-generational) PAYG component of the scheme affects the equilibrium net wage in the formal sector, calling for a careful assessment of the moral-hazard problem implicit in such schemes. Finally, in the process of switching from a PAYG to a FF system, the public nature of the implicit pension debt tends to be clearly perceived by currently active workers. As overall fiscal pressure increases, the incentive to tax evasion may be high.

3. SOME EVIDENCE FROM CHILE

Chile's radical 1981 pension reform substituted a state PAYG system by a privately-managed and non-redistributive FF scheme, complemented by a small state-run redistributive and means-tested minimum-pension transfer program financed by general taxation.^{12/} The Chilean government had also started other major structural changes since the mid 1970s -- including trade liberalization, financial deregulation, privatization, and labor market reform --

¹² For a comprehensive analysis of Chile's pension reform see Diamond and Valdés-Prieto (1993).

that were deepened during the 1980s.^{13/} The economy was also hit by major terms-of-trade and financial shocks during the last two decades. The interaction of different structural reforms and foreign shocks makes it hard to disentangle the effects that can be attributed to the pension reform. The purpose of this section is to focus on the potential effects that pension reform has had on Chile's structure and performance, bearing in mind the difficulties of such an endeavor.

Table 3.1 summarizes the performance of Chile's labor markets, capital markets, public finances, and overall macroeconomy, that were affected, *inter alia*, by the 1981 pension reform. There is some evidence that the share of formal employment has increased after 1980. A massive improvement in Chile's private saving and overall growth performance has taken place during the last decade. A closer look at the changes in economic structure, private saving, and growth is warranted.

3.1 Economic Structure

Chile's pension reform involved a reduction of overall social security contribution rates from 29.3% to 17%, of which the contribution to the new FF scheme is 10% (table 3.1). The new system provides a close relation between earnings and pension benefits, that was absent under the preceding PAYG regime. The estimated reduction in the pure tax component of pension contributions -- from 16.0% of net wages in 1980 to 6.8% in 1982-1985 and 2.8% in 1990-1992 -- may have contributed to higher net wages, lower gross wages, and higher employment in formal labor markets.

Possible efficiency gains in labor markets are suggested by the following changes. The share of independent workers in the labor force (who are not required to contribute to mandatory pension schemes) has declined from 26% before the reform to an average 24.5% after the mid 1980s, signalling an increase of both potential pension contributors and formal labor markets. More direct evidence on the change in the formal-informal structure of labor markets is provided by the significant decline in the relative share of informal-sector employment, from 36.0% in 1980 to 31.1% in 1990-92.^{14/} In addition, male labor force participation -- that could

¹³ Among recent volumes on Chile's reforms and macroeconomic performance during the last two decades see Edwards and Cox Edwards (1988), Morandé and Schmidt-Hebbel (1988), and Bosworth, Dornbusch, and Labán (1994).

¹⁴ This formalization of Chile's employment structure stands in marked contrast to the informalization observed in other Latin American countries -- such as Argentina and Colombia -- where PAYG schemes were prevalent in the 1980s. The latter regional trend is reflected by the average share of informal sector employment in Latin America, which increased from 25.6% in 1980 to 31.4% in 1990-92 (Source: Uthoff 1994, Table 1).

reflect the incentive effect of the reform on total male employment -- has increased slightly during the last years. More ambiguous is the behavior of the share of active contributors to pension systems (comprising contributors to both the old and new schemes) in total employment, starting at 62.5% in the early 1980s to decline thereafter and recovering to an estimated 63% in 1993.

One should be careful in attributing too quickly a causal contribution to pension reform in the formalization of Chile's labor markets evidenced by the preceding figures, as that requires controlling for other intervening factors. Hence we only conclude tentatively that pension reform is a possible explanation -- among others -- for the labor market changes observed in Chile since 1980.

3.2 Private Saving

One of the major shifts observed in Chile is the large increase in the private sector saving rate, from close to zero in 1979-81 to an average 17.1% of GDP in 1990-92. The mirror image of the saving boom is a trend decline in the share of private consumption in GDP, from 73% in 1960-1981 to 63% in 1986-92 (Figure 3.1). This radical departure from the past has made possible both higher investment levels and lower foreign saving flows.

Different policy changes could be behind Chile's saving boom. One of them is pension reform, that could affect private consumption in different ways. We identify next seven channels from pension reform to private saving that may be at work.

(i) A PAYG-FF pension reform financed by tax increases (or government expenditure cuts) reduces consumption and saving of tax-paying cohorts and raises consumption and saving of future generations that benefit from the elimination of the PAYG debt. The phase of negative effects on transition consumption and saving could be protracted before the positive consumption and saving effect on future generations takes place.^{15/}

(ii) Changes in rates of return derived from the intergenerational transfer effects and efficiency gains of the pension reform could also impinge on private consumption, as long as the intertemporal substitution, income and human wealth effects of changes in rates of return do not offset each other. Pension reform has allowed contributors to reap very high real returns on their pension fund assets that exceeding significantly real rates on bank deposits after and before the

¹⁵ See Arrau (1992), Arrau and Schmidt-Hebbel (1993), and Cifuentes and Valdés-Prieto (1994) for illustrative simulations.

1981 pension reform (see Table 3.1). However, the existing evidence for Chile suggests that interest rates do not affect significantly private consumption or saving levels.

- (iii) Higher growth induced by pension-reform could reduce consumption ratios to income once growth materializes, when consumers show consumption habit persistence.
- (iv) Anticipation of higher future growth induced by pension reform could raise current consumption ratios to income when consumers anticipate future higher income levels.
- (v) The decline and ultimate elimination of the pure tax component of the old PAYG system reduces the demand for leisure and raises consumption under conventional consumer preferences and labor market conditions.^{16/}
- (vi) Consumer awareness of the need to save for the future could increase (that is, consumer myopia could decline) with the start of a fully-funded pension system that provides them with regular statements of their pension funds, protected by adequate regulation and supervision. This heightened awareness would imply that additional voluntary saving would not be offset one-by-one by the new mandatory saving program.
- (vii) As opposed to the previous group of consumers whose consumption preferences are changed by pension reform, another group of borrowing-constrained consumers could be pushed into a corner solution by the pension savings mandated by the new FF pension system, requiring them to save in excess of what they would save voluntarily in the absence of any mandatory saving system. As suggested by the simulations by Cifuentes and Valdés-Prieto (1994) discussed above, this may raise overall saving significantly.

It is analytically intractable to derive a structural model for aggregate consumption from an optimizing framework that embeds the seven channels of transmission from pension reform to private consumption listed above. In addition, in the absence of a general-equilibrium framework it is not really possible to identify the precise contribution of pension reform through some of the intervening variables -- such as public debt, interest rates, or growth rates -- as the latter may reflect many other policy and structural changes that are contemporaneous to pension reform in Chile.

¹⁶ That is, when consumer utility depends on both consumption and leisure (and both are gross substitutes) and the labor supply schedule is a positive function of the real wage.

FIGURE 3.1
CHILE: CURRENT-PRICE CONSUMPTION/GDP RATIO AND
CONSTANT-PRICE GDP/CAPITAL RATIO (1960-1993)

Table 3.1

CHILE: PENSION REFORM, LABOR MARKETS, CAPITAL MARKETS,
FISCAL POLICY, AND MACROECONOMIC PERFORMANCE (1979-1992)

	1979-1981	1982-1985	1986-1989	1990-1992	1979-1992
<u>Labor Markets (%)</u>					
Total Social Security Contribution Rate (a)	29.3	17.0	17.0	17.0	
Average Pension Contribution Rate	n.a.	10.0	10.0	10.0	
Average Pure Tax Component of PAYG Contributions (b)	14.6	6.8	4.8	2.8	
Independent Workers / Labor Force (c)	26.0	23.6	24.3	24.7	
Informal Employment / Total Employment (d)	36.0	34.2	n.a.	31.1	
Male Labor Force/Males Aged 15 and above	n.a.	n.a.	74.6	75.3	
Pension Contributors / Employment (e)	n.a.	62.5	57.3	60.0	
<u>Capital Markets (%)</u>					
Real Rates of Return:					
Bank Deposit Rate (90-365 days)	12.0	9.1	4.9	6.7	
Public Debt Yield (f)	n.a.	8.9	5.7	7.7	
Private Pension Fund Return	n.a.	16.7	7.8	22.7	
Private Pension Fund Capitalization/GDP (g)	0.2	7.2	16.3	31.0	
<u>Public Deficit and Debt (% of GDP)</u>					
Overall Public Deficit (h)	-3.5	14.0	-1.3	-0.9	2.7
Pension-Reform Public Sector Deficit (j)	0.6	3.6	3.9	4.7	3.3
Non-Pension Reform Public Sector Deficit	-4.1	10.4	-5.2	-5.6	-0.6
Public Domestic Debt	2.3	42.7	33.1	40.8	
<u>Investment, Saving and Private Consumption (% of GDP)</u>					
Gross Domestic Investment	20.3	14.3	22.4	23.5	19.9
Foreign Saving	9.0	8.7	3.7	1.3	5.8
National Saving	11.3	5.5	18.7	22.2	14.1
Public Saving	10.5	-3.8	4.7	5.1	3.6
Private Saving	0.8	9.3	14.0	17.1	10.5
Private Consumption	72.2	70.9	62.5	63.5	67.2
<u>Growth (%)</u>					
Per Capita Real GDP Growth	5.4	-3.5	5.7	4.7	2.5
Average Product of Capital (1961-81 = 0.33)	0.38	0.33	0.39	0.44	0.38

Table 3.1

(Continuation)

Notes:

n.a. Not available

- (a) Sum of pension, health, and accident and survival insurance contributions.
- (b) The average pure tax rate (on net wages) implicit in PAYG pension contributions before 1981 is calculated as the excess of the rate of social security contributions over the present value of social contributions after the pension reform, the latter assumed to be equal to the post-pension reform social security contribution rate (17% in 1981). (Source: Schmidt-Hebbel 1981). For 1981-1992 it is assumed here that the PAYG pure tax declines linearly, reflecting both the rise in credibility in the new FF system and the gradual shift of contributors from PAYG to FF.
- (c) First figure is for 1980-81.
- (d) Non-agricultural employment. First figure is for 1980, the second is for 1985, and the third is an average for 1990 and 1992. Source: ILO-PREALC, reported by Uthoff (1994), Table 1.
- (e) Source for 1982-1990: Chamorro (1992). The figure for 1990-1992 is an average of Chamorro (1992) and own estimates.
- (f) First figure is for 1983-85.
- (g) Source: Diamond and Valdés-Prieto (1994).
- (h) Comprises the non-financial and financial (Central Bank) public sector deficit. Source: Marshall and Schmidt-Hebbel (1994).
- (j) Observed public deficit due to pension reform transition. Source: Arrau (1992) and Schmidt-Hebbel (1994).

Other Sources: Central Bank of Chile: Boletín Mensual and Cuentas Nacionales de Chile, various issues; Arrau (1992); Marshall and Schmidt-Hebbel (1994); National Institute of Statistics (INE); and Ministry of Finance of Chile.

Hence the approach followed below is to propose and estimate a simple reduced-form consumption model that controls for variables that reflect well-known consumption theories and, in addition, includes proxies for some of the pension reform-induced changes listed above. It combines a framework developed by Corbo and Schmidt-Hebbel (1991) -- that discriminates between Keynesian, permanent-income and Ricardian/crowding-out consumption hypotheses -- with additional proxies reflecting some of the pension reform effects mentioned above. The equation for the ratio of private consumption to private disposable income as the dependent variable is the following linear relation:^{17/}

$$(3.1) \quad \frac{C_t}{DY_t} = \beta_0 + \beta_1 \frac{PDY_t}{DY_t} + \beta_2 \frac{PS_t}{DY_t} + \beta_3 \frac{FS_t}{DY_t} + \beta_4 r_t + \beta_5 pfs_t + \beta_6 tax_t$$

where C is private consumption expenditure, DY is current private disposable income, PDY is permanent private disposable income (permanent private gross income plus government transfers

¹⁷ All potentially non-stationary variables are scaled to current private disposable income in order to reduce the incidence of spurious correlation. An alternative procedure, based on unit root and co-integration tests and a dynamic error-correction specification, is not feasible due to the short sample period to which the model is applied.

minus tax payments), PS is permanent public saving (permanent tax payments minus government transfers minus government consumption), FS is foreign saving, r is the consumption-based real interest rate, pfs is the share of private pension funds in GDP, and tax is the pure tax component of PAYG contributions.^{18/} Expected signs of the coefficients are: $\beta_0, \beta_1, \beta_2, \beta_3 > 0$; $\beta_5, \beta_6 < 0$; $\beta_4 < > 0$.

Equation (3.1) combines neoclassical determinants (permanent disposable income, the real interest rate), Keynesian variables and liquidity constraints (current income, foreign saving), public saving, and two pension reform-related variables.

Three simple null hypotheses are nested by this specification: (i) Keynesian (or liquidity-constraints) theory : $\beta_0 > 0, \beta_1 = \beta_2 = 0$; (ii) Permanent income hypothesis without Ricardian equivalence: $\beta_1 > 0, \beta_0 = \beta_2 = 0$; and (iii) Ricardian equivalence or direct crowding-out hypothesis: $\beta_0 = 0, \beta_1 = \beta_2 > 0$.^{19/}

The size of private pension fund savings (pfs) stands here as a proxy for both the growing awareness of one group of consumers to provide for future consumption (the decline in myopia) and the increase in mandatory saving that forces another group of consumers (those with high discount rates and unable to borrow against their future income streams) to save beyond what they would like to do.^{20/} Finally, the pure tax component of PAYG contributions -- the cause of labor market distortions under PAYG -- should have a negative effect on consumption under normal conditions of consumption-leisure substitutability.

Equation 3.1 was estimated for Chilean annual data for the 1971-1992 period.^{21/}

¹⁸ See the notes in Table 3.1 for the definitions of pfs and tax, and the notes in Table 3.2 for the definitions of PDY and PS.

¹⁹ Note that the inclusion of (permanent) public saving reflects two very different hypotheses, among which it is not possible to discriminate: Ricardian equivalence, which states that private consumption increases one-to-one with permanent public saving, and "direct crowding out", which asserts that under an institutional arrangement by which the public sector captures private saving either directly or through the domestic financial markets, current private saving is crowded out one-to-one by current public saving.

²⁰ Note that pfs does not represent here a component or a proxy of total consumer wealth -- the latter is included in the consumption function in flow terms as permanent income.

²¹ The basic data sources are: C (current-price private consumption expenditure): Central Bank of Chile: Cuentas Nacionales de Chile, various issues; current-price GDP, taxes and foreign transfers used in constructing DY (current-price private disposable income): Central Bank of Chile and Ministry of Finance; current-price public saving used for PS (permanent public saving): Ministry of Finance and Marshall and Schmidt-Hebbel (1994); current-price foreign saving (FS): Central Bank of Chile: Cuentas Nacionales de Chile, various issues; nominal interest rate and CPI used in constructing real interest rate (r): Central Bank of Chile; private pension fund savings used in constructing the share to current-price GDP (pfs): Diamond and Valdés-Prieto (1994); and the pure tax component of the PAYG pension system

Table 3.2 reports results for two-stage least squares estimations under two alternative measures of permanent public saving (forward-looking and static expectations). The results should be taken with caution in view of the small sample size.

The relative size and high significance levels of the first three right-hand variables is consistent with preceding findings for developing countries at large (Corbo and Schmidt-Hebbel 1991 and Easterly, Rodríguez and Schmidt-Hebbel 1994) and Chile in particular (Marshall and Schmidt-Hebbel 1994). Chilean consumers are predominantly Keynesian, with a coefficient for current disposable income (0.75) that is six times as large as the coefficient for (neoclassical) permanent disposable income (0.15). Interestingly, permanent public saving shows a larger coefficient (0.33 to 0.45) than permanent disposable income. The latter finding suggests that liquidity constraints are here more important than Ricardian farsightedness, as the coefficient on permanent public saving is larger than the one on permanent disposable income.

Foreign saving has a very strong crowding-out effect on private saving, with the latter variable (after controlling for possible endogeneity of foreign saving by using instrumental-variable estimation) showing offset coefficients that vary between 0.6 and 0.9. The real interest rate (also instrumentalized) has a small and marginally significantly negative effect on private consumption in one of the equations reported here, suggesting (at least for this case) that the negative substitution and human wealth effects dominate the positive income effect of a higher interest rate.^{22/}

Having controlled for the effects of five variables that are consistent with conventional consumption theories, let's focus now on the possible contribution of the two additional variables linked to the pension reform. The relative size of private pension fund savings affects negatively private consumption in Chile, suggesting that part of the positive saving response could be related to financial deepening and a derived reduction in consumer myopia, as well as to the influence of involuntary saving by other consumers suffering from large myopia and borrowing constraints. However, one should be also keenly aware that pfs is highly correlated with other structural and policy changes that took place during the 1980s and early 1990s in Chile -- such as the

(tax): Schmidt-Hebbel (1981).

²² Recent cross-country saving studies for developing countries (for instance Giovannini 1983, Corbo and Schmidt-Hebbel 1991, and Schmidt-Hebbel, Webb and Corsetti 1992), typically report that interest rates are not significant. Schmidt-Hebbel (1987) and Arrau (1989) estimate elasticities of intertemporal consumption for Chile and find values close to 1.0, implying that the substitution and income effects offset each other. That leaves, however, a negative role for the interest rate on consumption, that takes place through the decline in discounted human wealth. Reduced-form consumption equations estimated by Marshall and Schmidt-Hebbel (1994) report a non-significant effect of the real interest rate.

deepening of capital markets at large -- that could have had an independent effect on consumption. Hence the influence of pfs on consumption -- explaining on average 10 percentage points of the 21 percentage point decline of the private consumption ratio between 1980 and 1992 -- should be interpreted as an upper bound of the response of aggregate private consumption to the pension reform effected through the two channels proxied by this variable.

Finally, the pure tax component of PAYG has a negative effect on consumption -- that reaches marginally significant levels in one of the equations in table 3.2 -- reflecting substitution between consumption and leisure. The reduction of the pure PAYG tax -- from 16% of net wages in 1980 to 2% in 1992 -- accounts at most (according to equation 3 in table 3.2) for an increase by 2 percentage points of GDP in the private consumption ratio during that time span.

We conclude very tentatively from this evidence that the Chilean 1981 pension reform may have contributed, in conjunction with other structural reforms, to the significant rise in private saving observed during the last decade.

3.3 Growth

Per capita GDP growth has risen significantly since the mid-1980s, exceeding 5% per year. Higher factor productivity explains in part this growth spurt. Figure 3.1 confirms that, in addition to the outstanding private saving improvement, real GDP growth based on rising capital productivity has made a turnaround during the last decade. While the average product of capital was 0.33 during 1961-1985, it started to rise significantly in the early 1980s to reach an average level of 0.44 during 1986-93.

Chile's radical pension reform may be contributing to less distorted factor markets and hence to higher growth. Both the elimination of the pure tax component of PAYG and the deepening of financial markets resulting from pension reform could have a significant influence on growth. However one should be careful -- in the absence of a well-specified framework that distinguishes between different structural growth determinants -- in assessing the contribution of pension reform. The reason, again, is that the latter has been approximately contemporaneous with other growth-enhancing structural changes such as trade reform and financial liberalization.

TABLE 3.2

CHILE: PRIVATE CONSUMPTION REGRESSIONS (1971-1992)

$$(3.1) \quad \frac{C_t}{DY_t} = \beta_0 + \beta_1 \frac{PDY_t}{DY_t} + \beta_2 \frac{PS_t}{DY_t} + \beta_3 \frac{FS_t}{DY_t} + \beta_4 r_t + \beta_5 pfs_t + \beta_6 tax_t$$

3.1A: Forward-Looking Expectations on Permanent Public Saving (PS)

Model	C	PDY/DY	PS/DY	FS/DY	r	pfs	tax	d74	DW	R2A
1. TSLS	0.75 (15.1)	0.15 (4.2)	0.45 (3.5)	0.64 (5.2)	-0.0002 (-1.0)	-0.003 (-3.4)	-0.12 (-1.2)	-0.11 (-5.4)	2.02	0.97
2. TSLS	0.71 (24.6)	0.15 (4.1)	0.45 (3.5)	0.85 (6.5)	-	-0.002 (-5.8)	-	-0.09 (-5.1)	2.09	0.96

3.1B: Static Expectations on Permanent Public Saving (PS)

Model	C	PDY/DY	PS/DY	FS/DY	r	pfs	tax	d74	DW	R2A
3. TSLS	0.78 (18.2)	0.14 (4.9)	0.35 (5.1)	0.64 (6.2)	-0.0004 (-1.9)	-0.004 (-4.3)	-0.15 (-1.8)	-0.08 (-5.1)	2.27	0.98
4. TSLS	0.73 (24.4)	0.13 (3.8)	0.33 (4.1)	0.92 (7.0)	--	-0.002 (-5.8)	--	-0.06 (-3.5)	2.27	0.96

Notes:

(1) Two alternatives were used for expected permanent public saving. The first is forward looking, defined as the simple average of current-period, one-period-ahead and two-periods-ahead values. The second is static expectations, with a 100% weight given to the current-period value. Permanent private disposable income is estimated from a trend regression.

(2) All equations are estimated by two-stage least squares (TSLS). The foreign saving share (FS/DY) and the real interest rate (r) were instrumentalized by a list of instruments comprised by all right-hand side variables other than the two former and the lagged values of all right-hand side variables including the two former.

(3) t-statistics reported in parentheses. DW and F are the Durbin-Watson and F statistics, respectively, and R²A is the adjusted R² coefficient.

4. CONCLUSIONS

The qualitative effects of PAYG-FF pension reform on long-term output and welfare hinge crucially on various features of the underlying economy and the way the transition deficit caused by the pension reform is financed. The quantitative effects of the reform via transfers to future generations and efficiency changes on long-term output and welfare are only modest to moderate when long-run growth is considered exogenous and factor market distortions are ruled out.

However, much larger and sustained effects are obtained when considering the impact of pension reform on factor markets and when long-term growth is endogenous. A new OLG model with endogenous growth and formal-informal production sectors is derived here. Simulations with this model suggest that a PAYG-FF reform could raise substantially long-term growth rates.

A look at the Chilean reform experience suggests that the structural transformation toward a formalization of labor markets and production is taking place and that both private saving and growth are rising substantially since 1980. Econometric evidence suggests that the 1981 pension reform could be contributing -- jointly with other contemporaneous structural changes -- to Chile's private saving boom.

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Appendix

This appendix briefly describes the model used in the simulations reported in section 2.2 of the paper. There are two sectors characterized by perfectly competitive markets with free entry. Production in the first sector requires both capital and labor and production in the second sector is carried out only with labor. Denoting by $L(t)$ the total labor force in the economy, measured in labor-time, the sectoral allocation of labor ($\sigma_L(t)$) can be summarized by the proportion of workers in the first sector:

$$\sigma_L(t) = \frac{L_1(t)}{L_1(t) + L_2(t)}$$

where L_1 and L_2 denote employment in sectors 1,2.

Labor in the production functions is measured in efficiency units which do not coincide with labor time. In the tradition of the endogenous growth literature, we assume the presence of an external effect of the existing capital stock on labor efficiency (Sheshinski 1967, Romer 1986). The efficiency of labor time spent in production in the i -th firm in either sector ($J_i(t)$) is therefore defined as:

$$J_i(t) = \epsilon(t) L_i(t)$$

where $\epsilon(t)$ is the economy-wide capital-labor ratio:

$$\epsilon(t) = \frac{K(t)}{L(t)}$$

Production in the first sector is characterized by constant returns to scale in capital and labor efficiency units. Because of the external effect of capital on labor, aggregate production in sector 1 (Y_1) can be expressed as a function of total capital (K) and the share of labor in sector 1:

$$Y_1 = K \sigma_L \left(\frac{1}{\sigma_L} \right) = \alpha_1 k \Phi[\sigma_L]; \quad \Phi' > 0, \Phi'' < 0, \Phi(0) = 0, \Phi(1) = 1$$

By construction, the newly-defined parameter α_1 is the social productivity of capital when the whole labor force is allocated to the first sector. In the case of a Cobb-Douglas production function, we would have:

$$Y = A K^q J^{1-q} = A K^q K^{1-q} \left(\frac{L_1}{L} \right)^{1-q} = A \sigma_L^{1-q} K$$

where A is a productivity parameter and q is the share of capital.

In our specification, capital is the only factor that is ultimately productive, even if part of it is embodied in labor. The above expression highlights the fact that moving labor away from

the first sector reduces sectoral (and aggregate) output by diverting the ultimately productive input -- embodied capital -- from the first production process to the second.

The production function in the second sector is linear in labor efficiency units, that is:

$$Y_{2i} = \alpha_2 J_{i2} = \alpha_2 \frac{K}{L} L_{i2}$$

As all output is distributed to labor, the wage rate per efficiency unit is simply equal to α_2 , while sectoral output can be easily calculated by aggregating across firms in sector 2:

$$Y_2 = \sum_{i=1}^M Y_{2i} = \alpha_2 \sum_{i=1}^M J_{i2} = \alpha_2 \frac{K}{L} L_2 = \alpha_2 (1 - \sigma_L) K$$

Note once again that, because of the external effect of capital on labor efficiency, shifting labor to the second sector is equivalent to reallocating capital away from the first sector.

Overall output, which is the sum of gross production across the two sectors, can be expressed in terms of a technology linear in capital -- a so-called AK technology. The aggregate productivity parameter is a weighted average of sector productivities, with weights determined by the sectoral allocation of labor:

$$Y_1 + Y_2 = (\Phi(\sigma_L) \alpha_1 + (1 - \sigma_L) \alpha_2) K \equiv A[\sigma_L, \alpha_1, \alpha_2] K$$

We assume that the informal sector is technologically less productive than the formal sector:

$$\alpha_2 < \alpha_1$$

Pensions in our economy are financed by taxing wages in the formal sector at a flat rate t_1 . Define γ as the fraction of social security wage tax (per efficiency unit of labor) that, at the margin, makes the present value of life-time taxes equal to the present value of pension payments paid conditional on past contributions. It is helpful to think of γ as the degree of future appropriability of an additional dollar of social security contributions at the market capitalization rate, as it is determined by pension law, regulation and (explicit and implicit, legal and political) contracts. For instance, γ will be equal to one in a fully-funded system, while it will be zero in regimes where a social pension is granted to everybody regardless of past contributions. Equilibrium in the labor market thus implies:

$$w_1(1 - t_1 + \gamma t_1) = [f(k_{i1}) - k_{i1} f'(k_{i1})](1 - t_1 + \gamma t_1) = \alpha_2 = w_2$$

where w_1 and w_2 are wage rates per efficiency-unit of labor in the first and the second sector, respectively. Note that the informal sector is (legally or illegally) sheltered from wage taxation and is not granting any sector-specific social security benefits. A positive γ inserts a wedge between cash wage rates net of taxes in the two sectors, the individual future appropriability of current contributions is crucial in assessing the magnitude of labor market distortions associated with alternative pension regimes.

The instantaneous flow of individual pension benefits ($p(s,v)$) is modelled after Saint-Paul (1992) in the following fashion:

$$p(s,v) = \Pi_1 e^{\Pi_2(t-s)} \epsilon(t)$$

At each instant in time, individual benefits are scaled up to the size of economic activity ($\epsilon(t)$). For a non zero Π_2 , pension benefits also increase (or fall) with age. Also, setting public debt equal to zero, the government will be required to run a balanced (primary) budget. Aggregating contributions and transfer over all generations alive at time t and denoting net transfers by $NT(t)$, we have:

$$NT(t) \equiv P(t) - T(t) = \epsilon(t) \beta e^{\mu t} \left[\frac{\Pi_1}{\beta - \Pi_2} - \frac{\sigma_L t_1 w_1}{(\varsigma + \beta)} \right] = 0$$

where $P(t)$ and $T(t)$ are the economy-wide instantaneous flows of pension payments and tax revenue, respectively.

We assume that agents choose their labor allocation at birth. Under this assumption, as both net pension payments and wage income grow with the capital labor ratio, in a long-run equilibrium individuals will supply the same constant share of labor-time $\sigma_L(s,t) = \sigma_L(t) = \sigma_L$ to firms in the formal sector.

By referring to a standard Yaari-Blanchard model, our simulations are carried out by using a system of four equations: the equilibrium condition in the labor market and three differential equations for consumption, capital, and the present value of pension benefits. Each of the three latter equations is associated with the appropriate solvency and feasibility constraints (omitted from the text). The three differential equations are the following:

$$\frac{dc(t)}{dt} = c(t)^2 + \psi c(t) - \eta(\beta + \varsigma) - \eta \omega(t)$$

$$\frac{dk(t)}{dt} = A - c(t) - \frac{G}{K} - \delta$$

$$\frac{d\omega}{dt} = [r + \beta - (A - c(t) - \delta) - \Pi_2] \omega(t) - \frac{\Pi_1 \beta}{\beta - \Pi_2}$$

where:

$$\psi \equiv \left(\frac{r - \rho}{R} + n + \varsigma - A + \delta \right)$$

where η is the consumption to wealth ratio, β is the birth rate, ς is the aging rate, ω is the pension wealth to capital ratio, δ is the capital depreciation rate, ρ is the subjective rate of

discount, and R is the inverse of the intertemporal elasticity of consumption substitution. Bold variables denote ratios to capital.

The first two differential equations show the law of motion of consumption per unit of capital $c(t)$ and the rate of growth of capital (i.e. the resource constraint of the economy). The third differential equation describes the evolution of the present value of the aggregate pension wealth to capital ratio (Π/K). Note that, as steady-state growth rates are positive in endogenous growth models, variables are appropriately expressed per units of capital rather than per person.

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