The economics of pensions

Principles, policies, and international experience

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SALVADOR VALDÉS-PRIETO
Catholic University of Chile

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CHAPTER 5

Pension reform and growth

Giancarlo Corsetti and Klaus Schmidt-Hebbel

Abstract

This chapter reviews the qualitative macroeconomic and welfare implications of substituting a pay-as-you-go pension system by a fully funded (FF) scheme and summarizes the typically small effects found by the simulations literature based on exogenous growth one-sector models. However, much larger and sustained effects are obtained in the framework of an overlapping-generations model with endogenous growth and formal–informal production sectors, presented in this chapter. Model simulations suggest that a pay-as-you-go-to-FF reform could raise substantially long-term growth rates by eliminating the pay-as-you-go incentives for an informalization of production and employment. A final look at the Chilean reform experience suggests that the structural transformation toward formalization 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 to Chile's large increase in private saving.

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

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long-term growth and welfare levels. This chapter evaluates these claims by surveying the existing literature, offering a new approach, and evaluating the empirical evidence limited to the Chilean pension reform experience.

We review first the simulation literature focused on macroeconomic and intergenerational welfare implications of adopting mandatory pension schemes and substituting a pay-as-you-go 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 chapter 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 United States 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.

We show 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 pay-as-you-go-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 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 chapter 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

[1] An analytical review is offered by Arrau and Schmidt-Hebbel (1993) that discusses 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.

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 that focus exclusively on intergenerational transfers. The issue of financial market liberalization is addressed by varying the mix of labor and capital income taxes financing a pay-as-you-go 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 pay-as-you-go-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 pay-as-you-go contributions in the informal sector when substituting pay-as-you-go by FF.

Only one country has implemented a radical pay-as-you-go-FF reform in which sufficient time has elapsed since its start to assess possible reform effects on economic structure, private saving, and growth. We present 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 reviews the qualitative macroeconomic and welfare changes of a pay-as-you-go-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 steady-state growth effects of pension reforms. Section 3 looks at Chile's changes in economic structure, saving, and growth and reports regression results for saving.

1 Pension systems, saving, and output levels

1.1 Pension systems and reforms

A pay-as-you-go scheme is an intergenerational social contract of mandatory 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 pay-as-you-go 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) pay-as-you-go systems typically show surpluses, which often turn into deficits when the ratio of pensioners to workers reaches that implied by system maturity. Changing demographic conditions also impinge on pay-as-you-go balances: A rising old-age dependency ratio leads to increasing pay-as-you-go system losses when contributions and pension benefits remain unchanged. Pay-as-you-go surpluses and deficits are typically absorbed by government budgets. Only when the pay-as-you-go system is mature, population growth is constant, and pay-as-you-go is financially balanced are pensioners 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 a la Diamond (1965). Second, although the growth rate of the wage bill determines the average return on pay-as-you-go contributions, the return obtained by each individual worker is different from the average pensioner's return. The reason is that pay-as-you-go 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 pay-as-you-go scheme is in general actuarially unfair from the point of view of individual workers.

An alternative mandatory pension arrangement is a defined-contribution fully funded scheme that 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, an FF system could also include distribution among groups of workers within a given generation, hence weakening the relation between contributions and pensions. As we abstract from this case, pensions in an FF system are actuarially fair for each individual.

A pension reform that substitutes pay-as-you-go by FF involves three changes: The link between worker contributions and benefits is strengthened, the previously hidden pay-as-you-go debt is made explicit, and the distributional function of the old pay-as-you-go system is separated from the new FF scheme. The most generalized feature of pay-as-you-go systems in the real world is pension system losses that grow over time as a result of rising old-age dependency and/or increasing pay-as-you-go system maturity. The fiscal consequences of rising pay-as-you-go system losses are the single most important motivation for reforming pay-as-you-go 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 chapter we focus on three main features that determine the consequences of substituting pay-as-you-go by FF.[2]

The distortionary nature of pay-as-you-go contributions

Pay-as-you-go pension contributions are typically proportional to wage income and therefore can distort labor market decisions and employment levels. As mentioned earlier, the reason is that the link between worker contributions and benefits is weakened twice by a pay-as-you-go 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 intragenerational 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 pay-as-you-go contributions, can be avoided. Firms respond to higher pay-as-you-go labor costs by adopting less labor-intensive technologies or by shifting operations to informal markets as well. Overall, pay-as-you-go tends to raise gross labor costs in formal markets while depressing real net wages – a labor market distortion that is avoided by an 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 pay-as-you-go contributions depends on the relevant supply and demand elasticities for labor and capital (saving and investment).

Form of financing of system transition

The straightforward way to finance the reform transition deficit is by issuing new government debt. The old implicit pay-as-you-go debt is swapped for new explicit government debt so that the government's old pay-as-you-go

[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, intergenerational altruism, the size of mandatory saving relative to presystem voluntary saving, consumer myopia, borrowing constraints, age structure, and incomplete insurance markets for sharing risk.

debt is now explicitly reflected on government books.[3] Debt financing implies that national saving, the capital stock, and the intergenerational 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, that is, by raising taxes (and/or cutting public spending). A fully tax-financed transition reverts the initial pay-as-you-go transfer from workers to pensioners – associated with the start of the initial pay-as-you-go scheme – by fully paying off the implicit pay-as-you-go debt. This hurts tax-paying transition generations[4] and benefits nontaxed posttransition generations. Tax financing of the transition – as any restrictive fiscal policy that 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 intergenerational 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.

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 pay-as-you-go debt. A higher tax rate raises the magnitude of distortions due to general taxation – independently of the underlying tax base. Hence, a shift from pay-as-you-go 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 efficiency.[5]

[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 pay-as-you-go system or could comprise only current and future working cohorts.

[5] On the relative efficiency of income taxation (which is the general tax considered by the simulations discussed in this chapter), 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

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 pay-as-you-go 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 – does the pay-as-you-go-FF reform raise unambiguously Pareto efficiency by eliminating the distortionary effects of pay-as-you-go 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 5.1: one for the U.S. economy (Auerbach and Kotlikoff, 1987), the second for a representative economy (Arrau and Schmidt-Hebbel, 1993), and the third and fourth also for a representative economy (Valdés-Prieto and Cifuentes, 1993, and Cifuentes and Valdés-Prieto, 1994).[7]

of preferences" (Auerbach and Kotlikoff, 1987, p. 80). Auerbach and Kotlikoff's (1987) simulation results for a switch from income to wage taxation (p. 77, table 5.7) 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 pay-as-you-go-FF reforms for real-world economies, one for Mexico (Arrau, 1990b) and a second for Chile (Arrau, 1991, 1992). However, they do not report long-run output and welfare effects of the reforms.

The four studies reported here 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 the dynamic general equilibrium framework by Auerbach and Kotlikoff for a closed economy composed of 55 optimizing overlapping cohorts. In all four models intergenerational voluntary transfers and intragenerational distribution are ruled out and mandatory saving always falls short of the amount consumers would voluntarily save in the absence of any pension scheme. Myopia and credit constraints are not considered in the first (Auerbach and Kotlikoff) and the second (Arrau and Schmidt-Hebbel) studies but are introduced in the third (Valdés-Prieto and Cifuentes) and the fourth (Cifuentes and Valdés-Prieto). The main differ-

Table 5.1
Long-run output and welfare effects of pension systems and reforms
(Exogenous growth)

	Output Change	Welfare Change
5.1A Effects at Year 150 after Introducing PAYG in the U.S. Economy		
Under Income Taxation	-5.3%	-6.0
Under Wage Taxation	-4.9%	-6.3
Under Consumption Taxation	-4.5%	-4.8
5.1B. Effects at Year 110 after Substituting PAYG by FF in Representative Economies		
High Population Growth (n=2% per year)		
Debt-Financed Transition Deficit	-1%	-0.3%
Tax-Financed Transition Deficit	+3%	+6.8%
Stationary Population (n=0)		
Debt-Financed Transition Deficit	-4%	3.5%
Tax-Financed Transition Deficit	+5%	+12.5%
5.1C Steady-State Effects of Substituting PAYG by FF in Representative Economies		
Tax-Financed Transition Deficit		
Without Credit Constraints	+1.9%	+5.9%
With Credit Constraints	+27.1%	+13.5%
5.1.D. Steady-State Effects of Substituting PAYG by FF in Representative Economies		
With Credit Constraints		
75% Debt, 25% Tax-financed Transition Deficit	+7.0%	+3.4%
Full Tax-Financed Transition Deficit	+21.8%	+16.3%

Sources:

5.1A: 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.

5.1B: 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.

5.1C: 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%.

5.1D: Cifuentes and Valdés-Prieto (1994), Table 5, and special calculations provided by those authors. Population growth is 0.5% and technical progress is 0.5%, hence stationary GDP growth is 1%.

ence between the model offered by Auerbach and Kotlikoff and the other frameworks is that both pay-as-you-go and general taxation are distortionary in the former but only general taxation is distortionary in the three latter models, where labor is supplied inelastically. The second study reports sensitivity analyses corresponding to alternative assumptions on critical parameter values – the results are similar to the base-case results summarized here. The first, second, and fourth studies report impact, transition, and steady-state effects on the main fiscal, macroeconomic, and welfare variables. The third study, however, is a model for steady-state equilibria. Here we focus only on long-run or steady-state results reported in the four studies, which often differ strongly from short or medium-term effects.

Starting pay-as-you-go shifts resources from future to current generations. For the United States (Table 5.1A), the start of pay-as-you-go 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%.[8]

The simulations for representative economies by Arrau and Schmidt-Hebbel 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 pay-as-you-go debt is put on government books. Therefore the explicit government debt increases significantly, although this massive debt buildup 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 pay-as-you-go 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.

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 posttransition 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 pay-as-you-go 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 pay-as-you-go debt) and a small efficiency gain due to slightly lower income taxes.

For a stationary population the qualitative results remain unchanged al-

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

though their size is larger. The reason that the reform effects grow with the old-age dependency ratio is the larger initial pay-as-you-go debt, implying stronger efficiency effects and, in the case of tax financing, a larger transfer toward future generations.

The third and fourth studies – as opposed to the two preceding studies – introduce heterogeneous consumer groups with different degrees of myopia (i.e., dissimilar subjective discount rates) in combination with credit constraints. The latter hit consumers with high discount rates – the young, who expect higher earnings growth, and those with high subjective discount rates – because of the additional restriction that nonhuman wealth has to be nonnegative at any point in time.

The study reported by Valdés-Prieto and Cifuentes allows one to assess the important role played by the group of myopic and credit-constrained individuals when substituting pay-as-you-go with FF (Table 5.1C). Without binding credit constraints or without myopes, the long-term effects of a tax-financed pension reform are modest, similar to the results shown by Arrau and Schmidt-Hebbel. However, when widespread myopia-cum-credit constraints is considered, the pension reform boosts (involuntary) saving significantly, so that the long-term output 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. The large size of these effects – and of those reported in the fourth study discussed next – is in part due to the assumption of both studies that FF savings are exempt from income taxation.[9] This assumption, not made in the two preceding studies, provides an additional incentive to saving and hence capital formation when adopting an FF system. However, the results in Chapter 6, where myopes are not considered, show that the impact of tax exemptions is moderate (Table 6.6).

Finally consider the results provided by Cifuentes and Valdés-Prieto, which allow one to distinguish between steady-state and transition effects, and also include a group of myopic and credit-constrained individuals. As this study solves and simulates the entire transition path, its quantitative results are more reliable than those of the preceding study, which is based only on comparisons across steady-state equilibria.

[9] 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 study by Cifuentes and Valdés-Prieto (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 5.1); it shrinks to only 4.5% without income tax exemption. One may infer that all other long-term output results reported by both the third and fourth studies should be adjusted downward by roughly one-third when evaluating a pay-as-you-go-FF pension reform without the provision of tax exemptions.

Even when debt financing is large relative to tax financing (75% and 25%, respectively), the fourth study (Table 5.1D) 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 assumptions: FF savings exemption from income taxation and low stationary GDP growth (1%). However, the main driving force of the reported 21.8% is the presence of a large group of myopes. Chapter 6 shows that in their absence, long-term output gains of a tax-financed pension reform when credit-constraints are present come down to a single-digit figure.

In sum, the simulation results for the four 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 overlapping-generations (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 employs 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; 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 rate of return may well be lower than the rate of growth of the economy. If this is the case, a pay-as-you-go system pays a higher average pension than an 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 will show the potential importance of the effect 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, 1993). 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, estimates point out that the tax wedge on labor costs imputable to social security is as high as 20% for small firms (Tokman, 1992).[10]

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 appropriation of social security contributions capitalized at the market interest rate. The competitive equilibrium in an economy with an FF pension system provides the base scenario in our simulations. Vis-à-vis this benchmark, we will consider different degrees of appropriation in a pay-as-you-go system. In a world without uncertainty and credit constraints, social security contributions are a component of private saving in the base scenario, whereas 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 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

[10] 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 chapter. All we require is that, at the margin, social security affects the choice to allocate labor between the two sectors.

both capital and labor, whereas production in the second sector is carried out only with labor. Labor in the production functions is measured in efficiency units that 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 (Yaari, 1965; Blanchard, 1985), in a version that 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: Technologies that would generate sustained steady-state growth rates in a representative agent model may not do so in an 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 – that is, persistently high productivity of accumulated factors of production. However, the same accumulation process rapidly dwarfs 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 internal-

ized, 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 nonrival and nonexcludable, 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 that 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 would characterize a representative-agent version of our model.

2.1.3 Social security and equilibrium

The instantaneous flow of pension benefits is modeled 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.

Whereas 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 that, 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 5.2.

The benchmark result is for the model under an FF pension regime (simulation 5.2A, Table 5.2). The following simulations reflect a pay-as-you-go regime that allows for an increase in pensions. In a first run of the model, the pay-as-you-go pension is financed by a lump sum tax and hence there is no informal sector (simulation 5.2B). Pay-as-you-go 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 5.2C). Now the informal sector emerges as a consequence of the pay-as-you-go system, absorbing up to 47.5% of the labor force. In the next simulation (5.2D), the individually perceived marginal appropriation of future social security benefits is raised from 0 (in simulations 5.2B and 5.2C) to 20%. The final case (simulation 5.2E) substitutes part of the distortionary pay-as-you-go 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 intergenerational transfer effect and the distortionary labor market and production effect of pay-as-you-go. The former is reflected by simulation 5.2B, which shows that long-run growth falls from 3.7% under FF to a range of 3.1% to 3.5%, depending on the magnitude of lump-sum taxation and hence the size of the intergenerational transfer. However, when pay-as-you-go taxation is distortionary (simulation 5.2C), growth declines very strongly at high pay-as-you-go contribution rates, as a result of a massive shift of labor from the formal to the informal sector. For instance, at a pay-as-you-go wage rate of 20% (and if the degree by which workers relate current pay-as-you-go contributions to future pensions is 0), stationary growth reaches only 1.8%, much below the 3.1% growth rate achieved when pay-as-you-go is not distortionary. This striking result reflects the much more significant role played by distortionary pay-as-you-go taxation in two-sector economies than by the pay-as-you-go transfer toward older cohorts.

Table 5.2
Long-run endogenous growth effects of mandatory pension systems

Steady-State Simulation Results with and Endogenous-Growth Model

Wage Tax Rate	Formal-Sector Labor Share	Share of Labor in Income	Consump-tion to Capital Ratio	PAYG Pension Rate	Capital and Output Growth
5.2A A FF system					
Any	1	0.75	14.38%	0	3.7%
5.2B A PAYG system financed by lump sum taxation					
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%
5.2C A PAYG system financed by distortionary taxation: labor shifts from the formal to the informal sector in response to higher tax rates.					
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%
5.2D A PAYG system financed by distortionary taxation: similar to 5.2.C but at the margin the degree of appropriability of future pension payment at the current capitalization rate is 20%.					
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%
5.2E A PAYG system financed by distortionary taxation on both labor and capital: similar to 5.2C but, in addition to the PAYG wage tax, there is a 0.5% tax on capital.					
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: α_1 = 0.2, α_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.

Simulation 5.2D introduces a link between current worker contributions and future pension benefits. It shows that a relatively weak link of 20% can substantially lower the pay-as-you-go labor and production distortions induced by high pay-as-you-go contribution rates. At a 20% contribution rate, growth decreases only to 2.3% as compared with 1.8% in simulation 5.2C.

The last simulation (5.2E) 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 one to reduce the pay-as-you-go wage tax rate. Lower labor market distortions are matched by higher intertemporal distortions. The net effect (comparing simulation 5.2E to 5.2B) 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 cannot be determined unambiguously because of the reform-related effects on the degree of labor market efficiency. As the intertemporal price of consumption responds to the pension regime, people revise their saving plans accordingly.

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 that 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 may be higher in a pay-as-you-go than in an FF system. Of course, this is typically not the case. Whereas the link between current contributions and future benefits is clear in an FF actuarially fair system, it must be carefully built in the design of the social security institutions of a pay-as-you-go scheme.

How are our results affected when allowing for credit constraints, uncertainty, and a pay-as-you-go-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 pay-as-you-go systems. The labor market equilibrium condition includes an extra term in which 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 an FF system. To the extent that public insurance weakens the link between contributions and pensions, the (inter- or intragenerational) pay-as-you-go 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 pay-as-you-go to an 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 pay-as-you-go system with a privately managed and nonredistributive FF scheme, complemented by a small state-run redistributive and means-tested minimum-pension transfer program financed by general taxation.[11] The Chilean government had also started other major structural changes since the mid 1970s – including trade liberalization, financial deregulation, privatization, and labor market reform – that were deepened during the 1980s.[12] 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 5.3 summarizes the performance of Chile's labor markets, capital markets, public finances, and overall macroeconomy, which 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 past 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 5.3). The new system provides a close relation between earnings and pension benefits, which was absent under the preceding pay-as-you-go 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

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

[12] Among recent volumes on Chile's reforms and macroeconomic performance during the past two decades, see Edwards and Cox-Edwards (1987), Morandé and Schmidt-Hebbel (1988), and Bosworth, Dornbusch, and Labán (1994).

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, signaling 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 1990–1992.[13] In addition, male labor force participation – which could reflect the incentive effect of the reform on total male employment – has increased slightly during the preceding 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, declining 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 1979–1981 to an average 17.1% of GDP in 1990–1992. 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 1986–1992 (Figure 5.1). 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 pay-as-you-go-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, which benefit from the elimination of the pay-as-you-go debt. The phase of negative effects on transition consumption

[13] 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 pay-as-you-go 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 1990–1992 (source: Uthoff 1994, table 1).

Table 5.3
Chile: Pension reform, labor markets, capital markets, fiscal policy, and macroeconomic performance (1979 - 1992)

	1979-81	1982-85	1986-89	1990-92	1979-92
Labor Markets (%)					
Total Social Security Contribution Rate (a)	29.3	17.0	20.0	20.0	
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	
Capital Markets (%)					
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	
Public Deficit and Debt (% of GDP)					
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
Other Public-Sector Deficit	-4.1	10.4	-5.2	-5.6	-0.6
Public Domestic Debt	2.3	42.7	33.1	40.8	
Investment, Saving and Private Consumption (% of GDP)					
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
Growth (%)					
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

Notes:

(a) After 1982 this is the sum of contributions for pensions and health insurance in the new system.

(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 postpension 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 - 1981.

(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.

Table 5.3 (cont.)

(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 - 1985.
(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. n.a. Not available

and saving could be protracted before the positive consumption and saving effect on future generations takes place.[14]

(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 exceeding significantly real rates on bank deposits after and before the 1981 pension reform (see Table 5.3). 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 habit persistence in consumption.

(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 pay-as-you-go system reduce the demand for leisure and raise consumption under conventional consumer preferences and labor market conditions.[15]

(vi) Consumer awareness of the need to save for the future could increase (i.e., consumer myopia could decline) with the start of a

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

[15] 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.

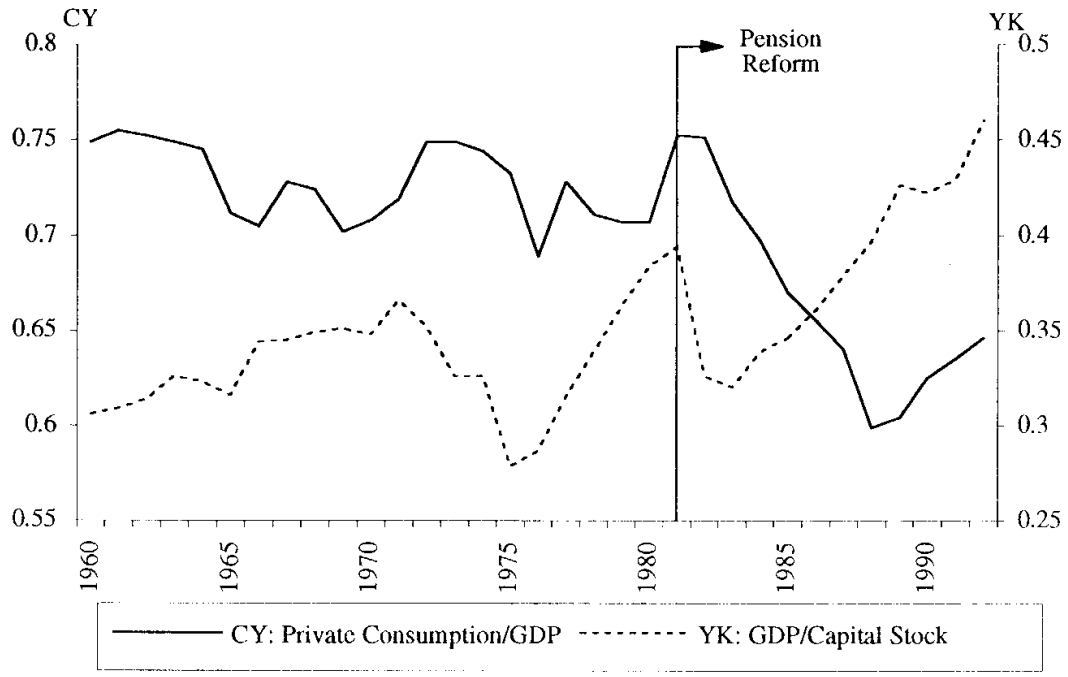

Figure 5.1. Consumption and output ratios in Chile, 1960–1992.

fully funded pension system that provides consumers with regular statements of their pension fund savings, 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 of Cifuentes and Valdés-Prieto (1994) discussed earlier, this may raise overall saving significantly.

It is analytically intractable to derive a structural model for aggregate consumption from an optimizing framework that embeds these seven channels of transmission from pension reform to private consumption. 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.

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 here. It combines a framework developed by Corbo and Schmidt-Hebbel (1991) – which discriminates between Keynesian, permanent-income and Ricardian/crowding-out consumption hypotheses – with additional proxies reflecting the pension reform effects. The equation for the ratio of private consumption to private disposable income as the dependent variable is the following linear relation:[16]

$$\frac{C_t}{DY_t} = \beta_0 + \beta_1 \frac{PDY_t}{DY_t} + \beta_2 \frac{PS_t}{DY_t} + \beta_3 \frac{FS_t}{DY_t} + \beta_4\, r_t + \beta_5\, pfs_t + \beta_6\, tax_t \qquad (1)$$

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 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 pay-as-you-go contributions.[17] Expected signs of the coefficients are: $\beta_0, \beta_1, \beta_2, \beta_3 > 0$; $\beta_5, \beta_6 < 0$; $\beta_4 \gtrless 0$.

Equation (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: Keynesian (or liquidity-constraints) theory: $\beta_0 > 0$, $\beta_1 = \beta_2 = 0$; permanent income hypothesis without Ricardian equivalence: $\beta_1 > 0$, $\beta_0 = \beta_2 = 0$; and Ricardian equivalence or direct crowding-out hypothesis: $\beta_0 = 0$, $\beta_1 = \beta_2 > 0$.[18]

[16] All potentially nonstationary 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.

[17] See the notes in Table 5.3 for the definitions of pfs and tax, and the notes in Table 5.4 for the definitions of PDY and PS.

[18] 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.

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.[19] Finally, the pure tax component of pay-as-you-go contributions – the cause of labor market distortions under pay-as-you-go – should have a negative effect on consumption under normal conditions of consumption–leisure substitutability.

Equation (1) was estimated for Chilean annual data for the 1971–1992 period.[20] Table 5.4 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; 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 borrowing 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)

[19] 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.

[20] 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 pay-as-you-go pension system (tax): Schmidt-Hebbel (1981).

Table 5.4
Chile: Private consumption regressions (1971 - 1992)

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

5.4A. Forward-looking expectations on permanent public saving (PS)

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

5.4B. Static expectations on permanent public saving (PS)

Model	Constant	PDY/DY	PS/DY	FS/DY	r	pfs	tax	d74	DW	R^2
3	0.78	0.14	0.35	0.64	0.0004	-0.004	-0.15	-0.08	2.27	0.98
	(18.2)	(4.9)	(5.1)	(6.2)	(-1.9)	(-4.3)	(-1.8)	(-5.1)		
4	0.73	0.13	0.33	0.92	--	-0.002	--	-0.06	2.27	0.96
	(24.4)	(3.8)	(4.1)	(7.0)		(-5.8)		(-3.5)		

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. 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 are reported in parentheses. DW and F are the Durbin-Watson and F statistics, respectively, and Adj. R^2 is the adjusted R^2 coefficient.

that the negative substitution and human wealth effects dominate the positive income effect of a higher interest rate.[21]

[21] 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 (1981) and Arrau (1990a) estimate elasticities of intertemporal consumption for Chile and fund values close to 1.0, implying that the substitution and income effects offset each other. The latter abstracts, however, from a negative role for the interest rate on consumption, which takes place through the decline in discounted human wealth. Reduced-form consumption equations estimated by Marshall and Schmidt-Hebbel (1994) report a nonsignificant effect of the real interest rate.

Having controlled for the effects of five variables that are consistent with conventional consumption theories, let us 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 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 pay-as-you-go has a negative effect on consumption – which reaches marginally significant levels in one of the equations in Table 5.4 – reflecting substitution between consumption and leisure. The reduction of the pure pay-as-you-go tax, from 16% of net wages in 1980 to 2% in 1992, accounts at most (according to equation 3 in Table 5.4) 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 1981 Chilean pension reform may have contributed, in conjunction with other structural reforms, to the significant rise in private saving observed during the past 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 5.1 confirms that, in addition to the outstanding private saving improvement, real GDP growth based on rising capital productivity has made a turnaround during the past decade. Whereas 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 1986–1993.

Chile's radical pension reform may be contributing to less distorted factor markets and, hence, to higher growth. Both the gradual elimination of the pure tax component of pay-as-you-go 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 frame-

work 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.

4 Conclusions

The qualitative effects of pay-as-you-go-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, provided 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 pay-as-you-go-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.

APPENDIX TO CHAPTER 5

This appendix briefly describes the model used in the simulations reported in section 2.2. 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:

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

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:

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

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:

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

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 preceding 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:

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

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 lifetime 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 appropriation 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, whereas 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 appropriation 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 modeled 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 nonzero 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:

$$NT(t) \equiv P(t) - T(t) = e(t)\beta e^{nt}\left[\frac{\pi_1}{\beta - \pi_2} - \frac{\sigma_L t_1 w_1}{(\varsigma + \beta)}\right] = 0$$

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 (Yaari, 1965; Blanchard, 1985), 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:

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

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

$$\frac{dw}{dt} = [r + \beta - (A - c(t) - \delta) - \pi_2]w(t) - \frac{\pi_1 \beta}{\beta - \pi_2}$$

where:

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

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.

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 ration (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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