A Matter Of Trust: Understanding Worldwide Public Pension Conversions

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Security markets between generations are naturally incomplete in a laissez-faire economy since risk sharing agreements cannot be made with the unborn. But suppose that generations *could* trade if, for example, a representative of the unborn negotiated on their behalf today. What would the trades look like? Can government fiscal policy be used to replicate these trades? Would completing this missing market be Pareto improving when the introduction of the new security changes the prices of existing assets? This paper characterizes analytically the hypothetical trades between generations and shows how the government can replicate these trades by taxing the realized equity premium on investments in a symmetric fashion. This tax is equivalent to the government providing a "collar-like" guarantee on personal investments. When technology shocks are mostly driven by changes in depreciation, a *positive* tax (a long collar) replicates the hypothetical trades; this tax is also Pareto improving under fairly general conditions. When technology shocks are mostly driven by changes in productivity, the choice between a positive and negative tax rate is unclear. However, with log utility, Cobb-Douglas production, and a depreciation rate less than 100 percent, a *negative* tax (short collar) is Pareto improving. Simulation analysis is used to consider more complicated cases, including when depreciation and productivity are both uncertain. Under the baseline calibration for the U.S., a *positive* tax (a long collar) on the equity premium is Pareto improving.

A MATTER OF TRUST: UNDERSTANDING WORLDWIDE PUBLIC PENSION CONVERSIONS[1]

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ABSTRACT

Reform of social security systems from traditional pay-as-you-go defined benefit systems toward defined-contribution accounts represents one of the most important fiscal policy changes worldwide during the past century. Current explanations of this phenomenon lack theoretical justification or empirical support. Why have so many countries reformed when traditional systems are likely superior in design? Why have these reforms typically have been *larger* in *developing* countries facing *less* severe demographic problems? We show that an overlapping-generations median voter model can help answer both questions. Larger reforms are motivated by a fundamental breakdown of intergenerational trust. Smaller reforms are motivated by a lack of trust in the ability of the government to save resources for smoothing demographic shocks. Empirical analysis seems to support the basic tenets of the model.

1.   Introduction

        One of the most far-reaching shifts in fiscal policy worldwide during the past two

decades has been the fundamental restructuring of public pension systems. At least 28

countries spanning five continents have converted, partially or completely, from pay-as-you-

go defined-benefit public pension systems to systems based on funded, defined-contribution

accounts. Reforms appear to be imminent in several more countries, while other countries

like the United States have seriously debated converting their public pension systems as well.

        These conversions are potentially the most significant policy reform during the past

century, except perhaps for the adoption of a market economy itself. Such a claim might at

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first seem to be a stretch. There have been many large public policy changes during the past century: Trade barriers have been curtailed; price controls have been dropped across many sectors; major industries have been deregulated; high tax rates levied on narrow bases have been replaced with lower, broad-based taxes; smarter monetary policy has brought inflation into check in many developed countries; and, many state-sponsored enterprises in developing countries have been removed. But their gains likely pale in comparison to pension reform.

Previous simulation analyses suggests that moving the United States Social Security system from pay-as-you-go financing to full funding could produce as much as a 30 percent or more increase in the size of capital stock as well as increase potential (full) lifetime income by over 20 percent[3] These potential gains are much larger than those associated with fundamentally reforming the US federal income tax (Altig et al 2000), and potentially larger than most other types of fiscal reforms, including even the adoption of free trade.[4]

While pension fund conversions from defined benefit (DB) to defined contribution (DC) plans in the *private* sector have been largely motivated by labor market mobility within a country, this explanation does not hold for *public* pension systems. In fact, the public plan conversions seem fairly puzzling. A traditional public DB plan can be funded like a standard DC plan. Moreover, in the presence of economic uncertainty, traditional plans more easily allow for inter-generational risk sharing. Financial illiteracy, moral hazard and adverse selection seem only to buttress the case for the traditional pension system.

So why have so many countries moved, or are in the process of moving, away from unfunded DB plans towards at least partially funded DC plans? Adding to the puzzle is that

these reforms have taken on numerous shapes and sizes across the world, and typically have been *larger* in *developing* countries, which don't face the same severe demographic problems motivating the reform debate in developed countries.

Table 1 gives an overview of reforming countries: the date of reform, the degree of privatization and whether participation in the reformed system was voluntary or required. To estimate the degree of privatization, we developed an actuarial model for each country that incorporates that country's specific reform rules, income distribution, life expectancy and other key economic and demographic variables (Appendix B). The degree of privatization is then calculated by estimating the annuitized fraction of retirement benefits provided by the new defined contribution system relative to the remaining (if any) defined benefit system for the median worker. Figure 1 plots the reform size against the per-capita income for each country. Notice that larger reforms typically occur in countries with lower per-capita income.

Table 1

Country	Year Personal Accounts Introduced	Percent of Retirement Benefit from Personal Account after Reform for Average Worker	Voluntary Participation Choice / Notes
Chile	1981	96.25%	New workers must join new system; current workers may choose between systems.
Switzerland	1982	62.87%	No.
U.K.	1986	n.a	Yes. Due to voluntary participation, problems with private pension administration, and rollbacks of the scheme, the U.K. is treated as a non-reforming country in our study.
Peru	1991	62.33%	Yes.
Australia	1992	71.69%	No.
Argentina	1993	62.98%	Yes.
Colombia	1993	32.51%	Yes, workers are allowed to switch back and forth every three years.
China	1995	n.a.	No. No unified national social security system. Implementation of reforms varies widely with substantial discretion by local

			government. Therefore, China is treated as a non-reforming country in our study.
Mexico	1995	98.87%	No.
Uruguay	1995	22.96%	Employees over 40 years old can choose, those under 40 years old and new workers must join new system.
El Salvador	1996	90.97%	All new and young workers must join new system. Older workers must remain with old system. Workers between 36 and 55 (men) / 50 (women) years old may choose.
Bolivia	1997	100.00%	No.
Hungary	1997	37.96%	No.
Denmark	1998	79.54%	No.
Kazakhstan	1998	100.00%	No.
Poland	1998	44.96%	Yes.
Sweden	1998	17.73%	Workers born before 1938 stay with old system; those born after 1953 switch to new system; gradual transition from old to new system for workers born between 1938 and 1953.
Croatia	1999	31.48%	Workers between age of 40 and 50 at the time of reform can opt into the new system. Older workers remain in old system, younger workers must participate in new system.
Costa Rica	2000	7.92%	No.
Bulgaria	2000	24.39%	All workers born after 1959 must participate in the new system.
Hong Kong	2000	n.a.	No. Country is not sovereign self-governing state. Therefore, country is not modeled and not included in our dataset.
Nicaragua	2000	100.00%	System implementation suspended in 2005 and prior public pension system restored.
Dominican Republic	2001	83.81%	No.
Ecuador	2001	22.96%	System implementation pending legal decision on constitutional grounds.
Latvia	2001	57.53%	All workers born after July 1st 1971 must participate in new system. Participation is voluntary for older workers.
Russian Federation	2001	26.71%	All workers born after 1966 must participate in new system.
Estonia	2002	55.65%	All workers born after 1982 must participate in the new system.
Lithuania	2003	25.99%	Yes.
Slovakia	2003	39.68%	Full implementation in 2005. All workers entering the labor force in 2005 or later must participate in the new system. Existing workers could opt into the new system before June 30th 2006.

Figure 1
Size of Reforms Relative to Per-Capita Income at the Time of Reform
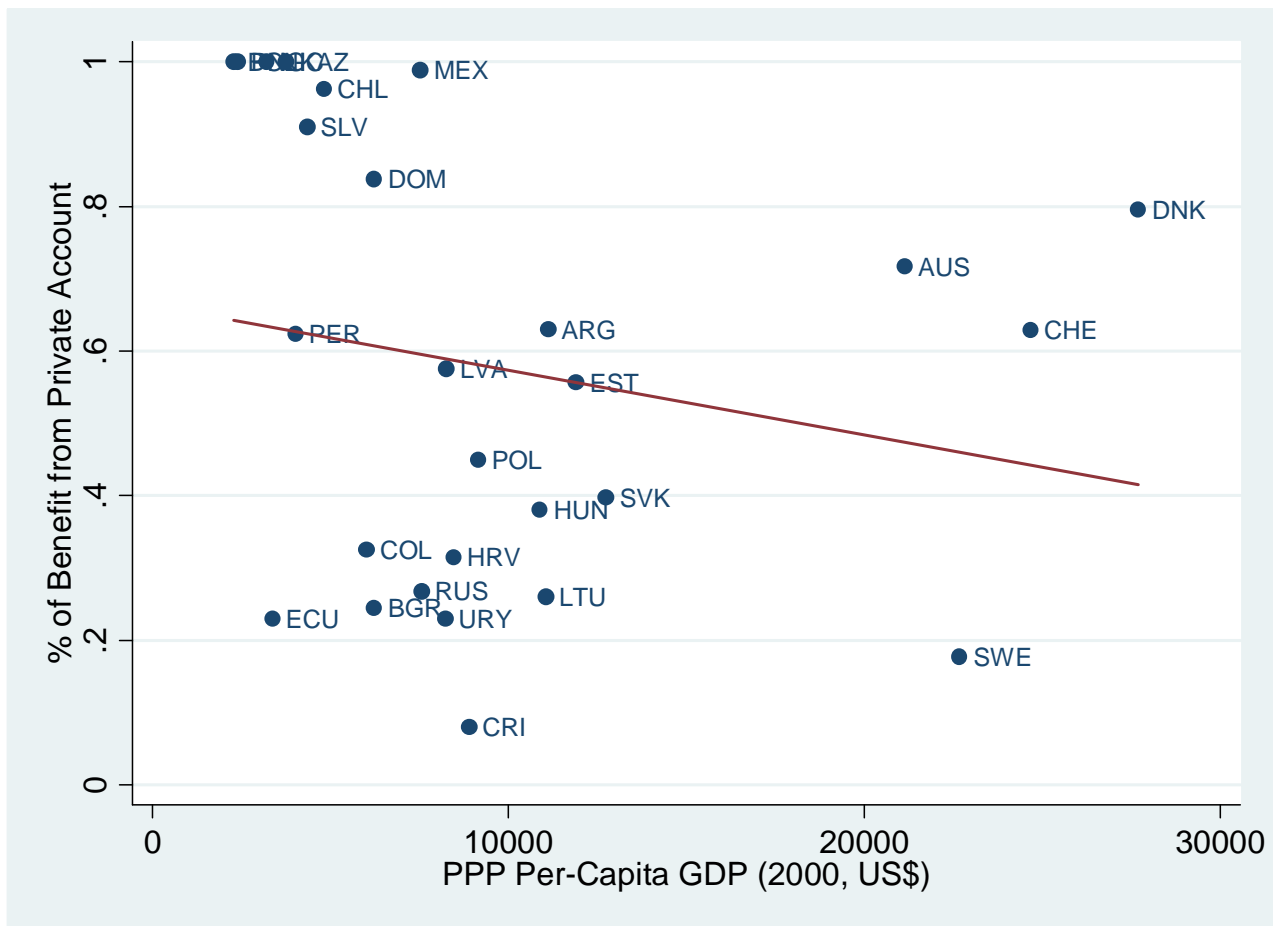
This paper addresses both of these questions using an overlapping-generations median voter model. One central theme emerges: the public pension conversions reflect a

fundamental mistrust in the ability of the government to provide secure retirement resources. The exact nature of the distrust, though, typically differs between reforming countries.

In countries where reforms have been the largest (typically developing countries), the distrust in the government provision of public pensions is conditioned on potential instability. In particular, workers do not trust the government to run even a strict pay-as-you-go system anymore. Personal funded DC accounts give workers greater transparency and control. While personal accounts can be subject to their own political risks, government interference is more obvious. The concomitant increase in the level of funding is *not* the primary object of reform itself. Rather the increase in funding is a byproduct of securing a safer retirement without trusting a pay-as-you-go scheme that only the government can run.[5] In other words, personal accounts would have been created even without reference to demographic concerns.

In contrast, in countries where reforms have been smaller (typically in developed economies), the role of instability is less important. Instead, the primary objective *is* to pre-fund future benefits since many of these countries face severe demographic problems. However, the government is not fully trusted to properly save the resources that are needed to pre-fund some of these future benefits. So the creation of personal accounts *is* a byproduct of attempting to increase funding. If these countries faced no demographic pressures, the incentive to create personal accounts would be greatly reduced.

Section 2 critically analyzes previous economics attempts to explain conversions to personal accounts. Common rationales include: higher returns; improvements in domestic financial institutional development; improving labor supply and retirement incentives; and

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[5] A couple of countries have adopted unfunded 'notional' defined-contribution accounts, sometimes in addition to funded defined-contribution accounts. While a notional account does create a clearer contract with the government, the lack of funding still requires a lot of trust that future governments will fulfill previous promises.

hedging demographic changes. In each case, a politically-stable and transparent government could have achieved similar – likely superior – results within the traditional system. The traditional also has lower transaction and other costs (Diamond 1996).

Section 3 presents a simple model of a pension system as a game between median voters of successive generations. The model incorporates the potential for fundamental reform as well as the potential for only a partial reform, that is, without fundamental reform.

Section 4 then presents empirical evidence while Section 5 concludes.

2.   Review of Common Explanations of Reform

We now critically examine several traditional reasons for pension reform.

2.1.   Pursuing Larger Returns

As traditional public pension systems around the world begin to mature, it is becoming increasingly clear to policymakers and voters that traditional systems provide poor returns. Privatization, it is sometimes argued, can improve the returns.

Figure 2 reports the average effective (or "internal") annualized rates of return earned in the United States Social Security system by generation over time. Effective rates of return have declined dramatically over time. The composite average U.S. worker who began to collect a benefit at age 65 in 1941 received a 36½ percent effective annual rate of return on his pension contributions. In sharp contrast, a person born today into the mature U.S. Social Security system is projected to receive less than a 2 percent effective rate of return.

Figure 2
Effective Real Rates of Returns to the U.S. Public Pension System
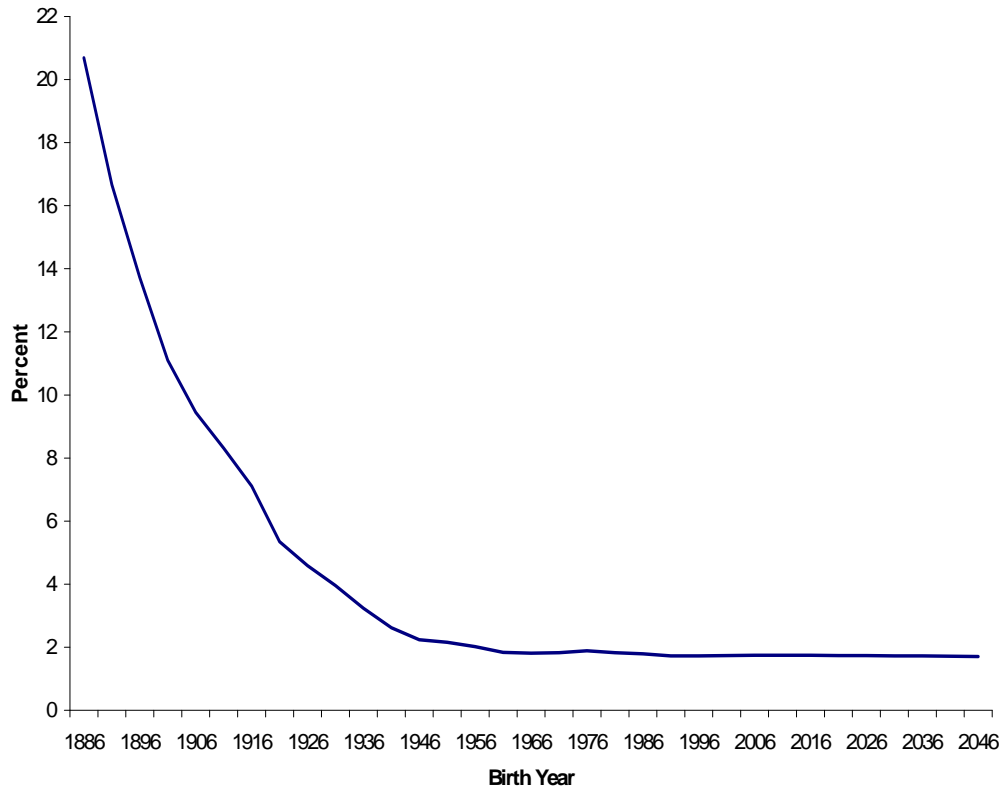
Source: Dean R. Leimer, "Cohort-Specific Measures of Lifetime Net Social Security Transfers," ORS Working Paper No. 59, Social Security Administration, 1994.

The declining rate of return stems directly from pay-as-you-go financing itself: money flowing into the pension system gets distributed immediately as benefit payments to retirees. Early retirees receive a windfall which is paid for in present value by future generations. Future generations receive a positive rate of return under a stationary tax rate only to the extent that the payroll tax base grows with population and productivity. Since windfalls to early generations have already been consumed, there is no potential for recovering them. This zero-sum condition of pay-as-you-go financing can be traced back to Samuelson (1958) and Diamond (1965); it has been extensively explored since then.[6]

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[6] See, for example, Breyer (1989), Geanakopolis, Mitchell, and Zeldes (1999) and Mariger (1999).

2.2. Improvements in Financial Markets

Another commonly cited reason for pension reform is to deepen the domestic capital markets. Figure 3 shows the amount of private credit as a share of GDP in several countries before and after pension reform (a hash mark indicates the respective reform dates for reforming countries). Private credit includes the total financial resources provided to the private sector through loans, purchases of non-equity securities, trade credits and other accounts receivable that establish a claim for repayment. Private credit is one of the most commonly used metrics in the literature for indicating an economy's level of financial sophistication, especially for less developed countries in which equity financing is less common. But changes in private credit also reflect the changes in the private savings level following pension reform rather than just changes in financial market institutions. Hence, the private credit levels for several reforming West European countries, where financial markets were already sophisticated before reform, are also shown in order to isolate the saving effect.

Private credit levels in Latin American and Eastern European countries are well below those in Western European countries. Even these differences underestimate the larger degree of capital market development in Western European countries, whose investments tend to be relatively more equity financed. Also notice that private credit indeed expanded in each country following reform, except for Mexico and Argentina, both of which suffered currency and other financial crises. This evidence would seem to buttress the case for the hypothesis that the development of domestic capital market institutions was a major influence in reform. After reform, many of these Latin American and Eastern European countries also put in place restrictions to prevent workers from investing their money abroad, which also seems consistent with the desire to develop the domestic capital market.

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Figure 3

Private Credit as a Percent of GDP

(Reform dates shown as short vertical lines)
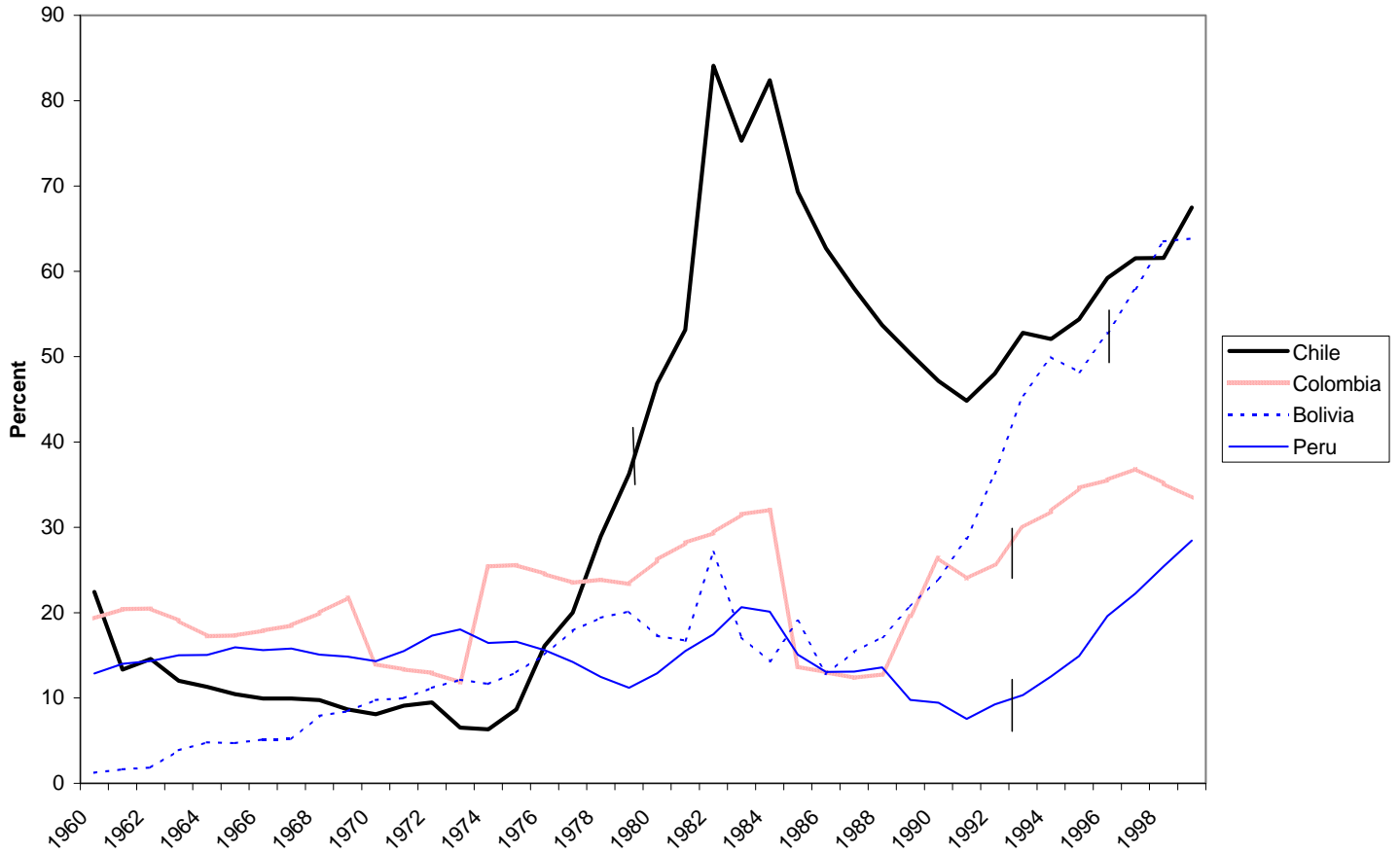
Bolivia, Chile, Colombia, and Peru

Figure 3 (Continued)
Private Credit as a Percent of GDP

Argentina, El Salvador, Mexico and Uruguay
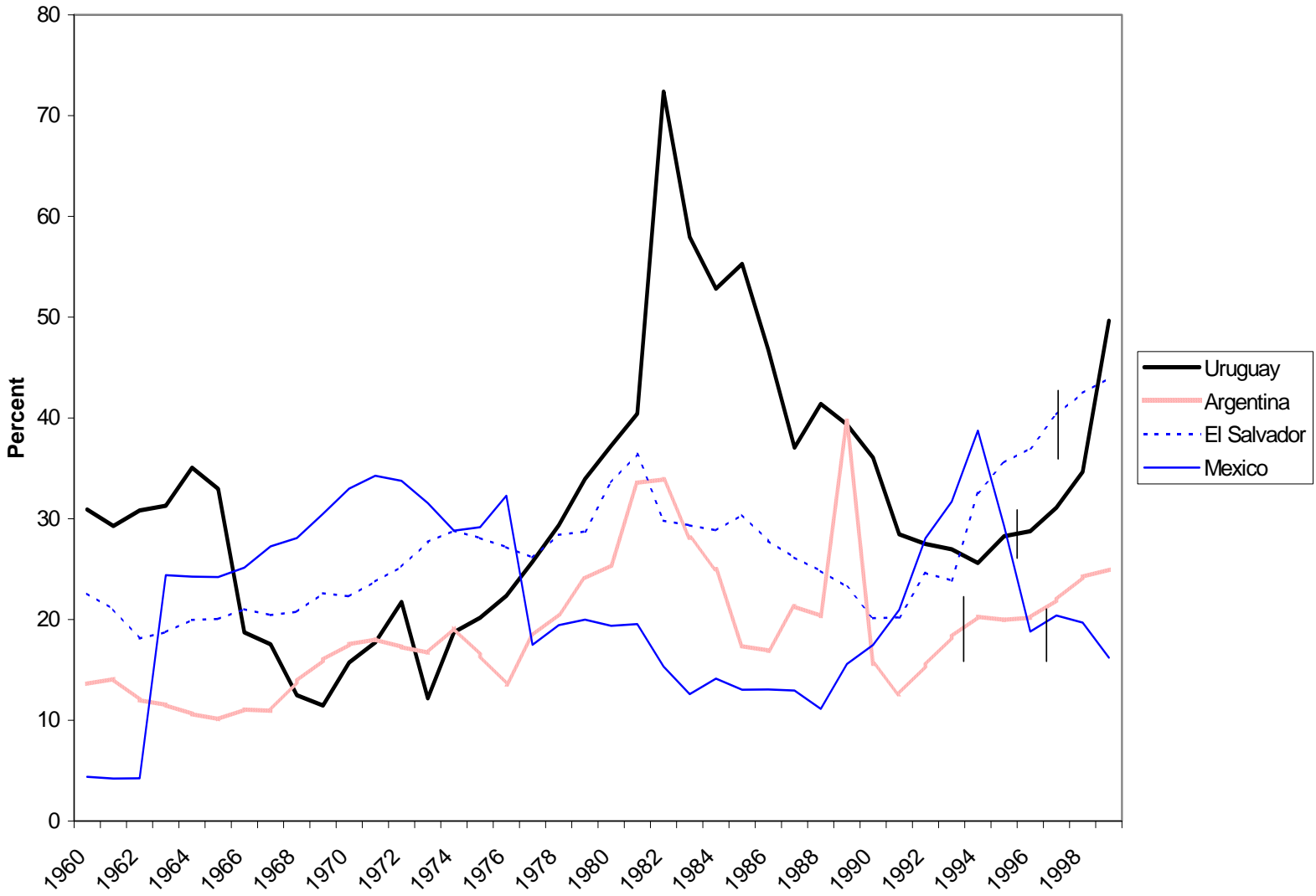
Figure 3 (Continued)
Private Credit as a Percent of GDP

Hungary, Kazakhstan, Poland
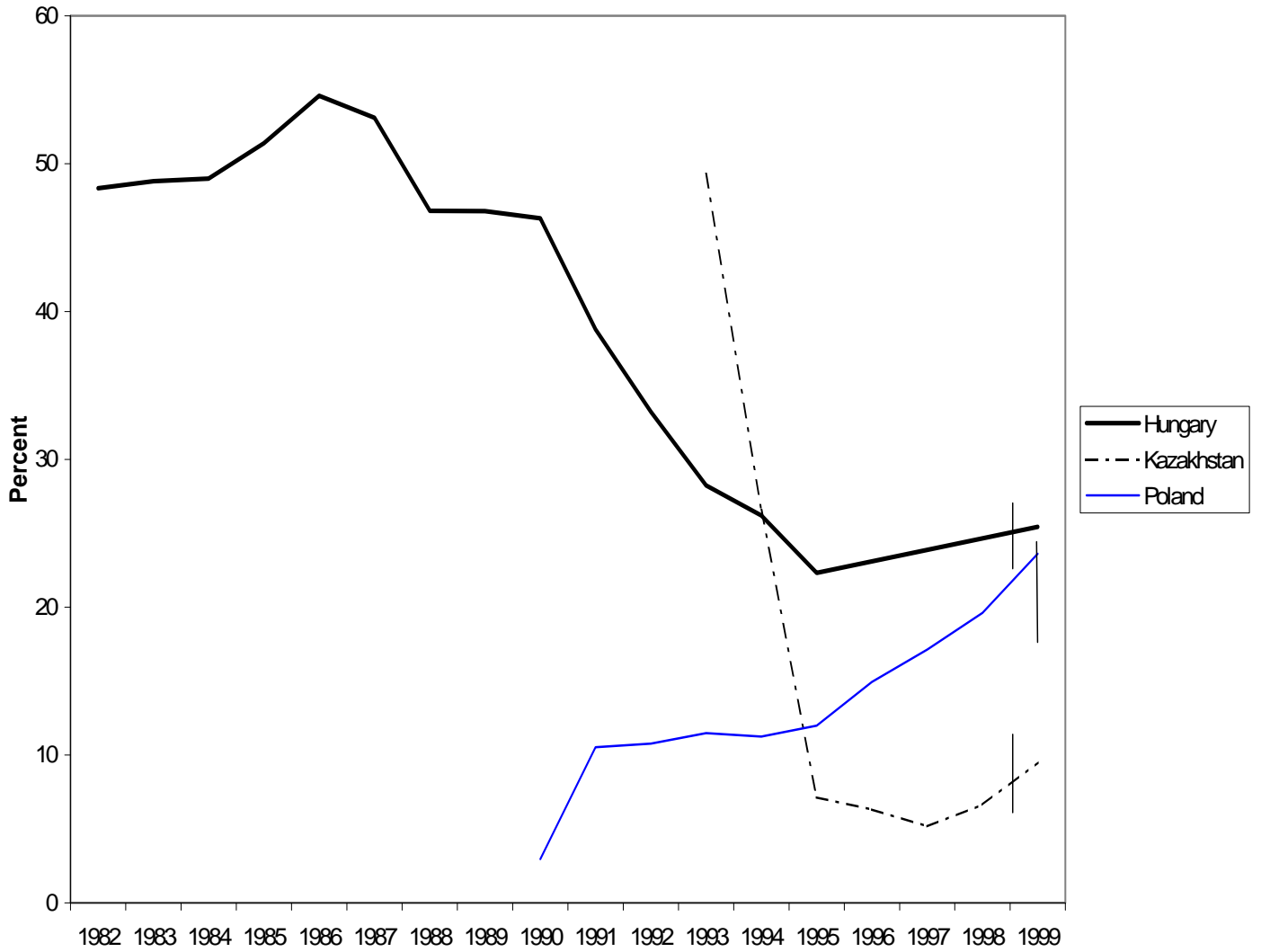
Figure 3 (Continued)
Private Credit as a Percent of GDP

Australia, Sweden, Switzerland, U.K.
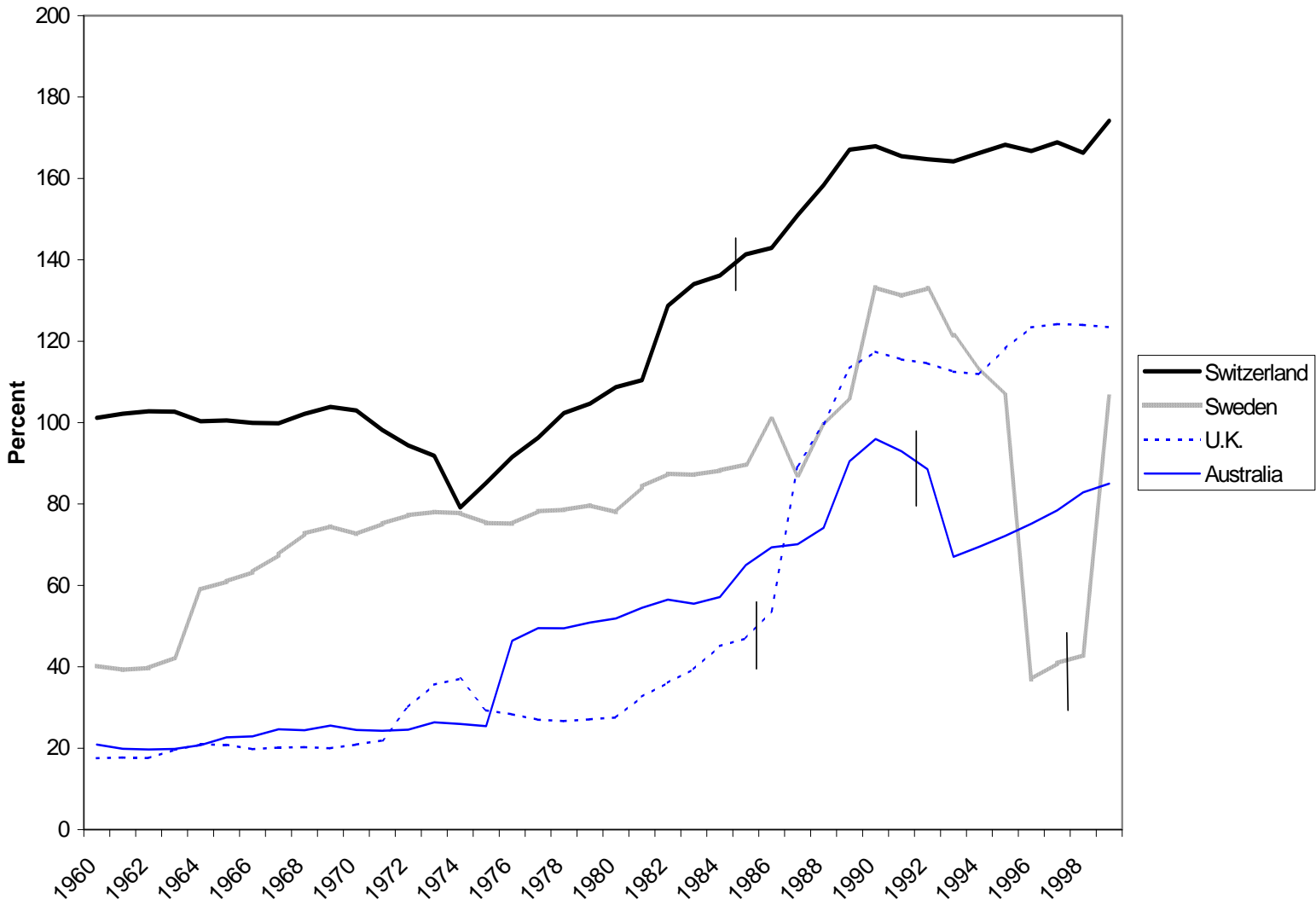
But notice that the post-reform rise in private credit tended to be sharper in Western European countries despite the smaller size of their pension reforms relative to the Latin American and Eastern European nations. Since most Western European countries already had sophisticated financial markets prior to reform, much of their increase presumably stemmed purely from increases in the amount of capital, since pension reforms presumably had little impact on the relative reliance on equity financing. This result suggests that a large fraction of the increase in private credit in Latin American and Eastern European nations might also be driven by the saving effect rather than by financial institution development.

Moreover, except Mexico and Argentina, the availability of private credit began to increase in most Latin American and Eastern European countries before the introduction of personal accounts. (Since the personal accounts are unlikely to have a large effect for several years, the effective pre-reform trend is even longer.) Indeed, the introduction of personal accounts does not seem to increase the pre-reform trend in most countries, suggesting that other factors might also be playing an important role in the expansion of private credit.

Pension reforms in developing countries were typically part of larger reforms that spurred capital market development. As discussed by Walker and Lefort (2002), the largest reforms in developing countries include: macroeconomic stability; tax incentives; capital control liberalization; deregulation and competition in the financial services; property rights, bankruptcy legislation and investor protection; and, privatization of state-owned enterprises. When controlling for country-specific factors, Walker and Lefort find little evidence that pension reform improved financial market development, including the cost of capital, stock market volatility and other measures. Only when other factors are ignored does pension reform have some effect in developing the domestic capital market. Consistently, our own

empirical estimation (reported in Section 4) provides only weak evidence that public pension reform was motivated by shallow financial markets.

Moreover, personal accounts were not the only way to develop financial institutions. Pre-funding existing traditional public pension systems could, in theory, have also done the job. Like in Chile's original private account system (since liberalized), public pension investments could have been restricted to domestic markets and divided among private fund managers. If domestic capital market development were truly the motivating concern, local investments through the public pension system would have presumably better avoided the appearance of a direct "tax" on returns earned by workers by forcing them to invest domestically. (Some developed countries including Singapore have invested their public pension funds directly in public projects.) Within the traditional system, a home bias in pension investments has no direct effect on a worker's pension benefit since benefits remain defined by law. Instead, any return reduction is a hidden obligation on future generations.

2.3. Enhancements to Labor Supply

Payroll taxes in a traditional defined benefit system are distorting for several reasons. First, workers are forced to invest into a pay-as-you-go public pension "asset" that pays a rate of return below what they could have earned in the private sector. Second, redistribution produces larger rates of returns for lower-income workers along with smaller returns for higher-income workers. Third, borrowing constrained workers might not wish to make any contributions at younger ages, even at a market rate of return. Fourth, particular features of the program, such as a spousal benefit, cause additional distortions. Fifth, as documented by Gruber and Wise (1998, eds. 1999), specific rules encourage early retirement.

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Private accounts are argued to ameliorate these tax-like disincentives to labor supply. Each of these distortions, however, can be just as easily addressed with the traditional pension system as with pension reform. Inferior rates of return are a natural outcome of pay-as-you-go financing or redistribution; similarly, tax-induced distortions caused by redistribution are simply the cost of redistribution, which would also exist in a private pension system that maintained the same level of redistribution.[7] Borrowing constraints could be lessened by starting payroll tax rates at a low level early in life and increasing them with age in order to collect the same present value of income from each worker on average (Hubbard and Judd, 1987). The other distortions are consequences of the rules specific to different public pension systems and can be addressed within the existing pension system.

2.4. *Addressing Demographic Changes*

It is also commonly claimed that traditional public pension systems are unable to deal effectively with demographic problems since payroll taxes must increase sharply or benefits decrease sharply as the ratio of retirees to workers increases. In contrast, private accounts should be less vulnerable to demographic changes since retirement benefits are directly tied to previous savings. However, as shown in Table 2 higher-income countries face the largest predicted declines in worker-retiree ratios; higher income countries are also those with the smallest pension reforms. In fact, as Figure 4 shows, among actual reforming countries, there appears to be an *inverse* correlation between demographic problems and the size of actual reform. It is not clear, therefore, that demographics is the main impetus behind large reforms.

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[7] In fact, actual implementations of privatization actually reduce labor supply distortions. Smetters (2006) derives the neutrality of labor supply to pension reform under the "carve out" scenario; he also demonstrates that "shutdown" reforms actually *reduce* labor supply incentives.

Table 2
Past and Projected Worker-Retiree Ratios

	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
High-Income Countries at time of their Reform										
Australia	3.6	3.5	3.3	2.9	2.5	2.2	1.9	1.7	1.6	1.6
Denmark	2.9	2.9	2.6	2.3	2.1	2.0	1.8	1.6	1.5	1.5
Hong Kong	4.2	4.3	4.2	3.5	2.8	2.0	1.5	1.3	1.2	1.1
Sweden	2.4	2.4	2.2	2.0	1.9	1.7	1.6	1.5	1.4	1.4
Switzerland	3.0	2.9	2.6	2.3	2.1	1.8	1.5	1.3	1.3	1.3
United Kingdom	2.6	2.6	2.5	2.3	2.1	2.0	1.7	1.6	1.5	1.5
Medium-Income Countries at time of their Reform										
Croatia	2.5	2.4	2.5	2.4	2.1	1.9	1.8	1.7	1.7	1.6
Hungary	2.8	2.9	2.8	2.6	2.3	2.1	2.1	2.0	1.8	1.6
Poland	3.4	3.4	3.6	3.2	2.7	2.2	2.1	2.1	2.0	1.8
Uruguay	2.9	3.0	3.1	3.1	3.0	2.8	2.6	2.5	2.3	2.1
Poorer Countries at time of their Reform										
Argentina	3.7	3.8	3.9	3.8	3.6	3.4	3.2	3.0	2.8	2.4
Bolivia	7.2	7.2	7.4	7.4	7.2	7.0	6.6	6.1	5.4	4.8
Chile	5.5	5.2	4.8	4.4	3.9	3.3	2.8	2.5	2.3	2.2
China	5.8	5.6	5.4	5.0	4.1	3.7	3.0	2.4	2.1	2.0
Colombia	6.2	6.2	6.2	6.0	5.5	4.9	4.2	3.7	3.2	2.9
Costa Rica	6.9	6.6	6.3	5.8	5.1	4.2	3.5	3.0	2.7	2.5
Domenica Rep.	7.9	7.5	7.3	6.9	6.1	5.2	4.3	3.6	3.2	2.8
Kazakhstan	5.3	4.3	4.9	4.9	4.4	3.6	3.2	3.1	3.1	2.9
El Salvador	6.7	7.3	7.6	7.5	7.4	7.3	6.7	5.5	4.3	3.4
Mexico	7.7	7.6	7.2	6.7	5.9	5.1	4.4	3.9	3.2	2.8
Nicaragua	8.9	9.4	9.9	9.7	8.7	7.8	6.8	5.8	4.9	4.1
Peru	7.0	7.0	7.0	6.7	6.1	5.5	4.8	4.1	3.5	3.0

Source: Data provided by Robert Palacios, World Bank.
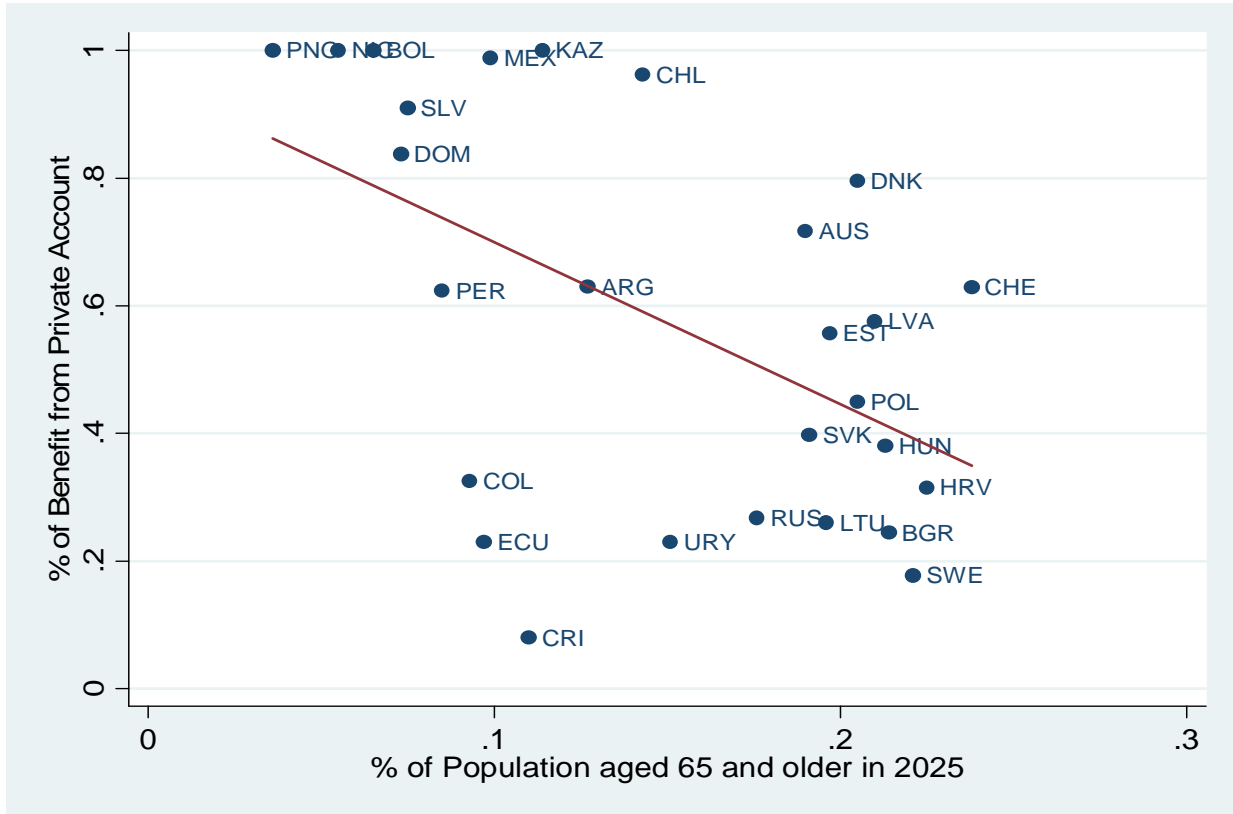
Moreover, in theory, a traditional system could effectively deal with changes in fertility rates by accumulating large reserves when the worker-retiree ratio is large and then spending down the reserves as the ratio decreases. (Since 1983, the United States has been building up its Social Security "trust fund" in an attempt to buffer future costs associated with the retirement of baby boomers.) *If* these reserves were saved, taxes would remain roughly flat throughout the entire period, as collections would initially exceed costs and then fall below. A personal account system would do no better in hedging demographic risk. However, creating an additional reserve within a traditional pension system requires a level of trust that the money will be saved, a consideration to which we now turn.

3.   A Model of Trust

We now show how a full breakdown of the inter-generational trust produces large, fundamental pension reform; demographics play very little role. However, smaller reforms are also motivated by a lack of trust of a different sort: while the government is trusted to run a strict pay-as-you-go system, it might not be trusted to truly save the additional reserve required to hedge a demographic shock. Smaller reforms are mainly demographic driven.

Consider a simple overlapping-generations median voter model. There are N_t first-period agents alive at time t. Population at time t grows at rate $n_t \equiv \dfrac{N_t}{N_{t-1}}$. The total wage base at time t grows at a gross rate $G_t \equiv (1+g_t) \equiv (1+n_t)(1+x)$, where x is the exogenous and constant rate of technological change between time periods. We initially assume that the population is stationary and so we often drop the time subscripts for N and G. The gross rate of return to risk-less capital is $R = (1+r)$, where r is the net rate of return. The wage rate at time t is w_t, which grows at rate x, i.e., $w_{t+1} = (1+x)w_t$. Factor prices are (trend) stationary, as in a small open economy or with linear technology.

An agent born at time t lives for three periods. The agent has exogenous levels of productivity of α_1 and α_2 in the first and second periods, respectively. Productivity in the third period is zero, where he retires. Lifetime utility is given by $\sum_{k=1}^{3} \beta^k u(c_{k,t}, 1-l_{k,t})$, where: β is the growth-adjusted discount rate; $c_{k,t}$ is the level of consumption at age k at time t; and, $l_{k,t}$ is the respective level of labor supply, where the total time endowment each period is normalized to unity. The function $u(,)$ is increasing and concave in both arguments. Lifetime utility is maximized subject to the following budget constraints:

(1) $\quad c_{1,t} + a_{1,t} = \alpha_1 w_t l_{1,t}(1-\tau)$

(2) $\quad c_{2,t+1} + a_{2,t+1} = \alpha_2 w_{t+1} l_{2,t+1}(1-\tau) + Ra_{1,t}$

(3) $\quad c_{3,t+2} = Ra_{2,t+1} + b_{t+2}$

Where a represents private assets, b is the social security benefit received in the third period that is financed on a pay-as-you-go basis with a proportional tax τ on labor earnings.

For expositional simplicity the analysis herein focuses on a social security system where benefits are proportional to previous contributions. In a proportional and stationary system, every agent earns the same gross "internal" rate of return G on their social security contributions, which is equal to the growth rate of the wage tax base. The pay-as-you-go social security benefit received by generation t during their third year, therefore, equals[8]

(4) $\quad b_{t+2} = G^2 \tau \alpha_1 w_t l_{1,t} + G \tau \alpha_2 w_{t+1} l_{2,t+1}$

3.1.   *A Theory of Fundamental Reforms: Voting Over Pay-as-you-go Financing*

Suppose that the population growth rate, n, is not very large, in particular, that $(1+n)^2 < (1+n)+1 = (2+n)$. Then, the age-2 agent is the *median voter* that determines whether the pay-as-you-go system continues. Since the median voter is not retired himself, he will vote to continue the system if and only if two conditions are satisfied:

(A)   (Incentive Compatible) $\tau \alpha_2 w_{t+1} l_{2,t+1} < \dfrac{b_{t+2}}{R} = \dfrac{G^2 \tau \alpha_1 w_t l_{1,t} + G \tau \alpha_2 w_{t+1} l_{2,t+1}}{R}$

(B)   (Continuation) The current *age-1* agent, generation t, votes for τ.

Condition (A) says that the present value of maintaining the pay-as-you-go social security program to the median voter must exceed the value of the second-period taxes saved from abandoning the system. Even though pay-as-you-go social security is actuarially unfair to age-1 households in a dynamically efficient economy where $R > G$, age-2 households have already contributed to the system in the previous year. Hence, its incentive compatibility constraint can hold even if social security pays a lower internal rate of return.

Condition (B) is the usual recursive "trigger strategy" belief that enforces cooperation across generations in pay-as-you-go games (Verbon 1988a,b; Kotlikoff, Persson and Svensson 1988; Drazen 2001; Cooley and Soares 1999; Rangel 2003). The current age-2 median voter won't vote to support continuation of the pay-as-you-go system unless the next median voter (currently age 1), when the current age-2 agent is then retired, also supports continuation, *ad infinitum*. Cooperation in enforced with a simple trigger: Any age-2 agent that abandons the system will be sufficiently punished by reducing his third-period social security benefit by more, in present value, than his second-period tax savings, $\alpha_2 w_{t+1} l_{2,t+1} \tau$.

Condition (A) is likely to hold in stable economies with a reasonable value of R. To see this, suppose that $\alpha_1 = \alpha_2$ (i.e., flat productivity profiles) and $R = 1/\beta$ (i.e., interest rate equals the growth-adjusted rate of time preference). Then condition (A) can be simplified to:

(A') $1 < \dfrac{G}{R} + \dfrac{G^2}{R} = \dfrac{G + G^2}{R}$

The first term G/R in equation (A') corresponds to the tax payments paid in the second period of life and represents the relative rate of return produced by pay-as-you-go financing G relative to the rate R which could have been received in the capital market. In a

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[8] I.e., in a stationary economy, equation (4) can be rewritten as the standard pay-as-you-go constraint,

dynamically inefficient economy, $G/R < 1$, reflecting the opportunity cost of capital. In other words, the median voter would have been better off if he could have invested his payroll taxes into the capital market. The second term G^2/R reflects the fact that the age-2 median voter, however, has already paid into the pay-as-you-go system in the first period, a contribution that would be lost if he votes to abandon the system. The inequality shown in equation (A'), therefore, holds, except for fairly large values of $R \gg G$. In that case, the opportunity cost of the median voter's second-year contribution is large enough that he is willing to forfeit his first-year contribution in order to obtain a larger rate of return.

However, the pay-as-you-go system unravels if the discount rate R effectively becomes too high, potentially in response to uncertainty about the future. Since the "trigger" is recursive, the game collapses if it is not incentive compatible for any future median voter.[9]

Proposition 1. A pay-as-you tax τ is a Nash, subgame perfect equilibrium if and only if Conditions (A) and (B) hold for current and future median voters. Also, let $[0, R_{max}] \in \Re^+$ be the support over the values of R such that Condition (A) holds. R_{max} is bounded above. □

So we arrive at a theory for large social security reforms: the system unravels if a current or future median voter faces a large enough value of R, which effectively causes them to highly discount the value of future social security benefits. Proposition 1 shows that such a value of R exists for any size of the pay-as-you-go system, τ.

$N_t b_{t+2} = N_{t+2} \tau \alpha_1 w_{t+2} l_{1,t+2} + N_{t+1} \tau \alpha_2 w_{t+2} l_{2,t+2}.$

Remark 1. Condition (A) can be generalized to the case of non-stationary demographics as:

$$(\text{A''}) \quad \alpha_2 w_{t+1} l_{2,t+1} \tau < \frac{G_{t+1} G_{t+2} \tau \alpha_1 w_t l_{1,t} + G_{t+2} \tau \alpha_2 w_{t+1} l_{2,t+1}}{R}$$

Even with substantial deviations from stationary demographics (e.g., a "baby boomer bulge."), the median voter is age-2 and Condition (A'') holds. To see the latter result, again suppose that $\alpha_1 = \alpha_2$ and $R = 1/\beta$. Condition (A'') is simplified to $1 < \frac{G_{t+2}}{R} + \frac{G_{t+1} G_{t+2}}{R}$. With (trend) stationary factor prices, a demographic bulge, as witnessed in many developed countries, implies $G_{t+1} > G_{t+2} > 0$.[10] For some parameter values, the new maximum support value of R, $R_{\max}^{''}$, might actually be larger than the support, $R_{\max}$, with stationary demographics; for some parameter values, it is smaller. In either case, the prevalence of non-stationary demographics does not play an important role in undermining the trigger. □

3.2. *An Extension to Partial Reforms: Including a Social Security Reserve*

The knife-edge nature of the trigger strategy used in Proposition 1, however, rules out an explanation of partial reforms. Moreover, as explained in Remark 1, demographics alone do not play a large role in explaining a collapse of intergenerational cooperation. So why then do some countries reform but not completely abandon their social security systems?

Consider now a dual policy space in which votes are also cast over an additional proportional payroll tax, τ^a, which might be interpreted as being used to fund a social security "reserve." A direct majority (median voter) model also determines the level of this

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[9] It can be shown that social security will continue provided that the *probability* of future collapse is not too large. This type of result is fairly standard in dynamic reputation games.
[10] While $n < 0$ is possible, $G > 0$ since $n > -1$ for any population to remain.

payroll tax.[11] If cohort t's own future social security benefit is then increased by

$R^2 \tau^a \alpha_1 w_t l_{1,t} + R \tau^a \alpha_2 w_{t+1} l_{2,t+1}$ then τ^a represents a pure "funded" portion of social security.[12]

Assuming that borrowing constraints are not binding, such a payroll tax, however, has no impact on any household's budget constraint; it just substitutes public saving for private. A "partial privatization" that simply undoes this payroll tax, τ^a, is economically neutral.

Suppose instead that the government contemporaneously redistributes τ^a instead of saving it for each generation. Of course, a majority of voters might choose such redistribution by its sheer voting power. However, our motivation in this setting is more practical: few people understand government budgetary arithmetic. (The U.S. debate over creating a true "lock box" for Social Security reflects that concern.) This additional revenue, therefore, might be viewed as a part of general pool of revenue that is up for grabs.

To avoid Condorcet type of cycles, we need to consider voting over a specific redistribution function.[13] For simplicity, consider voting over a policy rule that distributes these resources as a subsidy across the population on a constant *per-capita* (per vote) basis. Alternative policy rules could be considered as well; the current rule simplifies the analysis.

Assume that labor supply is inelastically supplied at one unit.[14] Let s_t denote the per-capita subsidy at time t, in the form of a rebate to each worker:

$$(5) \quad s_t = \frac{N_{t-1} \tau^a \alpha_2 w_t + N_t \tau^a \alpha_1 w_t}{N_{t-2} + N_{t-1} + N_t}.$$

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[11] Alternatively, both issues could be voted upon as a bundle, as in a representative democracy model. The solution that we derive extends to this case as well, with some fairly minor modifications.

[12] More technically, we require that, when τ^a is implement, benefits are not increase on the current age-3 retirees. Current age-2 households then see their third-period benefit increase to $R \tau^a \alpha_2 w_{t+1} l_{2,t+1}$.

[13] This same issue arises with most fiscal policies: for example, we previously considered voting over a fixed form of redistribution from workers to retirees. Voting over exogenous fiscal policy functions is commonly assumed in the literature to avoid Condorcet types of voting indeterminacies.

The numerator in equation (5) equals the additional tax revenue collected from workers at time t. The denominator is equal to the size of the population, including retirees at time t (N_{t-2}), age-2 workers (N_{t-1}), and age-1 workers (N_t). Workers who are age 1 at time t will vote for this subsidy in a one-shot static game (we extend to a dynamic game below) if

(C1) $s_t > \tau^a \alpha_1 w_t$.

In words, the value of the subsidy must exceed the taxes paid by the additional tax. Similarly, workers who are age 2 at time t will vote for it if:

(C2) $s_t > \tau^a \alpha_2 w_t$.

Since factor prices are fixed, retirees will always vote for the subsidy, i.e.,

(C3) $s_t > 0$.

With some algebraic substitution, Conditions (C1) and (C2) can be reduced to:

(C1') $\dfrac{\alpha_2}{\alpha_1} N_{t-1} > N_{t-1} + N_{t-2} \Rightarrow \dfrac{\alpha_2}{\alpha_1} > 1 + \left(1 + n_{t-1}\right)^{-1}$

(C2') $\dfrac{\alpha_1}{\alpha_2} N_t > N_t + N_{t-2} \Rightarrow \dfrac{\alpha_1}{\alpha_2} > 1 + \left(1 + n_t\right)^{-1} \left(1 + n_{t-1}\right)^{-1}$

In words, (C1'), for example, says that age-1 workers at time t are more willing to support the social security reserve if age-2 workers, whom are also in the tax base, are sufficiently more productive than age-1 workers, adjusted by the other population competing for the transfer. Intuitively, given the simple per-capita rebate subsidy rule, age-1 households want to effectively "pool" their reserves with more productive age-2 workers, provided that there are not too many other competing voters, $N_{t-1} + N_{t-2}$, participating in the subsidy.

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[14] The tax-subsidy distorts labor supply, which we want to abstract from for the sake of simplicity.

Lemma 1. (i) With non-negative population growth ($n_t \geq 0$), age-1 and age-2 workers at time t won't both support a social security reserve, τ^a. **(ii)** The converse is not true: there is a non-empty set of parameters, $\{\alpha_1, \alpha_2, N_{t-1}, N_t, N_{t+1}\}$, where both workers reject a reserve. $\square$

To prove Lemma 1, insert (C1') into (C2'): $\left[1 + \left(1 + n_{t-1}\right)^{-1}\right]^{-1} > 1 + \left(1 + n_t\right)^{-1}\left(1 + n_{t-1}\right)^{-1}$,

which is a contradiction in the presence of a non-negative population growth. However, it is easy to show that the converse is not true: workers of both ages can vote to reject a reserve.[15] Intuitively, the transfer to age-3 retirees breaks the direct linkage between these two cases since the redistribution between workers is not zero-sum.

With non-negative trend stationary demographics (where $n_t = n \geq 0$), a social security reserve will either always exist or not; a reversal of policy cannot occur.[16] Consider first the case where age-1 workers favor the reserve. By Lemma 1 (i), age-2 workers will oppose:

(6) $\qquad \dfrac{\alpha_2}{\alpha_1} > 1 + \left(1 + n\right)^{-1}$

(7) $\qquad \dfrac{\alpha_1}{\alpha_2} < 1 + \left(1 + n\right)^{-2}$

Aged-3 retirees, of course, still favor the social security reserve redistribution. Combining their votes with age-1 households will produce a winning coalition in favor of the reserve since $1 < (1 - n) + (1 + n) = 2$. Now, consider the case where age-1 households oppose the social security reserve and age-2 workers favor it (i.e., the opposite signs in equations (6) and (7)). If $n < 1/2$ then the winning coalition always favors the reserve since $1 + n < 1 + (1 - n)$; if

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[15] For example, both aged workers will vote against a reserve for the following parameter combination:
$\alpha_1 = 1.25$, $\alpha_2 = 1.75$, and $N_t = N_{t-1} = N_{t-2}$

$n > 1/2$ then age-1 workers are plentiful enough to always vote down the reserve. Finally, by Lemma 1 (ii), both aged workers can also reject a social security reserve under the right parameter combination (e.g., $\alpha_1 = 1.25$, $\alpha_2 = 1.75$; $n = 0$), i.e., reverse the sign of the inequality shown in equation (6). In particular, they always create a winning coalition that rejects the reserve since $1 - n < 1 + (1 + n)$ when $n \geq 0 > -1/2$. We summarize as follows:

Proposition 2. (i) With non-negative trend stationary demographics $(n_t = n \geq 0)$, a policy reversal of social security reserving (i.e., $\tau_t^a > 0$; $\tau_{t+1}^a = 0 = 0$) cannot occur. **(ii)** With non-stationary demographics, there exists a non-empty parameter set in which social security reserving is eventually reversed, i.e., "partial privatization." □

We have already proven Proposition 2 (ii). We use an example to prove Part (ii) under the fairly plausible restriction $n_t \geq 0$, i.e., non-negative population growth.[17]

Example 1. Fix $\alpha_1 = 1.25$ and $\alpha_2 = 1.75$. To reduce notation, set $\tau_t^a = 1 = w_t$. Hence, an age-*j* agent will support a social security reserve at time t, τ^a, if $s_t > \alpha_j$. Consider the following sequence of cohort sizes: {30, 100, 200, 400, 450, 500}. In other words, sharp increases in cohort sizes are followed by much smaller growth rates, near trend stationary:

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[16] Technically, we only require $n_t = n \geq -\dfrac{1}{2}$.

[17] Part (ii) holds under an even larger parameter space if population growth is not non-negative.

Table 3

	Age 1		Age 2		Age 3		Subsidy	Votes For −
Time	α_1	N_1	α_2	N_2	α_3	N_3	s_t	Votes Against
T	1.25	200	1.75	100	0.0	30	1.29	+130
$t+1$	1.25	400	1.75	200	0.0	100	1.21	-500
$t+2$	1.25	450	1.75	400	0.0	200	1.20	-650
$t+2$	1.25	500	1.75	450	0.0	400	1.04	-550

An additional social security reserve is established (by +130 votes) at t in face of a large demographic transition, where the worker-to-retiree ratio is 10. As the population ages, the worker-to-retiree ratio declines to 5 by time $t+1$, and the additional social security reserving is *reversed* (by 500 votes). Over the longer-term, the worker-to-retiree ratio settles a little above 2; the additional social security reserves are not reintroduced. □

In other words, a "partial privatization" occurs and is driven by undoing the redistribution of the additional payroll tax, τ^a. As noted earlier, if the government were able to actually save the additional payroll taxes paid by each generation rather than redistribute these resources, then the additional payroll tax reserves would be economically neutral.

It is easy to demonstrate, however, that, even in the presence of a reversal of additional social security reserves, there is a value of R such that Conditions (A) and (B) still holds, thereby supporting the fundamental pay-as-you-go system. For example, pay-as-you-go financing continues to hold at $R=1$ for the parameters used in Example 1.

In a dynamic setting, where reputation can enforce an equilibrium, it is easy to construct examples in the base pay-as-you-go τ can be supported by a trigger strategy (Conditions (A) and (B) hold) while an additional social security reserve τ^a is created and then reversed. (In Example 1, set $R = 1.9$.) In other words, there is a nonempty parameter

space where a trigger strategy supports an equilibrium pay-as-you-go transfer τ from workers to retirees but no trigger strategy exists to support an additional tax τ^a from workers to both workers and retirees. This result is generally consistent with Rangel (2003) who shows that a "Backward Intergenerational Good" can be supported on its own as a trigger strategy whereas a "Forward Intergenerational Good" cannot be supported on its own.[18]

Proposition 3. (i) With trend stationary demographics, Conditions (A) and (B) can hold (pay-as-you-go financing) with or without additional social security reserves. **(ii)** With non-stationary demographics, a reversal of the additional social security reserving ("partial privatization") can occur even if pay-as-you-go finance remains (no "full privatization"). □

3.3.   *Summary*

Fundamental reforms to a public pension system ("full privatizations") are expected to be motivated by economic turbulence that increases the effective discount rate, thereby undermining the inter-generational trust (the "trigger strategy") that is required to enforce continuation of the traditional public pension system. Demographic changes play very little role in motivating reforms. These types of reforms are consistent in less developed economies with a history of more economic and political turbulence. However, smaller reforms ("partial privatizations") are more motivated by demographic concerns and are smaller in magnitude since some fundamental inter-generational trust still remains; the government is simply not trusted to hold additional reserves against demographic changes.

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[18] Rangel shows that a FIG can be supported in equilibrium if bundled together as a single vote with a BIG. In our voting model herein, however, allowing for bundled voting (as in a representative democracy) would not affect our key results provided that the range of voting bundles is not restricted. Under the parameter conditions

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4.   Empirical Findings

Our theoretical model, therefore, produces two testable hypotheses. First, large reforms are the result of a complete breakdown of the intergenerational game; they are primarily motivated by political and economic turbulence and the associated loss of trust rather than demographic pressure. Second, smaller reforms are more motivated more by demographic pressure rather than a fundamental breakdown of intergenerational trust. This section attempts to test these hypotheses empirically.

4.1.   The Data

We assembled a comprehensive list of 117 countries throughout the world with current or historic pay-as-you-go systems.[19] We excluded from our collection 20 countries with provident fund systems.[20] In addition, a few, mostly smaller, countries with pay-as-you-go systems were excluded due to data constraints.[21] The specific countries used in the analysis are listed in Appendix A. Of the 117 countries included in our data set, only 26 are reformers. Given the limited size of data, our results should be interpreted as only suggestive.

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described therein, a representative who favors a bundle of keeping pay-as-you-go financing while abandoning reserving would obtain more votes than a representative who tries to maintain both.

[19] Our primary data source was *Social Security Programs Throughout the World*, published by the U.S. Social Security Administration and the International Social Security Administration. This publication includes information on almost all countries in the world, but does exclude some countries. Excluded countries consist mostly of developing smaller nations, such as Bhutan and Guinea-Bissau, or countries wracked by conflict, like Afghanistan, Iraq, Somalia, and Eritrea. Other excluded countries simply do not participate in the international community, such as North Korea.

[20] The provident fund countries, many of which are former British colonies such as Singapore, Malaysia, and India, operate a mandatory savings scheme similar in spirit to the private account reforms which are the subject of this paper. However, unlike private account reforms, these provident fund systems typically offer little individual control over investments. All the provident fund systems excluded from our analysis are systems that are the original (often since state declaration of independence) pension systems of the countries concerned.

[21] These are the Bahamas, Belize, Barbados, Cape Verde, Malta, which are small nations for which sufficient reliable data is not available. For Iceland and Luxembourg, we have insufficient political data available from our primary sources because of their small size, although they are advanced economies. Hong Kong's unique political position also excludes it from the analysis. In addition, Cuba, Libya, Liberia, and Uzbekistan are excluded because reliable economic data is unavailable.

Our dependent (left-hand side) variable in our analysis is the degree of reform, as shown previously in Table 1. We calculate the annuitized value of private account components, as a percentage of the average retiree's total pension income, based on the published parameters of the pension system. The maximum degree of reform is achieved when 100% of the average retiree's state pension income is derived from private account sources. Our calculations explicitly model the idiosyncratic features each country's reform, including state financed minimum pension guarantees and old-age welfare programs, both of which tend to reduce the degree of pension income from private sources, depending on the income distribution in that country. Our actuarial model for each country incorporates that country's income distribution, life expectancy and other key economic and demographic variables. Details of these calculations are in Appendix B. Appendix C explains the variables used in our empirical estimation as well their sources in detail.

To measure the degree of intergenerational 'trust' that is needed to continue a pay-as-you-go system, we examine the amount of historic political instability within a given country. Countries with significant historic political instability, due to concomitant regime changes and systemic upheaval, should possess less inter-generational trust, and are more likely to reform. We constructed an instability index based on data from the Polity IV Project, a widely used panel containing political characteristics of 162 countries from 1800-2006. Our historic instability index measures the number of times a country had a political regime lasting at least 5 years, since the inception of the state pension system (summarized in Appendix B). This index captures the frequency of regime change, while ignoring extremely short and volatile regimes which would have insufficient time to disrupt existing institutions severely.

Table 4
Political and Civil Rights

	Year	Freedom Index Two Years Before Reform (1:Most Free to 7:Least Free)			% of Benefit From
	Reformed	Political Rights	Civil Liberties	Total Score	Private Account
Countries with Stronger Records of Political and Civil Rights Two Years Before Reform					
Australia	1992	1	1	1	71.69
Denmark	1998	1	1	1	79.54
Sweden	1998	1	1	1	17.73
Switzerland	1982	1	1	1	62.87
United Kingdom	1986	1	1	1	n.a.
Argentina	1993	1	3	1.5	62.98
Costa Rica	2000	1	2	1.5	7.92
Estonia	2002	1	2	1.5	55.65
Hungary	1997	1	2	1.5	37.96
Latvia	2001	1	2	1.5	57.53
Lithuania	2003	1	2	1.5	25.99
Poland	1998	1	2	1.5	44.96
Slovakia	2003	1	2	1.5	39.68
Uruguay	1995	1	2	1.5	22.96
Bulgaria	2000	2	3	2.5	24.39
Bolivia	1997	2	3	2.5	100.00
Dominican Rep.	2001	2	3	2.5	83.81
Ecuador	2001	2	3	2.5	22.96
Papua N. Guinea	2000	2	3	2.5	100.00
Peru	1991	2	3	2.5	62.33
Countries with Weaker Records of Political and Civil Rights Two Years Before Reform					
El Salvador	1996	3	3	3	90.97
Nicaragua	2000	3	3	3	100.00
Colombia	1993	3	4	3.5	32.51
Mexico	1995	4	3	3.5	98.87
Croatia	1999	4	4	4	31.48
Russia	2001	4	4	4	26.71
Chile	1981	6	5	5.5	96.25
Kazakhstan	1998	6	5	5.5	100.00
China	1995	7	7	7	n.a.

Source: *Freedom in the World*, Freedom House

However, it is also likely that countries with a longer history of political freedoms are more likely to have the political conditions necessary for the public to express their preferences for reform in the face of instability. Toward that end, we include a measure of "historic democracy" based on the Total Score from the Freedom House index that is popular in the political science literature. Table 4 shows the corresponding values for reforming countries in the year of their reform, although our empirical analysis, of course, includes the values for non-reforming countries as well. To reduce the potential sensitivity of this variable to a single year of data, we take the average this variable for each country over the last several decades (depending on the amount of data available for each country).

Additional economic and demographic control variables are obtained from the World Bank's World Development Indicators database. We use per-capita GDP, measured in purchasing power parity, as the indicator of the country's wealth level. To control for a country's projected demographic constraints, we include the percentage of the population that is projected to be above 65 in the year 2025, as estimated by the U.N. World Population Prospects database. We also include credit provided by the private sector, scaled by GDP, as a measure of the amount of financial investment and development of the local economy.

Table 5
Empirical Results

Model	(1) Probit: All Countries	(2) Tobit: All Countries	(3) Tobit: Small Reformer	(4) Tobit: Large Reformers	(5) Tobit: Large Reformers 2[#]
Historic Instability	0.235** (0.100)	0.169** (0.083)	0.086* (0.045)	0.116 (0.075)	0.131* (0.070)
Projected % Population 65+ in 2025	0.109*** (0.031)	0.068*** (0.030)	0.064*** (0.024)	0.027 (0.025)	0.018 (0.023)
Annual Per Capita PPP GDP (1,000s)	-0.057 (0.034)	-0.037 (0.031)	-0.038 (0.023)	-0.018 (0.025)	-0.014 (0.022)
Historic Democracy	0.083** (0.035)	0.059* (0.032)	0.041* (0.021)	0.035 (0.028)	0.035 (0.025)
Domestic Private Sector Credit (%GDP)	-0.011* (0.005)	-0.007 (0.005)	-0.004 (0.003)	-0.003 (0.004)	-0.002 (0.003)
Constant	-1.653*** (0.326)	-1.207*** (0.401)	-0.941*** (0.326)	-0.437 (0.391)	-0.407 (0.366)
Observations	116	116	102	104	103
R-Squared	0.231	0.143	0.469	0.090	0.107

Robust standard errors in parentheses: *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Includes larger reformers except Kazakhstan

4.2.   Estimates

We begin by investigating what motivates the decision to embark on reform itself, regardless of the eventual degree of reform, through the following Probit model:

$$Y_i^* = \beta_0 + \beta_1 INS_i + \beta_2 DEMO_i + \beta X_i + e_i$$

Y_i^* is the latent variable: $Y=1$ if country i has undergone social security system reform and $Y=0$ otherwise. *INS* is our constructed measure of historic instability indicating the number of times that country i has undergone a political regime change lasting at least 5 years since the inception of its traditional public pension system. *DEMO* is the projected proportion of country i's population aged 65 and older in the year 2025. *X* is a vector of controls for country i consisting of: Purchasing power-adjusted GDP; credit provided to the private sector as a percentage of GDP; and, a measure of historic democratic freedom.

The Probit estimates displayed in Column (1) in Table 5 demonstrate that, as expected, larger degrees of historic instability and greater demographic pressure statistically increase the probability of reform. In relative terms, an increase of one point in the index of historic instability has roughly the same impact as a two percentage point increase in the projected proportion of the population above 65; the *marginal* effect of the one-point instability index increase (not shown) is to increase the probability of reform by 5.4 percentage points, which represents a one-third increase from the base probability of 14.7 percent calculated at the mean of independent variables. The controls have the expected signs; countries with a larger pre-existing private sector capitalization have a lower propensity for reform, while countries with higher values of historic political freedoms are more likely to have the political conditions necessary for the public to express their preferences for reform. Interestingly, per-capita GDP is not statistically significant, thereby

suggesting that the other factors better explain the variation. The Probit model, though, while a useful first cut, does not give information about the motivation behind the *size* of reforms.

The Tobit estimator is useful for that purpose:

$$Y_i^* = \beta_0 + \beta_1 INS_i + \beta_2 DEMO_i + \beta X_i + e_i$$

Y_i^* is the latent dependent variable. For values of Yi^* above and below the censoring limits of 0 and 1, we observe Y_i which is the percentage of pension wealth derived from private account sources on a 0% to 100% scale, which describes the extent of reform in country i. The independent variables were described above. Column (2) of Table 5 reports the results.

The Tobit estimator shows that an increase in the instability index of one point is associated with an unconditional increase of 16.9 percentage points in pension wealth derived from private account sources. In contrast, the impact of a one percentage-point increase in the projected proportion of the population above 65 is 6.8 percentage points. Thus, the estimated effect of a one point increase in the instability index is roughly two and half times the effect of a one percentage point increase in demographic pressure.

Judging the *relative* impact of instability versus demographic pressure, though, is not possible based on these coefficients alone because the associated independent variables are not identically normalized. To explore further, the mean value of the instability index is 2.65 for reforming countries with a standard deviation of 1.71, while the mean value of the projected population above 65 is 15.26 with a standard deviation of 5.94. Assuming linearity in effects, our coefficients therefore suggest that a one standard deviation change in demographic pressures has an approximately 40.53% greater impact on the extent of reform (conditional on the reform occurring) than a one standard deviation change in the instability index. Still, even these numbers don't directly test the part of our theory arguing that larger

reforms are more likely caused by instability than demographics. These magnitudes are also consistent with simply having more countries with smaller reforms (motivated by demographics) in the data relative to countries with larger reforms (motivated by instability).

We, therefore, also report Tobit estimates over restricted ranges of our dependent variable, the size of reform.[22] Column (3) of Table 5 reports the Tobit results with only smaller reforming nations – those 13 countries in the bottom 50% of reform size -- included as reformers. The role of demographics for small reformers is now much greater than instability: a one standard deviation change in demographic pressures has a 117% greater impact on the extent of reform than a one standard deviation change in the instability index.

Column (4) of Table 5 reports the Tobit results with only *larger* reforming nations – those in the top 50% of reform size -- included. Now, as suspected, the importance of the roles is reversed: a one standard deviation change in the *instability* index has a 19% *greater* impact on the extent of reform than a one standard deviation change in demographic. However, neither statistic is significant at conventional levels (the *p* value for the instability index is 0.126). This insignificance appears to be largely driven by a single outlier with a large reform despite the presence only one major period of instability: Kazakhstan. In a rush to reform after the fall of communism, this country announced its private pension system plans before its public safety net. Hence, to be conservative, we coded Kazakhstan as a 100% reformer even though it has since announced a more traditional public safety net (although the details still remain sketchy). Column (5) of Table 5 shows the effect of dropping Kazakhstan: now instability is significant while the role of demographics remains insignificant for large reformers. Taken at their reported values, a one standard deviation

change in the instability index has a 99% greater impact on the extent of reform than a one standard deviation change in demographic.

4.3. *Robustness*

To check the robustness of our results, we first examine the effect of reducing the impact of potential outliers, which is potentially quite important in light of our small dataset. A standard way of examining the impact of outliers is with *median* regression analysis with iterative weighting. However, our median country is non-reforming (the dependent variable is 0%) and so weights cannot be accurately assigned; moreover, this procedure does not respect the censoring at 0%.

Instead, we examine the impact on the Tobit regression of simply dropping the top and bottom 10% of reforming countries. Comparison of Column (1) of Table 5 and Column (1) of Table 6 shows that the results are basically unchanged, although the importance of instability relative to demographics becomes a little larger.

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[22] A formal "quantile Tobit" estimator that has been recently developed does not solve for our dataset due to the significant amount of censoring, as most countries are non-reformers. The restricted estimators that we report, therefore, are not full information and are, therefore, not strictly comparable.

Table 6

Robustness Checks

Model	(1) Tobit: 10% Outliers Removed	(2) Cox Proportional Hazards[#]	(3) Tobit: Latin America 1	(4) Tobit: Latin America 2	(5) Tobit: Large Reforms and Latin America 2
Historic Instability	0.169** (0.074)	1.251** (0.139)	-0.150 (0.124)	-0.141 (0.125)	-0.237 (0.153)
Projected % Population 65+ in 2025	0.066** (0.027)		0.093*** (0.031)	0.118*** (0.038)	0.067** (0.032)
Annual Per Capita PPP GDP (1,000s)	-0.211 (0.027)	0.896** (0.043)	-0.014 (0.028)	-0.005 (0.029)	0.005 (0.021)
Historic Democracy	0.052* (0.030)		0.004 (0.033)	-0.009 (0.035)	-0.016 (0.029)
Domestic Private Sector Credit (%GDP)	-0.009* (0.005)	0.989 (0.007)	-0.009* (0.004)	-0.010* (0.005)	-0.006 (0.004)
Annual Life Expectancy		1.145*** (0.054)			
Latin America * Historic Instability			0.299* (0.163)	0.224 (0.156)	0.287 (0.177)
Latin America * Projected % Population 65+ in 2025			0.032 (0.047)	-0.129* (0.072)	-0.080 (0.060)
Latin America				2.198*** (0.817)	1.307* (0.670)
Constant	-1.301*** (0.406)		-1.282*** (0.416)	-1.833*** (0.587)	-0.697 (0.512)
Observations	111		116	116	104
R-Squared	0.220		0.236	0.298	0.338

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
#: Hazard ratios are reported.

We also estimate a Cox proportional hazard model with time-varying covariates:

$$H_{it} = \beta_0 + \beta_1 INS_{it} + \beta_2 DEMO_{it} + \beta X_{it} + e_i$$

H_{it} is the log of the hazard ratio, the probability of "failure" (reform) at time t for country i. Country i is modeled as "failing" in the year t at which that country undergoes pension reform; otherwise, country i is assumed to continue without failure until the year 2003, when our dataset ends. *INS* is the instability index of country i at time t, while *DEMO* is now the *life expectancy* in country i at time t; we are not able to include the share of the population that is projected to be above age 65 because a time series of *historical* population projections are not available. The only other control contained in X is the purchasing power GDP in country i at time t; our other covariates were not available over the relevant historical period.

An advantage of the Cox specification is its ability to include the actual timing of a reform. The key disadvantage is the required omission of many important control variables. Nonetheless, Column (2) of Table 6 shows that both instability and increases in life expectancy are associated with an increased hazard, or probability, of reform. In terms of relative effects, an increase in our instability index of one unit increases the risk of reform by the same amount as a 1.5 year increase in population life expectancy.

Finally, we test the importance of the "Latin America" effect. Brooks (2007) argues that peer effects are an important factor behind the adoption of pension reforms with other countries following Chile's pioneering reform. Under this view, reforms are transmitted between countries through formal and informal links, which are more pronounced among geographic and cultural peers.

Table 7

Demographic Pressure, Historic Instability and Degree of Reform

Country	Projected % Population 65+ in 2025	Historic Instability Index	Degree of Reform
Latin American Countries			
Nicaragua	5.5	2	100.00%
Bolivia	6.5	3	100.00%
Dominican Republic	7.3	3	83.81%
El Salvador	7.5	3	90.97%
Peru	8.5	4	62.33%
Columbia	9.3	2	32.51%
Ecuador	9.7	4	22.96%
Mexico	9.9	3	98.87%
Costa Rica	11	0	7.92%
Argentina	12.7	7	62.98%
Chile	14.3	5	96.25%
Uruguay	15.1	6	22.96%
Eastern European Countries			
Kazakhstan	11.4	1	100.00%
Russian Federation	17.6	2	26.71%
Slovakia	19.1	4	39.68%
Lithuania	19.6	2	25.99%
Estonia	19.7	1	55.65%
Poland	20.5	3	44.96%
Latvia	21.0	3	57.53%
Hungary	21.3	3	37.96%
Bulgaria	21.4	3	24.39%
Croatia	22.5	5	31.48%
Western Europe and Rest of World			
Australia	19	0	71.69%
Denmark	20.5	2	79.54%
Sweden	22.1	1	17.73%
Switzerland	23.8	0	62.87%

Of course, peer effects are not inconsistent with our model: similar to our "historic democracy" variable, peer effects potentially help enable voters to push for large reforms in the face of instability. Nonetheless, Table 7 reveals a striking pattern. The majority of reforming countries with severe demographic problems are located in Europe and the former

Eastern Europe, while countries with relatively young populations are mostly in Latin America. By contrast, no such strong pattern is present in the instability index. Significantly, it is largely those countries in Latin America with high instability and relatively young populations, who have undertaken the largest degrees of reform.

Column (3) of Table 6, present results from a modified Tobit model with the interaction terms "Latin America * Historic Instability" and "Latin America * Projected % Population 65+ in 2025." The coefficient for the Latin America instability interaction term is large and statistically significant at the 10% level while the Latin America population interaction term is not. (The previous control for Historic Instability now becomes insignificant and the "wrong" sign.) Hence, instability in "Latin America" is associated with reform whereas demographics in Latin America seem to play a smaller role.

Column (4) of Table 6 then adds a fixed-effects indicator for "Latin America" to allow for a different intercept for Latin America. Since there are just 14 non-Latin American reforming countries and 12 Latin American reformers, this additional control substantially slices the data. So, our empirical results, which should already be interpreted with some caution, become a bit more suspect. With that caveat in mind, we find a strong and highly significant pure "Latin American" intercept effect. This finding has an unclear interpretation with our theoretical model. One on hand, it is consistent with a "general revolution" in Latin America that is occurring independently of demographics, a conjecture consistent with our model. Indeed, notice that the coefficient on the interaction term "Latin America * Projected % Population 65+ in 2025" (significant at the 10% level) is now of the "wrong" sign, suggesting that demographics play very little (in fact, a negative) role in Latin American reforms. On the other hand, the strong "Latin American" intercept could reflect other fixed

factors in Latin America outside of our model. The coefficient on the interaction term "Latin America * Historic Instability" is of the "correct" sign but has a corresponding *p* value around 15.5, making it significant at the 16% level, outside of conventional levels.

For additional robustness, Column (5) of Table 6 shows a version of "Large Reformers" reported in Column (4) of Table 5 combined with "Latin America 2" reported in Column (4) of Table 6. The coefficient on the pure "Latin American" intercept is reduced in half (1.31) and is now barely significant at the 5% level. The interaction of "Latin America * Historic Instability" is now significant at the 10.7% level, just outside our normal threshold. The demographics interaction term is now insignificant (and still of the "wrong" sign).

5.   Conclusions

Fundamental reform of social security systems from traditional pay-as-you-go defined benefit systems toward defined-contribution accounts represents one of the most important fiscal policy changes worldwide during the past century. The motivation for reform has been previously unclear, especially since the traditional pension model is superior along several meaningful fronts. Even less clear is why these reforms have been larger in developing countries facing less severe demographic problems. We propose a simple model of "intergenerational trust" model that is consistent with these stylized facts. The model generates fundamental (large) reforms in the face of political instability that are largely not demographically driven. Smaller reforms, however, can also emerge, which are mostly driven by demographics. Empirical analysis is provided that seems to support the basic tenets of the model. However, we interpret our evidence with some caution. Ethnographic country case studies could provide useful complementary analysis in the future.

(Countries in Bold reformed their state pension systems as of 2003)

No Instability (0)	*Low (1)*	*Low-Moderate (2)*	*Moderate (3)*
Australia	Armenia	Albania	**Bolivia**
Bangladesh	Azerbaijan	Algeria	**Bulgaria**
Botswana	Bahrain	Austria	Burkina Faso
Canada	Belarus	Belgium	**Dominican Republic**
Costa Rica	Burundi	Benin	**El Salvador**
Haiti	Cameroon	Central African Rep.	France
Israel	Chad	**Colombia**	Greece
Jamaica	China	Congo	Guyana
Laos	Cote d'Ivoire	Cyprus	**Hungary**
Lebanon	Dem. Rep. Congo	**Denmark**	Iran
New Zealand	Egypt	Ethiopia	**Latvia**
Niger	Equatorial Guinea	Gabon	**Mexico**
Oman	**Estonia**	Germany	Panama
Saudi Arabia	Finland	Ghana	Philippines
Sierra Leone	Georgia	Guinea	**Poland**
Switzerland	Honduras	Italy	Venezuela
United Kingdom	Ireland	Kyrgyzstan	
United States	Japan	**Lithuania**	*High (4)*
Vietnam	Jordan	Madagascar	Czech Republic
Zimbabwe	**Kazakhstan**	Mali	**Ecuador**
	Kuwait	Morocco	Guatemala
	Mauritania	Netherlands	Paraguay
	Mauritius	**Nicaragua**	**Peru**
	Norway	Pakistan	Romania
	Portugal	Republic of Korea	**Slovakia**
	Moldova	**Russian Fed.**	Spain
	Senegal	Rwanda	
	South Africa	Sudan	*Very High (5+)*
	Sweden	Tunisia	Brazil
	Syria	Ukraine	**Chile**
	Thailand		**Croatia**
	Togo		Slovenia
	Trinidad and Tobago		Turkey
	Turkmenistan		**Uruguay**
	Uzbekistan		**Argentina**
	Yemen		

Appendix B: Modeling the share of pension payments attributable to the personal accounts

Some countries, like Chile, have replaced their entire pension system with private accounts, while other countries have chosen to retain significant elements of their existing public pension systems and use private accounts as a supplementary source of retirement income. We construct an actuarial model of the future share of pension payments that will be derived from the privatized portion of the social security system. This produces a scaled reform variable that ranges from 0 to 1, with 1 indicating that 100% of future pension payments in that country will come from private accounts. We model all countries with private account reforms in our dataset.

First, we collected the published rules of the private account system and the complementary public pension system after reform. These rules include the contribution rates to the private and public pension system, the retirement age, and the payout formulas used for the public pension system (Social Security Programs Throughout the World, Various Editions). Next, we obtain detailed data on the income distribution of the country, and life expectancy by gender (WDI World Development Indicators 2004). We use the income distribution data to construct country wages by income percentile, and then model contributions into a private account for a typical worker of a given income percentile. At retirement, the worker's private account, with compounded returns, is used to buy an annuity. The cost of the annuity is actuarially calculated based on the country-specific life table. The annual value of the annuity is the yearly income attributable to the private account component of the pension system. We add to this annuity the annual value of the payment provided by the public component of the pension system, as determined by the rules of the country's public pension system, to obtain the total annual income available to the worker at retirement. The percentage of this total value which is derived from the private account component is the scaled reform variable, which ranges from 0 for no reform to 1, representing 100% reforms with all retirement income derived from the

private accounts. Since contribution rates may differ by income by country, we perform this calculation at different income percentiles for each country, and obtain the average scaled reform percentage, which corresponds closely to the percentage of income derived from private accounts for the median wage earner.

A simplified structural representation of our modeling process is given by:

$$REFORMPCT_i = PRIVATEPENSION_i / [PRIVATEPENSION_i + GOVTPENSION_i]$$

Where:

$REFORMPCT_i$ = The percentage of retirement income from private account sources for a representative retiree in income percentile i (subsequently appropriately weighted to determine the average country-wide percentage of retirement income from private account sources)

$GOVTPENSION_i$ = Sum of annual country-specific government-administered, publicly financed transfer payments including specific old age welfare programs and minimum pension guarantees, to a representative retiree in income percentile i

$PRIVATEPENSION_i$ = Value of the annuity purchased with accumulated private account contributions by the representative retiree in income percentile i:

$$ANNUAL\ VALUE\ OF\ PRIVATE\ COMPONENT = \frac{\sum_{t=0}^{T}[(INCOMEX\%_t \times PRIVATE\tau)(1+R)^{T-t}]}{NPV\ of\ \$1\ ANNUITY}$$

where:

PRIVATEτ = Private account contribution tax rate

INCOMEX%$_t$ = Annual labor income at the Xth percentile of wages in period t

R = Real rate of return on private account funds, set to 3%

T = Labor Income Periods till Retirement Age (assuming working life begins at age 20)

Note that our modeling process differs by country due to structural differences such as the country's tax rates on retirement income (if any), contribution ceilings, floors, and caps,

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guaranteed minimum income plans, and the like. Two major pension system features and their modeling decisions are given below:

Redistributive Payments: Many countries explicitly include redistributive elements in their pension systems. These often take the form of a minimum pension guarantee or other old-age transfers. These transfers are financed by the government, and thus are excluded from calculations of the private system's share of overall pension payments, even when the transfer is paid out 'through' the private system. In general, redistributive elements will decrease the share of pensions attributable to the private system when the income distribution of the country is such that a large number of workers will likely qualify for redistributive payments.

Voluntary Participation / Switching Between Systems: Under some systems, workers have a choice of participating in the new system or old system, or even of switching between new and old systems at certain times. Generally, this choice of participation is limited by age group, so older workers have the ability to opt-in while younger workers generally must switch to the new system. For simplicity, for all reforms that include age-related opt-outs, we assume that the system is fully transitioned to younger workers when modeling private system payouts. However, for reforms that give workers the ability to continuously choose which system to participate in, we model the NPV of each system choice for a representative worker of that income group, and have the worker choose the system which offers them the higher NPV at that point in time.

The spreadsheets used in calculating each country's scaled reform variable are available from the authors.

Appendix C: Variable Definitions and Sources for Empirical Estimation (Section 4)

Variable	Description / Source
Instability	Based on the DURABLE variable from the Polity IV Project: Political Regime Characteristics and Transitions, 1800-2006 database. DURABLE is a country by year level observation that indicates the number of years since the last regime change in that country. *Instability* measures the number of times, since the creation of that country's public pension system, that DURABLE reaches 5. Thus, *Instability* is higher for countries with frequent regime changes.
WDI: Annual Per Capita PPP GDP in 1,000s (Inter/Expolated)	Based on NYGDPPCAPPPKD from the World Development Indicators 2005 database from the World Bank. Annual Per-Capital Purchasing Power Parity GDP, in $1,000s of dollars. Due to data continuity problems, data is interpolated and extrapolated when necessary to ensure a balanced panel for estimates.
WDI: Annual % Of Population 65+	Obtained from SPPOP65UPTOZS from the World Development Indicators 2005 database from the World Bank. Percentage of the country's total population in that year who are aged 65 years and older.
UN Projected Population 65+ in 2025, Percent of Total Population	Obtained from World Population Prospects, the 2004 Revision, Medium Variant. United Nations Population Division.
Historic Democracy	Based on the POLITY2 variable from the Polity IV Project database. POLITY2 is a country by year level observation that ranges from +10 (strongly democratic) to -10 (strongly autocratic). *Historic Democracy* is the average historical POLITY2 score for the period between the creation of that country's public pension system, and the year of reform or the year 2003, whichever comes first.
WDI: Domestic Credit to Private Sector, % of GDP	Based on FSASTPRVTGDZS from the World Development Indicators 2005 database from the World Bank. *Domestic Credit to Private Sector* refers to financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable that establish a claim for repayment. For some countries these claims include credit to public enterprises. *Domestic Credit to Private Sector* is divided by country's GDP and expressed as a multiple of GDP.
WDI: Annual Interpolated and Extrapolated Life Expectancy	Based on SPDYNLE00IN from the World Development Indicators 2005 database. SPDYNLE00IN is a country by year observation indicating that country's current life expectancy at birth. Due to data continuity problems, we interpolate and extrapolate this variable to form a continuous series.

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