

MANAGING PENSION PLAN IN AN AGING POPULATION -THE DYNAMIC PROFIT-SHARE PENSION MODEL

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Abstract

This study examined the profit-share pension model as a potential vehicle for generating capital accumulation and effecting a progressive redistribution of wealth. Taking the functions of the pension mechanism as the guiding principle, we attempted to incorporate a profit-share fund into a three-pillar pension system, eliminating the need for full funding from public resources. The general equilibrium model, with each agent solving a specific optimization problem, in which, on top of the full set of first order conditions for each problem, constraint conditions are imposed. Consideration of the equilibrium conditions gave us a complete system which conceivably, allowed us to solve the equilibrium paths for endogenous variables. The use of simulation techniques allowed us to accommodate a flexible and behaviorally realistic setting to examine the model's behavior over time and compare its level of consistency to that of the real existing systems. The use of sensitivity analysis additionally investigated the model's behavior in the presence of macroeconomic shocks by making changes to the model variables and observing their effects. The findings show profit-sharing has a positive impact on business and economic activity and also has a positive impact on pension activity.

Keywords: Profit-share pension, Crude Monte Carlo simulation, social security. JEL Classification: J20, C53, J32

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Introduction

Despite the heterogeneous redistribution design, the funding mechanism for both the pay-as-you-go and the fully-funded pension

schemes is based on inter-generation transfers (Barr, 2000; Cesaratto, 2003; Eatwell, 2003; Eisner, 1998; Sawyer, 2003). According to the proponents of the pay-as-you-go and the fully-funded schemes, the solution lies with fundamental factors of the scheme. The design of most funding mechanisms are based on the assumptions of sustained economic growth, full employment, low inflation and constant replacement rates. Subsequent literature argued that these suggestions are not viable in practice (Aaron, 1966; Diamond, 1977; Merton, 1983; Samuelson, 1958). The traditional supplementation and support from family contributions on top of the available retirement benefits, from both the public and the private sectors, are no longer dependable with the changing social trends and pressures of urban high cost of living. As a result, the fiscal burden of social security to maintain social harmony with a basic safety net, with the passage of time, will become substantial. Governments will be unable to stop this vicious circle of the chronic deficit, and the public and general pension schemes tend to be underfunded or the available funds for individuals tend to be too low for sustainable retirement. For schemes that are not fully funded, substantial structural changes will be needed to ensure sustainable retirement or the scheme will have to be moved to a fully-funded scheme, with the government bearing the funding mechanism.

The re-schematization of the funding mechanism will be the platform for the introduction of a new pension model which forms the direction of this study, one that does not draw from public funding. The aim of this study is to introduce a new pension branch of funding that ideally matches the employers' and employees' contributions with the pension benefits, minimizing at the same time its exposure to various microeconomic and macroeconomic risks. This study intends to assess the new funding scheme through profit-sharing by firms with their employees, using actual historical data to assess the behavior of the total fund for retirement under macroeconomic dynamism.

Literature Review on Profit-share Wage Factor in Retirement Funding

Profit-sharing is a performance mechanism that firms use to distribute part of their profits in the form of cash or kind to their employees, in addition to their prevailing labor income. Profit-sharing literature shows that profit-sharing can be a locomotive of efficiency and development for the firm. It promotes employee cooperation and

active participation, optimizes employee performance, abridges absenteeism, minimizes labor turnover, reduces labor and training costs and provides financial and retirement security (Azfar & Danninger, 2001; Bental & Demougin, 2006; Blasi, Freeman, Mackin, & Kruse, 2008; Brouwer, 2005; Bryson & Freeman, 2008; Carstensen, Gerlach, & Hubler, 1995; Conyon & Freeman, 2004; Doucouliagos, 1995; FitzRoy & Kraft, 1987; Freeman, 2008; Gielen, 2007; Hashimoto, 1975; 1979; Huselid, 1995; Jerger & Michaelis, 1999; Kraft & Ugarkovic, 2005; OECD, 1995; Parent, 2004; Weitzman, 1983, 1985, 1986, 1987, 1995, 1990). The study aims to look into the transfer of the positive impact of the profit-sharing concept from business and economic activity to individuals' pension funds, the other segment of the pension chain.

The estimation of the profit-share wage factor comprises the first contribution of this study. The insertion of the profit-share factor in the household's lifetime utility function as part of the individual's total wealth enhances the household's earnings and savings, offers the household an additional source of income, albeit as a retirement income. Apart from employee contributions, the direct total wage cost for the firm will be the sum of the wage plus the operating profit-share. The wage reflects the prevailing wage. The permanent character of the profit-sharing factor also portrays an additional source of funding for pension systems. When the firm exhibits zero or negative profits, the employee receives only the basic wage. The incentive therefore, is there for the employee to generate profits for the firm.

The profit-share factor is estimated as a percentage of the firm's gross profit. The base wage emerges as the prevailing wage across hierarchical levels. The periodic increase of the basic wage is based on standardized criteria, such as education, experience, knowledge, skills and abilities needed to perform the job. Basic wage is considered a fixed cost for the firm. Variable wage reflects the accumulated years of service acquired within the same position and is a variable cost to the firm. The firm distributes a defined portion of its pre-tax operating profits among the employees, who in turn, pay variable contributions to the pension fund. Promotion to higher levels is associated with base wage and variable wage increase. The variable wage increase is set by a percentage from the profit-share pool.

As mentioned previously, there is a growing body of empirical research oriented to micro-level benefits of profit-sharing. Several theories were consequently developed to investigate the capital-utilization decisions of labor-managed business models (Betancourt

& Clague, 1977; Jensen & Meckling, 1979; Meade, 1972; Vanek, 1970; Weitzman, 1983, 1985). However, the current literature focuses on the impact of profit-sharing on business performance rather than on the actual estimation of profit-sharing for retirement planning. This study identifies this literature gap and the estimation of the profit-share factor for retirement planning, and attempts to cover it.

Methodology

The theoretical framework was based on Diamond's (1965) overlapping generations model with the behavior of various agents interacting with each other. The numerical computation of the consumption and saving required the estimation of the function of exogenous parameters. In doing so, this study employed econometric methods (calibration) based on time series data as well as exogenous estimates taken from literature. The calculation of the exogenous parameters provide a statistical basis for the reduced-form model, a state-space model with cross-coefficient restrictions. The consumption and saving parameters are assumed to be unchanging over time. Once the consumption and saving parameters were estimated, the next step was to examine whether the initial model was exactly identified by the reduced-form system. Our proposed procedure for determining identification involved the crude Monte Carlo simulation and sensitivity analysis. The Monte Carlo methods associate probabilistic and deterministic mechanisms to portray the model's behavior over time. This study used the linear approximation technique (logarithms) to transform the nonlinear state-space model in a linear form followed by the integration techniques (Trapezoidal Rule) to describe the logarithmic functions in terms of probability distribution functions. The crude Monte Carlo method uses the simple mean average for the integration of the consumptions and saving functions over time. The simulation consists of a series of iterations based on random uniformly generated parameters that produce an overall figure for the most likely potential values as well as the statistical distribution.

Study analysis with a detailed profit-share model requires two simulations. The first simulation is the baseline forecast or business-as-usual simulation. In this deterministic phase, each state variable is determined by the *a priori* state of the exogenous model parameters. Therefore, the profit-share model performs the same way for a given

set of initial conditions in the absence of any change in the micro and/or macro level environments. The second simulation is the policy simulation. In this simulation state parameters are described by probability distributions. This simulation generates a second forecast that incorporates all the exogenous features of the baseline forecast, and now includes the policy-related shocks reflecting the details of the policy under consideration.

The majority of the secondary data was taken from the congressional budget office. The US Congressional Budget Office (CBO) has developed an alternative stochastic projection model for the US social security system. Based on a 50-year period (1954-2005), the estimated distribution of the projected data available on an annual basis were carried out. The rest of the data was taken from several sources. The Elasticity of Inter-temporal Substitution (EIS) was given by Havranek, Horvath, Irsova, and Marek (2013). The depreciation rate was estimated by Kamps (2006), and the real rate of return to capital was estimated based on the analysis of Du, Muysken and Sleijpen (2010). The labor growth rate was estimated by Lee and Mather (2008) using data from the United States Bureau for Economic Analysis. Finally, the profit-share coefficient, wage share and profit-share weight coefficients, the profit-share coefficient, and labor costs in the percentage of government expenditures were estimated with the use of secondary data from the United States Census Bureau and the Social Security Administration of the United States.

Results and Discussion

Our aim was to conduct a comparative sensitivity analysis between the profit-share model and a model without pension, a Pay-As-You-Go (PAYGO) pension model and a Fully-funded (FF) pension model. In a simple life cycle, the absence of social security implies that the wealth in the old period is zero, which correspondingly affects household savings. The introduction of a FF pension system increases wealth, assets and savings at the rate r^k . The presence of PAYGO similarly increases wealth, assets and savings at the rate n . The following table features the diverse findings of consumptions and savings functions of no pension, PAYGO, and the FF pension model, respectively. Following the baseline simulation procedure, this study proceeded to the numerical estimation of the system functions. The values of consumptions and savings functions are presented in Table 1 below:

Table 1

Numerical Results of Consumptions and Saving

	Pension premium	Young-period savings	Young-period consumption	Old-period consumption
No pension	0	0.136	1.008	0.364
FF pension model	0.012	0.135	0.996	0.620
PAYGO pension model	0.0256	0.130	0.998	0.611

Source: Authors' elaboration

Given the equilibrium values from the benchmark scenario, this study normalized consumption and savings functions by dividing with wage, expressing them in proportions of wage (see Table 2).

Table 2

Numerical Results in Terms of Wage

	Pension premium	Young-period savings	Young-period consumption	Old-period consumption
No pension	0	0.119	0.881	0.318
FF pension model	0.012	0.119	0.881	0.548
PAYGO pension model	0.0256	0.119	0.881	0.545

Source: Authors' elaboration

The indicated values of the formal pension models follow a consistent pattern logically entailed by the conceptual framework premises. It is a plausible conjecture that the modified model comparison captures the essence of social security: in individual account setting, regardless of what pension model is applied, the level of young saving and young consumption remain fairly steady over time, while old consumption differs substantially. *Ceteris paribus*, the contribution rates under fully-funded and pay-as-you-go systems are not practically the same. Pension systems with identical expenditures, contribution rates in a pay-as-you-go system need to be higher than in a fully-funded system due to the absence of a compensatory mechanism (Oksasen, 2001).

This study presented the results of the indicated pension model-based simulations aimed at assessing the impact of inflationary pressures

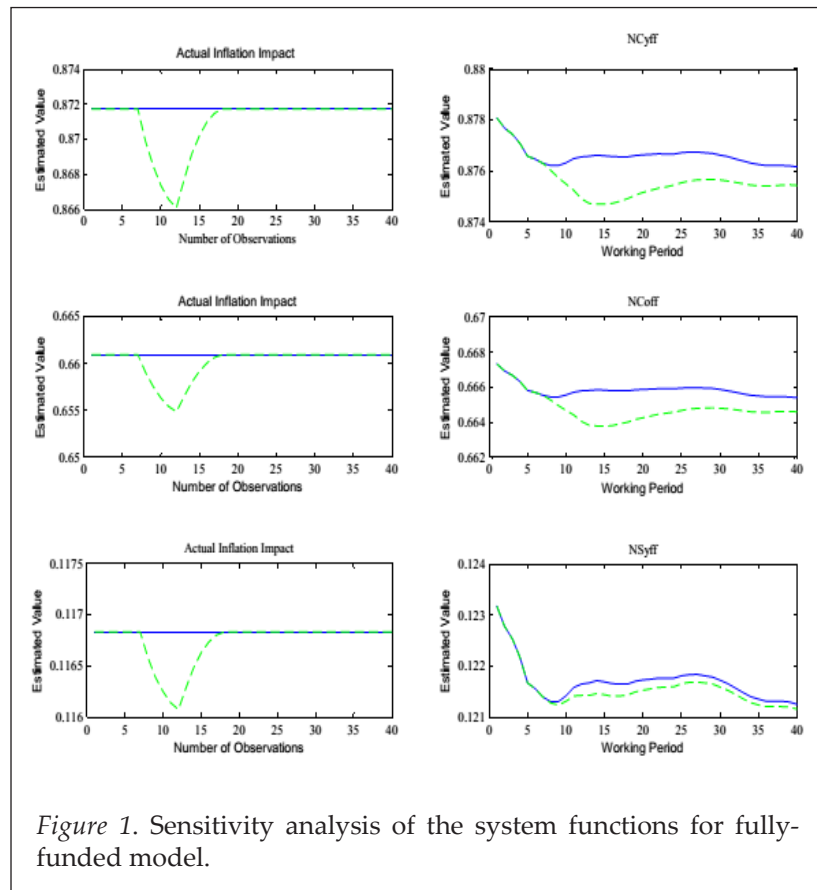
on our economy. It should be noted that pension benefits were not indexed to inflation. This study considered an unexpected increase in inflation of 5 percent, from its initial level of 3.9 percent, while expected inflation gradually adjusted to 3.9 percent the following period. The following graphs summarize the pension models used for the sensitivity analysis and highlight the impact of inflation on model parameters.

Changes in the anticipated rate of inflation had no effect on pension premium, disposable income, life consumption and savings in the long run. Central bank adjusted the nominal interest rates in response to inflation and the output gap. The coefficient of inflation expectations equalled unity, which held real interest rates constant. An unexpected change of inflation alternatively led to a higher steady state that asymmetrically affected almost all the variables in the model. The presence of a temporary inflation episode inherently presupposed stable discount interest rates, bounding the shock effect on debt and equity real returns. The policy functions of the pensionless model remained intact. The pay-as-you-go model also did not respond to inflationary pressures because the system was based on direct intra-generational transfers. With regards to the fully-funded and profit-share systems, inflation had a positive impact on pension premiums, thereby lowering real wage. Unanticipated inflation generated an increased variance of the expected real income that did not asymmetrically affect household behavior. Life consumption and savings remained smooth over time; intertemporal household preferences followed the cyclicity of inflation dynamics.

Figure 1 illustrates the impact of the inflation episode on the policy functions of the fully-funded model. The left panels show the actual impact of the inflation shock on the model state parameters. The right panels depict the expected evolution of life consumption and savings and their components over household's life cycle. The blue line represents the state of equilibrium for each of the indicated functions, whereas the green dotted line shows the inflation adjusted path. Consistent with our initial assumptions, this study considered an individual that worked for 40 years who entered the work force at the age of 25 and retired at the age of 65.

As shown in the left panels, the magnitude of the inflation response is negative in the first 12 periods. The fully-funded policy functions exhibit downward concave trajectories, which correspond to the rate of change of their first and second derivatives, and decrease

at a decreasing rate (the first and second function derivatives are negative). Young consumption (NCyff), old consumption (NCoff) and saving (NSyff) functions reach their minimum positive displacements from the path equilibrium at 0.8661, 0.6549, and 0.1161, respectively. The global minimum points are also considered inflection points: the second derivatives of the policy functions in the global minimum point are zero, whereas the curvature of the adjusted paths switch signs from being negative to positive. The gradual expiration of the deflationary process will contribute towards state recovery, reaching eventually the equilibrium path in the 17th period.



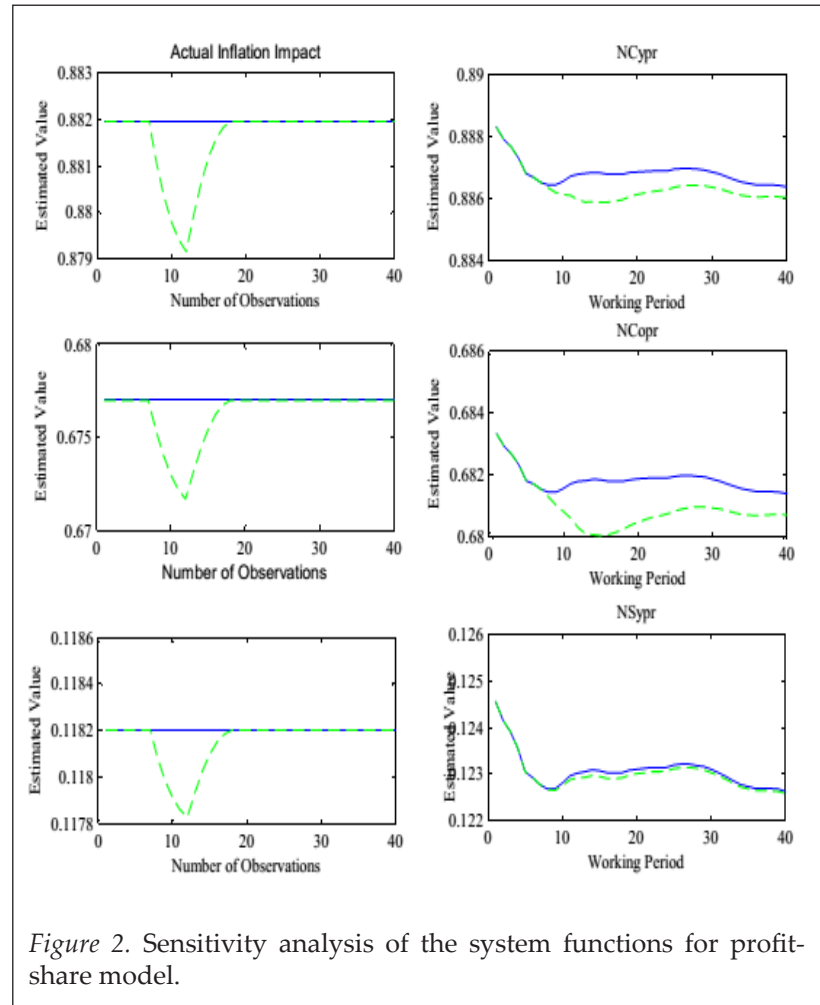
Source: Authors' elaboration

Higher prices correspond to episodes of unexpected inflationary pressures. This rise reduces the real value of disposable income and

household net worth, since the nominal values of these variables are unaffected. Price increment will reduce real consumption expenditure. The right panels show the persistence of inflation measured by the impulse response function, which shows how quickly the effect of a shock to inflation vanishes. An increase of 28 percent inflation-induced redistribution leads to a negative consumption of the young cohorts from 0.8781 to 0.8762, an approximate decrease of 0.22 percent. Old consumption correspondingly decreased by 0.93 percent, from 0.661 to 0.6549. Nominal consumption expenditure is likely to rise initially, because consumers will adjust real purchases slowly to their reduced real incomes and net worth. Thus, nominal savings drop from 0.1232 to 0.1212 (1.62 percent). A temporary inflation episode does not alter consumer behavior; however, it does affect the average disposable income, and consequently, the average consumption and savings functions.

Figure 2 shows the household consumption and savings functions under the profit-share model following an analogous behavior pattern. In the case of non-indexation of the profit-share model, inflation rate will affect all variables in the model. The magnitude of the inflation episode though is partially offset by debt and equity premiums. Young consumption (NCypr), old consumption (NCopr) and savings (NSypr) functions declined 0.32, 0.78 and 0.34 percent, respectively. The inflation episode affects debt real values much more than equity real values. The inflation episode diminishes the real value of the coupon stream due to the fixed character of the coupon rate. The nominal value of the stock dividend stream, in contrast, rises in response to inflation shock, leaving the real value of the dividend stream fairly stable. The findings are consistent with Winklevoss' (1977) findings. He estimated that a 5 percent increase of wage and interest rates would reduce the present value of pension benefits by 13 percent. Since earnings are not generally indexed for inflation, benefits at retirement decline in real value with inflation unless an inflation adjustment is made. During retirement, indexation of benefits are generally far from complete.

The above pension system comparison shows that both pension models are qualitatively consistent with the negative impact of inflation, although not significantly different in value terms. Young consumption exhibits a similar percentage decrease, old consumption decreases unambiguously and the same applies to savings functions. However, inflation can distort old consumption behavior, but pension fund diversification of the profit-share fund partly offsets inflationary pressures. The capital gains minimize the inflation impact on savings.



Source: Authors' elaboration

Figure 3 shows the macroeconomic results of sovereign default in changes from the baseline for the profit-share model. The simulation process assumes that profit-share fund rebalances its portfolios by matching the duration of portfolios with that of the investment horizon of future liability, resulting in the purchase of debt securities at lower prices with given interest rates. Furthermore, people follow homogeneous and consistent time-varying preferences throughout their lives: pension contributions, income earnings, and time of

retirement are the same for all under the no-crash scenario. Debt market crisis affects only the pension sub-funds that holds fixed income assets. This study ignored the side effects caused by the debt market crisis in the stock and housing markets as well as their implications on employment, earnings, or employer-sponsored pension benefits.

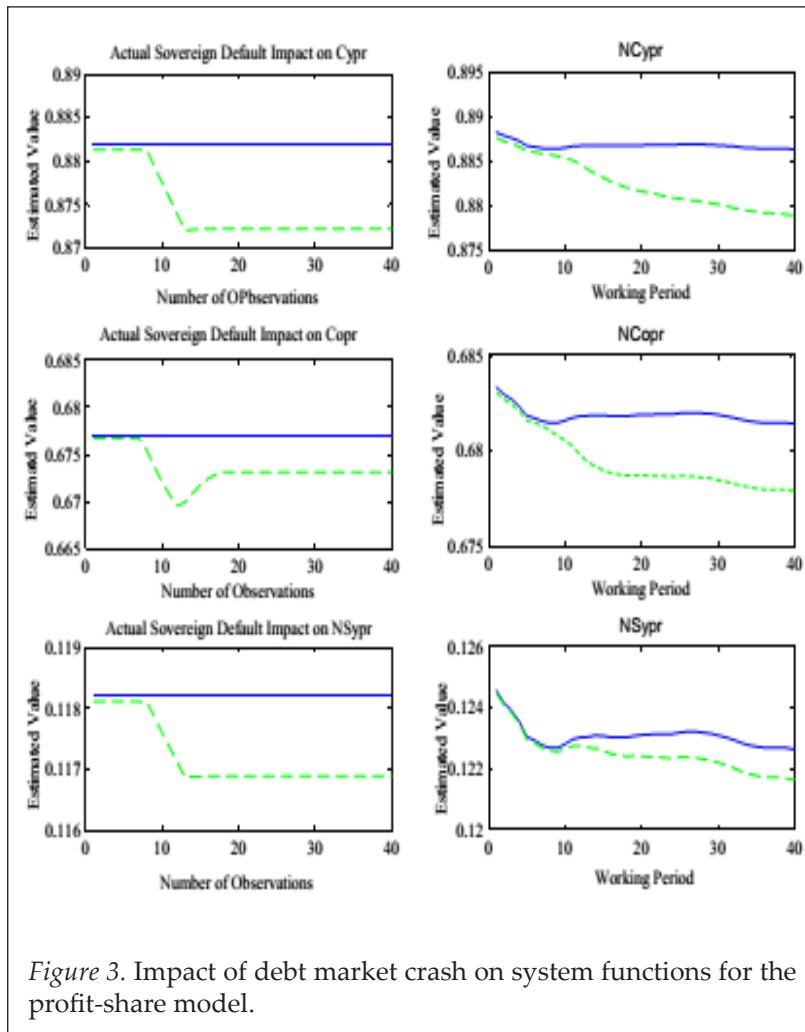


Figure 3. Impact of debt market crash on system functions for the profit-share model.

Source: Authors' elaboration

This study investigated the negative implications of such a fall in the profit-share model and considered a sovereign default event where the government pays back only 70 percent of its outstanding debt. The profit-share fund will experience a wealth loss of 30 percent (our model is denominated in real terms, so higher values will derive negative results). As shown in the left panels, the imposed losses in the profit-share pension wealth cause a permanent downward shift in household utility. Our findings are consistent with those of the life-cycle hypothesis and the permanent-income hypothesis. Households tend to smooth consumption through time by savings during periods of high income and by dis-savings during periods of low income. Consumption as well as savings during the young period exhibit a downward adjustment, following the same behavioral pattern. Unanticipated income changes affect the marginal utility of consumption at the time it occurs because consumers would have not incorporated the expectation of the income decline in their optimal consumption plan when the information first becomes known. Lower level of savings indicates the desire of young households to maintain a certain level of consumption.

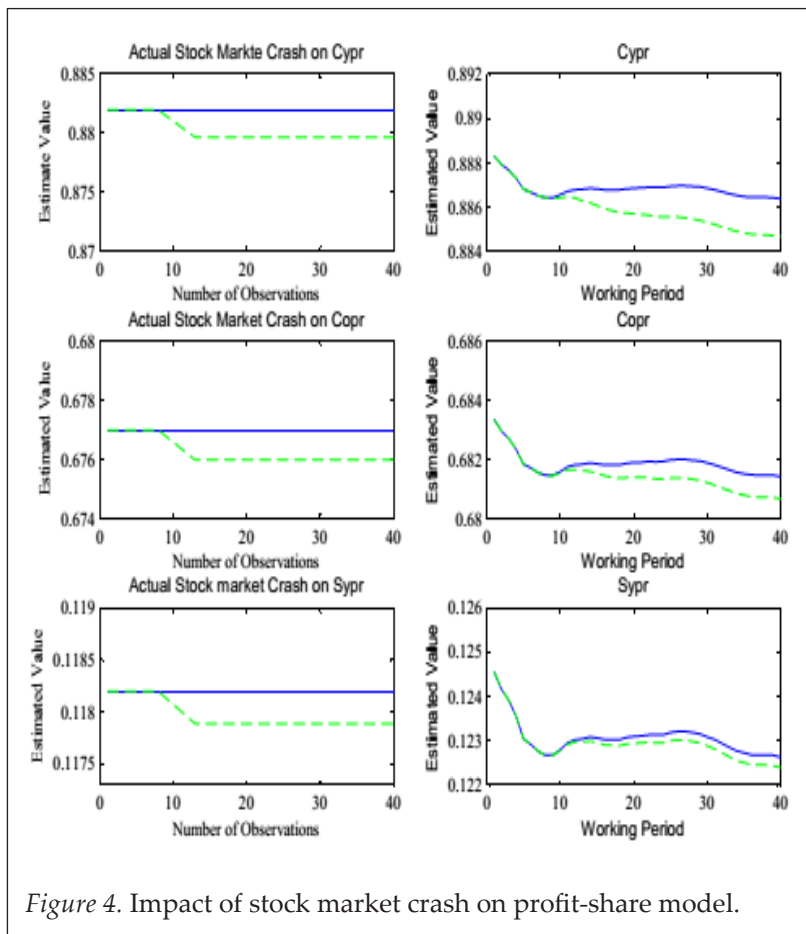
Old consumption accordingly is expected to shift down and maintain the desired intertemporal allocation of consumption. This reduction is attributable to uncertainties regarding health, life expectancy, and ability to maintain household independence. However, the determinants of old consumption differentiate consumption patterns between short and long run. An unanticipated decline in disposable income viewed as permanent results in a sharp temporary fall, reaching its highest peak in the 12th period, and in contrast to young consumption, it bounces back reaching a new equilibrium level. Empirical findings plausibly confirm our findings that despite the fact that older households exhibiting a lower consumption bundle, they spend more of their incomes on basic needs than do younger households (Abdel-Ghany & Sharpe, 1997).

The profit-share fund's diversified state absorbs the impact of the sharp decline of interest rates. Existing literature emphasizes the adverse movement of debt and capital markets. Normally when bond yields rise, stock markets rise as well and vice versa. This is the result of selling pressure on the lower risk, lower return potential bonds in favor of equities, which drives down bond values. This reduced value increases the relative yield their fixed coupons payments constitute *vs* the market value of the bond. As a result, the overall impact of the macro shock is substantially lower, with consumptions and savings

functions experiencing a decline of 9 percent on average. A potential increase of capital markets can offset bond portfolio losses.

This study also investigated the negative implications of such a fall in the profit-share model (see Figure 4) due to stock market collapse. This study followed the same restrictions and assumptions for the stock market crash simulation as this study did with the sovereign default scenario.

Consumption and savings functions exhibit similar behavioral patterns with those of the sovereign default scenario. Old consumption though, does not follow a correction path, which reveals the



Source: Authors' elaboration

level of elasticity of the profit-share household income. The substitution effect is stronger in this case; households respond significantly to macroeconomic changes since profit-share income meets additional consumption needs. Certain empirical findings on life-cycle consumption suggests that stock market fluctuations affect marginal propensity to consume (Garner, 1988; Starr-McCluer, 1998). A sharp decline in the stock market will determine the level of the retirement income until the stock market recovers some or all of its losses (Butrica, Smith, & Toder, 2009). Households want to retain their lifetime net worth and absorb the loss of their disposable income by rearranging their intertemporal consumption patterns. These streaming rearrangements set a new equilibrium, where households try to optimize their lifetime consumption by ensuring a proper balance of spending and savings. As in the case of the sovereign default, asset diversification absorbs to a great extent the capital losses suffered from the stock market financial distress. Capital losses can be offset as long as stock market fall is equal to debt market gains.

The profit-share pension fund is profoundly affected by macroeconomic shocks given the long term fund's investment horizon. This study thereupon examined the fund's performance, assuming a lower return for stocks over the long term, which was translated to a lower equity premium. Equity returns empirically follow a lognormal distribution (Osborne, 1959), so the rate neither falls below zero nor reflects off a barrier at zero (Black & Karasinski, 1991). Besides, when the continuously compounded equity returns are normally distributed, the equity prices are lognormal distributed (DeFusco, McLeavey, Pinto, & Runkle, 2007). This study generated a lognormal sample and calculated the expected development for the expected equity real return of 6.8 percent with a standard deviation equal to 0.0136 (± 20 percent) and 0.0272 (± 40 percent). Figure 5 shows the steady state path and the two expected developments of the equity return; consumption of young, consumption of old and savings during the forty-year period.

We also examined the long-run persistence of the equity return volatility on consumption and savings functions. The blue line represents the state of equilibrium for each of the indicated functions, whereas the black dotted lines show the policy function volatility. The target rate, mean reversion and local volatility vary deterministically through time from the baseline for two shock scenarios (see Figure 5).

Personal income, wealth, assets, consumption and saving are all reduced modestly and proportionately to the size of the premium

increases. The presence of a higher volatility plausibly indicates the tendency to generate high-frequency values, as depicted in the equity return graph. The dispersion around the mean of the baseline state values demonstrates an equivalent behavior pattern under both underlying scenarios. Notwithstanding, a closer look at the state values reveals diverse gradients in volatility. Consumption and savings of the young absorb pension wealth loss in an equivalent proportion. The synchronized movement of young consumption and savings indicate the desire of young households to maintain their wealth, since profit-share income meets additional consumption needs. The magnitude of return volatility on the old consumption alternatively is higher. Consumption is proportional to total wealth. Total wealth is the sum of the financial wealth and the human capital. Financially this wealth is the savings and contributions accumulated in the previous periods, and equity return has a partial effect on both. Asset diversification partially offsets that volatility, both on the upside and downside, thus producing a more stable return pattern.

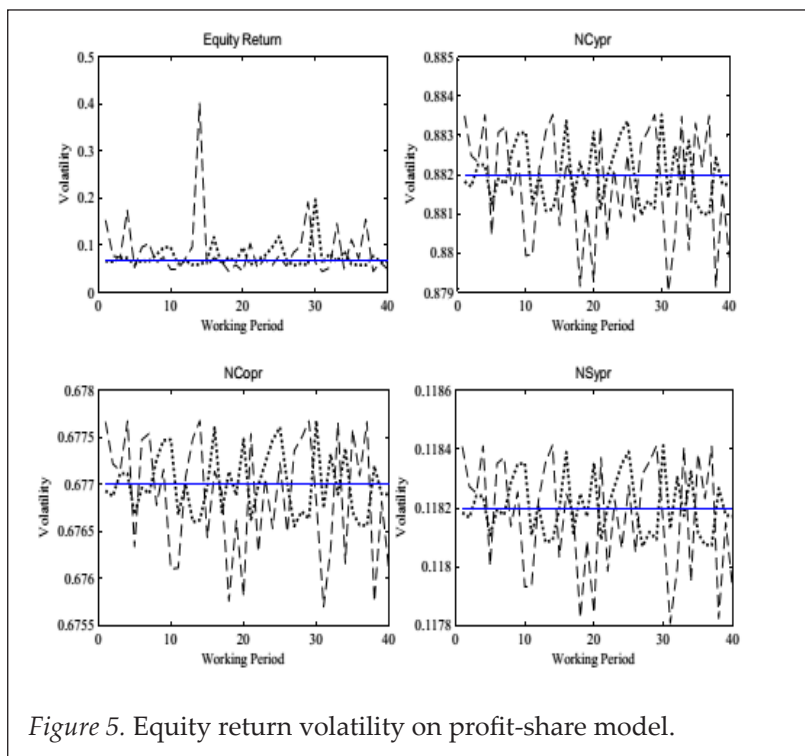


Figure 5. Equity return volatility on profit-share model.

Source: Authors' elaboration

Conclusions

Our findings in the capital dynamic analysis are consistent with Samuelson (1975) and Feldstein (1985) who suggest that the pension system in place has major implications for capital formation. The twofold pension system exhibits level and growth effect in capital. The basic-wage pension affects savings positively, which in turn, affects the level of the steady-state, but the impact of the level effect is not sufficient to surpass the effective labor rate in the long run due to diminishing returns of capital. The presence of the operating-profit-share pension as an additional source of income will proportionately increase individual consumption as well as savings in the long run. The permanent increase of savings will lead to investment of new capital, setting factors of production to a new level and thus affecting the steady-state growth rate.

Compared to the pay-as-you-go and the fully funded system, capital is always higher under a profit-share system due to the crowding out induced under the pay-as-you-go system and the level effect from the presence of the profit component. By extending the model to a general equilibrium framework, this study was able to show that a profit-share model yields higher than the traditional counterparts. This study also found that in so far as an economy is dynamically efficient, a profit-share system is optimal for consumption smoothing purposes. The diversified investment structure of the model may not approach a dynamic inefficiency, that is, a potential of over-accumulation of capital. The presence of a profit-share system will ensure the economy remains dynamically efficient. These findings will require to be justified in that it only holds for a small range of parameter values when the economy is approaching dynamic inefficiency.

The aforementioned findings provide insightful connotations for developing countries which are experiencing demographic dynamics such as Malaysia. The Malaysian population is tending toward becoming an ageing population with older people steadily growing in percentage on an annual basis since 1970 (Ismail, Abdul Rahman, & Tengku Abdul Hamid, 2015; Karim, 1997; Tengku Abdul Hamid, 2015). According to the Malaysian Department of Statistics, the population who is 60 or older is expected to grow at 7.1 percent, higher than before and also that of other age groups, in 2021 and beyond (Department of Statistics Malaysia, 2015). An aging population will affect everything from the economy and labor markets to health

and social care. This profit-share model intends to improve income redistribution in conjunction with the state's "invisible hand" which brings balance, social sustainability and personal responsibility. The objective of the profit-share model is the preservation of desirable living standards for the present and future generations.

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