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DEPARTMENT OF ECONOMICS WORKING PAPER SERIES

**Introducing Demographic Changes  
in a Model of Economic Growth and Income Distribution**

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Working Paper No: 2009-01

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## **Introducing Demographic Changes in a Model of Economic Growth and Income Distribution**

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### **Abstract**

Unprecedented demographic changes are set to unfold in most of the industrialized world. They are relevant not only because of the diminishing pool of workers, but also because of the increasing importance of retirees as an economic class. Retirees' consumption and saving patterns can differ considerably from those of wage earners and capitalists, as retirees tend to consume more services and save less or in fact dissave. From this perspective of changing aggregate consumption and saving patterns I argue that population aging together with existing constraints to growth and the institutional framework in place leads to a reconfiguration of income distribution and therefore to possible changes in the growth rate of the economy. Understanding how future income distribution may look like and the behavior of different economic classes, helps in designing the right policies to accommodate the demographic transition.

**Keywords:** population aging, income distribution and growth, Keynesian macroeconomics

**JEL Classification:** E12, E24, E60

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## **1. Introduction:**

The unprecedented demographic changes that are set to unfold in most of the industrialized world are interesting not only because of the diminishing pool of workers (either in absolute terms or relative to the non-working population) but also because of the rising importance of an economic class, the retirees, who are expected to behave differently in economic terms. Specifically, their consumption and saving patterns can be considerably distinct from those of wage earners or capitalists. Retirees tend to consume more services and save less or in fact dissave (Luhrman 2008). From this perspective of changing aggregate consumption and saving patterns I argue that population aging together with the existing constraints to growth and the institutional framework leads to a reconfiguration of income distribution and therefore to possible changes in the growth rate of the economy. In addition, demographic changes and the pension system in place have an impact on the stock of wealth and its distribution among different classes which amplifies the cumulative effects that aging is expected to have upon the economy.<sup>1</sup>

Besides this short introduction, the present paper begins with a section on demographic trends and some simple counterfactuals on growth and distribution based on very broad assumptions for few selected countries. The third section sketches a Kaldor-Keynesian model of growth that can be effectively used to show how demographic changes impact upon economic activity and income distribution over the business cycles. Next, the focus is on policies. The goal is to discuss how policies that address increasing dependency rates in the US and Japan may affect economic activity.

## **2. Economic consequences of population aging: What are the questions we should ask?**

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<sup>1</sup> Michl and Foley (2004) build a classical model with an elastic labor supply that captures some of the wealth effects on economic growth and income distribution when demographic changes take place.

For the last few decades most of the developed countries have been undergoing rapid demographic changes towards lower fertility rates and increased life expectancy. As a result significant population aging is underway. For economists and policy-makers alike the concern with population aging has to do with the fact that a relatively smaller pool of working age population has to provide the means of living for a larger number of retirees. The discussion in the literature often starts with a look at trends in the old-age dependency rate defined as a ratio between non-working elderly and the working-age population.

### **Table 1**

Table 1 presents forecasts of this ratio as well as total dependency rates for few selected countries. The most dramatic aging trends are expected for Japan where by 2050 for every three working age persons there will be two persons over the age of 65. In the case of Japan the increase in the old-age dependency rates is not being compensated by a sufficient decline in young-age dependency rates (also computed as a ratio, this time between population of 0-14 years of age and working age population) and as a result total dependency rates are expected to approach one. Among the selected developed countries the US is least affected by population aging due to higher rates of immigration and fertility rates which remain robust compared to most OECD countries.

Taking account of the above demographic trends two questions come to mind. The first concerns the ability of the economy to provide for a rising share of older, non-working population. The second is about the implications of population aging for economic growth. These two questions are nevertheless connected by the simple fact that securing an income for the elderly has an impact upon income distribution, aggregate demand and therefore on the growth rate of the economy. Although important, these linkages among population aging, growth and distribution remain largely ignored by most of the economic literature. Instead, the prevalent belief is that an economy is always labor supply constrained and investment is driven by available savings. As a result, policies focus almost entirely on ways to boost savings as a mean to stimulate capital accumulation and economic growth. A closer look at the economic conditions in selected countries suggests that in several cases the real challenge posed by rising dependency rates has

more to do with how to distribute the output rather than how to overcome labor supply shortages or saving constraints.

It is true however that regardless of the way economists approach the aging issue, economic growth sustainability becomes a prerequisite in dealing successfully with rising old-age dependency rates. In the words of the former Federal Reserves' Chairman, Alan Greenspan "The real resources available to fund pension benefits depend on the economy's long-term growth rate, which in its simplest terms is determined by the growth rate of labor employed plus the growth rate of the productivity of that labor"(Greenspan, 2003). Since the growth rate of labor supply is predicted to decline during the next few decades what policy-makers are left to tinker with is labor productivity growth. A rise in productivity translates into an increase in the number of *effective workers* (Palley 1998). In simple terms let real output,  $X$ , be given by:

$$X = \varepsilon_L L \quad (2.1)$$

Where  $L$  is the amount of labor, and  $\varepsilon_L$  is labor productivity or output per worker. In growth rates, relation (2.1) becomes:

$$\hat{X} = (\hat{\varepsilon}_L + \hat{L}) \quad (2.2)$$

(2.2) redelivers the message stated above that output growth can come from either an increase in productivity or in the labor inputs. Subtracting the rate of growth of population from both sides of equation (2.2) we obtain:

$$\hat{X} - \hat{P} = (\hat{\varepsilon}_L + \hat{L}) - \hat{P} \quad (2.3)$$

Based on the decomposition in equation (2.3) one can simulate the required productivity growth necessary to sustain an annual GDP per capita growth of 2 per cent. Results are presented in table 2.

### **Table 2**

In a historical perspective a labor productivity growth in the range of 2-2.5% in developed economies is certainly attainable, however, maintaining such growth on an annual basis over several decades is not a trivial task either (see World Economic and Social Survey 2007). The numbers in table 2 also point out that labor supply constraints may be less significant than we are

told by most of the literature. This is certainly the case for the US where, as already mentioned, immigration and higher fertility rates ease some of the labor supply shortages. Arguments supporting the assumption that the economy is below its full capacity can be brought forward also for Germany and Italy where higher unemployment rates -- in the range of 8 to 11 per cent for the recent period -- and low participation rates especially among those 50 and older point to little or no labor supply constraints for now. Japan on the other hand is more likely to reach (if it hasn't done so already) its full capacity due to labor supply limits.

Next, we turn our attention to distributive issues. The focus here is on the pay-as-you-go system where pensions come directly from contributions made by the working population<sup>2</sup>. The wage earned at time  $t$  provides for the consumption by both workers,  $C_w$  and retirees,  $C_R$  according to:

$$C_w + C_R = \psi X \quad (2.4)$$

where  $\psi = 1 - \pi$  is the wage share and  $\pi$  stands for the profit share. Total consumption by pensioners is obtained by multiplying their total number,  $R$ , with the individual pensions or benefits,  $q$  according to  $C_R = Rq$ . The assumption is that retirees consume all the income they receive or  $c_R = q$ . Differentiating (2.4) in respect to time and using relation (2.2) above we further obtain that:

$$\lambda(\hat{L} + \hat{c}_w) + (1 - \lambda)(\hat{R} + \hat{q}) = (\hat{L} + \hat{\varepsilon}_L) + \hat{\psi} \quad (2.5)$$

where  $\lambda$  is the wage-earners' share of consumption in total consumption and a hat over a variable signifies its growth rate. In the event that the number of retirees goes up relative to the working age population several policy scenarios are available based on the decomposition in (2.5):

- a) Growth rate of consumption by the working-age population decreases or in fiscal terms the taxes on wages goes up.
- b) Labor force  $\hat{L}$  grows faster
- c) Labor productivity  $\hat{\varepsilon}_L$  increases

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<sup>2</sup> It can be shown that a fully-funded or a combination of fully-funded and pay-as-you-go produce similar results.

- d) Distributive shifts towards wages as captured by a higher wage share on the right hand side of equation (2.5) or  $\hat{\psi} > 0$ .

Option (a) is unsustainable in the long-run and may have immediate negative effects on economic growth. Option (d) depends on institutional factors and as we will see in the next section, it could end up discouraging growth if economic activity is profit-led. Options (b) and (c) are preferred and macroeconomic policy should focus on boosting labor force and/or labor productivity.

A more detailed analysis of (2.5) provides further insights into policy alternatives. Together with a set of broad assumptions to be described shortly, (2.5) can be used to calculate the gap between the surplus from the wage bill after deducting the consumption by workers, and expected amount of resources necessary to finance elderly consumption.

The exercise is conducted only for the United States for 2000-2050. Using estimates from *National Income and Product Accounts*, total wages are assumed to equal 60 per cent of GDP throughout the period thus making  $\hat{\psi} = 0$  in (2.5). Estimates of per capita consumption for year 2000 come from the *National Income and Product Accounts* database and Lee and Mason (2007). Consumption per capita is assumed to increase at 2 per cent per year and it includes both private and public consumption.

### **Table 3**

The last row in table 3 indicates that starting with 2015 available surplus out of wages, calculated as total wages minus consumption by workers, will be insufficient to sponsor consumption by a growing share of non-working population that is 65 years or older. If we were to include transfers towards young dependents the results would indicate that surplus from the working population would fall short of sponsoring consumption by non-working population throughout the entire period. Nonetheless, further calculations show that a 35 % corporate tax on profits -- where profits amount to 40% of GDP-- added to surplus from wages would help cover the needs of the entire dependent population -- young and old -- until 2030 after which financing consumption would be possible only through a policy change. Even if at first sight the necessary policy changes in the US economy are not expected to be dramatic it is obvious that the volume



of consumption by non-working population which needs to be met in the future will be expanding. Interestingly the numbers on consumption per capita provided by *National Income and Product Accounts* and Lee and Mason (2007) reveal that those 65 and over consume on average 36% more than the working age population. A closer look at the data shows that the reason behind this difference has to do with a rapid increase in public expenditures on health care after 65! It seems therefore that present and future policies in the US should pay considerable attention to providing more cost efficient health care services.

### **3. Introducing Demographic Changes in a Kaldor-Keynesian Model of Growth**

Several conclusions from the preceding section will be guiding the forthcoming analysis. First, old-age dependency ratios are going up in the industrial world, however the labor supply constraints tend to be less significant than it is assumed by most macroeconomic models. Second, the success, at least from economic viewpoint, in dealing with population aging is largely dependent on robust labor productivity growth. Third, even if economic growth does take place, a larger share of older population implies that redistributive measures will still have to be implemented. In other words, it is not only the growth in output that matters but equally important how we allocate the increase in output.

In order to trace the effects that demographic changes and redistributive policies associated with it have on economic activity we use the standard Keynesian model of growth which assumes that the economy operates below full capacity -- there is excess supply of labor given the available technology. There are three main mechanisms/ideas on which the model is based. These mechanisms, illustrated in figure 1, describe how output growth, productivity growth and changes in income distribution interact with each other.

#### **Figure 1**

*The output-productivity nexus* is captured by the arrows between box A and box B. All other things equal economic activity is stimulated by higher labor productivity. In a Keynesian model output growth responds positively to higher effective demand coming from more investment, consumption or government expenditures. In the context of population aging, if

retirees tend to have higher propensities to consume and maintain similar purchasing power as the wage earners, an increase in their share relative to the working population could stimulate the economy. However, if the economy is operating at its full capacity then a rise in demand translates into higher prices. Turning our attention to the reversed linkage, a rise in output growth induces higher productivity growth in the presence of economies of scale through the Kaldor-Verdoorn channel.

*The output-distribution nexus* -- To analyze the implications that income distribution has on output and productivity growth, the wage share is introduced as a distributive variable into the model. The exercise is meant to illustrate how the dynamics governing the output-distribution nexus determines the success of redistributive policies implemented in response to population aging.

The relation between distribution and output growth is well established in the literature. Higher profitability, as measured by the markup or the profit share, stimulates the entrepreneurial spirit and therefore investment. At the same time, a lower wage share cuts into household demand. The direction of change in output growth due to income redistribution -- higher profit share and lower wage share or vice versa -- depends on which of the two effects dominates. If the rise in investment demand following increased profitability is larger than the negative effect on demand resulting from lower wage share then we say that economic activity is “profit-led” or “exhilarationist” (Taylor 2004, Bhaduri and Marglin 1990). If a higher wage share stimulates output growth the economy is said to be “wage-led” or “stagnationist”.

How about the effects of economic activity on income distribution? Using his trademark stylized facts Kaldor (1966) points out that in mature economies wage and profit shares tend to stay roughly constant over very long periods of time. Nonetheless, Kaldor made this observation over a period when demographic changes were not as pronounced. Second, even if incomes shares do not exhibit a visible change in their trend the question of what happens with income distribution over the cycles (or the medium run) is equally important. Barbosa and Taylor (2006) find out that for the US economy the wage share ( $\psi = \omega / \varepsilon_L$ ) responds positively to higher

capacity utilization, thus squeezing profit. Alternatively, a negative response of wage share to increased economic activity suggests forced saving along Kaldorian lines.

*Productivity-distribution nexus* -- The relationship between productivity growth and changes in income distribution, described by the connections between A and C, is more nuanced. Enhanced labor productivity leads to lower labor costs and/or loss of jobs. For an economy operating below full employment, productivity increases do not translate directly into a one-to-one increase in real wages. As a result the wage share is expected to decline. The same result applies when productivity growth leads to labor shedding.

Consequences of changes in income distribution on productivity growth can go either way. Neoclassical economics assumes that a higher profit share (lower wage share) and therefore higher profitability stimulates entrepreneurs to re-invest the additional cash flow into capital and technology. A similar view is held by Kaldor. On the other hand there are those who believe in induced technical change. A decline in profit share pushes entrepreneurs to search more efficient methods of production i.e. to boost labor productivity (Naastepad 2006).

The linkages between the three mechanisms described above can be formalized into a two-dimensional system that captures the dynamics governing changes in capacity utilization and income distribution. The model can be visually described by the slopes for the *Distributive curve*  $\dot{\psi} = 0$  and *Effective Demand curve*  $\dot{u} = 0$  in the  $(u, \psi)$  plane. When growth is profit-led the effective demand is downward sloping implying that a rise in the wage share results in a contraction of economic activity. A positive effective demand schedule on the other hand describes the wage-led case.

The response of income distribution to changes in the effective demand depends on whether there is a profit squeeze, described by a positive slope of the distributive curve, or a forced saving regime captured by a downward sloping curve<sup>3</sup>. A multitude of factors among them the strength of supply constraints, the institutions in place and the power held by different economic classes determine which of the two regimes applies. A profit squeeze is usually

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<sup>3</sup> A negative slope of DC can also occur in the case of an unstable profit squeeze however we rule out this case and focus on the stable cases only.

associated with a low rate of unemployment and a significant bargaining power held by workers (Palley 2008). Economic activity is stimulated by more demand, but wages rise fast due to the tightening of the labor market thus creating a squeeze on the profit share. Capacity or supply constraints on the other hand lead to forced saving when prices tend to rise faster than nominal wages. In a sense forced saving can be thought of as a situation where moderate price increases are permitted by policy-makers such that expenditures switch from consumption to capital goods (Thirlwall 2004). Finally, forced saving can also result from a situation of fast labor productivity growth and modest real wage growth.

#### **4. Economic Implications of Population Aging and Macro Policies**

To keep the discussion accessible I use the growth-distribution model described above to show potential effects of population aging on the US and Japanese economies in the decades to come. In particular, I want to focus on two points. First, population aging together with the pension system in place may lead to changes in the demand-distribution dynamics as captured by the slopes of the distributive and effective demand curves. Second, I will assess the effectiveness of macro and fiscal policies implemented in response to rising dependency rates given different demand-distribution regimes.

##### **4.1 Aging and the demand-distribution dynamics**

To understand how aging impacts upon the economy it is necessary to know sources of old-age income. Japan's current pension system relies heavily on the mandatory defined-benefit public and private pension schemes which make up about 3/4 of old age income (*Annual Report on the Ageing Society*)<sup>4</sup>. Within this category *Employee's Pension Insurance* plan, which is equivalent to the pay-as-you-go system, provides most of the retirees' income. Defined-contribution private pension accounts established only in 2001 have great appeal to firms because it diminishes their responsibilities however, employees' participation remains very

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<sup>4</sup> The mean share of overall income provided by defined-benefit pensions is smaller for those in the 65-70 years old bracket who continue to supplement their old-age income through earnings from working.

limited. In the US on the other hand, in the last two decades, there has been a rapid move towards defined-contribution schemes (Poterba et al. 2007). If this trend continues income of future retirees is expected to be more evenly distributed between private and public sources of income.

Taking account of sources of old-age income how is population aging expected to affect the demand and distributive regimes in the two economies? Intuition suggests that in an economy with fully-funded accounts where old-age income depends on current profits, as population ages, growth is likely to become strongly profit-led. Barbosa and Taylor (2006) estimate a growth-distribution model for the US for 1948-2001 and find out that with the exception of 1970s the US economy was characterized by a profit-led/profit-squeeze regime. If my intuition is right then we should expect the profit-led regime in the US to be reinforced as population ages.

Studies by Bowles and Boyer (1995) and Naastepad and Storm (2007) find out that growth in Japan is profit-led as well. However, Hein and Vogel (2007) point out that “the identification of an accumulation regime in a certain country in a certain period of time becomes a question of concrete historical and empirical analysis”. Following the above reasoning if public pensions remain predominant in Japan and therefore retirees continue to receive most of their pensions from current wages, we may see economic activity in Japan shifting to a wage-led regime.

We have seen how population aging may affect the demand regime. How about the shape of the distributive curve in the two economies? It was mentioned already that according to Barbosa and Taylor’s (2006) econometric findings, a rise in economic activity in the US causes a decline in profit share, or in other words a profit squeeze. Assuming that the US economy stays below full capacity as a result of immigration and higher fertility rates and that institutional framework will not see major changes, profit-squeeze at the top of the cycles could remain a characteristic of US business cycles.

## **Figure 2**

Eyeballing movements in the wage share relative to the business cycles in figure 2, forced saving seem to be the case for the Japanese economy. In a recent econometric study

Wakita (2006) finds out that, indeed, for Japan the wage share tends to vary counter-cyclically to business cycles. In the context of population aging, many, especially in the mainstream, would disagree that Japan will continue having its high saving rates and therefore forced saving will not be observed anymore. This predicament remains to be tested but ultimately it may depend on the policy stance in place. What exactly do we mean?

First of all, forced saving induced by policy is nothing new under the sun. On the contrary, it has been a policy tool used throughout stages of early development in Japan, the former Soviet Union or the newly-industrialized countries. The idea is that entrepreneurs respond positively to higher profit rates (due to forced saving) by increasing investment in capital and technology. The final outcome is faster labor productivity growth. Second, as has been discussed in section 2, accommodating successfully rapid population aging requires robust labor productivity growth. Hence a trade-off ensues between incentives i.e. a forced saving regime, to firms to boost productivity and a certain level of real income for wage-earners and retirees. This trade-off is expected to be more evident when a pay-as-you-go system provides most of the old-age income as is the case in Japan. To counteract the negative effects on wages and pensions the government can step in by increasing its expenditures that target most vulnerable groups such as the retirees, or by subsidizing some essential services such as health and long-term care.

#### **4.2 Aging and macroeconomic policies**

It was suggested above that with population aging underway the US economy is likely to remain profit-led/profit-squeeze while Japan may become a wage-led/forced-saving case. Over the cycles the two cases are described by figures 3a and 3b respectively.

##### **Figure 3a and 3b**

Demographic changes have a direct impact on the growth-distribution dynamics through the effective demand as discussed in the previous section and an indirect effect through changes in the macro and fiscal policies. In an attempt to stimulate the economy expansionary policies will not always have a beneficial effect on old-age income.

In the US an expansionary policy described in diagram 3a by a shift in the effective demand curve has a limited impact on growth in medium-run. In the short-run economic activity picks up the pace determining a positive response from productivity growth, through the Kaldor-Verdoorn channel, and higher wages – assuming strong bargaining power of labor. Eventually, the latter gets stronger and wages end up growing faster than productivity thus raising the wage share. As the profit squeeze kicks in, investment in our profit-led economy declines which brings down the growth rate of output. What will be the effects on old-age income? The answer depends on how much of their income comes from profits and how much as transfers from wages.

Let total income of retirees come from both public pensions and a fully-funded or private accounts and be given by  $Y_R = qR + \alpha_R \pi X$ , where  $\alpha_R \pi X$  is the share of profits attributed to the retirees based on the stock of wealth  $\alpha_R$  they hold. Assuming that the public pension  $q$  is a proportion  $e$  of the prevailing wage we can re-write income distributed to the elderly as  $Y_R = (e * \omega)R + \alpha_R \pi X$ . Dividing this relation by the level of output and multiplying the first term on the right hand side by  $L/L$  one gets:

$$Y_R / X = e * (1 - \pi) * d + \alpha_R \pi \quad (4.1)$$

Where  $d$  is the old-age dependency rate. In (4.1) a profit squeeze depresses old-age income from private pension accounts but raises the pensions transferred from current wages. From a policy perspective if most of the old-age income comes from a private pension system, taxing wages or in other words raising  $e$  in a profit-led economy could be one effective attempt at income redistribution.

In a wage-led/forced savings regime as assumed to apply in Japan, the expansion in economic activity eventually leads to higher prices and a decline in real income for both wage earners and the retirees with public pensions.

In the two cases just discussed a redistributive fiscal policy produces very different results. Assuming forced saving, income redistribution from profits to wages will only set off an inflationary reaction as higher taxes on profits are passed into higher markups,  $\tau$ , and therefore

higher prices. The distributive schedule in the end will not shift (unless the inflationary reaction overshoots).

The effect on retirees' income can be established using the definition that  $\pi = \tau/(1 + \tau)$  and re-writing (4.1) as  $Y_R / X = e^* [1/(1 + \tau)]^* d + \alpha_R \tau/(1 + \tau)$ . It is straightforward that benefits transferred from wages decline but this negative development is being compensated by an increase in the income from profits as a result of a rise in the profit rate.

A redistributive policy towards wages in an economy where profit squeeze co-exists with profit-led growth has by itself clear negative effects since it will determine a rise in the wage share and as a result a decline in equilibrium output in the medium run. In this case such policy can be combined with a rise in public investment meant to shift the effective demand schedule outwards and with it the new equilibrium output and wage share.

How about the effects of higher productivity growth? A rise in labor productivity growth in a profit-led economy always shifts the new equilibrium downwards and to the right as the wage share drops and capacity utilization rises<sup>5</sup>. In the wage-led case on the other hand the downward shift in the distributive curve causes a decline in capacity utilization. Changes in the retired households' income follow from the same relation (4.1). The policy question is how to redistribute the increase in output per worker more equitably, especially when pensions come from current wages. In the profit squeeze case the easiest way to do it is by having government non-pensions expenditures go up. Such policy would not work however in the forced saving case due to inflationary pressures which would cut into the real wages. But what could work is a reallocation of government expenditures towards retirees in order to compensate for the decline in their real income.

## 5. Final Remarks

This paper tries to fill the gap that exists in the literature on the economic implications of population aging. The focus here is on understanding how a rising share of older population,

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<sup>5</sup> The wage share is lower following a labor productivity growth because the growth in output per worker exceeds the increase in real wages, or in other words not all productivity gains are passed through into wages.



which behaves differently in economic terms, may affect the workings of an economy over the business cycles. More work has to be done in order to extend the analysis to several decades, a task that I will be undertaking in near future. Nonetheless, one important conclusion is that regardless of the time span we are looking at, demographic changes are becoming an important determinant of macro policies that target the distribution of income. Redistributing income on the other hand has an impact on economic activity and growth and therefore trade-offs as the ones discussed above will surely surface. However, the economy will manage to adapt successfully to the expected demographic transitions if policy makers recognize ahead of time which policy choices are right for the existing economic environment.

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## Tables and Figures

	Germany		Italy		Japan		USA		India	
	Old-age	Total	Old-age	Total	Old-age	Total	Old-age	Total	Old-age	Total
2000	0.24	0.47	0.27	0.48	0.25	0.47	0.19	0.51	0.08	0.64
2025	0.38	0.60	0.43	0.62	0.50	0.71	0.28	0.57	0.12	0.48
2040	0.51	0.76	0.66	0.90	0.64	0.88	0.32	0.61	0.18	0.46
2050	0.50	0.76	0.69	0.95	0.71	0.97	0.33	0.61	0.22	0.50

Table 1: Forecasts of old-age and total dependency rates for selected countries and years.

Sources: UN World Population Prospects database 2007

Labor Productivity	Germany*	Italy	US	India	Japan
Fold Increase 1960-2000	2.63	3.33	1.94	2.60	4.82
Annual growth 1960-2000	2.6%	3.1%	1.7%	2.4%	4.0%
Fold Increase 2000-2050	2.98	2.75	2.93	2.50	3.60
Annual growth 2000-2050	2.2%	2.0%	2.2%	1.8%	2.6%

Table 2: Required labor productivity growth such that GDP per capita grows at 2.5% annually.

Note: a) Unemployment rates are kept at 4% for India, Japan and US for the entire period.

Germany and Italy reach a 4% unemployment rate by 2030 and 2035 respectively b) GDP per capita for India increases at 4% annually instead of 2% as for the rest

Sources: World Development Indicators 2006 database for GDP per capita and employment. UN World Population Prospects 2007 database for statistics on demographic changes. International Labour Office, "LABORSTA: economic active population estimates and projections".

United States	2000	2015	2030	2050
Total Consumption 15-64	5,614,864,922	8,677,109,903	12,242,598,194	19,733,224,659
Total Consumption 65+	1,430,831,369	2,521,079,012	5,132,155,579	8,953,033,424
Total Consumption by workers	4,314,722,600	6,520,922,801	9,193,808,215	14,817,912,592
Wage bill (as 60% of total GDP, where GDP/cap at 2%)	5,816,103,657	8,972,860,071	13,380,227,690	21,760,069,971
Savings by workers (Wage bill - Total consumption by workers only)	1,501,381,057	2,451,937,270	4,186,419,476	6,942,157,379
<b>Difference between registered from wages surplus and consumption by 65+</b>	70,549,688	(69,141,742)	(945,736,103)	(2,010,876,044)

Table 3: Simulations of the distribution of output between wage-earners and retirees for the US economy.

Source: National Transfer Accounts Database, <http://www.schemearts.com/proj/nta/web/nta/show> for consumption per capita. Also see Lee and Mason (2007). GDP and wage share from National Income and Product Accounts database.

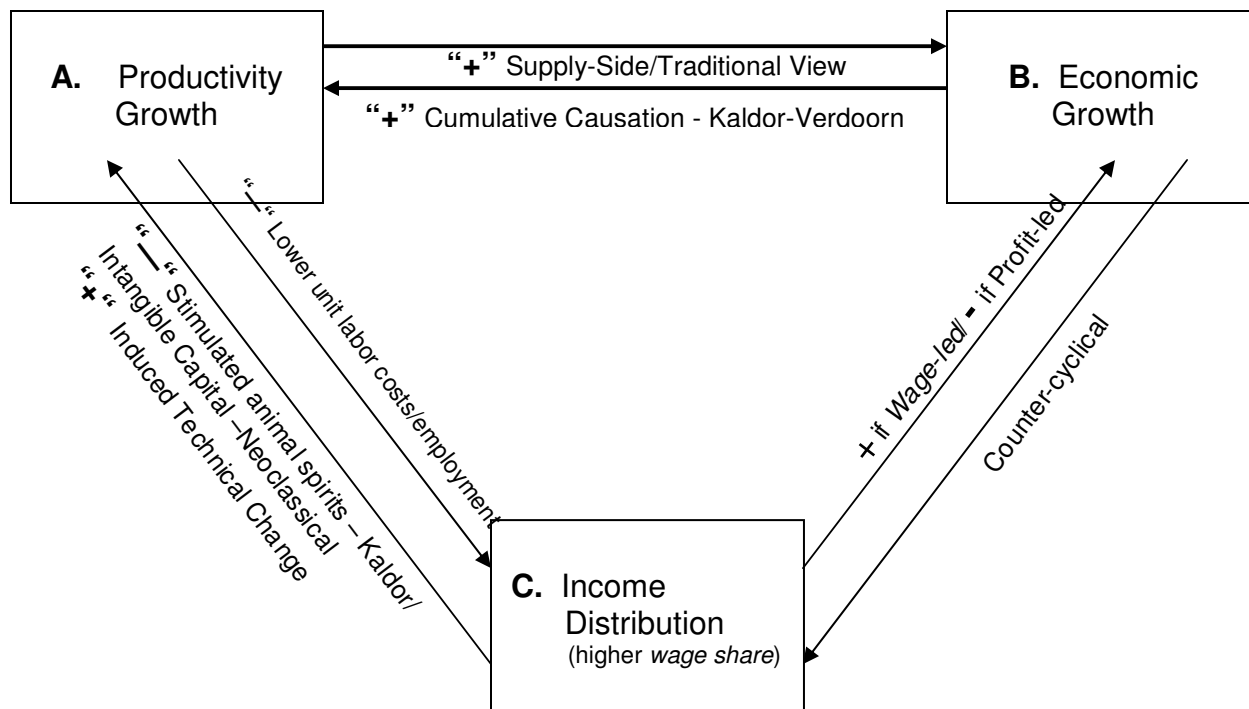


Figure 1: Linkages among productivity growth, output growth and income distribution in the Barbosa-Taylor model.

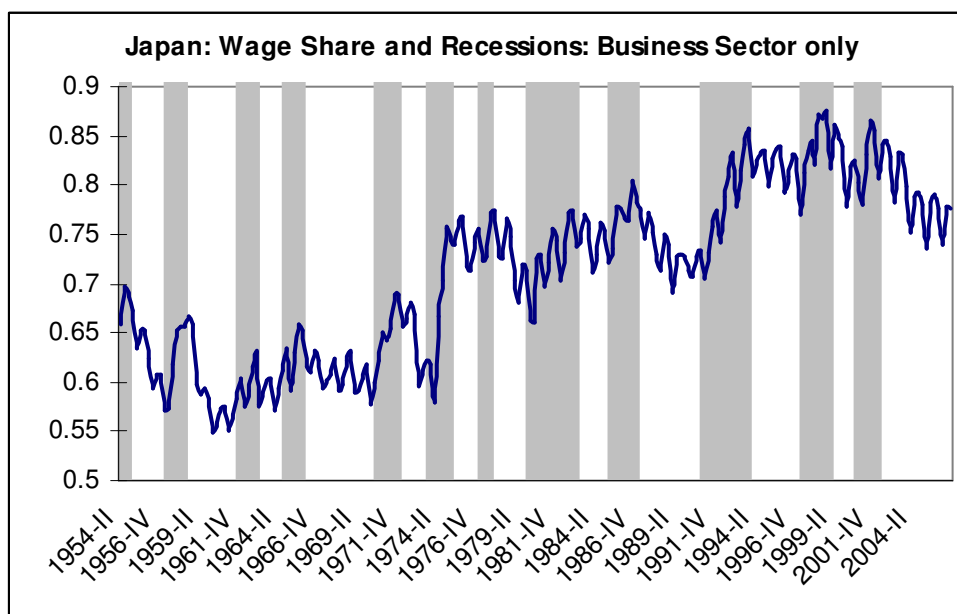


Figure 2: Wage share and business cycles in Japan  
 Source: *Financial Statements Statistics of Corporations by Industry*, Ministry of Finance, Japan.  
<http://www.mof.go.jp/english/ssc/historical.htm>

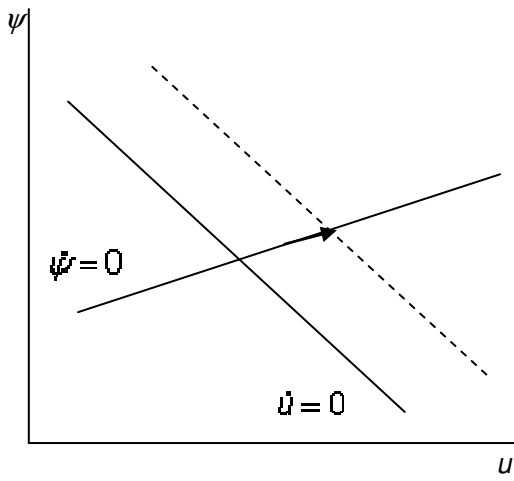


Figure 3a: Profit-led and profit squeeze

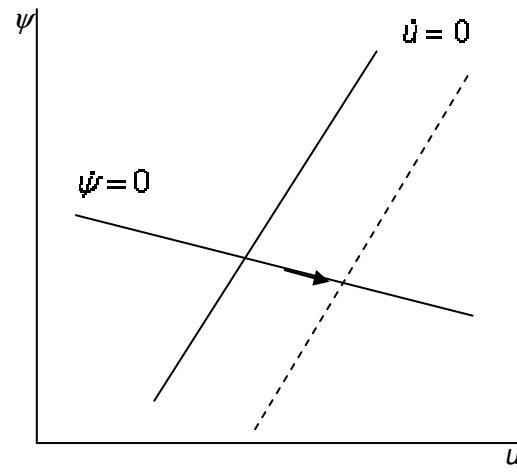


Figure 3b: Wage-led and forced savings