A Short Note On The Economics Of Depopulation: The Case of Japan, Considering Demand As Well As Supply

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"All theory depends on assumptions which are not quite true. That is what makes it theory. The art of successful theorizing is to make the inevitable simplifying assumptions in such a way that the final results are not very sensitive.' A "crucial" assumption is one on which the conclusions do depend sensitively, and it is important that crucial assumptions be reasonably realistic. When the results of a theory seem to flow specifically from a special crucial assumption, then if the assumption is dubious, the results are suspect."

Those are the opening words of Robert Solow's 1956 article, "A Contribution to the Theory of Economic Growth" In the *Quarterly Journal of Economics*. Almost certainly, everyone who reads this note will have read that work, in which Professor Solow demonstrates the properties of a simple model of neoclassical economic growth. The model is shown to be stable and to converge to a stable exponential growth path on the assumptions of exponential growth of the labor force and saving a constant proportion of income.

As Professor Solow warns, though, crucial assumptions are needed to make the model realistic. The outcomes of his models depend crucially on the assumption that population indeed grows exponentially forever. For most of the postwar period—the time in which every reader of this paper matured and became an economist—exponential population growth was pretty much the only economic experience on the planet. Thus, our views on the subject are biased toward thinking about the conditions for growth to the point where we even name the branch of economic theory devoted to studying dynamic long-term changes in the economy "Growth Theory". However, depopulation and declines in the labor force are not only possible, they are apparent in the experience of several nations including Japan today.

How do we have to modify our thinking about "growth" when the direction of population change is down and not up?

We shall show in this short note that deflation should be expected as the constant condition of an ageing and depopulating economy, just as inflation is the constant companion and natural consequence of an economy where population is growing. The reason for this, in the simplest possible terms, is that demand naturally tends to fall faster than output as an economy depopulates, leading to persistent excess supply. It is the exact logical and analytical obverse of the case of an economy with a growing population, where demand growth tends to exceed output growth generating persistent excess demand. Our analysis shall be simple for the sake of clarity, ignoring the distortions to long term trends cause by short-term fiscal and monetary policy, and our analytical framework will not be broadened to include trade.

In effect, we shall undertake the exercise of running Adam Smith's pin factory backwards, removing workers rather than adding them. Our labor force modelization will be stylized rather than blunt to fit facts of Japan's situation, and we will consider demand explicitly in a neoclassical growth framework. Simpler thinking about Japan's problems is impossible. However, do not let the simplicity of the argument deceive you: Harsher conclusions about the outcome of Japan's depopulation are unthinkable.

Solow's World

In Solow's model, the population is assumed to be full fully employed and growing at a constant rate per year. So labor force equaled population, and

 $L_t = L_0 \cdot e^{nt}$,

where n is the that steady growth of labor. Savings, S, are assumed to be a constant proportion, s, of income denoted by Y. All savings are assumed to be used to finance investment. This implies that consumption is a constant proportion of income, (1-s). Therefore,

 $S_t = sY_t = I_t = dK/dt$, and

 $C_t = (1-s)Y_t$.

Output, Q, is modeled by a Cobb-Douglas production function,

 $Q(t) = AK_t^a L_t^{1-a}$

This idyllic world generates the following smooth, exponential time paths... as you might expect



However, these kinds of extrapolations do not reflect the harsher reality that Japan faces today. A generation of Baby Boomers, a cohort group of people born between 1945 and 1960, has reached retirement age. As they age, they are starting to die off. Their arrival in the population was followed by a dearth of births through the 1970s as fertility rates and marriage rates declined.

On January 17, 2019, BoJ Governor Kuroda described Japan's demographic situation to the G-20 Symposium in Tokyo: "In Japan, the working age population peaked in 1995 and the total population in 2008, and both have been declining since then. The share of the elderly population in the total population was 10 percent in 1985, but this increased to 28 percent in 2017."

So even if we use the "economic" part of the neoclassical growth model, we have to use different demographic assumptions to fit the facts of Japan. Our assumptions have to consider for a difference between population – the number of consumers – and workers, the number of producers. We have to assume that both will decline, not rise forever, and at different rates indifferent phases of depopulation. We also have to model changing savings ratios in an ageing population, as proposed by Modigliani and Friedman.

Kuroda-san's January presentation went on to argue that technological innovation could offset the impact of a decreased labor force on output, leaving income per capital steady at worst and possibly growing despite a reduced workforce and a higher dependency ratio. In our view, the Governor's rosy outlook for the economy is biased because he failed to consider the impact of depopulation on demand.

Consider, first the Cobb Douglas production function. The marginal product of labor at any point of time is

 $dQ/dL = A \cdot (1-a)(K_t/L_t)^a.$

Since the function is homogeneous in A, K and L, we can index the initial values of the variables to $K_t = L_t = 100$ and A = 1. So if we assume for the sake of discussion that a, the share of capital in national income, is 0.15, then the marginal product of labor is simply (1 – a) or 0.85. A 10% drop in the labor supply will reduce output by 8-1/2%.

Let us model an individual consumption as equal to fixed, or subsistence, consumption, CF_t and discretionary consumption CD_t . Discretionary income can be defined as what is left over out of total income after fixed income is done, $YD_t = Y_t - CF_t$. We will model discretionary consumption as $CD_t = (1-s)YD_t$. So total consumption per capita is

 $CP_t = CF_t + CD_t = CF_t + (1-s)YD_t$, and that makes aggregate consumption

 $C_t = POP_t [CF_t + (1-s)YD_t]$ where we have introduced the concept of population, POP_t. The labor force, L is a proportion of the population that works to product output, μ_t . That can vary over time.

So the change in consumer spending with population change will be

 $dC/dPOP = [CF_t + (1-s)YD_t]$

The innovation of this equation to neoclassical growth models is the link of consumption to population, not labor. Full employment is not assured. In effect, aggregate consumption is modeled as population times consumption per capita, which is pretty constant if only because half of it is fixed, subsistence spending. One may imagine that as a population ages, moves into retirement, and depletes household resources per capita over time, subsistence spending rises as percentage of total spending.

The implication of this formulation is that a change in the number of consumers, the population, changes aggregate demand. For discussion purposes, let us assume that half of all income goes to subsistence items that will not vary with income, like shelter and food. If the saving rate out of discretionary income is 20%, then a 1% increase in the population—a rise in the number of consumers--will increase aggregate spending by 1%. Symmetrically, the loss of a consumer would subtract 1% from aggregate demand.

If we run the model only forward, as Solow and his contemporaries intended, a 1% increase in the labor force would increase output by 0.85%. However, demand would increase by 1%. Demand grows persistently faster than output in an economy with a growing population, and that tends to generate persistent price increases. Coincidentally in parallel with productivity and money wage gains, this is a scenario of persistent but steady inflation. It describes the experience of most advanced economies since the end of World War II.

In Japan's case, however, we have to model the demographics differently. We can identify three distinct periods. They look like this, with the following very different outcome profiles.



In the initial phase, population and labor force are both growing in parallel. Savings rates are constant. Labor force participation rates are constant. This is the regime just described in the paragraph above.

In the second phase, the one that fits Kuroda-san's description of 1995 to 2008, the population is still growing but the labor force is declining. We suspect households with earners in retirement spend less than they did when they were working: The general assumption of the life cycle models is that household spending declines, and savings rates swing from positive to negative as households age and shift into retirement. So even though output falls when workers retire, consumption may fall only a little bit faster. We see that other than the time of the 1997-98 sales tax increase, prices were generally falling during this phase of depopulation.

The third phase is one that Japan faces today. As the Baby Boomers die, they stop consuming: This is certainly true. Mostly, they will die after retirement, so their passing reduces consumption without having any impact on output. Now demand falls faster than output, and the economy is faced with persistent deflation. No monetary or fiscal policy can reverse this steady excess supply and the consequent downward pressure on prices.



Some people will argue that investment spending in new technology, like robotics and AI, can offset the decline in the workforce to maintain output levels. This certainly was the argument presented by Governor Kuroda in January. Perhaps investment can boost output of goods and services faster than the decline of the labor force reduces potential output. A more important question, though, is why would any company want to invest to increase production or productivity when declining demand is assured by a shrinking population? Who will buy all that output?

Turning the microscope on the economy, there are some sectoral insights. Depopulation means Japan needs fewer houses, not more, so the construction industry is certain to shrink. Housing starts in the first quarter of this year ran at half their pace in the same quarter of 1990. Property prices will fall. This will be bad news for retirees hoping to live of the appreciation of the value of their houses. Older and fewer, Japanese consumers will be buying fewer autos too: Domestic auto sales have dropped to half their 1990 pace already, and continue to fall. Sectors that benefit from this aging of Japan, at least for the moment, are medical services and elder care. However, even these sectors have only a decade or so to thrive before the bulk of the Baby Boomers have left us.

Notice that we have not mentioned Japan's financial sector in this conversation. The sharp decline in interest rates and bond yields that has accompanied Japan's deflation and extraordinary recent monetary easing has rendered large financial intermediaries actuarially bankrupt: A life insurance company has liabilities with durations of decades, funded by assets with durations that average a lot less than seven years. As interest rates fall, the value of the liabilities rises two, three or even four times faster in percentage terms than the value of the assets. At the same time, coupon income on bonds is reduced by ultra-low or even negative interest rates, impinging on cash flow. *It can only be a matter of time before one of the large insurance companies or pension funds folds.*

Unspoken in this conversation is the role of Japan's restrictions, formal and otherwise, on immigration. Other advanced economies have finessed the population bulges of the late 40s, 50s and 60s by opening their borders to immigration. Japan has refused to do so as a matter of cultural preference and social choice. So Japan is exposed to the brunt of its demographic challenges with almost no relief at all. The benefit to the advanced economies of this immigration is obvious: Today's low wage immigrants hold down labor costs, but they demand goods and services and they save they pay most taxes and they invariably evolve into a new generation of middle class households. Less obvious the fact that if all advanced economies are importing workers to address their demographic challenges at once, then they must be reducing the supply of able labor in the emerging world. This is a potential drag on the development of the developing world, a squeeze that may already be becoming apparent in eastern Europe amongst other places.

For Japan, however, the bottom line is that its economy needs more people, not more central bank asset purchases or more negative interest rates or fiscal stimulus.

Japan also needs a miracle to be able to unwind its financial sector obligations to be able to pay out retirees who need to convert their life savings into cash. On top of the economic adversity and deflation that seems assured, the risk of a financial sector implosion is not to be ignored.

Carl B. Weinberg June 17, 2019







Japan: Industrial Production Index

Seasonally Adjusted Monthly Index, 2010 = 100, Trend Line Since 2010 Shown



Japan: Bank Lending In The Lost Decades



Japan: Housing Starts, Thousands Of Units Per Month

Line Is 12-Month Moving Average



73 75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05 07 09 11 13 15 17

Japan: Employment, Percent Change Year Ago



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Japan: Tokyo-Area CPI, Index Level



Japan: Inventory To Sales Ratio



Japan: Current Account Balance, Trillions Of Yen

Line Shows 12-Month Moving Average



Japan: Monthly Vehicle Sales, Thousands Of Units

