The Demographic Deficit*

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Abstract

There has been a slowdown in growth in the world's strongest economies. One argument is that this slowdown represents a permanent shift in potential output because the innovations available to us in the future will not lead to the productivity growth that we have experienced in the recent past. An alternative argument, the Secular Stagnation hypothesis - is that the slower growth reflects a shortfall of aggregate demand at current interest rates. In this view the real natural rate of interest has declined and the real interest rate required to equate savings and investment at full employment is negative. One of the important issues that both explanations must confront is the impact of changing demographics for growth. In this paper we provide estimates of the demographic deficit that arise from the increase in life expectancy and the decline in fertility.......

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1 Introduction

Beginning with Japan in the 1990s and now Europe and to a lesser extent the U.S. since the 2008 there has been a marked slowdown in economic growth when compared with previous decades. In Japan the slowdown was initially attributed to the collapse of the asset price bubble in 1991 and subsequently to shortcomings in the response of monetary and fiscal policy to the Asian Financial Crisis. In the run up to the financial crisis of 207-2009 and the Great Recession that followed, Europe and the U.S. also experienced asset inflation followed by a shock to the financial system that was global and severe. As in Japan, the growth rate after the financial crisis has been below that in previous recoveries from recession in both Europe and the U.S. and below the trend growth in the period leading up to the crisis.

There are two popular accounts of why current and future growth rates are low. One view, articulated by Robert Gordon, holds that aggregate supply may be impaired because the opportunities for technological change that exist in the future are not going to provide the increases in productivity that we have experienced in the past. The more nuanced statement of this view argues that the period from 1980-2007 when productivity grew an average annual rate of 0.05% is likely to be characteristic of the future largely because the potential for technological innovation is unlikely to offer the opportunities for big increases in productivity that we experienced in the past. An alternative view, the Secular Stagnation hypothesis associated with former Treasury Secretary Larry Summers, is that future growth is likely to be constrained by insufficient investment demand. On this view our current slow growth is more than just a hangover of the financial crisis. It is a consequence of the fall in the real interest that prevails in equilibrium. If the real interest rate (the nominal rate minus inflation) is well below zero then monetary policy is going to have a hard time delivering a real rate that is consistent with long term growth as we have experienced it in the past. There is also concern that persistent low nominal rates may foster financial instability as investors search for yield in every more risky places, or borrowers take on more debt because of the low carrying costs. [1]

Everyone who focuses on the slowdown in growth acknowledges that there are many other factors that may be contributing to the slowdown. Most of them cite demographics as a factor that may contribute to the growth deficit. In this paper we are going to provide a precise accounting of the magnitude and role of the Demographic Deficit and a projection of its impact into the future. It is widely recognized that demographic changes have important implications for economic growth. But the channels through which these changes work are less well understood. In this paper we will make them precise in a life cycle model with rich demographics. In particular we emphasize how demographics work through both the intensive (hours) and extensive (employment) margins of adjustment of labor supply. There are significant differences in labor market institutions across countries and these affect how labor markt adjustments take place. In the U.S. two thirds of the labor market adjustment

[1] An alternative view is that savings are simply too high and not flowing to investment because households and firms are trying to deleverage and rebuild their balance sheets.

over the business cycle occur on the intensive margin, meaning that changes in employment dominate changes in hours (Cho and Cooley 1994). Lhosa, Ohanian, Raffo amd Rogerson (2012)show in countries with employment portection laws and much large fraction of the adjustment takes place on the intensive margin.

Understanding the contribution of demographics to long term growth potential is particularly important because the demographic forces are essentially baked in to the future path of the economy. They are not easily altered or easily influenced by economic policy other than perhaps by immigration policy. So, to a large extent, the demographic contributions to growth are forces that are already in motion that we will have to live with.

2 Demographic Background

The combination of increasing life expectancy and decreasing fertility means that the median age of the populations are increasing, in some cases dramatically. This pattern is most evident in Japan where the combination of low fertility and increasing life expectancy is causing the population to shrink by a million people a year a decline that has not been offset by immigration. Figure **??** shows the fertility rate for Europe, the United States, Japan, China, and India. Only the U.S. and India have fertility rates that are above replacement rates. While fertility has been decreasing, life expectancy has been increasing. Indeed there has been a remarkable convergence of poor countries and wealthy countries in terms of life expectancy at birth. Figure **??** shows the life expectancy for Europe, the United States, Japan, China, and India. The impact of these demographic trends on the median age is shown in Figure **??**.

These demographic trends have significant implications for many things. Henriksen (2002) and Backus, Cooley and Henriksen (2014) discuss the implications for international capital flows and asset returns. Attanasio, Kitao and Violante (2007) and Kitao (2014), study the impact of demographics on the sustainability of social security programs. Here we are concerned with the impact of these trends on economic growth. It is clear that the profound changes in the age structure of the population will have significant implications for growth. To see this consider the simplest form of growth accounting exercise that takes into account population, labor force participation and hours of work.

Consider the standard neoclassical production function:

$$Y_t = A_t K_t^{\alpha} \left(L_t h_t\right)^{1-\alpha} \tag{1}$$

where Y is output, K is the capital stock, L is employment (the extensive margin of labor supply), and h is average hours conditional on being in the labor force (the intensive margin of labor supply). Dividing through by population, Pop, we can write this as

$$Y_t = A_t \cdot \left(\frac{K_t}{L_t}\right)^{\alpha} \cdot Pop_t \cdot \frac{L_t}{Pop_t} \cdot h_t^{1-\alpha} \tag{2}$$

and

$$A_t = \frac{Y_t}{\left(\frac{K_t}{L_t}\right)^{\alpha} \cdot L_t \cdot h_t^{1-\alpha}} \tag{3}$$

and decompose the growth in output as

$$\gamma_Y = \gamma_A + \alpha\gamma_{K/L} + \gamma_{Pop} + \gamma_{L/Pop} + (1-\alpha)\gamma_h \tag{4}$$

The last three terms are the contributions of demographics.

For illustration we contrast, Japan and the U.S. and assume that capital's share is 1/3.

Assuming $\alpha = 1/3$, we get

Table 1: Growth Accounting 1990-2006

	γ_Y	γ_A	$\alpha \cdot \gamma_{K/L}$	γ_{Pop}	$\gamma_{L/Pop}$	$(1-\alpha) \cdot \gamma_h$
United States	2.84	1.35	0.484	0.986	0.047	-0.029
Japan	1.107	0.706	0.829	0.199	-0.194	-0.433

Table 2: Growth Accounting 2007–2011

	γ_Y	γ_A	$\alpha \cdot \gamma_{K/L}$	γ_{Pop}	$\gamma_{L/Pop}$	$(1-\alpha) \cdot \gamma_h$
United States	0.124	0.467	0.526	0.702	-0.194	-0.040
Japan	-0.629	0.428	0.296	-0.0002	-0.588	-0.762

It is clear over both of these subperiods demographics is a major contributor to the growth deficit in Japan. In the period from 1990 to 2006 demographic factors added just over 1% to U.S. growth. Over the same period demographic factors reduced Japan's growth by nearly half a percent. In the period after the financial crisis the demographic deficit for Japan is 1.36% with the biggest contribution coming from the intensive margin. For the United The demographic deficit is 0.85% with nearly all the adjustment coming from the intensive margin, offset partly by population growth.

This is happening because the combined effects of low fertility and increased life expectancy is shifting the cohort structure of the population, with more population concentrated in later cohorts. As the population ages this affects both labor participation and hours worked since older people participate less and when they do they work fewer hours.

3 Model Economy

How much of the growth difference between countries can be accounted for by differences in their demographics? If the evolution of demographics has an important influence on growth then a model that captures that connection can be used to project the future path of growth. Since, absent substantial immigration, the demographics are essentially baked in this will give us a good picture of what to expect for the future. Italy and Japan have particularly challenging demographics, with large concentrations in older chorts and it is only projected to get worse.

3.1 Demography

The economy is populated by overlapping generations of individuals. The demographic structure of the population depends on fertility, mortality and immigration. A crticial parameter is the survival probability of agents. The conditional probability of an agent of age i at date t surviving to the next period is $s_{i,t}$. The unconditional probability of reaching age i is $s^i = \prod_{j=1}^{i-1} s_j$.

Fertility rates connect the current age distribution to the number of age-1 agents next period.

Let $x_t \in \mathbb{R}^I$ be the vector of number of members in each cohort in period t.

Let $m_t \in \mathbb{R}^I$ be a vector of immigrants by age. If $\hat{\Gamma}_t$ contains fertility and survival rates at time t, the law of motion for the population is

$$x_{t+1} = \hat{\Gamma}_t x_t + m_t.$$

This gives the evolution of the cohort distribution.

3.2 Preferences

Individuals order the sequence of consumption and labor supply over the life-cycle according to a time-separable utility function

$$\mathrm{E}\left\{\sum_{j=j_0}^{J} \beta^{j-j_0} u(c_j, h_j)\right\} \tag{5}$$

where β is the subjective discount factor and the expectation is with respect to the shocks associated with the time of death and idiosyncratic labor productivity. Consumption and labor supply at age j are denoted as c_j and h_j , respectively. Accidental bequests are assumed to be collected and distributed lump sum across the population. Agents may accumulate assets in positive and negative amounts. The agent maximizes utility subject to the budget constraint

$$c_{i,t} + a_{t+1,i+1} = a_{i,t}\left(1 + r_t\right) + \varepsilon_i w_t + b_{i,t}, \tag{6}$$

and the constraints following from the absence of a bequest motive

$$a_{1,t} = a_{I+1,t} = 0. \tag{7}$$

$a_{i,t}$ represents asset holdings, r_{t+i-1} is the rate of return on capital, w_{t+i+1} is the market price of one efficiency unit of labor, and accidental bequests, b_t, is the fraction of total inheritance or bequests received by each agent alive at time t

$$b_t = \frac{B_t}{\sum_{i=I_0}^{I} x_t},$$

where

$$B_t = \sum_{i=I_0}^{I} \left(1 - s_i\right) a_{i,t}.$$

To get predictions of the demographic drivers of growth we need to specify preferences that capture the features mentioned above - the decision to participate in the labor force (the extensive margin) and the decision about how many hours to work (the intensive margin).Individuals can allocate each period a unit of time to leisure or work. We follow (Kitao2014) in specifying the instantaneous utility function:

$$u(c,h) = \frac{c^{1-\sigma}}{1-\sigma} + \chi \frac{(1 - h - \theta_j \cdot i_p)^{1-\gamma}}{1-\gamma} \tag{8}$$

The parameter χ represents the weight on utility from leisure relative to consumption. i_p is an indicator that takes a value 0 when $h = 0$ and 1 otherwise. θ_j represents the disutility associated with the participation in the labor market. Kitao assumes that the fixed cost of participation is measured in terms of lost time for leisure and varies by age. The fixed cost of participation conditional on age j is given the following functional form

$$\theta_j = \kappa_1 + \kappa_2 j^{\kappa_3}.$$

3.2.1 Endowments

Individuals' earnings are given by $y_L = \tilde{\omega} h$, where $\tilde{\omega}$ denotes the wage rate per work hour h of each individual and is determined as

$$\tilde{\omega} = \omega(j,h)\eta w \tag{9}$$

$\omega(j,h)$ is the part of the wage that depends on the age and work hours of each individual and η denotes an idiosyncratic labor productivity that evolves stochastically as a first order autoregressive process in logs:

$$\eta_{t+1} = \rho\eta_t + \sigma^2 \tag{10}$$

The component $\omega(j,h)$ is a function of age and hours worked given as

$$\ln\omega(j,h) = \ln h + \psi j \tag{11}$$

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3.2.2 Budget constraint

In this model dispense with the government sector(taxes), social security and simply assume that these features of the environment are invarant to changes in the cohort structure drive by demographics.

3.3 Technology

We assume competitive firms have access to a constant returns to scale techology with the form:

$$Y_t = A_t K_t^{\alpha} \left(L_t h_t\right)^{1-\alpha} \tag{12}$$

3.4 The Agents Problem

The state vector for each individual is $x = i, a, \eta$ where i is the age, a are the assets carried over from the previous period, and η is the idiosyncratic labor productivity. The problem of the age i agent is:

$$V\left(i.a,\eta\right) = \max_{c,a',h}\{u\left(c,h\right) + \beta s_j E\left[V\left(i+1,a',\eta'\right)\right] + \left(1+s_j\right)u_b\} \text{ subject to} \tag{13}$$

$$c' + a' = \left(1+r\right)\left(a+b\right) = \omega^t ilde * h(14)$$

$$a' \geq 0 \tag{15}$$

3.5 Competitive equilibrium

TBA

4 Calibration

The persistence parameter of the idiosyncratic component η of a worker's wage is set to $\rho =$ ..... and the variance of the white noise is set to $\sigma^2 =$ ....., which lie in the range of estimates in the literature (see, for example, Heathcote, et al, 2010).

The three parameters κ_1, κ_2 and κ_3 are calibrated to match the following three targets: average participation rate at age 55-60 and at age 80-84, and average work years over the life-cycle.

4.1 Labor Force Participation

The participation rates by five year cohorts are shown in the following figures:

Figure 1
Labor Force Participation - Japan

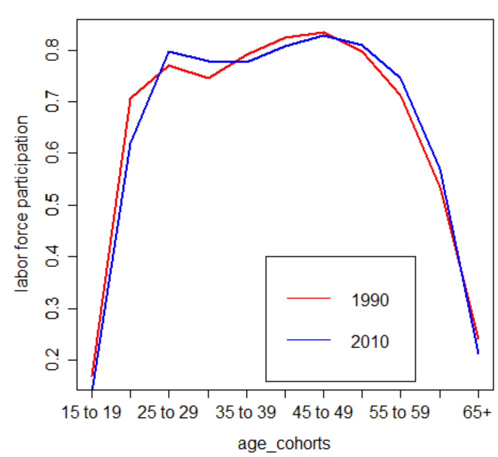
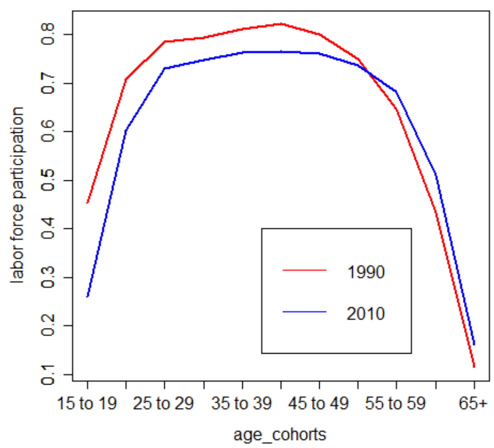


Figure 2
Labor Force Participation - U.S.



5 Experiments

TBA... TBA... TBA...