On the Persistence of Low Birthrate in Japan

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Abstract

We first show that quality of consumption is an important determinant of fertility and labor supply. Taking this observation into account and using a general equilibrium model with vertical quality differentiation and heterogeneous labor, we show how low fertility may persist. This occurs because product quality and skilled labor supply adjust, never realizing the change in labor productivity necessary to reverse declining fertility.

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1 Introduction

This paper consists of two parts. First, we present a model of consumer choice where children and consumption experience require both goods and time. We demonstrate how change in marginal utility of consumption and change in wages generate different relationship between fertility and labor participation, i.e., possible source of the difference between cross section and time series. In the second half, we embed a simplified version of this consumer into a general equilibrium model with heterogenous labor and vertically differentiated products. Through comparative statics, we analyze the cause and implications of low birthrate in the long run. We show that the feedback mechanism of the economy may not reverse the declining birthrate, contradicting an implication of the Easterlin Hypothesis cohort effect. This is because the labor market structure and product market adjusts to change in birthrate and thus the cohort effect never materializes.

This paper is in the spirit to papers in growth and trade that take into account the reaction of the economy in the long run (Acemoglu (1998), Flam and Helpman (1987), Thoenig and Verdier (2003)). Acemoglu (1998) showed that while in the short run, labor input is reduced in response to scarcity of skilled labor and high wages, skilled labor supply increase in response triggers technological change that makes skilled labor even more productive, raising skilled labor wage in the long run. Our analysis suggests that a similar long term adjustment of the economy will prevent a natural feedback mechanism from working. That is, smaller population will increase marginal product of labor more productive in the short run but consumption pattern will change in the long run reducing such an advantage.

2 Re-examination of female labor participation - birthrate relationship

Large Time series among many OECD countries show negative relationship between female labor participation and TFR (Figure 1) , while cross country in 2005 (average of years 1985-1996 as well as year 2000, Sleebos (2003), d'Addio and d'Ercole (2005), Da Rocha and Fuster (2006)) show a positive relationship. In Japan, although time series relationship has been negative for 1980 - 2000 (Figure 1) , cross section among prefectures show positive relationship in 1987 and 2002 (Figure 2). Obviously conditions that differ across regions in Japan are different from difference between two points in time. We also note that countries with high per capita GDP have low birthrates (Figure 3), suggesting low fertility may be correlated with high consumption. In this section we introduce a consumer optimization model to capture differences in income difference and quality of consumption.

We assume that a utility of a household depends on number of children, n, consumption of a good x. Both child rearing and consumption of a good requires time. Number of children is determined by amount of good x_c, and time devoted, ℓ_c,

$$n = f(x_c, \ell_c), \quad f_x > 0, f_\ell > 0.$$

Subscripts on functions denote partial derivatives. The utility of consumer is actually determined by amount of z, which is consumption experience that depends on amount of the good, x, and time devoted, ℓ,

$$z = g(x, \ell), \quad g_x > 0, g_\ell > 0.$$

Utility function is,

$$u(n, z), u_n > 0, u_z > 0.$$

Budget constraint depends on price of good and wage, and labor endowment, $\bar{\ell}$,

$$px + px_c + w\ell + w\ell_c = w\bar{\ell}.$$

Figure 4 demonstrates the optimization problem. The opportunity set is defined as,

$$\left\{(z,n)|n = f(x_c, \ell_c), \quad z = g(x,\ell), \quad p(x+x_c) + w(\ell+\ell_c) = w\bar{\ell}\right\}.$$

The frontier is downward sloping (see Appendix). It reflects the budget constraint as well as the technologies, g and f.

We further index consumption (consumption experience) by quality, Q. Utility function is

$$u(Qz, n)$$

where z measures quantity of consumption. First-order condition for utility maximization are,

$$\frac{f_x}{f_\ell} = \frac{g_x}{g_\ell} = \frac{p}{w}, \tag{1}$$

$$\frac{u_n}{u_z} = Q\frac{g_x}{f_x}. \tag{2}$$

Equation (1) implies less labor intensive consumption and child rearing method will be used when wage increase. The time series of female wage has been rising in Japan would lead to less labor intensive methods which means greater labor participation. Equation (2) implies better quality of consumption leads to more consumption and less children.

Higher wage but not significantly higher quality means positive relationship. However with the same higher relative wage and higher quality consumption means negative relationship between labor participation and fertility. Availability of consumption goods, such as entertainment and restaurants, is much greater in larger cities. This means higher Q, meaning less children and more consumption in cities.[1]

[1]For instance, there are 191 Tokyo restaurants listed in the Michelin restaurant guide, compared to 64 in Paris and 42 in New York (Robinson (2007)). Same hours spend at a Tokyo restaurant yields higher Qz on the average compared to other locations in Japan.

3 General Equilibrium with high quality product and heterogenous labor

In this section we analyze a general equilibrium in which consumers have a utility function that reflect the previous analysis, although somewhat simplified. Consumers differ by two attributes, their preference and quality of labor. Consumers choose either to consumer high quality product or standard (low quality) product. Child bearing choice differ according to which product they choose, as well as if they are skilled or not. Skilled workers produce the high quality product and the labor supply level determine the level of quality.

Consumers

We simplify the consumer's problem so that she chooses between consumption (x) and childbearing (n). Her preference is represented by the following utility function which also depends on the quality of the good consumed, Q,

$$U_\rho(n,x) = (Qx^\rho + n^\rho)^{\frac{1}{\rho}}, \quad 0 < \rho < 1. \tag{3}$$

Consumers preference, ρ, is distributed uniformly over [0,1]. Consumption good is either the standard (low quality) $Q = 1$ or high quality $Q > 1$. Consumer's labor endowment is $\bar{\ell}$ and wage is w which is also the opportunity cost of children. Denoting price of the good by p, consumer chooses consumption and number of children to maximize (3) with respect to the budget constraint,

$$px + wn = w\bar{\ell}.$$

Each consumer's consumption and number of children given quality Q is determined by the utility maximization given the budget constraint,

$$x^*_\sigma(p,w;Q) = \frac{Q^\sigma \bar{\ell}}{(\frac{p}{w})^\sigma \left(Q^\sigma (\frac{p}{w})^{1-\sigma} + 1\right)}, \quad n^*_\sigma(p,w;Q) = \frac{\bar{\ell}}{Q^\sigma (\frac{p}{w})^{1-\sigma} + 1}, \tag{4}$$

$$\text{where } \sigma \equiv \frac{1}{1-\rho} > 1.$$

Consumption is increasing and number of children is decreasing in quality, as in the previous section. The indirect utility is,

$$v_\sigma(p, w; Q) = \bar{\ell}\left(Q^\sigma(\frac{w}{p})^{\sigma-1} + 1\right)^{\frac{1}{\sigma-1}}.$$

The consumer must choose which quality to consume. If her marginal utility from more consumption is relatively large, she devotes less resources to children and has fewer children. If the quality is low and not as beneficial, she derives utility by having many children. She compares the utility levels from consuming each quality and buys whichever yields higher utility. We denote the prices of the goods with different qualities by p_H and p_L. Consumer will buy the high quality good when

$$v_\sigma(p_H, w; Q) > v_\sigma(p_L, w; 1).$$

This condition is equivalent to,

$$\sigma < \hat{\sigma} \equiv \frac{\ln \frac{p_H}{p_L}}{\ln \frac{p_H}{p_L} - \ln Q}. \tag{5}$$

Since $\sigma > 1$, there will be no demand for the low quality good if $\ln \frac{p_H}{p_L} < \ln Q$. This occurs if low quality product is more expensive ($p_L \geq p_H$) since $Q > 1$ and $p_H > p_L$ but the price premium for the high quality is small relative to difference in quality. It does not depend on the level of income.

Consumer's labor supply is the hours not devoted to raising children,

$$\ell_\sigma(p, w; Q) = \bar{\ell} - n^*_\sigma(p, w; Q) = \frac{Q^\sigma}{Q^\sigma + (\frac{p}{w})^{\sigma-1}}. \tag{6}$$

Markets

The labor each consumer supplies is either skilled (s) or unskilled (u). There are total of N consumers, and $\theta \in (0, 1)$ of the consumers are skilled. Labor endowment, $\bar{\ell}$, is the same for both types. We denote wages for skilled and unskilled by w_s and w_u. Production technology is constant returns to scale in labor: one unit of skilled labor produces one unit of high quality product and one unit of unskilled labor produces one unit of the standard product. Furthermore we assume both products are supplied competitively. Thus we have $p_H = w_s$ and $p_L = w_u$.

One skilled worker's demand for high quality product is , denoting relative wage by $\xi = \frac{w_s}{w_u} > 1$ and using (4),

$$x_s^H(\xi) = x_\sigma^*(w_s, w_s; Q) = \frac{Q^\sigma \bar{\ell}}{Q^\sigma + 1}, \quad \sigma < \hat{\sigma} = \frac{\ln \xi}{\ln \xi - \ln Q},$$

and demand for low quality is,

$$x_s^L(\xi) = x_\sigma^*(w_u, w_s; Q) = \frac{\bar{\ell}}{\xi^{-\sigma}(\xi^{\sigma-1} + 1)}, \quad \sigma > \hat{\sigma}.$$

There will be positive demand for the low quality only if $\xi > 1$ since $\xi = \frac{p_H}{p_L}$. We make the following observation

Claim 1. *High skilled consumers consume more of both quality,* $x_s^H(\xi) > x_u^H(\xi)$ *and* $x_s^L(\xi) > x_u^L(\xi)$.

Total demands from all the skilled workers for high quality product and low quality product are ,

$$X_s^H(\xi) = \theta N \int_1^{\hat{\sigma}} x_s^H(\xi) d\sigma, \quad X_s^L(\xi) = \theta N \int_{\hat{\sigma}} x_s^L d\sigma.$$

Similarly for unskilled workers, we have the individual demands for high quality good,

$$x_u^H(\xi) = x_\sigma^*(w_s, w_u; Q) = \frac{Q^\sigma \bar{\ell}}{\xi^\sigma (Q^\sigma \xi^{1-\sigma} + 1)}, \quad \sigma < \hat{\sigma} = \frac{\ln \xi}{\ln \xi - \ln Q},$$

and demand for low quality good,

$$x_u^L(\xi) = x_\sigma^*(w_u, w_u; Q) = \frac{\bar{\ell}}{2}, \quad \sigma > \hat{\sigma}.$$

Total demands for each quality from all unskilled workers are,

$$X_u^H(\xi) = \int_1^{\hat{\sigma}} x_u^H(\xi) d\sigma, \quad X_u^L(\xi) = \int_{\hat{\sigma}} x_u^L(\xi) d\sigma.$$

Since production of one unit of good requires one unit of labor, demand for skilled and unskilled labor, L_s^D and L_u^D are,

$$L_s^D(\xi) = \theta N X_s^H(\xi) + (1-\theta) N X_u^H(\xi), \tag{7}$$

$$L_u^D(\xi) = \theta N X_s^L(\xi) + (1-\theta) N X_u^L(\xi). \tag{8}$$

Labor supply is constructed in a similar manner from individual supplies. Individual labor supply as function of relative wage is , using (6) ,

$$\ell_s^H(\xi) = \ell_\sigma^*(w_s, w_s; Q) = \frac{Q^\sigma \bar{\ell}}{Q^\sigma + 1}, \quad \sigma < \hat{\sigma},$$

$$\ell_s^L(\xi) = \ell_\sigma^*(w_u, w_s; 1) = \frac{\bar{\ell}}{\xi^{1-\sigma} + 1}, \quad \sigma > \hat{\sigma}$$

$$\ell_u^H(\xi) = \ell_\sigma^*(w_s, w_u; Q) = \frac{Q^\sigma \bar{\ell}}{Q^\sigma + \xi^{\sigma-1}}, \quad \sigma < \hat{\sigma},$$

$$\ell_u^L(\xi) = \ell_\sigma^*(w_u, w_u; 1) = \frac{\bar{\ell}}{2}, \quad \sigma > \hat{\sigma}.$$

Aggregation yields the total labor supply of each type,

$$L_s^S = N\bar{\ell} \int_1^{\hat{\sigma}} \left\{ \theta \frac{Q^\sigma}{Q^\sigma + 1} + (1-\theta) \frac{Q^\sigma}{Q^\sigma + \xi^{\sigma-1}} \right\} d\sigma, \tag{9}$$

$$L_u^S = N\bar{\ell} \int_{\hat{\sigma}}^{\infty} \left\{ \theta \frac{Q^\sigma}{Q^\sigma + \xi^{1-\sigma}} + (1-\theta) \frac{1}{2} \right\} d\sigma. \tag{10}$$

It is easy to show, from (5), that $\hat{\sigma}$ is decreasing in ξ that L_s^D and L_u^S is decreasing in $\xi = \frac{w_s}{w_u}$ and L_s^S and L_u^D are increasing in ξ. Equilibrium relative wage for a given quality level, $\xi^*(Q)$, is determined by the skilled labor market clearing condition,

$$L_s^D(\xi) = L_s^S(\xi).$$

The unskilled labor market has cleared by Walrus Law.

Comparative statics

We first see how the equilibrium labor supply and relative wage change with quality.

Claim 2. *(i) L_s^S, L_u^S and L_s^D are increasing and L_u^D are decreasing in Q.*

(ii) Equilibrium relative wages and level of skilled labor are increasing in quality. That is, $\partial\xi^*(Q)/\partial Q > 0$ and $\partial L_s^*(Q)/\partial Q > 0$.

(See Figures 5 and 6. Proof is in the Appendix.) Higher quality makes consumption attractive for skilled workers and also increase proportion of all workers that consumer the high quality product. Thus both demand and supply of skilled labor is increasing in quality. The same effect increases the supply of unskilled workers and reduces demand for low quality good. The latter effect implies demand for unskilled workers decreases when quality improves.

Skilled labor supply is increasing in population, $\partial L_s^S/\partial N > 0$, from (9) and demand is also increasing in population, $\partial L_s^D/\partial N > 0$, from (7). (See proof of Claim 2 in the Appendix.) This implies

Claim 3. *Both equilibrium skilled and unskilled labor will increase when population increases, $\partial L_s^*/\partial N > 0$ and $\partial L_u^*/\partial N > 0$.*

Again, using the proof of Claim 2 in the Appendix, both demand and supply of skilled labor is also increasing in proportion of skilled consumers, $\partial L_s^S/\partial\theta > 0$, from (9) and $\partial L_s^D/\partial\theta > 0$, from (7).

Claim 4. *Equilibrium skilled labor and equilibrium relative wage are increasing in the proportion of skilled consumers,$\partial L_s^*/\partial\theta > 0$ and $\partial\xi^*/\partial\theta > 0$.*

Birthrate

Individual number of children are,

$$n_s^H(\xi) = n_\sigma^*(w_s, w_s; Q) = \frac{\bar{\ell}}{Q^\sigma + 1}, \quad \sigma < \hat{\sigma},$$
$$n_s^L(\xi) = n_\sigma^*(w_u, w_s; 1) = \frac{\bar{\ell}}{\xi^{\sigma-1} + 1}, \quad \sigma > \hat{\sigma}$$
$$n_u^H(\xi) = n_\sigma^*(w_s, w_u; Q) = \frac{\bar{\ell}}{Q^\sigma \xi^{1-\sigma} + 1}, \quad \sigma < \hat{\sigma},$$
$$n_u^L(\xi) = n_\sigma^*(w_u, w_u; 1) = \frac{\bar{\ell}}{2}, \quad \sigma > \hat{\sigma}.$$

It is clear that for given wage level, those that consume high quality good devoted even more resources for consumption and thus reduce number of children when quality improves. Since the equilibrium relative wage in increasing in quality, we can say the following,

Claim 5. *(i) Skilled consumers have less children . That is , $n_s^H < n_u^H$ for $\sigma < \hat{\sigma}$ and $n_s^L < n_u^L$ for $\sigma > \hat{\sigma}$.*

(ii) Skilled consumers have less children when quality of product improves. That is, $dn_s^H/dQ < 0$ for $\sigma < \hat{\sigma}$ and $dn_s^L < dQ$¡0 for $\sigma > \hat{\sigma}$.

(iii) Unskilled consumers that consume low quality product have the same number of children when quality improves. That is, $dn_u^L/dQ = 0$ for $\sigma > \hat{\sigma}$.

Although there is the income effect, the substitution effect dominates and skilled workers that consumer low quality reduce number of children. For unskilled consumers that bought high quality good, improvement makes consumption more attractive (reduce children) but their relative wage becomes lower and the substitution effect works in the opposite direction. The total effect is not clear.

Endogenous quality

Assume that level of quality is increasing in the size of the skilled labor. That is, $Q = Q_T(L_s)$ is an increasing function of Q. Subscript T refers to "technology" which is what this relationship reflects. We will denote the inverse relationship between the market equilibrium supply of skilled labor and quality of $L_s^*(Q)$ by $Q = Q_M(L_s)$, which is an increasing function from Claim 2. The equilibrium level of labor L_s^* and equilibrium level of quality, $Q^* = Q_M(L_s^*) = Q_T(L_s^*)$, is the intersection of the two curves.

When marginal increase in quality from labor is very large, then the equilibrium is unstable. Graphically, this would mean slope of Q_T is steeper than Q_M $(Q_T' > Q_M')$. This is the case around equilibrium E_1 in Figure 7. A perturbation away from E_1 results in either spiral increase in quality and skilled labor supply or decrease of quality and skilled labor supply. When technology is mature so that marginal quality improvement is very small, then equilibrium is stable $(Q_T' < Q_M')$. This is equilibrium E_2 in Figure 7. There may be multiple equilibria, some stable and others unstable. A slight perturbation from low quality with small skilled labor force will start a spiral of labor and quality improvement until E_2 is reached.

Now using Claim 3, we analyze the effect of declining population. The claim implies that the $Q_M(L_s)$ function will shift upward in the $L_s - Q$ space (Figure 8).

Claim 6. *(i) If the technology is in its infancy, then equilibrium quality and skilled labor supply increase when population declines. That is ,*

$$Q_T' > Q_M' \quad \Rightarrow \quad \frac{\partial Q^*}{\partial N} < 0, \quad \frac{\partial L_s^*}{\partial N} < 0.$$

(ii) If the technology is mature, then equilibrium quality and skilled labor supply decrease when the population decreases. That is ,

$$Q_T' < Q_M' \quad \Rightarrow \quad \frac{\partial Q^*}{\partial N} > 0, \quad \frac{\partial L_s^*}{\partial N} > 0.$$

When the technology is mature, then declining population results in "contraction" of the economy. That is, quality and supply of skilled labor are reduced. Claim 5 suggests that lower quality will increase the birthrate. Recall that all but unskilled consumers that consumed high quality product will increase birthrate when quality improves. This situation is consistent with cohort effect.

The situation is different when the technology still has not exhausted increasing marginal returns. The new equilibrium results in more skilled labor and higher quality. Products are more polarized, skilled labor has higher relative wages and work more. Utility is derived from more consumption and there is less children. The cohort effect does not hold because the economy adjusts to the lower level of population according to the available technology.

Now we consider the effect of more skilled workers, using Claim 4. The claim implies that the $Q_M(L_s)$ function will shift downward in the $L_s - Q$ space (Figure 9). Immediately we have the following,

Claim 7. *(i) If the technology is in its infancy, then equilibrium quality and skilled labor supply decrease when the proportion of skilled workers increase. That is ,*

$$Q'_T > Q'_M \quad \Rightarrow \quad \frac{\partial Q^*}{\partial \theta} < 0, \quad \frac{\partial L_s^*}{\partial \theta} < 0.$$

(ii) If the technology is mature, then equilibrium quality and skilled labor supply increase when the proportion of skilled workers increase. That is ,

$$Q'_T < Q'_M \quad \Rightarrow \quad \frac{\partial Q^*}{\partial \theta} > 0, \quad \frac{\partial L_s^*}{\partial \theta} > 0.$$

Equilibrium quality will decrease (increase) when technology is in its infancy (maturity). When proportion of skilled consumers increase, each skilled worker needs to supply less labor to maintain the same quality. When marginal quality from labor is very large, quality must be lower to accommodate it. Lower quality (and lower wage) likely to imply higher birthrate. Thus when technology is sufficiently productive, the increasing skilled workers will increase the birthrate. On the other hand when the marginal product of labor is low, then higher labor implies higher quality. This may reduce the birthrate.

Claims 6 and 7 suggest that increasing the proportion of skilled labor can be effective in reversing decline in birthrate whenever the cohort effect may not hod. This was the case when marginal return from increasing skilled labor is large. On the other hand, when the technology is mature, Esterlin Hypothesis is likely to hold and the same policy will prevent the feedback mechanism that otherwise will function.

4 Concluding Remarks

We have employed comparative statics of a general equilibrium framework to understand the long term (stationary equilibrium) effect of declining population on the economy, including labor supply and birthrate. We incorporated vertically differentiated goods in the general equilibrium model based on the observation of time series and cross sectional date of birthrate - female labor participation relationship.

Our analysis suggests that if the technology is productive enough, the economy will adjust to smaller population and the cohort effect does not reverse the trend of declining population. We also showed that increasing the proportion of skilled consumers (potential workers) can increase birthrate and reverse the trend precisely when the cohort effect does not hold. We note that the same relationship between population size and proportion of skilled consumers means that changing the proportion can prevent the natural feedback mechanism from functioning when it would have functioned.

The two situations are characterized by if the technology has high marginal return from skilled labor (infant) or if this has been exhausted (mature). The economy will correct itself when it is mature, where we also observed the equilibrium to be stable. Therefore, another possible policy is to let the technology mature quickly.

Besides extending the model to a dynamic framework, analysis of an economy such as Japan requires understanding the effect of international trade. Assuming Japan will export high quality products, trade should reduce the substitution effect of high quality product while maintaining or increasing the income effect. This suggests trade by itself could correct the bias towards consumption and less children. On the other hand, existing trade literature (Flam and Helpman (1987), Theonig and Verier (2003)) suggest that trade will lead to greater specialization, particularly in a dynamic framework. This is left for future research.

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Appendix

Optimization of $u(Qx, n)$

Denoting the Lagrange multiplier by λ, fist-order conditions are,

$$u_n f_x = \lambda p, \quad u_n f_\ell = \lambda w, \quad u_n g_x = \lambda p, \quad u_n g_\ell = \lambda w,$$

and the budget constraint. This implies

$$\frac{f_x}{f_\ell} = \frac{g_x}{g_\ell} = \frac{p}{w}.$$

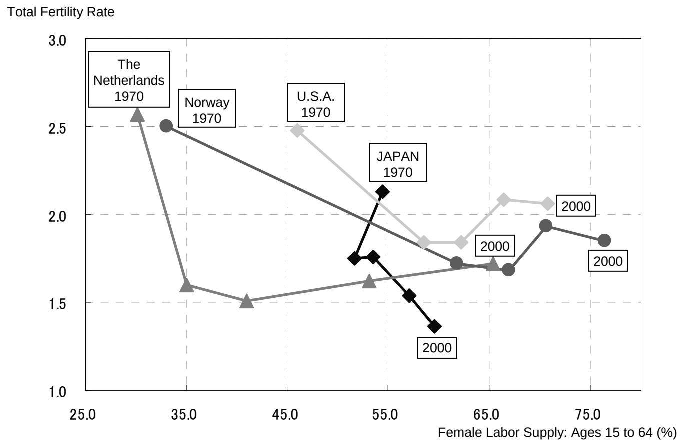
When w increases, ℓ_c and ℓ decrease while x and x_c increase.

Proof of Claim 2

The demand and supply functions, (7),(8), (9), and (10), can be rewritten as,

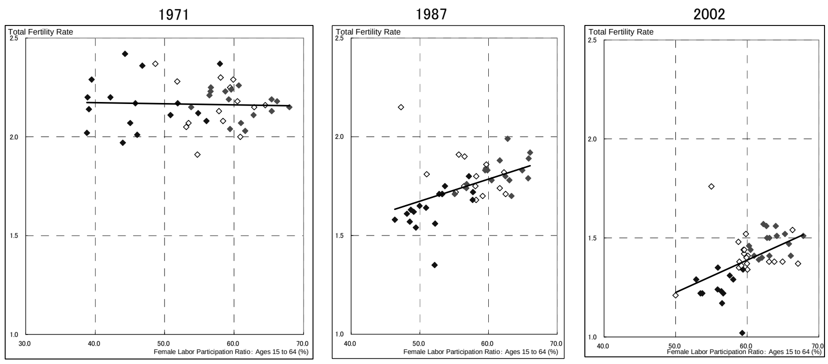
$$\begin{aligned}
L_s^S &= \theta N\bar{\ell}\int_1^\infty \frac{Q^\sigma}{Q^\sigma + \xi^{1-\sigma}}d\sigma + \theta N\bar{\ell}\int_{\hat{\sigma}}^\infty \left\{\frac{Q^\sigma}{Q^\sigma + \xi^{1-\sigma}} - \frac{Q^\sigma}{Q^\sigma + 1}\right\} d\sigma \\
L_s^D &= \theta N\bar{\ell}\int_1^{\hat{\sigma}} \frac{Q^\sigma}{Q^\sigma + 1}d\sigma + (1-\theta)N\bar{\ell}\int_1^{\hat{\sigma}} \frac{Q^\sigma}{Q^\sigma\xi + \xi^\sigma}d\sigma \\
L_u^S &= (1-\theta)N\bar{\ell}\int_1^\infty \left\{\frac{Q^\sigma\xi^{1-\sigma}}{Q^\sigma\xi^{1-\sigma} + 1} - \frac{1}{2}\right\} d\sigma + (1-\theta)N\bar{\ell}\int_1^\infty \frac{1}{2}d\sigma, \\
L_u^D &= (1-\theta)N\bar{\ell}\int_{\hat{\sigma}}^\infty \frac{1}{2}d\sigma + \theta N\bar{\ell}\int_{\hat{\sigma}}^\infty 1\xi^{-1} + \xi^{-\sigma}d\sigma.
\end{aligned}$$

The claim follows from noting that $\hat{\sigma}$ is decreasing in ξ and increasing in Q, and that $Q^\sigma\xi^{1-\sigma} > 1$ for $\sigma < \hat{\sigma}$.



NOTE) 5 time points: 1970, 1980, 1985, 1990, and 2000.

Figure 1: TFR and female labor supply 1970,80,85,90,2000
(Council for Gender Equality, Special Committee on the Declining Birthrate and Gender-Equal Participation, 2006a)



NOTE) Pink points are TYPE1(low declining rate in TFR and high level of TFR and female labor supply). Blue points are TYPE7(high declining rate in TFR and low level in TFR and female labor supply).

Sources) Ministry of Internal Affairs and Communications “Employment Status Survey,” National Institute of Population and Social Security Research “Indicators of Fertility by Prefecture in 1970-1985,“ and Health, Labor and Welfare Ministry “Population Survey Report.”

Figure 2: TFR and female labor participation ratio by prefecture in 1971, 1987, 2002
(Council for Gender Equality, Special Committee on the Decling Birthrate and Gender-Equal Participation, 2006b)

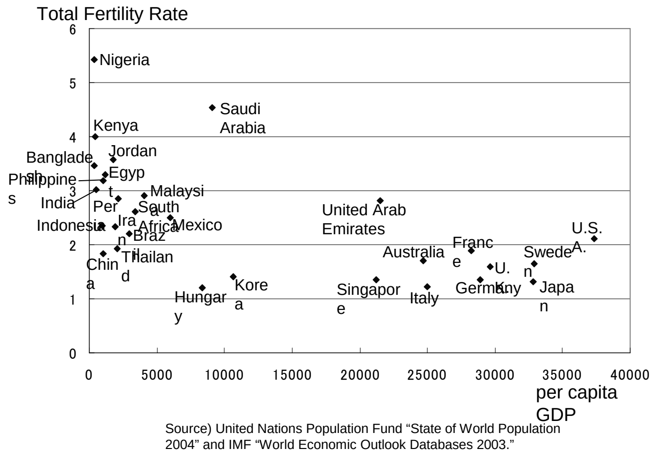


Figure 3: TFR and Per Capita GDP
(Council for Gender Equality, Special Committee on the Declining Birthrate and Gender-Equal Participation, 2006a)

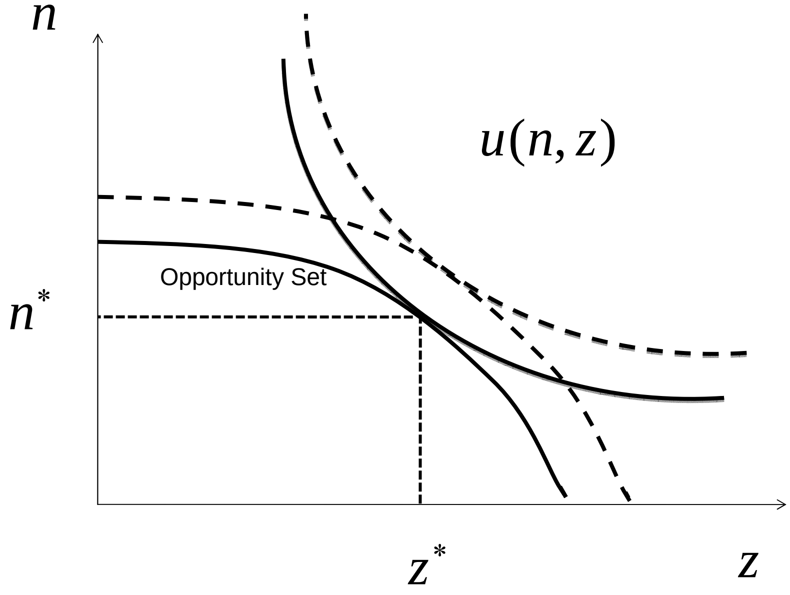


Figure 4: Optimization Problem

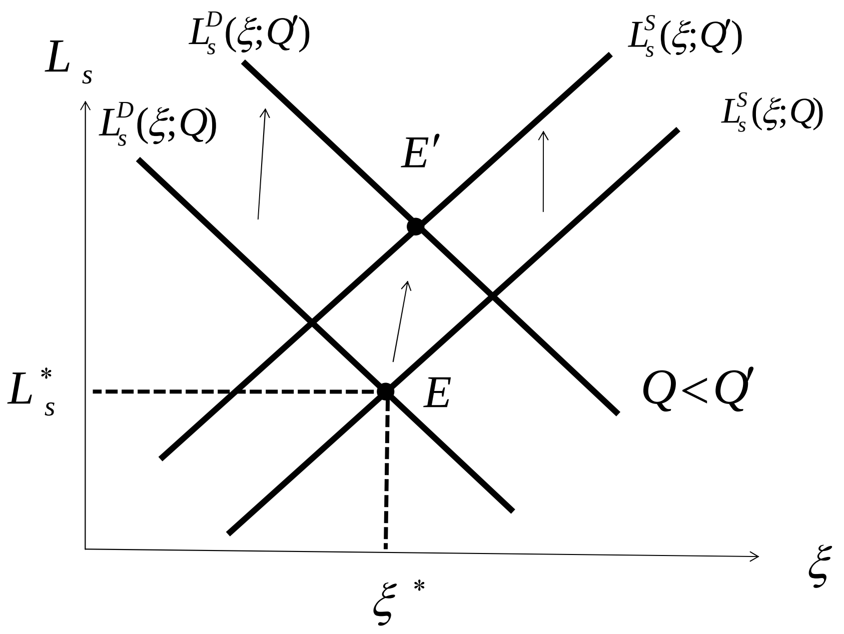


Figure 5: Skilled Labor Market

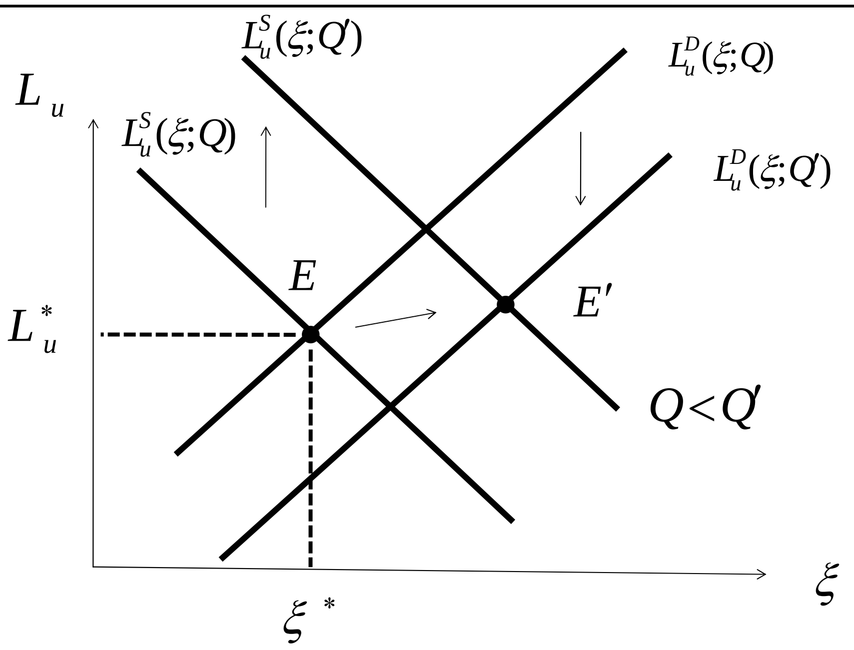


Figure 6: Unskilled Labor Market

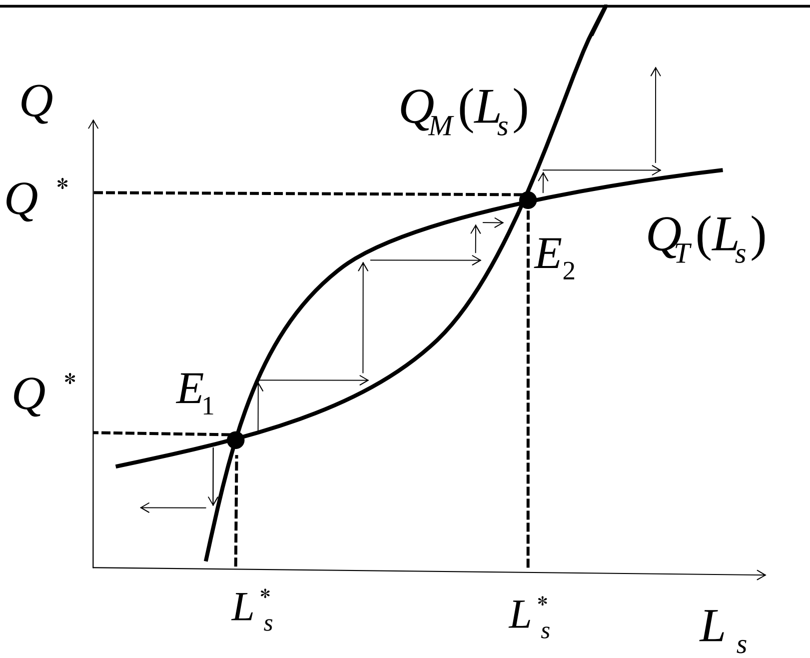


Figure 7: Equilibrium Quality and Skilled Labor

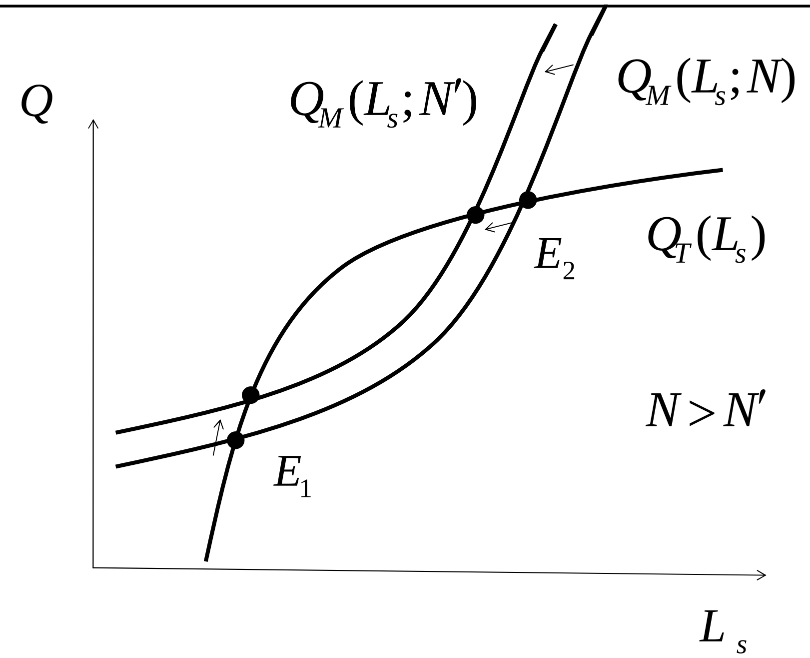


Figure 8: Declining Population

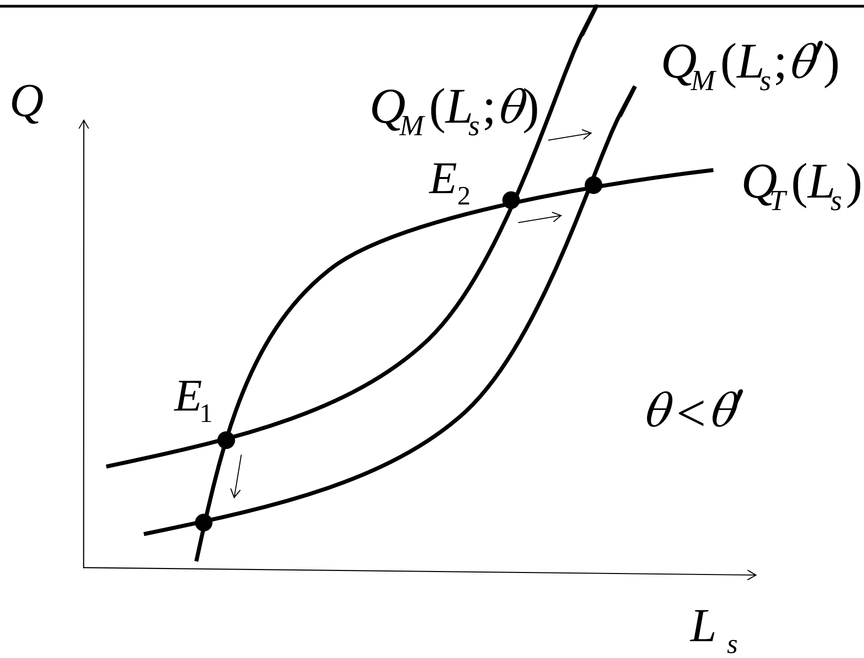


Figure 9: Larger Proportion of Skilled Labor