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Does More Female Labor Supply Really Save a Graying Japan?

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Abstract

This paper examines the impact of stimulated female labor supply on the Japanese economy as well as the government fiscal imbalance within a numerical dynamic general equilibrium model with multiple overlapping generations, particularly by paying attention to females' time costs of child rearing and elderly care in a graying Japan. Several numerical results indicate that even complete elimination of females' time costs of child rearing and elderly care stimulates the total GDP only by 1 percent. If complete elimination of time costs occurs in accordance with no gender gap in wage profiles, then the total GDP expands by 4 percent. The results also suggest importance of government policies not only to stimulate female labor force participation but also to improve human capital accumulation of females to reduce a gender gap in wage profiles.

Keywords: Female Labor Supply, Childcare, Child Allowance, Elderly Care, Public Pension, Long-Term Care Insurance, Population Aging, Japan, Simulation

JEL Classification: C68, H51, E62, H55, and J16

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1 Introduction

This paper examines the impact of stimulated female labor supply on the Japanese economy as well as the government fiscal imbalance within a numerical dynamic general equilibrium model with multiple overlapping generations, particularly by paying attention to females' time costs of child rearing and elderly care in a graying Japan.

In the rapidly growing literature on population aging of Japan, in order to improve fiscal imbalance and to reduce heavier burdens in social security schemes, a possible positive impact of stimulated female labor supply has been pointed out. Hansen and İmrohoroğlu (2016) suggested in their neoclassical model that stimulation of more female labor force participation could be one of options to avoid an unrealistically high consumption tax rate in the future of Japan. Braun and Joines (2015) estimated a 5 % increase in output in a steady state within the framework of Auerback and Kotlikoff (1987), when a gender gap in wage profiles between male and female regular workers shrinks to be 10 % and 70 % of female non-regular workers become regular in Japan. İmrohoroğlu et al (2016) argued the quantitative importance of raising the female labor force participation rates in Japan. While the importance of female labor supply to save a graying Japan has gradually been recognized, the reason why female labor force participation is still low has clearly not been taken into account. This paper explicitly considers the time costs to prevent female workers from supplying their labor; females' time costs of child rearing and elderly care. The time spent on child rearing and elderly care by females is historically still long in Japan, and this paper focuses on the impact of elimination of such time costs on the Japanese economy as well as the fiscal imbalance.

A simulation analysis must take into account realistic aspects as much as it can. First, the latest population projection by the National Institute of Population and Social Security Research (IPSS) (2017) is used for the future demographics. The past population data is also used as much as possible. Second, several assumptions on the future economic environment given in the latest version of *Economic and Fiscal Projections for Medium to Long-term*

Analysis (EFPMLA: January 2016) are used to specify the future economy such as primary balance and future government deficits. EFPMLA (2016) numerically embodies the so-called *growth strategy*, the main policy of Abenomics, and this paper tries to examine to the extent how much assumptions given in Abenomics are realistic within the framework of Auerback and Kotlikoff (1987) with the latest population projection. Third, the future path of already highly accumulated public pension fund is assumed to follow the assumption by the Ministry of Health, Labor and Welfare (MHLW). Fourth, the general account, the public pension account, and the long-term care insurance (LTCI) are separately considered explicitly in order to reflect reality. Realistic structures of the contribution and replacement rates in the public pension as well as of the cost distribution in the LTCI are also taken into account in numerical experiments.

Several numerical results are obtained as follows: First, even when females' time costs of both child rearing and elderly care are completely eliminated, the impact of such elimination on the Japanese economy and thus on the fiscal imbalance is very little. While the complete elimination of time costs of both child rearing and elderly care induces a 2 % increase in potential labor force, the impact of such elimination on the total GDP is at most 1 %. Since elimination of time costs stimulates total labor supply in efficiency unit, GDP per capita (over labor in efficiency unit) decreases by elimination of time costs. This also reduces wage, thus resulting in a slight decrease in the ratio of time of labor supply to additionally increased available time by elimination. While the total amount of labor supply in efficiency unit increases in the whole economy, the ratio of labor supply to additionally increased available time by the household decreases by the relatively stronger substitution effect than the income effect. This very small impact on the Japanese economy rises from the fact that the negative effect of reduced wage also exists in addition to the positive effect of an increased total labor supply by elimination of time costs. While the negative effect is relatively stronger than the positive effect at the beginning when time costs are eliminated, the positive effect gradually outweighs the negative effect, thus the total GDP eventually expands even though the total GDP initially shrinks at the beginning of elimination of time costs. Second, another reason of the very limited impact on the total GDP rises from a wide gender gap in wage profiles. If a gender gap in wage profiles completely vanishes, then the total GDP eventually expands by approximately 4 %. The positive effect of a substantial increase in labor supply in efficiency unit is partially weakened by the negative effect of reduced wage. Third, exclusion of the negative effect of reduced wage from the overall effect in our counterfactual experiment unexpectedly reduces the total GDP for the first 50 years, while the total GDP eventually expands. If wage does not go down even when more female labor is supplied in the labor market, then wage staying at a high rate induces the strong income effect, so that lifetime labor supply by the household substantially decreases. A fall in wage rather weakens such a strong income effect to further reduce labor supply preferably. Reduced wage does necessarily not result in a worse outcome, and obstacles in the labor market to interfere a flexible change in wage should be removed. Fourth, when a child allowance increases, both GDP per labor in efficiency unit and the total GDP increase. An increase in GDP per labor also induces an increase in wage. The positive impact of an increased child allowance soon appears by stimulating savings, and the impact of such an increase in a child allowance is larger than that of elimination of time costs at the beginning. However, the positive impact of elimination of time costs eventually becomes stronger than that of an increase in a child allowance in the long-run, but such a result is obatained only when elimination of time costs occurs with no gender gap in wage profiles.

The above results indicate that stimulated female labor supply would not help the Japanese economy improve its economic environment in a graying Japan, as long as a wide gender gap in wage profiles exists. If the gender gap in wage profiles rises from more human capital of males than that of females, then government policies not only to stimulate female labor force participation but also to improve human capital accumulation of females should be implemented. Additional policies to help female workers accumulate their human capital through on-the-job training and off-the-job-training on their maternal leave are suggested.

This paper is organized as follows. The next two sections review the background and the literature. Then Section 4 introduces the model in detail. Section 5 explains calibration, and Section 6 presents numerical results in detail. Section 7 concludes the paper.

2 The Background

2.1 Demographics of Japan

The National Institute of Population and Social Security Research (IPSS) released the latest population projection of Japan in year 2017. Figures 1-1, 1-2, and 1-3 show the difference between the last projection of year 2012 and the latest projection of year 2017, respectively[1]. Note that the IPSS also releases the projected demographic structure for another 50 years in each projection as a reference estimate in the projections[2]. In Figures 1-1, 1-2, and 1-3, all values have been obtained from the projections by the IPSS.

In year 2010 the total population was 128 million at peak, but it has been decreasing since year 2011. While all figures show that the latest projection was made based on a slightly optimistic assumption, population aging in Japan is still rapid and high enough for currently on-going arguments. Even under the relatively optimistic assumption made in the latest projection of year 2017, the total population is expected to shrink to less than 60 million in the next 100 years. Reflecting population aging, the labor force is also expected to drastically decrease as shown in Figure 1-4[3]. The future decreasing trend of labor force suggests a further severe economic environment in a graying Japan.

[1] In all figures, the actual data has been used until year 2010 for the projection of year 2012 and until year 2015 for the projection of year 2017. On the future projected values, the midium variant values of the fertily rate as well as of the death rate are used for both projections in the figures. The aging rate is defined as the ratio of age 65 and over to the total number of population, and the dependency ratio is defined as the ratio of age 65 and over to the total number of age 20 to age 64 in each figure.

[2] A reference estimate for another 50 years in the last projection of year 2012 starts from year 2061, and also that in the latest projection of year 2017 starts from year 2066.

[3] The labor force is calculated based on the total number of age 18 and over of both genders and also on the wage profile of male non-regular workers of age 20 - 24 in year 2012 for calculation of efficiency. The detailed explanation will be given in the next section.

On the demographic structure, this paper uses the actual data from year 1920 to year 2015, and the future population projection of year 2017 from year 2016 to year 2115 for the specification of parameter values. Note that in the growing literature all studies assume that the Japanese economy converges to a new steady state with a low dependency ratio after experiencing its very high ratio at peak. However, based on the latest population projection of year 2017, a new steady state is described with a quite high dependency ratio. The IPSS estimates that the Japanese economy remains in a steady state with a high dependency ratio. Thus, since the latest population projection of year 2017 by the IPSS only shows the reliable future demographics of a graying Japan, this paper uses the entire estimates by the IPSS until year 2115, rather than imposing any assumption to converge to a new steady state with a low dependency ratio in the next 100 years. Note also that this paper tries to use the oldest data of the past population structure as much as possible, and it uses the actual past demographics from year 1920. Since there are many overlapping generations alive even in a initial state, the past demographics directly affect the initial state. This paper tries to minimize the impact of ad-hoc assumptions on the initial demographic structure on model specification in a benchmark model.

2.2 The Gender Differences in Wage and Time

In order for the Japanese government to cope with fiscal imbalance in a graying Japan, several studies point out the importance of female labor supply (Braun and Joines (2015), Hansen and İmrohoroğlu (2016), and İmrohoroğlu et al (2016)). Figure 2 shows the wage profiles of male and female workers, calculated based on the Basic Survey of Wage Structure (BSWS) of year 2011. In the figure, non-regular workers include temporary, and dispatched workers (hi-seiki). The annual wage of male non-regular workers of age 20 - 24 is used for normalization. The observed wide gap in the wage profiles between male and female regular workers in Japan was pointed out by Lise et al (2014), and Day (2012) argued several reasons for the Japanese case in association with the recently observed positive relationship between the fertility rate and economic growth. Lise et al (2014) empirically estimated inequality in Japan, and they concluded that inequality between male and female workers is becoming wider. Day (2012) tried to answer the puzzle observed in Japan that Japanese female relative wages have remained relatively constant over the last decade in spite of the Japanese economic growth[4], and she explained the gap by gender inequity in firm-specific human capital.

Gender inequity in firm-specific human capital seems to be related to the difference in time allocation between male and female workers, as Day (2012) pointed out. Figure 3-1 and 3-2 show the time spent on child rearing and elderly care, calculated based on the Survey on Time Use and Leisure Activities (STULA) of year 2012, respectively. In both figures, the relative time to working hours at different ages is shown. Both figures show the gaps in the time cost not only in gender but also in the type of jobs (regular or non-regular)[5].

This paper explicitly considers such differences in wage and time between male and female workers, and tries to explore the impact of more female labor force participation in a graying Japan. Several experiments will be conducted when females' time costs of child rearing and elderly care are reduced so that female workers can work more. If female workers can work more, then gender inequity in firm-specific human capital would becomes smaller, thus resulting in a smaller gap in the wage profile between male and female workers. The experiment of reduction of the wage gap is also conducted to examine how much the total labor supply changes.

[4]As Day (2012) pointed out, the positive relationship between the fertility rate and economic growth has recently been observed among developed countries, although it was opposite before. Galor and Weil (1996) developed a theoretical framework to explain the negative relationship between the fertility rate and economic growth in the relatively old data, but Day (2012) developed a theoretical framework to explain the positve relashionship in the recently observed data.

[5]It was argued in the past in Japan that females should look after their children and also their parents-in-law. While the common view keeps changing in Japan, thus more females tend to work, there would still be an old idea that females should stay at home for rearing children and looking after their parents-in-law, particularly among males's idea.

3 The Literature

A number of studies have investigated the impact of population aging in Japan on the government budget, including the public pension, the national health services, and the long-term care insurance schemes.

It is the common knowledge in the growing literature that more fiscal imbalance of the Japanese government cannot be avoidable without drastic policy changes in the future of an aging Japan. In the vast literature, several policy options, such as a drastic cut of government expenditures, the prolonged retirement age, a substantial increase in several taxes, the reduction of the replacement rate in the public pension scheme, the change in timing of implementation of policies, and an introduction of a new scheme, have recently been suggested in order to make the future government schemes sustainable. Since Homma et al (1987) applied Auerbach et al (1983) to the Japanese context to examine the impact of the tax reform, the framework of Auerback and Kotlikoff (1987) has developed substantially for examining population aging of Japan[6]. Yamada (2011) examined political feasibility of the social security reform in Japan, particularly paying attention to the two-tier structure of the public pension scheme, and suggested a politically feasible option. While labor supply was exogenous in Yamada (2011), Kitao (2015a) and Braun and Joines (2015) recently investigated the impact of population aging in Japan within the framework of endogenous labor supply. Braun and Joines (2015) experimented the impact of different future fertility rates, thus different future population structures, on the schemes of public pension and national health services within their forward looking model[7]. Kitao (2015a) used the dynamic programming

[6]Within the standard growth model, İmrohoroğlu and Sudo (2010) concluded that a 15 % increase in the consumption tax rate would not result in a surplus of the primary ballance even under the assumption of a 3 % increase in the annual GDP growth rate in the next 20 years, and then sugggested a drastic cut of govenment expenditures to make the future policy sustainable. Hansen and İmrohoroğlu (2016) also concluded with the neoclassical growth model that the fiscal sustainablity could not be achieved without a large increase in the consumption tax rate nearly up to 60 %. They also suggested five other options to make the policy sustainable: Reforms of the schemes of public pension and national health services, the immigration policy, stimulated fertility, more participation of female labor, and high innovation. Doi et al (2011) and Hoshi and Ito (2012) also similarly concluded that a large increase in the consumption tax rate is needed for sustainabllity in their emprical research.

[7]Miyazawa and Yamada (2015) also used a forward-looking model. Attanasio et al (2007) solved their

(DP) method in her model[8], and considered the long-term care insurance scheme separately, taking into account endogenous labor supply in both intensive and extensive margins[9] with income shocks. While Braun and Joines (2015) obtained the result of the negative impact of reduced pension benefits on labor supply as well as on welfare, Kitao (2015a) reversely resulted in the positive impact of such reduction on labor supply and welfare. According to Braun and Joines (2015), their opposite result could be attributed to the different assumption in their experiments[10]. Kitao (2015b, and 2017) further examined several policy options in the public pension scheme in an aging Japan. Kitao(2015b) proposed an introduction of individual retirement accounts (IRA), which seem similar to the transfer from the current pay-as-you-go scheme to the fully-funded scheme, and obtained the positive impact of the introduction on capital, labor, and welfare. Kitao (2017) also explored the impact of the reduction of the replacement rate of the public pension as well as the prolonged retirement

two-region model in the same way, to investigate the impact of social securiy reforms when capital freely moves between two regions.

[8]İmrohoroğlu et al (1995) used the dynamic programming method to examine the impact of social security with overlapping generations of 65-period lived individuals facing mortality risk and individual income risk. An applied general equilibrium model with overlapping generations of multi-period lived individuals has been developed with the DP method, where income shocks in addition to mortality risk usually exist. These articles include De Nardi et al (1999), Conesa et al (2009), Yamada (2011), İmrohoroğlu and Kitao (2009 and 2012), Kitao (2014, 2015a, 2015b, and 2017) , and Kitao et al (2017). In particular İmrohoroğlu et al (1995) and Conesa et al (2009) numerically showed the optimality of non-zero tax and non-zero replacement rates where the market is incomplete with un-hedged risk and the liquidity constraint.

[9]Rogerson and Wallenius (2009) theoretically studied endogenous labor supply in intensive and extensive margins. Diaz-Gimenez and Diaz-Saavedra (2009) explored the impact of social security on endogenous retirement age in Spain. On the imapct of social security on endogenous retirement age decison, many empirical articles investigated. These include Rust and Phelan (1997), French (2005), Gustman and Steimeier (2005), Benitez-Silva and Heiland (2007 and 2008), and Van der Klaauw and Wolpin (2008). Rust and Phelan (1997) empirically esitimated, based on the dynamic programming model in the presence of incomplete markets, that low income individuals would not take an early retirement option. French (2005) expanded Rust and Phelan (1997) by imposing the liquidity constraint in its estimation of the dynamic programming model, and found that the impact of the earning test is the largest on retirement decision, while the impact of pension benefits is very little. Gustman and Steimeier (2005) explicitly introduced the different time preference into their estimation, and Benitez-Silva and Heiland (2007 and 2008) explored the impact of the earning test and the prolonged retirement age to 67 in the US. Van der Klaauw and Wolpin (2008) explicitly took into account other key elements such as intentional bequests, health status, Medicare, and employer-provided health isnuranc ecoverage for retirement decision. French and Jones (2011) estimated the impact of health insurace on endogenous retirement decision.

[10]Braun and Joines (2015) referred to the assumption that both pension benefits and public medical benefits are simultaneously reduced in Kitao (2015a). Note that the reduction of public medical benefits implies a decreases in the co-payment rate, which induces more private savings. Thus, if private savings are substantially stimulated, then the reduction in both benefits could result in stimulated labor supply, higher economic actitivies, and also higher welfare.

age from 65 to 68. In Kitao (2017) the difference in timing of implementation of such policy changes was also investigated, and she obtained the result that the delayed policy change is more preferable among current generations, but not future generations.

In the recently growing literature on population aging in Japan within the framework of Auerback and Kotlikoff (1987), there are several common assumptions. First, they all use the population projection of year 2012, and also only use the values up to year 2060. Then, they impose several assumptions on the future demographics after year 2060, all of which basically result in the stable demographics with the low aging rate and the dependency ratio in the future eventually. However, as Figures 1-1, 1-2, and 1-3 show, the population projection of year 2017 with a reference estimate up to year 2115 by the IPSS shows the stable demographics with the very high aging rate and dependency ratio. Obviously, such future demographics indicates more pessimistic results in comparison with recent studies. In the population projection of year 2017, the total population of each cohort from age 0 to 100 from year 2016 to year 2065 is available in the usual estimate[11]. Furthermore, the figures from year 2066 to 2115 are also available as a reference estimate. This paper uses both estimates for specification of parameter values of fertility and mortality rates of each cohort from year 2016 to year 2115. On the past value, the actual demographic data is used for specification from year 1920 to year 2015. Second, although the general account, the pension account, and the long-term care insurance account in the government budget are all separately operated in reality[12], many studies have simple assumptions with an integrated budget constraint of the government. This paper explicitly considers separated budget constraints with transfers between different accounts. Third, several assumptions on the future government deficits and the public pension fund seem unrealistic and sometime unspecified clearly. The assumption on the future paths of government deficits and the public pension fund does matter for the argument on fiscal imbalance of public schemes. The future amount of interest payments

[11]Precisely speaking, the estimated value of year 2015 is also available in the projection. However, since the actual data of year 2015 is also available, this paper uses the projection value from year 2016.

[12]Several transfers between accounts in reality must be mentioned.

incurred by accumulated government bonds as well as the interest receipt from accumulated public pension fund in reality is not negligible. In this paper, a realistic assumption on the future government deficits and the public pension fund is made, in order to reflect the currently on-going policy. Miyazawa and Yamada (2015) investigated the feasibility of the growth strategy of Abenomics within the framework of Auerback and Kotlikoff (1987), and they concluded that a surplus in the primary balance by year 2020 seems difficult to be achieved, which has been promised by the Japanese government. Their conclusion was obtained even under optimistic assumptions given in Abenomics. This paper tries to follow the assumptions in Abenomics as close as possible, and examines the impact under more realistic assumptions on the future government deficits and the future public pension fund.

The purpose of this paper is to examine the impact of more participation of female labor on the economy and the government schemes in a graying Japan within the framework of Auerback and Kotlikoff (1987). As Braun and Joines (2015), Hansen and İmrohoroğlu (2016), and İmrohoroğlu et al (2016) pointed out, more participation of female labor could be an option to save a graying Japan. While Kato and Kawade (2015) studied the impact of more female labor supply obstructed by child rearing on the Japanese economy, they argued the impact without any specific reason why female labor supply is obstructed This paper explicitly incorporates the financial and time costs of child rearing as well as elderly care of females in Japan. This paper also takes into account the realistic aspect in the type of jobs; regular and non-regular jobs. As İmrohoroğlu et al (2016) explicitly assumed, the difference in the job type in Japan is widely observed, and the difference substantially causes the wage gap between two different types. In particular, the wage gap between regular male and regular female workers is very wide, and the wide wage gap is the key aspect for analyzing the impact of more participation of female labor. In İmrohoroğlu et al (2016), the optimal decision making behavior was not incorporated[13], but this paper studies the impact of more female labor supply with the optimal behavior under the assumption of different type of jobs

[13] In İmrohoroğlu et al (2016) the actual aspect of the Japanese public pension scheme is examined in detail.

between males and females.

Regarding the literature on female labor supply and female wage, several studies argued the gender gap in association with fertility. Galer and Weil (1996) developed a theoretical model to explain an observed inverse relationship between fertility and economic growth by taking into account the gender gap. Recently, however, the positive relationship has reversely been observed at least in developed countries. Apps and Rees (2004) and Day (2012) tried to theoretically explain it, by incorporating the optimal behavior of females: Females can rear their child in their maternal time at home, or they can use bought-in childcare services outside and thus they can work in the labor market. In particular, the impact of the financial child support as well as the physical provision of childcare facilities on fertility was investigated[14]. The time cost of child rearing can possibly be reduced by bought-in childcare services. While this paper does not take into account explicit causality of bought-in childcare to elimination of the time cost of child rearing, the reduction of the time cost of child rearing can be attributed to more provision of childcare facilities in the context of this paper.

In Japan, while the positive relationship between childcare and fertility has been empirically supported, Fukai (2017) recently questioned an endogeneity problem in the past studies, and empirically examined it with municipality data to conclude that the positive relationship can be found only in the municipalities where strong motivation of female labor supply is observed. The strong evidence for the impact of more childcare support on more fertility cannot be found in Japan, and this paper simply uses future values of the fertility rate calculated based on the IPSS data, and thus takes the future fertility rate and demographics as given.

In the Japanese context, Unayama (2011 and 2013) and Unayama and Yamamoto (2015) empirically investigated the impact of an expansion of nursery services on female labor

[14]Momota (2000) theoretically studied a possibility of a decrease in fertility caused by a rise in the financial child support. Fertility can be affected by other reasons. Hazan and Zoabi (2015) explored the impact of education of females on fertility, and they pointed out a possiblity that highly educated women are able to have more children and work longer hours.

supply and marriage decision. There are also several empirical studies on the impact of several government policies on marriage decision and female labor supply (Higuchi (1994), Shigeno and Ohkusa (1998 and 1999), Suruga and Nishimoto (2002), and Nagase (2007)). Asai et al (2015) empirically investigated the impact of childcare on maternal employment by using panel data in Japan.

This paper examines the impact of more female labor supply on the economy and the government schemes, particularly by paying attention to females' time costs of child rearing and elderly care within the framework of Auerback and Kotlikoff (1987). If females have an option of maternal childcare and bought-in childcare and also bought-in childcare becomes cheaper, then females will substitute bought-in childcare for maternal time. Bought-in childcare services at the lower cost will reduce the time cost of child rearing. While causality of bought-in childcare services to reduction of the time cost of child rearing is not taken into account explicitly due to data limitation, a fall in the time cost of child rearing can rise from cheaper bought-in childcare. Since this paper also consider a financial child allowance, relative effectiveness between bought-in childcare and a child allowance is also examined. On the time cost of elderly care by females, the public long-term care insurance for the elderly is explicitly considered. The time cost of elderly care can be reduced by more provision of elderly care services through the public long-term care insurance for the elderly. While causality of elderly care services through the long-term care insurance to reduction of the time cost of elderly care is also not taken into account explicitly due to data limitation, a fall in the time cost of elderly care can rise from more provision of elderly care services through the long-term care insurance.

4 The Model

4.1 Demographic Structure

An overlapping generations economy in discrete time with a model period of one year is considered. The representative household in each cohort appears in the economy at age 20 as a decision maker. Although the household faces uncertainty regarding its death in each period, it dies with certainty at the end of its age of 99 if it is alive until age 99. It is assumed that there is no uncertainty regarding the size of the total population in each period. Denote the survival rate by P_s, which is defined by $P_s = \prod_{i=1}^{s} q_i$, where q_{j+1} is the conditional survival rate of a j years old household which survives to $j+1$ years old. Due to uncertainty of lifetime in each period, accidental/unintended bequests generated by death of all cohorts exist in each period, and such bequests are distributed to the surviving household in a particular age. Denote the pre-taxed amount of accidental/unintended bequests inherited in age s at time t by $bq_{s,t}$, and each cohort receives the net bequests denoted by $(1-\tau_{q,t})\, bq_{s,t}$ once in its life, where $\tau_{q,t}$ is the inheritance tax rate at time t. No bequest motives are assumed so that the representative household of each cohort enters an economy with no assets. No liquidity constraint is imposed. The age-specific fertility and mortality rates are time variant, both of which are calculated based on the actual past data and the projection of year 2017 by the IPSS. This implies each cohort has different fertility and mortality rates over time, and P_s differs among different cohorts.

4.2 The Representative Household

The representative household in each cohort is forward-looking, and future events affect decisions made today. The representative household faces lifetime uncertainty in each period, but there is no other uncertainty such as an income shock through its lifetime[15]. The

[15] If there is also uncertantiy in lifetime wage income, then precautionary savings motives exist. Thus, with the assumption of no income shocks, the magnitude of the impact of any policy change on savings, thus on the capital labor ratio, will be smaller. However, qualitative results should not be affected.

representative household consists of four different types of workers. Workers differ, depending on the gender as well as the types of the job contract. Workers are differentiated by the difference in their job types with their employer; regular workers (Seiki koyo) and non-regular workers (Hi-Seiki koyo). The latter workers include part-time, dispatched, or fixed term workers. Thus, there are four different workers in the representative household in each cohort; male regular, female regular, male non-regular, and female non-regular workers, respectively. While the representative household consists of four different workers, there is no heterogeneity in terms of preference among them, and the representative household in each cohort is assumed to have unitary preference[16].

The representative household is assumed to maximize its expected lifetime utility with respect to its own consumption and leisure time. The household's expected lifetime utility of cohort g, denoted by $E\left[V_g\right]$, is given

$$E\left[V_g\right] = \sum_{s=20}^{99} P_s \left(1+\delta\right)^{-(s-20)} \frac{u\left(c_{s,t}, l_{s,t}\right)^{1-\rho}}{1-\rho}, \tag{1}$$

where ρ is a reciprocal of the elasticity of substitution between consumption at the different time. δ is the time preference. $c_{s,t}$ and $l_{s,t}$ are consumption and leisure of a s years old household at time t, respectively. Note that there is a relationship of $t = g + s$. The felicity function of u is given by:

$$u\left(c_{s,t}, l_{s,t}\right) = \left[c_{s,t}^{\frac{\xi-1}{\xi}} + \kappa l_{s,t}^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}}, \tag{2}$$

where ξ denotes the elasticity of substitution between consumption and leisure, and κ denotes the weight parameter for leisure.

[16]For simplicity, the collective approach to modelling the household is not adopted. See Basu (2006) and Agenor (2017) for the collective approach.

The budget constraint of the representative household is:

$$a_{s+1,t+1} = [1 + (1 - \tau_{r,t}) r_t] a_{s,t} + (1 - \tau_{w,t} - \tau_{p,t} - \tau_{e,s,t}) e_s (1 - l_{s,t} - lc_{s,t} - le_{s,t}) w_t$$
$$+ (1 - \tau_{w,t}) b_{s,t} + d_{s,t} + (1 - \tau_{q,t}) bq_{s,t} - (1 + \tau_{c,t}) c_{s,t} - h_{s,t} - IC_{s,t} - \theta_t LT_{s,t}, \quad (3)$$

where $a_{s,t}$ is the amount of assets held by a s years old household at the beginning of time t. e_s is the measure of efficiency of labor of the household, and e_s is the weighted average of efficiency of four different workers. Note that efficiency is different in age among all four different workers as well. $lc_{s,t}$ and $le_{s,t}$ denote the time spent on child rearing and elderly care, respectively, both of which are assumed to be exogenously given to the household. $d_{s,t}$ and $h_{s,t}$ denote a financial child allowance given by the government and the financial cost of child rearing in age s at time t, respectively. The representative household in each cohort is assumed to have the average number of children when it becomes age 28 (the age of its child is 0)[17]. As expressed by (1), the representative household does not have any utility from having a child. It starts rearing its own child until its child becomes age 20, thus until its own age of 48[18]. To reflect reality, a financial child allowance is given to the representative household by the time when its own child becomes age 15. This implies that the representative household in each cohort receives a child allowance between its own ages of 28 and 43, while it has to pay the financial child rearing cost until its own age of 48. The actual data of $d_{s,t}$ from Cabinet Office of Japan is used to specify the value in the model. On the value of $h_{s,t}$, the study on the financial cost of child rearing conducted by Cabinet Office of Japan (2010) is used.

$\tau_{r,t}$, $\tau_{w,t}$, $\tau_{p,t}$,and $\tau_{c,t}$ are the interest income tax rate, the wage income tax rate, the public pension contribution rate, and the consumption tax rate, respectively. $\tau_{e,s,t}$ is the contribution rate to the long-term care insurance (LTCI), which is applied to the representative

[17]The average number of children the representative household in each cohort has is calculated by the ratio of the total number in the cohort of age 0 to the total number in the cohort of age 28 in each period.

[18]Precisely speaking, the household keeps rearing its own child until the end of age 19 of its own child.

household while it is working in age s at time t[19]. After retirement, the representative household still has to contribute to the LTCI. The fixed amount of contributions is denoted by $IC_{s,t}$ in age s at time t. Note that an individual starts to contribute to the LTCI once she becomes age 40 in Japan. Between age 40 and 64, all individuals belong to the second group (age group between 40 and 64), and the amount of their contributions depends on their earnings. Their contribution rate is given by $\tau_{e,s,t}$. Once an individual becomes age 65, then she is transferred to the first group (age group of 65 and over), in which she still has to contribute to the LTCI, but the amount of contributions is fixed by $IC_{s,t}$. This paper takes into account such a realistic aspect of the LTCI, and the contribution rate for the second group (age group between 40 and 64) and the fixed amount of contributions for the first group (age group of 65 and over) are both calculated based on A Summary of the Long-term Care Insurance by the Ministry of Health, Labor and Welfare (MHLW; 2017). $LT_{s,t}$ is the total cost of obtaining services through the LTCI, and the θ_t is the co-payment rate at time t. $LT_{s,t}$ is calculated based on Survey of Long-term Care Benefit Expenditure (SLCBE) of year 2014, and $LT_{s,t}$ is assumed to be age-dependent, but time invariant. θ_t is assumed to be 0.1 to reflect the current rate.

Labor efficiency of four different workers is obtained from the data. In this paper, Basic Survey of Wage Structure (BSWS) of year 2011 and Labor Force Survey (LFS) of year 2012 are both used to specify the efficiency profile of each worker over time. The weight for efficiency of the household in age s, e_s, was calculated from these two data sets. In the simulation section, efficiency of male non-regular workers in age 20 - 24 is used to normalize efficiency of other workers in different age. Note also that the wage rate, w_t, the household faces is determined in the competitive labor market, and the total wage income of the household is the weighted average wage income of four different workers. The wage profiles of four different workers are obtained from the above two data sets. The time spent on child

[19]Precisely speaking, although the retirement age is assumed to be fixed at age 65, the positive rate of $\tau_{e,s,t}$ is applied up to age 64, and it becomes zero when the representative household becomes age 65. When the household becomes age 65, it starts paying the fixed amount of contributions.

rearing and elderly care is also differentiated among four different types of workers; male regular, male non-regular, female regular, and female non-regular workers.

Thus, the total labor supply by the representative household in age s at time t is such that:

$$\begin{aligned} e_s\left(1-l_{s,t}-lc_{s,t}-le_{s,t}\right) &= \nu^s_{m,ft}e^s_{m,ft}\left(1-l_{s,t}-lc_{s,t,m,ft}-le_{s,t,m,ft}\right) \\ &+ \nu^s_{fe,ft}e^s_{fe,ft}\left(1-l_{s,t}-lc_{s,t,fe,ft}-le_{s,t,fe,ft}\right) \\ &+ \nu^s_{m,nf}e^s_{m,nf}\left(1-l_{s,t}-lc_{s,t,m,nt}-le_{s,t,m,nt}\right) \\ &+ \nu^s_{fe,nf}e^s_{fe,nt}\left(1-l_{s,t}-lc_{s,t,fe,nt}-le_{s,t,fe,nt}\right), \end{aligned} \tag{4}$$

where m, fe, ft, and nt denote male, female, regular contract, and non-regular contract, respectively. Thus, $e^s_{k,n}$ denotes labor efficiency of gender k of contract type of n in age s. $v^s_{k,n}$ denotes the weight of gender k of contract type of n in age s in efficiency of the household. Note that both $e^s_{k,n}$ and $v^s_{k,n}$ are also calculated from LFS (2012) and BSWS (2011). $lc_{s,t,k,n}$ and $le_{s,t,k,n}$ are time spent on child rearing and elderly care by gender k of contract type of n in age s at time t, respectively. $lc_{s,t,k,n}$ and $le_{s,t,k,n}$ are calculated from Survey on Time Use and Leisure Activities (STULA) of year 2012. All four different workers in the representative household retire at the end of their age of 65, and they never come back to the labor market after their retirement.

$b_{s,t}$ is the amount of public pension benefits in age s at time t[20]. w_t and r_t are the wage rate per the efficiency unit and the interest rate, respectively. Public pension benefits are given by

$$b_t = \begin{Bmatrix} \epsilon_t\left(H_t+\overline{H}_t\right); & s \geq RH \\ 0; & s, < RH \end{Bmatrix},$$

where RH is the retirement age of 65, and fixed through this paper. This implies that the representative household optimally chooses labor supply in intensive margin but not in

[20] A simplified assumption on the pension benefits is made in this paper. For more detailed studies, see, for instance, Yamada (2011) and İmrohoroğlu et al (2016).

extensive margin. Public pension benefits are taxed to reflect reality. ϵ_t is the replacement rate[21]. $\overline{H}_t$ and H_t denote the fixed amount of basic pension benefits and earning related benefits, respectively, and H_t is given by:

$$H_t = \frac{1}{RH} \sum_{s=20}^{RH} w_t e_s \left(1 - l_{s,t} - lc_{s,t} - le_{s,t}\right).$$

It is assumed that the representative household maximizes (1) with respect to $c_{s,t}$ and $l_{s,t}$ subject to (3), and the first order conditions yield the following optimal equations:

$$u'\left(c_{s,t}, l_{s,t}\right) u\left(c_{s,t}, l_{s,t}\right)^{-\rho} = \frac{q_{s+1,g}\left[1 + \left(1 - \tau_{r,t+1}\right) r_{t+1}\right]}{1+\delta} \frac{1 + \tau_{c,t}}{1 + \tau_{c,t+1}} \times u'\left(c_{s+1,t+1}, l_{s+1,t+1}\right) u\left(c_{s+1,t+1}, l_{s+1,t+1}\right)^{-\rho}, \quad (5)$$

$$l_{s,t} = \left[\frac{\kappa\left(1 + \tau_{c,t}\right)}{\left(1 - \tau_{w,t} - \tau_{p,t} - \tau_{e,s,t}\right) w_t e_s}\right]^{\xi} c_{s,t}, \quad (6)$$

where

$$u'\left(c_{s,t}, l_{s,t}\right) = \frac{\partial\left(c_{s,t}, l_{s,t}\right)}{\partial c_{s,t}}.$$

4.3 The Firm

The firm is assumed to maximize its profits, taking the wage rate and the interest rate as given. The wage rate and the interest rate are determined in perfectly competitive factor markets in equilibrium in each period. The aggregate private production function is assumed to be Cobb- Douglas such that

$$Y_t = \Omega_t L_t^{\alpha} K_t^{1-\alpha}, \quad (7)$$

[21] There are several definitions of the replacement rate of the public pension scheme. See İmrohoroğlu et al (2016) in detail. This paper uses the Japanese official definition of the replacement rate, which is defined as the ratio of pension benefits, which a typical household of a 65 years old husband of category 2 and a wife only with the basic fixed amount of pension benefits receives, to average disposal earnings of category 2 male workres. The replacement rate based on this definition is currently just above 60 %.

where Y_t, K_t denote aggregate output, and capital at time t. L_t is total labor demand measured in the efficiency unit. Ω_t is technology of production of the private sector. The fully competitive assumption of factor markets yields:

$$w_t = \alpha \frac{Y_t}{L_t}, \tag{8}$$

$$r_t = (1-\alpha)\frac{Y_t}{K_t} - \varphi, \tag{9}$$

where φ is the depreciation rate.

4.4 The Government

The government sector consists of a general account, a public pension account, and a long-term care insurance account. The government issues government bonds, and accumulates the public pension fund.

4.4.1 General Account

The budget constraint of the general account is such that:

$$D_{t+1} - D_t = AG_t + r_t D_t + P_t + E_t + CH_t - R_t, \tag{10}$$

where D_t denotes the amount of outstanding government debts at time t. AG_t is the total government expenditure. P_t and E_t denote the amount of transfers from the general account to the public pension account and to the long-term care insurance account at time t, respectively. CH_t denotes the total amount of a child allowance given to each household. A child allowance is assumed to be given to the household while it is between age 28 and 43. Thus,

$$CH_t = \sum_{s=28}^{43} d_{s,t} POP_{s,t},$$

where $POP_{s,t}$ denotes the total population of age s at time t. R_t is the total tax revenue, which is given by:

$$R_t = \tau_{w,t} \left(w_t L_t + AB_t \right) + \tau_{r,t} AS_t + \tau_{c,t} AC_t + \tau_{q,t} BQ_t,$$

where[22]

$$\begin{aligned} L_t &= \sum_{s=0}^{RH} e_s \left(1 - l_{s,t} - lc_{s,t} - le_{s,t}\right) POP_{s,t} \\ &= \sum_{s=0}^{RH} \left[\nu^s_{m,ft} e^s_{m,,ft} + \nu^s_{fe,ft} e^s_{fe,ft} + \nu^s_{m,nf} e^s_{m,nf} + \nu^s_{fe,nf} e^s_{fe,nt} \right] \left(1 - l_{s,t} - lc_{s,t} - le_{s,t}\right) POP_{s,t}. \end{aligned} \tag{11}$$

The aggregated values of AB_t, AS_t, AC_t, and BQ_t are given by:

$$\begin{aligned} AB_t &= \sum_{s=RH}^{99} b_{s,t} POP_{s,t} \\ AS_t &= \sum_{s=20}^{99} a_{s,t} POP_{s,t} \\ AC_t &= \sum_{s=20}^{99} c_{s,t} POP_{s,t} \\ BQ_t &= \sum_{s=20}^{99} bq_{s,t} POP_{s,t}. \end{aligned}$$

4.4.2 Public Pension Account

On the public pension account, the budget constraint is such that:

$$F_{t+1} - F_t = r_t F_t + P_t + CP_t - AB_t, \tag{12}$$

[22]The labor market is assumed to be fully competitive, and (11) is also interpretted as an equilibrium condition of the labor market

where F_t denotes the accumulated pension fund at time t. CP_t is the total amount of contributions collected at time t, which is given by:

$$CP_t = \sum_{s=20}^{RH} \tau_{p,t} w_t e_s \left(1 - l_{s,t} - lc_{s,t} - le_{s,t}\right) POP_{s,t}.$$

4.4.3 Long-term Care Insurance (LTCI) Account

The budget constraint of the long-term care insurance (LTCI) is given by:

$$TLT_t = FIC_t + TIC_t + OIC_t + E_t, \tag{13}$$

where TLT_t is the total expenditure in the account at time t, and it is given by:

$$TLT_t = \sum_{s=RH-1}^{99} (1-\theta) LT_{s,t} POP_{s,t}.$$

FIC_t and TIC_t, are aggregated revenues contributed by each household at time t, which are such that:

$$FIC_t = \sum_{s=40}^{RH-1} \tau_{e,s,t} w_t e_s \left(1 - l_{s,t} - lc_{s,t} - le_{s,t}\right) POP_{s,t},$$

$$TIC_t = \tau_{e,RH-1,t} w_t e_{RH-1} \left(1 - l_{RH-1,t} - lc_{RH-1,t} - le_{RH-1,t}\right) POP_{RH-1,t} + \sum_{s=RH}^{99} IC_{s,t} POP_{s,t}.$$

Note that FIC_t and TIC_t are the total contributions by the household which belongs to the first group between age 40 and 64, and to the second group between age 65 and over, respectively. The household has to pay a part of the total cost as a co-payment when it receives services through the long-term care insurance. The current co-payment rate, θ, is 10 %. OIC_t is the total amount the household pays by itself when it receives services through the long-term care insurance at time t, which is given by:

$$OIC_t = \sum_{s=RH-1}^{99} \theta_t LT_{s,t} POP_{s,t}.$$

In order to reflect reality, $\tau_{e,s,t}$ and $IC_{s,t}$ are both endogenously calculated to satisfy (6) in the following simulations.

4.5 Competitive Equilibrium

For a given sequence of all demographic parameters, $\{POP_t, P_{t-g}\}_{t=0}^{\infty}$, a given sequence of all government policies, $\left\{D_t, F_t, d_{s,t}, \tau_{w,t}, \tau_{r,t}, \tau_{c,t}, \tau_{q,t}, \tau_{p,t}, \tau_{e,s,t}, \tau_{e,RH-1,t}, \theta_t, b_t, IC_{s,t}, \epsilon_t, \overline{H}_t\right\}_{t=0}^{\infty}$, and a given sequence of the financial cost of child rearing as well as of elderly care services, $\{h_{s,t}, LT_{s,t}\}_{t=0}^{\infty}$, the perfect foresight competitive equilibrium is defined as the sequence of $\{r_t, w_t\}_{t=0}^{\infty}$,which satisfies the following conditions:

1. The optimal conditions for the representative household, (5) and (6), are satisfied for all generations in each period with the non-ponzi condition.

2. The optimal conditions for the firm, (8) and (9), are satisfied in each period.

3. Three budget constraints for the government, (10), (12), and (13), are satisfied in each period.

4. The capital market equilibrium condition is satisfied in each period such that:

$$AS_t + F_t = K_t + D_t.$$

5. The goods market equilibrium condition is satisfied in each period such that:

$$Y_t = AC_t + K_{t+1} - (1 - \varphi) K_t + AG_t.$$

6. The sequence of the consumption tax rate, $\{\tau_{c,t}\}$, is endogenously determined to satisfy (10) from year 2019.

7. The sequence of the contribution rate of the public pension scheme, $\{\tau_{p,t}\}$, is endogenously determined to satisfy (12) until year 2017.

8. The sequence of the replacement rate of the public pension scheme, $\{\epsilon_t\}$, is endogenously determined to satisfy (12) from year 2018.

9. The sequence of the revenue instruments of the LTCI, $\{\tau_{e,s,t}, \tau_{e,RH-1,t}, IC_{s,t}\}$, is endogenously determined to satisfy (13) in each period.

5 Calibration

5.1 Demographics

The assumption on the demographics is a key factor, and all available data should be used as much as possible. From year 2016 to year 2115, the latest population projection of year 2017 by the IPSS is used for age 0 to 100. Since the IPSS produces a reference estimate from year 2066 to year 2115 as well as the usual estimate till 2065, such a reference estimate with the medium variant assumption for both fertility and mortality rates is also used for the future demographics. From year 2116, the same distribution as that of year 2115 is assumed for another 100 years. As Figures 1-2 and 1-3 show, the Japanese economy converges to a new steady state with the high aging rate and dependency ratio under this assumption, but this could be most done to make this study as close to reality as possible.

Regarding the past demographic structure, the actual data from year 1920 to year 2015 is used. Parameter values are set to reproduce the values of key variables in the model as close to real values in year 2012 as possible in the following benchmark. some available parameter values in the literature are used. Although parameter values are calibrated under such an assumption, it is not assumed that year 2012 is an initial steady state in this paper. In reality, year 2012 is also on the transition of the demographic structure. This paper, instead, tries to use the past data as much as possible, in order to minimize the impact caused by the ad-hoc assumption on the past demographics. Note that in year 2012 there are still many old generations born in the past, and their behavior affects all future policies. The distortionary impact of the population structure should be minimized. Since the oldest available data starts from year 1920[23], the demographic structure before year 1920 is assumed to have the same distribution as that of year 1920.

As Auerback and Kotlikoff (1987) and De Nardi et al (1999) pointed out, the impact of policy changes is quite different among different generations, and the impact on an economy on the transition matters in a computable general equilibrium model. Instead of assuming an initial steady state, this paper explores the impact of several policies in a graying Japan on transition. Since all parameter values of the total population and the survival rate are calculated by using the actual and projected data, the demographics in the model can perfectly capture the actual and projected demographic structure with the assumption of no uncertainty in the aggregated values.

5.2 Preference and Production

İmrohoroğlu and Kitao (2009) argued that the value for the intertemporal elasticity of substitution (IES) in labor is sensitive to the impact of social security reforms on the profile of hours over the life-cycle, while the wide range of values results in the impact on aggregate labor supply. Rogerson and Wallenius (2016) recently reexamined the existing parameter value of labor supply elasticity, and they obtained a different result from the values widely accepted in the existing literature. Key parameter values in (1) and (2) have been carefully calibrated in order for the model values of key variables in the benchmark model to become close to those of year 2012. The benchmark model is discussed again in Section 5.5. The detailed values of parameters are given in Table 1.

On the values of tax rates and parameter values in production, available values from Hayashi and Prescott (2002) as well as Hansen and İmrohoroğlu (2016) are used. See in

[23]The data of age 85 and over from year 1920 to 1946 was calculated based on the actual survival rate of age 85 and over between year 1947 and 1948. The data of all ages from year 1941 to 1943 are missing, and missing data was recursively calculated based on the survival rates of all ages between year 1947 and 1948 with the data of year 1944.

Table 1. On the value of technological progress (Ω_t), as pointed out by Ihori et al (2006), all simulation results are quite sensitive to the value. As will be discussed in Section 5.4, this paper tries to follow several assumptions given in the actual government strategy, in order to specify the value of technological progress (Ω_t). In such official strategy documents, the future economic growth rates are given as targeted values. However, the economic growth rate is endogenously calculated in this paper, and it cannot be given exogenously. Thus, this paper exogenously gives the value of Ω_t so that the endogenously calculated rate of economic growth becomes close to the exogenous value given in the official documents made by the Japanese government. The model values of economic growth calculated endogenously in the benchmark model will be shown in Section 5.5.

5.3 The Financial Cost of Child Rearing and Childcare Benefits

The Cabinet Office of Japan conducted an analysis on the financial cost of child rearing based on a questionnaire by internet (2009), and Figure 4 shows the result[24]. The analysis reported that the average cost of child rearing from birth to age 22 is around 32 million Japanese yen per child. This paper uses the values shown in Figure 4. It is assumed that the age dependent cost is time-invariant, and also that the child rearing cost per child depends on the relative size of the population of children of age 0 to 20 to the population of the household of age 28 to 48.

On a child allowance given by the government, Figure 5 shows the past trend. In this paper, the same value of year 2014 is assumed to continue from year 2015. Since GDP is endogenously calculated in this paper, for each given value of the ratio of a child allowance to GDP, the total amount of child allowances is also calculated.

[24] In the questionnaire, the data up to child's age of 16 is obtained. Since this paper assumes the household rears its child until its child becomes age 20, the values in the figure from age 17 to 19 are calculated by using the increasing trend on average.

5.4 Government

The assumption on the future government policy is another key factor. The Japanese government has been trying to stimulate the Japanese economy based on the so-called *growth strategy*, of which the main policy of Abenomics consists. In order to accomplish the growth strategy, the government documented concrete figures[25] of several key variables such as the future primary balance and economic growth as targeted figures. Miyazawa and Yamada (2015) examined the growth strategy of Abenomics within the framework of Auerback and Kotlikoff (1987), and they concluded that the growth strategy seems difficult to be achieved even under very optimistic assumptions made in one of the official documents, *Economic and Fiscal Projections for Medium to Long-term Analysis* (July 2014). This paper uses several assumptions made in the latest version of *Economic and Fiscal Projections for Medium to Long-term Analysis* (EFPMLA: January 2016) to specify the future government policy, and expands Miyazawa and Yamada (2015) by separately introducing the government accounts in a more realistic way.

In *Economic and Fiscal Projections for Medium to Long-term Analysis* (EFPMLA: January 2016), there are two assumptions on the future economic environment up to year 2024; a recovery case and a baseline case. Figure 6 shows the different assumption on the future primary balance between two cases. Figure 7 also shows the different assumption on the future government deficits between two cases. In both figures the actual data is used until year 2014. As both figures show, the assumptions on the future values of the recovery case seems quite optimistic in comparison with the past trend. Furthermore, the future economic growth rate in the recovery case is assumed to be more than 3 % in the nominal term and more than 2 % in the real term[26]. Figure 8 shows the past trend and the different future economic growth rates given in two cases, and optimistic assumptions in the recovery case

[25]Several official documents have been made. This paper follows several assumptions made by the Cabinet Office of Japan (*Economic and Fiscal Projection for Medium to Long-term Analysis* (January 2016)).

[26]In the baseline case, the fture economic growth rate is assumed to be 1.5 % in the nominal term and less than 1 % in the real term.

can be found. Based on this observation, this paper follows assumptions made in the baseline case of *Economic and Fiscal Projections for Medium to Long-term Analysis* (EFPMLA: January 2016) as follows.

5.4.1 General Account

The future government expenditures and future deficits are both exogenously given. The future government expenditures are assumed to increase according to population aging based on the latest Population Projection of year 2017 by the IPSS. According to the past increasing trend of social security benefits shown in Figure 9-1, the future government expenditures are assumed to gradually increase in Figure 9-2, which shows the past trend and the future assumed values. The actual value is used until year 2014.

On the future deficits, the assumption made in the baseline case in EFPMLA is used. Figure 10 shows the future scenario of the ratio of outstanding government debts to GDP. The actual values of government expenditures, deficits, and GDP are used until year 2014.

The consumption tax rate is assumed to be endogenously calculated after year 2019 in order to satisfy (10) with the future given values of government expenditures and deficits. In order to reflect reality, the consumption tax rate exogenously remains at 8% until year 2018, while the wage income tax rate is endogenously calculated until 2018 to satisfy (10)[27]. All other tax rates are exogenously given shown in Table 1, and the consumption tax is only used to measure to the extent how much population aging affects the general account in the government budget[28].

[27]The exogenously given values of the consumption tax rate in all simuations are 0 %, 3 %, 5 %, and 8 % for before year 1989, between 1989 and 1997, between 1997 and 2014, and between 2014 and 2018, respectively. The wage income tax rate is given exogenously after year 2018 at the same value of that of year 2018.

[28]As pointed by Kitao (2015a), the wage income tax is more distortinary to labor supply than the consumption tax, and thus a more welfare loss is generated by the wage income tax. This paper only uses the consumption tax to finance the future government policy.

5.4.2 Public Pension Account

According to the recent decision by the Ministry of Health, Labor and Welfare (MHLW), the decreasing trend of the GDP ratio of accumulated public pension fund has already started since year 2003 in reality. Then, by following the actual plan of decreasing the fund in the next 100 years to the minimum level, the public pension fund is assumed to keep decreasing down to the level at which the annual amount of total benefits can be paid in year 2115. Figure 11 shows the actual past trend and the future values given in the following numerical analysis. Until year 2014, the actual values are used in the figure.

A half of the total amount of basic pension benefits is transferred annually from the general account, which is P_t in (10) and (12). Until year 2003 the transfer rate, defined as the ratio of transfers from the general account to the total basic pension benefits, was one-third, and it was gradually increased to a half from year 2004 to year 2009 in reality. This paper incorporates this fact.

The contribution rate ($\tau_{p,t}$) and the replacement rate (ϵ_t) are endogenously calculated in order to satisfy (12) under the assumption of values in Figure 11. In order to reflect the actual policy change, the contribution rate is endogenously calculated until year 2017 to satisfy the budget constraint of the public pension account with the fixed rate of the replacement. Until year 2017 the contribution rate is an endogenous policy instrument to satisfy (12). From year 2018, as the Ministry of Health, Labour and Welfare of Japan (MHLW) announced, the contribution rate is exogenously given at 18.3%, and the replacement rate becomes a new policy instrument to satisfy (12), so that the replacement rate is endogenously calculated from year 2018. The MHLW announced that the replacement rate will be reduced gradually to 50 ˜51 % in the future, and it is reported that the replacement rate in year 2009 was 62.3 %[29]. Thus in this paper the exogenous replacement rate is assumed to be fixed at 62.3 % until year 2017, while the contribution rate is endogenously calculated until year 2017 in order to

[29]Note that this is the offical replacement rate. See Kitao (2015a) for different definitions of the replacement rate. The official replacement rate used here is different from the definition of the replacement rate used in Kitao (2015a, 2015b, and 2017).

satisfy the budget constraint of (12). From year 2018 the replacement rate is endogenously calculated, while the contribution rate is exogenously fixed at 18.3 % afterwards.

5.4.3 Long-term Care Insurance (LTCI) Account

The public long-term care insurance (LTCI) for the elderly was introduced in year 2000. The expenditures basically depend on the demographic structure and population aging, and the expenditures seem exogenous to the scheme with its unchanged structure. In fact, in the actual scheme of the LTCI, the revenue is endogenously calculated to balance the budget where expenditures are exogenously given. This paper assumes the exogenous expenditures and endogenously calculate the fixed amount and the rate of contributions paid by the insured. Figure 12 shows the future expenditures in the LTCI based on the assumption that the age-dependent cost is time-invariant. The values in Figure 12 are calculated only by reflecting population aging[30], and these values are given exogenously in this paper.

On the revenue side, a 10% of the total cost is paid by the insured as co-payments who receive services through the scheme. A half of the remaining cost (90% of the total cost) is covered by transfers from the general account (E_t). Another half of the remaining cost is paid by the insured. A 28 % and a 22% of the remaining cost are currently paid by people belonging to the second group, and the first group, respectively. Note that the scheme is compulsory so that people between age 40 and 64 have to belong to the second group, and people of age 65 and over have to belong to the first group.

The current ratios of the distribution of the cost between the first group (age 65 and over) and the second group (ages between 40 and 64) are 22 % and 28%, respectively. While the total ratio paid by the insured remains at 50% (=22 % + 28 %) of the 90 % of the total cost, the ratios between two groups will change according to the future demographic structure. The MHLW has announced that the ratios will be modified every 3 years, and

[30]The age specific cost in the LTCI is used for Figure 12. The age specific cost is calculated based on Survey of Long-term Care Benefit Expenditure (SLCBE) of year 2014. Based on the assumption that the age specific cost does not change over time, Figure 12 shows the future cost of the LTCI by reflecting the future change in the demographics of Japan.

indeed the actual ratios have been changed since its launch in year 2000. Table 2 shows the actual ratios in the past as well as the future calculated ratios based on the guideline made by the MHLW. This paper endogenously calculates the contribution rate ($\tau_{e,s,t}$) for the second group and the fixed amount of contributions ($IC_{s,t}$) for the first group to satisfy (6), based on the given ratios in Table 2.

Note also that a 50 % of the remaining cost is paid by the central and local governments in the actual LTCI. Since the future total expenditures of the LTCI change according to population aging, the total amount of transfers from the general account to the LTCI account (E_t) also changes.

5.5 Benchmark

While this paper does not assume any initial steady state, year 2012 is assumed to be a benchmark year. This implies that parameter values have been given for the values of key variables calculated within the model for year 2012 to be as close to actual values in year 2012 as possible. Table 3 shows the comparison of values of key variables between actual and model values in year 2012. Figures 13-1 and 13-2 show model prediction of the primary balance and the real GDP growth rate, respectively. Note that in both figures future values are obtained from the baseline case in *Economic and Fiscal Projections for Medium to Long-term Analysis* (EFPMLA: January 2016). Note also that the annual economic growth rate assumed in the baseline case in *Economic and Fiscal Projections for Medium to Long-term Analysis* (EFPMLA: January 2016) is 0.8 % from year 2019 to 2024.

Figure 13-3 shows the endogenously calculated value of technological progress denoted by Ω in (7). Note that the value given in Figure 13-3 resulted in the model value of the GDP growth rate given in Figure 13-2. Since the future labor force is expected to decrease, technology has to keep increasing in order to maintain GDP at a certain level. Since the total population is expected to decrease in the future, keeping annual economic growth rate of GDP at 0.8% implies a constant increase in Ω. This also implies that the growth rate of

GDP per capita is further higher with a shrinking population.

In the following numerical experiments, technological progress is assumed to increase based on the value given in Figure 13-3, in order to follow the assumption on the future environment given in the baseline case in *Economic and Fiscal Projections for Medium to Long-term Analysis* (EFPMLA: January 2016).

Based on such given values in the benchmark case, Figure 13-4 shows lifetime labor supply of the cohorts born in year 2000 and in year 2050. The cohort born in year 2000 (year 2050) starts supplying labor from year 2020 (year 2070). Figures 1-2 and 1-3 show that the future demographic structure becomes stable at high aging and dependency ratios in around year 2070, and the cohort born in year 2050 can be recognized as a cohort starting to supply labor in a new steady state. Due to the increasing trend of technological progress as well as the decreasing population, GDP per capita increases in the future, implying an increase in wage in the future. As long as leisure is a normal good, the impact of an increase in wage on labor supply is ambiguous due to contrary substitution and income effects. However, Figure 13-4 shows that increased wage in an aged Japan reduces labor supply with the relatively stronger income effect than the substitution effect, thus resulting in lower labor supply by increased wage. As will be shown later, the wage rate indeed increases in an new aged steady state, and population aging in Japan will result in less labor supply. Note also that population aging induces a higher consumption tax rate, lower pension benefits, and higher burdens in the public long-term care insurance. Such higher burdens on cohorts in an new aged steady state through the public schemes affect lifetime labor supply as well.

6 Numerical Results

The purpose of this paper is to explore the impact of more female labor supply on a graying Japan. In particular, this paper focuses on the impact of elimination females' time costs of child rearing and elderly care. As Figures 3-1 and 3-2 show, female workers spend more time on child rearing and elderly care than male workers. Then, if females' time costs of both activities are completely eliminated, then the time, which was used for child rearing and elderly care before, is now available for more leisure and labor supply.

Apps and Rees (2004), and Day (2012) developed a theoretical model where females can choose to rear their child at home, or to use bought-in childcare services and thus females can work in the labor market. In particular, they investigated the impact of a child allowance as well as bought-in childcare on fertility. In the context of this paper, the reduction of females' time cost of child rearing can be attributed to more provision of bought-in childcare. Furthermore, elimination of females' time cost of elderly care can be achieved by more provision of elderly care services through the public long-term care insurance[31]. Thus, the impact of elimination of females's time costs of child rearing and elderly care can also be investigated as the impact of an increase in bought-in childcare services and elderly care services through the public long-term care insurance on female labor supply. In this paper, females' time costs are assumed to be eliminated from year 2018 onwards.

6.1 Impact on Labor Force in Efficiency Unit

If more time becomes available due to complete elimination of females' time costs of child rearing and elderly care, then potential labor force measured in efficiency unit increases. Figure 14 shows the impact of complete elimination of females' time costs of child rearing and elderly care on labor force measured in efficiency unit, *if female workers spent all newly available time on labor supply*, which was used for child rearing and elderly care before. In the figure, 'No elimination (benchmark)' corresponds to the case of Figure 1-4. 'Elimination of females' child rearing and elderly care time costs' corresponds to the case when females' time costs of both child rearing and elderly care are completely eliminated so that female workers could spend all the time previously used for both child rearing and elderly care on

[31]The cost of more provision of childcare services and elderly care services is not taken into account explicitly in this paper. If the government provides more services, then an increased cost of more provision should be taken into account to the budget constraint of the government. This is a drawback of this paper.

additional labor supply. If all female workers spent the all additional time for more labor supply completely which was spent on child rearing and elderly care before, then labor force is expected to increase by approximately 2 % for almost all periods from year 2018.

6.2 Impact on Labor Participation Decision

While potential labor force in efficiency unit increases by elimination of females' time costs, the impact on the labor supply decision by the representative household is ambiguous, since more labor supply reduces the equilibrium wage rate. The reduced wage rate results in a fall in wage income, and the change in the wage rate also implies the change in the relative price of leisure. Thus, the overall impact on labor supply by the household is ambiguous due to substitution and income effects, which operate reversely to each other, as long as leisure is a normal good.

Elimination of females' time costs increases available time for leisure and labor supply. However, this does not imply more labor supply out of all available time. Even if the ratio of time for labor supply to all available time decreases, the total amount of labor supply in efficiency unit can increase, since all available time becomes longer by elimination of females' time costs. An increase in labor supply in efficiency unit induces a decrease in the wage rate in the labor market. Thus, even if the representative household optimally chooses the lower ratio of labor time to newly longer available time, more labor supply in efficiency unit with lower wage as well as with higher GDP can happen in the whole economy. Indeed, this will happen from a certain future time with the calibrated parameter values in Japan. Tables 4-1 and 4-2 show the impact of elimination of females' time costs on labor participation/supply. First, the impact of elimination of time costs is very little, and the magnitude of the impact is less than 0.5 % point. Second, except for the case in year 2020 when only time cost of elderly care is eliminated, the ratio of labor supply decreases in all cases in both year 2020 and year 2070.

Figures 15-1 and 15-2 show the impact on *lifetime* labor supply of the cohort born in year 2000 and year 2050, respectively. Both figures show that elimination of females' time costs decreases the ratio of labor supply to the total available time for both cohorts, and the impact is similar to the whole economy. A fall in the ratio of labor supply becomes larger as both cohorts become aged. However, a fall in the ratio is larger for the cohort born in year 2050 than the cohort born in year 2000. While the impact is quite small for both cohorts, a decrease in the ratio of labor supply is nearly double for the cohort born in year 2050 in comparison with the cohort born in year 2000. This implies that while the impact of elimination of females' time costs on labor supply is small the magnitude of the impact becomes larger when Japan becomes aged. Apps and Rees (2004) demonstrated that provision of bought-in childcare at the lower cost stimulates female labor supply. Elimination of females' time cost of child rearing can be induced by more provision of bought-in childcare at the lower cost. In our counterfactual experiment, the time ratio of labor supply decreases, and our result seems opposite to Apps and Rees (2004). However, note that the total available time after elimination of females' time costs is longer than that without elimination (benchmark). Since the total available time for female workers becomes longer, the total labor supply measured in efficiency unit can increase. Indeed, the total labor supply in efficiency unit increases by elimination of females' time costs, which could be induced by cheaper bought-in childcare, as shown in the next section.

6.3 Impact on GDP per capita and Total GDP

Figure 16-1 shows the impact of elimination of females' time costs on GDP over labor in efficiency unit, $\frac{Y_t}{L_t}$. Note that L_t is the total labor supply measured in efficiency unit. Note also that GDP per labor, $\frac{Y_t}{L_t}$, keeps increasing even in a graying Japan. Since elimination of females' time costs results in an increase in the total labor supply in efficiency unit, GDP per labor, $\frac{Y_t}{L_t}$, decreases. Since GDP per labor,$\frac{Y_t}{L_t}$, decreases by elimination of females' time costs, $\frac{K_t}{L_t}$ also decreases, so that w_t decreases by elimination of females' time costs as shown in Figure 16-2. Table 5-1 also shows the change in $\frac{Y_t}{L_t}$ from the benchmark level, and also that the magnitude of the impact on reduced GDP per labor becomes smaller as time passes.

Since the total available time becomes longer, more labor supply is stimulated even though the ratio of time of labor supply to the total available time optimally chosen by the representative household decreases. Indeed, the total GDP starts increasing from a future year by elimination of females' time costs, since the total labor supply increases. Figure 16-3[32] and Table 5-2 show the impact on the total GDP. Note that the wage rate decreases by elimination of females' time costs, but the amount of labor supply in efficiency unit increases. The former effect is negative, but the latter effect is positive on the total GDP. Table 5-2 shows that the latter positive effect gradually outweighs the former negative effect in all three cases. Once the latter positive effect outweighs the former negative effect, the overall impact on an expansion of the total GDP keeps increasing as time passes. The negative effect of elimination of females' time cost is the strongest when the time cost of elderly care is only eliminated. While the total GDP starts to increase in year 2029 when females' time cost of child rearing is only eliminated, the total GDP does not start to increase until year 2032 when females' time costs of both child rearing and elderly care are eliminated, due to the fact that the former negative effect is the strongest when the females' time cost of elderly care is only eliminated. However, as time passes, the overall effect on the total GDP becomes largest when both time costs are eliminated, so that the total GDP more expands from year 2085 when both time costs are eliminated in comparison with the case when only the time cost of child rearing cost is eliminated.

Note that elimination of females' time costs occurs in year 2018 in our experiments. In year 2018, the number of cohorts which have the direct impact of elimination of females' time costs is 46 (the cohorts from age 20 to 65) among all 81 cohorts alive. The cohorts

[32]Even with the increasing trend of technological progress shown in Figure 13-3, the total GDP starts decreasing due to the shrinking population in the future. Since it is unrealistic to assume that the total GDP keeps growing even when the total population is expected to drastically shrink in the future, unrealistically too high values of technological progress are not given to maintain 0.8 % annual growth rate in the future, while technological progress with the same increasing rate is still assumed in the far future. Since the total population decreases faster than the total GDP in the future, GDP per capita keeps increasing even after the total GDP starts to decline, as shown in Figure 16-1.

of age 66 and over do not have any *direct* impact when time costs are eliminated in year 2018[33]. It takes 35 years from year 2018 until all 81 cohorts alive are directly affected by elimination of females' time costs. Furthermore, the duration/periods each cohort has the *direct* impact becomes shorter for more aged cohorts. For instance, the cohort of age 65 in year 2018 can obtain the *direct* impact once in year 2018, since it did not obtain the impact until it becomes age 65 in year 2018. it does not obtain the *direct* impact from year 2019, since it retires from year 2019. The cohort of age 64 in year 2018 can obtain the *direct* impact twice in its lifetime in year 2018 and year 2019. Thus, it takes time until all cohorts obtain the impact for all working periods.

When females' time cost of child rearing is only eliminated, the total GDP only increases by less than 1 % although the positive effect appears relatively soon. When females' time costs of both child rearing and elderly care are eliminated, the total GDP increases by more than 1 %, while it takes more time to have the positive overall effect. However, the impact on the total GDP is quite little, even when all females' time costs of child rearing and elderly care are completely eliminated. This is because a rise in the available time by elimination of time costs induces a fall in the wage rate caused by more labor supply, and the positive effect on the total GDP is partially weakened by the negative effect.

Since the overall effect on the total GDP over time depends on when the positive effect starts outweighing the negative effect, the impact on welfare of different cohorts is also different.

6.4 Impact on the Public Schemes

Since the impact of elimination of time costs on the Japanese economy is very limited, the impact on the public schemes is also quite little. The impacts on the three government accounts are as follows.

[33] All of 81 cohorts alive in year 2018 are affected by the indirect impact through changes in endogenous prices, tax rates, the contribution rate and the replacement rate in the public pension scheme, the fix amount of contributions and the contribution rate in the long-term care insurance.

6.4.1 On the General Account

The little impact on the general account is shown by the effect on the consumption tax rate in Table 6-1. Due to the relatively stronger negative effect of a decrease in wage, the total GDP first decreases when females' time costs are eliminated. This is the reason why the consumption tax rate goes up initially. As time passes, the positive effect of an increase in labor supply gradually outweighs the negative effect, thus resulting in the lower consumption tax rate with higher GDP in the future eventually. However, since the impact of elimination of females' time costs on GDP is quite small, the impact on the consumption tax rate is also small. The consumption tax rate only goes down by less than 1 % point.

Note that the increasing trend of the consumption tax rate rises from population aging. In the expanding literature (Braun and Joines (2015), Kitao (2015a), Hansen and İmrohoroğlu (2016), and İmrohoroğlu et al (2016)), it has been pointed out that very heavy fiscal imbalance and/or a very high consumption tax rate cannot be avoidable in an aged Japan. Although this paper assumes the stable future technical progress to follow the baseline case of *Economic and Fiscal Projections for Medium to Long-term Analysis* (EFPMLA: January 2016), the increasing trend of the consumption tax rate can still not be avoidable. Furthermore, while several studies suggest the importance of female labor supply to improve the fiscal imbalance (Braun and Joines (2015), Hansen and İmrohoroğlu (2016), and İmrohoroğlu et al (2016)), the improvement in the government budget is very little. Even when females' time costs of both child rearing and elderly care are completely eliminated, the positive impact of an increasing labor supply is weakened by the negative effect of a decrease in wage, and the overall impact of time cost elimination is quite limited. If the government expects the effective impact of stimulated female labor supply on an expansion of the Japanese economy as well as improvement in its fiscal imbalance by providing more childcare services and/or elderly care services, its expectation seems difficult to be realized. The total GDP is expected to expand by less than 1 %, and the consumption tax rate only goes down only by less than 1 % point.

6.4.2 On the Public Pension

Taking into account the actual aspect of the public pension scheme, this paper assumes that the contribution rate is adjusted to satisfy the budget constraint of the public pension scheme until year 2017. Then, the replacement rate is adjusted to satisfy the budget constraint with the fixed contribution rate at 18.3 % from year 2018. Until year 2017, the replacement rate is fixed at 62.3 % to reflect reality. Table 6-2 shows the impact of elimination of females' time costs on the replacement rate. The decreasing trend comes from population aging. While the impact of elimination of females' time costs is quite small, the timing when the replacement rate becomes below 50 % is slightly different. The MHLW announces that the replacement rate could remain over 50 % even in a graying Japan, but our result shows that it becomes below 50 % from year 2037 in the benchmark case. The timing of becoming below 50 % is slightly delayed when females' time costs are eliminated, but it is only one year later. This result suggests that it seems difficult to maintain the replacement rate over 50 %, if the contribution rate is fixed at 18.3 % in the future. This implies that reduction of the replacement rate *and* an increase in the contribution rate are both needed to maintain the public pension scheme in a graying Japan.

6.4.3 On the Long-term Care Insurance (LTCI)

Tables 6-3 and 6-4 show the impact on the financial burden on the first group (age 65 and over) and the second group (age 40 - 64), respectively. Note that the fixed amount of contributions given in Table 6-3 is calculated based on the annual income of male non-regular workers of age 20 - 24 in year 2012. The value given in Table 6-3 is the relative amount of the fixed contributions to the annual income of male non-regular workers of age 20 - 24 in year 2012. The increasing trend rises from population aging in all cases. Since wage decreases by increasing labor supply in efficiency unit, the contribution rate and the contribution amount become higher and larger when females' time costs are eliminated. Note that the total cost of the LTCI increases by population aging, and also that the budget of the LTCI is balanced every year. While the contribution rate and the contribution amount shown in both figures become higher and larger, the total amount of financial burdens does necessarily not increase. The increased burden rates to balance the budget reflect decreased wage. Elimination of time costs results in a rise in the burden rates, but its impact is also quite small.

6.5 Impact on Welfare

The impact on welfare of different cohorts is calculated based on consumption equivalence, which measures a percentage change in consumption to make the household indifferent between the benchmark with no time cost elimination and alternative cases with time cost elimination. If the calculated value of consumption equivalence is greater than 1, then the household prefers an alternative case with time cost elimination. Figure 17 shows the welfare effect of time cost elimination. The cohort born in year 1952 becomes age 66 in year 2018 when elimination occurs, and all cohorts born before year 1952 do not obtain any *direct* impact since they have all retired in year 2018. Since elimination of females' time costs reduces the total GDP at the beginning by relatively stronger negative effect, elder cohorts are negatively affected. Since the positive effect on the GDP gradually becomes stronger as time passes, elimination of females' time costs result in welfare improvement from the cohorts born in around year 2000.

6.6 Impact of Improvement in Wage Profiles

Day (2012) observed the fact that female relative wages have remained relatively constant over the last decades despite economic growth in Japan, and also pointed out the reason why the gender gap in wages is persistent in Japan: There is gender inequity in firm-specific human capital such as on-the-job training, tenure and promotion, probably caused by low probability of finding regular employment after career interruption due to childbearing. Kato and Kawade (2015) presented their result that a gender gap in wage profiles is a key factor to explain why the impact of more female labor supply on economic growth is very little in Japan. As pointed by Day (2012), if a gender gap in wage profiles rises from more human capital of male workers than female workers due to childbearing, then elimination of females' time costs would result in more opportunities for female workers to accumulate their firm-specific human capital, so that a gender gap in wage profiles will become smaller. This section experiments the impact of improvement in wage profiles, by explicitly taking into account the difference in the type of jobs; regular and non-regular female workers. It is assumed in this section that *both* elimination of females' time costs of child rearing and elderly care *and* improvement in human capital of female regular and non-regular workers occur at the same time. The human capital of female regular workers becomes the same as that of male regular workers, and the human capital of female non-regular workers becomes the same as that of male non-regular workers. This implies that there is no gender difference in wage profiles in this counterfactual experiment. Note that there is still a difference in wage profiles between regular and non-regular workers for both males and females. Figures 18-1 to 18-3 show the impact on GDP and the wage rate. Since the total labor supply in efficiency unit drastically increases by improvement in human capital of female workers, GDP per labor in efficiency unit and wage decrease. However, the total GDP increases as shown in Figure 18-3 and Table 7-1. While it takes time, the total GDP increases by more than 4 %. Tables 7-2 to 7-5 show the impact on the government schemes. While the consumption tax rate is higher until year 2040, it becomes lower from year 2045, and it eventually becomes about 0.7 % point lower than the benchmark case in year 2100. The public pension account is slightly improved, and the replacement rate can remain at more than 50 % until year 2040. However, it seems difficult to maintain the replacement rate above 50 % with the fixed contribution rate of 18.3 % in an aged Japan, and the contribution rate should be increased in order to maintain the replacement rate above 50 %, even if the gender difference in human capital vanishes.

Figure 18-4 shows the impact on welfare. Since wage is further reduced by more labor supply in efficiency unit by increased human capital of female workers, it takes more time for the positive effect of increased labor supply to outweigh the negative impact of decreased wage. The cohort born after year 2013 becomes better off when elimination of females' time costs of child rearing and elderly care with improvement in human capital of female workers occurs. However, the positive effect of an expanded economy becomes stronger eventually, and welfare of cohorts born from year 2066 more improves if elimination of females' time costs occurs with improvement in human capital of female workers.

It seems that reduced wage weakens the positive effect of increased labor supply in efficiency unit. Then, the impact of reduced wage can be excluded in our next counterfactual experiment. Figures 18-5 to 18-9 show this case. In this experiment, the wage rate remains at the benchmark level even though there is no gender gap in wage profiles. Females' time costs of child rearing and elderly care are completed eliminated as well. In this counterfactual experiment, the optimal consumption and savings paths are calculated at the same wage rate as that of benchmark, and then GDP is calculated. Government policy instruments such as the consumption tax rate for the general account, the replacement rate for the public pension account, and the contributions for the LTCI are all calculated to satisfy their own budget constraints. First, the impact on the optimal behavior should be noticed. Figures 18-5 and 18-6 show the impact on lifetime labor supply of two cohorts. Each cohort drastically reduces their labor supply by the strong income effect, since the wage rate remains at the benchmark level. In other words, in the benchmark, the household does not reduce the ratio of time of labor supply so much due to the income effect, when elimination of females' time costs of child rearing and elderly care reduces wage. However, if wage does not go down, real income does not shrink, so that the income effect results in a substantial decrease in the ratio of time of labor supply. Second, by reflecting such a substantial decrease in labor supply, the total GDP goes down as shown in Figure 18-8. Third, since the total GDP decreases more than labor supply in the first 50 years, GDP per labor also becomes smaller in Figure 18-7. Fourth, however, since the wage rate remains at a higher level, welfare reversely becomes higher as shown in Figure 18-9. In this counterfactual experiment it is implicitly assumed that the labor market is not in equilibrium. If the labor market is in equilibrium, then the wage rate should go down to clear the market. In reality, the Japanese economy will be between such two extreme cases. Wage has not increased in several decades, and wage might not go down so much like what the model predicts, even if female labor supply increases. However, the result of this experiment indicates that the income effect weakens an incentive of more labor supply if wage does not go down when a gender gap in wage profiles disappears.

A fall in wage rather weakens the strong income effect to further reduce labor supply. Reduced wage does necessarily not result in a worse outcome, and obstacles in the labor market to interfere a flexible change in wage should be removed. As Figure 18-8 shows, Elimination of females' time costs with no gender gap in wage profiles as well as with a more fully competitive condition to induce a decrease in wage in the labor market achieves the largest expansion of the economy, particularly in the long-run.

6.7 Financial Child Allowance VS. Bought-in Childcare

If bought-in childcare becomes cheaper, then females will substitute bought-in childcare for maternal time, and they will supply more labor in the labor market, as pointed out by Apps and Rees (2004) and Day (2012). Apps and Rees (2004) argued that a budget-neutral policy with a lower financial child allowance and more subsidies for bought-in childcare stimulates female labor supply. Since this paper does explicitly not consider the financial cost of time cost elimination of child rearing and elderly care within the government bugdget, the impact of a budget-neutral policy between a child allowance and subsidies for bought-in childcare cannot be explored. However, elimination of females' time cost of child rearing can be induced by more subsidies for bought-in childcare, and this section compares the impact of a more child allowance with the cases of elimination of females' time costs. Note that if more subsidies are financed by a higher consumption tax in the general account then the following results will be weakened[34]. Figures 19-1 to 19-3 and Tables 8-1 and 8-2 show the impact when a child allowance is increased by 30 % from the benchmark level in year 2014 and onwards[35]. Since an increase in a child allowance imposes more financial burdens on the general account, the consumption tax increases.

Note that elimination of females' time costs, which could possibly be induced by more subsidies for bought-in childcare, directly induces a rise in labor supply in efficiency unit and thus a fall in wage as well. However, when a child allowance is increased, the increase directly affects savings. When a child allowance increases, both GDP per labor in efficiency unit (Figure 19-1) and the total GDP increase. An increase in GDP per labor induces an increase in wage as well. Since the impact on wage operates reversely in comparison with the cases in time cost elimination, the impact on GDP is larger. However as time passes, the positive effect of increasing labor supply with time cost elimination gradually outweighs the negative effect of reduced wage, and the economy becomes better off eventually in the long-run. While the magnitude of the impact substantially depends on to the extent how much a child allowance is increased, the quantitative result does not change. When a child allowance is increased, the positive impact appears relatively sooner, while it takes more time until the positive impact of elimination of females' time costs of child rearing and elderly care appears. Note that if human capital of female workers is not accumulated up to the level of male workers, the impact on the whole economy is less than 1 %. If a gender gap in wage profiles rises from the difference in human capital between male and female workers as pointed out by Day (2012), then any policy attempting to stimulate female labor supply does not help the Japanese government improve its fiscal situation as long as a gender gap in human capital exists, even when the total labor supply by females increases. If the gender gap in human capital persistently exists, then an increasing child allowance would relatively

[34]This argument does still not seem satisfactory, since the relationship between subsidies and time spent on child rearing is not argued. However, since there is no data available for the impact of subsidies for bought-in childcare on the time spent on child rearing, this is at most what could be experimented.

[35]The latest available value of child allowances is of year 2014. Since the future values in the benchmark are assumed to be the same as that of year 2014 onwards, a 30 % increase in this experiment implies that the values from year 2014 increase by 30 % from the benchmark values onwards.

result in better outcomes in Japan at least in the short-run.

7 Concluding Remarks

This paper examined the impact of stimulated female labor supply on the Japanese economy as well as the government fiscal imbalance within a numerical dynamic general equilibrium model with multiple overlapping generations, particularly by paying attention to females' time costs of child rearing and elderly care in a graying Japan.

Among all numerical results, the following result should be noticed again. Elimination of females' time costs of child rearing and elderly care, possibly induced by more bought-in childcare and/or more elderly care services through the LTCI, would not save a graying Japan substantially. The economy would not expand, and thus fiscal imbalance would not improve as well. This is because a wide gender gap in wage profiles exists. If elimination of females' time costs with no gender gap in wage profiles occurs, then the total GDP would expand by 4 %. If a gender gap in wage profiles rises from more accumulation of males' human capital, then government policies to help female workers accumulate their human capital is needed in addition to a policy to stimulate female labor force participation. Even when female labor force participation increases, the impact of such an increase on a graying Japan is limited, as long as a gender wage gap is persistent in the future.

Finally, a drawback should be mentioned. This paper does not take into account any explicit relation of elimination of females' time costs with government policies. If females' time costs of child rearing and elderly care is eliminated by government policies, then financial cost on the government should be considered. For instance, females' time cost of child rearing can be reduced by subsidies for bought-in childcare. If bought-in childcare becomes cheaper by government subsidies, then female workers will substitute bought-in childcare for maternal time, and thus elimination of females' time cost of child rearing would result in more female labor supply in the labor market. While females' time cost of elderly care was considered, the explicit relationship between elimination of females' time cost of elderly care and the long-term care insurance was not taken into account. This is because of difficulty of obtaining any data to connect such financial cost and subsidies to elimination of females' time costs, and it should be improved if the financial cost in the government budget constraint is explicitly considered.

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Figure 1-1

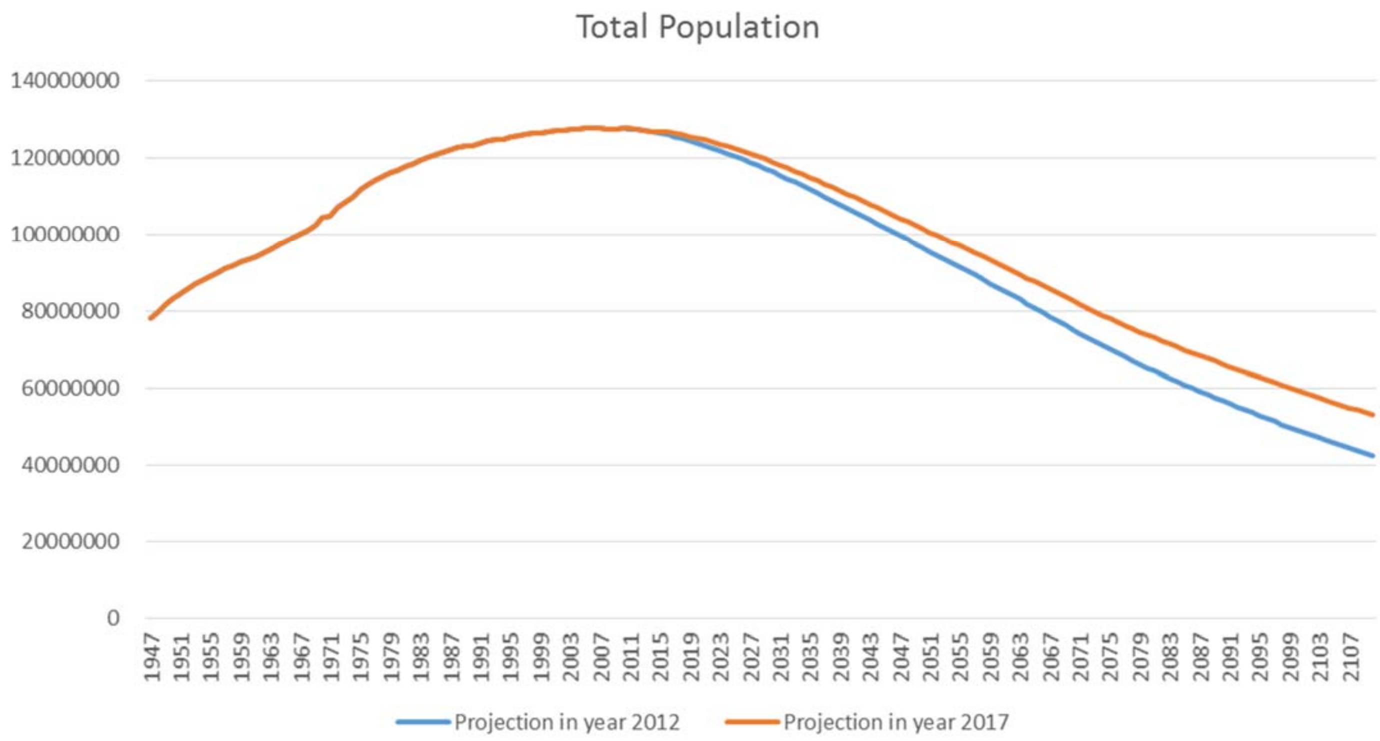
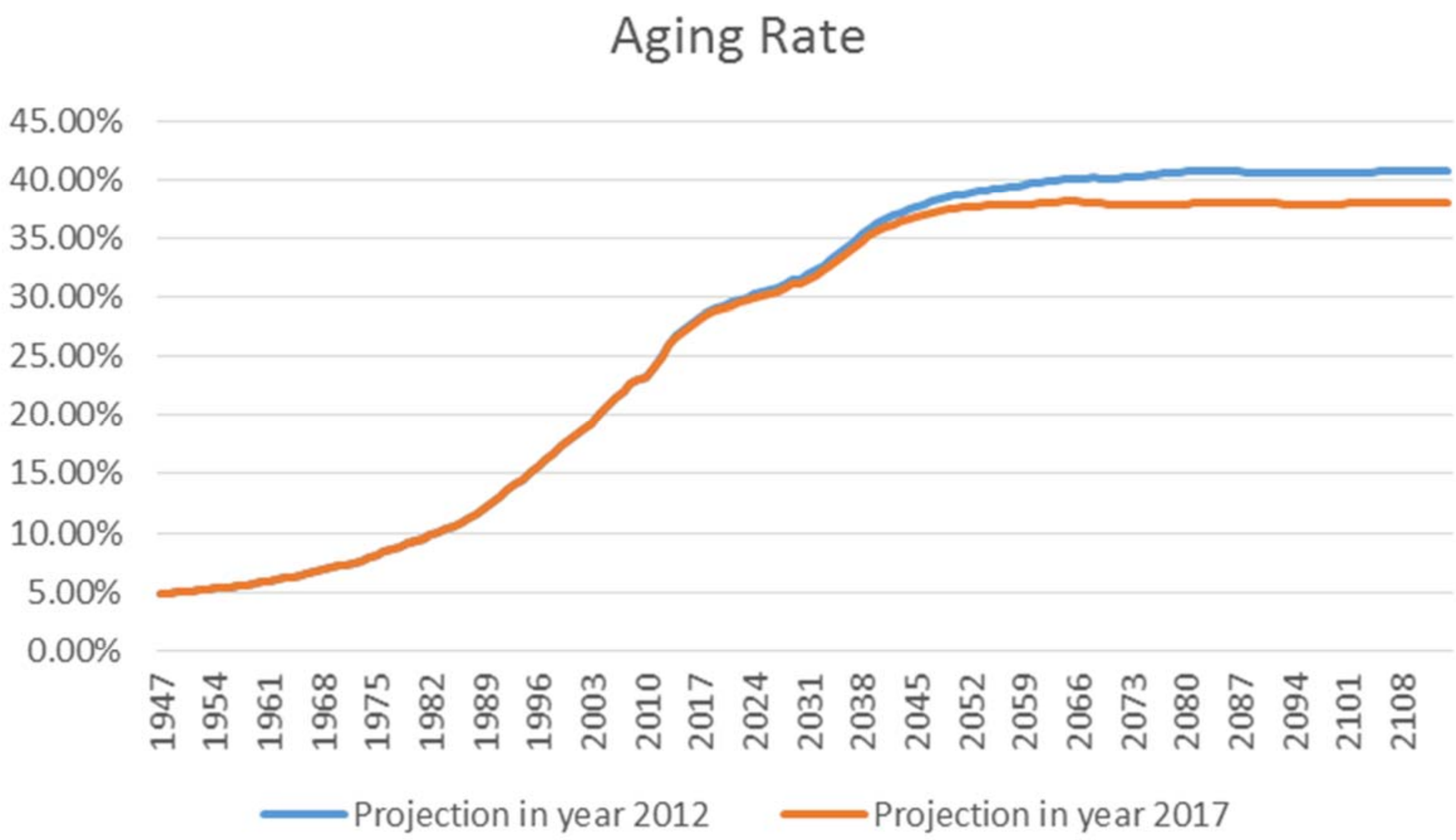
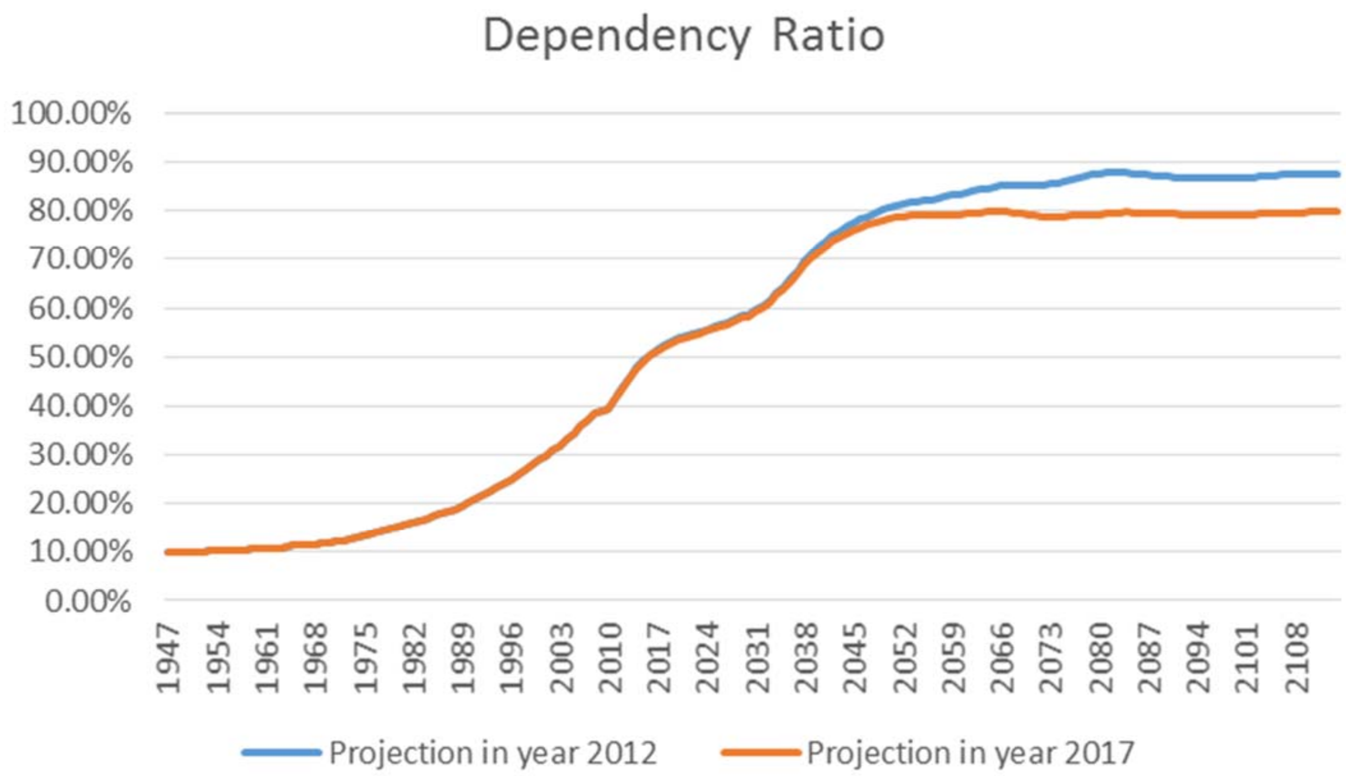

Total Population
140000000
120000000
100000000
80000000
60000000
40000000
20000000
0
1947 1951 1955 1959 1963 1967 1971 1975 1979 1983 1987 1991 1995 1999 2003 2007 2011 2015 2019 2023 2027 2031 2035 2039 2043 2047 2051 2055 2059 2063 2067 2071 2075 2079 2083 2087 2091 2095 2099 2103 2107
Projection in year 2012
Projection in year 2017

Figure 1-2: Aging Rate



Data: the actual data from Statistics Bureau, Ministry of Internal Affairs and Communications, and the future projections from the National Institute of Population and Social Security Research (IPSS)

Figure 1-3: Dependency Ratio



Data: the actual data from Statistics Bureau, Ministry of Internal Affairs and Communications, and the future projections from the National Institute of Population and Social Security Research (IPSS)

Figure 1-4: Labor Force

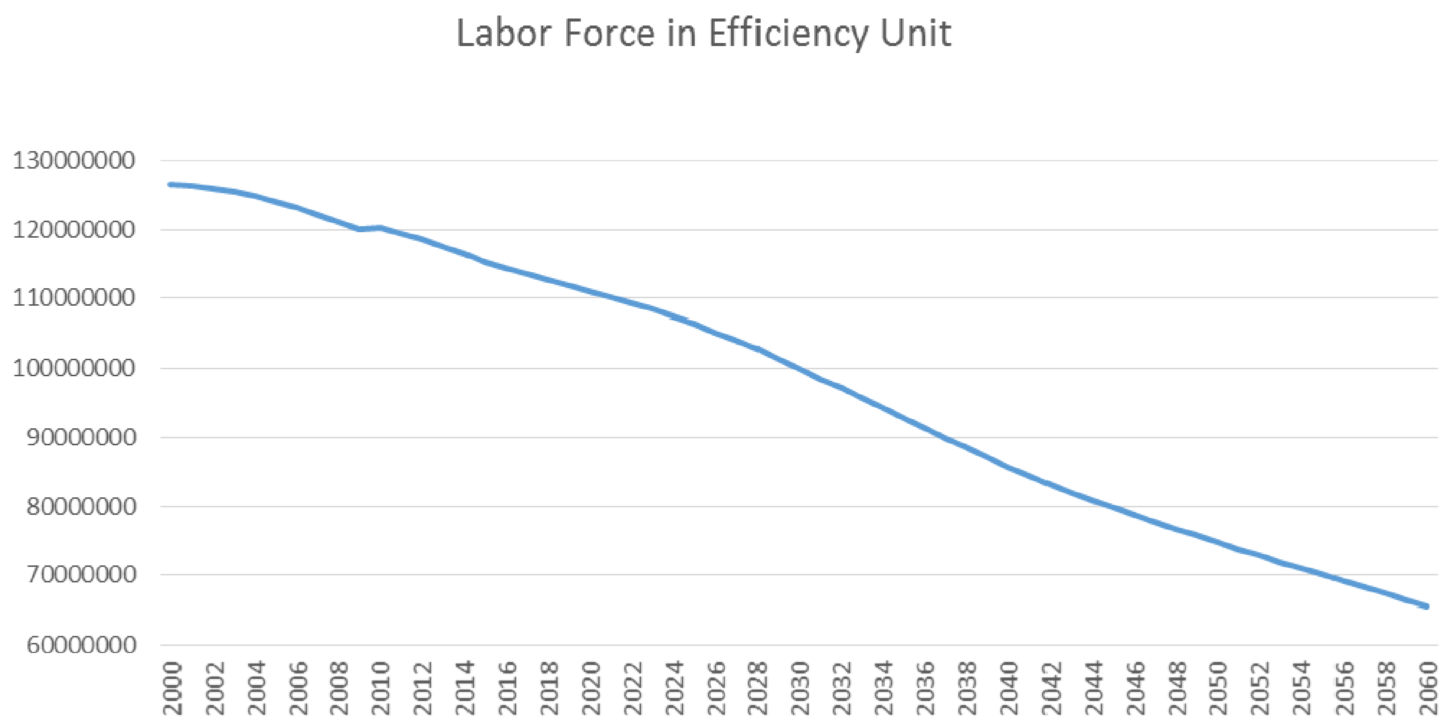
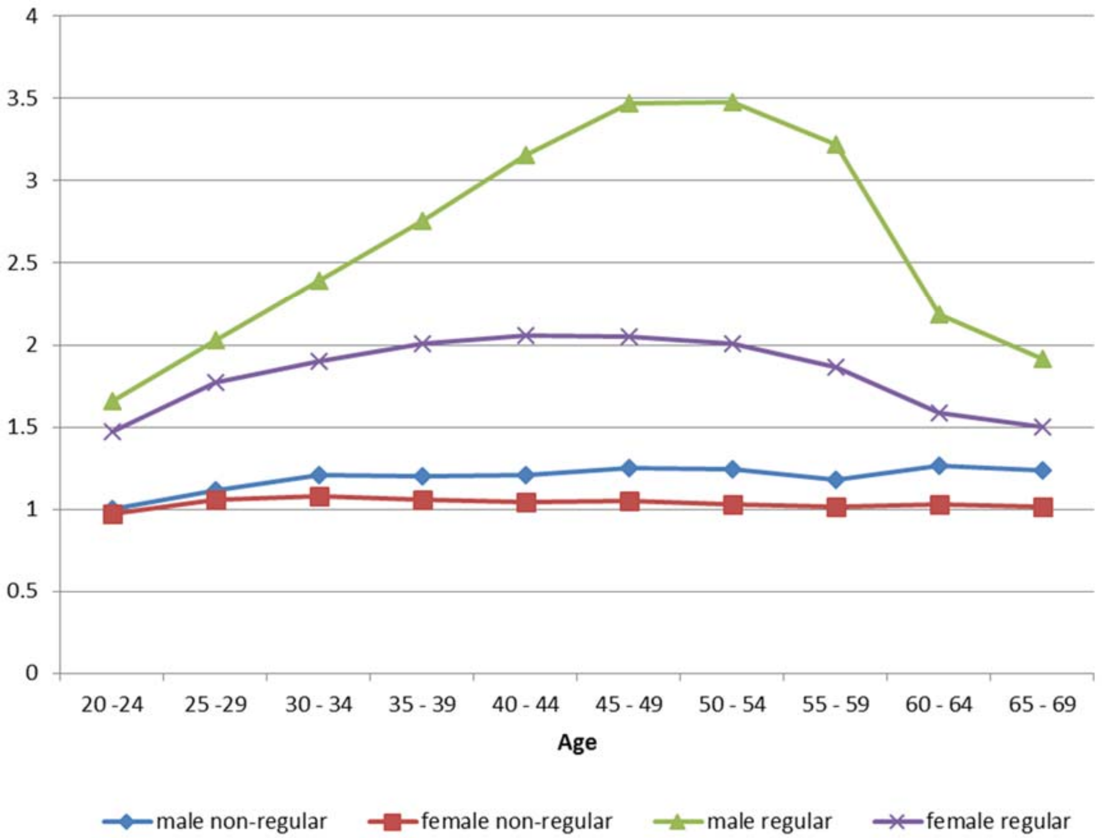
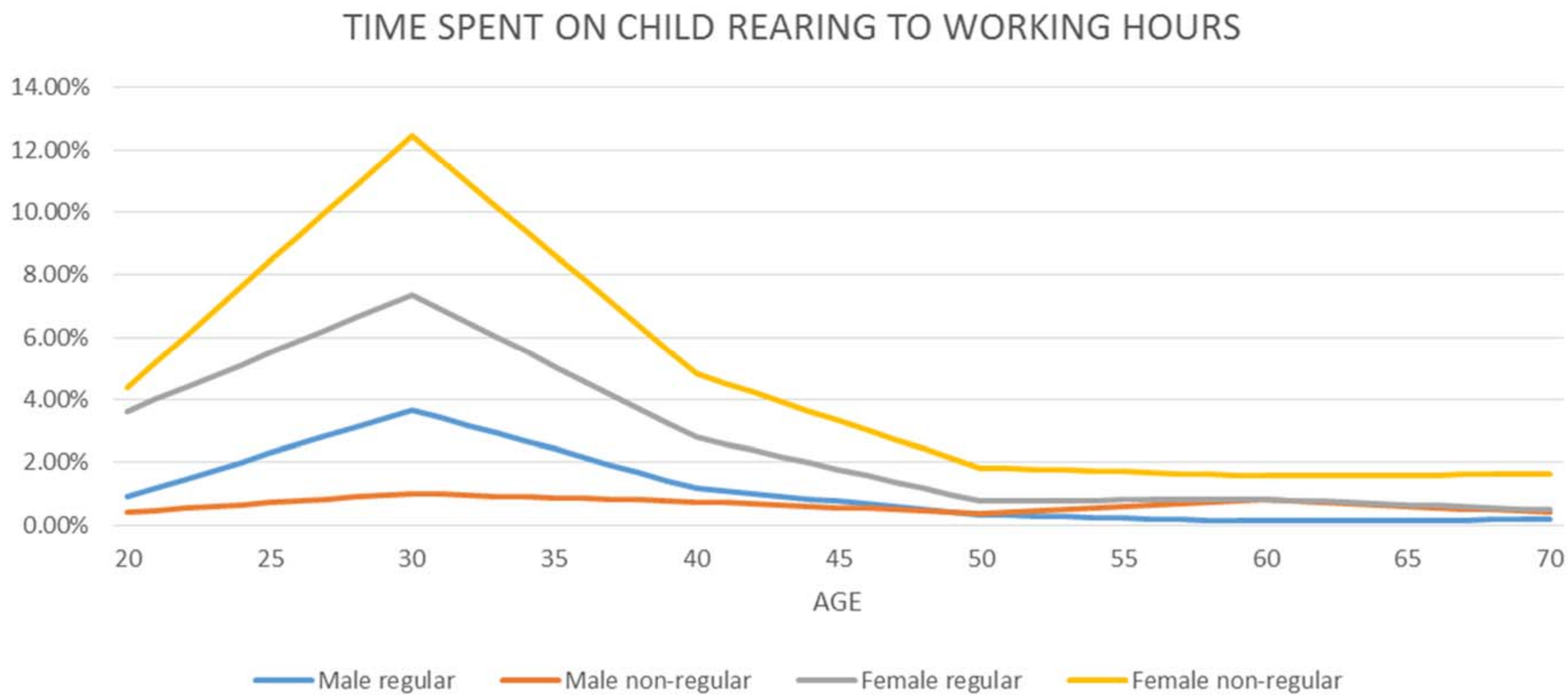


Figure 2: Wage Profiles



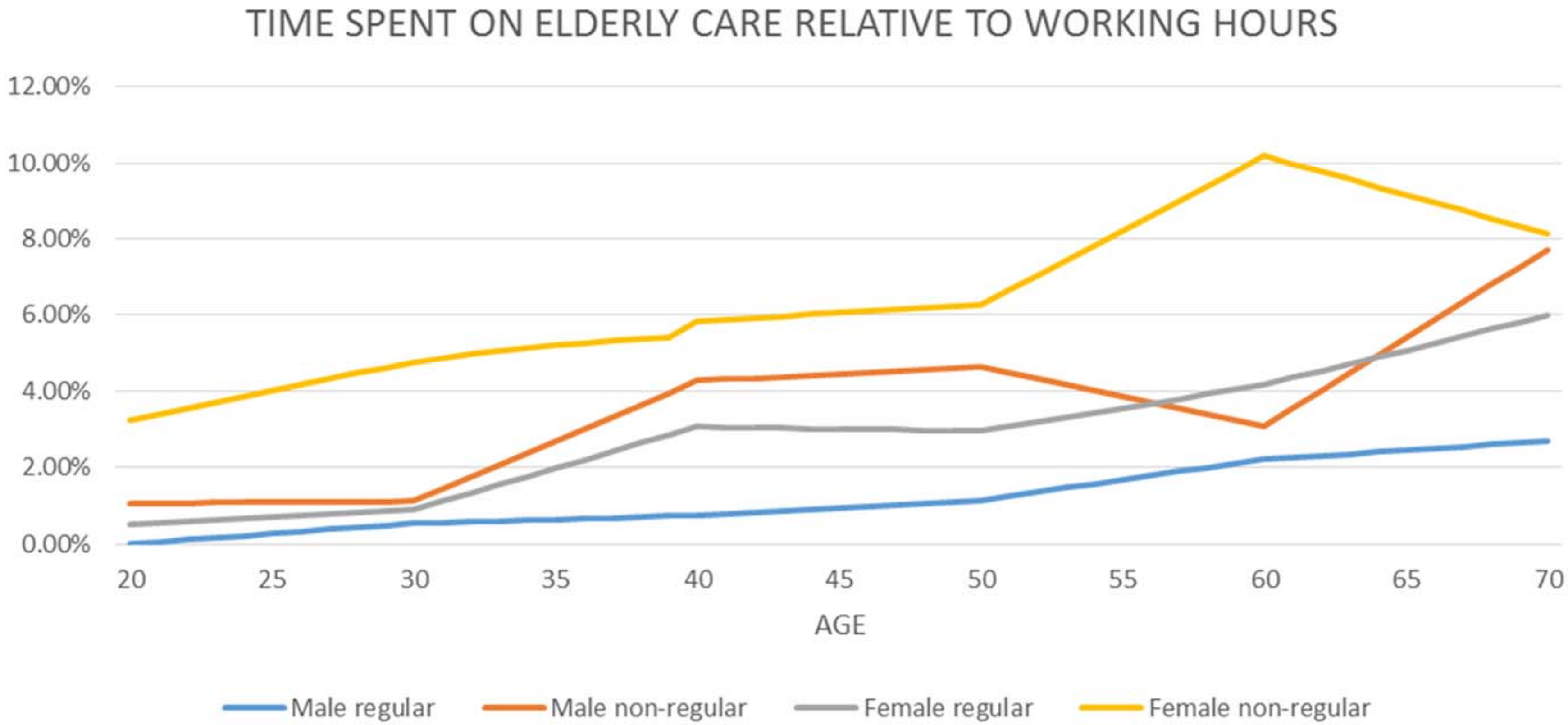
The annual wage of male non-regular workers of age 20 – 24 is used for normalization.
Data: Basic Survey of Wage Structure (BSWS) of year 2011 and Labor Force Survey (LFS) of year 2012
Originally from Kato and Kawade (2015)

Figure 3-1: Time Spent on Child Rearing



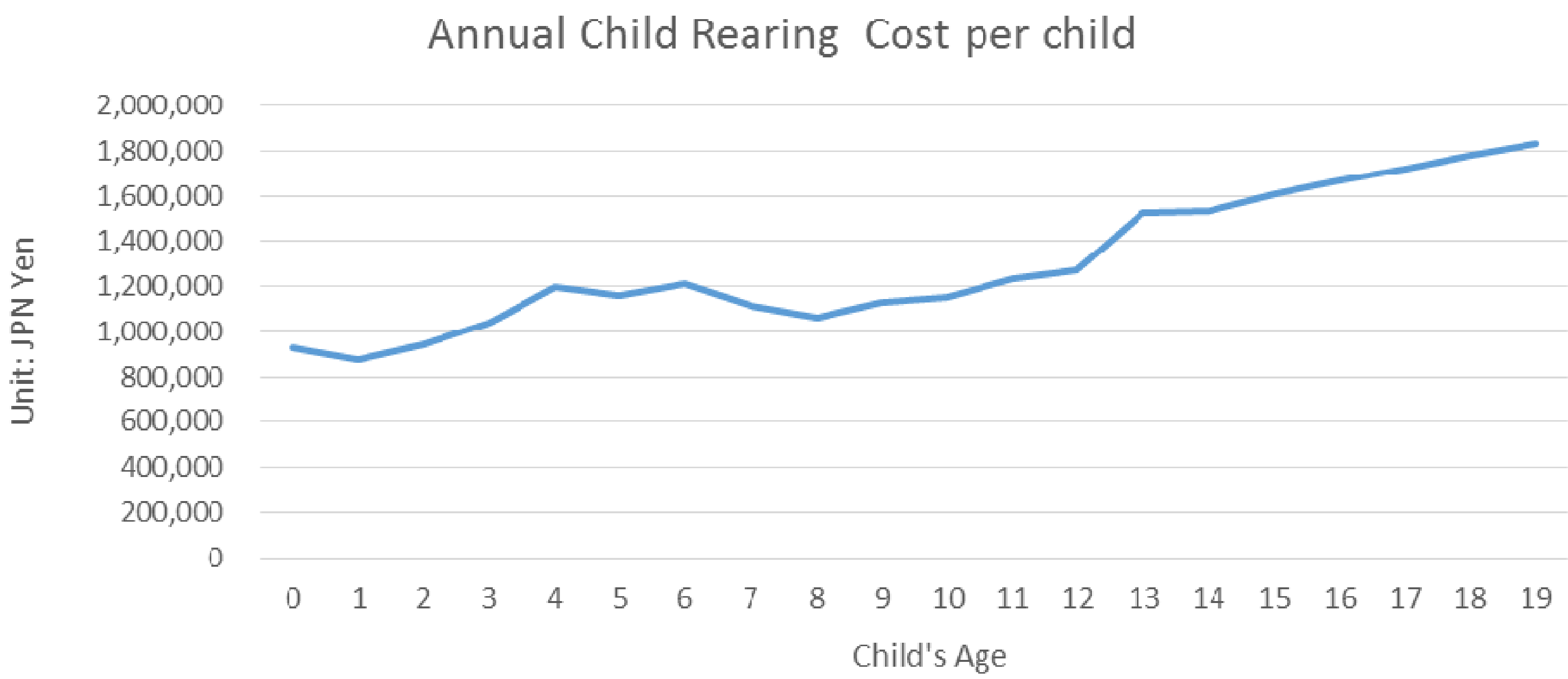
Data: Survey on Time Use and Leisure Activities (STULA) of year 2012, Statistics Bureau, Ministry of Internal Affairs and Communications

Figure 3-2: Time Spent on Elderly Care



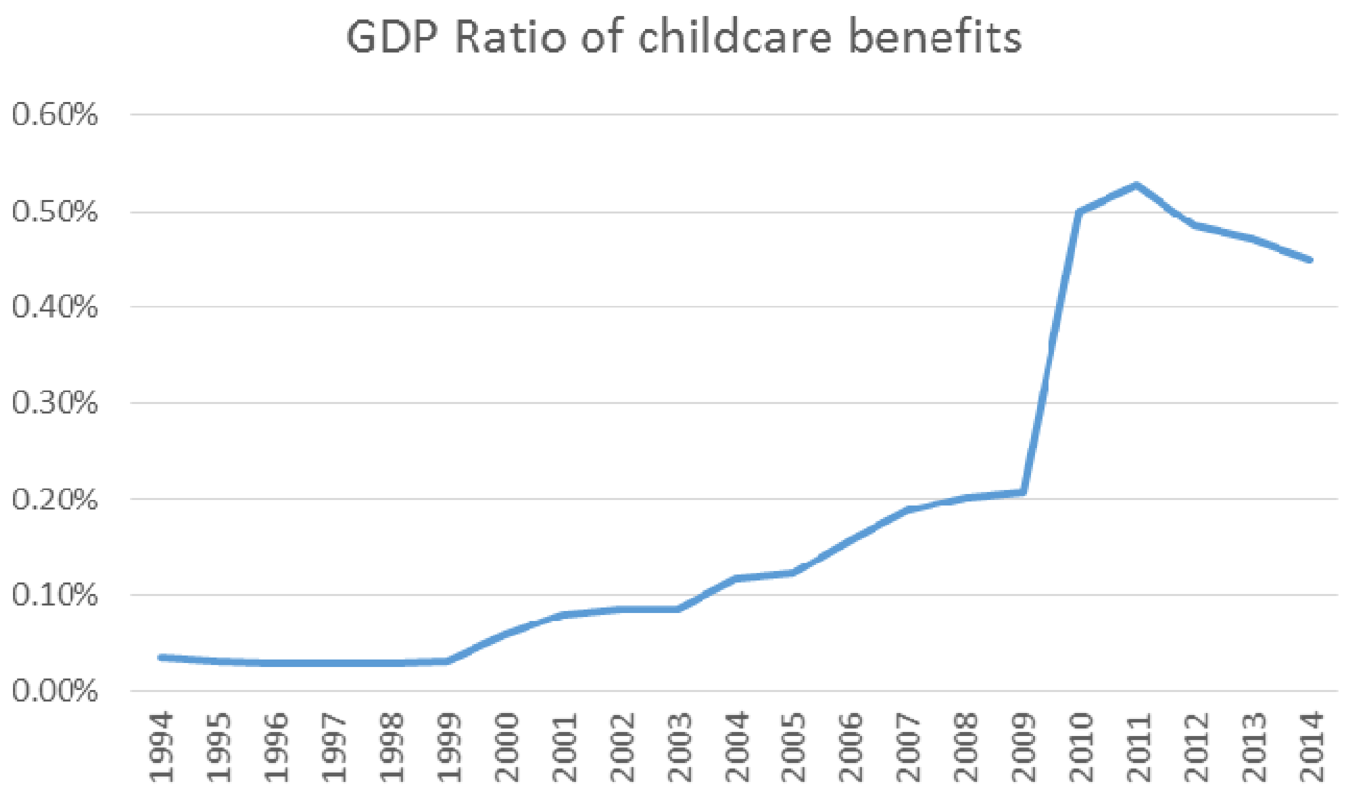
Data: Survey on Time Use and Leisure Activities (STULA) of year 2012, Statistics Bureau, Ministry of Internal Affairs and Communications

Figure 4: The Financial Cost of Child Rearing per Child



Data: The Financial Cost of Child Rearing by internet, Cabinet Office (2009)

Figure 5: The Amount of Child Care Benefits relative to GDP



Data: SNA

Figure 6: Primary Balance

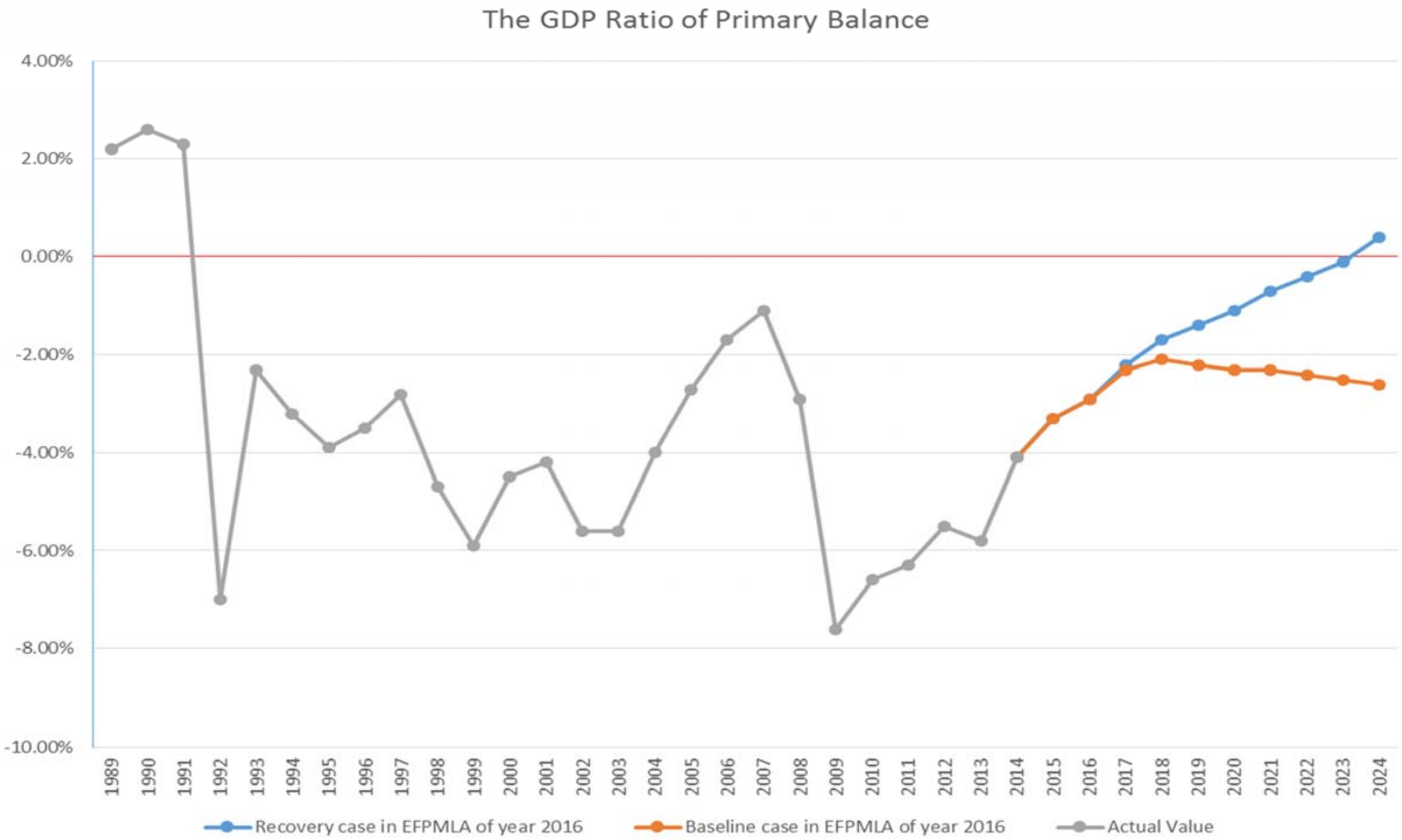
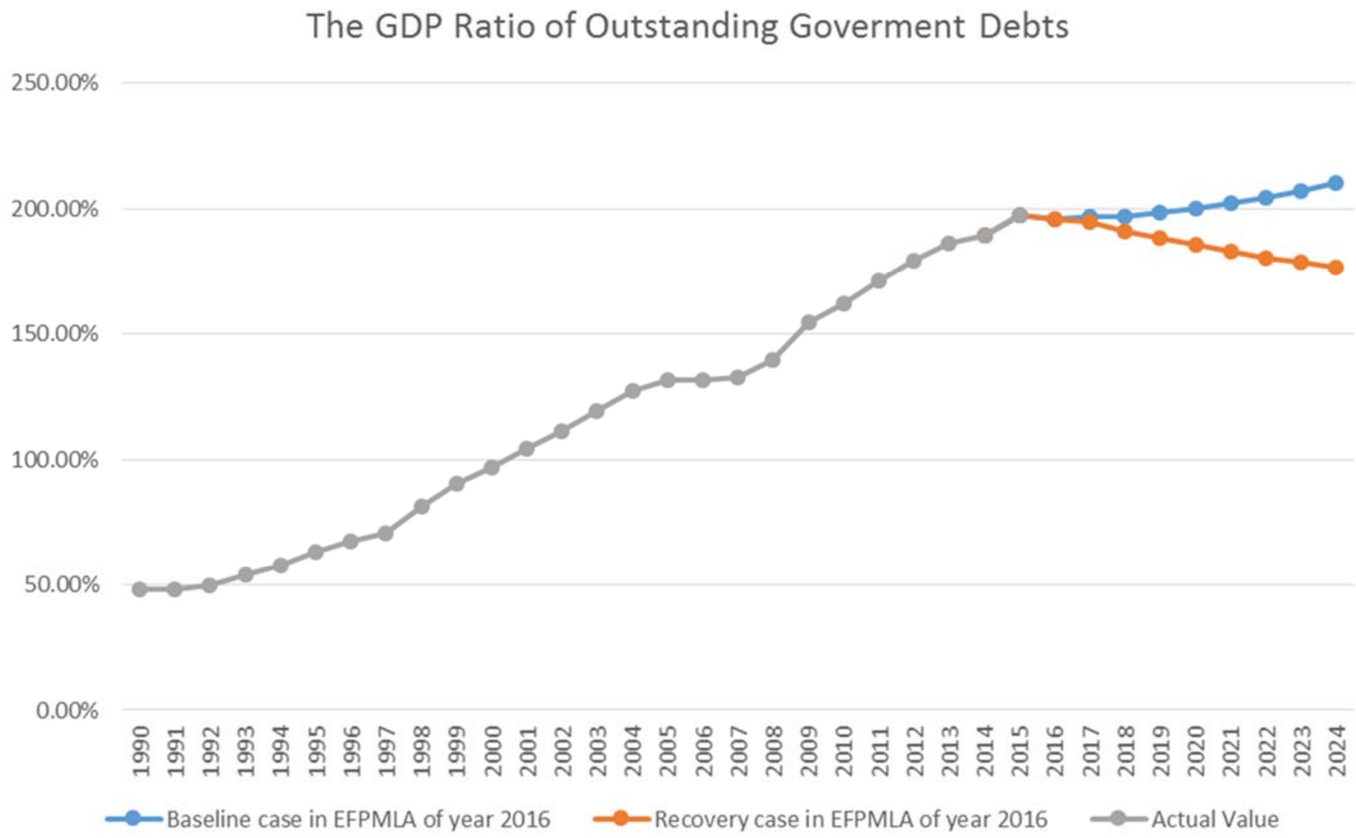


Figure 7: Government Deficits



Central and local governments debts are included.

Figure 8: Economic Growth

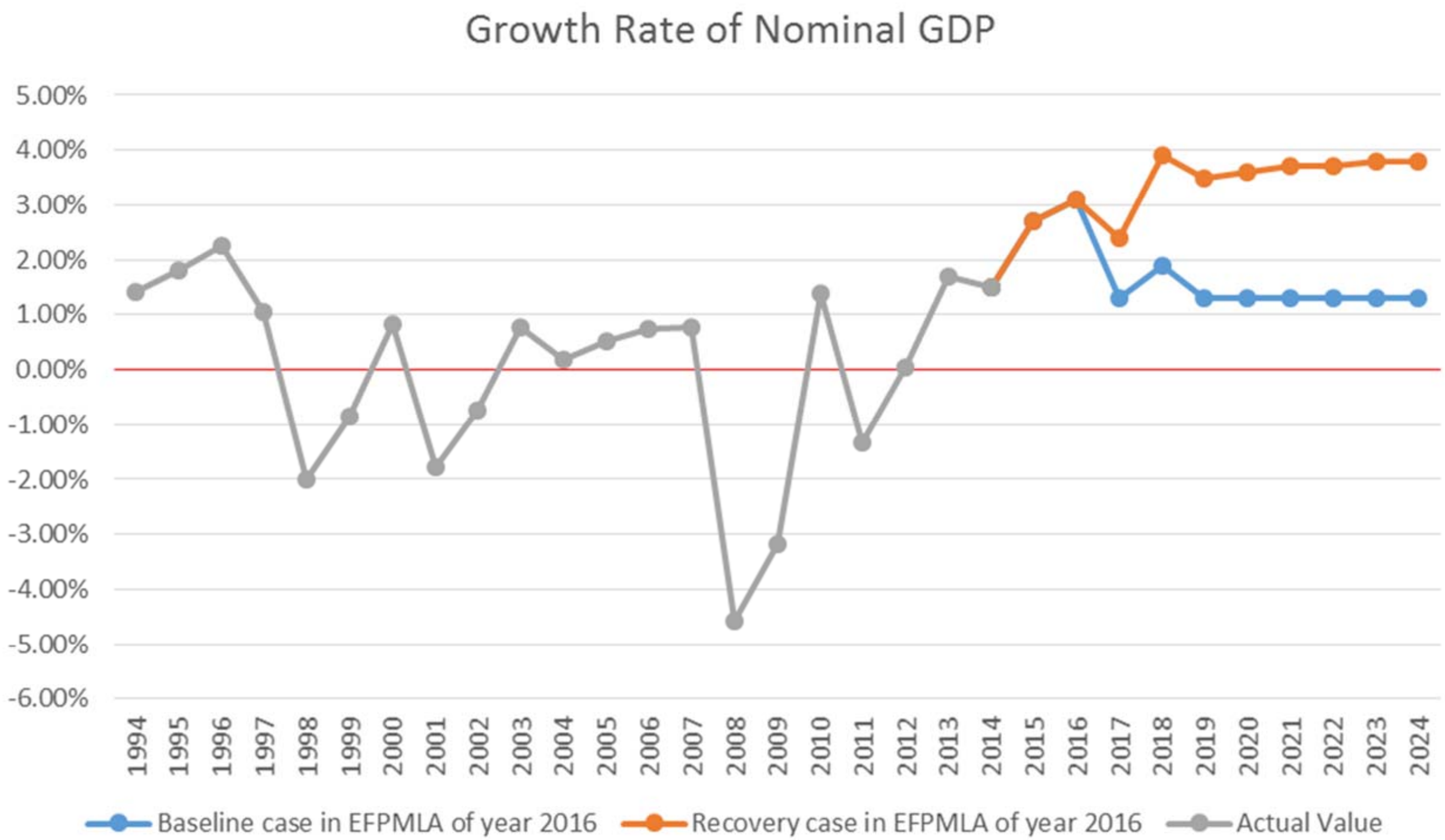


Figure 9-1: The Past Trend of Social Security Benefits

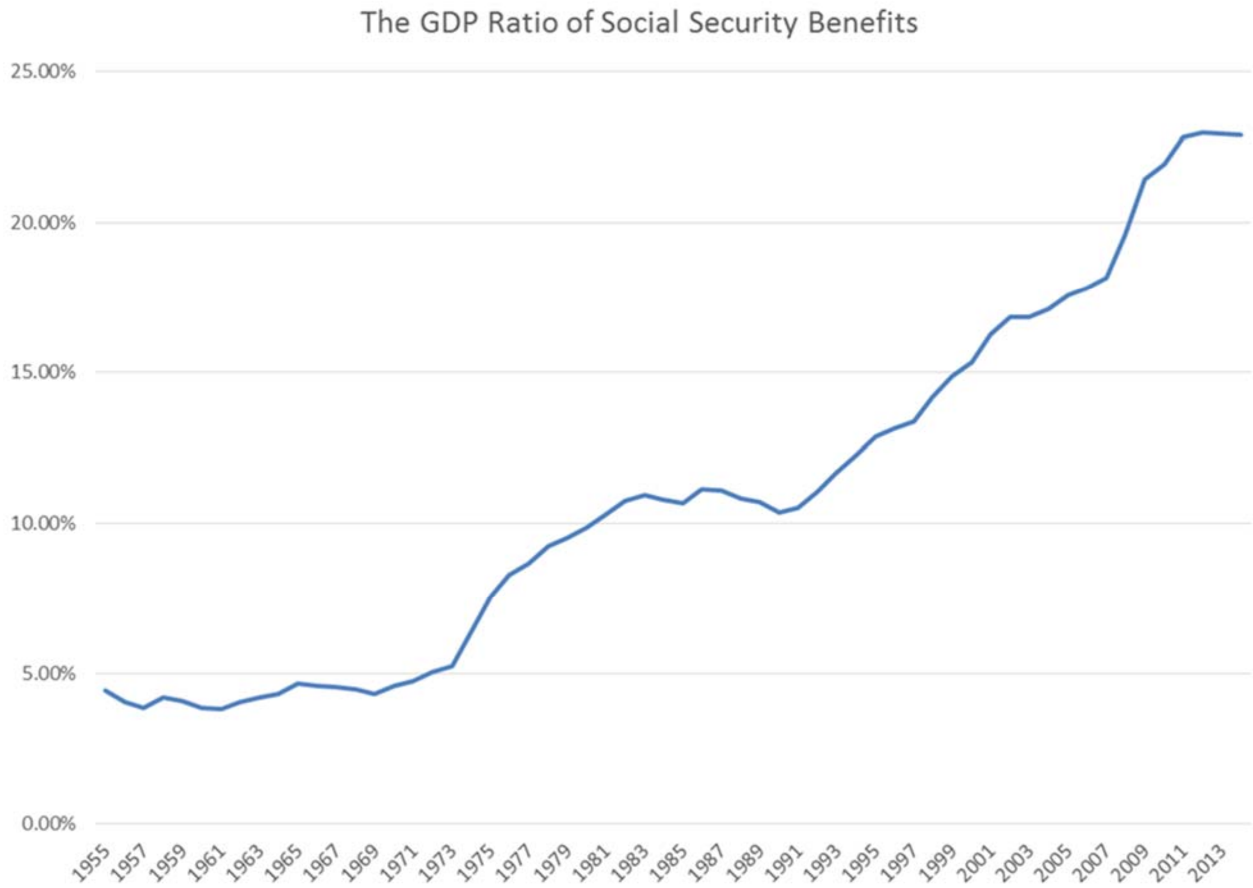


Figure 9-2: The Government Expenditures

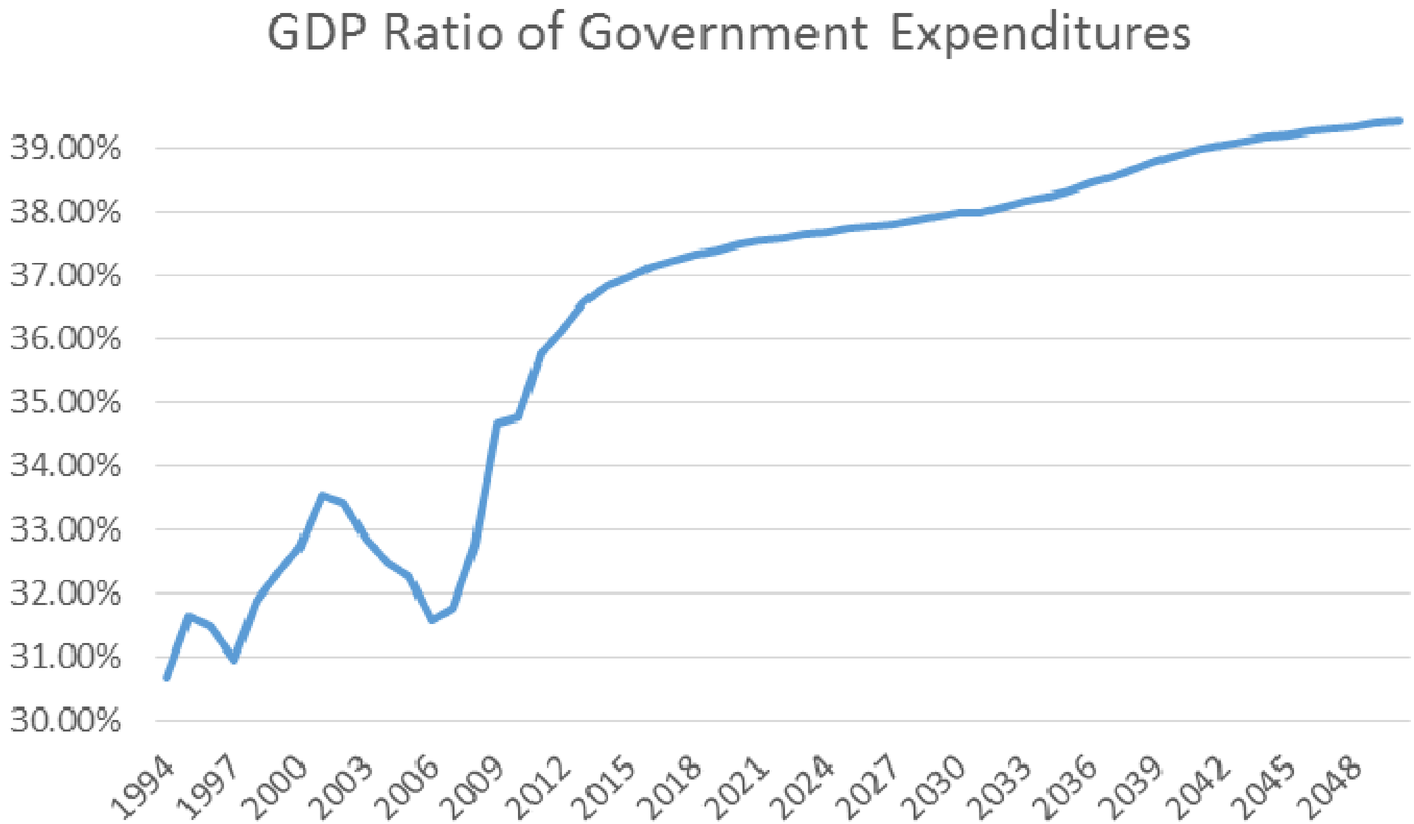


Figure 10: Future Deficits Ratio to GDP

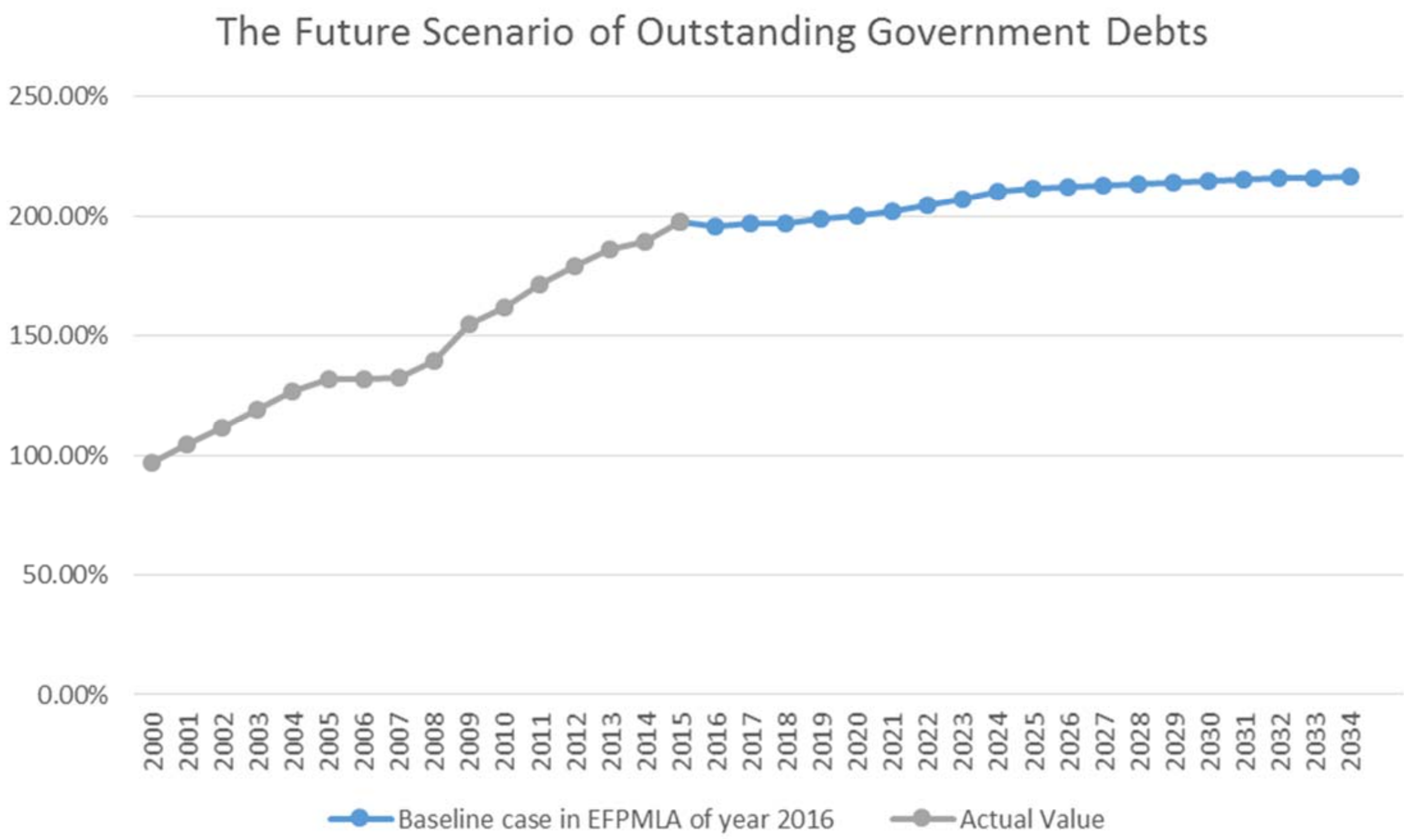


Figure 11: Public Pension Fund

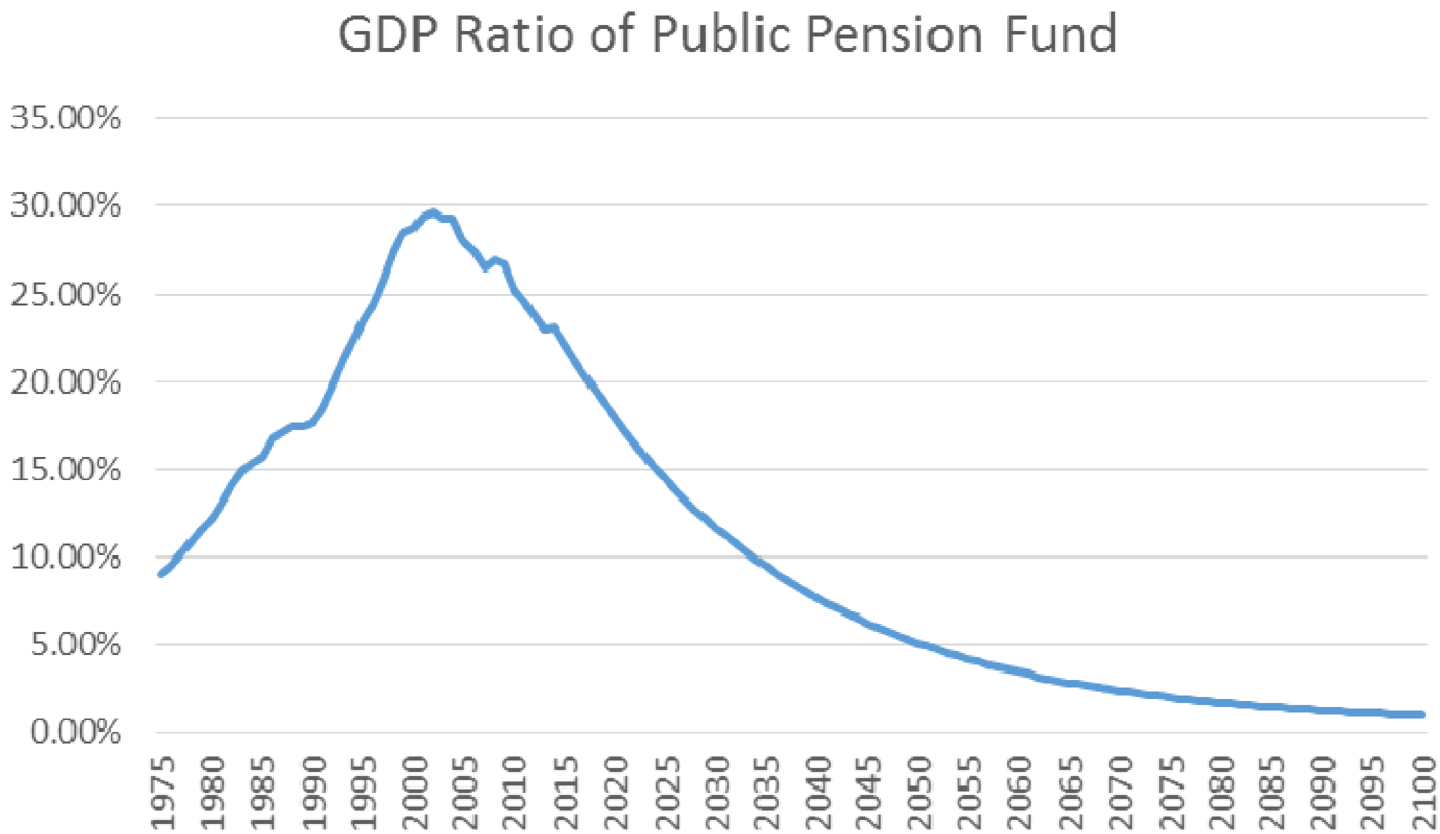
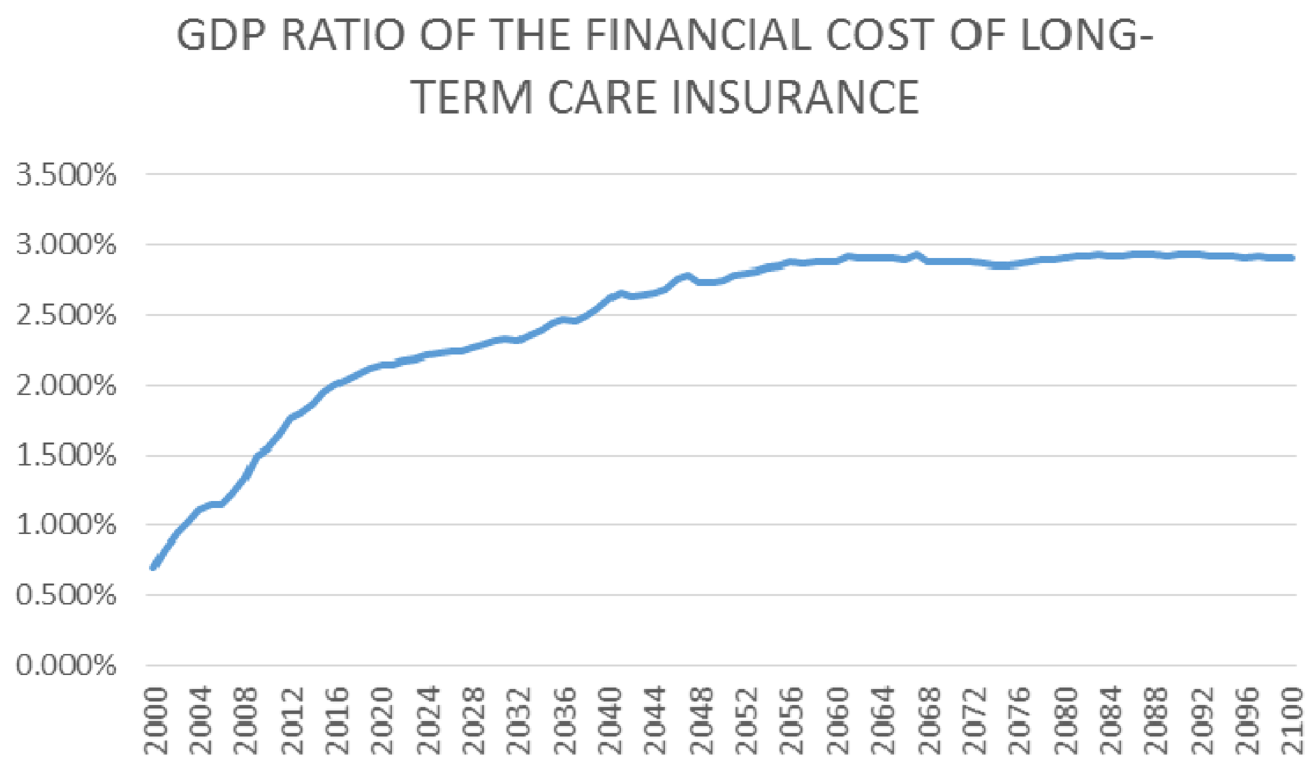


Figure 12: The GDP Ratio of the Expenditures of the Long-Term Care Insurance



Until 2014, the actual data is used.
The amount of Co-payments paid by the insured is not included.

Table 1: Parameters

Parameter	Description	Value/Source
P_s	Survival rate	IPSS(2017)
δ	Subjective discount factor	0.0286 / Kitao (2015a)
ρ	Risk aversion	3.0 / Kitao (2015a)
ξ	Relative preference	0.15
κ	Weight parameter for leisure	0.00001
$\tau_{r,t}$	Interest income tax rate	35.57 %/ Hansen and İmrohoroğlu (2016)
$\tau_{w,t}$	Wage income tax rate *	33.24 %/ Hansen and İmrohoroğlu (2016)
$\tau_{q,t}$	Inheritance tax rate	35 .00 %
α	Labor income share	0.6217/ Hansen and İmrohoroğlu (2016)
φ	Depreciation rate	8.421 %/ Hansen and İmrohoroğlu (2016)

*) The wage income tax rate is endogenously calculated until year 2018, and it is exogenously given at this value from year 2019.

Table 2: The Distribution of the Cost of the Long Term Care Insurance

Year	Contributins by		Tax
	1st group	2nd group	
2000－2002	17%	33%	50%
2003－2005	18%	32%	50%
2006 - 2008	19%	31%	50%
2009 - 2011	20%	30%	50%
2012 - 2014	21%	29%	50%
2015 - 2017	22%	28%	50%
2018 - 2020	23%	27%	50%
2021 - 2023	23%	27%	50%
2024 - 2026	24%	26%	50%
2027 - 2029	24%	26%	50%
2030 - 2032	24%	26%	50%
2033 - 2035	25%	25%	50%
2036 - 2038	26%	24%	50%
2039 - 2041	27%	23%	50%
2042 - 2044	27%	23%	50%
2045 - 2047	28%	22%	50%
2048 - 2050	28%	22%	50%
2051 - 2053	28%	22%	50%
2054 - 2056	28%	22%	50%
2057 - 2059	28%	22%	50%
2060 - 2062	28%	22%	50%
2063 - 2065	29%	21%	50%
2066 - 2068	29%	21%	50%
2069 - 2071	29%	21%	50%

1st Group: Age 65 and Over
2nd Group: Age 40 – 64

Table 3: The Values in Year 2012

Variables	Actual	Model
GDP ratio of outstanding government bonds	179.11 %	179.11 %
GDP ratio of public pension fund	23.79 %	23.79 %
GDP ratio of government expenditures	36.14 %	36.14 %
GDP ratio of childcare benefits	0.49 %	0.49 %
GDP ratio of long-term care insurance expenditures	1.758 %	1.758 %
Primary balance	-5.50 %	-5.00 %
GDP growth rate (real)	0.9 %	1.1 %
National burden ratio	40.6 %	40.61 %
Contribution rate in the public pension *	16.766 %	15.366 %
Contribution rate in the public pension in year 2017 *	18.3 %	18.29 %
Wage income tax rate in year 2018**	33.24 %	33.78 %

Sources: Ministry of Finance, Cabinet Office, and Ministry of Internal Affairs and Communications

*) Both contribution rates are of the Kousei-Nenkin. The contribution rate is endogenously calculated until year 2017.
**) The wage income tax rate is endogenously calculated until year 2018.

Figure 13-1: Model Prediction for the Primary Balance

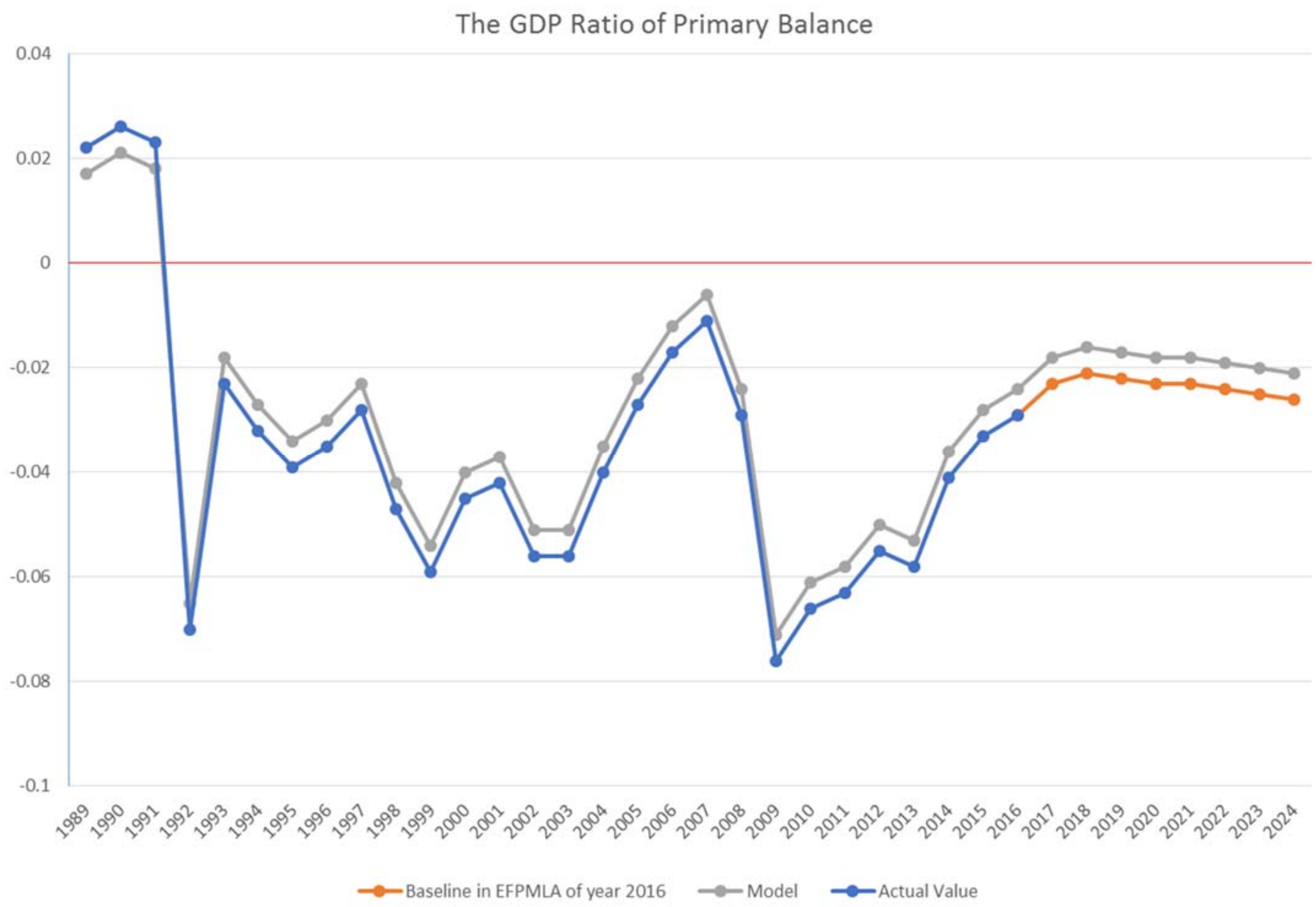


Figure 13-2: Model Prediction for GDP Growth Rate

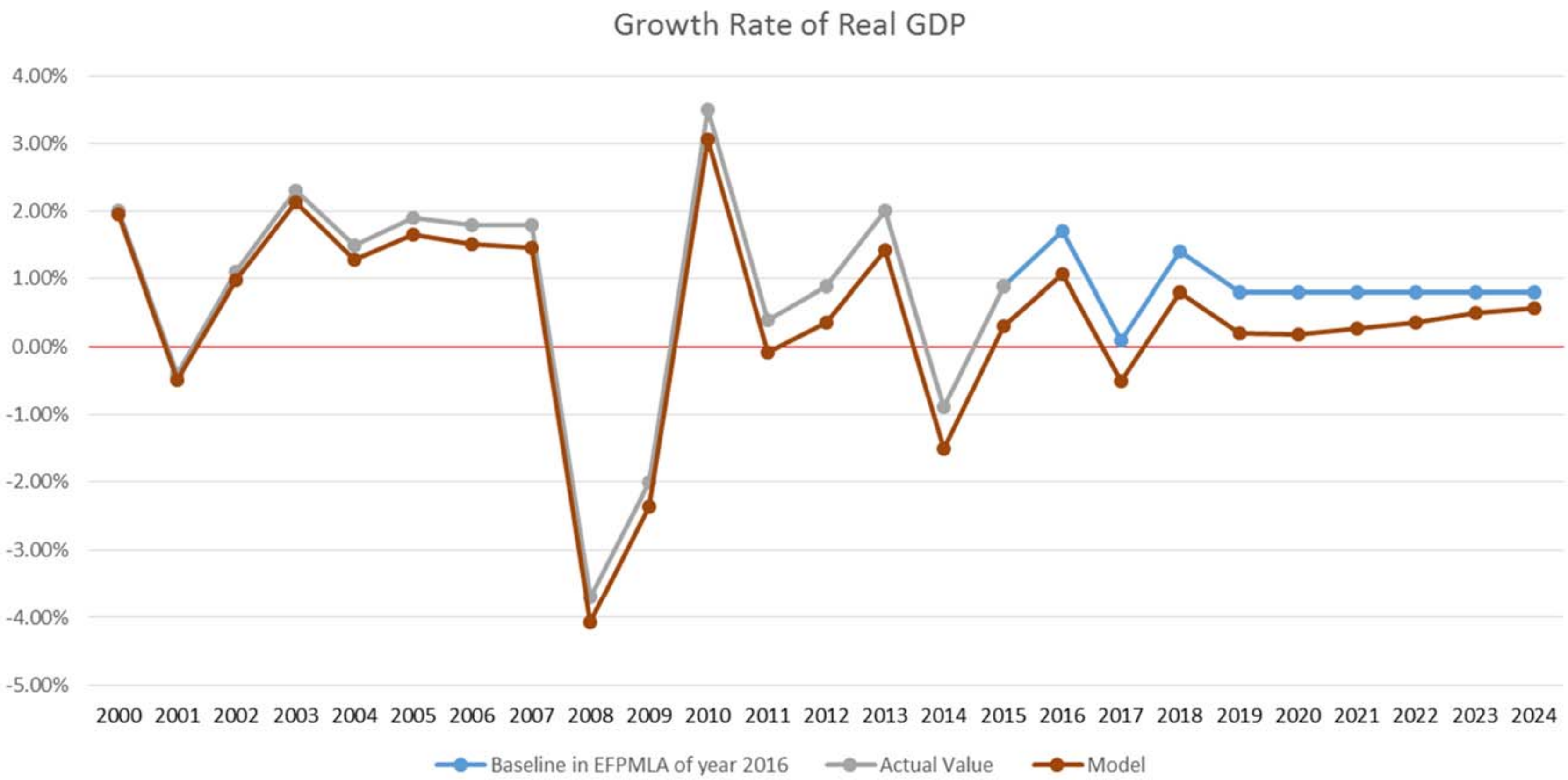


Figure 13-3: Parameter Value of Technological Progress (Ω)

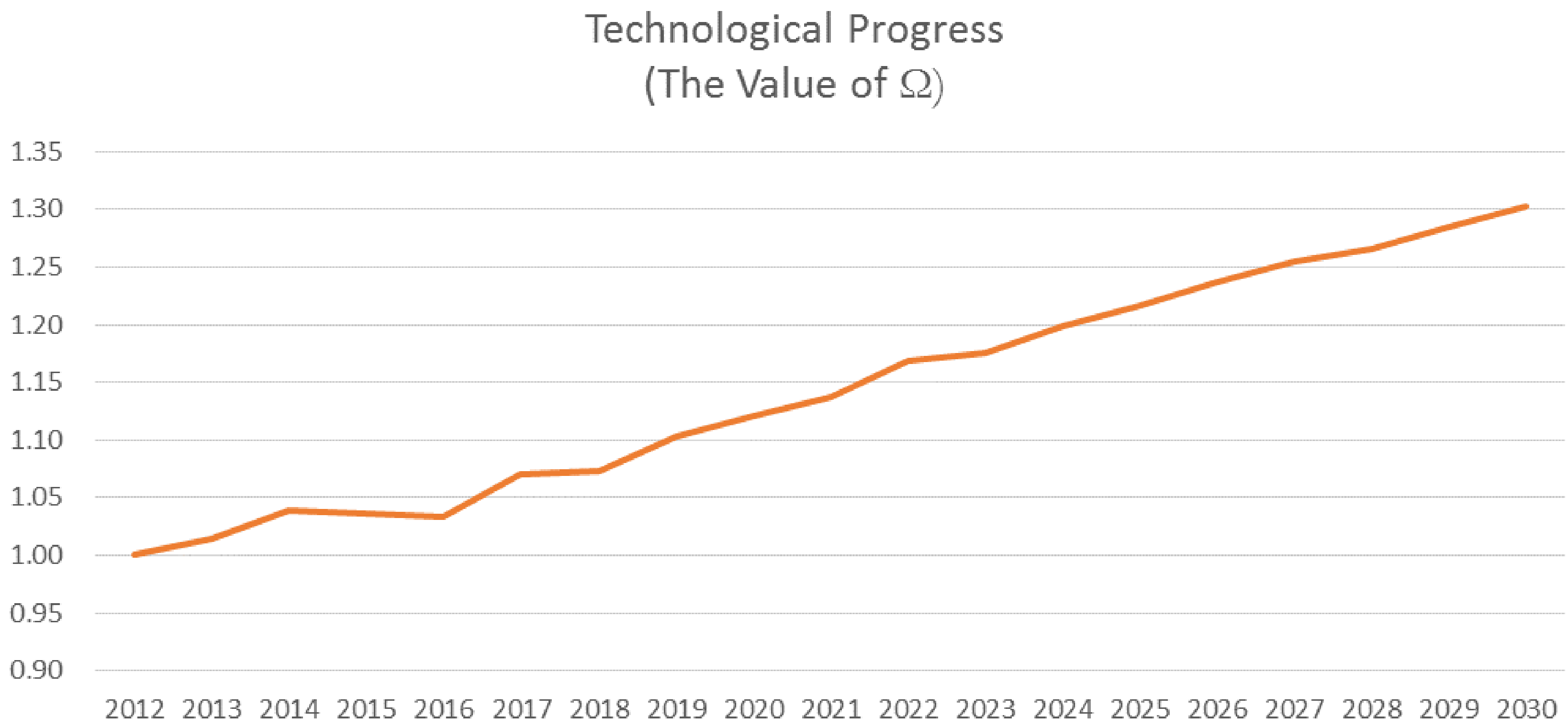


Figure 13-4: Lifetime Labor Supply of the Cohorts born in 2000 and 2050 in the Benchmark Case

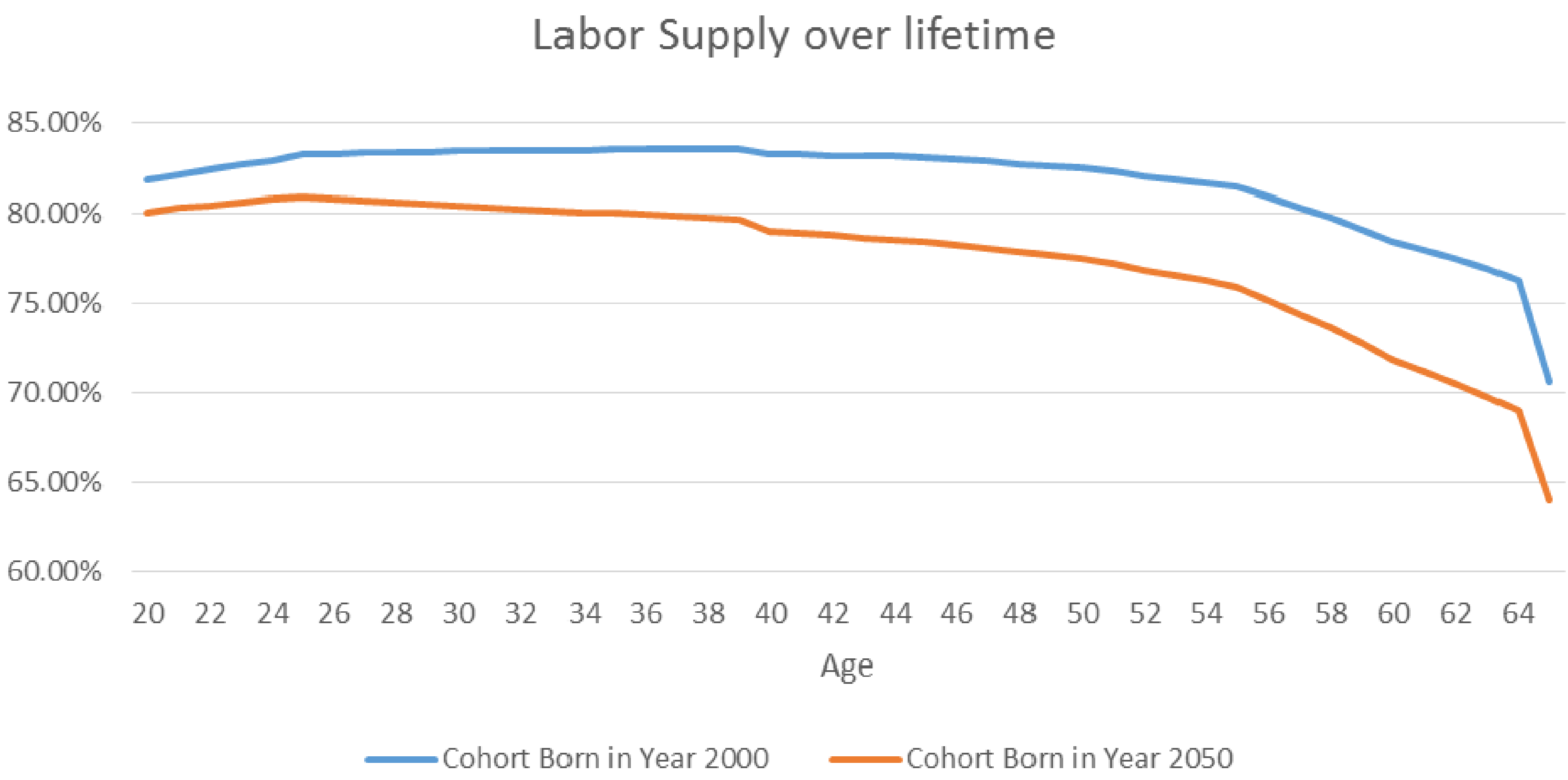


Figure 14: The Impact of Elimination of Females' Time Costs of Child Rearing and Elderly Care On the Total Labor Force

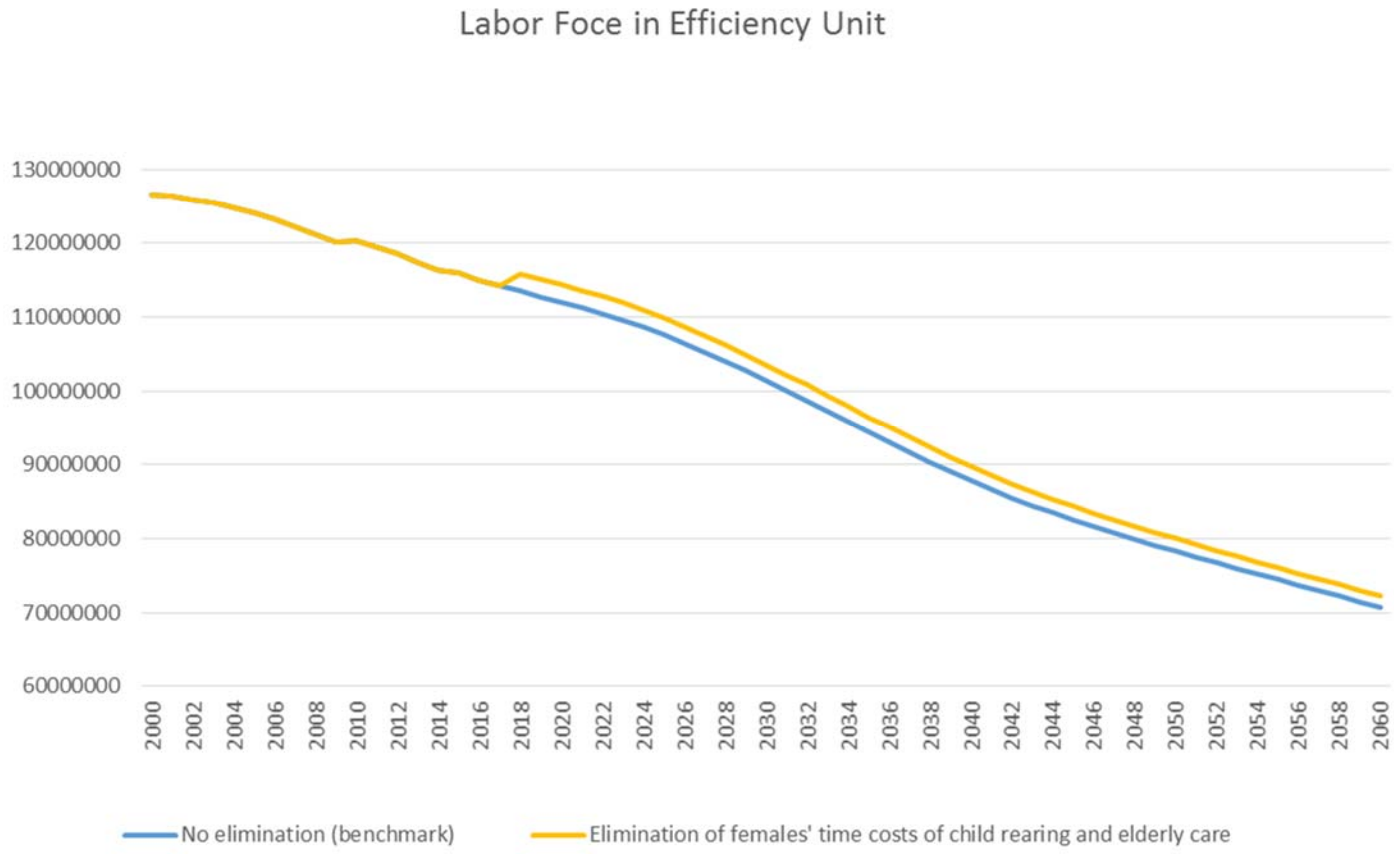


Table 4-1: The Impact of Elimination of Females' Time Costs of Child Rearing and Elderly Care on the Total Labor Participation Rate in Year 2020

Age Group	No elimination (benchmark)	Elimination of child rearing time	Elimination of elderly care time	Elimination of both child rearing and elderly care time
	Labor Participation Rate			
20～24	82.65%	82.51%	82.73%	82.57%
25～29	84.04%	83.93%	84.07%	83.95%
30～34	84.15%	84.08%	84.15%	84.07%
35～39	83.66%	83.66%	83.66%	83.62%
40～44	82.91%	82.93%	82.90%	82.88%
45～49	82.12%	82.16%	82.12%	82.09%
50～54	81.87%	81.92%	81.88%	81.84%
55～59	80.37%	80.43%	80.40%	80.34%
60～64	78.20%	78.27%	78.24%	78.17%
65～69	37.76%	37.79%	37.78%	37.72%

Table 4-2: The Impact of Elimination of Females' Time Costs of Child Rearing and Elderly Care on the Total Labor Participation Rate in Year 2070

Age Group	No elimination (benchmark)	Elimination of child rearing time	Elimination of elderly care time	Elimination of both child rearing and elderly care time
	Labor Participation Rate			
20～24	80.57%	80.19%	80.60%	80.23%
25～29	81.10%	80.73%	81.10%	80.72%
30～34	80.97%	80.58%	80.93%	80.54%
35～39	80.94%	80.55%	80.87%	80.48%
40～44	80.48%	80.06%	80.36%	79.95%
45～49	80.48%	80.06%	80.33%	79.92%
50～54	79.78%	79.36%	79.61%	79.18%
55～59	78.38%	77.93%	78.16%	77.71%
60～64	76.03%	75.54%	75.76%	75.26%
65～69	34.40%	34.56%	34.63%	34.27%

Figure 15-1: The Impact of Elimination of Females' Time Costs of Child Rearing and Elderly Care on Lifetime Labor Supply of the Cohort born in 2000

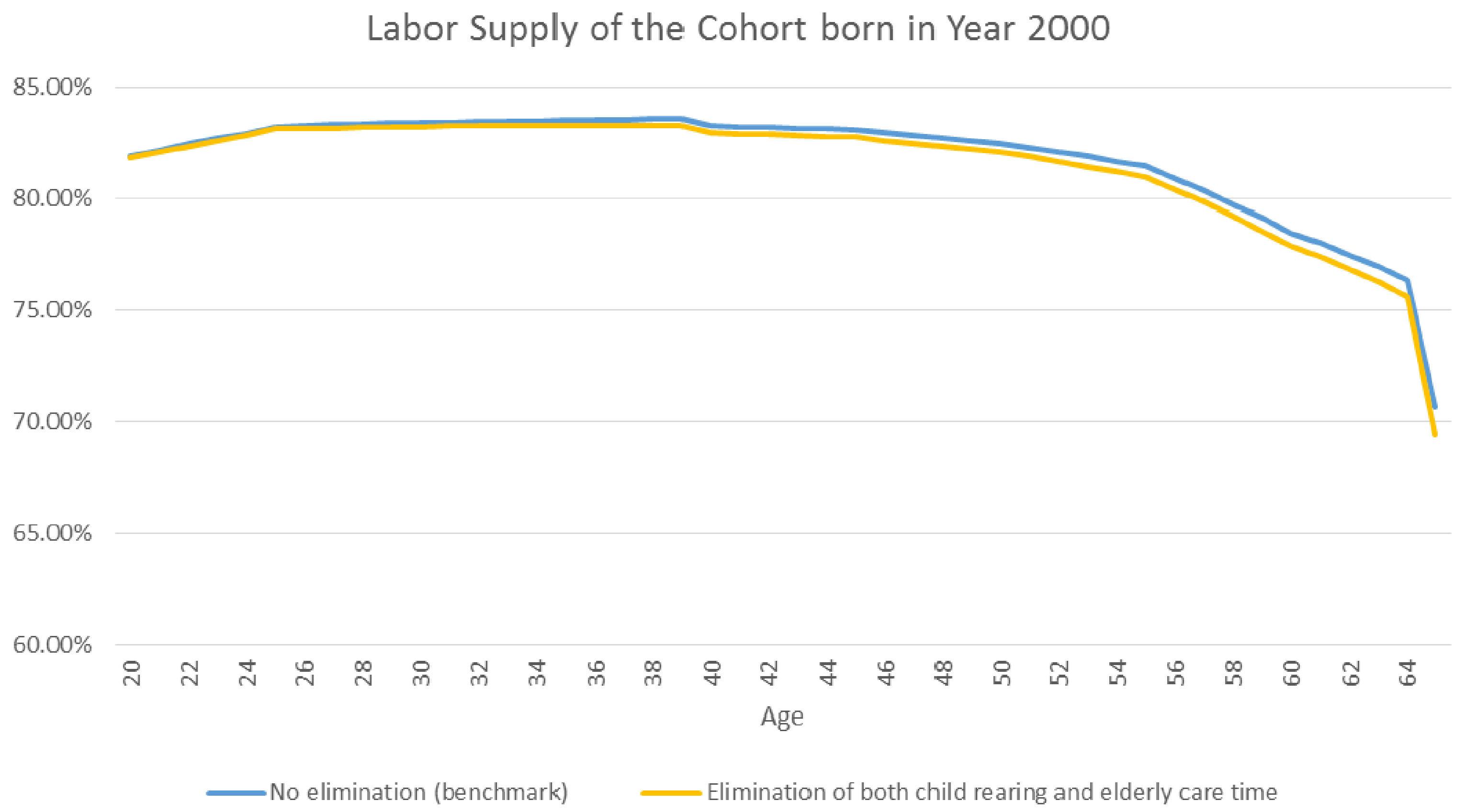


Figure 15-2: The Impact of Elimination of Females' Time Costs of Child Rearing and Elderly Care on Lifetime Labor Supply of the Cohort born in 2050

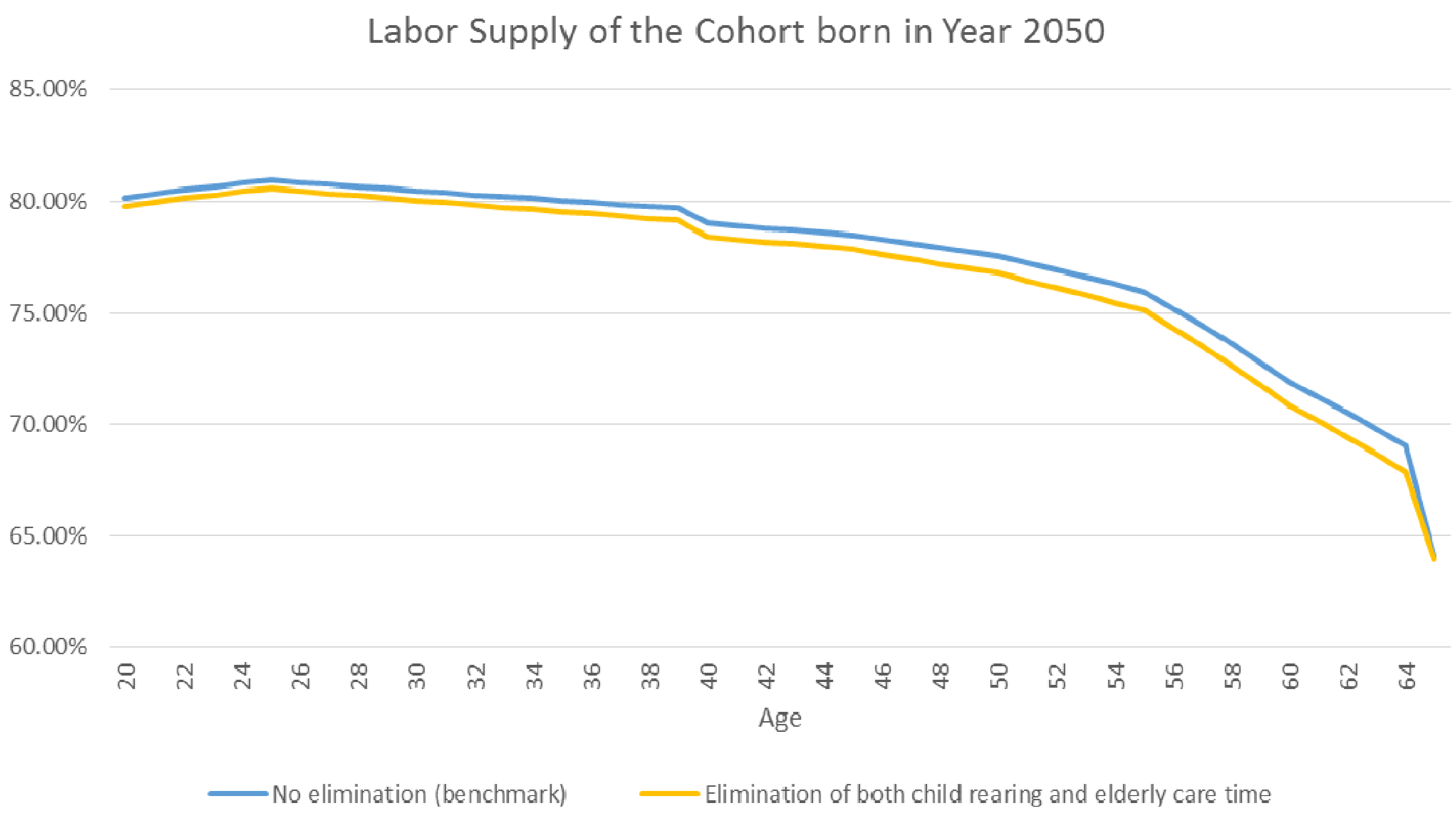
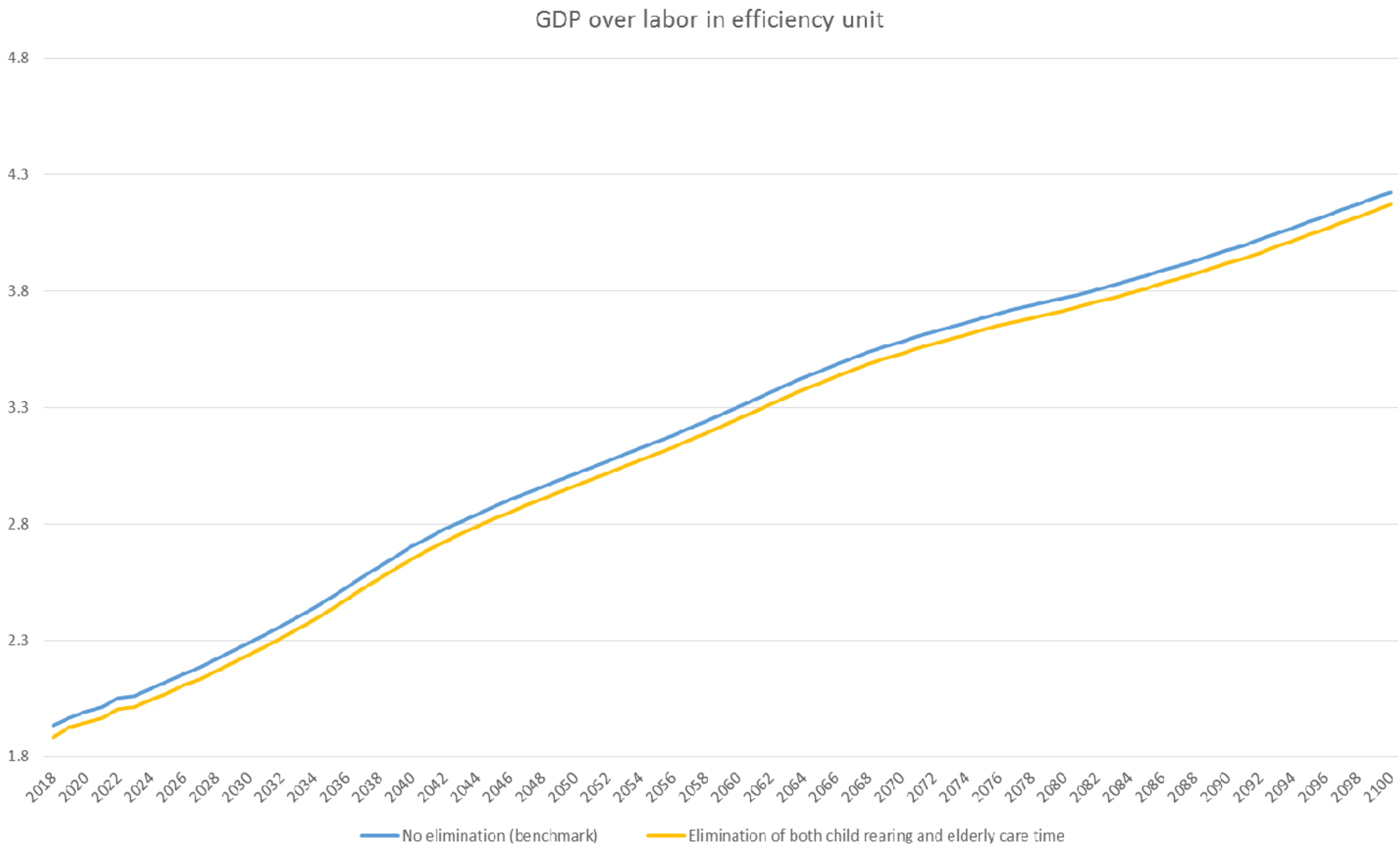


Figure 16-1: GDP over Labor in Efficiency Unit ($\frac{Y_t}{L_t}$)



GDP over labor in efficiency unit is defined by the ratio of GDP to the total number of labor supply measured in efficiency unit.

Figure 16-2: The Wage Rate

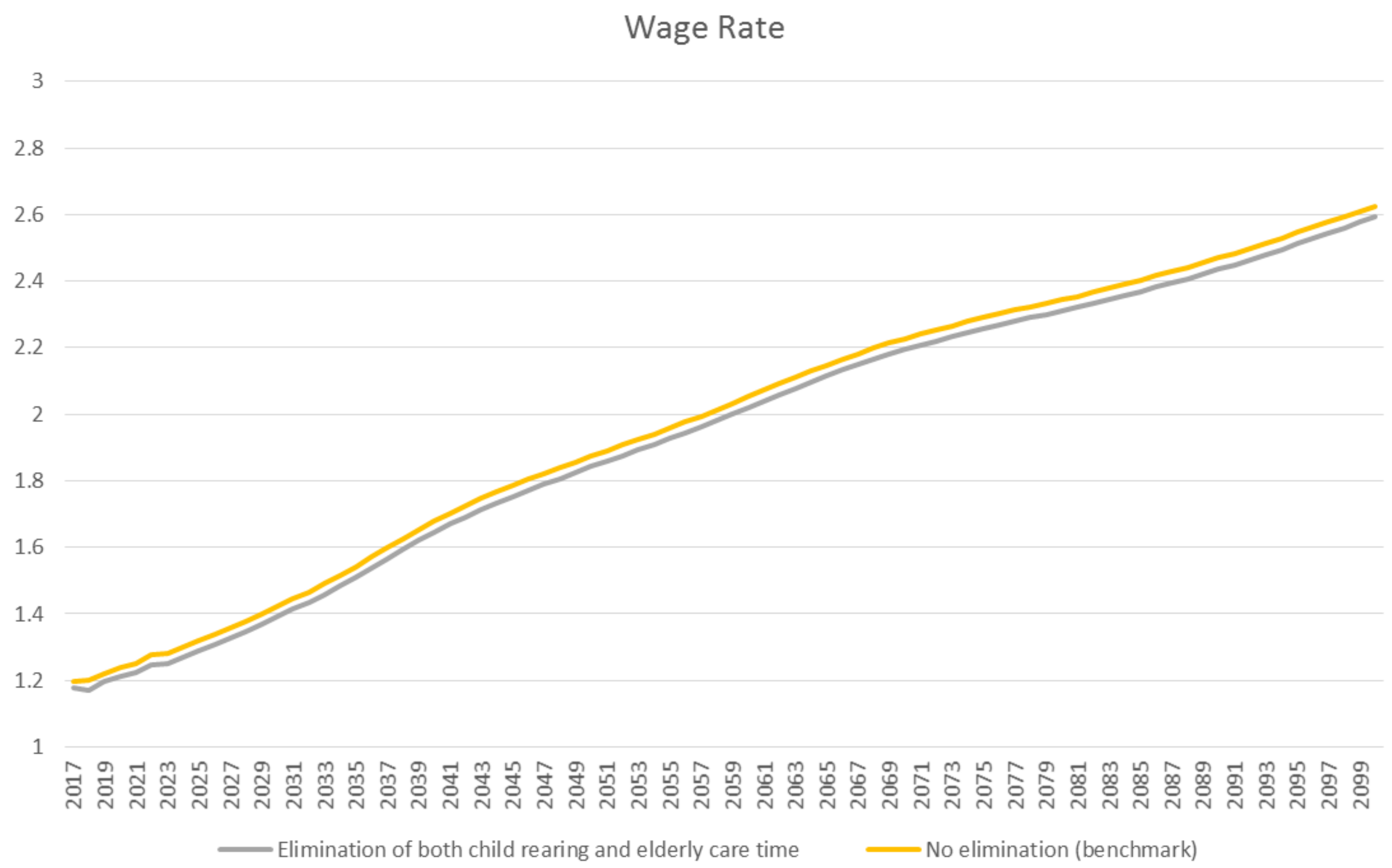


Table 5-1: Change in GDP over labor in efficiency unit ($\frac{Y_t}{L_t}$) from the benchmark

	Elimination of child rearing time	Elimination of elderly care time	Elimination of both child rearing and elderly care time
2018	-1.18%	-1.36%	-2.56%
2019	-0.71%	-0.85%	-1.90%
2020	-1.19%	-1.35%	-2.38%
2021	-1.16%	-1.34%	-2.35%
2022	-1.15%	-1.33%	-2.34%
2023	-1.12%	-1.33%	-2.31%
2024	-1.10%	-1.32%	-2.30%
2025	-1.08%	-1.31%	-2.27%
2026	-1.06%	-1.30%	-2.25%
2027	-1.04%	-1.30%	-2.23%
2028	-1.02%	-1.29%	-2.22%
2029	-1.00%	-1.28%	-2.20%
2030	-0.98%	-1.28%	-2.18%
2031	-0.97%	-1.27%	-2.16%
2032	-0.95%	-1.26%	-2.14%
2033	-0.93%	-1.25%	-2.12%
2034	-0.91%	-1.25%	-2.10%
2035	-0.89%	-1.24%	-2.08%
2036	-0.87%	-1.23%	-2.06%
2037	-0.85%	-1.22%	-2.04%
2038	-0.83%	-1.21%	-2.02%
2039	-0.81%	-1.20%	-2.00%
2040	-0.79%	-1.19%	-1.97%
2041	-0.77%	-1.18%	-1.94%
2042	-0.74%	-1.17%	-1.92%
2043	-0.72%	-1.16%	-1.89%
2044	-0.70%	-1.15%	-1.86%
2045	-0.68%	-1.14%	-1.84%
2046	-0.66%	-1.13%	-1.81%
2047	-0.63%	-1.12%	-1.78%
2048	-0.61%	-1.11%	-1.76%
2049	-0.59%	-1.10%	-1.73%
2050	-0.57%	-1.09%	-1.71%
2051	-0.55%	-1.09%	-1.69%
2052	-0.54%	-1.08%	-1.67%
2053	-0.52%	-1.07%	-1.65%
2054	-0.51%	-1.06%	-1.63%
2055	-0.50%	-1.05%	-1.61%
2056	-0.49%	-1.05%	-1.60%
2057	-0.48%	-1.04%	-1.58%
2058	-0.47%	-1.04%	-1.57%
2059	-0.46%	-1.03%	-1.56%
2060	-0.45%	-1.03%	-1.55%

Figure 16-3: Total GDP

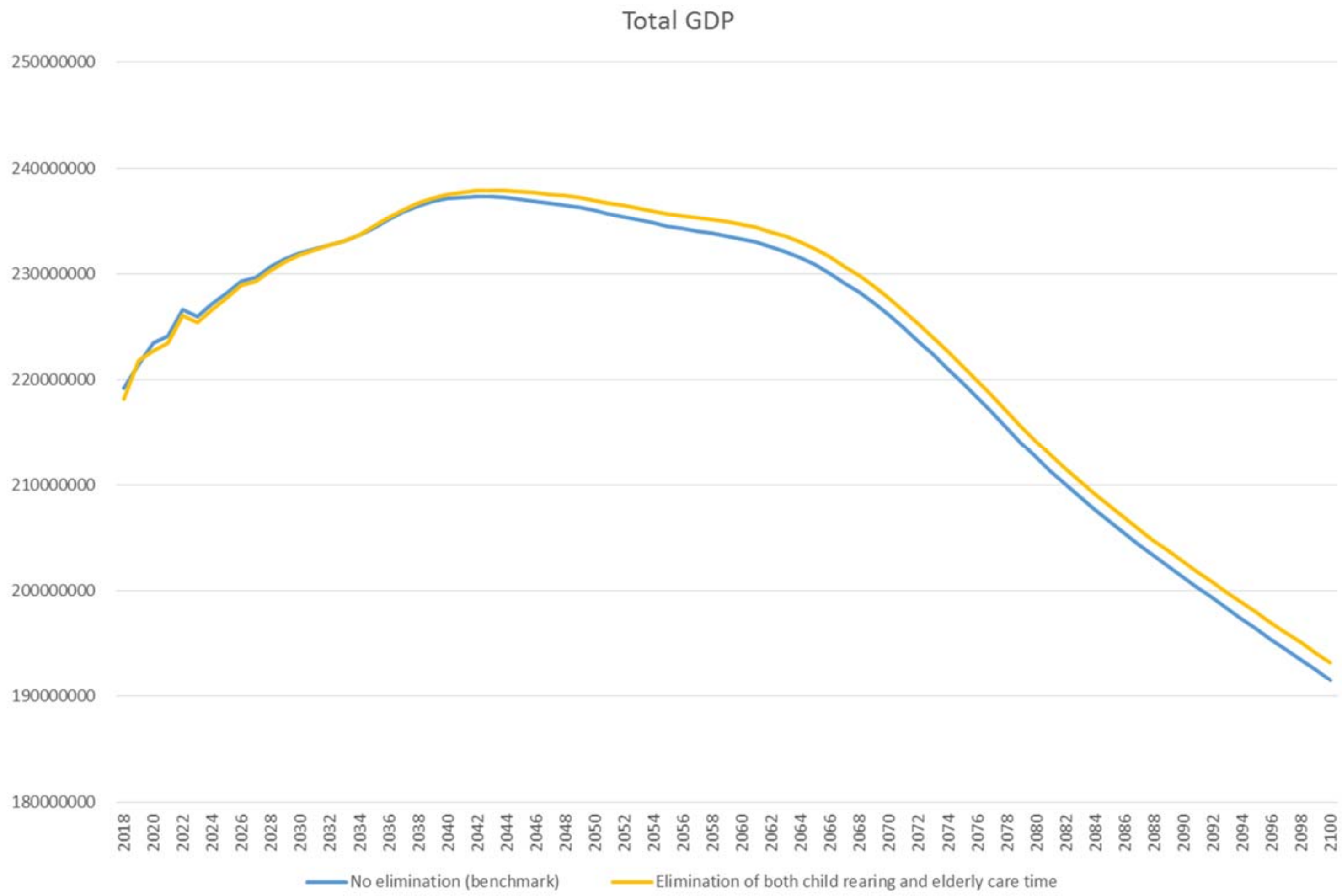


Table 5-2: Change in Total GDP from the benchmark

	Elimination of child rearing time	Elimination of elderly care time	Elimination of both child rearing and elderly care time
2018	-0.15%	-0.29%	-0.48%
2019	0.33%	0.23%	0.19%
2020	-0.16%	-0.27%	-0.30%
2021	-0.14%	-0.26%	-0.28%
2022	-0.13%	-0.26%	-0.27%
2023	-0.11%	-0.25%	-0.24%
2024	-0.09%	-0.24%	-0.23%
2025	-0.07%	-0.22%	-0.20%
2026	-0.05%	-0.21%	-0.18%
2027	-0.03%	-0.20%	-0.15%
2028	-0.01%	-0.19%	-0.13%
2029	0.01%	-0.18%	-0.10%
2030	0.04%	-0.17%	-0.08%
2031	0.06%	-0.16%	-0.05%
2032	0.08%	-0.15%	-0.02%
2033	0.10%	-0.14%	0.00%
2034	0.13%	-0.13%	0.03%
2035	0.15%	-0.13%	0.05%
2036	0.17%	-0.12%	0.07%
2037	0.20%	-0.11%	0.09%
2038	0.22%	-0.11%	0.11%
2039	0.24%	-0.10%	0.14%
2040	0.27%	-0.09%	0.17%
2041	0.29%	-0.09%	0.19%
2042	0.32%	-0.08%	0.22%
2043	0.34%	-0.07%	0.24%
2044	0.36%	-0.06%	0.27%
2045	0.38%	-0.05%	0.29%
2046	0.40%	-0.04%	0.32%
2047	0.43%	-0.03%	0.34%
2048	0.45%	-0.02%	0.37%
2049	0.46%	-0.01%	0.39%
2050	0.48%	-0.01%	0.41%
2051	0.50%	0.00%	0.43%
2052	0.51%	0.01%	0.45%
2053	0.52%	0.02%	0.47%
2054	0.54%	0.03%	0.49%
2055	0.55%	0.04%	0.51%
2056	0.56%	0.05%	0.52%
2057	0.57%	0.05%	0.54%
2058	0.58%	0.06%	0.56%
2059	0.59%	0.06%	0.57%
2060	0.59%	0.07%	0.58%

Table 6-1: Consumption Tax Rate for the General Account

	No elimination (benchmark)	Elimination of child rearing time	Elimination of elderly care time	Elimination of both child rearing and elderly care time
2017	8.00%	8.00%	8.00%	8.00%
2018	8.00%	8.00%	8.00%	8.00%
2020	7.90%	8.22%	8.32%	8.51%
2025	11.82%	12.08%	12.25%	12.41%
2030	14.93%	15.11%	15.36%	15.45%
2035	17.68%	17.74%	18.09%	18.09%
2040	20.83%	20.74%	21.22%	21.12%
2045	22.70%	22.46%	23.06%	22.83%
2050	24.14%	23.76%	24.46%	24.11%
2055	25.83%	25.34%	26.11%	25.66%
2060	28.97%	28.37%	29.23%	28.68%
2065	32.48%	31.77%	32.73%	32.08%
2070	34.99%	34.18%	35.23%	34.48%
2075	35.57%	34.69%	35.82%	34.99%
2080	35.68%	34.75%	35.92%	35.03%
2085	36.08%	35.14%	36.35%	35.40%
2090	36.38%	35.42%	36.65%	35.65%
2095	37.72%	36.70%	37.93%	36.89%
2100	40.60%	39.50%	40.76%	39.65%

Table 6-2: Replacement Rate of the Public Pension

	No elimination (benchmark)	Elimination of child rearing time	Elimination of elderly care time	Elimination of both child rearing and elderly care time
2017	62.30%	62.30%	62.30%	62.30%
2018	61.97%	62.04%	62.04%	62.26%
2019	61.64%	61.29%	61.27%	61.41%
2020	60.51%	60.47%	60.45%	60.59%
2021	59.68%	59.64%	59.61%	59.76%
2022	59.51%	59.48%	59.45%	59.60%
2023	58.61%	58.59%	58.56%	58.71%
2024	58.23%	58.22%	58.18%	58.35%
2025	57.72%	57.71%	57.68%	57.85%
2026	57.32%	57.33%	57.29%	57.47%
2027	56.77%	56.79%	56.74%	56.93%
2028	56.35%	56.38%	56.33%	56.53%
2029	55.80%	55.85%	55.80%	56.01%
2030	55.18%	55.24%	55.18%	55.41%
2031	54.37%	54.44%	54.39%	54.62%
2032	54.07%	54.16%	54.10%	54.35%
2033	53.19%	53.30%	53.24%	53.50%
2034	52.37%	52.50%	52.44%	52.71%
2035	51.56%	51.71%	51.64%	51.93%
2036	50.76%	50.93%	50.86%	51.15%
2037	49.88%	50.07%	50.00%	50.30%
2038	48.91%	49.11%	49.04%	49.36%
2039	47.88%	48.10%	48.02%	48.36%
2040	46.88%	47.12%	47.04%	47.38%
2041	46.02%	46.28%	46.20%	46.55%
2042	45.26%	45.54%	45.45%	45.81%
2043	44.59%	44.88%	44.79%	45.17%
2044	43.95%	44.26%	44.17%	44.56%
2045	43.38%	43.70%	43.61%	44.01%
2046	42.82%	43.16%	43.07%	43.47%
2047	42.33%	42.69%	42.59%	43.01%
2048	41.90%	42.27%	42.17%	42.60%
2049	41.44%	41.83%	41.73%	42.17%
2050	40.99%	41.39%	41.30%	41.74%
2051	40.57%	40.98%	40.89%	41.33%
2052	40.20%	40.62%	40.53%	40.98%
2053	39.84%	40.28%	40.19%	40.65%
2054	39.52%	39.97%	39.88%	40.35%
2055	39.25%	39.70%	39.61%	40.09%
2056	39.02%	39.48%	39.39%	39.88%
2057	38.82%	39.29%	39.21%	39.70%
2058	38.61%	39.10%	39.01%	39.51%
2059	38.42%	38.92%	38.83%	39.35%
2060	38.20%	38.71%	38.62%	39.14%

Table 6-3: The Fixed Amount of Contributions by the First Group (age 65 and over) of the LTCI

	No elimination (benchmark)	Elimination of child rearing time	Elimination of elderly care time	Elimination of both child rearing and elderly care time
2017	5.41%	5.43%	5.44%	5.46%
2018	5.51%	5.56%	5.57%	5.62%
2019	5.63%	5.66%	5.67%	5.71%
2020	5.74%	5.79%	5.79%	5.84%
2021	5.84%	5.89%	5.90%	5.95%
2022	5.92%	5.96%	5.97%	6.02%
2023	6.08%	6.14%	6.14%	6.19%
2024	6.23%	6.28%	6.29%	6.34%
2025	6.37%	6.42%	6.44%	6.48%
2026	6.50%	6.55%	6.57%	6.61%
2027	6.63%	6.68%	6.69%	6.74%
2028	6.75%	6.80%	6.81%	6.86%
2029	6.90%	6.95%	6.96%	7.01%
2030	7.04%	7.09%	7.12%	7.16%
2031	7.15%	7.20%	7.22%	7.27%
2032	7.28%	7.33%	7.35%	7.40%
2033	7.38%	7.43%	7.45%	7.50%
2034	7.50%	7.55%	7.57%	7.62%
2035	7.59%	7.65%	7.67%	7.72%
2036	7.76%	7.81%	7.83%	7.88%
2037	7.71%	7.76%	7.78%	7.83%
2038	7.75%	7.81%	7.83%	7.88%
2039	7.79%	7.83%	7.86%	7.91%
2040	7.92%	7.97%	7.99%	8.04%
2041	8.00%	8.05%	8.08%	8.12%
2042	8.02%	8.06%	8.09%	8.13%
2043	8.01%	8.06%	8.09%	8.13%
2044	8.01%	8.05%	8.08%	8.12%
2045	8.03%	8.07%	8.10%	8.14%
2046	8.14%	8.19%	8.22%	8.26%
2047	8.23%	8.27%	8.30%	8.35%
2048	8.26%	8.30%	8.33%	8.37%
2049	8.27%	8.30%	8.34%	8.37%
2050	8.26%	8.30%	8.33%	8.37%
2051	8.31%	8.35%	8.39%	8.42%
2052	8.39%	8.42%	8.46%	8.50%
2053	8.47%	8.50%	8.54%	8.57%
2054	8.49%	8.52%	8.56%	8.59%
2055	8.61%	8.64%	8.68%	8.71%
2056	8.79%	8.83%	8.87%	8.90%
2057	8.93%	8.96%	9.00%	9.03%
2058	9.01%	9.04%	9.08%	9.11%
2059	9.15%	9.19%	9.23%	9.27%
2060	9.28%	9.32%	9.36%	9.39%

The figures in the table are the relative amount of the fixed amount of contributions to the annual income of male non-regular workers in year 2012.

Table 6-4: Contribution Rate for the Second Group (age 40 – 64) of the LTCI

	No elimination (benchmark)	Elimination of child rearing time	Elimination of elderly care time	Elimination of both child rearing and elderly care time
2017	2.07%	2.09%	2.09%	2.11%
2018	2.14%	2.17%	2.18%	2.21%
2019	2.23%	2.24%	2.25%	2.28%
2020	2.29%	2.33%	2.33%	2.36%
2021	2.37%	2.40%	2.41%	2.44%
2022	2.43%	2.46%	2.47%	2.50%
2023	2.55%	2.58%	2.59%	2.62%
2024	2.65%	2.69%	2.69%	2.73%
2025	2.76%	2.80%	2.80%	2.84%
2026	2.86%	2.90%	2.91%	2.94%
2027	2.96%	3.00%	3.01%	3.04%
2028	3.06%	3.10%	3.11%	3.15%
2029	3.18%	3.22%	3.23%	3.27%
2030	3.30%	3.34%	3.35%	3.38%
2031	3.42%	3.47%	3.48%	3.52%
2032	3.50%	3.54%	3.55%	3.59%
2033	3.59%	3.63%	3.64%	3.68%
2034	3.68%	3.73%	3.74%	3.78%
2035	3.86%	3.90%	3.91%	3.96%
2036	3.98%	4.02%	4.04%	4.08%
2037	4.03%	4.08%	4.10%	4.14%
2038	4.06%	4.10%	4.12%	4.16%
2039	4.07%	4.11%	4.13%	4.17%
2040	4.17%	4.21%	4.23%	4.27%
2041	4.34%	4.38%	4.40%	4.44%
2042	4.34%	4.39%	4.41%	4.45%
2043	4.33%	4.37%	4.39%	4.44%
2044	4.31%	4.36%	4.38%	4.42%
2045	4.31%	4.35%	4.38%	4.42%
2046	4.41%	4.44%	4.47%	4.51%
2047	4.58%	4.62%	4.65%	4.68%
2048	4.59%	4.63%	4.65%	4.69%
2049	4.58%	4.62%	4.64%	4.68%
2050	4.56%	4.60%	4.63%	4.67%
2051	4.61%	4.64%	4.67%	4.71%
2052	4.66%	4.70%	4.72%	4.76%
2053	4.72%	4.76%	4.79%	4.83%
2054	4.86%	4.89%	4.92%	4.96%
2055	4.96%	5.00%	5.03%	5.07%
2056	5.12%	5.16%	5.19%	5.23%
2057	5.24%	5.28%	5.31%	5.35%
2058	5.43%	5.47%	5.51%	5.55%
2059	5.57%	5.60%	5.64%	5.68%
2060	5.68%	5.72%	5.75%	5.79%

Figure 17: The Impact on Welfare of the Household

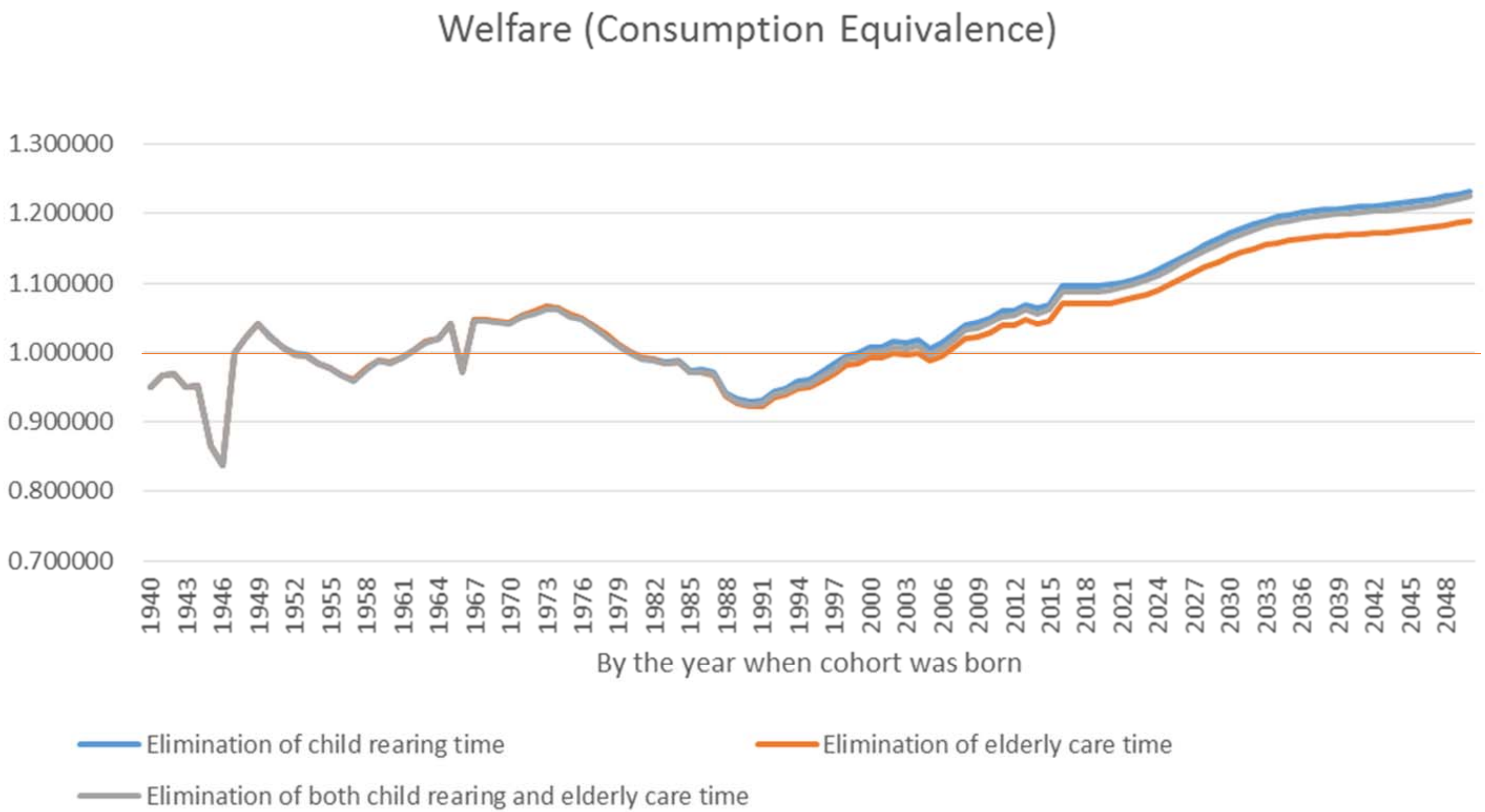


Figure 18-1: GDP over Labor in Efficiency Unit ($\frac{Y_t}{L_t}$)

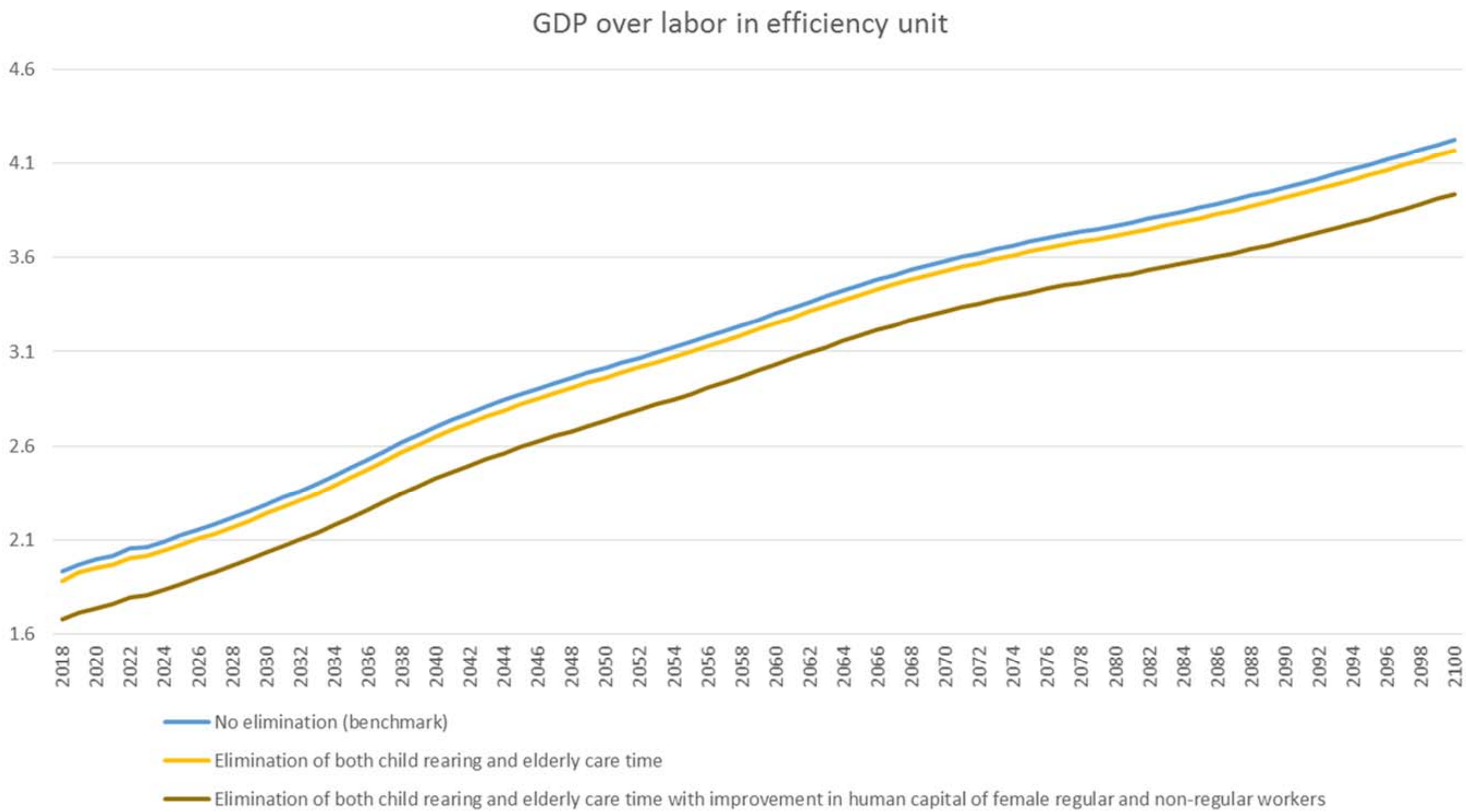


Figure 18-2: The Wage Rate

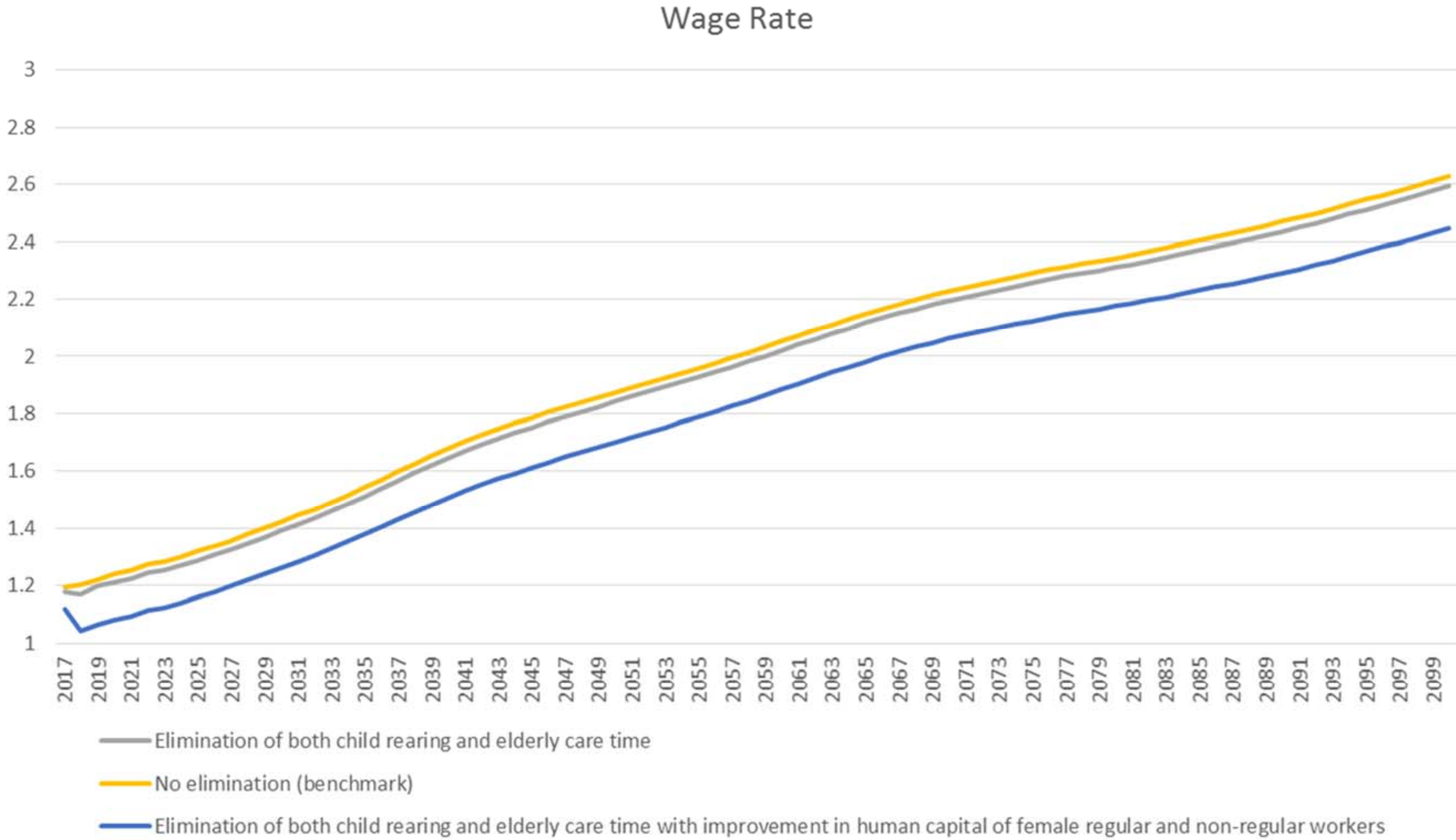


Figure 18-3: Total GDP

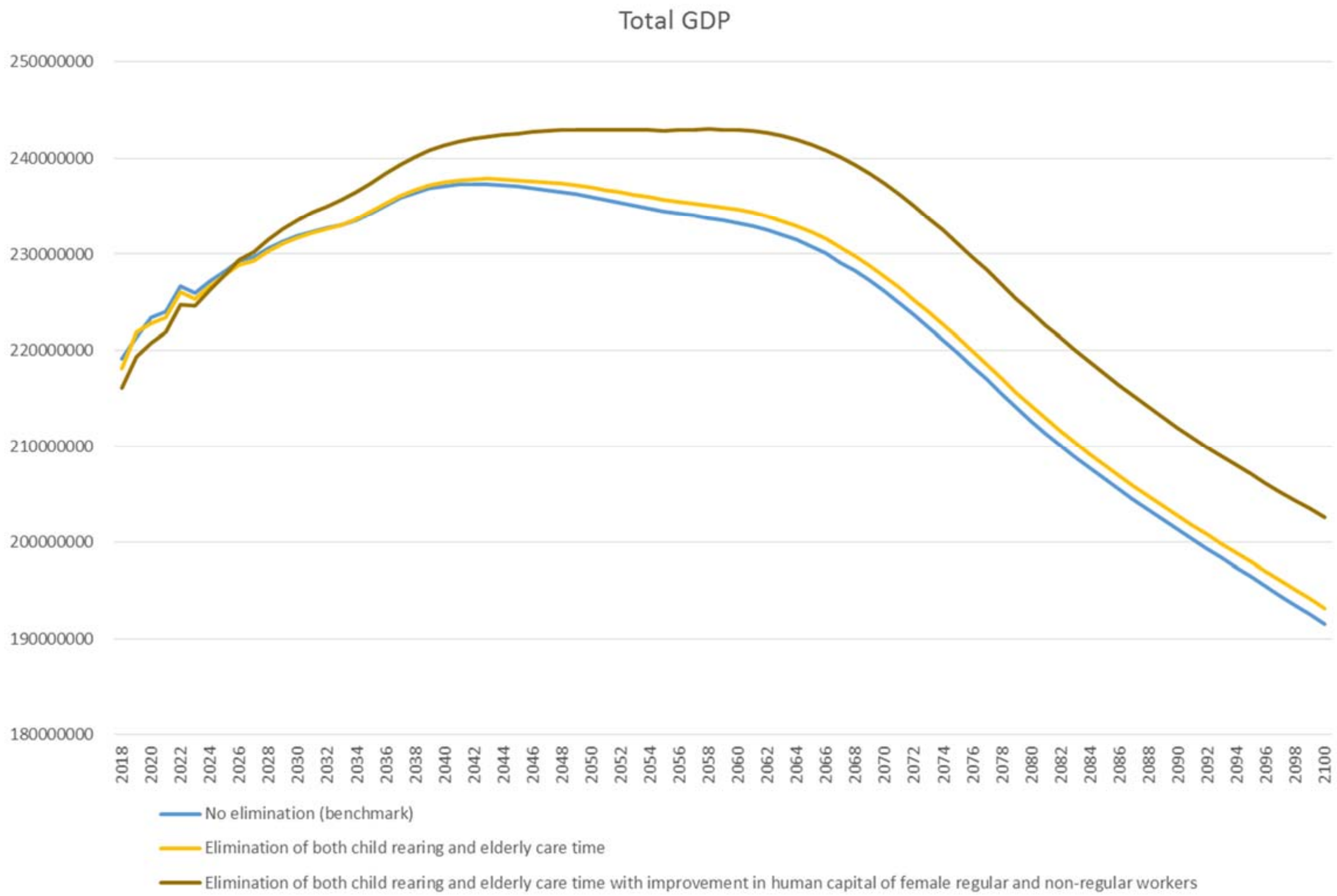


Table 7-1: Change in Total GDP from the benchmark

	Elimination of both child rearing and elderly care time	Elimination of both child rearing and elderly care time with improvement in human capital of female regular and non-regular workers
2018	-0.48%	-1.43%
2019	0.19%	-0.93%
2020	-0.30%	-1.21%
2021	-0.28%	-0.99%
2022	-0.27%	-0.84%
2023	-0.24%	-0.58%
2024	-0.23%	-0.41%
2025	-0.20%	-0.17%
2026	-0.18%	0.02%
2027	-0.15%	0.22%
2028	-0.13%	0.38%
2029	-0.10%	0.55%
2030	-0.08%	0.70%
2031	-0.05%	0.85%
2032	-0.02%	0.99%
2033	0.00%	1.12%
2034	0.03%	1.23%
2035	0.05%	1.32%
2036	0.07%	1.41%
2037	0.09%	1.49%
2038	0.11%	1.58%
2039	0.14%	1.67%
2040	0.17%	1.77%
2041	0.19%	1.88%
2042	0.22%	1.99%
2043	0.24%	2.10%
2044	0.27%	2.23%
2045	0.29%	2.35%
2046	0.32%	2.48%
2047	0.34%	2.60%
2048	0.37%	2.72%
2049	0.39%	2.84%
2050	0.41%	2.96%
2051	0.43%	3.09%
2052	0.45%	3.22%
2053	0.47%	3.35%
2054	0.49%	3.47%
2055	0.51%	3.60%
2056	0.52%	3.73%
2057	0.54%	3.84%
2058	0.56%	3.95%
2059	0.57%	4.06%
2060	0.58%	4.16%

Table 7-2: Consumption Tax Rate for the General Account

	No elimination (benchmark)	Elimination of both child rearing and elderly care time	Elimination of both child rearing and elderly care time with improvement in human capital of female regular and non-regular workers
2017	8.00%	8.00%	8.00%
2018	8.00%	8.00%	8.00%
2020	7.90%	8.51%	11.34%
2025	11.82%	12.41%	14.63%
2030	14.93%	15.45%	16.88%
2035	17.68%	18.09%	18.86%
2040	20.83%	21.12%	21.43%
2045	22.70%	22.83%	22.55%
2050	24.14%	24.11%	23.18%
2055	25.83%	25.66%	24.01%
2060	28.97%	28.68%	26.30%
2065	32.48%	32.08%	29.02%
2070	34.99%	34.48%	30.84%
2075	35.57%	34.99%	30.93%
2080	35.68%	35.03%	30.60%
2085	36.08%	35.40%	30.60%
2090	36.38%	35.65%	30.51%
2095	37.72%	36.89%	31.15%
2100	40.60%	39.65%	33.08%

Table 7-3: Replacement Rate of the Public Pension

	No elimination (benchmark)	Elimination of both child rearing and elderly care time	Elimination of both child rearing and elderly care time with improvement in human capital of female regular and non-regular workers
2017	62.30%	62.30%	62.30%
2018	61.97%	62.26%	63.10%
2019	61.64%	61.41%	62.73%
2020	60.51%	60.59%	61.99%
2021	59.68%	59.76%	61.24%
2022	59.51%	59.60%	61.17%
2023	58.61%	58.71%	60.38%
2024	58.23%	58.35%	60.11%
2025	57.72%	57.85%	59.71%
2026	57.32%	57.47%	59.43%
2027	56.77%	56.93%	59.00%
2028	56.35%	56.53%	58.69%
2029	55.80%	56.01%	58.27%
2030	55.18%	55.41%	57.76%
2031	54.37%	54.62%	57.07%
2032	54.07%	54.35%	56.91%
2033	53.19%	53.50%	56.15%
2034	52.37%	52.71%	55.46%
2035	51.56%	51.93%	54.78%
2036	50.76%	51.15%	54.11%
2037	49.88%	50.30%	53.36%
2038	48.91%	49.36%	52.51%
2039	47.88%	48.36%	51.60%
2040	46.88%	47.38%	50.71%
2041	46.02%	46.55%	49.98%
2042	45.26%	45.81%	49.34%
2043	44.59%	45.17%	48.80%
2044	43.95%	44.56%	48.29%
2045	43.38%	44.01%	47.84%
2046	42.82%	43.47%	47.42%
2047	42.33%	43.01%	47.05%
2048	41.90%	42.60%	46.75%
2049	41.44%	42.17%	46.42%
2050	40.99%	41.74%	46.10%
2051	40.57%	41.33%	45.79%
2052	40.20%	40.98%	45.54%
2053	39.84%	40.65%	45.31%
2054	39.52%	40.35%	45.10%
2055	39.25%	40.09%	44.95%
2056	39.02%	39.88%	44.84%
2057	38.82%	39.70%	44.75%
2058	38.61%	39.51%	44.66%
2059	38.42%	39.35%	44.58%
2060	38.20%	39.14%	44.46%

Table 7-4: The Fixed Amount of Contributions by the First Group (age 65 and over) of the LTCI

	No elimination (benchmark)	Elimination of both child rearing and elderly care time	Elimination of both child rearing and elderly care time with improvement in human capital of female regular and non-regular workers
2017	5.41%	5.46%	5.68%
2018	5.51%	5.62%	6.04%
2019	5.63%	5.71%	6.15%
2020	5.74%	5.84%	6.29%
2021	5.84%	5.95%	6.40%
2022	5.92%	6.02%	6.47%
2023	6.08%	6.19%	6.65%
2024	6.23%	6.34%	6.80%
2025	6.37%	6.48%	6.95%
2026	6.50%	6.61%	7.08%
2027	6.63%	6.74%	7.21%
2028	6.75%	6.86%	7.33%
2029	6.90%	7.01%	7.49%
2030	7.04%	7.16%	7.65%
2031	7.15%	7.27%	7.75%
2032	7.28%	7.40%	7.88%
2033	7.38%	7.50%	7.98%
2034	7.50%	7.62%	8.11%
2035	7.59%	7.72%	8.21%
2036	7.76%	7.88%	8.39%
2037	7.71%	7.83%	8.34%
2038	7.75%	7.88%	8.37%
2039	7.79%	7.91%	8.40%
2040	7.92%	8.04%	8.54%
2041	8.00%	8.12%	8.63%
2042	8.02%	8.13%	8.64%
2043	8.01%	8.13%	8.63%
2044	8.01%	8.12%	8.61%
2045	8.03%	8.14%	8.62%
2046	8.14%	8.26%	8.67%
2047	8.23%	8.35%	8.84%
2048	8.26%	8.37%	8.86%
2049	8.27%	8.37%	8.86%
2050	8.26%	8.37%	8.84%
2051	8.31%	8.42%	8.89%
2052	8.39%	8.50%	8.97%
2053	8.47%	8.57%	8.96%
2054	8.49%	8.59%	9.06%
2055	8.61%	8.71%	9.18%
2056	8.79%	8.90%	9.38%
2057	8.93%	9.03%	9.51%
2058	9.01%	9.11%	9.59%
2059	9.15%	9.27%	9.75%
2060	9.28%	9.39%	9.88%

Table 7-5: Contribution Rate for the Second Group (age 40 – 64) of the LTCI

	No elimination (benchmark)	Elimination of both child rearing and elderly care time	Elimination of both child rearing and elderly care time with improvement in human capital of female regular and non-regular workers
2017	2.07%	2.11%	2.25%
2018	2.14%	2.21%	2.29%
2019	2.23%	2.28%	2.36%
2020	2.29%	2.36%	2.44%
2021	2.37%	2.44%	2.52%
2022	2.43%	2.50%	2.58%
2023	2.55%	2.62%	2.68%
2024	2.65%	2.73%	2.79%
2025	2.76%	2.84%	2.89%
2026	2.86%	2.94%	2.99%
2027	2.96%	3.04%	3.09%
2028	3.06%	3.15%	3.18%
2029	3.18%	3.27%	3.30%
2030	3.30%	3.38%	3.42%
2031	3.42%	3.52%	3.54%
2032	3.50%	3.59%	3.62%
2033	3.59%	3.68%	3.71%
2034	3.68%	3.78%	3.80%
2035	3.86%	3.96%	3.97%
2036	3.98%	4.08%	4.09%
2037	4.03%	4.14%	4.14%
2038	4.06%	4.16%	4.17%
2039	4.07%	4.17%	4.18%
2040	4.17%	4.27%	4.28%
2041	4.34%	4.44%	4.44%
2042	4.34%	4.45%	4.45%
2043	4.33%	4.44%	4.43%
2044	4.31%	4.42%	4.42%
2045	4.31%	4.42%	4.41%
2046	4.41%	4.51%	4.54%
2047	4.58%	4.68%	4.66%
2048	4.59%	4.69%	4.66%
2049	4.58%	4.68%	4.65%
2050	4.56%	4.67%	4.63%
2051	4.61%	4.71%	4.67%
2052	4.66%	4.76%	4.72%
2053	4.72%	4.83%	4.82%
2054	4.86%	4.96%	4.90%
2055	4.96%	5.07%	5.00%
2056	5.12%	5.23%	5.15%
2057	5.24%	5.35%	5.26%
2058	5.43%	5.55%	5.44%
2059	5.57%	5.68%	5.56%
2060	5.68%	5.79%	5.67%

Figure 18-4: The Impact on Welfare of the Household

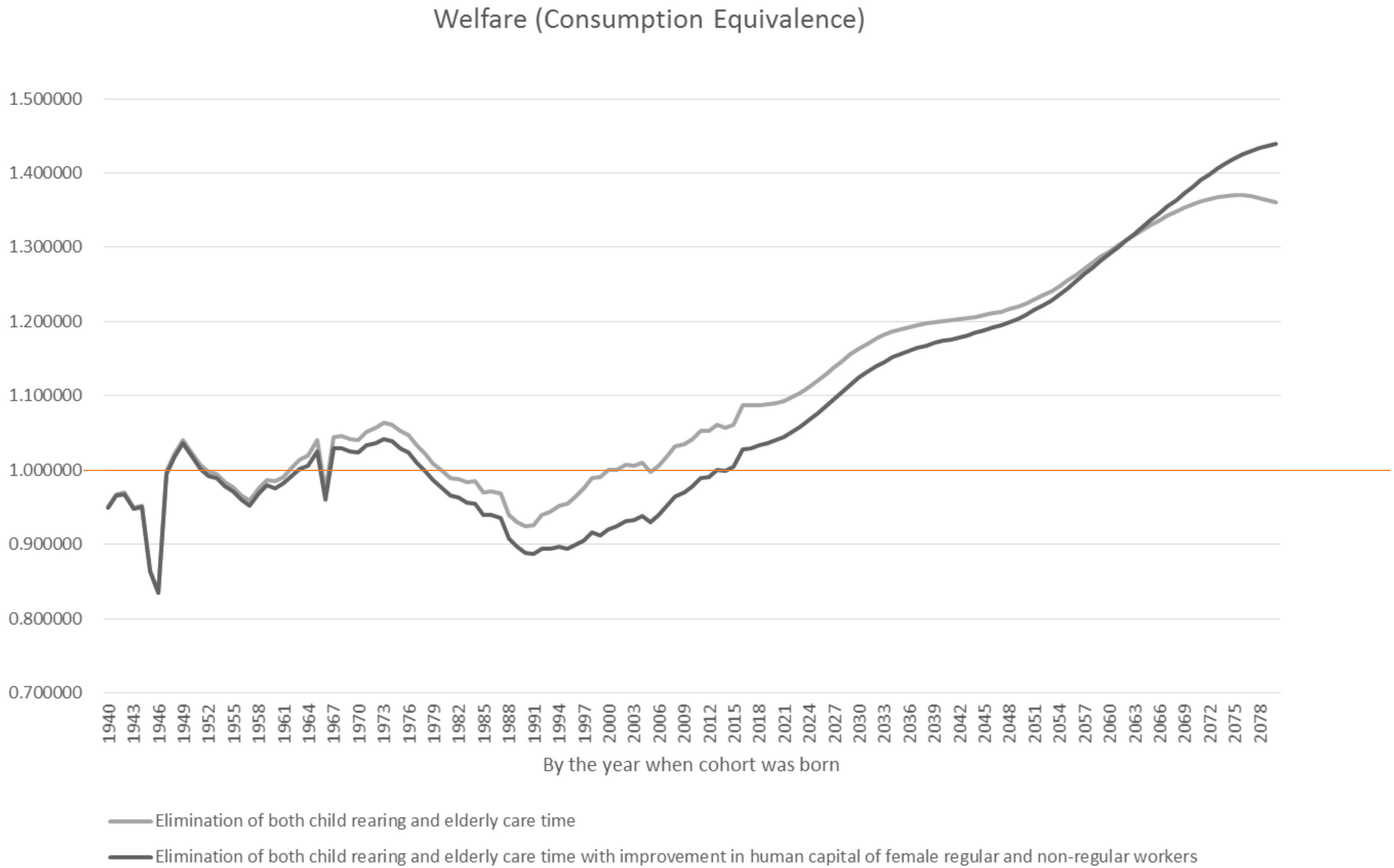


Figure 18-5: Lifetime Labor Supply of the Cohort born in 2000

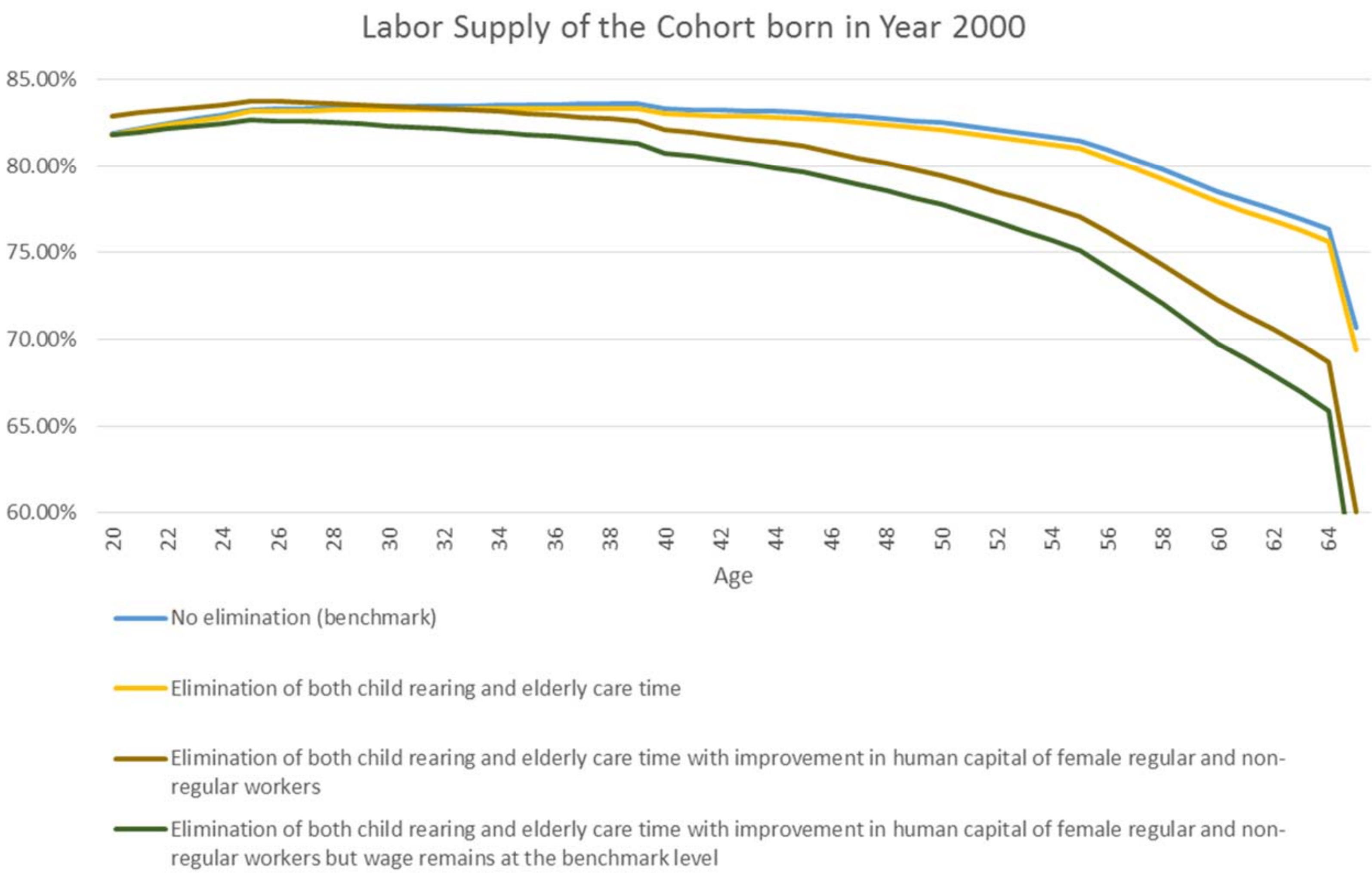


Figure 18-6: Lifetime Labor Supply of the Cohort born in 2050

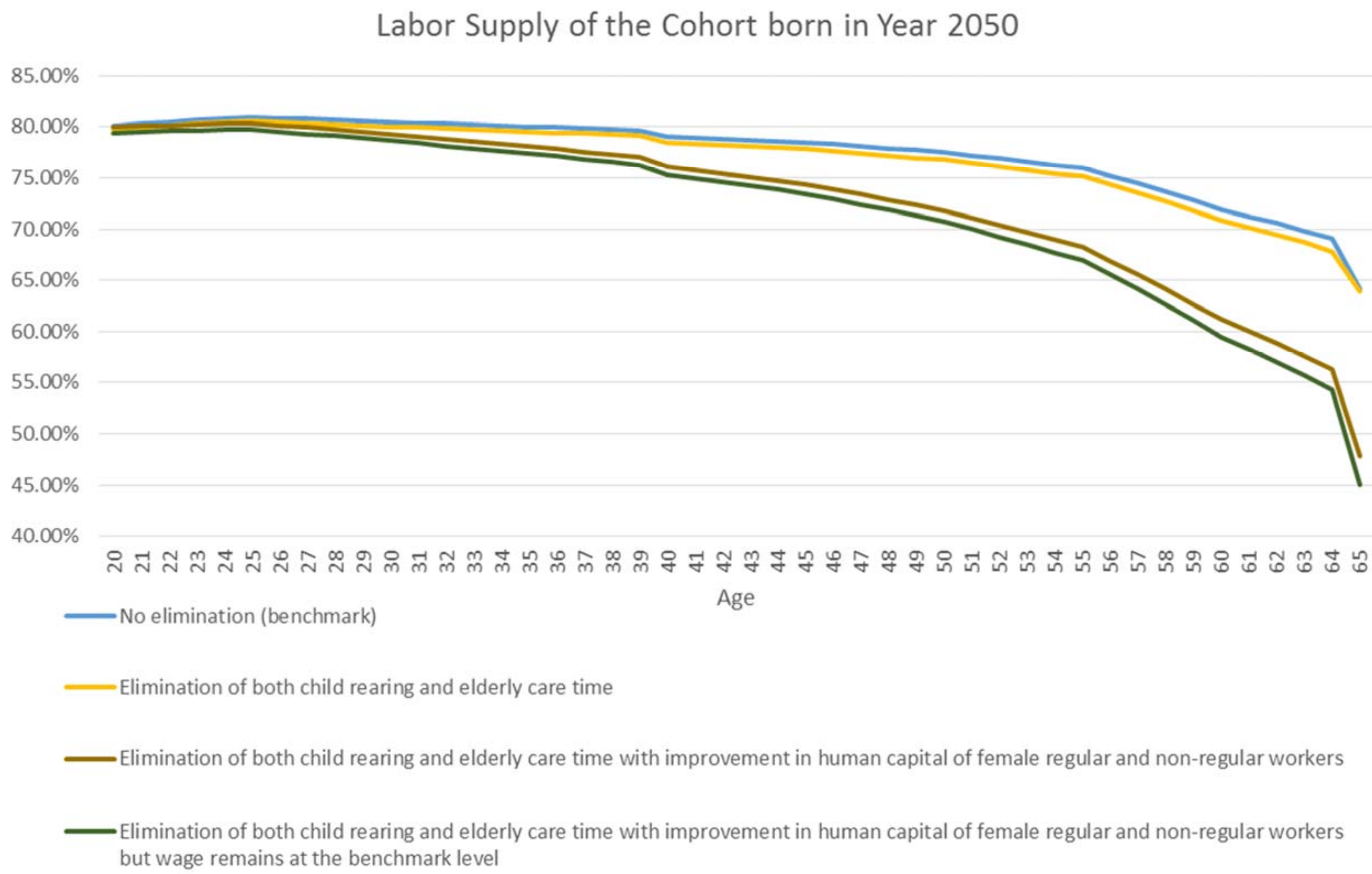


Figure 18-7: GDP over Labor in Efficiency Unit ($\frac{Y_t}{L_t}$)

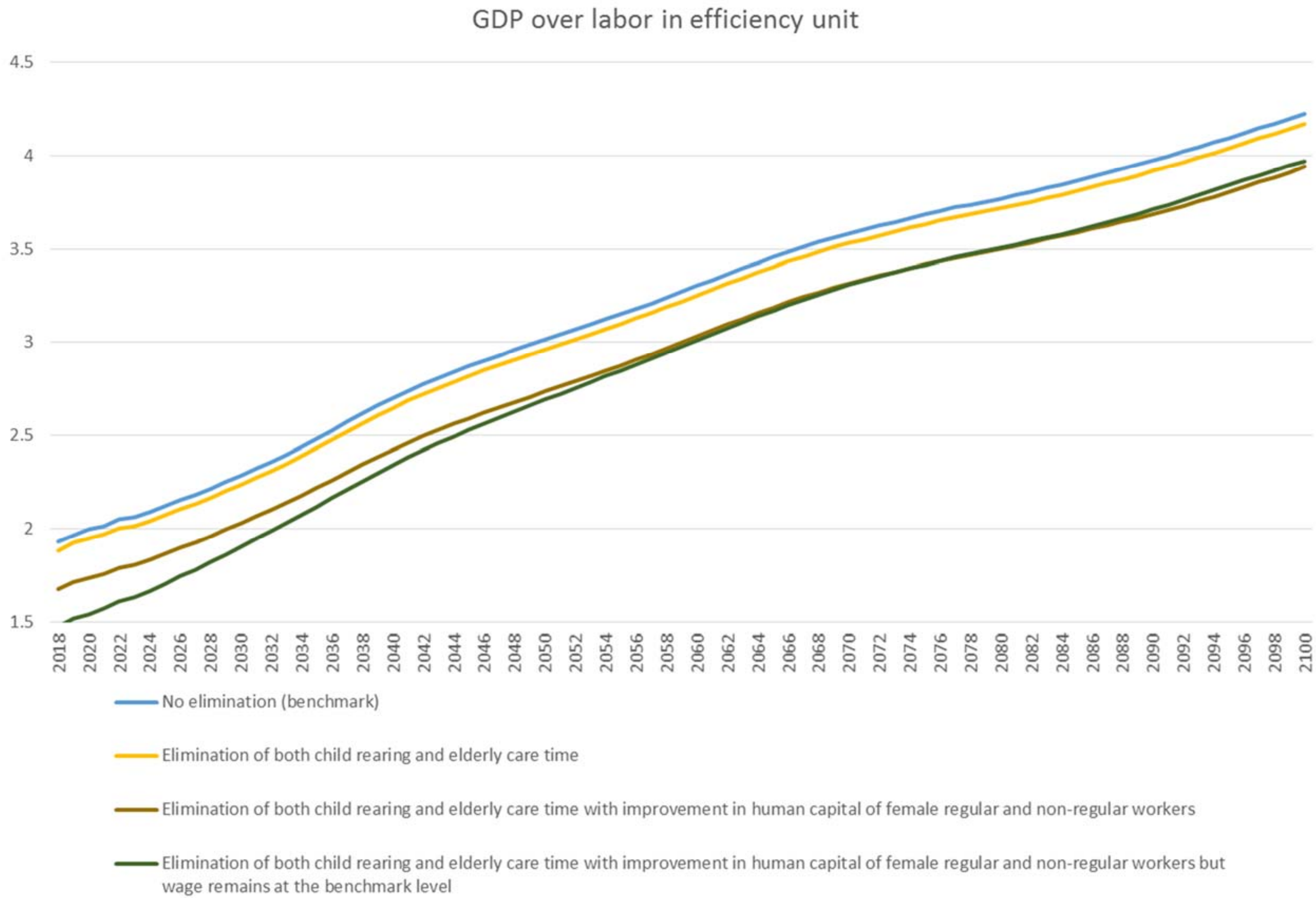


Figure 18-8: Total GDP

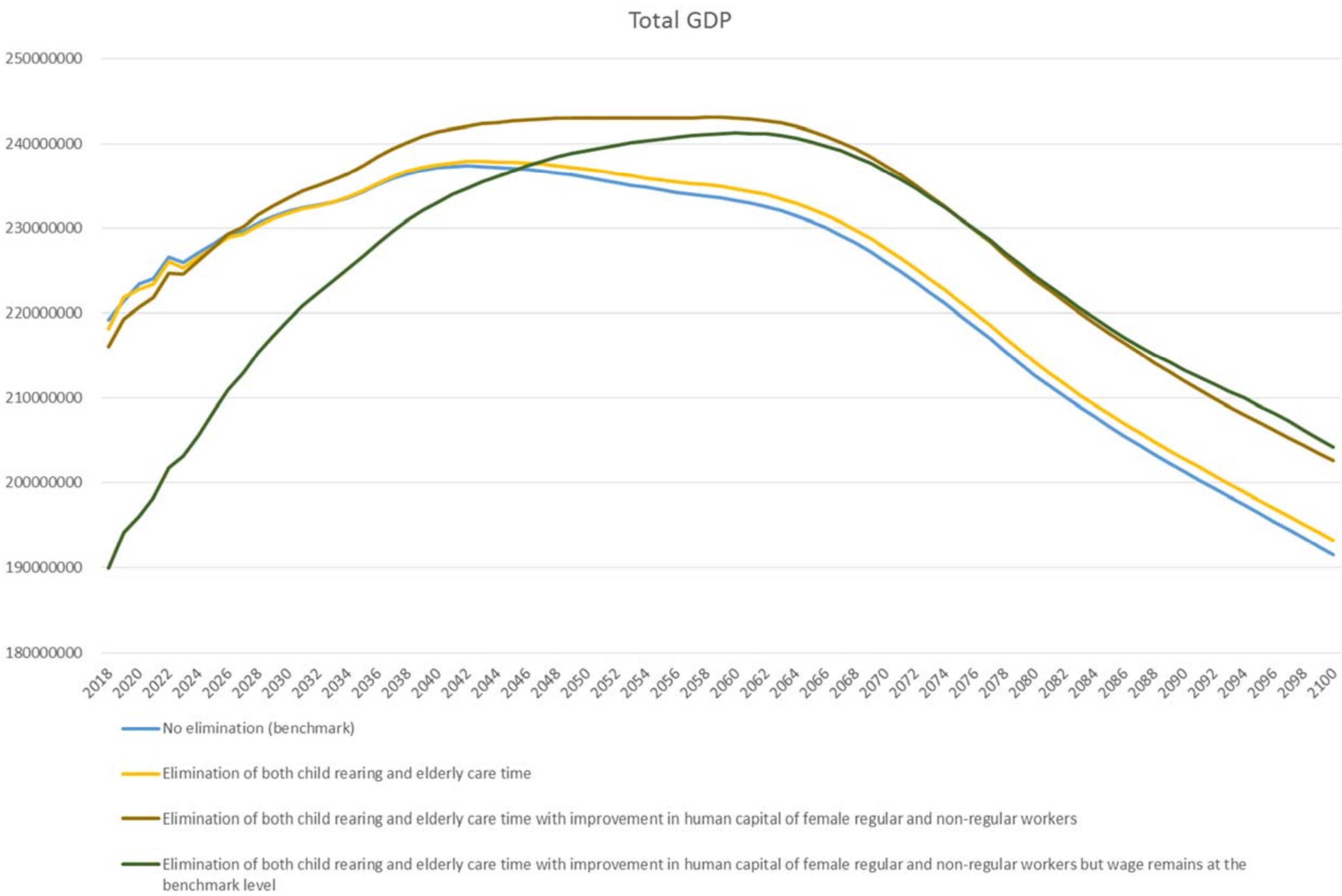


Figure 18-9: The Impact on Welfare of the Household

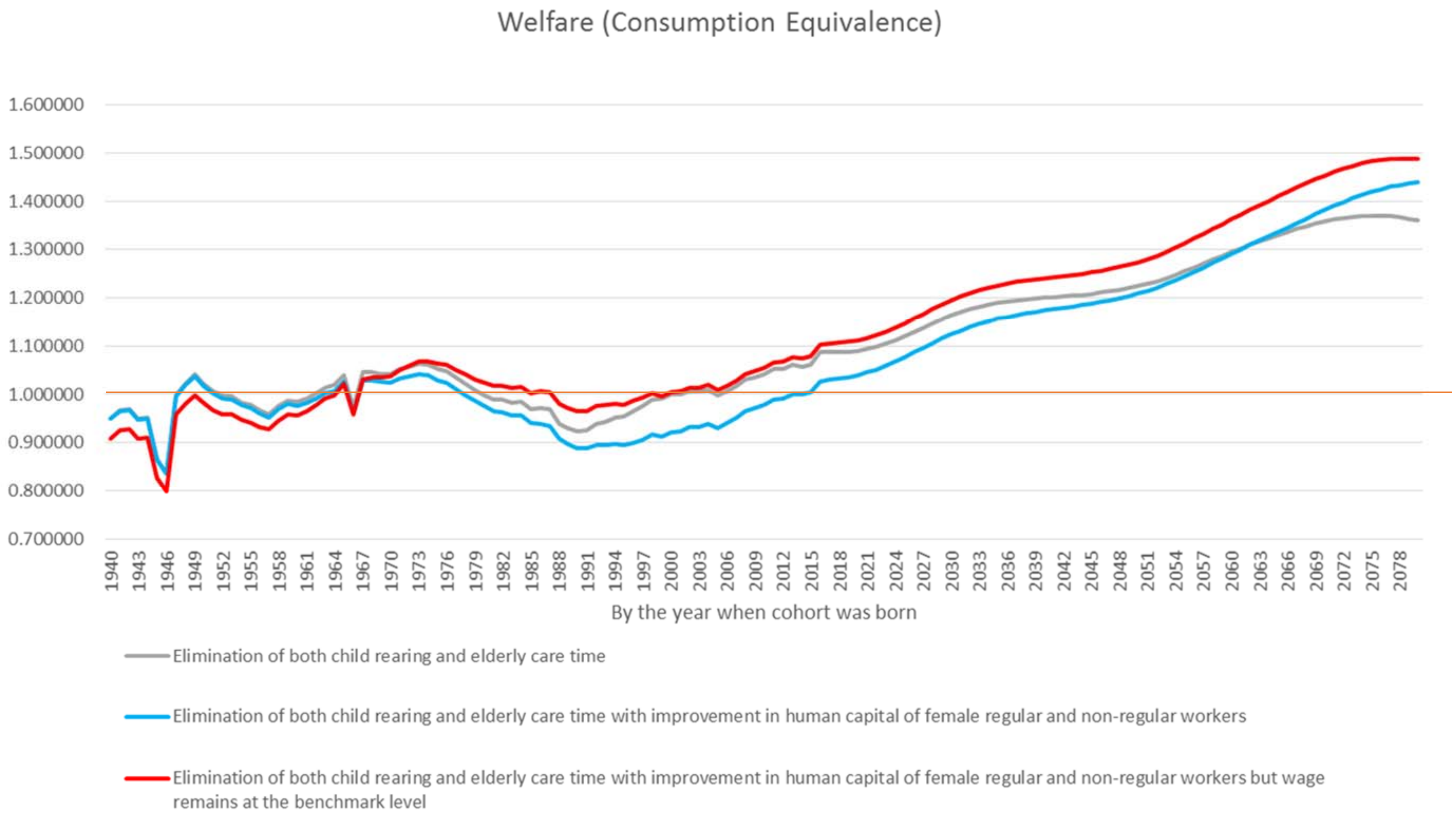


Figure 19-1: GDP over Labor in Efficiency Unit ($\frac{Y_t}{L_t}$)

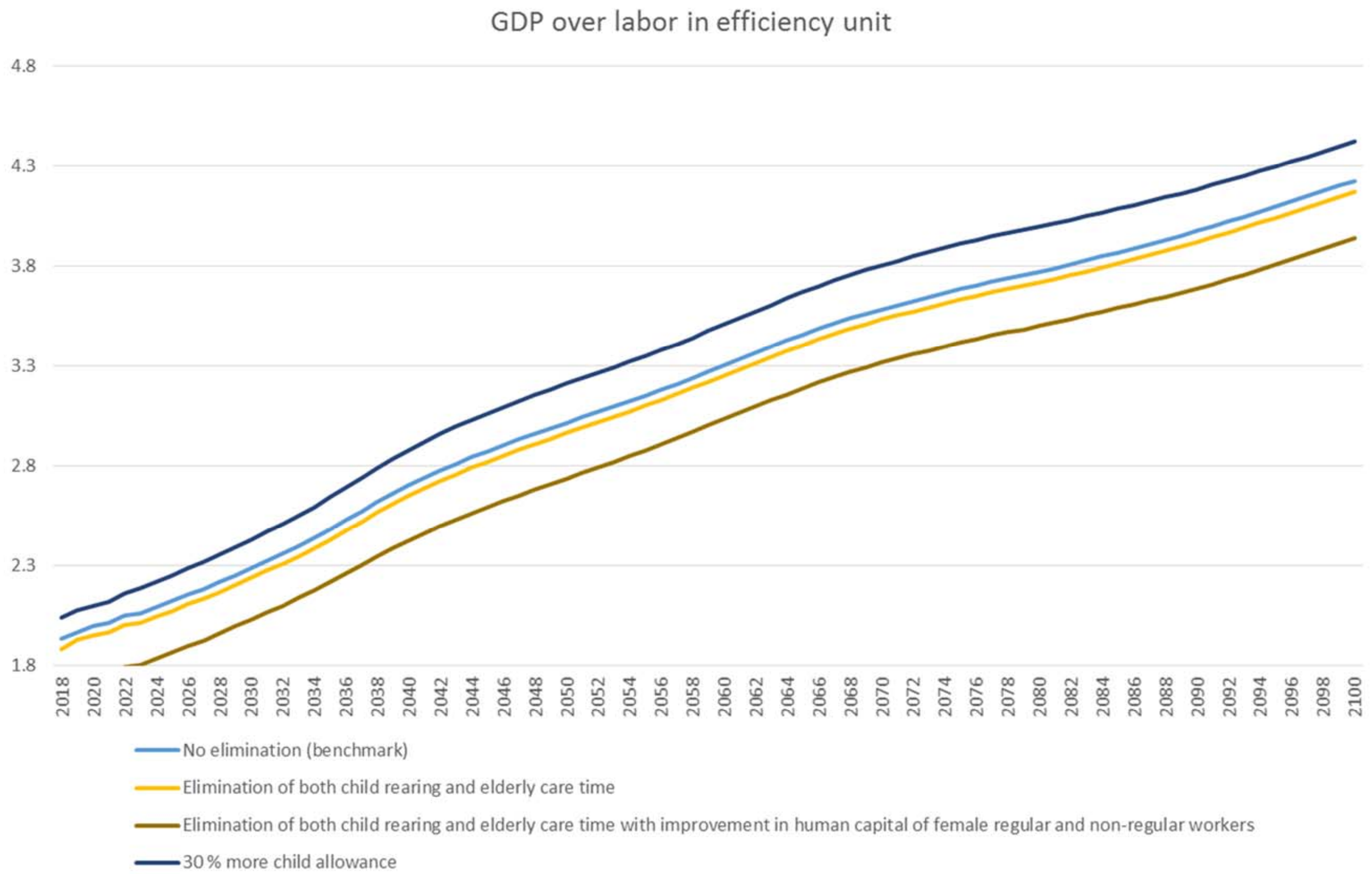


Figure 19-2: Total GDP

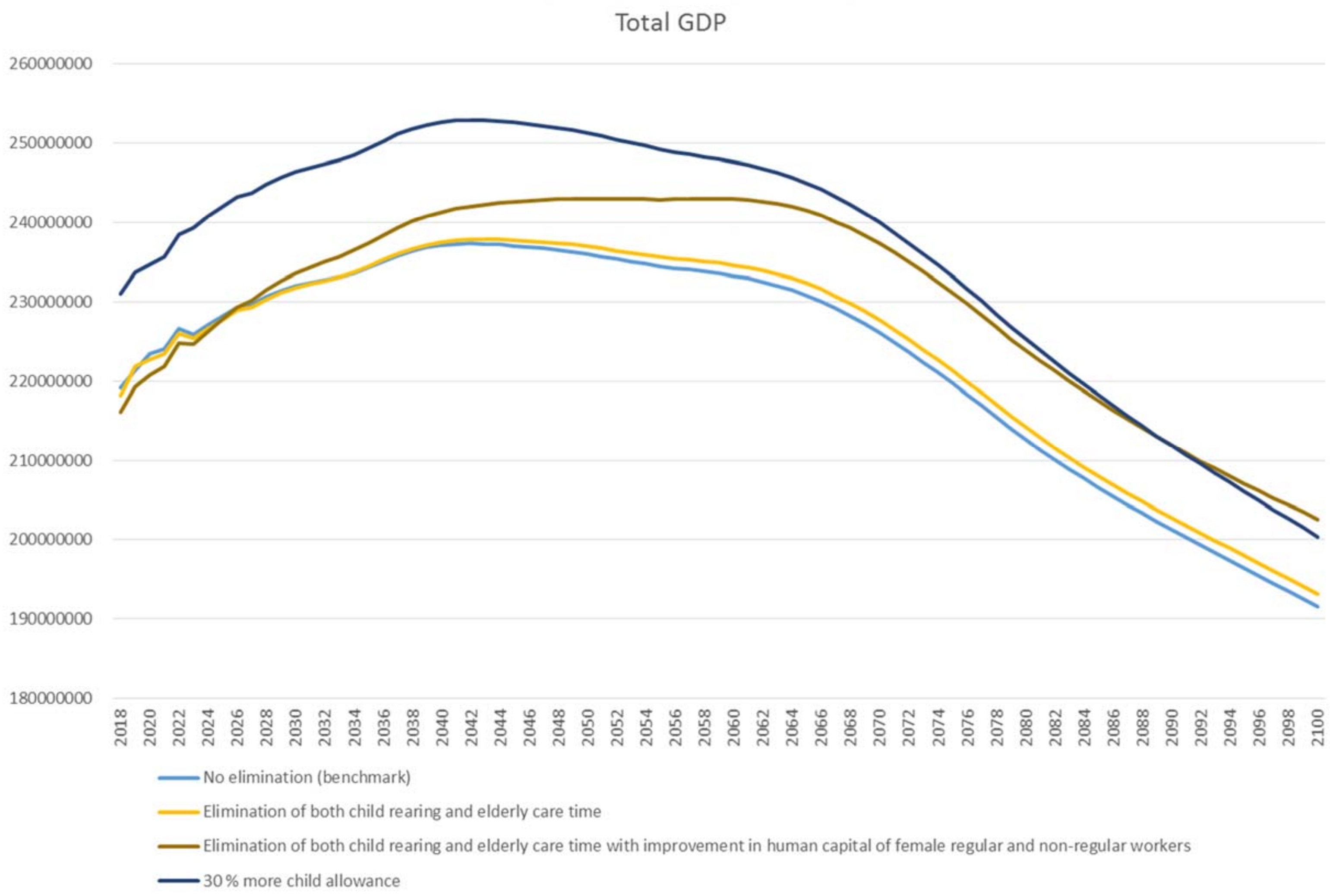


Figure 19-3: The Impact on Welfare of the Household

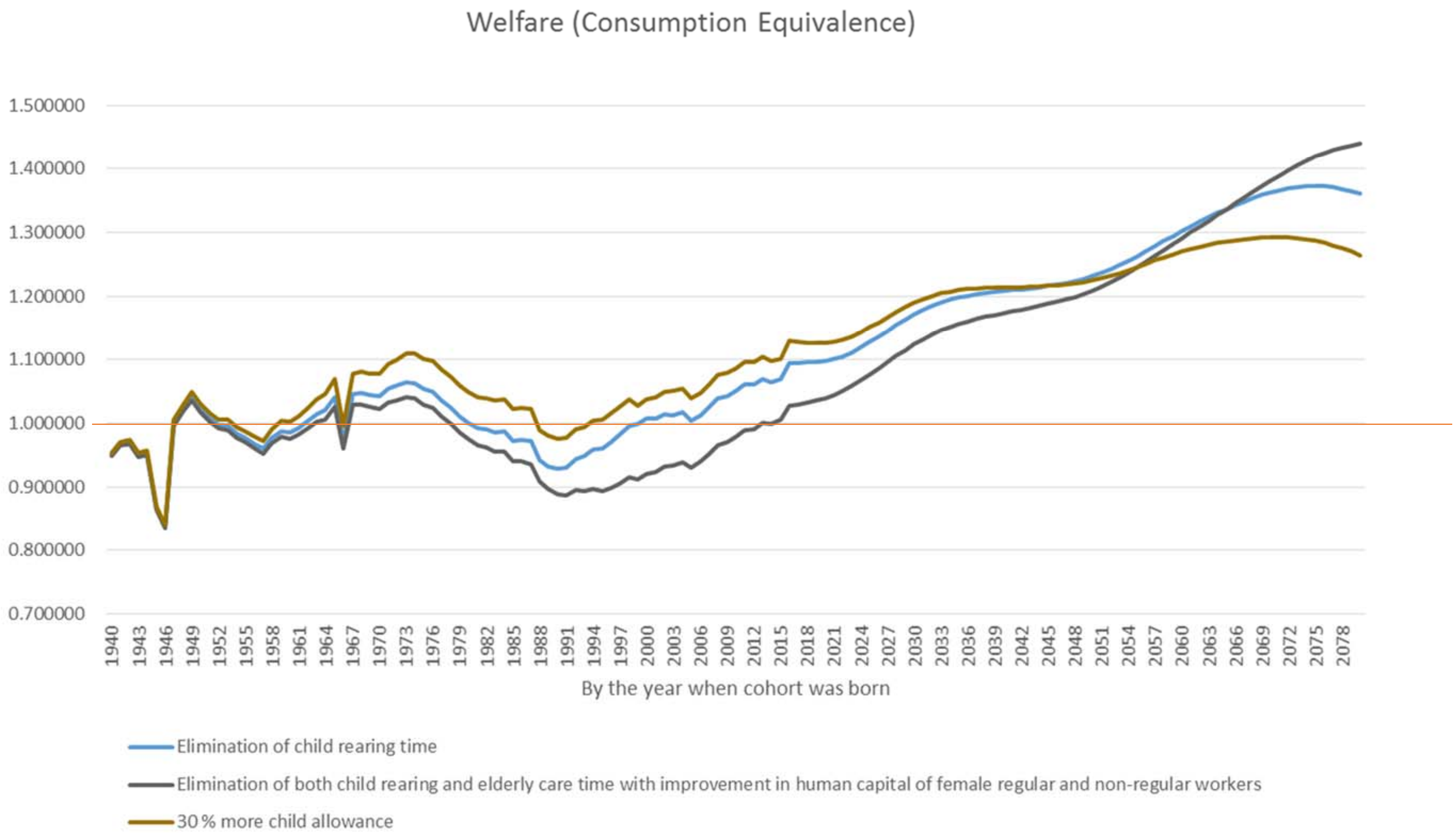


Table 8-1: Consumption Tax Rate for the General Account

	No elimination (benchmark)	Elimination of both child rearing and elderly care time with improvement in human capital of female regular and non-regular workers	30 % more child allowance
2017	8.00%	8.00%	8.00%
2018	8.00%	8.00%	8.00%
2020	7.90%	11.34%	12.70%
2025	11.82%	14.63%	16.03%
2030	14.93%	16.88%	19.33%
2035	17.68%	18.86%	22.24%
2040	20.83%	21.43%	25.64%
2045	22.70%	22.55%	27.78%
2050	24.14%	23.18%	29.54%
2055	25.83%	24.01%	31.66%
2060	28.97%	26.30%	35.34%
2065	32.48%	29.02%	39.30%
2070	34.99%	30.84%	42.15%
2075	35.57%	30.93%	42.98%
2080	35.68%	30.60%	43.45%
2085	36.08%	30.60%	44.40%
2090	36.38%	30.51%	45.33%
2095	37.72%	31.15%	47.34%
2100	40.60%	33.08%	51.09%

Table 8-2: Replacement Rate of the Public Pension

	No elimination (benchmark)	Elimination of both child rearing and elderly care time with improvement in human capital of female regular and non-regular workers	30 % more child allowance
2017	62.30%	62.30%	62.30%
2018	61.97%	63.10%	59.64%
2019	61.64%	62.73%	59.39%
2020	60.51%	61.99%	58.67%
2021	59.68%	61.24%	57.92%
2022	59.51%	61.17%	57.92%
2023	58.61%	60.38%	56.80%
2024	58.23%	60.11%	56.42%
2025	57.72%	59.71%	55.91%
2026	57.32%	59.43%	55.51%
2027	56.77%	59.00%	54.95%
2028	56.35%	58.69%	54.53%
2029	55.80%	58.27%	53.99%
2030	55.18%	57.76%	53.36%
2031	54.37%	57.07%	52.55%
2032	54.07%	56.91%	52.24%
2033	53.19%	56.15%	51.36%
2034	52.37%	55.46%	50.55%
2035	51.56%	54.78%	49.74%
2036	50.76%	54.11%	48.94%
2037	49.88%	53.36%	48.06%
2038	48.91%	52.51%	47.09%
2039	47.88%	51.60%	46.07%
2040	46.88%	50.71%	45.08%
2041	46.02%	49.98%	44.22%
2042	45.26%	49.34%	43.46%
2043	44.59%	48.80%	42.79%
2044	43.95%	48.29%	42.14%
2045	43.38%	47.84%	41.56%
2046	42.82%	47.42%	41.00%
2047	42.33%	47.05%	40.50%
2048	41.90%	46.75%	40.06%
2049	41.44%	46.42%	39.60%
2050	40.99%	46.10%	39.14%
2051	40.57%	45.79%	38.70%
2052	40.20%	45.54%	38.32%
2053	39.84%	45.31%	37.96%
2054	39.52%	45.10%	37.62%
2055	39.25%	44.95%	37.33%
2056	39.02%	44.84%	37.09%
2057	38.82%	44.75%	36.87%
2058	38.61%	44.66%	36.65%
2059	38.42%	44.58%	36.45%
2060	38.20%	44.46%	36.23%