The Japanese economy

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IDG RAS

2006

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Abstract

The Japanese economic behavior is modeled. GDP evolution is represented as a sum two components: economic tend and fluctuations. The trend is an inverse function of GDP per capita with a constant numerator. The growth rate fluctuations are numerically equal to two thirds of the relative change in the number of eighteen-year-olds. Inflation is represented by a linear function of labor force change rate. The models provide an accurate description for the poor economic performance and deflation separately. Using the models, GDP per capita is predicted for the next ten years and recommendations are given to overcome deflation.

Key words: economic growth, inflation, modeling, Japan

JEL classification: O11, E32, J21

Introduction

Japan is one of developed countries attracting enormous attention of economists because of some outstanding features demonstrated after World War II. Between 1950s and 1980s, the Japanese economy grew extremely intensive with just a short slowdown in the middle of the period. Starting from 1990, the growth has been very weak creating a long period of economic underperformance often referred to as a "paradox". There are numerous explanations of the observed behavior of the Japanese economy: "inadequate fiscal policy, the liquidity trap, depressed investment …, … problems with financial intermediation", and "low productivity growth" [Hayashi and Prescott, 2002]. In this paper, we present a simple explanation for both the long-term depression and the observed deflation. The approach is based on population estimates and labor force surveys. The study is strictly numerical, i.e. only the measured values of GDP growth rate and inflation are modeled.

The economic growth in Japan relative to different developed countries can be accurately characterized by the annual increment of real GDP per capita. The mean per capita GDP increment for the period between 1960 and 1991 was $494 and only $168 between 1992 and 2003. Here we use GDP per capita values published by the Conference Board and Groningen Growth and Development Center [CB&GGDC, 2006] as converted at Geary-Khamis PPPs, i.e. expressed in 1990 US dollars. If to exclude same smaller economies such as Norway and Ireland, no one developed economy has demonstrated a change of $326 between periods of strong growth and depression. Switzerland, however, is characterized by an even lower mean increment for the last 15 years - $102.

Obviously, there were periods of low performance in many developed countries and very successful years as well. But duration and amplitude of these phenomena in Japan need an explanation far beyond the current understanding of economic evolution of developed economies. Kydland and Prescott [1982] have developed a theory explaining business cycle by exogenous shocks of productivity. Being a relatively useful tool for analysis of a "normal" or steady developing capitalist economy, it fails to predict the Japanese time series if no extraordinary assumptions are used [Hayashi&Prescott, 2002]. In addition, the approach does not offer any means to recover from the current state.

There were several practical attempts to revitalize the Japanese economy based on various economic theories and assumptions. All failed as one can conclude from the figures of economic growth and inflation during the last fifteen years. The problems are just growing in time if to consider the long deflationary period started in 1999 as described by the consumer price index published by the Japanese Statistics Bureau. Only in 2005, some indications of potential recovery from the deflationary period were mentioned. So, after the fifteen years of unsuccessful attempts, a new insight is necessary for explanation of the past poor performance and for developing feasible socio-economic measures for return to the successful path.

In section 1, two models developed by Kitov [2005a, 2006a] are presented. These models describe real economic growth and inflation as related to only one source - population. Real economic growth is defined as a sum of two components: an economic trend and fluctuations. (This approach has been proposed by Hodrick and Prescott [1980].) In the Kitov's model, the economic trend is associated with a constant annual increment of real GDP per capita. The constant varies from $350 to $450 (1990 US dollars) depending on country [Kitov, 2006b]. Relative amplitude of the growth rate fluctuations is numerically equal to a half of the relative change in the number of nine-year-olds in the USA [Kitov, 2005a]. The defining age varies with country.

Another principal parameter characterizing any developed economy is inflation. Kitov [2006a] represented inflation by a lagged linear function of only one measurable variable - labor force change rate. In the USA and France, the labor force change leads the observed inflation by several years. In some European developed countries, evolution of the variables coincides in time [Kitov, 2006c]. Hence, one can control inflation by creating conditions for labor force growth or decrease depending on current needs. By definition, labor force includes two components - employment and unemployment. So, one can developed various social-economic tactics and strategies aimed to affect these two groups. It is found, however, that inflation does not directly depend on or affect economic growth. The two variables depend only through corresponding population changes.

The population-based economic concept is clear and simple. It involves only one defining parameter and is accompanied by the advantage that any desirable accuracy is reachable through more precise population estimates. More efforts in the population enumeration practice and methodology will result in a more accurate prediction of economic growth and inflation.

In section 2, the models are applied to Japan. Numerical results are represented in several figures illustrating the extraordinary features of the Japanese economic development, explaining the past behavior, and forecasting economic growth at various time horizons.

In section 3, we discuss the results obtained and compare them to those for the USA. In addition, we formulate some recommendations how to overcome the long term deflation. We are also looking for similar effects observed or to be observed in near future in other developed countries.

1. The models

This section briefly presents the two models used in this paper for the description of the eccentric features of the Japanese economy. The first model predicts the behavior of real GDP per capita in developed countries as resulted from a relative change in population of some specific age. The model was developed for the USA and extended to the UK and France in order to validate the principal findings [Kitov, 2005a].

The principal relationship for the real GDP per capita growth rate is as follows:

$$dGDP(t)/GDP(t)dt=A/GDP(t)+B*dN(t)/N(t)dt \ , \qquad (1)$$

where $GDP(t)$ is the real per capita GDP at time t, A and B are empirically determined constants, $N(t)$ is the number of people of the defining age. For Japan, the defining age is eighteen years. Relationship (1) implies that the GDP growth rate depends explicitly only on the attained level of real GDP per capita and the population change. If to gather relevant terms at the two sides of the expression, the relationship can be converted in a simpler form:

$$d\{GDP(t)-(At+C)\}/GDP(t)dt= d\{BN(t)\}/N(t)dt\ , \tag{2}$$

where C is a constant. Relationship (2) demonstrates that the GDP per capita evolution depends only on the population change term with constants A, B, and C to be determined by calibration and initial conditions. It should be noticed that the number of people of the defining age is an exogenous parameter because it does not depend only on the GDP per capita history. There are quite a few means to control such demographic characteristics as birth rate, mortality rate, and net immigration in addition to the level of GDP per capita. Besides, a number of forces influencing the demographic processes is out of any control. There is a correlation between birth rate and speed of economic growth, however, which potentially introduces a coherent interference in time expressed in the observed periodicity.

The second model used in the study is even a simpler one. It links together inflation and labor force change. An implicit assumption of the model is that inflation does not depend directly on economic growth. Inflation is a linear and potentially lagged function of labor force change as expressed by the following relationship:

$$INF(t)=C_1dLF(t-t_0)/LF(t-t_0)+C_2\ , \tag{3}$$

where $INF(t)$ is the level of inflation at time t, $LF(t-t_0)$ is the level of labor force at time $t-t_0$ ($t_0 \geq 0$), C_1 and C_2 are empirically determined constants potentially depending on country. For the USA, C_1=4, C_2=-0.03, t_0=2 years [Kitov, 2006a]. The negative constant C_2 makes a permanent increase in labor force of great importance for avoiding deflationary periods. The population growth rate of 0.01 to 0.015 per year as observed in the USA during completely compensates the influence of the negative term C_2. With the boomers retirement, however, the labor force growth will be highly decelerated starting from 2010.

Labor force consists of two principally different groups - employed and unemployed people. In a market economy, the number of employed is hardly to be controlled by any means except inherent economic forces. The number of unemployed, however, is defined mostly by socio-economic policy adopted in a given country. More protection for the unemployed means more people willing to stay for a longer time in this group. A more liberal approach with minimum benefits available can significantly reduce the amount of unemployed. Thus, an encouraging or discouraging state policy can effectively control the labor force magnitude and thus inflation.

2. The modeling results

Japan is a country with a modern statistical service. The Statistics Bureau [JSB, 2006] of the Ministry of Internal Affairs and Communications provides information on various economic and demographic variables. We are especially interested in real GDP per capita annual figures, different estimates of inflation, estimated and enumerated distributions of the Japanese population by single year of age, labor force estimates. The Conference Board and Groningen Growth and Development Center [CB GGDC, 2006] provides additional data on GDP per capita converted at various PPPs. The Organization of Economic Cooperation and Development [OECD, 2006] along with Eurostat [ES, 2006] publishes very useful data on labor force measurements for a relatively long period.

The single year of age population estimates are available from 1920 to 2005 [JSB, 2006]. The estimates are given as of October 1 for each year. Accuracy of the estimates is apparently decaying back in past. GDP figures are available since 1955, both nominal and real. This allows construction of a GDP deflator as one of inflation measures. Consumer price index (CPI) without imputed rent is published since 1946. A new CPI version, that includes the imputed rent, is available from 1971.

Population estimates between censuses are usually based on current information related to birth rate, age and sex dependent mortality, net migration. In Japan, censuses are conducted every five years, i.e. twice as often at in the USA. The most recent census was conducted in October 2005, but its results are not available yet, in January 2006. So, the last available enumerated population distribution was obtained in 2000. The intercensal estimates, relevant surveys, statistics and methodology are tested by the census data.

In practice, censuses are considered as a more reliable and accurate source of population related information than that associated with the intercensal estimates. In Japan, for example, it is obligatory to answer the census questions. It happens very often that the population estimated at the end of an intercensal period does not coincide with that enumerated in the later census. This effect is known as the “closure error” and sometimes reaches several per cent in such developed countries as the USA and the UK.

In order to match the enumerated figures, the estimated population is adjusted for the closure error. The correction is usually age dependent and may significantly differ even for neighboring ages. Figure 1 illustrates the magnitude and timing of these corrections. Annual relative increment in the number of people of the same age is plotted for the 17- and 18-year-olds. For a given year, the relative increment in the number of 17-year-olds is calculated as the difference between the number of 18-year-olds and that of 17-year-olds a year before divided by the latter value. One can easily find the census years in the Figure. Such sharp and high amplitude adjustments are very characteristic for statistical and census agencies over the world. For the purposes of our study, a strong disadvantage of these impulsive corrections consists in the difference of their amplitudes as applied for adjacent years. For example, in 1995, the number of 18-year-olds was corrected by about 0.4% compared to the mean annual increment of 0.03% during the previous four years. At the same time, the correction applied to the number of 17-year-olds is very small. Thus, for 1994, one observes a biased value of the 18-year-olds. The difference of the 18-year-olds for 1995 in also biased because one of the two terms is biased by 0.4%. The difference for 1996 is less biased because it involves two corrected values. In 2000, the corrections are opposite in sign what evidences even larger errors in the intercensal estimation procedure. In 1970, the corrections were as large as 2%. So, one should be careful when using the population estimates in economic analysis. Inherent uncertainty in surveys and measurements can not be currently avoided and one may rely only on large population differences between neighboring ages. Any discrepancy in amplitude between predicted and observed value, which is comparable to the inherent uncertainty in population, inflation or GDP measurements, might be neglected. The measurement errors are usually uncorrelated in time and can be easily smoothed out with a zero residual by a long period filter or in cumulative representation, as described by Kitov [2006a].

The population estimates are used for the prediction of GDP per capita growth rate in Japan. The relative change in the 18 years of age population defines the fluctuations in the economic growth around the trend values defined by the constant increment *A* in relationship (1). Figure 2 represents the observed values of GDP per capita growth rate as obtained from the JSB and the Conference Board and GGDC. There are some differences in the growth rates supposedly induced by corresponding PPPs. For converting currency into the same units to allow comparison of per capita GDP across developed countries we systematically use EKS PPPs [CB&GGDC, 2006] as more reliable and accurate. The economic trend defined by the inverse GDP per capita function with a constant increment A=\$800 (2002 US dollars) is also shown in the Figure. The trend line is not smooth because the actually measured GDP per capita values were used.

Coefficients A and B are determined in a calibration procedure aimed to match the observed and predicted values of growth rate. By varying A and B in relationship (1) one can reach a qualitative resemblance of the curves. Figure 3 shows results of this procedure with A=\$800 and B=2/3. The values of GDP per capita are in 2002 US dollars. The obtained value of factor B is somewhat larger than 0.5, the value obtained for the USA. This finding implies that the economic growth fluctuations in Japan are more sensitive to the change in the specific age population than in the USA. Thus, any change in the number of 18-year-olds results in a higher deviation from the trend value. The Japanese have to be very careful with the demographic processes.

One of the principal features to be modeled is the sharp fall in growth rate started in 1991. This is a critical point for any theoretical description of the Japanese economic evolution. Our model links the drop to the specific age population change. Figure 4 displays evolution of the population level for several neighboring ages. The specific age is chosen to be 18 years because this age is characterized by a fast decay staring in 1991.

There is a problem associated with timing of the GDP and population readings to be discussed. By definition, the GDP per capita values are given for the last day of the corresponding years. The population estimates are published for the first day of October. So, formally the readings are separated by one quarter and the 17-year-olds should be used instead of 18-year-olds if to judge by the start of decrease demonstrated by the curves in Figure 4. One has to bear in mind, however, that for the 18-year-olds the mid-term point is April 1. This point divides the 18-year-olds in a given "population" year in relatively equal portions. Thus, we consider the middle point for the 18-year-olds (April 1, 1991) as the closest to the end of 1990 and use this age population as the defining one. So, we shift the predicted curve by a quarter back (from April 1, 1991 to January 1, 1991) in order to synchronize the curves. The procedure has brought an excellent match in the most important part of the curves – the sharp decrease. One can also use the 17-year-olds with a one year shift, however, as follows from Figure 3.

Another prominent feature of the Japanese economic history is a long-term stagnation. The model successfully reproduces this feature. The number of 18-year-olds systematically decreases since 1991. This effectively means a reduced economic growth. The fifteen years of "less than stellar" performance has been explained by various processes and phenomena related to the monetary policy and a sudden drop in the rate of total factor productivity growth [Hayashi &Prescott, 2002]. The explanation is much simpler and more natural – not enough young people entering the economy. This is the driving force behind all those negative effects involved in the explanation of the paradoxes of the Japanese economy.

The concept of the population dependent economic growth allows prediction of the future behavior. There are two principal approaches – to use a younger population as a proxy to the future evolution of the 18-year-olds or to convert a measured population pyramid into the age distribution. The first approach includes the population estimates prone to corrections and adjustments carried out by the JSB. Even for the closest years, these corrections are not similar as Figures 1 and 3 demonstrate. The second approach guarantees the census enumerated difference between the adjacent years, but also suffers severe changes induced by demographic processes. Figure 5 displays two predictions which use the estimated number of 8-year-olds and the population age distribution obtained in the 2000 census. The curves are very close before 2005. This effect is related to the corrections made to the single year populations after the census. The predicted values for the next ten years (2005-2014) well coincide. In principle, one can obtain a relatively accurate eighteen year forecast for GDP per capita if demographic processes will be similar to the currently observed.

The second model provides a link between inflation and labor force change. In the USA, the link is characterized by a time lag of two years [Kitov, 2006a]. In Japan, the change in labor force occurs simultaneously with that of inflation. If to extend the US findings for the driving force behind inflation to the Japan’s case, one can assume that the labor force change drives the observed inflation rather than opposite direction. There are various definitions for inflation. The most popular definitions for the overall price change are GDP deflator and CPI. The CPI definition was extended recently by inclusion of imputed rent. Thus, three potential measures of inflation can be studied. Figure 6 shows corresponding curves for the three inflation estimates. Difference between the curves is just minor. The only important difference in the 2004 values is between the old and new CPI estimates. The CPI with imputed rent suddenly falls by about 3% below the old CPI estimate.

As many economic parameters, the labor force estimates are also agency dependent due to various definitions of labor force itself and the population adjustments applied. Figure 7 compares the values of the labor force change provided by the OECD [2006] and Eurostat [2006]. Despite strong similarity, some discrepancy reaching 0.1 (or 10% of the total labor force) are observed. Such a difference is an important indicator of the difficulties in labor force definition itself. Further investigations are necessary to elaborate a consistent understanding of the term “labor force”. The proposed model connecting labor force change and inflation is a good candidate for consolidation of various definitions and approaches under the umbrella of numerical consistency.

Coefficients C_1 and C_2 have to be determined for the prediction of inflation according to relationship (3). A standard fitting procedure is applied to the cumulative values as discussed by Kitov [2006a]. When applied to the Japanese CPI inflation (with imputed rent) the procedure gives C_1=1.77 and C_2=-0.0035. The predicted and observed curves are shown in Figure 8. The curves are in a good shape and amplitude agreement considering the uncertainty of the inflation and labor force readings. Moreover, the agreement is somewhat better than that between the two labor force estimates.

A more robust and reliable method to compare the observed and predicted inflation consists in comparison of cumulative inflation curves. Short-term oscillations and uncorrelated noise in data induced by inaccurate measurements and a bias in definitions of the measured variables are smoothed out in the cumulative curves. Any actual deviation between the two curves persists in time if the measured values are not matched by the defining relationship. The predicted cumulative values are very sensitive to the coefficients in relationship (3). So, the coefficients obtained in the cumulative curves fitting process are used in the prediction, as mentioned above. Figure 9 shows the observed and predicted cumulative curves and the obtained coefficients for relationship (3) as well. The curves are characterized by a very complex behavior. There are periods of intensive inflation growth and deflationary periods. The labor force change defining the predicted inflation curve follows all the turns in the measured inflation. One can conclude that relationship (3) is valid and the labor force change is the driving force for inflation. An alternative opportunity is that the both variables are defined by some third external force causing the synchronous evolution. There is no obvious candidate for this external force, however. Labor force depends on the level of working age population and participation rate. The former parameter is, apparently, inflation independent. The latter might be partially dependent on simultaneous inflation, but also sensitive to many other social and economic conditions. This is clear from a cross-country comparison showing quite different unemployment rates in developed countries, unemployment being a constituent part of labor force.

3. Discussion and conclusions

The above given forecast of the economic development for the next ten years is based on the estimated number of 8-year-olds. This is a relatively good approximation for the future demographic development in Japan. There is almost no net migration and a very stable population structure with a predictable mortality rate. (For the USA, one can not be so sure about demographic processes so far ahead.) Hence, one can predict the GDP growth rate with a very high reliability. Having the forecast and knowing the principal mechanism driving economic growth one can propose a new migration strategy, however, in order to speed up the economy. Any birth rate accelerating means will give results only in 18 years. It is too long time for such means to be incorporated in any current socio-economic policy. On the other hand, the Japanese have paid fifteen years of low performance for the ignorance of the importance of demographic processes. Repetition of such a period should not be allowed in future.

Inflation is defined by the labor force change rate with a factor of 1.77. This is a low factor if to compare to those in the USA (4) and France (18). It makes inflation relatively insensitive to the labor force change. The problem is not the sensitivity but steadily decreasing growth rate of the Japanese labor force. The rate dropped by 0.035 since 1990 and stalls in the negative zone. A simple means to recover from deflation would be the labor force increase. The participation rate of civilian labor force in systematically decreases in Japan from 70% in 1956 to 60% in 2003 (see Figure 10). No recovery from the deflationary period is possible if this trend will continue. The means to win the battle are very simple, however, and bear not only pure economic but also social character. In the situation when the observed employment can not be easily changed one can change the unemployment rate. It sounds extravagant for the conventional economic theory but exactly matches the revealed relationship between labor force and inflation.

Inflation is only one of many phenomena defining the labor force level and change rate. There is just a weak positive feed-back in the direction inflation-labor force, but very strong in the opposite direction. In Japan, the changes in labor force coincide in time with the inflation change to the extent one can judge from the data available. In the USA and France, the labor force change leads inflation by two to four years. This delay demonstrates the chain of command which should be the same for any developed country. In this case, any activity aimed to control inflation except via labor force seems to be not effective. Central banks varying interest rate just follow a natural evolution of inflation driven by the labor force change. The play is harmless until the evolution is favorable as was during the last 15 years in the USA. It might be too late, however, if something will happen to labor force, as was in the 1970s and 1980s in the USA, and in the 1990s and the first half of the 2000s in Japan. Judging by the Japanese experience, the USA is approaching a very dangerous period with a high thread of deflation starting in 2012. Japan is close to the end of its deflationary period if the future economic growth will result in more jobs and unemployment will also grow affected by the growth and reasonable socioeconomic policy aimed to attract more people into the labor force.

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Figures

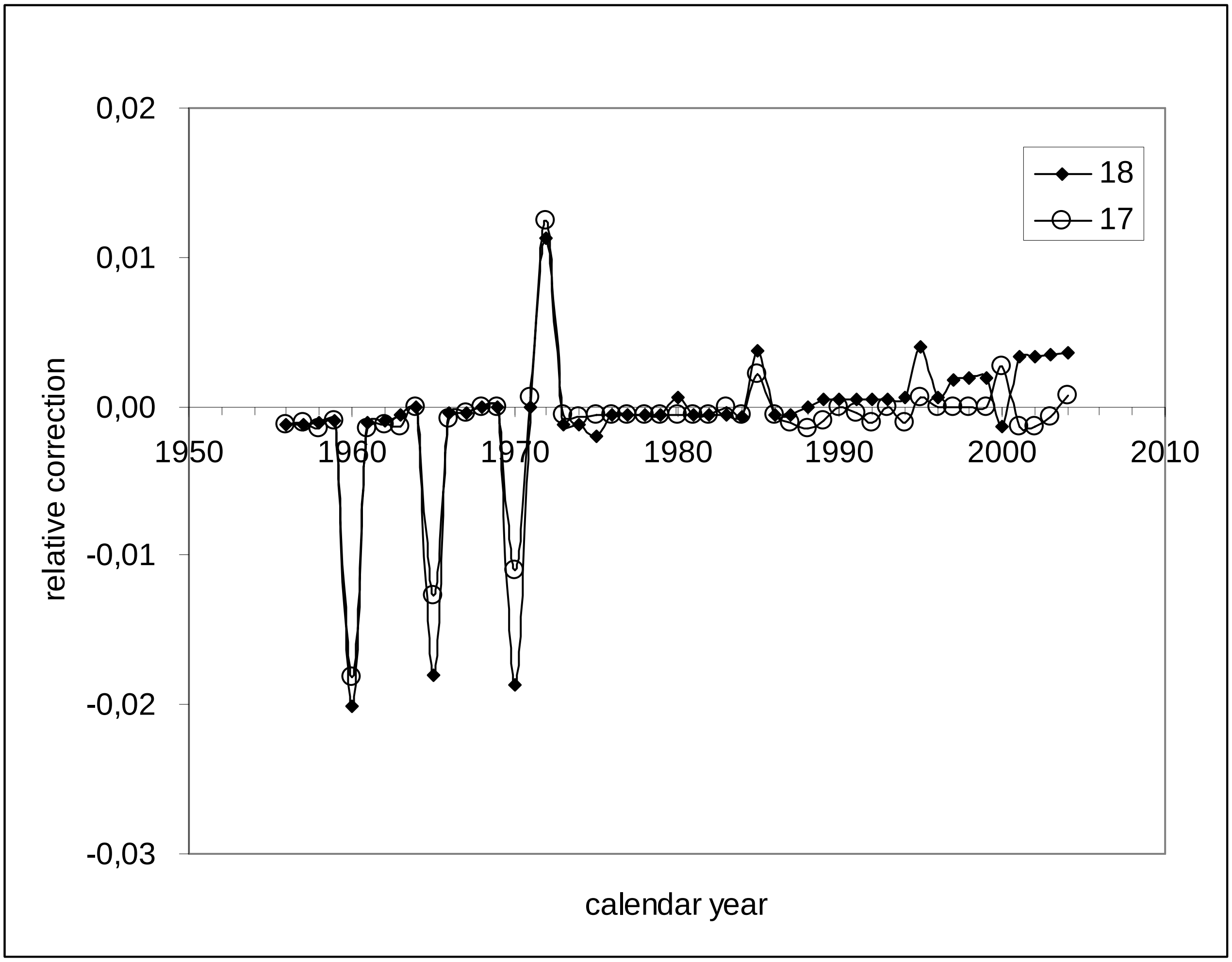


Fig. 1. Relative growth rate of a single year of age population per one year. Solid line with filled diamonds represents the growth equal to the difference of the 18-year-olds and 17-year-olds one year before divided by the number of 17-year-olds. Solid line with open circles represents the same relative growth rate for the 17-year-olds. The correction in 1995 disturbs the 18-year-olds time series because there is no such a corrections for the following cohort.

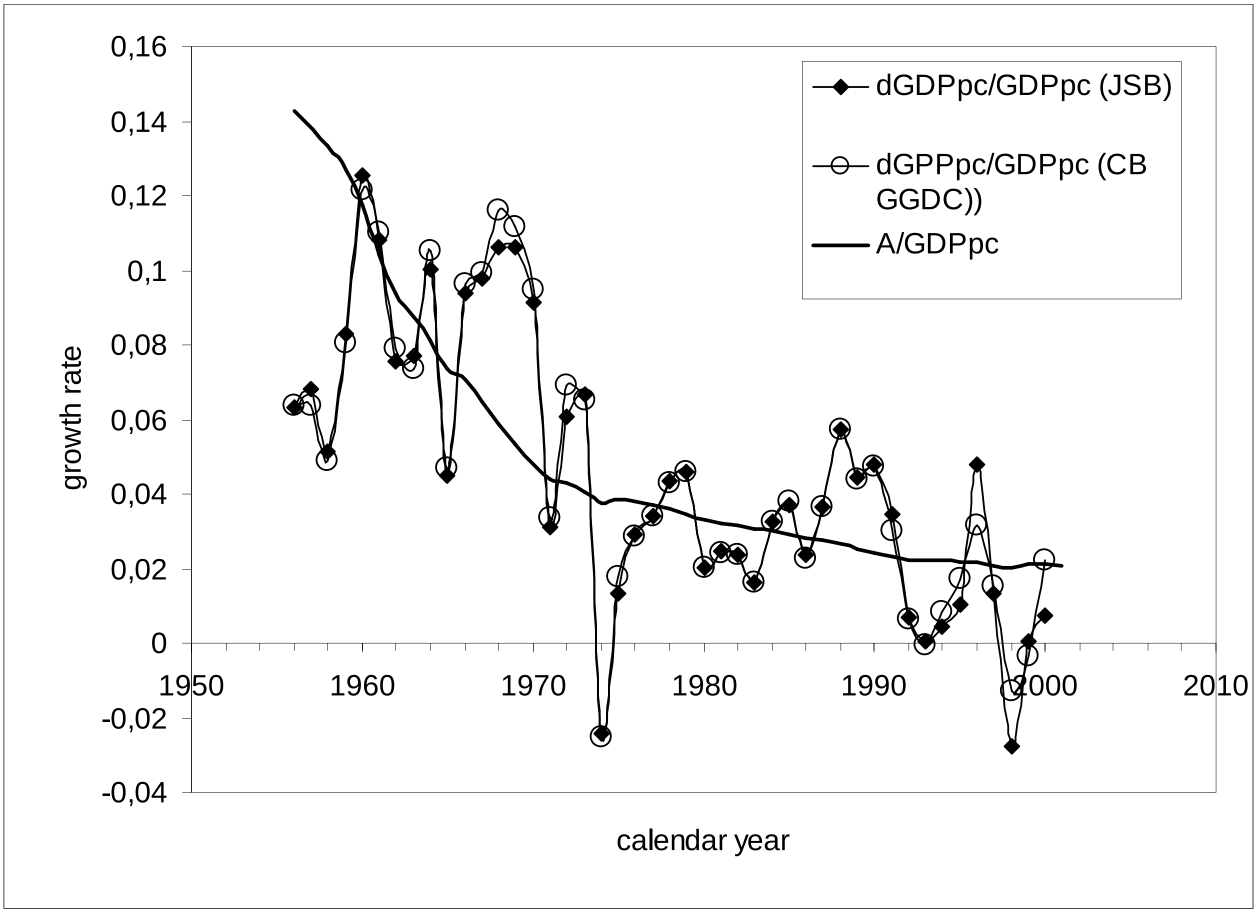


Fig. 2. GDP per capita growth rate as obtained from the data provided by the Japanese Statistics Bureau [JSB, 2006] and the Conference Board and Groningen Growth and Development Center [CB GGDC, 2006]. There are periods of coincidence and discrepancy. Bold line represents the trend line as obtained by relationship *A/GDPpc*, *A*=$800. The GDP per capita values, GDPpc, are expressed in 2002 US dollars.

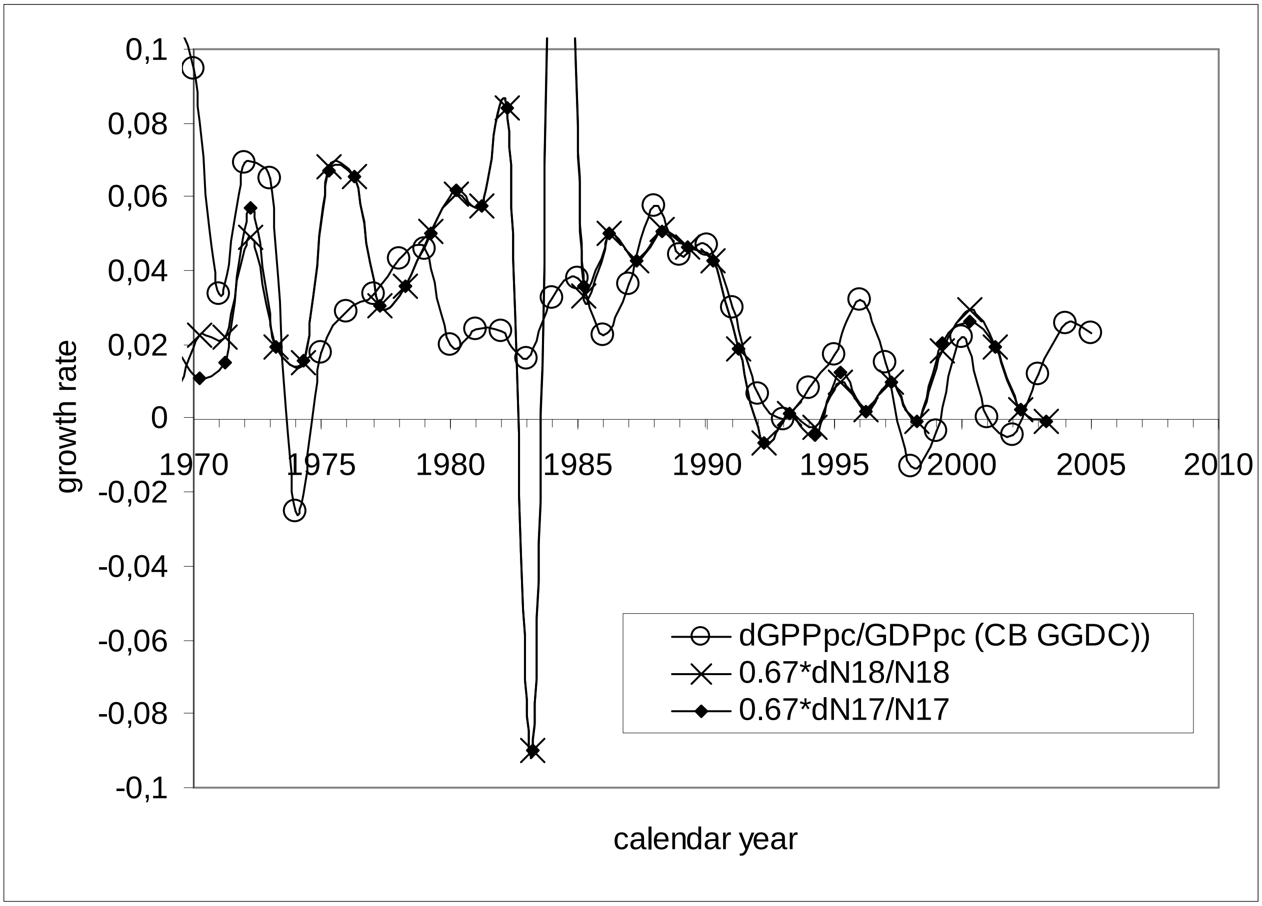


Fig. 3. Modeling the observed evolution of growth rate of GDP per capita using relationship (1). The most important feature is a sudden drop in growth rate in 1991. The effect of the population correction discussed in Figure 1 might be responsible for the discrepancy between the observed and predicted values in 1996.

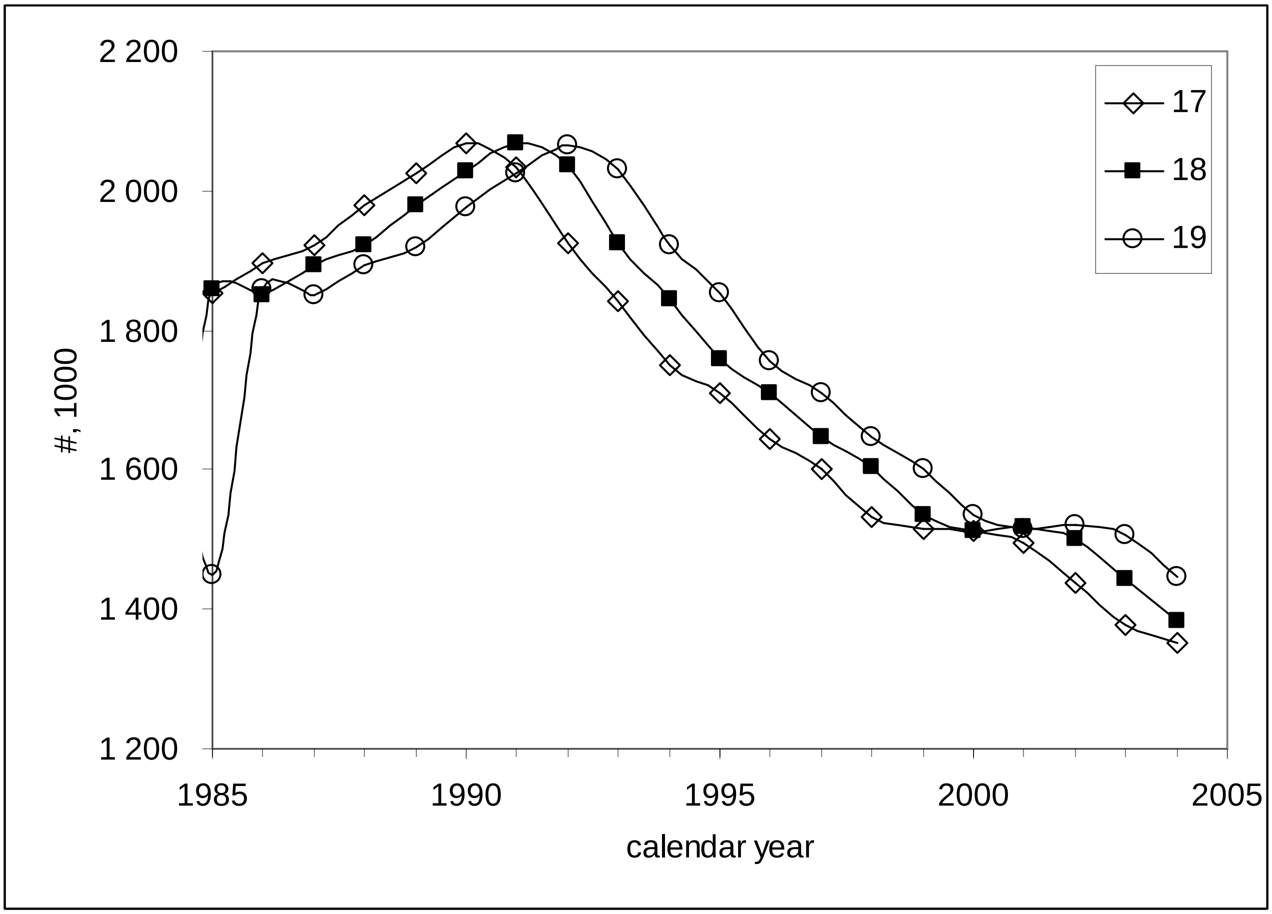


Fig. 4. Evolution of single year of age populations. Shown are the 17- 18- and 19-year-olds. For the 18-year-olds a decrease starts in 1991. Because the single year of age populations are defined on October 1 of each year, the 18-year-olds are the closest to the start of GDP per capita fall in 1991.

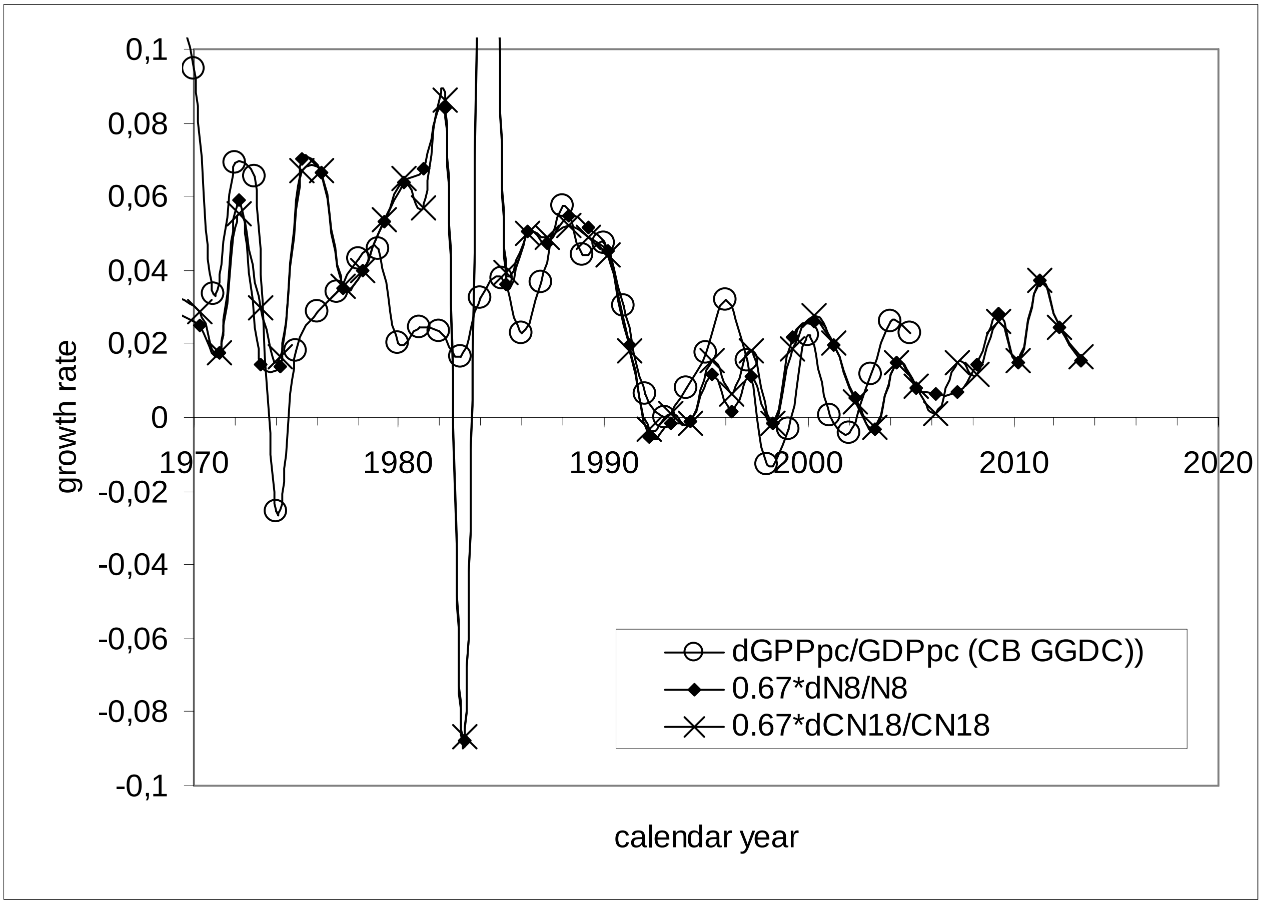


Fig. 5. Modeling the observed and future evolution of growth rate of GDP per capita using relationship (1). The prediction till 2014 is given from the number of 8-year-olds (N8) and the 2000 population age distribution converted into the number of 18-year-olds (CN18). The two approximations give close predictions for the GDP per capita growth rate.

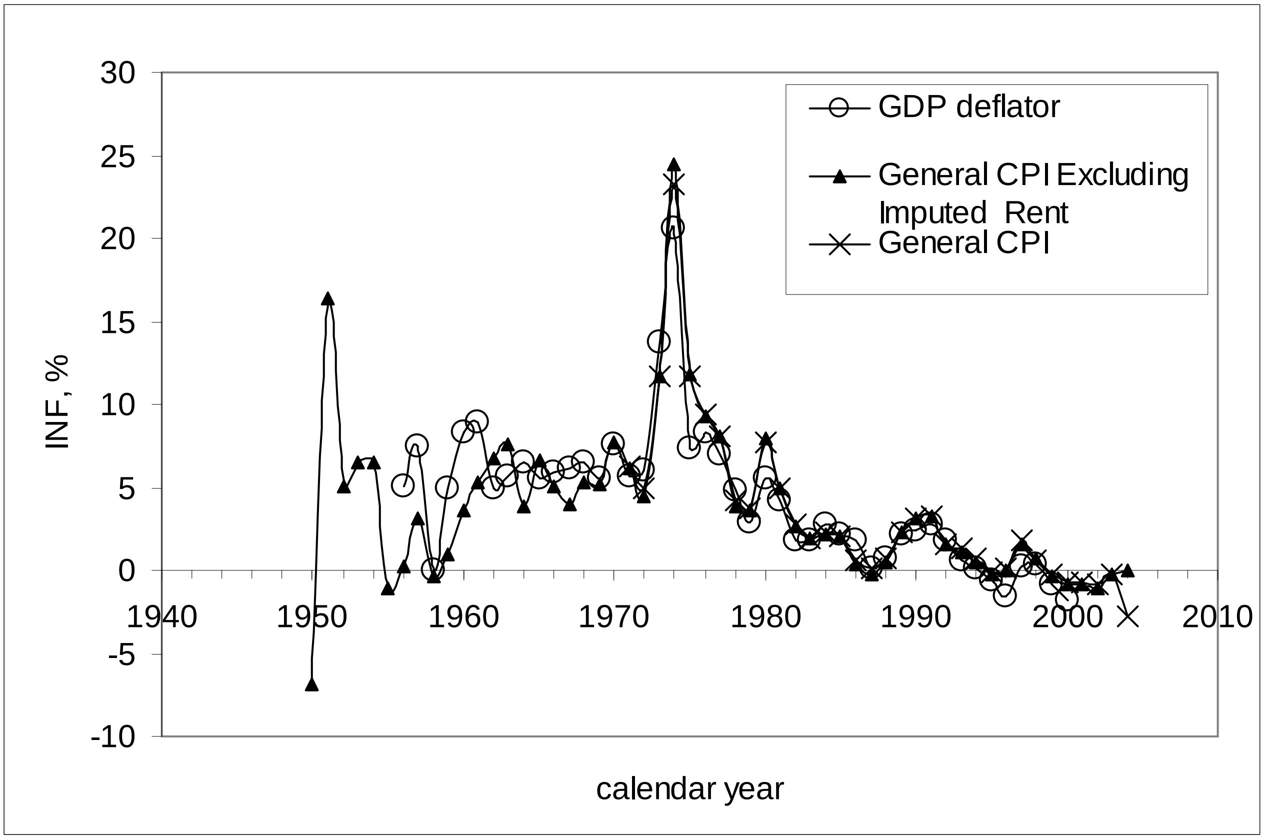
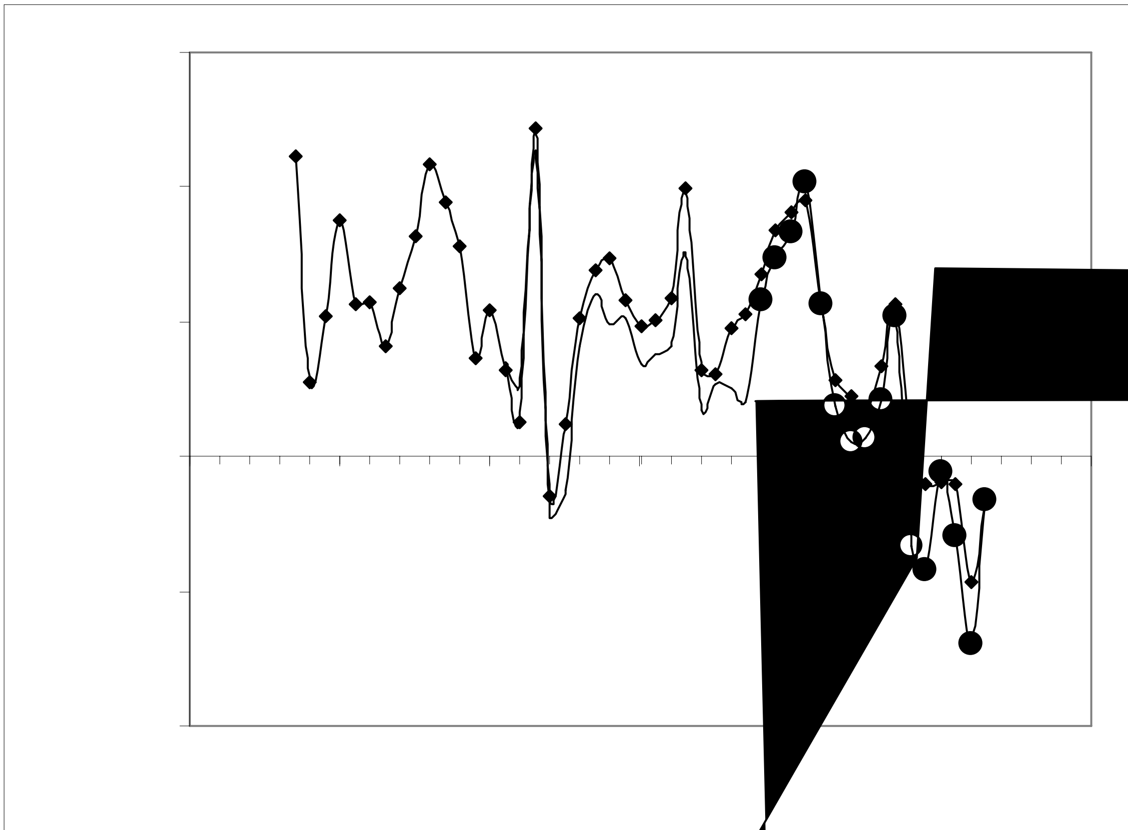


Fig. 6. Comparison of various measures of inflation. The curves are slightly different during some periods of time.



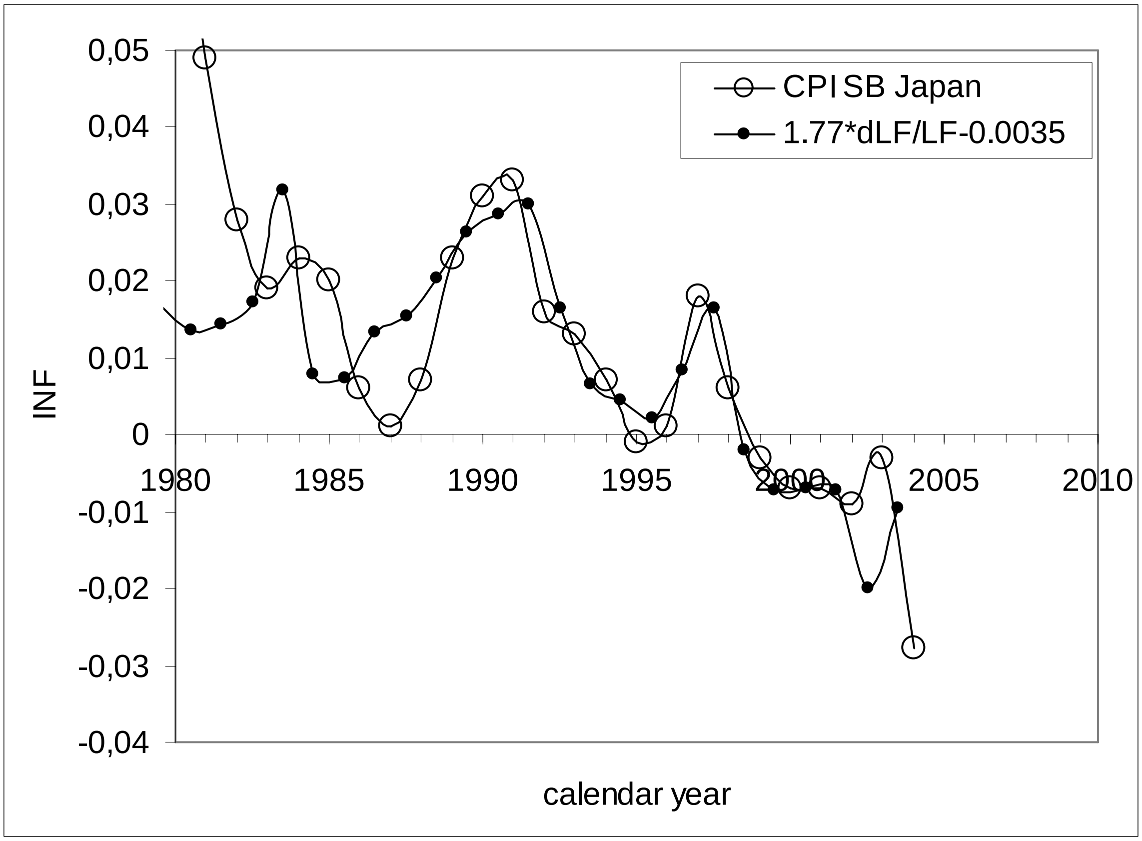


Fig. 8. The measured inflation (CPI) and that predicted from the labor force change. The linear relationship is given in the upper right corner. A good agreement between the curves illustrates the prediction accuracy.

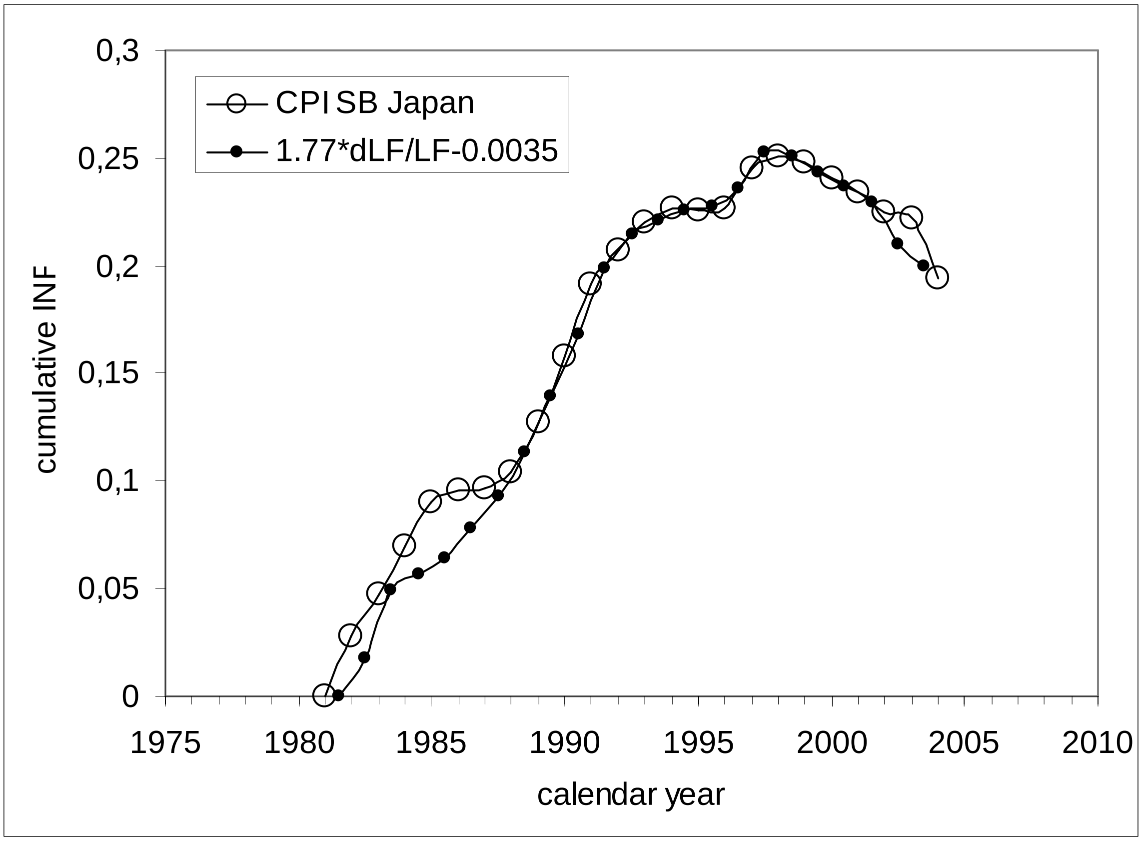


Fig. 9. Comparison of the observed and predicted cumulative (starting in 1981) inflation curves. The predicted curve is shifted by half a year ahead to compensate for the difference between the measurement procedures for inflation and labor force.

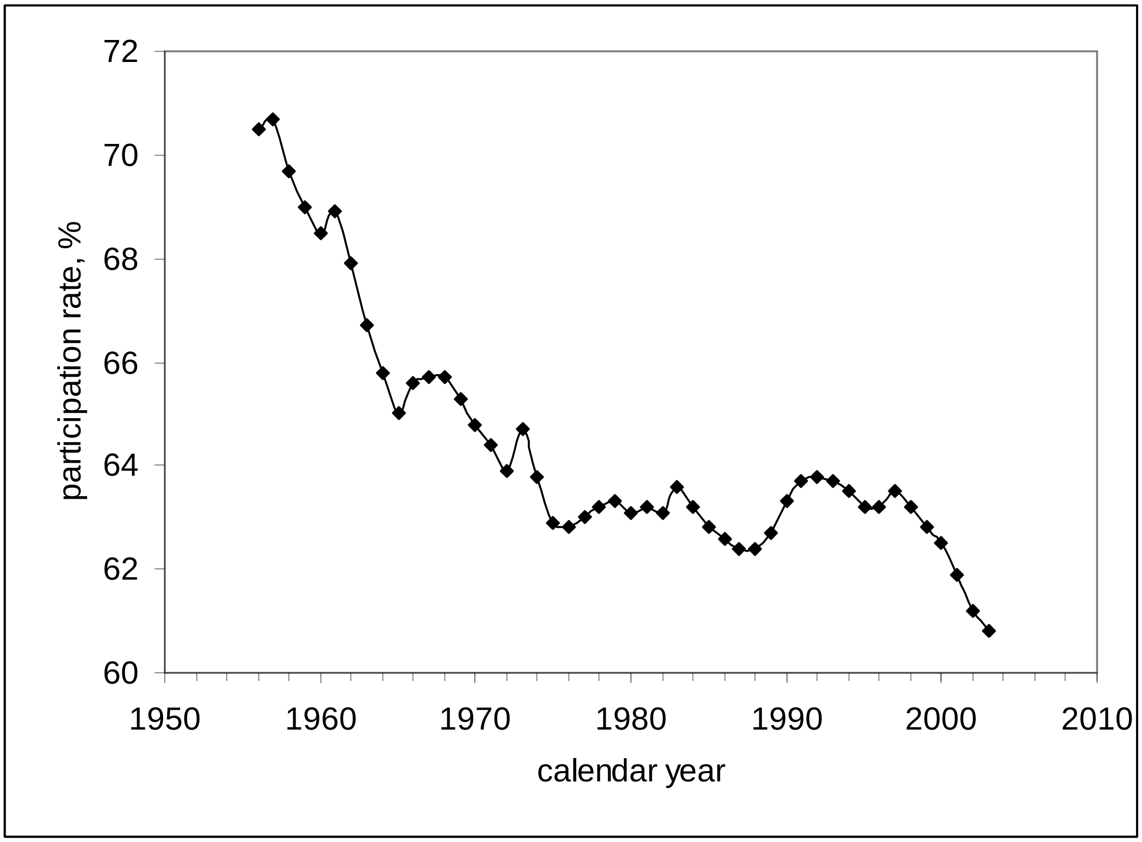


Fig. 10. Evolution of the civilian force participation rate in Japan. A downward tendency is observed during the last seven years indicating a continuing deflationary period.