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Data revisions of pension obligations and alternative extrapolation methods: practical issues in bank of Japan's revised flow of funds accounts[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Data Revisions of Pension Obligations and Alternative Extrapolation Methods: Practical Issues in the Bank of Japan's Revised Flow of Funds Accounts

Mizuki Honda, Naoto Osawa and Yoshiko Sato[1]

Abstract

The Bank of Japan (BOJ) has published its revised Flow of Funds Accounts (FFA) conforming to the 2008 SNA in March 2016, distinguishing two types of employment-related pension schemes—defined-benefit (DB) and defined-contribution (DC)—as one of its major pillars of revisions. As a particular interest, the FFA records DB pension obligations as the present discounted value of future pension payments calculated by an actuarial model using a discount rate. On the one hand, this explicit presentation has revealed a linkage between long-term interest rates, a benchmark for a discount rate, and the pension fund balance sheet (and ultimately the corporate balance sheet). On the other hand, a limitation of low frequency source data on pension obligations obtained from corporate annual financial statements poses a practical challenge for statisticians; at most seven quarters of data must rely on estimates, but not actual data, which are subject to substantial revisions, with the current method of not accounting for a sharp declining trend in long-term interest rates induced by BOJ's recent accommodative monetary policy. This paper discusses sensitivities of pension obligations to interest rate changes and alternative extrapolation methods to minimize data revisions of pension obligations by examining forecast errors.

Keywords: defined-benefit pension schemes; actuarial model; discount rate; monetary policy

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1. Introduction

Since March 2016, the Bank of Japan (BOJ) has published its revised Flow of Funds Accounts (FFA) in accordance with the recommendations of the 2008 SNA (System of National Accounts), making significant improvements in data and methodologies of compiling corporate pensions. First, the BOJ separately records two different types of corporate pension schemes: a defined benefit (DB) scheme and a defined contribution (DC) scheme. In a DB scheme, employers promise employees to provide pensions on an actuarial basis, whereas in a DC scheme pensions paid are limited to the amount of contributions and investment performance of the funds. Second, in a DB scheme, retirement benefit obligations (RBO)[2] are recognized as total pension benefit obligations on an accrual basis and recorded in discounted present value. Third, the actuarial calculation of pension obligations makes it possible to explicitly record the claims of pension funds on pension managers as the assets of corporate pensions and liabilities of pension managers (corporations) in the FFA.

The revision to corporate pensions in the FFA makes it possible to present differences in the two types of pension schemes. Chart 1 shows that, as of the end of Fiscal Year (FY) 2015[3], the value of stocks of pension liabilities under the DB schemes is 128 trillion yen, whereas that for the DC schemes is 8 trillion yen.[4] The share of the DC schemes has remained at a significantly low level, despite its gradual upward trend in recent years. The pension liabilities under the DB schemes have shown a gradual declining trend during the second half of the 2000s, with the exception of a sudden increase in FY2014. This increase reflects a substantial decrease in long-term interest rates in recent years, which has resulted in a decrease in discount rates used to calculate the present discounted value of DB pension liabilities. Note that the two types of pension schemes also differ from each other in asset compositions, as depicted in Chart 2: the DB schemes invest in a wide range of financial assets from safe to risky; DC schemes concentrate on relatively safe assets such as currency and deposits, and investment fund shares.

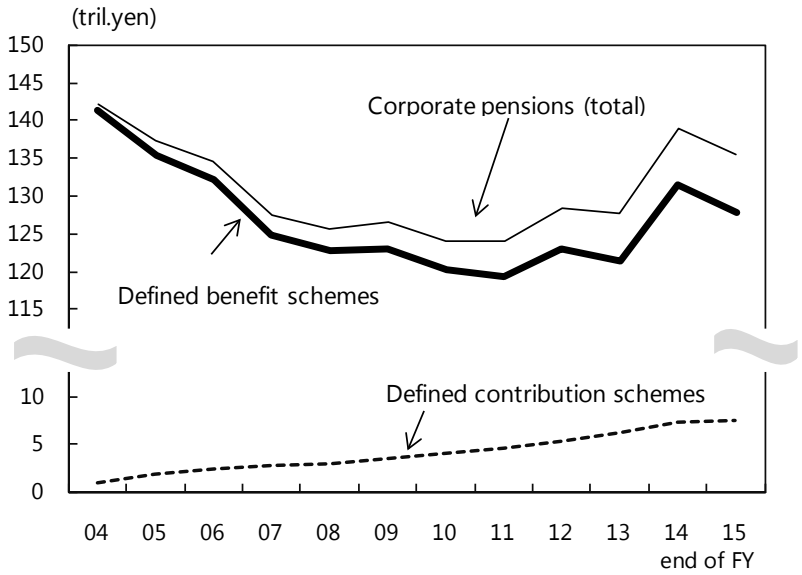
[2] The FFA uses "pension entitlements" as the official statistical term for the RBO.

[3] Fiscal year starts in Q2 and ends Q1 in the following year.

[4] To be precise, pension liabilities under the DB schemes include liabilities of financial derivatives. In this paper, since financial derivatives hold a very small share in the total amount of DB pension liabilities, the term "RBO" is used synonymously with "DB pension liabilities."

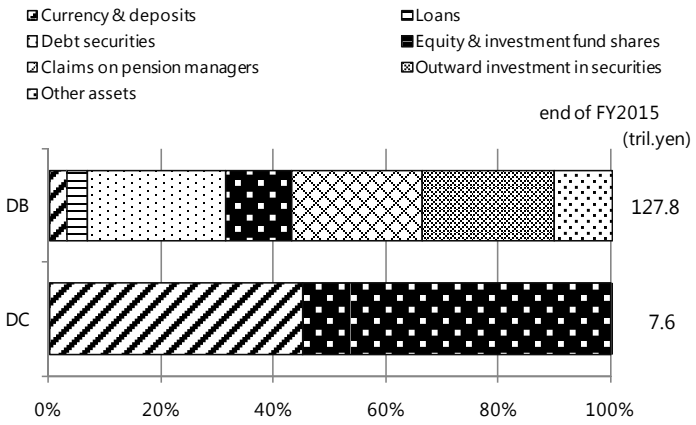
Pension liabilities

Chart 1



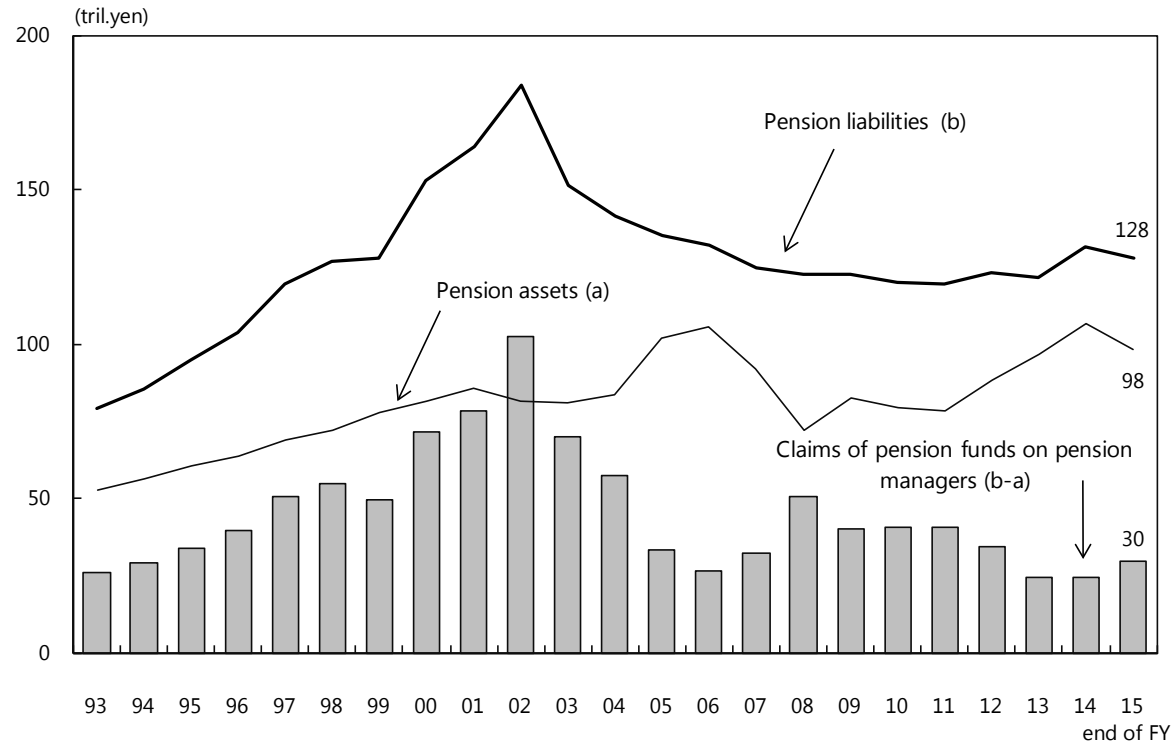
Pension assets

Chart 2



The FFA also reveals the underfunded portion of DB pension schemes. Claims of pension funds on pension managers—derived by deducting DB pension assets from liabilities—peaked at 102 trillion yen at the end of FY2002, as shown in Chart 3. Since then, however, with the retirement of baby boomers causing a decline in pension liabilities and with improved performance of financial markets causing an increase in pension assets in value, they turned to a decreasing trend and reached 30 trillion yen at the end of FY2015.

Claims of pension funds on pension managers (DB schemes) Chart 3



Moreover, this revision to corporate pensions enables users to analyze effects of interest rate changes on RBO. The revised FFA provides in its data a linkage between interest rates and a DB scheme: long-term interest rates would cause changes in discount rates used in the calculation of RBO by individual firms, revising the present discounted value of RBO. In particular, users would be interested in the effects of the interest rate changes on corporate balance sheets through the changes in the balance sheet of DB pension funds, and ultimately on corporate profits. While direct effects would center on the RBO on the liability side of the DB, total effects depend on other factors: interest rate changes may affect the asset side of the DB as well.[5] In the end, the claims of pension funds on pension managers, the difference between assets and

[5] For example, a decline in interest rate raises DB pension liabilities via discount rate, but would also raise the value of DB pension assets if induced by lower interest rates, partially offsetting the effect of interest rates on the liabilities. It is even more complicated: taking into account differences in composition of assets and maturity mismatches between assets and liabilities, interest rate changes would affect corporate balance sheets through multiple channels.

liabilities in the DB balance sheet, would be a more appropriate indicator to examine effects on corporate profits.

While bringing about benefits for users to be able to analyze a DB scheme, the revisions of the FFA have posed a serious challenge to statisticians due to slow timeliness and low frequency of source data: raw data to calculate the RBO are disclosed only annually in financial statements of individual firms and thus statisticians must extrapolate data for periods in which actual data have not yet been available. Naturally, ensuring the accuracy of estimated figures is a serious issue for statisticians.

In fact, the magnitude of estimation errors turns out to be quite large, with the current extrapolation method. An estimation error of RBO comes out to be around 12 trillion yen, or 9% for FY2014 – an estimated level of 118 trillion yen of RBO has been revised up to be an actual level of 130 trillion yen. The current extrapolation method estimates the amount of claims of pension funds on pension managers as 13 trillion yen, while the actual figure turns out to be 25 trillion yen. The magnitude of this estimation error accounts for 46% of the claims of pension funds on pension managers and 1.5% of the net asset value of non-financial corporations.

This paper aims to present an alternative extrapolation method of RBO in the DB pension scheme, by taking into account interest rate changes and to examine the extent to which the alternative method would improve estimated figures. The rest of the paper is organized as follows. Section 2 explains data and the current extrapolation method of RBO, and shows the differences between actual and estimated figures of RBO in a time series from 2005 to 2015. Section 3 presents an alternative method that takes into account the effects of interest rate changes. Section 4 discusses the robustness of the alternative method and explores possibilities of further improvement compared with the current method. Section 5 concludes the paper.

2. Data and Current Estimation Method

2.1. Data and Current Compilation Method for Actual Value of RBO[6]

The FFA compiles actual value for stocks of RBO based on retirement benefit obligations disclosed in annual financial statements by individual firms. Despite quite large data coverage available from more than 3,000 firms—mainly but not limited to listed firms—aggregated figures for the pension liabilities do not represent total economy, mainly because many small and mid-size firms are exempt from disclosing pension liabilities. As a result, to calculate economy-wide DB pension liabilities, the FFA grosses up the aggregated figures from available microdata to the economy total by making use of available data on economy-wide pension assets disclosed by pension asset management companies.

The FFA compiles flows/transactions of RBO as the sum of service costs and interest costs net of pension benefits paid out. The data come from two sources: 1) annual financial statements of individual firms disclose actual value for service costs and interest costs, which are grossed up by the same proportion as the stock value of RBO, and 2) economy-wide pension funds provide actual value for pension benefits paid out annually.

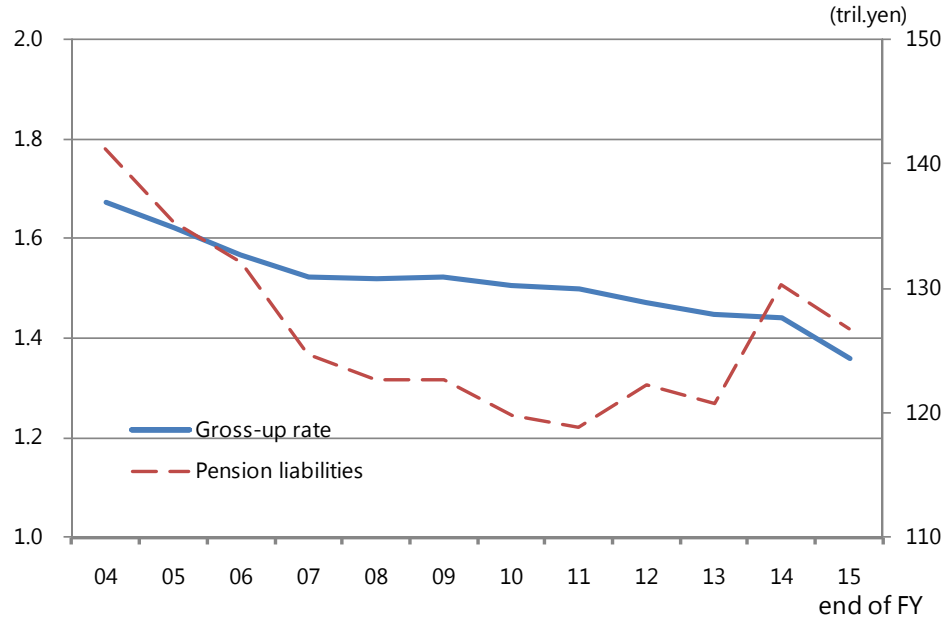
Note that all data to compile stocks and flows of RBO are at annual frequency and available only with a long lag. As a result, the FFA, which compiles and publishes quarterly data, needs to extrapolate the value of RBO for quarters in which actual data have not yet been available, with the maximum of seven quarters. For example, for Q4 2016, preliminary figures are to be released in March 2017 (Q1 2017), and the latest actual value of RBO available as source data is only for FY2014 (ending in Q1 2015). It means that the FFA needs to reasonably extrapolate stocks and flows of RBO for the quarters from Q2 2015 to Q4 2016.

Also note that in the current estimation method, the estimated actual value of RBO conceptually consists of two elements: pension liabilities aggregated from more than 3,000 sample firms and the gross-up rate of sample to economy-wide pension liabilities. The accuracy of the extrapolated value of RBO, therefore, depends on the accuracy of the extrapolated value of those two elements. Historically, as Chart 4 shows the gross-up rate remains around 1.5 without wide fluctuations, whereas the

[6] The Annex drawing on Bank of Japan (2016) describes in detail the current estimation method for both stocks and flows of DB pension liabilities.

pension liabilities aggregated from the sample fluctuate relatively widely. Based on this observation, this paper focuses on an alternative extrapolation method only for the aggregated value of pension liabilities in the sample firms, which is discussed in Section 3. But, first, the next subsection takes up the current extrapolation method and its challenges.

Gross-up rate and pension liabilities — Chart 4



2.2. Current Extrapolation Method for Estimated Value of RBO

The FFA currently uses an extrapolation method to estimate flows and stocks of RBO, as explained below. The current method decides the value of flows for each quarter, which is assumed to be exactly the same as in the previous periods, and then derives the current quarter-end stock value by adding the quarter flow value to the previous quarter-end stock value.[7] For example, if the actual value of quarterly flows in FY2014 is 0.4 trillion yen, the extrapolated value in FY2015 is also 0.4 trillion yen. If the actual stock value of RBO in FY2014 ending in Q1 2015 is 100 trillion yen, that in Q2 2015 would be 100.4 trillion, and amounts to 102.8 trillion yen in Q4 2016.

[7] Except for lump-sum payment upon retirement as part of pension benefits—since no information regarding obvious seasonality exists in source data—annual data are by and large equally divided into four to derive actual value of quarterly data.

Note that the current method takes into account only accumulation of flows when estimating value of stocks. Reconciliations between stocks and flows, which account mostly for changes in the value of stocks due to interest rate and discount rate fluctuations and thus might greatly affect the value of RBO stocks, are implicitly assumed to be zero in the extrapolation periods.

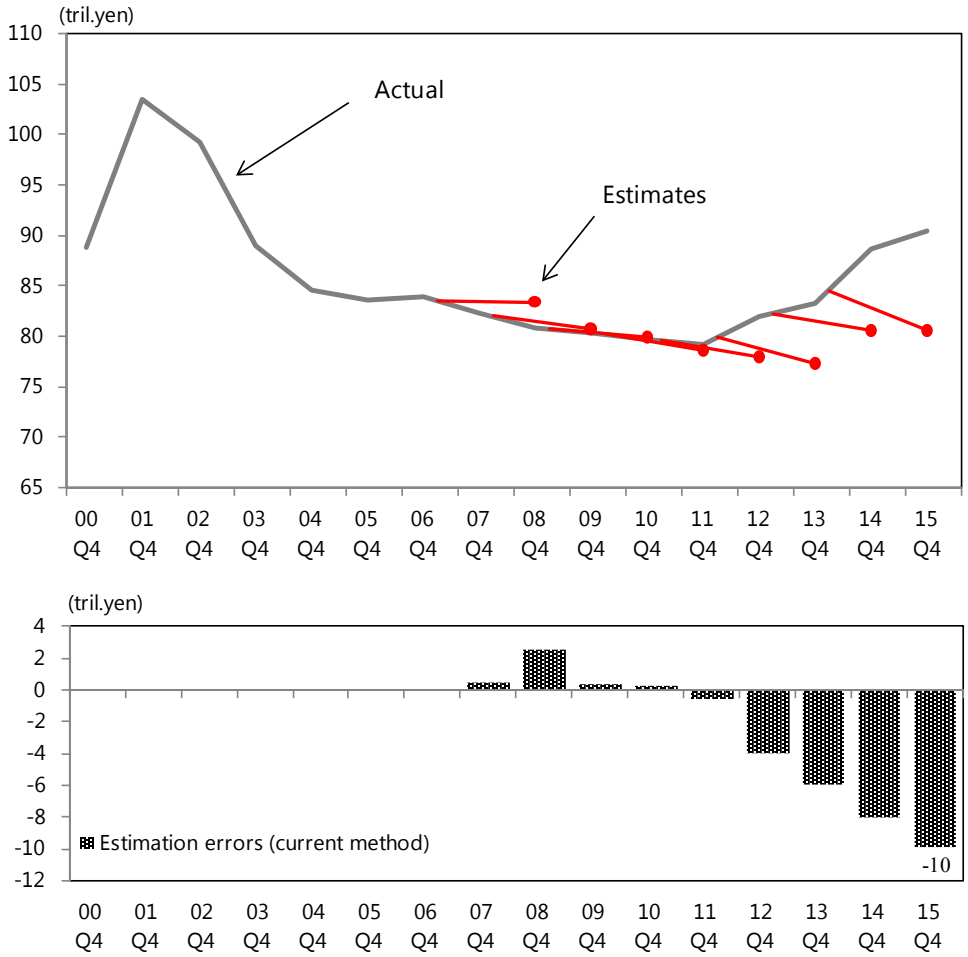
2.3. Estimation Errors

Current methods of estimating flows and stocks of RBO are considered reasonable under circumstances in which discount rates do not substantially change. In theory, the value of RBO, employees' pension entitlements, depends on factors such as the rate of increase in wages, working periods, turnover rates, and discount rates. In addition, institutional changes such as retirement benefit rules affect the value of RBO. Among the factors mentioned above, except for discount rates—which are determined based on long-term interest rates—other factors regarding employment are considered to be relatively stable in the short term. Institutional change—which usually require painstaking negotiation processes between employers and employees—would not take place in the short term. In fact, periods from the late 2000s through the early 2010s have not observed large fluctuations of long-term interest rates or major institutional changes.

Nonetheless, the current extrapolation method has generated substantial estimation errors—the differences between actual and estimated value of RBO—which widen sharply in times of large interest rate fluctuations. Chart 5 in the upper panel shows the actual stock value of RBO every fourth quarter until Q4 2015 in a solid black line, and the values of preliminary estimates are in red lines under the current extrapolation method. The current method extrapolates estimates, starting from the actual stock value of Q1 every year, by adding the value of the same quarter flows of the previous year—which are the latest values available at the time of estimation—to the previous quarter-end stock value. Since the actual value is only available seven quarters after the relevant Q1, the current method shows the extrapolated values from Q1 of any particular year to Q4 of the following year. For example, in deriving the stock value in Q4 2015, the current method takes the stock value in Q1 2014 and adds the quarter flow in the previous year to the previous quarter-end stock value until Q4 2015. Chart 5 in the lower panel shows estimation errors between the actual and estimated values, indicating a large overestimate of 2.9 trillion yen in Q4 2008 and widening large underestimates for the last few years , reaching 10 trillion yen in Q4 2015.

Current extrapolation method and estimation errors

Chart 5



The improvement of methodology for estimating RBO stocks is a vital issue in terms of magnitude as well as length of periods. Underestimates of RBO generate the same amount of underestimates of assets (pension entitlements) in the households' balance sheet and the same amount of underestimates of liabilities (claims of pension funds on pension managers) in the corporations' balance sheets. At the end of FY2015, claims of pension funds on pension managers were 30 trillion yen. The estimation error of 10 trillion yen means that the actual value of the claims of pension funds on pension managers in the corporations' balance sheet is underestimated by 33%. Note that if the same extrapolation estimate extends for seven consecutive quarters at maximum, the estimation errors would accumulate to nearly double at the end of the seventh quarter.

3. Alternative Extrapolation Method Considering Interest Rate Changes

This section presents an alternative extrapolation method that takes into account the effects of interest rate changes by examining two steps: the link between interest rate and discount rate, and the link between discount rate and RBO. Note that data used in the analysis are all aggregated levels from individual firms' micro data. In particular, discount rates are computed as a weighted average of the ratio of interest costs to RBO at the individual firm level.

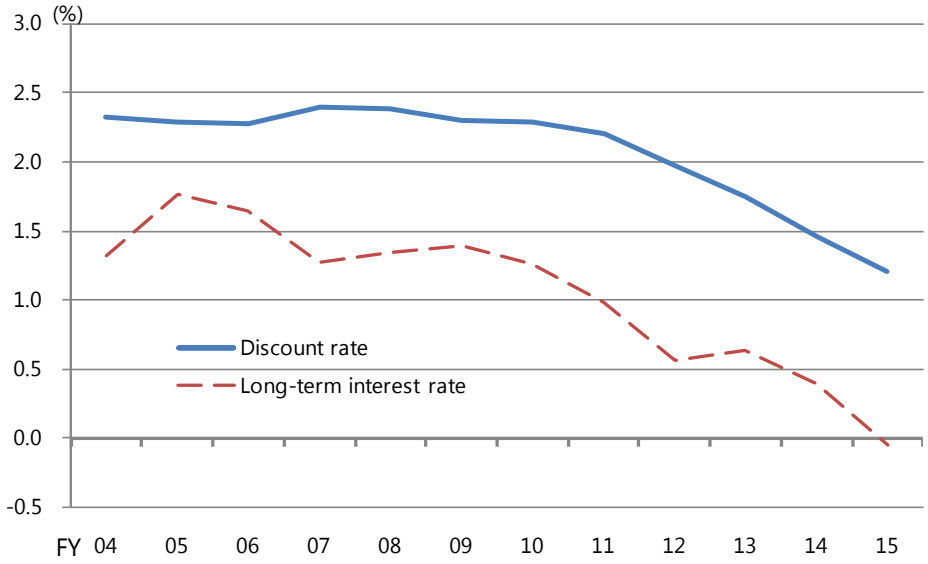
3.1. Link between Interest Rates and Discount Rates

Accounting standards for retirement benefits in Japan stipulate that the discount rate applied to the calculation of the present value is the yield equivalent to risk-free bonds such as JGBs (Japan's Government Bonds), government agency bonds and high-quality corporate bonds; all reflect the expected payment periods of each pension.

Chart 6 depicts the time series of discount rate and long-term interest rate from FY2004 to FY2015. Long-term interest rate is a newly issued ten-year government bond yield at the end-date of each fiscal year. Looking at the levels, the discount rate has been higher than the long-term interest rate, running by and large in parallel throughout the time periods. A closer observation at the difference from a previous period reveals that discount rate has been influenced by long-term interest rates with a two year lag.

Long-term interest rate and discount rate

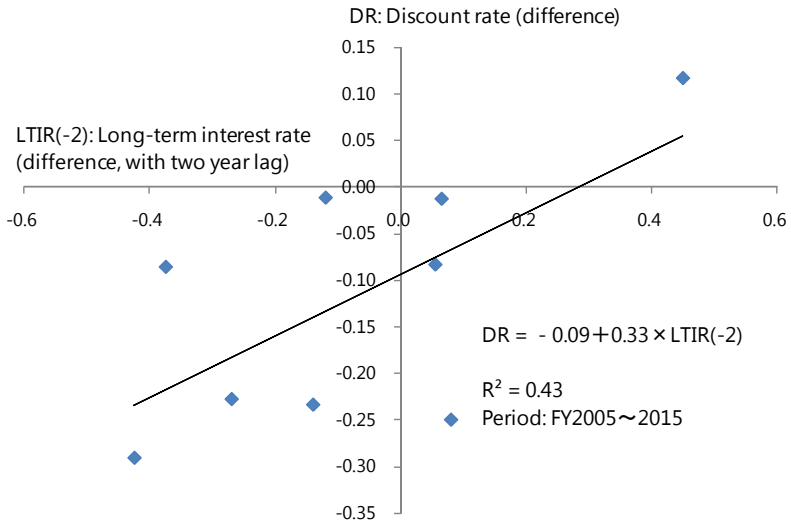
Chart 6



The two year lag may partly be attributable to the so called "10% rule" of the accounting practice in Japan. Accounting standards allow firms to maintain the existing discount rates if the RBO calculated by using the new discount rate at the year-end does not change by more than 10% of the value calculated at the previous year-end discount rate.

Regressing the year-on-year difference of the discount rate on that of the long-term interest rate with two year lag yields the coefficient of around 0.3 for the period from FY2005 to FY2015, as shown in Chart 7. This result implies that the elasticity of the discount rate to long-term interest rates is around 0.3: if long-term interest rates decline by 1% point from the previous year, the discount rate will fall by 0.3% points two years later.

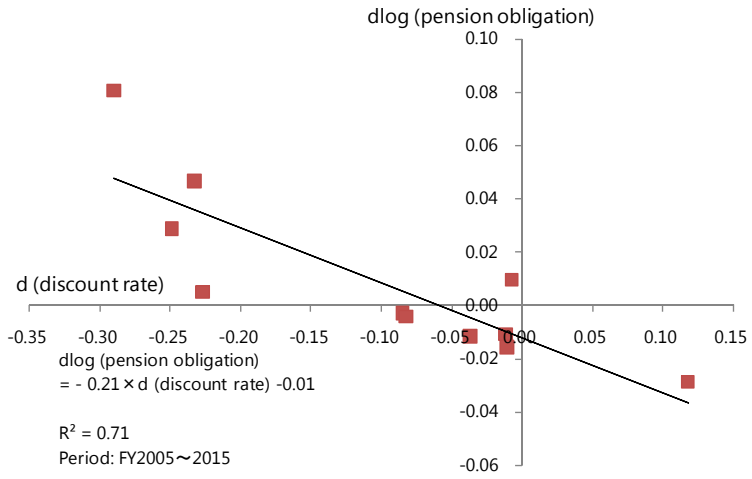
Elasticity of discount rate to long-term interest rate Chart 7



3.2. Link Between Discount Rates and RBO

Unlike the relationship between long-term interest rates and discount rates, no obvious lags and leads relationship are observed between discount rates and RBO. Regressing the difference of RBO in logarithm on the year-on-year difference of the discount rate yields a coefficient of around 0.21 for the same time period between FY2005 and FY2015, as shown in Chart 8. This result implies that the elasticity of RBO to the discount rate is around 0.21: a 1% point decline of discount rate leads to an increase of RBO by 21%. Combining the results of the two links together implies that a 1% point decline in long-term interest rates induces an increase of RBO by 6.3% (= 0.3 x 0.21).

Elasticity of pension obligation to discount rate Chart 8



3.3. Alternative Extrapolation Method for Estimated Value of RBO

Building on the two links above among long-term interest rates, discount rates, and RBO, an alternative extrapolation method attempts to estimate the stock value of RBO by taking into account the effects of interest rate changes. Note that this alternative method aims to estimate the stock value directly while maintaining the same assumption of the constant value of flows unchanged during the estimation periods. It follows that, compared with the current method of assuming zero value of reconciliations, an alternative method generates a non-zero value of reconciliations.

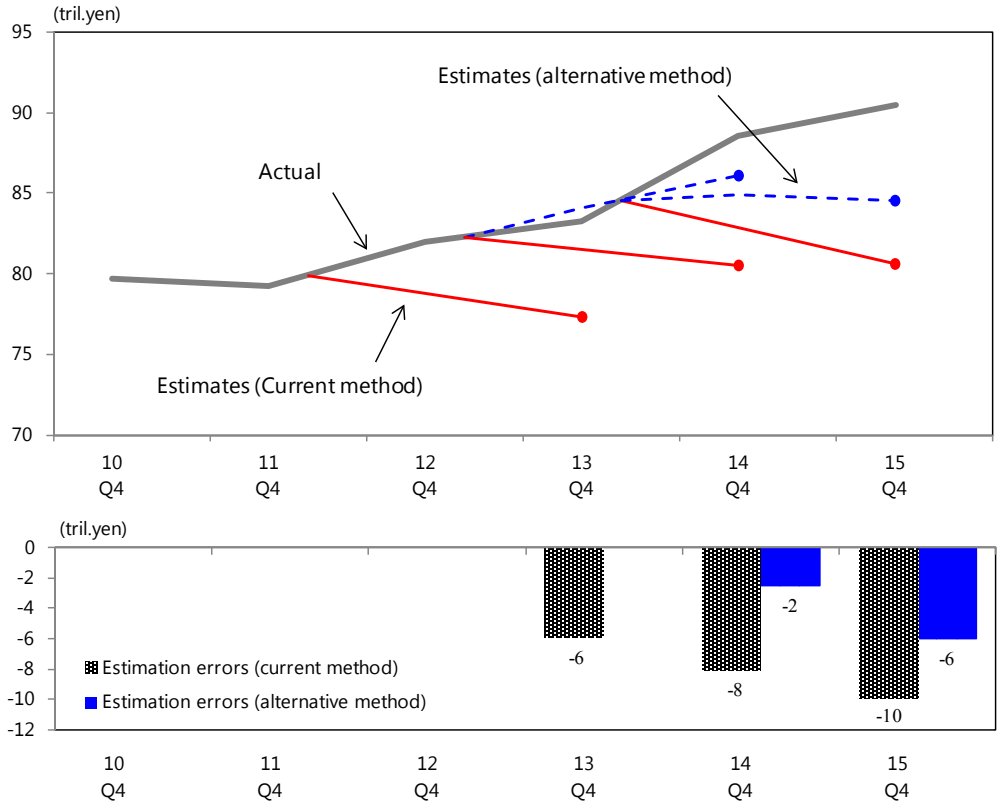
Chart 9 in the upper panel shows the actual stock value of RBO until Q4 2015 in a solid black line, with estimates by the alternative extrapolation method in a blue dotted line, and estimates by the current method in a red line, as calculated in Chart 5. The chart depicts estimates over seven quarters in blue dotted lines by the alternative extrapolation method for the two overlapping time periods: one starting from the actual stock value of Q1 2013 and ending in Q4 2014; and the other starting from the actual stock value of Q1 2014 and ending in Q4 2015. The alternative extrapolation method derives estimates in three steps: first, estimating the difference of the discount rate by multiplying the difference of long-term interest rates with the relevant estimated elasticity; second, estimating the difference of RBO by multiplying the difference of the estimated discount rate with the relevant estimated elasticity; and finally, estimating the value of RBO by adding the estimated difference value of RBO onto the previous period, starting the actual value of RBO of Q1.

The elasticities used to estimate for time periods ending in Q4 2014 and ending in Q4 2015 respectively differ due to different sample periods: the elasticities used to

extrapolate for the time period ending in Q4 2014 are estimated by the sample from FY2005 to FY2012, the latest data available as of Q1 2013; and the elasticity of discount rate to long-term interest rate is 0.29 and that of RBO to discount rate is 0.20. Similarly, the elasticities used to extrapolate for the time period ending in Q4 2015 are estimated by the sample from FY2005 to FY2013, the latest data available as of Q1 2014; and the elasticity of discount rate to long-term interest rate is 0.34 and that of RBO to discount rate is 0.15. Note that since the alternative method uses the long-term interest rate with a two-year lag of the discount rate, the difference of the long-term interest rate can be used every year even during the extrapolation time period. As a result, the estimates in the blue dotted lines in Chart 9 in the upper panel are not linear, unlike those in the red lines.

Compared with estimates by the current method in red lines—which have a downward trend reflecting decreasing flows in recent years—the alternative method virtually reflects the increasing value of RBO due to recent declines of long-term interest rates. For Q4 2014 and Q4 2015, the accuracy of estimates clearly improves in terms of estimation errors measured as differences between the actual and the estimated values. The estimation error substantially lessens from 8 trillion yen to 2 trillion yen for Q4 2014 and from 10 to 6 for Q4 2015, suggesting that the alternative extrapolation method that considers interest rate changes performs better than the current method.

Alternative extrapolation method and estimation errors Chart 9

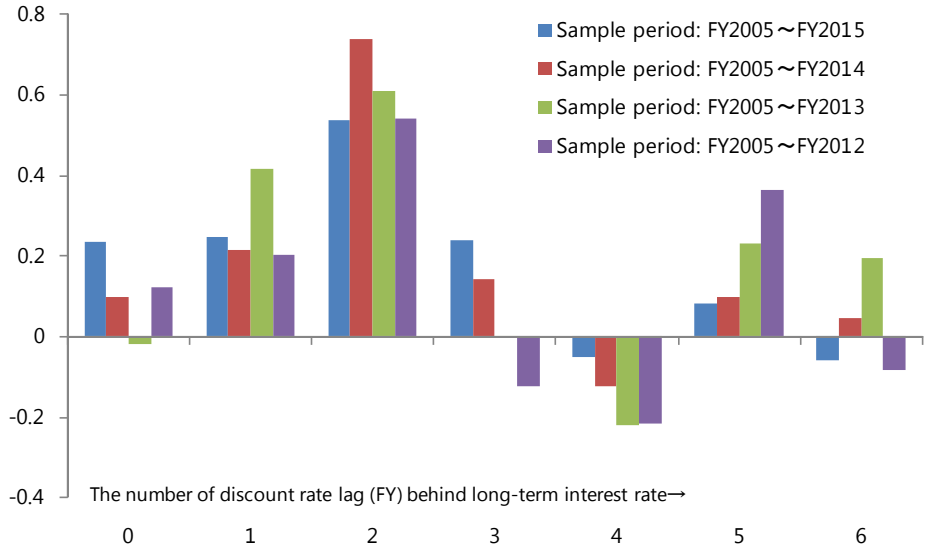


4. Discussion

The analyses in the previous section demonstrate that the accuracy of estimation improves if the alternative method takes into account the declining trend in long-term interest rates. Nonetheless, attention should be paid to the robustness of this alternative method in terms of the following issues. First, the sample size of 10 observations in a time series is small, and data accumulation is highly desirable. Second, the alternative method has been examined only with aggregated data. Using micro data on individual firms in a panel analysis would reinforce elasticity estimates. Third, the length of the lag of two years may not be robust enough. When there is a large increase or decrease of long-term interest rates—which will cause it to exceed the 10% rule of RBO—the lag length might well be shorter than two years. In fact, Chart 10 shows cross correlation coefficients between the year-on-year difference of the discount rate and that of long-term interest rate for four sets of observations in different time periods, indicating that in all cases the highest correlation is two years

– the discount rate lags two years behind long-term interest rates. Nonetheless, the distribution of correlation coefficients around two years varies among sample periods, with the highest concentration for sample periods of FY 2005-FY2014 and the lowest concentration for FY2005-FY2013, which may indicate that a one-year lag is nearly as dominant as a two-year lag. This sensitivity of correlation coefficients to the time periods would necessitate continuous examination regarding the lag length as time series data accumulate.

Cross correlation coefficients Chart 10



Based on these observations above, one extrapolation method does not necessarily surpass the other regarding the accuracy of estimation and robustness when extrapolating estimated value of RBO in the FFA. On the one hand, the current method—accumulating flow values on the previous quarter-end stock—may run risks of reducing confidence in the FFA figures, if continuing to show the similar size of substantial estimation errors for recent periods. On the other hand, the alternative method improves estimation accuracy for the given small sample size, but contains estimation uncertainties significant enough not to be yet applied to the compilation of the FFA.

5. Conclusion

This paper presents the alternative extrapolation method of RBO in the DB pension scheme, which takes into account the effects of interest rate changes and examines the extent to which the alternative method would improve estimated figures in the FFA. While in theory the alternative method would improve the accuracy of estimates, in practice it still lacks robustness, should it be adopted by the FFA, partly because of the small number of sample.

This paper offers two implications from a statistical compilation point of view. First, as the alternative method is not robust enough at the moment, the FFA continues to use the current method but to re-examine estimates as more data observations accumulate. Second, even without improving the accuracy of estimates, statisticians need to explicitly explain source data and compilation methods to the public so that statistics users will be able to make an educated guess regarding directions of revisions in the data.

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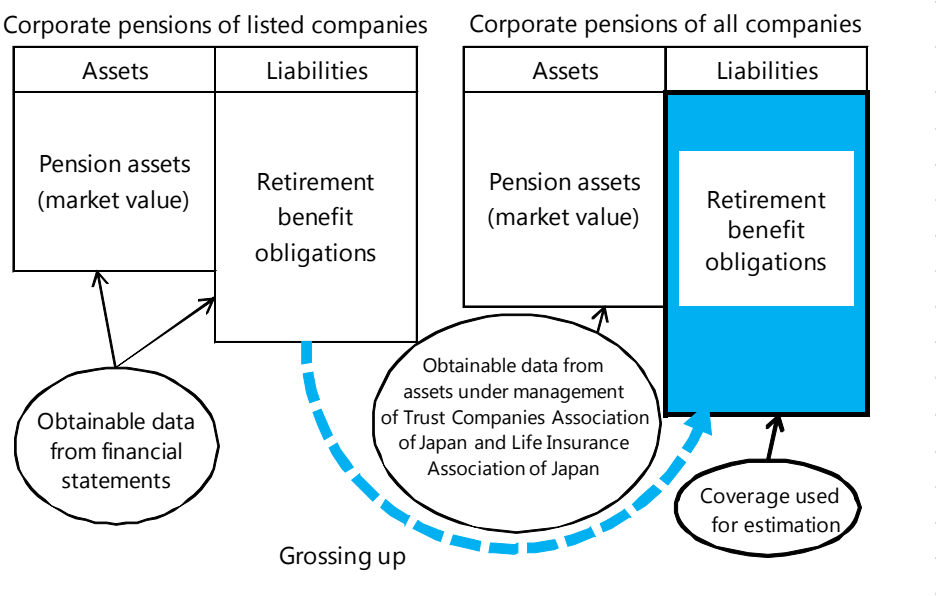
Annex : Compilation Methodologies for Stocks and Flows of DB Pension Liabilities

To compile the economy-wide DB pension liabilities, the FFA aggregates figures for pension liabilities of more than 3,000 mainly listed firms and grosses up to the total population in the economy by using pension assets as a benchmark.



The aggregated figure for pension assets of all companies is obtainable from asset management associations (trust companies and life insurance companies). The gross-up rate can be calculated by dividing the figure with the aggregates of pension assets of our more than 3,000 sample firms. The RBO of all companies is then derived by multiplying the gross-up rate with the aggregated amount of RBO of the sample.

$$\begin{pmatrix}\text{Retirement benefit obligations}\\ \text{of all companies}\end{pmatrix} = \frac{\text{Total assets under management of all companies (market value)}}{\text{Total pension assets of listed companies (market value)}} \times \begin{pmatrix}\text{Retirement benefit}\\ \text{obligations of listed companies}\end{pmatrix}$$

Claims of pension funds on pension managers are calculated as the difference between pension assets and liabilities.

$$\begin{pmatrix}\text{Claims of pension funds}\\ \text{on pension managers}\end{pmatrix} = \begin{pmatrix}\text{Pension entitlements}\\ \text{of all companies}\end{pmatrix} - \begin{pmatrix}\text{Pension assets}\\ \text{of all companies}\end{pmatrix}$$

Transaction flow is the amount of pension entitlement employees earn through their service in a relevant period (service cost) plus money earned by investing their

pension assets (interest cost) minus pension paid to pensioners in the period (actual pension benefits). The service cost and interest cost are obtained from our sample firms and grossed up with the same rate used in RBO.

$$\text{(Transaction flow)} = \left\{\left(\begin{array}{c}\text{service cost}\\ \text{of listed companies}\end{array}\right) + \left(\begin{array}{c}\text{Interest cost}\\ \text{of listed companies}\end{array}\right)\right\}$$

$$\times \frac{\text{Total assets under management of all companies (market value)}}{\text{Total pension assets of listed companies (market value)}} -$$

$$\left(\begin{array}{c}\text{Actual}\\ \text{pension benefits}\end{array}\right)$$

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Data Revisions of Pension Obligations and Alternative Extrapolation Methods

Practical Issues in Bank of Japan's Flow of Funds Accounts

8th IFC Conference "Statistical implications of the new financial landscape"
Session 4 C – Assessing balance sheet vulnerabilities
BIS, Basel, 8 September 2016

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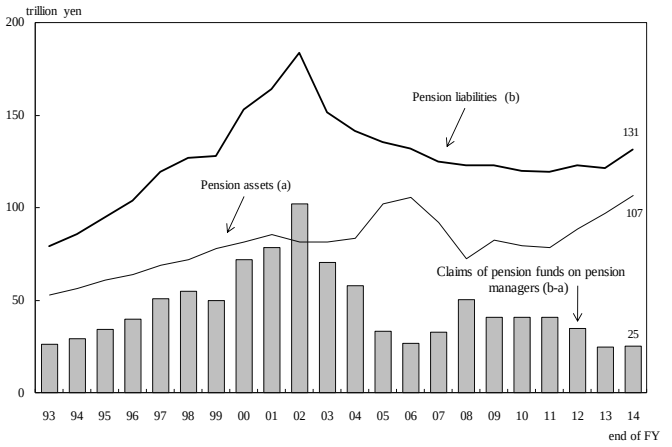
Purpose of This Paper

- The revised FFA distinguishes defined benefit pension schemes (DB) and defined contribution schemes (DC), with the former recording **retirement benefit obligations (RBO)** as an actuarially calculated present discounted value of future pension payments, as well as underfunded portion of RBO.
- It enables, therefore, users to analyze effects of interest rate (IR), a benchmark for a discount rate (DR), on RBO and on its underfunded portion.
- However, it poses a serious challenges to statistician. At most 7 quarters of data **must rely on estimates** since source data are at **low frequency** and slow to be available.
- Moreover, the current estimation method **does not take into account IR changes**. Recent sharp decline of IR would widen estimation errors through a decline of DR.
- **Improvement of methodology** for estimating RBO stocks is required.



>>What this paper does.

Alternative extrapolation method of RBO is considered by taking into account the effects of interest rate changes.

Data and Current Estimation Method

- All data to compile RBO are at annual frequency
  - Stocks of RBO: complied based on data disclosed in financial statements of over 3000 individual firms, actuarially calculated => finally grossed up.
  - Flows of RBO: the sum of service costs, interest costs and net of pension benefits paid out, disclosed in financial statements => finally grossed up.
  - Reconciliations between stocks and flows: non-zero value.
- Current Extrapolation Method

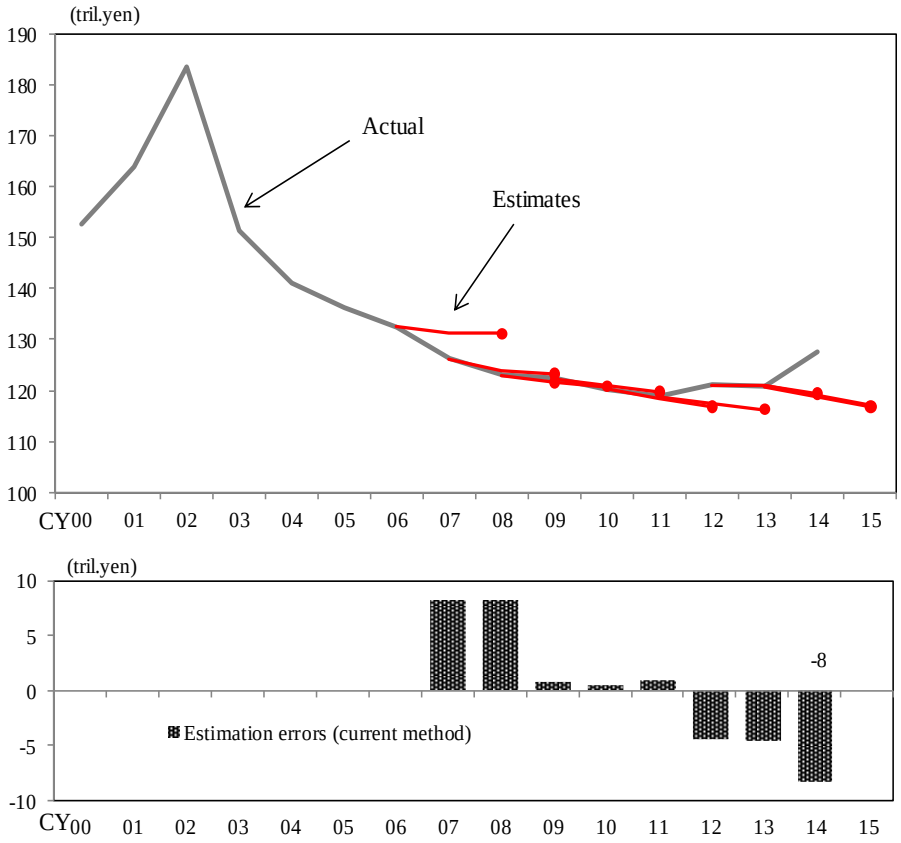
Mostly discount rate changes

  - Stocks: estimated by **adding the quarter flow value to the previous quarter-end stock value**.
  - Flows: assumed to be the same as in the previous periods.
  - Reconciliation between stocks and flows **are implicitly assumed to be zero**.

Mostly discount rate changes

Current Extrapolation Method

Current method is considered as reasonable under the circumstances where DRs do not substantially change.

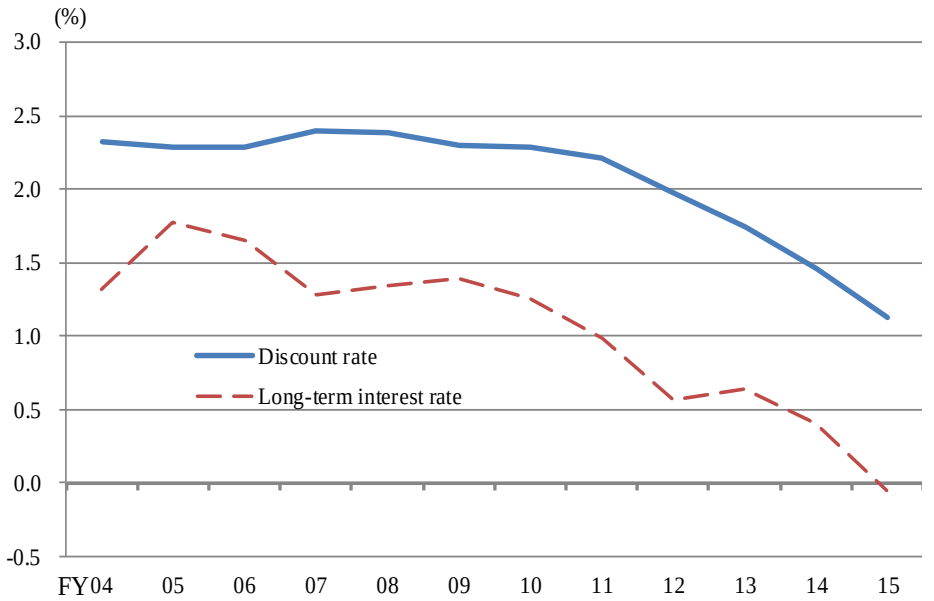


- Factors determining RBO
  - Increase in wages, working periods, turnover rates, changes in retirement benefit rules, and DRs.
  - Relatively stable in the short term except for DRs

The current extrapolation method has generated substantial **estimation errors**, which widen sharply in times of large interest rate fluctuations.

Alternative Extrapolation Method considering IR changes (1/2)

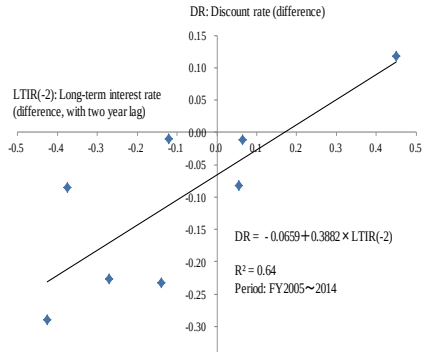
DR is higher than long term IR running by and large in parallel.

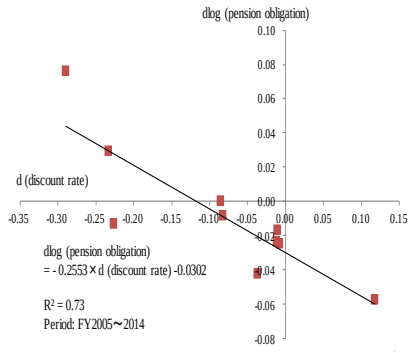


- Examine the effects of IR on RBO in two steps:

$$d(IR) \xrightarrow[\text{Step1}]{} d(DR) \xrightarrow[\text{Step2}]{} dlog(RBO)$$

- Regressions





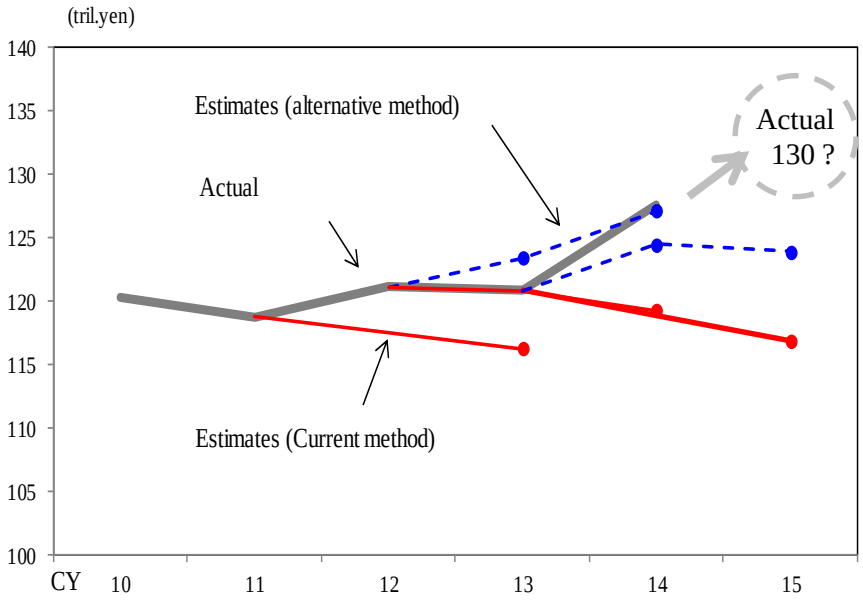
Elasticities:	Coefficients	
Step 1 IR- DR	0.4	*
Step 2 DR-RBO	- 0.25	

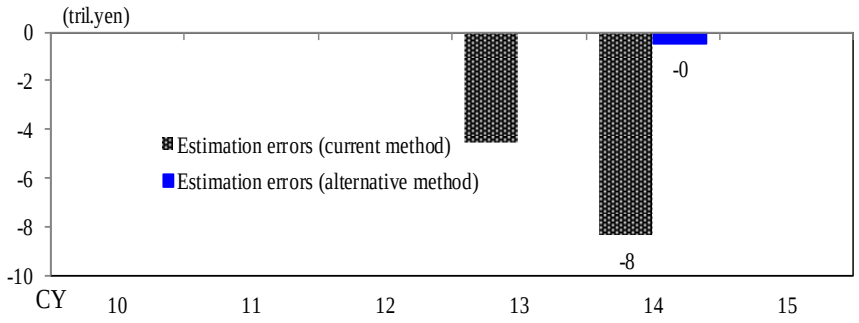
* There is a lag of two years between IR and responses of DR

Combined effects of the two links (IR-RBO) 10%

Implication:
1% point decrease of long term IR induces an increase of RBO by 10%

Alternative Extrapolation Method considering IR changes (2/2)





- Alternative extrapolation method reflects the increasing value of RBO due to recent declines of long term IR.
- Accuracy improvement:

  CY2014: Estimation error significantly lessens.

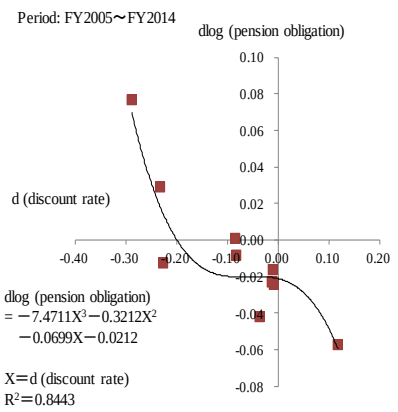
  CY2015: Results could not be so over whelming. With the RBO expected to exceed 130 trillion yen, errors would be larger than in CY2014.

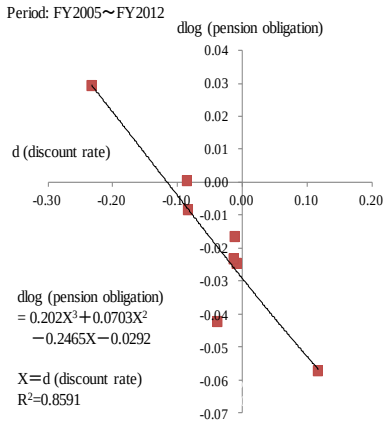
Discussion - Robustness

Attention should be paid to:

- **Small sample** (10 observations)
- Aggregated data are used. **Micro data in panel regression** would reinforce elasticity estimates?
- The length of **lag of two years** might be shorter when there is a large increase or decrease of long term IR.
- **Non-linear** relationship between DR and RBO.

— A cubic function fits data well for the period including a large decrease of IR. A linear relationship is unstable as it disappears with adding a few extra data points.





Conclusion and Implication

…One extrapolation method does not necessarily surpass the other regarding accuracy of estimation and robustness.

— The current method would better be reviewed in times of large IR fluctuations by reducing estimation errors.

— Other alternative method might perform better: the alternative method in this paper still contain errors unrevealed with small sample.

- While in theory, the alternative method would **improve accuracy** of estimates, in practice, it still **lacks its robustness**.

- The FFA continues to **use the current method** but to re-examine estimates as more data observations accumulate.
- Even without improving accuracy of estimates, statisticians need to **explicitly explain mechanism** determining RBO to the public.

Thank you for your attention