Private Defined Benefit Pension Plans in the U.S. National Accounts: Accrual Measures for the 2013 Comprehensive Revision

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Abstract

With the comprehensive revision of the U.S. National Income and Product Accounts published in July 2013, the U.S. Bureau of Economic Analysis introduced new accrual-based measures of income generated by defined benefit (DB) pension plans. In addition to the improved measurement, BEA introduced a new DB pension subsector and a new set of tables that provide a complete picture of transactions conducted in the DB pension subsector. Separate tables were introduced for each sector of employers that sponsor DB plans: business or private sector, state and local government sector, and federal government sector. This paper summarizes the methodology for each of the estimated series included in the table for DB plans sponsored by business or private sector employers (i.e., private plans). In addition, the paper provides general background information on DB pension plans and summarizes the DB pension subsector and the related table for private DB plans.

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1. Introduction

A defined benefit (DB) pension plan is an employment-related plan that promises a recipient a certain amount to be paid in retirement based on a benefit formula, which is generally a function of factors such as length of service and average compensation. The *System of National Accounts 1993* (*SNA93*) recommends periodic household income attributable to DB plans be limited to actual employer contributions and property income earned on actual assets held by plans. Thus, household income and saving attributable to DB pension plans under the *SNA93* reflect "cash-based" measures. A key innovation in the *System of National Accounts 2008* (*SNA2008*) is accounting for periodic household income attributable to DB plans based on actuarial estimates of the change in net present value of future benefit entitlements. In addition to the change in benefit entitlements, household income includes the actuarial interest cost on accumulated benefit entitlements. Thus, household income and saving attributable to DB pension plans under the *SNA2008* reflect "accrual-based" measures.

Accrual-based measures of DB pension income are designed to match income earned with the related production, which offers at least two important advantages over cash-based measures. First, accrual-based measures display less inter-temporal volatility than cash-based measures because employers anticipate funding future benefit entitlements in part from holding gains on equity assets. Since market values of equity assets tend to vary widely over time, actual employer contributions to DB pension plans tend to vary widely over time. Second, accrual-based measures yield more accurate measures of household income and saving than cash-based measures because of differences between actual employer contributions and the change in benefit entitlements and because of differences between property income earned on actual plan assets

and the actuarial interest cost on accumulated benefit entitlements. Household income and saving should reflect the differences.

As part of the comprehensive revision of the U.S. National Income and Product Accounts (NIPAs) published in July 2013, the U.S. Bureau of Economic Analysis (BEA) changed the accounting for DB pension income from a cash basis under *SNA93* to an accrual basis under *SNA2008* (Smith and Holdren, 2013). In addition to introducing the new accounting treatment, the U.S. NIPAs now include a new pension subsector and new pension plan tables for each sector of employers that sponsor DB plans: business or private sector, state and local government sector, and federal government sector.

This paper summarizes the methodology for each of the estimated series included in the table for DB plans sponsored by business or private sector employers (i.e., private plans). First, we provide general background information on DB pension plans, including U.S. institutional characteristics specific to plans sponsored by private sector employers. Second, we present source data and estimation methodologies that are used to construct time series for DB plans sponsored by private sector employers. Finally, we summarize the DB pension subsector and the related table for private DB plans.

2. Background on Defined Benefit Pension Plans

This section provides general background information on DB pension plans. We first summarize DB pension cost concepts that are relevant to the new accrual-based accounting treatment. We then relate the cost concepts to the income flows measured in the U.S. NIPAs. In addition, we describe two categories of actuarial methods available to estimate changes in benefit entitlements. Finally, we describe U.S. institutional characteristics that are specific to plans sponsored by private sector employers.

2.1. Defined Benefit Pension Plan Concepts

From an economic perspective, an employee is willing to accept lower compensation for services rendered in the current period in exchange for an employer's promise to pay future pension benefits related to the services. Thus, a DB pension plan is a form of deferred compensation, and the employer incurs a liability attributable to the related pension cost. The periodic pension cost may be determined by applying data on participants covered by the plan to actuarial methods. For economic accounting purposes, the periodic pension cost requires measurement of two components that reflect income earned in production: *normal cost* and *interest cost*.

The *normal cost* component reflects the actuarial cost of benefit entitlements earned in the current period for services rendered in the current period. The normal cost may be borne by the employer or may be borne by the employee. The portion of the normal cost borne by the employer is referred to as the *employer normal cost*; the portion of the normal cost borne by the employee is referred to as the *employee contribution*.

The *interest cost* component reflects interest earned in the current period on accumulated benefit entitlements for services rendered in past periods. Accumulated benefit entitlements can be thought of as a loan from households to employers. Indeed, the *SNA2008* treats the accumulated benefit entitlements as property of households. As with any loan, interest cost accrues on the unpaid balance. Thus, the interest cost is borne exclusively by the employer.

The *actuarial liability* or *plan liability* reflects the value of the accumulated benefit entitlements. For any given period, the change in actuarial liability may be determined by adding the normal cost and interest cost for the period and subtracting the benefit payments and withdrawals for the period. In addition, changes in the actuarial liability may result from

changes in actuarial assumptions such as the discount rate, from amendments to the pension plan contract such as changes in the benefit formula, or from differences between actual experience and previous actuarial assumptions (i.e., experience gains and losses). The change in actuarial liability is summarized as follows:

(2.1) Change in actuarial liability = normal cost + interest cost – benefit payments + / – *(actuarial assumptions, amendments, experience gains and losses).*

Assets held by the plan, or *plan assets*, reflect the market value of all resources available to satisfy the actuarial liability. For any given period, the change in plan assets may be determined by adding contributions from employers and employees and property income earned on plan assets for the period and subtracting benefit payments and withdrawals and administrative expenses related to operating the plan for the period. In addition, changes in plan assets may result from holding gains and losses or from capital transfers. The change in plan assets is summarized as follows:

(2.2) Change in plan assets = employer contributions + employee contributions + property income – benefit payments – administrative expenses + / – *(holding gains and losses, capital transfers).*

The difference between the actuarial liability and plan assets is referred to as the *unfunded actuarial liability* or simply the *UAL*. If the actuarial liability exceeds the plan assets, the UAL is positive and households have a claim on the employer for deficient assets. If the plan assets exceed the actuarial liability, the UAL is negative and the employer has a claim on households for excess assets. The UAL is summarized as follows:

(2.3) UAL = actuarial liability – plan assets.

Finally, a common measure of funding status for DB pension plans is the funding ratio, which is calculated as follows:

(2.4) Funding ratio = plan assets ÷ actuarial liability.

If the ratio if less than one, the plan is under-funded; if the ratio is greater than one, the plan is over-funded.

2.2. Defined Benefit Pension Income Flows

A key innovation in the *SNA2008* is the treatment of DB benefit entitlements (i.e., the actuarial liability) as long-term legal or contractual obligations by plan sponsors to plan participants. As a result, benefit entitlements are recognized as a liability of a sponsor and as property of the participants, regardless of whether a pension plan holds sufficient assets to fulfill the benefit entitlements. The *SNA2008* measures claims to benefits earned by active participants through service to employers based on actuarial estimates. This subsection relates the DB pension cost concepts introduced in the previous subsection to the related income flows measured in the U.S. NIPAs based on the *SNA2008* guidance.

Compensation income attributable to employee participation in a DB plan is measured in the *SNA2008* by the employer normal cost. If actual employer contributions to the plan equal the employer normal cost, no difference results between compensation income attributable to DB plans and actual employer contributions. However, actual experience often deviates from actuarial estimates, so the *SNA2008* introduces an additional concept: imputed employer contributions. Imputed employer contributions to the plan are measured by the difference between the employer normal cost and actual employer contributions. In other words, the employer normal cost is the sum of actual employer contributions and imputed employer contributions. For practical reasons, the *SNA2008* considers pension plan service charges (i.e., administrative expenses of the plan) a form of in-kind household income included with imputed employer contributions. Thus, we measure imputed employer contributions in the NIPAs as follows:

(2.5) Imputed employer contributions = employer normal cost + pension service charges – actual employer contributions.

Negative imputed employer contributions reflect employers making catch-up contributions to underfunded plans. In other words, actual contributions have been inadequate in previous periods. Positive imputed employer contributions reflect inadequate actual employer contributions for benefits earned in the current service period.

Property income attributable to employee participation in a DB plan is measured in the *SNA2008* by the interest cost. The interest cost is determined by simply multiplying the assumed discount rate by the actuarial liability – i.e., the actuarial interest cost – as follows:

(2.6) Actuarial interest cost = discount rate × actuarial liability.

Thus, the interest cost is imputed based on the plan sponsor's obligation to participants rather than based on property income earned on actual assets held by the plan.

Actual property income is likely to be less than the actuarial interest cost if a pension plan is underfunded or if a pension plan invests in assets that are expected to generate holding gains. In the case of expected holding gains, asset appreciation is a substitute for property income. Appreciated assets must be sold in order to raise cash to fund benefit payments, but the pension plan sponsor is considered current on the obligation to plan participants. However, according to conventional economic accounting guidelines, holding gains and losses should not be included in measures of income because holding gains and losses do not arise from production. In the case of underfunding, actual employer contributions have been inadequate, which generates a funding gap (i.e., a UAL as defined in equation (2.3)) between the actuarial liability and the plan assets and generates a shortfall in the related property income. In other words, the UAL is a claim on the party responsible for funding the pension plan. The property income that the pension plan would have earned had the actual employer contributions been made on time will eventually

need to be replaced if the pension plan is to have the means to make benefit payments when they come due.

To reflect the obligation of the party responsible for the shortfall in property income due to underfunding, a transaction of imputed interest on the UAL should be recognized. Thus, we include a transaction of imputed interest on the UAL from employers to persons as follows:

(2.7) Imputed interest on the UAL = discount rate × (actuarial liability – plan assets).

We define property income attributable to DB plans as the sum of property income earned on actual assets held by plans (i.e., monetary interest and dividends) and imputed interest on the UAL. We exclude from personal income expected holding gains used to fund benefit payments and treat the holding gains instead as a component of the change in personal wealth attributable to DB plans. We call the component "implied funding of benefits from holding gains on assets", and our treatment yields a measure of saving that is identically zero for the pension subsector. In other words, the pension subsector is treated in the U.S. NIPAs as a pass-through subsector with no income or saving of its own, and all income and saving related to DB plans is attributed to persons.

2.3. Actuarial Methods

The *SNA2008* summarizes two broad categories of actuarial methods from business accounting that are used to value the normal cost and the actuarial liability: projected benefit obligation (PBO) and accrued benefit obligation (ABO). No consensus exists regarding the choice of actuarial method, but there is some agreement among national economic accountants about the principles that can guide the choice. To understand the practical implications of methods under each category, consider a traditional DB pension benefit formula that equates the benefit with final pay or average final pay times the length of the career times a fixed percentage

replacement rate. With this kind of formula, salary increases raise the value of the pension, and we can either account for the salary growth effect on an *ex post* basis, or attempt to incorporate the effect of projected future salary increases into the value of the benefits being earned today.

ABO methods reflect salary growth on an *ex post* basis. Under ABO methods, the normal cost and actuarial liability reflect the present value of benefits that would be due to participants if the plan were to be frozen on the valuation date. The periodic normal cost is measured as the increment to the value of benefit entitlements that results from working during the period, including both the effect of credit for an additional year of service and the effect of pay raises received during the year. Assuming the benefit level depends on final pay, the effect of a pay raise on the value of the benefit entitlement will be large for participants who have accumulated credit for many years of service. As a result, ABO methods tend to yield relatively high estimates of normal cost in the last years of the career and relatively low estimates of accumulated participant wealth in the early and middle years of the career. The average level of periodic normal cost over the course of the career must be higher because the back-loading of normal cost implies less time is available to accumulate property income. Thus, ABO methods tend to yield relatively high estimates of compensation and relatively low estimates of property income for households.

PBO methods project the ultimate level of benefit entitlements assuming the participants will receive future salary increases. Allowing for projected future pay raises yields higher estimates of normal cost for participants in the early years of their careers than under ABO methods, and it yields higher estimates of accumulated wealth for participants not at the end of their careers. Thus, PBO methods tend to yield lower estimates of compensation and higher estimates of property income for households than under ABO methods.

One criterion for choosing between an ABO method and a PBO method is whether participants effectively have a secure right to accrue benefits in future years. In the U.S., business or private sector sponsors of DB plans are allowed to freeze or terminate their plans at will, depriving participants of the opportunity to accrue additional benefit entitlements. Because neither law nor custom obligates the sponsor to give participants future opportunities to accrue benefits, ABO methods are more reasonable for measuring the DB pension income of private sector participants.

2.4. Institutional Characteristics of Private Defined Benefit Pension Plans

A DB plan sponsored by a business in the U.S. (i.e., a private plan) is generally funded by contributions from employers and may be funded by contributions from employees. A private plan may also be funded by property income earned and holding gains generated on actual assets held by the plan, which may include equity assets and interest-bearing assets. Employee contributions are collected each pay period as a percentage of an employee's pay. Employer contributions are driven in part by federal funding requirements under the Employee Retirement Income Security Act of 1974 (ERISA). Under ERISA, a private DB plan sponsor incurs a penalty if the funding ratio falls below a minimum threshold; likewise, the sponsor incurs an excise tax if the funding ratio exceeds a maximum threshold. Employer contributions are also driven in part by accounting rules under U.S. generally accepted accounting principles (GAAP) for nongovernmental entities. U.S. GAAP requires a private DB plan sponsor to report on financial statements a liability to reflect any unfunded benefit entitlements. Thus, a business employer has incentives to make contributions in cases of inadequate funding and incentives to limit contributions in cases of excess funding. As the funding ratio of a private plan rises and

falls, employer contributions tend to be inversely related to the funding ratio. The result can generate volatility in the employer's actual contributions to the plan.

In addition to establishing funding requirements and other regulatory requirements, ERISA created the Pension Benefit Guaranty Corporation (PBGC), which is a privately funded federal agency responsible for insuring benefit entitlements for participants covered by private DB pension plans. As a percentage of assets held by private DB plans, over 98 percent of the plans are covered under PBGC insurance in recent years. Each private plan sponsor subject to ERISA is required to file a form 5500 with its federal income tax return for each plan sponsored. Form 5500 is an annual report that contains financial information and actuarial information on individual plans. In addition to filing the form with the U.S. Internal Revenue Service, form 5500 for private DB plans is filed with the PBGC and the Employee Benefits Security Administration (EBSA) of the U.S. Department of Labor. We use information reported on form 5500 for our estimates of income attributable to private DB plans in the U.S. NIPAs.

3. Source Data and Methodologies for Private Defined Benefit Pension Plans

The NIPA table that was published in the 2013 comprehensive revision for private DB plans is replicated for 2012 in table 1. The published NIPA table includes annual flows for 1984 to 2012 because all estimated series were feasible for the period. Estimates for monetary interest and dividends attributable to private DB plans were not feasible prior to 1984 due to a lack of data. However, monetary interest and dividends attributable to private DB plans are indirectly estimated in property income to persons for the entire NIPA series (i.e., 1929 to 2012). In addition, estimates for compensation attributable to private DB plans were feasible for the entire NIPA series. However, compensation attributable to private DB plans was only revised for 1968

to 2012 because the new accrual-based estimates prior to 1968 are similar to the previous cash-based estimates.

Our source data include data from five U.S. government agencies and one trade association: BEA, EBSA, PBGC, the U.S. Federal Reserve Board (FRB), the U.S. Social Security Administration (SSA), and the American Council of Life Insurance (ACLI). The next two subsections present source data and methodologies for the normal cost series and the interest cost series attributable to private DB plans. The third subsection then presents methodologies for the other estimated series in table 1 that are attributable to private DB plans. The last subsection explains an adjustment that is required for U.S. corporate profits.

3.1. Estimated Normal Cost

We estimate the annual normal cost using plan-level form 5500 data that are provided to us by PBGC. Form 5500 is required to be filed with an employer's annual corporate income tax return. The form includes balance sheet and income statement information as well as actuarial estimates of normal cost and plan liabilities. Plan sponsors report their normal cost and liabilities calculated by professional actuaries using different actuarial methods. One method required of all plans on form 5500 is an ABO method referred to as RPA '94, which is named after the Retirement Protection Act of 1994. RPA '94 provides consistent actuarial estimates across all plans that file form 5500.

For 2000-2011, we tabulate the RPA '94 normal cost reported on form 5500. For 2000, 2001, and 2011, we make a coverage adjustment because some plans are missing. Prior to 2000, we do not have form 5500 data. However, assuming future benefit payments provide a good indicator of benefits accrued for current service, we calculate normal cost rates for 2000 to 2011 and back-cast the rates to 1929 to 1999 using as an indicator the percentage change in the rate at

which future benefits are paid. We back-cast the normal cost rate rather than simply the normal cost because the normal cost rate captures variation in wages and salaries as well as variation in coverage rates. When possible, we use a 20-year lag between benefits paid and normal cost.[1] We also do not have form 5500 data for 2012 because the data are only available with an 18-month lag. Thus, we extrapolate 2012 using the previous 2-year average normal cost rate. We limit the average to two years because our assumed discount rate is the same for 2010 to 2012. The following equations summarize the calculations of normal cost for 1929 to 2012:

(3.1) Coverage rate = active participants ÷ private full-time employment,

(3.2) Covered payroll = coverage rate × private wages and salaries,

(3.3) Benefits paid rate = benefits paid ÷ covered payroll,

(3.4) 2012: Normal cost rate = previous 2-year average normal cost rate,

(3.5) 2000 to 2011: Normal cost rate = normal cost ÷ covered payroll,

(3.6) 1929 to 1999: Normal cost rate = subsequent 5-year average normal cost rate ÷ (1 + 5-year average percent change in benefits paid rate),[2]

and

(3.7) 1929 to 2012: Normal cost = normal cost rate × covered payroll.

We adjust all years to a discount rate based on AAA corporate bond rates published by the FRB. Our adjustments are based on standard formulas provided by PBGC. The formulas apply different discounting for active participants and retirees and are summarized in appendix A. We construct a discount rate series based on assumptions laid out in appendix B. The resulting NIPA discount rate series is presented in appendix B table B1.

[1] The correlation coefficient between benefits paid and normal cost for 2000 to 2008 is 0.88. A regression of normal cost on benefits paid for 2000 to 2008 yields an adjusted r-squared of 0.74 and a statistically significant positive coefficient estimate. We are unable to use a 20-year lag for this analysis because data for benefits paid are not available 20 years into the future. However, we perform the same analysis for liabilities with a lag, which yields even stronger results (adjusted r-squared of 0.90 and a statistically significant positive coefficient estimate).

[2] Where possible, we use a 20-year lag between benefits paid and normal cost.

Prior to 2009, the RPA ’94 normal cost reported for a plan on form 5500 excludes administrative expenses and includes employee contributions. For 2009 forward, the reported RPA ’94 normal cost includes administrative expenses and excludes employee contributions. We adjust the RPA ’94 normal cost for 2009 forward to be consistent with the RPA ’94 normal cost prior to 2009. We then calculate compensation earned on private DB plans as a sum of actual employer contributions and imputed employer contributions. Table 2 summarizes source data and methodologies by year for the normal cost series of private DB plans. Table 3 presents estimates of the complete normal cost series for 1929 to 2012.

3.2. Estimated Interest Cost

We calculate the annual interest cost as a sum of property income on actual assets held by private DB plans and imputed interest on the UAL. Estimates for each series are described in the following subsections.

3.2.1. Actual Property Income

Actual property income is included in personal income for the entire NIPA series. However, prior to the 2013 comprehensive revision, actual property income was not separately estimated for private DB plans. We use data published by the FRB in the Flow of Funds Accounts (FFAs) on the distribution of assets held by private DB plans in order to estimate actual property income generated by private DB plans for 1984 to 2012. Prior to 1984, the FFAs do not provide separate asset series for private DB plans; the data are combined with private defined contribution (DC) plans. In addition to data on the distribution of assets, we use data published in the FFAs and by Shiller (2005) on interest rates and dividend yields, respectively.

To estimate actual property income, we multiply the asset value in the FFAs by the applicable rate of return as follows:

(3.8) Interest = interest-bearing assets × interest rate

and

(3.9) Dividends = equity assets × dividend yield.

Table 4 summarizes source data and methodologies by year for the actual property income series of private DB plans. Table 5 presents estimates of the complete property income series for 1984 to 2012.

3.2.2. Imputed Interest on the UAL

The methodology for imputed interest on the UAL includes three pieces: funding ratios, plan assets, and plan liabilities. Since we do not initially have a complete time series for plan liabilities, we first calculate funding ratios and then apply the ratios to plan assets to calculate a measure of plan liabilities.

Funding Ratios: For 1979 to 2008, we calculate annual funding ratios (i.e., plan assets ÷ plan liabilities) using tabulations published by PBGC of plan assets and plan liabilities reported on form 5500. Plan assets are reported at market value. Plan liabilities are adjusted by PBGC to a common discount rate by year (i.e., discount rates vary across years but do not vary across plans within a year). For 1950 to 1978, we use annual funding ratios published by Ippolito (1986). Ippolito (1986) calculates funding ratios based on the market value of plan assets from the FFAs and plan liabilities, which are determined by applying annual aggregate data on number of participants and benefits paid published in Skolnik (1976) to parameter estimates of the relationship between reported liabilities and reported discount rates on form 5500 for 1978.[3] We adjust liabilities for all years to the NIPA discount rate series that we use for normal cost. In addition to the funding ratios for 1950 to 2008, we assume a funding ratio of 15 percent for 1929,

[3] Ippolito (1986) makes an adjustment to remove assets and liabilities related to DC plans.

which is consistent with the funding ratio cited in Williamson (1992) and Sass (1997) based on Latimer (1932) of approximately 13 to 16 percent.

Plan Assets: For 1985 to 2008, we use the annual market value of plan assets published in the FFAs. Prior to 1985, we back-cast the annual market value of plan assets using rates of change in annual plan assets published by EBSA, SSA, and ACLI. EBSA publishes the annual market value of plan assets back to 1975. SSA published the annual book value of plan assets for 1940 to 1974 in Skolnik (1976). ACLI published the annual book value of plan assets for 1930. We use linear interpolation for missing years. For 2009 and 2010, we use the annual market value of plan assets published by EBSA. For 2011 and 2012, we extrapolate the market value of plan assets using rates of change in annual plan assets published in the Milliman *2013 Pension Funding Study* (Ehrhardt et al., 2013).

Plan Liabilities: For 1929 and 1950 to 2008, we calculate annual plan liabilities by dividing annual plan assets by the corresponding annual funding ratio. To reduce the effects of variation introduced by the funding ratios, we either apply the previous 3- or 5-year average funding ratio or use linear interpolation. Since we are missing funding ratios for 1930 to 1949, we interpolate the liabilities between 1929 and 1950 using benefits paid as an indicator. We assume a 20-year lag between benefits paid and plan liabilities.[4] For 2009 to 2011, we tabulate the RPA '94 liabilities reported on form 5500. For 2011, we make a coverage adjustment from prior years' data for missing plans. Similar to liabilities for 1950 to 2008, we adjust liabilities for 2009 to 2011 to the NIPA discount rate series that we use for normal cost. For 2012, we extrapolate liabilities using the previous 2-year average growth rate of liabilities. We limit the

[4] The correlation coefficient between benefits paid in 1970 to 2008 and plan liabilities in 1950 to 1988 is 0.95. A regression of liabilities on benefits paid yields an adjusted r-squared of 0.90 and a statistically significant positive coefficient estimate.

average to two years because our assumed discount rate is the same for 2010 to 2012. The following equations summarize the calculation of plan liabilities for 1929 to 2008:

(3.10) 1950 to 2008: Plan liabilities = plan assets ÷ previous 3- or 5-year average funding ratio,

(3.11) 1930 to 1949: Plan liabilities = interpolation using benefits paid as indicator,

and

(3.12) 1929: Plan liabilities = plan assets ÷ assumed funding ratio of 15 percent.

Imputed Interest on the UAL: We impute interest on the UAL by multiplying the NIPA discount rate in appendix B table B1 by the difference between plan liabilities and plan assets. Equation (2.7) summarizes the imputation of interest on the UAL. Table 6 summarizes source data and methodologies by year for the imputed interest of private DB plans. Table 7 presents estimates of the complete imputed interest series for 1929 to 2012.

3.3. Other Estimated Series

The other estimated series include actual employer contributions, actual employee contributions, administrative expenses, benefits paid, and interest accrued on benefit entitlements. Actual employer contributions, actual employee contributions, administrative expenses, and benefits paid are estimated directly from source data. Interest accrued on benefit entitlements reflects the actuarial interest cost on the loan from plan participants to employers as shown in equation (2.6). Table 8 summarizes source data and methodologies by year for the other estimated series of private DB plans. Table 9 presents estimates of the complete other estimated series for 1929 to 2012.

3.4. Adjustment for U.S. Corporate Profits

Actual contributions made by a corporation to a DB plan and reported on form 5500 are deductible for U.S. corporate income tax purposes. BEA uses total receipts less total deductions

reported on annual corporate income tax returns to estimate annual U.S. corporate profits. The data for a given period are generally available with a two year lag, and the data are adjusted by BEA for differences between tax accounting concepts and economic accounting concepts.

Under a cash-based methodology, BEA assumed that pension expense reflected in the annual tax-based source data is the same as actual employer contributions tabulated by EBSA from form 5500, which implies the statistical discrepancy is unaffected. Under an accrual-based methodology, the annual pension cost (i.e., employer normal cost plus interest cost) may be different than the pension expense reflected in annual tax-based source data to the extent that the annual pension cost differs from actual employer contributions. Unless an adjustment is made to total receipts less total deductions reported on corporate income tax returns for the difference between the annual pension cost and actual employer contributions, the statistical discrepancy is presumably affected. Thus, to measure annual U.S. corporate profits, we make an adjustment to the tax-based source data by deducting from total receipts less total deductions the imputed employer contributions and the imputed interest on the UAL, which are not claimed as deductions on U.S. corporate income tax returns.

4. The U.S. Defined Benefit Pension Subsector

Figure 1 summarizes the DB pension subsector that is constructed for the U.S. NIPAs. The values in figure 1 come from the transactions for private DB plans that are presented in table 1 for 2012. The transactions in table 1 reflect the pass-through construction of the U.S. DB pension subsector.

In figure 1, employees provide labor services valued at $85.6 to employers (figure 1, line 1). Employers pay employees in the form of actual contributions of $148.0 and imputed contributions of -$62.4 to DB pension plans; the contributions are included in compensation

(figure 1, line 2). Imputed employer contributions are determined by adding the normal cost of $76.4 (table 1, line 4) to pension service charges of $10.1 (table 1, line 8) and subtracting actual employee contributions of $1.0 (table 1, line 7) and actual employer contributions of $148.0 (table 1, line 5). Under "claims to benefits accrued" in figure 1, actual employer contributions and imputed employer contributions are redistributed by employees to the pension subsector along with the employee contributions. An adjustment of -$10.1 (figure 1, line 6) is made for pension service charges because pension service charges are included in imputed employer contributions, but they will not be paid as future benefits. Output produced by the pension subsector (figure 1, line 7) is included in personal consumption expenditures (PCE). The pension subsector receives monetary interest and dividends of $39.6 (figure 1, line 9a) on assets held by pension plans, which are passed through to persons (figure 1, line 9b). In addition to monetary interest and dividends, the employers pay imputed interest on the UAL of $22.2 (figure 1, line 10a), which is also passed through to persons (figure 1, line 10b). Employees then redistribute the property income to the pension subsector in the form of contribution supplements (figure 1, line 8). The pension subsector pays benefits to participants of $178.4 (figure 1, line 11) and purchases administrative services of $10.1 (figure 1, line 13). The net change in benefit entitlements of -$11.2 (figure 1, line 12) reflects the difference between all contributions and redistributions made by participants to the pension subsector and all benefit payments made by the pension subsector to participants.

Each of the flows shown in figure 1 has a corresponding line item in the current receipts and current expenditures of table 1. Property income received by pension plans (table 1, line 10) excludes holding gains and losses because we limit the property income to monetary interest (table 1, line 12), dividends (table 1, line 14), and imputed interest on the UAL (table 1, line 13).

Likewise, property income paid by pension plans to persons (table 1, line 17) and property income redistributed to pension plans by participants (table 1, line 9) exclude holding gains and losses. Thus, the net change in benefit entitlements (table 1, line 21) also excludes holding gains and losses, and current receipts (table 1, line 1) are equal to current expenditures (table 1, line 15). In other words, saving is zero in the U.S. DB pension subsector by construction.

In addition to sections for current receipts and current expenditures, table 1 includes sections for cash flow of the pension subsector and the effect of participation in DB plans on U.S. personal income, saving, and wealth. Cash flow reflects actual receipts and expenditures. The effect on personal income and saving excludes holding gains and losses on plan assets because they are constructed from current receipts and expenditures. Implied funding of benefits from holding gains on assets (table 1, line 30) is constructed from the actuarial interest cost (table 1, line 31) and property income received by pension plans (table 1, line 10). Thus, the change in personal wealth (table 1, line 33) includes holding gains and losses implied by the actuarial interest earned on benefit entitlements. Likewise, the change in benefit entitlements (table 1, line 36) includes the implied holding gains and losses.

Summary

With the 2013 comprehensive revision of the U.S. NIPAs, BEA replaced cash-based measures of personal income with accrual-based measures. In addition to the improved measurement, BEA introduced a new DB pension subsector and a new set of tables that provide a complete picture of transactions conducted in the DB pension subsector. This paper summarizes the methodology for each of the estimated series included in the table for private DB plans. In addition, the paper provides general background information on DB pension plans and summarizes the DB pension subsector and the related table for private DB plans.

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Figure 1: Summary of the U.S. Defined Benefit Pension Subsector

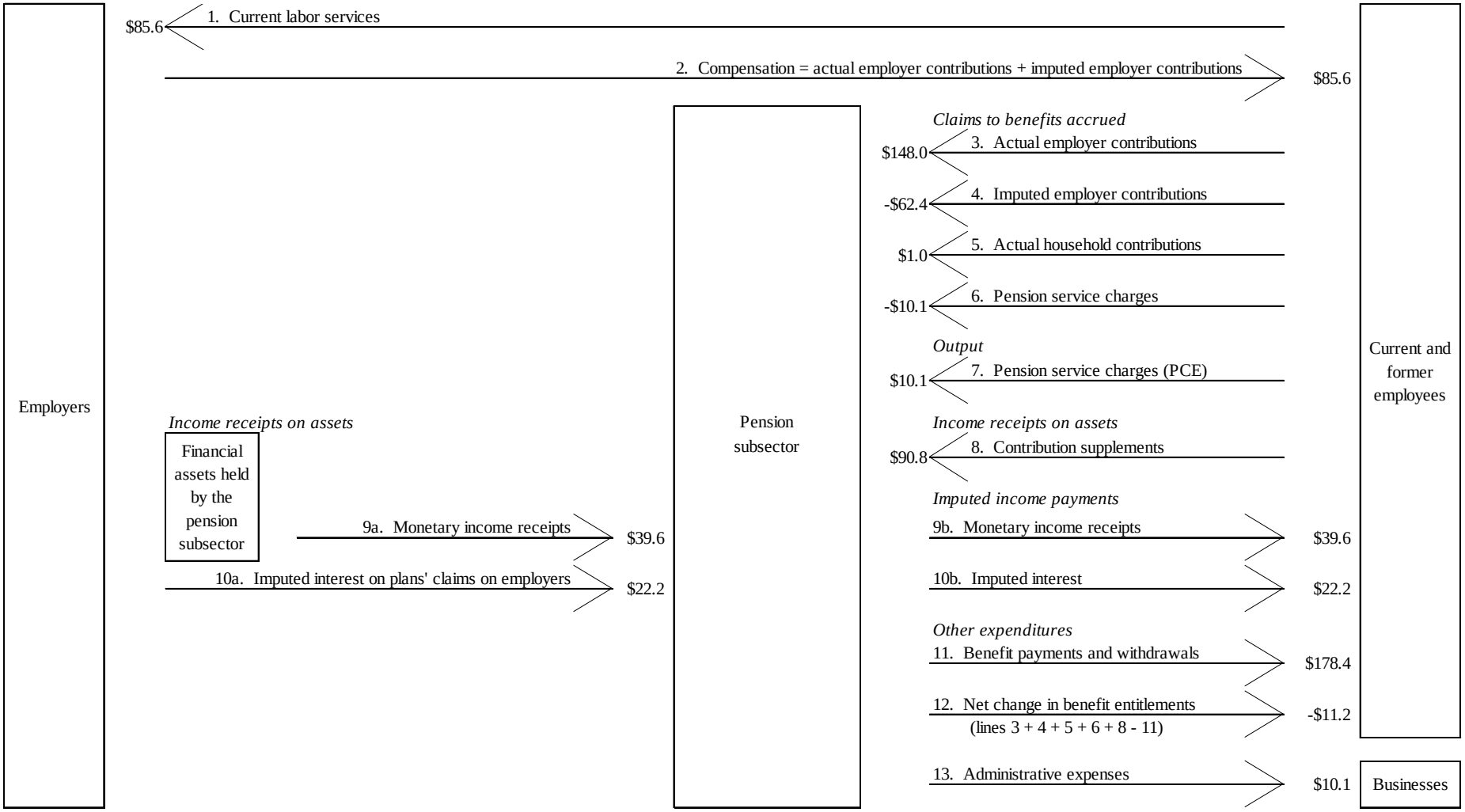

Table 1: Transactions of Private DB Pension Plans (billions USD)

Line		*2012*
1	**Current receipts, accrual basis**	268.1
2	Output /1/	10.1
3	Contributions	167.2
4	Claims to benefits accrued through service to employers	76.4
5	Actual employer contributions	148.0
6	Imputed employer contributions	-62.4
7	Actual household contributions	1.0
8	Less: Pension service charges /1/	10.1
9	Household pension contribution supplements /2/	90.8
10	Income receipts on assets (including plans' claims on employers)	90.8
11	Interest	61.8
12	Monetary interest	39.6
13	Imputed interest on plans' claims on employers /3/	22.2
14	Dividends	29.0
15	**Current expenditures, accrual basis**	268.1
16	Administrative expenses	10.1
17	Imputed income payments on assets to persons	90.8
18	Interest	61.8
19	Dividends	29.0
20	Benefit payments and withdrawals	178.4
21	Net change in benefit entitlements /4/	-11.2
22	**Cash flow**	29.0
23	Actual employer and household contributions (5+7)	148.9
24	Monetary income receipts on assets (12+14)	68.6
25	Less: Benefit payments and withdrawals	178.4
26	Less: Administrative expenses	10.1
	Effect of participation in defined benefit plans on personal income, saving, and wealth:	
27	Effect on personal income (1-7-9 or 15-7-9)	176.3
28	Less: Effect on personal consumption expenditures (2)	10.1
29	Equals: Effect on personal saving	166.2
30	Plus: Implied funding of benefits from holding gains on assets	61.9
31	Interest accrued on benefit entitlements	152.7
32	Less: Interest and dividend income received by plans (10)	90.8
33	Equals: Change in personal wealth /5/	228.1
34	Less: Benefit payments and withdrawals (20)	178.4
35	Plus: Household actual contributions (7)	1.0
36	Equals: Change in benefit entitlements including implied funding of benefits from holding gains on assets /5/	50.7

Legend / Footnotes:

1. Included in personal consumption expenditures as part of financial services furnished without payment; the value is equal to administrative expenses (line 16).

2. Imputed income payments received by persons from the pension plans (line 17) are reinvested as household pension contribution supplements.

3. Plans' claims on employers is the difference between actuarial liabilities and financial assets held by plans. When actuarial liabilities exceed plan assets, imputed interest is positive; when plan assets exceed actuarial liabilities, imputed interest is negative.

4. Excludes implied funding of benefits from holding gains on assets and excludes effects on change in the estimated value of benefit entitlements that come from differences between actual experience and previous actuarial assumptions, changes in actuarial assumptions, and changes in plan provisions.

5. Excludes effects on change in the estimated value of benefit entitlements that come from differences between actual experience and previous actuarial assumptions, changes in actuarial assumptions, and changes in plan provisions.

Note: Values shown are published with the 2013 comprehensive revision of the U.S. NIPAs (August 7, 2013).

Table 2: Summary of the Normal Cost Series for Private DB Plans

Series	*Source Data or Methodology by Year*
Active Participants	2011 – 2012: Extrapolation from previous 5-year average growth rate 2009 – 2010: EBSA *Private Pension Plan Bulletin*, table A1 1975 – 2008: EBSA *Private Pension Plan Bulletin Historical Tables and Graphs*, table E8 1940 – 1974: Skolnik (1976), table 1 1931 – 1939: Linear interpolation between 1930 and 1940 1930: ACLI *1987 Pension Facts*, pp. 30-35 1929: Back-cast from subsequent 5-year average growth rate
Private Full-Time Employment	1929 – 2012: BEA NIPA table 6.5
Private Wages and Salaries	1929 – 2012: BEA NIPA table 6.3
Normal Cost	2012: Extrapolation from previous 2-year average normal cost rate 2000 – 2011: BEA tabulations of form 5500 with coverage adjustments for 2000, 2001, and 2011 1929 – 1999: Back-cast using benefits paid as indicator

Table 3: Estimated Normal Cost Series for Private DB Plans (billions USD)

Year	*Normal Cost*	*Year*	*Normal Cost*	*Year*	*Normal Cost*	*Year*	*Normal Cost*
1929	0.2	1950	1.8	1971	12.4	1992	52.4
1930	0.2	1951	2.3	1972	13.5	1993	53.7
1931	0.2	1952	2.6	1973	12.6	1994	54.5
1932	0.1	1953	3.1	1974	14.1	1995	53.8
1933	0.1	1954	3.4	1975	16.4	1996	55.6
1934	0.1	1955	3.9	1976	15.0	1997	57.8
1935	0.2	1956	4.6	1977	16.8	1998	62.5
1936	0.2	1957	5.1	1978	18.8	1999	65.5
1937	0.2	1958	5.4	1979	21.0	2000	65.8
1938	0.2	1959	5.6	1980	22.0	2001	69.8
1939	0.2	1960	5.8	1981	24.5	2002	71.8
1940	0.3	1961	6.0	1982	26.0	2003	74.0
1941	0.3	1962	5.4	1983	28.0	2004	75.6
1942	0.4	1963	5.9	1984	29.7	2005	76.1
1943	0.5	1964	6.3	1985	30.4	2006	77.9
1944	0.7	1965	7.0	1986	31.0	2007	81.4
1945	0.7	1966	7.8	1987	32.6	2008	80.0
1946	0.9	1967	8.5	1988	33.6	2009	78.7
1947	1.1	1968	9.7	1989	40.3	2010	79.4
1948	1.3	1969	11.1	1990	41.1	2011	76.6
1949	1.5	1970	11.3	1991	42.1	2012	76.4

Table 4: Summary of the Actual Property Income Series for Private DB Plans

Series	*Source Data or Methodology by Year*
Assets	1984 – 2012: FRB FFA table L.116.b
Interest Rates	1984 – 2012: FRB FFA table H.15 Time and Savings Deposits: 1-month CDs Money Market Fund Shares: 1-month CDs Security RPs: 1-month CDs Open Market Paper: 3-month commercial paper Treasury Securities: 20-year constant maturity Agency- and GSE-Backed Securities: 20-year constant maturity Corporate and Foreign Bonds: AAA corporate bonds Unallocated Insurance Contracts: AAA corporate bonds 30-year fixed mortgages
Dividend Yields	1984 – 2012: S&P 500 yield from Shiller (2005)

Table 5: Estimated Actual Property Income Series for Private DB Plans (billions USD)

Year	*Interest*	*Dividends*	*Year*	*Interest*	*Dividends*
1984	30.0	10.5	1999	46.8	14.6
1985	34.6	11.6	2000	45.0	14.7
1986	36.1	11.8	2001	41.8	15.7
1987	36.2	11.9	2002	35.0	17.6
1988	35.0	11.1	2003	31.2	19.4
1989	38.3	11.4	2004	29.9	22.2
1990	41.3	11.8	2005	30.7	25.2
1991	42.5	12.9	2006	33.0	28.8
1992	40.8	13.7	2007	37.6	32.2
1993	38.0	14.5	2008	41.4	33.4
1994	38.8	15.5	2009	44.7	30.0
1995	41.3	16.5	2010	42.1	27.8
1996	44.2	16.9	2011	41.3	26.4
1997	45.6	16.5	2012	39.6	29.0
1998	45.0	15.5			

Table 6: Summary of the Imputed Interest Series for Private DB Plans

Series	*Source Data or Methodology by Year*
Funding Ratios	1989 – 2008: PBGC *Pension Insurance Data Book 2009*, tables S-44 and M-9 1979 – 1988: PBGC *Pension Insurance Data Book 1998*, tables S-23 and M-8 1950 – 1978: Ippolito (1986), table 4-5 1929: Williamson (1992), Sass (1997), Latimer (1932)
Assets	2011 – 2012: Extrapolation from previous year using Milliman (Ehrhardt et al., 2013) as indicator 2009 – 2010: EBSA *Private Pension Plan Bulletin*, table A3 1985 – 2008: FRB FFA table L.116.b 1975 – 1984: Back-cast using EBSA tabulations as indicator 1940 – 1974: Back-cast using Skolnik, 1976, table 1, as indicator 1931 – 1939: Linear interpolation between 1930 and 1940 1930: ACLI *1987 Pension Facts*, pp. 30-35 1929: Back-cast from subsequent 5-year average growth rate
Liabilities	2012: Extrapolation from previous 2-year average growth rate 2009 – 2011: BEA tabulations of form 5500 with coverage adjustment for 2011 1997 – 2008: Plan assets ÷ previous 5-year average funding ratio 1992 – 1996: Linear interpolation between 1991 and 1997 1991: Plan assets ÷ previous 3-year average funding ratio 1986 – 1990: Linear interpolation between 1985 and 1991 1985: Plan assets ÷ previous 3-year average funding ratio 1984: Simple average of 1983 and 1985 1979 – 1983: Plan assets ÷ previous 5-year average funding ratio 1976 – 1978: Linear interpolation between 1975 and 1979 1950 – 1975: Plan assets ÷ previous 5-year average funding ratio 1930 – 1949: Interpolation between 1929 and 1950 using benefits paid as indicator 1929: Plan assets ÷ assumed funding ratio of 15 percent

Table 7: Estimated Liabilities, Assets, and Imputed Interest Series for Private DB Plans (billions USD)

Year	*Liabilities*	*Assets*	*Imputed Interest*
1929	4.6	0.7	0.2
1930	5.0	0.8	0.2
1931	5.4	0.9	0.2
1932	5.9	1.1	0.2
1933	6.5	1.2	0.2
1934	7.2	1.4	0.3
1935	8.2	1.5	0.2
1936	9.2	1.7	0.3
1937	10.3	1.9	0.3
1938	11.3	2.0	0.3
1939	12.6	2.2	0.3
1940	13.7	2.3	0.3
1941	14.9	2.9	0.4
1942	16.1	3.5	0.4
1943	17.4	4.1	0.4
1944	18.6	4.6	0.4
1945	19.9	5.2	0.4
1946	21.3	6.5	0.4
1947	22.6	7.8	0.4
1948	23.8	9.1	0.4
1949	24.9	10.4	0.4
1950	25.8	11.7	0.4
1951	30.2	14.0	0.5
1952	34.4	16.7	0.5
1953	39.4	19.8	0.6
1954	43.3	23.0	0.6
1955	47.1	26.6	0.6
1956	51.5	30.4	0.6
1957	58.1	34.9	0.7
1958	62.9	39.6	0.7
1959	68.7	45.1	0.8
1960	73.1	50.3	0.8
1961	75.6	55.9	0.7
1962	76.7	61.4	0.7
1963	78.9	67.6	0.5
1964	82.6	75.2	0.3
1965	88.5	83.7	0.2
1966	97.7	92.4	0.2
1967	108.1	102.6	0.3
1968	120.6	114.0	0.3
1969	138.3	123.6	0.7
1970	154.2	132.6	1.2
1971	168.1	146.5	1.2
1972	184.8	162.3	1.2
1973	201.9	174.3	1.8
1974	222.6	185.5	2.4
1975	239.9	179.9	3.9
1976	262.6	209.2	4.0
1977	285.4	226.0	4.5
1978	308.1	263.8	3.3
1979	330.8	309.2	1.6
1980	412.6	367.0	3.6
1981	461.9	398.2	5.1
1982	518.2	454.2	5.1
1983	617.1	547.5	5.6
1984	706.2	606.5	8.0
1985	795.2	795.1	0.0
1986	856.9	816.0	3.3
1987	918.6	803.3	9.2
1988	980.3	812.8	13.4
1989	1,042.0	921.5	8.4
1990	1,103.7	899.9	14.3
1991	1,165.4	1,051.7	8.0
1992	1,227.2	1,079.9	8.8
1993	1,289.0	1,195.1	5.6
1994	1,350.7	1,276.0	4.5
1995	1,412.5	1,466.1	-3.2
1996	1,474.3	1,590.2	-7.0
1997	1,536.0	1,763.5	-13.6
1998	1,664.2	1,907.7	-14.6
1999	1,755.6	2,074.6	-19.1
2000	1,826.0	1,979.0	-9.2
2001	1,968.4	1,810.2	9.5
2002	2,021.1	1,639.3	22.9
2003	2,064.3	1,994.5	4.2
2004	2,207.1	2,132.2	4.1
2005	2,290.4	2,281.3	0.5
2006	2,402.0	2,529.5	-7.0
2007	2,529.1	2,596.0	-3.7
2008	2,608.2	1,853.5	41.5
2009	2,662.7	2,138.9	28.8
2010	2,872.2	2,389.6	24.1
2011	2,953.1	2,466.2	24.3
2012	3,054.3	2,610.6	22.2

Table 8: Summary of Other Estimated Series for Private DB Plans

Series	*Source Data or Methodology by Year*
Actual Employer Contributions	2012: Extrapolation from previous 5-year average growth rate 2011: BEA tabulations of form 5500 with coverage adjustment 1993 – 2010: EBSA *Private Pension Plan Bulletin*, table A4 1988 – 1992: BEA NIPA table 6.11 1975 – 1987: Interpolation between 1974 and 1988 using total contributions from EBSA as indicator 1940 – 1974: Skolnik (1976), table 1 1931 – 1939: Linear interpolation between 1930 and 1940 1930: ACLI *1987 Pension Facts*, pp. 30-35 1929: Back-cast from subsequent 5-year average growth rate
Actual Employee Contributions	2012: Extrapolation from previous year using participant contributions from Compustat as indicator 2011: BEA tabulations of form 5500 with coverage adjustment 1993 – 2010: EBSA *Private Pension Plan Bulletin*, table A4 1975 – 1992: Interpolation between 1974 and 1993 using total contributions from EBSA as indicator 1940 – 1974: Skolnik (1976), table 1 1931 – 1939: Linear interpolation between 1930 and 1940 1930: ACLI *1987 Pension Facts*, pp. 30-35 1929: Back-cast from subsequent 5-year average growth rate
Administrative Expenses	2012: Extrapolation from previous 5-year average growth rate 2011: BEA tabulations of form 5500 with coverage adjustment 1989 – 2010: EBSA *Private Pension Plan Bulletin*, table C9 1929 – 1988: Plan assets × sample average administrative expenses as a percent of plan assets
Benefits Paid	2012: Extrapolation from previous 5-year average growth rate 2011: BEA tabulations of form 5500 with coverage adjustment 2009 – 2010: EBSA *Private Pension Plan Bulletin*, table A4 1975 – 2008: EBSA P*rivate Pension Plan Bulletin Historical Tables and Graphs*, table E17 1940 – 1974: Skolnik (1976), table 1 1931 – 1939: Linear interpolation between 1930 and 1940 1930: ACLI *1987 Pension Facts*, pp. 30-35 1929: Back-cast from subsequent 5-year average growth rate
Actuarial Interest Cost	1929 – 2012: Plan liabilities × NIPA discount rate

Table 9: Other Estimated Series for Private DB Plans (billions USD)

Year	*Actual Employer Cont.*	*Actual Employee Cont.*	*Admin. Exp.*	*Ben. Paid*	*Actuarial Interest Cost*
1929	0.1	0.1	0.0	0.1	0.2
1930	0.1	0.1	0.0	0.1	0.2
1931	0.1	0.1	0.0	0.1	0.2
1932	0.1	0.1	0.0	0.1	0.3
1933	0.1	0.1	0.0	0.1	0.3
1934	0.2	0.1	0.0	0.1	0.3
1935	0.2	0.1	0.0	0.1	0.3
1936	0.2	0.1	0.0	0.1	0.3
1937	0.2	0.1	0.0	0.1	0.4
1938	0.2	0.1	0.0	0.1	0.3
1939	0.2	0.1	0.0	0.1	0.4
1940	0.2	0.1	0.0	0.1	0.4
1941	0.3	0.1	0.0	0.2	0.4
1942	0.4	0.1	0.0	0.2	0.5
1943	0.6	0.1	0.0	0.2	0.5
1944	0.7	0.2	0.0	0.2	0.6
1945	0.8	0.2	0.0	0.2	0.6
1946	1.0	0.2	0.0	0.3	0.6
1947	1.2	0.2	0.0	0.3	0.7
1948	1.4	0.3	0.0	0.3	0.7
1949	1.6	0.3	0.0	0.3	0.7
1950	1.8	0.3	0.0	0.4	0.8
1951	2.3	0.4	0.1	0.5	0.9
1952	2.5	0.4	0.1	0.5	1.0
1953	3.0	0.5	0.1	0.6	1.2
1954	3.0	0.5	0.1	0.7	1.3
1955	3.3	0.6	0.1	0.9	1.4
1956	3.6	0.6	0.1	1.0	1.5
1957	4.0	0.7	0.1	1.1	1.7
1958	4.1	0.7	0.2	1.3	1.9
1959	4.6	0.8	0.2	1.5	2.4
1960	4.7	0.8	0.2	1.7	2.6
1961	4.8	0.8	0.2	2.0	2.6
1962	5.2	0.8	0.2	2.3	3.5
1963	5.6	0.9	0.3	2.6	3.6
1964	6.4	0.9	0.3	3.0	3.7
1965	7.4	1.0	0.3	3.5	4.0
1966	8.2	1.0	0.4	4.2	4.4
1967	9.1	1.1	0.4	4.8	5.4
1968	10.0	1.2	0.4	5.5	6.0
1969	11.4	1.4	0.5	6.5	6.9
1970	12.6	1.4	0.5	7.4	8.5
1971	15.2	1.5	0.6	8.6	9.2
1972	16.9	1.6	0.6	10.0	10.2
1973	19.4	1.7	0.7	11.2	13.1
1974	23.0	2.0	0.7	12.9	14.5
1975	22.1	2.0	0.7	12.9	15.6
1976	26.0	2.3	0.8	14.0	19.7
1977	28.4	2.4	0.9	15.2	21.4
1978	34.2	2.8	1.0	17.7	23.1
1979	36.9	2.8	1.2	18.7	24.8
1980	38.7	2.8	1.5	22.1	33.0
1981	42.6	2.9	1.7	27.3	37.0
1982	43.9	2.9	2.1	33.9	41.5
1983	42.0	2.6	2.4	37.0	49.4
1984	42.7	2.4	2.6	46.5	56.5
1985	38.0	2.0	3.1	54.5	63.6
1986	30.0	1.5	3.3	68.0	68.6
1987	26.9	1.2	3.3	66.2	73.5
1988	23.3	1.0	3.4	60.5	78.4
1989	22.3	0.8	3.4	66.7	72.9
1990	20.9	0.7	3.7	66.4	77.3
1991	27.2	0.8	4.0	71.5	81.6
1992	32.1	0.8	4.0	77.9	73.6
1993	50.0	0.9	4.3	79.1	77.3
1994	37.2	0.6	4.7	82.6	81.0
1995	39.1	0.8	5.0	85.1	84.8
1996	34.5	0.8	5.9	96.9	88.5
1997	28.3	0.6	6.3	97.2	92.2
1998	33.5	0.7	6.7	111.2	99.9
1999	28.6	0.7	6.7	119.4	105.3
2000	32.4	0.6	7.3	127.5	109.6
2001	47.5	0.6	7.1	129.4	118.1
2002	83.5	0.7	7.1	135.8	121.3
2003	117.2	0.8	7.2	134.9	123.9
2004	92.8	0.8	7.9	140.4	121.4
2005	89.8	0.8	8.2	136.6	126.0
2006	88.4	0.9	9.2	150.6	132.1
2007	67.1	0.8	9.8	158.7	139.1
2008	104.0	1.0	9.6	166.0	143.5
2009	112.1	1.0	9.0	167.8	146.4
2010	127.4	0.8	9.8	169.6	143.6
2011	132.9	0.9	9.9	173.4	147.7
2012	148.0	1.0	10.1	178.4	152.7

Appendix A. Adjusting Actuarial Estimates to a Common Discount Rate

There are three methods to adjust actuarial estimates to reflect a single discount rate across multiple pension plans: termination formula, alternative calculation method (ACM) formula, and uniform distribution formula. Each formula yields a factor by which the actuarial estimate can be multiplied. Let r denote the discount rate assumed in the actuarial estimate, and let r^* denote the desired single discount rate.

The termination formulas to calculate adjustment factors for retired and non-retired participants are provided by PBGC as follows:

(A.1) $$Term^{Retired} = e^{-5.38(r^*-r)} = 0.00460782^{(r^*-r)}$$

and

(A.2) $$Term^{Non-retired} = e^{-15.02(r^*-r)} = 0.0000003^{(r^*-r)}.$$

The ACM formulas to calculate adjustment factors for retired and non-retired participants are provided by PBGC as follows, where *Age* is the average retirement age:

(A.3) $$ACM^{Retired} = 0.94^{100(r^*-r)} = 0.00205487^{(r^*-r)}$$

and

(A.4) $$ACM^{Non-retired} = 0.94^{100(r^*-r)}[(1+r)/(1+r^*)]^{Age-50}.$$

If $r^* > r$, equations (A.1) through (A.4) yield factors less than 1. In this case, actuarial estimates will be adjusted downward to reflect the higher than assumed discount rate.

Termination formulas are used by PBGC to adjust termination liabilities for plans taken over by PBGC. The ACM formulas are used by PBGC for general purposes. Given the obscurity of the underlying assumptions for each set of formulas used by PBGC, we use an alternative set of formulas to adjust actuarial estimates. The alternative set of formulas assumes a uniform distribution of years of retirement, denoted *NYR*. The alternative set also assumes a

uniform distribution of years until retirement, denoted *NYA*, with each cohort receiving an annuity that is paid out over a number of years upon retirement. The formulas to calculate adjustment factors for retired and non-retired participants under the uniform distribution are as follows:

$$\text{(A.5)} \quad Uniform^{\text{Retired}} = \left[\left(\frac{r}{r^*}\right)^2 \times \left(\frac{1+r^*}{1+r}\right)\right] \times \left[\frac{(NYR \times r^*) - (1-(1+r^*)^{-NYR})}{(NYR \times r) - (1-(1+r)^{-NYR})}\right]$$

and

$$\text{(A.6)} \quad Uniform^{Non-retired} = \left[\left(\frac{r}{r^*}\right)^2 \times \left(\frac{1+r^*}{1+r}\right)\right] \times \left[\frac{1-(1+r^*)^{-NYR}}{1-(1+r)^{-NYR}}\right] \times \left[\frac{1-(1+r^*)^{-NYA}}{1-(1+r)^{-NYA}}\right].$$

One use of equation (A.5) is to adjust actuarial estimates of benefits payable to retired participants. One use of equation (A.6) is to adjust actuarial estimates of normal cost for non-retired participants. To adjust actuarial estimates of the actuarial liability, which includes amounts for retired and non-retired participants, equations (A.5) and (A.6) can be combined with weights to distinguish retired participants from non-retired participants. The following equation in which α denotes the weight for retired participants, shows the adjustment factor for current liability under the uniform distribution:

$$\text{(A.7)} \quad Uniform^{Liability} = \left[\left(\frac{r}{r^*}\right)^2 \times \left(\frac{1+r^*}{1+r}\right)\right] \times$$

$$\left\{\alpha\left[\frac{(NYR \times r^*) - (1-(1+r^*)^{-NYR})}{(NYR \times r) - (1-(1+r)^{-NYR})}\right] + (1-\alpha)\left[\frac{1-(1+r^*)^{-NYR}}{1-(1+r)^{-NYR}}\right] \times \left[\frac{1-(1+r^*)^{-NYA}}{1-(1+r)^{-NYA}}\right]\right\}.$$

We determine the weight in equation (A.7) by dividing the aggregate actuarial liability for retired participants by the aggregate actuarial liability for active and retired participants. We use the formulas in equations (A.5) through (A.7) to adjust the normal cost and the actuarial liability

across plans to a common discount rate. Additional information on adjusting actuarial estimates to a common discount rate can be found in Applebaum (1992) and Ippolito (1986).

Appendix B. Discount Rate Assumptions for Private Defined Benefit Pension Plans

The discount rate series for private plans are presented in table B1. We assume a discount rate series using the AAA corporate bond yields published by the FRB, table H.15, as a reference series. We apply four decision criteria. First, in addition to using corporate bond yields as a reference series, we use 5 – 7 percent as a target range for all long-term trends because the averages of all our references hover around 6 percent over time. For example, the average AAA corporate bond yield from 1929 to 2008 is 6.0 percent, the average discount rate used by PBGC from 1979 to 2008 is 6.8 percent, and the median discount rate reported by plans on form 5500 is approximately 6.0 percent from 2000 to 2009. Second, we do not let the rate change more than once in a consecutive three-year period. Third, the top rate in our series is 9.5 percent based on PBGC's published rates for the early 1980s. In the early 1980s, corporate bond yields were as high as 14 percent in 1981. PBGC's rate is 11 percent in 1986 but under 10 percent in all surrounding years. We know now the high rates in the 1980s were not sustainable. Fourth, we generally do not let the discount rate change more than one percentage point from one year to the next except immediately preceding the early 1980s when corporate bond rates were at their highest. We allow the rate to increase two percentage points from 1979 to 1980 in order to meet the second criterion. A one percentage point increase (decrease) in the discount rate generally decreases (increases) the normal cost by approximately 12 percentage points.

Table B1. NIPA Discount Rate Series and AAA Corporate Bond Rate Series

Year	*NIPA Discount Rate*	*AAA Corporate Bond Rate*	*Year*	*NIPA Discount Rate*	*AAA Corporate Bond Rate*	*Year*	*NIPA Discount Rate*	*AAA Corporate Bond Rate*
1929	4.5%	4.7%	1957	3.0%	3.9%	1985	9.0%	11.4%
1930	4.5%	4.6%	1958	3.0%	3.8%	1986	8.0%	9.0%
1931	4.5%	4.6%	1959	3.5%	4.4%	1987	8.0%	9.4%
1932	4.5%	5.0%	1960	3.5%	4.4%	1988	8.0%	9.7%
1933	4.5%	4.5%	1961	3.5%	4.4%	1989	7.0%	9.3%
1934	4.5%	4.0%	1962	4.5%	4.3%	1990	7.0%	9.3%
1935	3.5%	3.6%	1963	4.5%	4.3%	1991	7.0%	8.8%
1936	3.5%	3.2%	1964	4.5%	4.4%	1992	6.0%	8.1%
1937	3.5%	3.3%	1965	4.5%	4.5%	1993	6.0%	7.2%
1938	3.0%	3.2%	1966	4.5%	5.1%	1994	6.0%	8.0%
1939	3.0%	3.0%	1967	5.0%	5.5%	1995	6.0%	7.6%
1940	3.0%	2.8%	1968	5.0%	6.2%	1996	6.0%	7.4%
1941	3.0%	2.8%	1969	5.0%	7.0%	1997	6.0%	7.3%
1942	3.0%	2.8%	1970	5.5%	8.0%	1998	6.0%	6.5%
1943	3.0%	2.7%	1971	5.5%	7.4%	1999	6.0%	7.0%
1944	3.0%	2.7%	1972	5.5%	7.2%	2000	6.0%	7.6%
1945	3.0%	2.6%	1973	6.5%	7.4%	2001	6.0%	7.1%
1946	3.0%	2.5%	1974	6.5%	8.6%	2002	6.0%	6.5%
1947	3.0%	2.6%	1975	6.5%	8.8%	2003	6.0%	5.7%
1948	3.0%	2.8%	1976	7.5%	8.4%	2004	5.5%	5.6%
1949	3.0%	2.7%	1977	7.5%	8.0%	2005	5.5%	5.2%
1950	3.0%	2.6%	1978	7.5%	8.7%	2006	5.5%	5.6%
1951	3.0%	2.9%	1979	7.5%	9.6%	2007	5.5%	5.6%
1952	3.0%	3.0%	1980	9.5%	11.9%	2008	5.5%	5.6%
1953	3.0%	3.2%	1981	9.5%	14.2%	2009	5.5%	5.3%
1954	3.0%	2.9%	1982	9.5%	13.8%	2010	5.0%	4.9%
1955	3.0%	3.1%	1983	9.0%	12.0%	2011	5.0%	4.6%
1956	3.0%	3.4%	1984	9.0%	12.7%	2012	5.0%	3.7%

Note: The AAA corporate bond rate published by the FRB is shown for reference.