Original Article

The cash balance plan as a real option: Financial innovation and implicit contacts

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ABSTRACT This study examines, from the employer's perspective, the conversion from a defined benefit plan to a cash balance plan. The conversion to a cash balance plan presents a real option that is a financial innovation for the firm. The reasons to exercise this option (convert from a defined benefit plan to a cash balance plan) are discussed. The conversion can offer several benefits for the company. The firm may profit by taking the surplus assets of the pension plan without a tax penalty; the firm can increase risk sharing between the company and the employee (by reducing the company's pension liability risk and improving the predictability of the company's pension costs); the firm may choose to reduce future pension liabilities (by changing contribution and accrual patterns); and if the firm converts to a cash balance plan, the firm may improve recruitment and employee retention. The real option approach does not necessarily conflict with the implicit contract theory of pension plans. From the real option point of view, the fuzzy nature of defined benefit plans includes more than one possible real option. Most discussions of implicit contracts for pension plans focus on the concept of an implicit lifetime employment guarantee. The implied contract of the defined benefit plan could be included in the legal provisions of a cash balance pension contract. Even though a lifetime employment guarantee is not included in the current legal contract agreement, a cash balance plan can be structured to offer alternatives that provide the benefits that current employees would expect based on the implicit promises. The real option alternatives for converting to a cash balance plan can be used by the company to change provisions for the un-accrued pension benefits in ways that benefit the company and the employees. Owing to the difficulties in valuing these complex options, the model developed and analysed focuses on the potential value to the

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company of the option to change future pension plan contributions and the concomitant pension fund accruals for employees. A model is developed to find an optimal conversion time for employers based on the accrual patterns of the two types of plans.

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INTRODUCTION

Some companies have constructed cash balance plans to replace existing defined benefit plans. Proponents argue that cash balance plans benefit younger, more-mobile employees who are less likely to accrue portable benefits in a traditional defined benefit plan. Opponents argue that cash balance plans penalize existing long-term employees who accrue the major portion of their retirement income in the last years of work. Examination of this issue has focused on the potential lower annuity value as the price workers are willing to pay for increased mobility of retirement benefits. Depending on how the cash balance plan is structured, the cost of the increased mobility may be borne by the older workers in the company. The benefits in defined benefit plans are back-end-loaded. In the latter part of their career, most employees accrue the largest part of their retirement benefits. Labor economists argue that the backend loading accrual pattern of the defined benefit plan sets up a potential loss of pension benefits and thereby tie the employee to the company. The penalty for leaving is assumed to be part of an implied contract. Cornondo and Copeland discuss that the employee's potential capital loss when leaving the company provides employees an incentive to invest in their company-specific human capital and work hard thereby boosting productivity.¹ Ippolito examines pension benefits from the perspective of a labor contract.² On the basis of implicit contract theory, the employee's cumulative foregone (deferred) wages and their increased productivity pay for their pension benefits. The employer payments are made more evenly through their career than the back-end-loaded benefits earned. The difference between the employee's cumulative foregone wages and

value of their future increased productivity, along with the future value of the accrued benefits, can be viewed as an implicit performance bond posted by the employees.

If the company terminates the plan before the employee retires, or the employee quits the firm, or the company reduces the benefit accrual rate by converting to a cash balance plan, the employee bears a loss as a portion of the implicit bond is forfeited.

Clark points out the differences between the benefits that workers are legally entitled to, based on the formal pension contract, and the earnings to date plus the future benefits that the employees expect at retirement if they stay with the firm.³ The implicit contract theory of pension liabilities assumes that the company and the employees have agreed to an implicit long-term employment contract. Under this contract the company has promised to provide a pension based on expected higher final earnings and the employee is expected to remain with the firm until they retire. When a company cancels the defined benefit pension plan by converting it to a cash balance plan, if an implicit contract applies, employees would have a claim to the pension benefits that they earned to date in the 'stay pension' rather than the expected pension benefits specified by the legal pension contract. The legal pension meets the minimum requirements set by government regulations plus additional expected future benefits agreed to by the company. In contrast, the 'stay pension' assumes that both the company and the employees have agreed to the implicit long-term employment contract.

On the basis of Ippolito and James's implicit contract theory of pensions, if a financially viable company imposes uncompensated pension losses

on their employees, the company is viewed as reneging on the implicit contract.⁴ An employee who quits the company violates the terms of the implied contract and willingly accepts the costs of the pension penalty. Likewise, a company reneges on the implied contract if they convert to a cash balance plan from a defined benefit plan, and thereby reduce the expected future benefits for vested employees without compensation. If at the conversion, the company fails to make compensation adjustments that provide these expected future benefits for vested employees, and instead provides vested employees with only the specified legal pension benefits, employees will suffer the same pension loss as if they had broken the implied contract. The company can realize a one-time gain if they opt for a change from a defined benefit plan to a cash balance plan. In this case, vested long-term employees would lose the expected future pension benefits that they presumed they had earned under the implicit contract view of the defined benefit plan.

Given the implicit contract theory of pensions, Ippolito and James hypothesize that only poorly performing companies would impose uncompensated pension losses on employees.⁴ Niehaus and Yu empirically test this implicit contract hypothesis of Ippolito and James.^{4,5} Niehaus and Yu analyze cash balance plan conversions to test whether actual conversions contradict the Ippolito and James predictions of the implicit contract theory of pensions (that employee losses due to these conversions will only occur at firms that are performing poorly).^{4,5}

Niehaus and Yu find that cash balance plan converters are generally sound, profitable firms.⁵ These cash balance plan conversions of sound and healthy firms contradict the implied contract theory of pensions, as stated by Ippolito and James, unless employees were compensated for the implicit losses suffered as a result of these conversions.⁴ If instead, the employers view cash balance plan conversions as an opportunity to take advantage of a real option for the employer's benefit, this would be consistent with the results reported by Niehaus and Yu.⁵ This premise is discussed below and additional considerations are also addressed. These additional considerations

could result in the switch from a defined benefit plan to a cash balance plan being too high a price to pay for mobility, even for younger workers.

As discussed by Ambachtsheer, defined benefit plans have a serious failing.⁶

Defined benefit plans generally do not specify how and who bears the risk embedded in the plan. Ambachtsheer points out that if game theory is applied to such ambiguous contracts, adversarial win-lose outcomes are likely.⁶ Adversarial win-lose results can produce win-lose situations among different age segments of the same defined benefit plan. Ambachtsheer states that currently this is more likely to surface in the public sector than in the private corporations, as current generations of taxpayers and public servants may skim off surpluses now at the expense of future generations.⁶

Ambachtsheer's conclusions have implications for the issue at hand here.⁶ The imprecise nature of implicit contracts allows a company to gain from a switch to cash balance plan, even though the company is prosperous and sound. Also, the imprecise nature of implicit contracts in pension plans can give rise to a win-lose situation in two ways. Some companies and their more recently employed workers both gain from a switch to cash balance plans while senior employees are likely to suffer losses.

Firms proposing to convert their existing defined benefit plan to a cash balance plan have argued that they desire to provide better retirement benefits to a larger number of employees. They cite studies noting advantages of the cash balance plan, such as: understandable benefits, encouragement of retirement savings, guaranteed benefits and mobile employee benefits.⁷ However, for the company, a key drawback is that federal regulations for defined benefit plans are more onerous than regulations imposed on defined contribution plans (Hustead).⁸ Stein asks why employers choose to replace defined benefit plans with cash balance plans rather than defined contribution plans.⁹ He notes that from the employer's perspective, 'defined contribution plans are, cheaper, simpler, less risky and more effective when recruiting employees than cash balance plans',

therefore additional considerations must motivate this choice.

For employers, there are at least four potential financial motivations to switch from a defined benefit plan to a cash balance plan:

1. The firm can capture any pension surplus without a tax penalty.
2. Cash balance plans increase risk for employees by shifting some risks from the company to the employee (some future pension liability risks are shifted to the employee and the company's pension costs are more predictable).
3. Early retirement benefits can be eliminated in any change of pension plans. Firms that switch to cash balance plans often choose to eliminate early retirement benefits.
4. For the employers, cash balance plans can reduce future pension liabilities (depending on the nature of changes in accrual patterns).

Ippolito and Thompson and Ippolito suggest that the reason companies do not switch from defined benefit plans to defined contribution plans is owing to the tax code.^{10–12} The Government Accountability Office (GAO) states that if firms terminate a defined benefit plan then they 'must pay income and excise taxes on any surplus assets, immediately vest all accrued benefits for plan participants, and provide participants with annuities or lump sum payments'.¹³ A provision in the Revenue Reconciliation Act (1990) set the excise tax to 20 per cent of reverted assets if 25 per cent of the excess pension assets are used to fund future retirement benefits or if benefits are increased by 25 per cent. If this is not the case the excise tax is 50 per cent.

To avoid these costs, especially the taxes on surplus assets, firms can switch to cash balance plans. Cash balance plans are classified as a defined benefit plan by the Internal Revenue Service (IRS). This maintains the legal status of the plan as a defined benefit plan, and allows the firm to capture any pension surplus without a tax penalty. Adopting this legal avoidance strategy conforms to Miller's definition of a 'successful' innovation: 'Each innovation that does its job successfully earns an immediate reward for its

adopters in the form of tax money saved'.¹⁴ By this definition the cash balance plan switch has been a successful financial innovation for employers. The empirical results reported by Niehaus and Yu support this tax-saving hypothesis, they suggest that one reason companies convert to cash balance plans is to avoid the excise tax on surplus pension assets.⁵ Although, as discussed in D'Souza, Jacob and Lougee, the increase in excise taxes is not likely to be the complete explanation for cash balance conversions as companies that would have faced the increased taxes on plan termination could have avoided them by freezing their defined benefit pension plans instead.¹⁵ D'Souza, Jacob and Lougee's empirical analysis concludes that tax factors are not a major motivation for cash balance conversions.¹⁵

Both cash balance and the traditional defined benefit plans offer a lifetime annuity at retirement. Some cash balance plans allow employees to choose an annuity or lump sum at retirement. Pension liability risks are increased if expected life spans increase.^{16,17} In a defined benefit plan, the growth rate in salary, the number of years worked, the pension multiplier and the mortality tables determine the total expected annuity payments by a company to an employee. Therefore mortality tables must be considered when the company initially determines the pension multiplier. The mortality risk of unexpected increases in the expected life span during the employee's work years can be reduced with the conversion from a defined benefit to a cash balance plan. If there is an unexpected increase in life span during the employee's work years, the company with a defined benefit plan can adjust the multiplier for future benefits but is restricted from reducing benefits already accrued. As the cash balance plan annuity is determined at retirement, this risk is reduced because the mortality table available at retirement is used to calculate the annuity. Firms with defined benefit or cash balance plans would continue to face mortality risk due to unexpected increases in life span during employees' retirement years. Although, if a firm shifts to a cash balance plan, the risk related to an aging population of retirees is eliminated if at retirement the employees take

the lump sum cash option. Van Horne notes that financial innovation increases risk sharing opportunities by offering more complete markets.¹⁸ In this vein, the cash balance plan has been a successful innovation for the employers as they shift some of the pension liability risk to their employees. Also, given that the cash balance plan improves the predictability of the company's pension costs by tying the rate of return (interest credit) to a market rate of interest, which also results in the financial market risk being shared by the company and employees (see Clark and Schieber).¹⁹

As discussed in Johnson and Steuerle, many traditional defined benefit plans included early retirement benefits, allowing employees to collect reduced benefits before they qualify for full benefits at a later age.¹⁷ Even though the annual benefits received are lower than what the employee could have received at full retirement age, they may be better off as they receive more years of these lower pension payments than those who retire later. The gains or losses from choosing early retirement depend on whether the discounted cash flows of an immediate start, with an increased number of payments at reduced payment amounts offsets, the effect of delayed higher payment amounts for shorter periods. The net result is that some employees in defined benefit plans may maximize their personal wealth by retiring at a relatively young age. Companies that switch from a defined benefit plan to a cash balance plan may choose to eliminate early retirement incentives. Elimination of these incentives will have workers spending more time working and less time in retirement. If the employee chooses the annuity option, this enables the employer to lower future pension liabilities.²⁰

The accrual rate is defined as the amount of benefits promised in retirement for each year worked. With a defined benefit plan the annual accrual rate is an increasing function based on the number of years worked.²¹ In the case of a cash balance plan the annual accrual rate is a decreasing function. Hence these functions will cross and the conversion to a cash balance plan from a defined benefit plan enables the employer to lower future pension liabilities.

The choices in conversions discussed above present potential real options for the company. The payments promised to retirees in a defined benefit plan can be modeled as a portfolio of zero coupon bonds that last until the death of the beneficiary or spouse. The cash balance conversion changes the nature of this portfolio by exercising the option to terminate the plan based on the legal contract and issue subsequent benefits with lower accrual rates or other changes in employer pension liabilities. This result is analogous to a firm that calls bonds after an interest rate decline as they issue new replacement debt that changes some of the characteristics of the previously issued debt to the benefit of the issuing firm.

The real option approach does not necessarily conflict with the implicit contract theory of pension plans. One implied contract issue is the difference in the legal pension contract and the 'stay pension'. If the implicit 'stay pension' guarantee was not explicitly included in the legal pension contract, only the legal contract has to be followed. As Clark states 'It is important to remember that no company is required to offer a pension and once established, a company has the legal right to terminate the plan provided it pays all vested workers the benefits that they are legally owed'.³ Under such options the company may change provisions for un-accrued pension benefits. Note that it is unlikely that most employees considered these employer options at the time they were hired.

Chakraborty reports that in November of 1999 employees brought a class action suit against IBM (*Cooper v. IBM*) after the IBM pension plan was converted from a defined benefit plan to a cash balance plan effective 1 July 1999.²² The suit contended that the cash balance plan discriminated against older employees and the district court held that IBM's cash balance plan violated ERISA. In September 2004 IBM agreed to settle some of the issues in the class action suit. However, IBM chose to appeal the age discrimination claim to the Seventh Circuit of Appeals.

The Seventh Circuit of Appeals ruled that IBM's cash balance plan did not violate the

ERISA requirement that an employee's benefit accrual rate cannot be reduced based on the employee's age. This ruling was appealed to the US Supreme Court. The US Supreme Court subsequently declined to review the appellate decision and this ended the litigation (Watson and Wyatt²³). The implicit contract issue was not explicitly addressed in this litigation but the court decisions did conclude that employers may change from a defined benefit plan to a cash balance plan, provided that there is no illegal discrimination against older workers.

Although not legally required, companies could accommodate the implicit contract expectations of vested employees by tailoring the cash balance plan accruals to meet these employees' expectations, while simultaneously setting up a typical cash balance plan accrual pattern for non-vested employees and new employees. While this approach could reduce the amount of surplus assets, it would meet the implicit contract expectations of loyal employees and eliminate criticisms as to the unfairness of the change. Of course, at the other extreme, the company could reject these considerations and maximize the amount of surplus assets by setting up a cash balance plan that provides for minimal employer contributions.

Measurable financial benefits are not the only potential benefits from conversion to a cash balance plan. Coronado and Copeland suggest that the conversion to cash balance plans may be prompted by labor market conditions.¹ Given the changing nature of the workforce, increased labor mobility and skilled labor shortages, cash balance plans may help in recruitment of younger employees, discourage early retirement and allow the company to hold on to their experienced skilled workforce. As noted above, companies could set up the cash balance plan contributions and accrual patterns to accommodate the implicit contract expectations of vested employees, yet provide the portability expected by non-vested employees and new employees by setting up contributions and accrual patterns that are typical of cash balance plans. Thus, recruiting could improve while older experienced workers

are retained. This could help overall morale, and enhance productivity, and provide additional financial benefits to the company although these potential financial benefits may be difficult to measure.^{24,25}

The goal of a firm's managers is to maximize shareholder wealth, which is generally measured by the share prices for the firm. If conversion to a cash balance plan will increase shareholder wealth, management should act accordingly. However, the amount of surplus assets produced by a cash balance plan conversion may or may not produce an increase in shareholder wealth. The conversion could generate negative publicity, create future problems recruiting employees, reduce employee morale or diminish productivity. Such negative impacts are likely to reduce the firm's current and future profitability. The losses associated with such impacts could outweigh the value of any surplus assets produced by the conversion so that the conversion may reduce shareholder wealth.

THE CASH BALANCE PLAN AS A REAL OPTION

If young workers in the company favor a switch to a cash balance plan, are younger workers willing to accept the potential lower annuity value in exchange for increased mobility of retirement benefits? In a real option framework the question discussed in previous literature becomes: Does the value of the option to increase mobility (for younger workers), with incremental benefits, equal the value of the embedded option for the company to change the accrual pattern? If the question is framed in this way by employees, we argue that the employers get additional options for free. The question for younger employees can be framed in a general functional form as follows:

Value of the option to leave for younger workers (with incremental benefits) = F (value of the following embedded options: the change the company's plan contributions and accrual patterns, benefits of market risk sharing between the company and the employee (benefits of

earning the specified market rate of return on the employees cash balance account, and the company's mortality risk that can be reduced by a switch to a cash balance plan), capture any pension surplus without tax penalty and, if applicable, the impact of eliminating early retirement option benefits.)

This general function assumes that the employer is not on the verge of declaring bankruptcy and default on its pension obligation to the government or to terminate its plan and offer no replacement. A general functional form is used as these option values overlap, may interact, not be additive and because companies may switch to cash balance plans for different reasons. Clearly, from the company's point of view, their main focus would be on the right hand side of the function, although the left hand side of the function plays a part by improving employee recruitment.

Owing to the difficulties in valuing these complex options, in the remainder of this article we focus on the value of the embedded option for the company to change the accrual pattern.²⁶ This issue has received the most press because it has the potential to penalize existing long-term employees. We present a model for finding an optimal conversion time for employers based on the accrual patterns of the two types of plans.

THE MODEL

The defined benefit plan guarantees a fixed retirement benefit per year for life. The formula used to determine the defined benefit varies by plan sponsor, but is usually based on the years of service and a terminal average salary of the employee. Such plans usually specify a minimum time of employment that is required from an employee to gain the right to the retirement benefits. The nature of this requirement varies from sponsor to sponsor, and some standards determined by Federal law. When the minimum time condition is met the employee becomes 'vested'. That is, the employee becomes entitled to the defined benefit at retirement or some specified

minimum age. One feature of such plans is the rate for benefits accrual increases at an increasing rate during the latter years of employment. The accrual rate is defined as the amount of promised benefits that are earned during each year of work. The total accrued benefit earned by an employee in year n (assuming you are fully vested) is calculated as:

$$nS_n m \quad (1)$$

where n is the year, S is the salary and m is the pension multiplier. The total accrued benefit earned by $n + 1$ is:

$$(n + 1)S_n(1 + g)m \quad (2)$$

where g is the salary growth rate. The change in accrued benefits each year is found by subtracting equation (1) from equation (2)

$$(n + 1)S_n(1 + g)m - nS_n m \quad (3)$$

Simplifying we get:

$$S_n m [g(n + 1) + 1] \quad (4)$$

Equation (4) is the additional annuity you earn in period $(n + 1)$, which is paid out at retirement.

Legally, cash balance plans are defined benefit plans and benefits are determined using a formula. These benefits are disclosed as an individual account balance. The individual account balance is determined by hypothetical pay credits (a percentage of salary) and hypothetical interest credits on an individual's beginning of the year account balance. This account balance is hypothetical because a cash balance plan is still a defined benefit plan and therefore the employee pension benefits are paid out of commingled funds invested in a pension trust.

The individual account balance in any given year n is calculated as:

$$S_n p + A_{n-1}(1 + i) = A_n \quad (5)$$

where p is the pay credit, i is the interest credit and A is the account balance. This amount is compounded to retirement:

$$A_n(1+i)^{w-n} \quad (6)$$

where w is the total number of years worked until retirement; and, the individual account balance in year $n+1$ compounds to retirement is:

$$[S_n(1+g)p + A_n(1+i)](1+i)^{w-(n+1)} \quad (7)$$

The difference in value at retirement is given by:

$$[S_n(1+g)p + A_n(1+i)](1+i)^{w-(n+1)} - A_n(1+i)^{w-n} \quad (8)$$

Simplifying we get:

$$S_n(1+g)p(1+i)^{w-n-1} \quad (9)$$

Equation (9) represents the lump sum attributable to year $n+1$. This amount is then converted to an annuity using plan-specific mortality assumptions.²⁷ Let d equal the number of years the employee is expected to live during retirement and assume the discount rate equals the investment rate. The additional annuity the employee earns in period $(n+1)$, which is paid out at retirement is given by:

$$\frac{S_n(1+g)p(1+i)^{w-n-1}}{\frac{1}{i} - \frac{1}{i(1+i)^d}} \quad (10)$$

The point where the accrual functions for the defined benefit and cash balance plans cross is the equality:

Additional annuity earned in

DB plan each year = Additional annuity
earned in CB plan each year

$$S_n m[g(n+1)+1] = \frac{[S_n(1+g)p(1+i)^{w-n-1}]}{\frac{1}{i} - \frac{1}{i(1+i)^d}} \quad (11)$$

Solving this for n would give the optimal time for a company to switch to a cash balance plan for this employee:

$$S_n m[g(n+1)+1] = \frac{S_n(1+g)p(1+i)^{w-n-1}}{AF} \quad (12)$$

where the annuity factor $AF = 1/i - 1/(i(1+i)^d)$

Solving further we obtain:

$$g(n+1)+1 = \frac{X}{(1+i)^n} \quad (13)$$

where $X = (1+g)p(1+i)^{w-1}/mAF$

Unfortunately, equation (13) is a transcendental equation (an equation involving functions other than simple polynomials). The solution to this equation cannot be expressed as a combination of elementary functions. There is no general formula for expressing the solution to the equation (13) (solving for n) as a combination of elementary functions X , i and g . Because of the intractable general equation, we make some further assumptions that allow us to solve it numerically. To solve for n we make the following assumptions:

Employee age	25 years
Employee starting salary	US\$30 000
Salary growth rate	3.4 per cent
Defined benefit pension multiplier	1.25 per cent (based on final year salary)
Cash balance plan pay credit	6.00 per cent
Work years	40 years
Mortality	The individual is expected to live 20 years after retirement at 65

Using equation (4) the accrued benefits of the defined benefit plan are calculated. The third column in Table 1 shows the accrued benefits. At retirement the employee has earned a defined benefit retirement salary of US\$55 258. To demonstrate the accrual rate difference between the defined benefit and the cash balance plan the interest credit was chosen to make the accrued benefits under both plans the same if the employee chose either plan and stayed with the company until retirement. The employee would have equal retirement benefit using an interest

Table 1: Annuity benefits: Defined benefit versus cash balance

Year	Employee age	Defined benefit (DB) accrual rate	Cash balance (CB) accrual rate	Accrual difference	Accrual if company switched to CB from DB in year 22
1	25	375.00	2548.88	-2173.88	375.00
2	26	400.50	2459.51	-2059.01	400.50
3	27	427.30	2373.27	-1945.97	427.30
4	28	455.46	2290.06	-1834.60	455.46
5	29	485.04	2209.76	-1724.72	485.04
6	30	516.11	2132.28	-1616.17	516.11
7	31	548.72	2057.51	-1508.79	548.72
8	32	582.96	1985.37	-1402.41	582.96
9	33	618.90	1915.76	-1296.86	618.90
10	34	656.60	1848.58	-1191.99	656.60
11	35	696.15	1783.77	-1087.62	696.15
12	36	737.63	1721.22	-983.59	737.63
13	37	781.13	1660.87	-879.74	781.13
14	38	826.73	1602.63	-775.90	826.73
15	39	874.53	1546.44	-671.91	874.53
16	40	924.63	1492.22	-567.59	924.63
17	41	977.12	1439.90	-462.78	977.12
18	42	1032.11	1389.41	-357.30	1032.11
19	43	1089.71	1340.69	-250.98	1089.71
20	44	1150.03	1293.68	-143.65	1150.03
21	45	1213.20	1248.32	-35.12	1213.20
22	46	1279.33	1204.55	74.78	1204.55
23	47	1348.56	1162.32	186.24	1162.32
24	48	1421.02	1121.56	299.46	1121.56
25	49	1496.84	1082.24	414.60	1082.24
26	50	1576.18	1044.29	531.89	1044.29
27	51	1659.18	1007.67	651.51	1007.67
28	52	1746.00	972.34	773.66	972.34
29	53	1836.81	938.25	898.57	938.25
30	54	1931.78	905.35	1026.43	905.35
31	55	2031.08	873.60	1157.48	873.60
32	56	2134.90	842.97	1291.93	842.97
33	57	2243.43	813.42	1430.02	813.42
34	58	2356.88	784.89	1571.98	784.89
35	59	2475.44	757.37	1718.07	757.37
36	60	2599.35	730.82	1868.53	730.82
37	61	2728.81	705.19	2023.62	705.19
38	62	2864.08	680.47	2183.61	680.47
39	63	3005.39	656.61	2348.78	656.61
40	64	3153.00	633.58	2519.41	633.58
Total benefit	—	55257.63	55257.63	—	32287.04

Assumptions: Employee age=25 years, Employee starting salary (S_1)=US\$30000, Salary growth rate (g)=3.4 per cent. Defined benefit multiplier (m)=1.25 per cent (based on final year salary), Cash balance plan pay credit (p)=6.00 per cent. Work years (w)=40 years, Mortality (d)=The individual is expected to live 20 years after retirement at 65. The interest credit (i) was chosen to make the accrued benefits under both plans the same if the employee chose either plan and stayed with the company until retirement. The employee would have equal retirement benefit using an interest credit of 7.15729 per cent. For the cash balance plan it is also assumed that the discount rate equals the investment rate (i). Accrual rate: The amount of promised benefits that are earned each year that is paid out at retirement. Annual accrued benefits of the defined benefit plan= $S_1 m [g(n+1)+1]$. Annual accrued benefits of the cash balance plan=

$$\frac{Sn(1+g)p(1+i)^{w-n-1}}{\frac{1}{i} - \frac{1}{i(1+i)^d}}$$

credit of 7.15729 per cent. Table 1 shows that the total retirement benefits under the cash balance plan also equals \$55258. Further examination of Table 1 indicates that the defined benefit plan has lower accrued benefits in the

early years and the cash balance plan has lower accrued benefits in the later years. Figure 1 clearly illustrates the different accrual patterns and shows that the accrual rate for the defined benefit plan is an increasing function based on years

Figure 1: Annuity benefits: Defined benefit versus defined contribution.

Notes: Assumptions: Employee age = 25 years, Employee starting salary (S_1) = \$30 000, Salary growth rate (g) = 3.4 per cent.

Defined benefit multiplier (m) = 1.25 per cent (based on final year salary), Cash balance plan pay credit (p) = 6.00 per cent. Work years (w) = 40 years, Mortality (d) = the individual is expected to live 20 years after retirement at 65.

The interest credit (i) was chosen to make the accrued benefits under both plans the same if the employee chose either plan and stayed with the company until retirement. The employee would have equal retirement benefit using an interest credit of 7.15729 per cent. For the cash balance plan it is also assumed that the discount rate equals the investment rate (i).

Accrual rate: the amount of promised benefits that are earned each year that is paid out at retirement.

Annual accrued benefits of the defined benefit plan = $S_n m [g(n+1) + 1]$

Annual accrued benefits of the cash balance plan =

$$\frac{Sn(1+g)p(1+i)^{w-n-1}}{\frac{1}{i} - \frac{1}{i(1+i)^d}}$$

worked whereas the cash balance plan annual accrual rate is a decreasing function of years worked. Given that the lines cross, there is an opportunity (real option) for the company to legally lower the employee's pension benefit.

Solving equation (13) numerically, the optimal time to exercise this option is in the employee's 22nd year of service. The last column in Table 1 demonstrates that if the company switched to the cash balance plan from the defined benefit plan in year 22 the employee's retirement benefit is reduced to \$32 287.04

The option to convert can only be exercised once for all employees and not for each individual employee. The company, having information on all employees in their defined benefit plan, can easily determine the optimal time to convert. The optimal time will give the company its lowest overall retirement liability.

Many companies that switched from defined benefit to cash balance plans grandfathered in older employees, those 55 and over, so that their

benefits would not be reduced. Some companies allowed the older workers to continue in the defined benefit plan while others made additional contributions to the older workers cash balance account. As argued by Clark and Schieber, grandfathering in some employees requires an arbitrary decision about the age and service cutoffs for staying in the old plan or being covered by the new.¹⁹ The implications from the single employee example shows that, depending on the age composition of the company's workforce, there still could be a major reduction in future pension liabilities, even if older workers are grandfathered in. In our example, workers above the crossover point in Figure 1 and below the age where the employees are grandfathered in would face capital losses as a result of conversion. Therefore even if a company provides transitional benefits to their senior employees, depending on the demographics of the overall workforce (number of years worked, salary), the company may still make substantial reductions in their overall accrual rates.

CONCLUSION

This study examines the cash balance plan from the employer's perspective. In the context of financial innovation, converting from a defined benefit plan to a cash balance plan can be viewed as a real option for the firm. The reasons to exercise this option (convert from a defined benefit plan to a cash balance plan) are discussed. The conversion can offer several benefits for the company. The firm may profit by taking the surplus assets of the pension plan without a tax penalty; the firm can increase risk sharing between the company and the employee (by reducing the company's pension liability risk and improving the predictability of the company's pension costs); the firm may choose to reduce future pension liabilities (by changing contribution and accrual patterns); and if the firm converts to a cash balance plan, the firm may improve recruitment and employee retention.

The real option approach need not conflict with the implicit contract theory. Employing a real option approach, given the uncertain nature of defined benefit contracts, there is more than

one option. The implied contract is the unwritten presumed commitment of the 'stay pension'. This implicit contract presumes that lifetime employment is guaranteed. This guarantee is not usually explicitly stated by the company and therefore the company is only bound by the legal contract. As Clark states 'It is important to remember that no company is required to offer a pension and once established, a company has the legal right to terminate the plan provided it pays all vested workers the benefits that they are legally owed'.³ Therefore there are real options for the company to change the provisions related to the unaccrued pension benefits. These real options were not usually recognized by employees at the time of hire.

Given that the goal of the firm is to maximize shareholder wealth, only if the conversion from a defined benefit plan to a cash balance plan negatively affected share price, through negative publicity, future recruiting problems or employee dissension would conversion not be consistent with the goals of the firm. The real option model discussed in this article is consistent with the findings of Niehaus and Yu that the companies who convert to cash balance plans are generally not poor performers.⁵

Owing to the difficulties in valuing these complex options, the model developed and analysed focuses on the value of the embedded option for the company to change the accrual pattern. We present a model for finding an optimal conversion time for employers based on the accrual patterns of the two types of plans.

REFERENCES AND NOTES

- 1 Coronado, J. and Copeland, P. (2004) Cash balance plan conversions and the new economy. *Journal of Pension Economics and Finance* 4(1): 297–314.
- 2 Ippolito, R. (1985) The labor contract and true economic pension liabilities. *American Economic Review* 74(5): 1031–1043.
- 3 Clark, R. (2003) Pension Plan Options: Preferences, Choices, and the Distribution of Benefits. *Pension Research Council Working Paper*, PRC WP 2003–04, University of Pennsylvania.
- 4 Ippolito, R. and James, W. (1992) LBOs, reversions and implicit contracts. *Journal of Finance* 47: 139–167.
- 5 Niehaus, G. and Yu, T. (2005) Cash-balance plan conversions: Evidence on excise taxes and implicit contracts. *Journal of Risk and Insurance* 72(2): 321–352.
- 6 Ambachtsheer, K. (2007) Why we need a pension revolution. *Financial Analysts Journal* 63(January/February): 21–25.
- 7 See: Submission of the ERISA Industry Committee to the Internal Revenue Service and the Department of the Treasury on Cash Balance Pension Plans, 19 January 2000.
- 8 Hustead, E. (1998) Trends in retirement income plan administrative expenses. In: O. Mitchell and S. Schieber (eds.) *Living with Defined Contribution Pensions*. Philadelphia, PA: University of Pennsylvania Press, pp. 166–177.
- 9 Stein, N. (1999) Some serious questions about cash balance plans. *American Academy of Actuaries: Contingencies* September/October: 28–33.
- 10 Ippolito, R. and Thompson, J. (1999) The survival rate of defined benefit plans, 1987–1995. *Industrial Relations* 39: 228–245.
- 11 Ippolito, R. (2001a) Reversion taxes, contingent benefits and the decline in pension funding. *Journal of Law and Economics* 44: 199–232.
- 12 Ippolito, R. (2001b) Issues surrounding cash balance plans. *Benefits Quarterly*, Third Quarter, 30–45.
- 13 See: Private Pensions Implications of Conversions to Cash Balance Plans (September). 2000, GAO/HEHS-00-185: 13.
- 14 Miller, M. (1986) Financial innovation: The last twenty years and the next. *Journal of Financial and Quantitative Analysis* 21(4): 459–471.
- 15 D'Souza, J., Jacob, J. and Lougee, B. (2008) Why Do Firms Convert to Cash Balance Plans? An Empirical Investigation Working Paper, Cornell University.
- 16 See Johnson and Steuerle (2004) for a discussion of changing life expectancy trends and worker demographics.
- 17 Johnson, R. and Steuerle, E. (2004) Promoting work at older ages: The role of hybrid pension plans in an aging population. *Journal of Pension Economics and Finance* 4(1): 315–337.
- 18 Van Horne, J. (1985) Of financial innovations and excesses. *Journal of Finance* 40(3): 621–631.
- 19 Clark, R. and Schieber, S. (2004) Adopting cash balance pension plans: Implications and issues. *Journal of Pension Economics and Finance* 4(1): 271–295.
- 20 The Pension Protection Act of 2006 requires that a newly converted plan must credit an employee with the amount of any early retirement benefits or retirement-type subsidies if the employee has met the requirements for the benefit or subsidy under the prior plan. Therefore if a company converts and eliminates early retirement, eligible employees must be compensated for the loss. The company may still benefit from the retention of experienced workers for a few more years. There will be pension cost savings related to workers that at the time of conversion had not met the requirements for early retirement but would have in the future.
- 21 The accrual patterns of both plans are described in detail in the model section of the article.
- 22 Chakraborty, A. (2006) Court ruled in favor of IBM in pension discrimination lawsuit. *The Legalizer*, <http://law.tatagnana.net/archive/court-rules-in-favor-of-ibm-in-pension-lawsuit/>, accessed 8 August 2006.
- 23 Watson and Wyatt (2007) Supreme court declines to review Cooper V. IBM and appellate court rules that cash balance plans are not age-discriminatory Watson and Wyatt insider, <http://www.watsonwyatt.be/us/pubs/insider/showarticle.asp?ArticleID=16922>, February 2007.

- 24 Mitchell and Mulvey (2004) note that there will be some redistribution of benefits among individual employees.
- 25 Mitchell, O. and Mulvey, J. (2004) Potential implications of mandating choice in corporate defined benefit plans. *Journal of Pension Economics and Finance* 4(1): 339–354.
- 26 Given the difficulties in valuing this function and insufficient data it is not surprising that support for any of these issues in previous studies is relatively weak. For example in the Coronado and Copeland (2004) study, the logit and probit regressions related to the switch from defined benefit to cash balance plans have R^2 that range from 0.066 to 0.112. Although they have some statistical significance for their independent variables, the economic significance is limited.
- 27 Here we are assuming that the employee does not have the lump sum option.