Paper Title: Addressing the Inflation Concerns for Public Pension Plan in China

Author: Wenliang Wang
Email: elink88@hotmail.com

Public pension plan is primarily to provide an effective protection vehicle against longevity risk and should also provide a protection floor against poverty for the elders in China. But the deteriorating replacement ratio, along with the slipping into lower income class by a large cohort of retiree over time, have triggered serious concerns on effectiveness of the public pension plan on its second function where the inflation effect take an implicit yet important role.

The paper proposed a general framework to evaluate inflation impact on public pension plan and to assess the effectiveness and efficiency of relevant inflation protection initiatives on the basis of a set of generic pension benefit formula revised for the specific purpose to take an explicit consideration of inflation impact over time, and then applied the framework to the China case, in particular for the 2005 scheme for urban work force and retirees (PUWFR).

The general observations for the PUWFR have led to a major concern that no efficient mechanism was established to address the post retirement inflation adjustment issue in China, which has been deteriorating over time. Additionally, the PUWFR is not efficient in term of inflation protection up to the retirement point particularly for the population in migration and urbanization.

The paper, as a primary focus, evaluated the effectiveness and reliability in term of inflation protection by two basic parameters in PUWFR, the annual credit rate for individual account and the benefit basis growth rate in sufficient detail. The paper also checked the alternatives in different mechanisms available in practice to have a potential in supporting a required DB funding credit rate implied by China case.

As an integrated part, the paper introduced and briefly discussed international experiences on inflation protection for both at retirement and after retirement. The discussion focused on their suitability to Chinese context in term of context requirement and give out clear opinions on these alternatives.

Finally, As a specific application extended in the paper for China case, the paper arrives some detailed conclusions on how to address the specific issues resulting from the inflation vulnerability of current public pension plan in China, and gives out ways to address the inflation concern within and beyond current plan characteristics in China, and advises policy change accordingly.

Key words: Public Pension Plan, Inflation Protection, Evaluation Framework, China

Addressing the Inflation Concerns for Public Pension Plan in China

Section 1 Introduction

While a public pension plan is designed primarily to offer an effective protection vehicle against longevity risk from the participant's perspective, Nicholas Barr and Peter Diamond [2010] claimed that it are also purposed to smooth consumption over time and reduce poverty particularly for the elder population. And the most distinctive threat to a proper and reliable function in these regards is the inflation in the real world.

Traditionally, we either disregarded the inflation in term of real interest rate (or real return rate) or took an implicit account on inflation in term of nominal interest rate (or nominal return rate) in the process to make a decision on pre-fund setting, conduct liability valuation and elaborate the plan characteristics. These simple methodologies have significantly increased vulnerability of model to parameter errors, and improperly ignored diverse sources of inflation offsetting mechanism available in the practices. Under one distinctive example, assuming the inflation rate follows a lognormal distribution with an expected inflation rate of 3% and volatility of 3%, a 100 times simulation shows that the liability estimate using only the expected inflation rate up to a 70 years period will produce a figure less than liability estimate using simulated experience of inflation over time in 65% of the simulation runs.

In contrary, an explicit account of inflation will benefit in the following aspects:

1. The effect of inflation on benefit level, discount factor, credit rate, interest rate and other plan characteristics can be checked and understood both in isolation and in an integrated way.
2. The inflation rate can serve an important benchmark to a variety of plan characteristics, such as credit rate, investment return rate, non market mechanism of inflation offsetting, and consequently facilitate effectiveness assessment of relevant plan characteristics.
3. In particular, inflation rate will be a critical threshold to a funding decision. If the funding basis cannot achieve an increase to sufficiently cover the inflation effect on benefit level, the funding sources will be deteriorating over time along with population aging. If a set aside reservation for pre-funding purpose cannot maintain its real value over time, such pre-funding won't be effective.
4. Inflation risk and its allocation mechanism (in term of inflation adjustment arrangement) between different age groups and income cohorts will be properly assessed . Jeremy I.Bulow [1982] found a scenario with an inflation rate higher than expected will benefit old worker rather

than young worker. An interesting result can be also shown that a decreasing inflation adjustment across the income ladder will function similarly to tax.

5. Double accounts (particularly unintended cancellation out) on inflation effects implicit in diverse parameters can be avoided. It will significantly improve the model accuracy and credibility, particularly avoid underestimate of pension benefit liability.

In this paper, we will develop a framework to explicitly consider the inflation effect on public pension plan and its practical application to China case, and have arrived some interesting conclusions.

Section 2 Framework to Understand the Inflation effect on Public Pension Plan in An Explicit Way

The inflation effect on retirement benefit under any public pension plans involve two different regimes separating at retirement, namely pro-retirement inflation and post retirement inflation. For up-to-retirement period, the accumulation effect of inflation is the most important, while for post retirement period, both accumulative and current inflation effect needs to be considered.

To isolate the inflation impact up to retirement and the post retirement inflation impact, we consider the accrued pension benefit in lump sum at retirement at first.

The pension benefit in lump sum accrued up to the retirement age can be set by a generic formula as follow, including both DB component and DC component in essence.

$$\text{Retirement Benefits} = S \cdot B_t \sum_{i=0,t} P_i + \sum_{i=0,t} [C_i \Pi_{j=i+1,t}(1+c_j)] + A \quad \ldots\ldots(1)$$

S is an actuarial present value factor representing the expected sum of each dollar of defined benefit can be received after retirement, B_t is the calculation basis of defined benefit at retirement age of t, C_i is the defined contribution at time i, P_i is the earned percentage for each year qualified service which is assumed independent of inflation effect, c_j is the credit rate (in terms of various mechanism, such as asset return rate, interest rate actually earned, or only a nominal interest rate) for the period from j-1 to j. A is the final ad hoc adjustment beyond the DB and DC sources. It will be zero, if the benefit under the plan doesn't have any sources other than DB and DC elements. In China, for those covered by the 2005 Scheme, the middle age workforce will be granted an arbitrary A to avoid an uncomfortable interruption in retirement benefit continuum.

For accrued benefit at any time k, it can be given as follow:

$$\text{Accrued Benefits} = S \cdot \Pr(k,t) D_{k,t} B_t \sum_{i=0,k} P_i + \sum_{i=0,k} [C_i \Pi_{j=i+1,k}(1+c_j)] \quad \ldots\ldots(2)$$

$D_{k,t}$ is the discount factor appropriate for the period between time k and t, Pr(k,t) is the joint possibility of survival and becoming vested between time k and t.

In event of any plan change or termination which results in any break in benefit basis regime, the accrued benefit at that time, k, can be given as follow:

$$\text{Accrued Benefits} = S \cdot \Pr(k,t) D_{k,t} B_k \sum_{i=0,k} P_i + \sum_{i=0,k} [C_i \Pi_{j=i+1,k}(1+c_j)] \quad \ldots\ldots(3)$$

This type of accrued benefit is relevant for China case in event of plan change or transfer.

To take an explicit account on relevant factors including inflation rate, benefit basis increase rate and credit rate inter period, and assuming the contribution will be based on a funding basis changing over time, the formula (1) (3) can be revised as follow:

Retirement Benefits in real value of time 0

$$= \{S \cdot B_0 \Pi_{j=1,t}(1+b_j) \sum_{i=0,t} P_i + \sum_{i=0,t} [cF^c{}_0 \Pi_{j=1,i}(1+f_j) \Pi_{j=i+1,t}(1+c_j)] + A\} / \Pi_{j=1,t}(1+i_j) \quad \ldots\ldots(4)$$

b_j is one period increase rate on benefit calculation basis, B, from time j-1 to time j; i_j is one period inflation rate from time j-1 to time j. f_j is one period increase rate on funding basis, F^c, from time j-1 to time j. A constant, c, represents a fixed percentage imposed on funding basis to calculate the DC contribution.

Accrued Benefits in real value of time 0=$\{[Pr(k,t)D^r_{k,t} S\cdot B_0\Pi_{j=1,t}(1+b_j)\sum_{i=0,k} P_i]/\Pi_{j=1,t}(1+i_j)\}+\{\sum_{i=0,k}[cF^c{}_0\Pi_{j=1,i}(1+f_j)\Pi_{j=i+1,k}(1+c_j)]/\Pi_{j=1,k}(1+i_j)\}$……(5)

$D^r_{k,t}$ is the discount factor on the basis of real return rate.

Accrued Benefits (Plan Termination) in real value of time 0

$=\{[Pr(k,t)D^r_{k,t} S\cdot B_0\Pi_{j=1,k}(1+b_j)\sum_{0,k}P_i]/\Pi_{j=1,t}(1+i_j)\}+\{\sum_{i=0,k}[cF^c{}_0\Pi_{j=1,i}(1+f_j)\Pi_{j=i+1,k}(1+c_j)]$

$/\Pi_{j=1,k}(1+i_j)\}$……(6)

We can draw some conclusions from formula (4) (6):

For the DC component,

1. The value of accrued benefit depends on the present value of the accrued assets at any time. The real value of the accrued assets depends on the combined accumulative effect from two sources, contribution value maintenance and accumulation growth maintenance. In other words, to maintain a equal purchasing power, the contributions over time shall be adjusted to fully include the inflation effect between each contribution date, and the accumulative DC assets shall be accrued at a rate to fully include the inflation effect during each accumulative period.
2. The purchasing power maintenance of any existing DC assets into future depends on the net accumulative effect from the credit rate against inflation rate in future evolution, which the beneficiary takes the risk by himself. The credit rate shall not be less than inflation rate to avoid losing real value of accrued DC assets at any time in future.
3. In practice, both the funding basis growth and credit rate may have a component corresponding in full or in part to the inflation rate. To the extent that the funding basis growth rate and credit rate don't include the inflation effect in full, they are not efficient in term of anti-inflation and their value will decrease by the inflation effect.

For the DB component,

1. The final value of accrued benefit in real term depends on the net effect of benefit basis growth rate against inflation rate over the entire work life, including historical and future evolution up to the retirement point on an ongoing basis. The benefit basis growth effect can be further separated into two part, the catch up effect (growth up to the point considered) and future development effect (growth into future until retirement).
2. To maintain the real value of the accrued benefit at all time, the benefit basis growth rate shall be larger than the inflation rate. The benefit basis growth usually provides compensation for diverse sources of attribution, including a component of inflation rate either in full or in part. And the inflation rate in the denominator serves as a offsetting factor, which will reduce the compensation for sources of attribution other than inflation if the offsetting is not exact.
3. In event of plan termination, the future evolution of current benefit basis into the retirement point can be broken, and consequently it leaves the devalue risk, which could be significant, to the beneficiary alone.

Furthermore, we can take an explicit account of funding sources for DB component and identify the plan balance (a net result) in a similar way. Assuming the DB funding will also achieve a credit rate over time, the accumulative funding from all sources at retirement or any time before retirement can be given as follows:

Accumulative fundings at retirement

$= \sum_{i=0,t} [gF^b_0 \Pi_{j=1,i}(1+u_j)\Pi_{j=i+1,t}(1+r_j)] + \sum_{i=0,t} [(cF^c_0 \Pi_{j=1,i}(1+f_j)\Pi_{j=i+1,t}(1+c_j)] \ldots\ldots\ldots (7)$

Accumulative fundings at any time k in real value of time 0 =

$\{\sum_{i=0,k} [gF^b_0 \Pi_{j=1,i}(1+u_j)\Pi_{j=i+1,k}(1+r_j)] + \sum_{i=0,k} [(cF^c_0 \Pi_{j=1,i}(1+f_j)\Pi_{j=i+1,k}(1+c_j)]\} / \Pi_{j=1,k}(1+i_j) \ldots (8)$

F^b_0 is the funding basis for DB component, F^c_0 is the funding basis for DC component. A constant, g, represents a fixed percentage imposed on funding basis to calculate the DB funding contribution for each period considered. u_j is one period growth rate on benefit funding basis, F^b, from time j-1 to time j; r_j is the credit rate applicable to accumulated DB funding (in terms of various mechanism depending on the perspective and purpose of consideration, such as internal internal rate, alternative asset return rate, or other appropriate benchmark rate, or even zero for any Pay As You Go system) for the period from j-1 to j.

In particular, if we assume the DB funding basis and DB benefit calculation basis are the same up to the retirement, the net balance from the plan (A work life overall effect evaluation perspective for both participant and plan sponsor) can be given as follows:

$$\text{Net result at retirement} = S \cdot B_0 \Pi_{j=1,t}(1+b_j) \sum_{i=0,t} P_i - \sum_{i=0,t} [gB_0 \Pi_{j=1,i}(1+b_j)\Pi_{j=i+1,t}(1+r_j)] + A$$

$$= S \cdot B_0 \sum_{i=0,t} [P_i \Pi_{j=1,t}(1+b_j)] - gB_0 \sum_{0,t} [\Pi_{j=1,i}(1+b_j)\Pi_{j=i+1,t}(1+r_j)] + A$$

$$= B_0\, S \cdot \{\sum_{i=0,t} [P_i \Pi_{j=1,t}(1+b_j)] - (g/S) \sum_{0,t} [\Pi_{j=1,i}(1+b_j)\Pi_{j=i+1,t}(1+r_j)]\} + A$$

$$= B_0\, S \cdot \sum_{i=0,t} \{ [P_i \Pi_{j=1,i}(1+b_j)\Pi_{j=1,i}(1+b_j)] - (g/S)[\Pi_{j=1,i}(1+b_j)\Pi_{j=i+1,t}(1+r_j)]\} + A$$

$$= B_0\, S \cdot \sum_{i=0,t} \{ [P_i \Pi_{j=i+1,t}(1+b_j) - (g/S)\Pi_{j=i+1,t}(1+r_j)]\Pi_{j=1,i}(1+b_j)\} + A \ldots\ldots\ldots\ldots (9)$$

Net result for accrued benefit at any time k before retirement in real value of time 0

$$= E_k \cdot S \cdot B_0 \Pi_{j=1,t}(1+b_j) \sum_{i=0,k} P_i - \sum_{i=0,k} [gB_0 \Pi_{j=1,i}(1+b_j)\Pi_{j=i+1,k}(1+r_j)] / \Pi_{j=1,k}(1+i_j)$$

$$= B_0\, S \cdot \sum_{i=0,k} \{ [E_k \cdot P_i \Pi_{j=i+1,k}(1+b_j) - (g/S)\Pi_{j=i+1,k}(1+r_j)]\Pi_{j=1,i}(1+b_j)\} / \Pi_{j=1,k}(1+i_j) \ldots (10)$$

where $E_k = Pr(k,t)D^r_{k,t}$.

We can draw some conclusions from formula (7) (10):

1. Due to the DC component to be canceled out in the net result, the impact of inflation on DC component will not have an influence on plan sponsor side. It's a risk burden shifted to participants and beneficiaries.
2. The accumulative funding for DC component will be influenced by both funding basis change (contribution value maintenance) up to the contribution date and forthcoming credit rate change into future (accumulation growth maintenance). To maintain the purchasing power in accumulative funding for DC component, the multiplicative effect from both funding basis change and credit rate change shall be larger than the corresponding inflation effect over time.
3. The accumulative funding for DB component will be influenced by both the funding basis change up to each DB funding payment date and credit rate change in future evolution after funding payment.
4. For a Pay-As-You-Go system where there is no explicit credit rate applicable to the funding source, the accumulative funding for DB component can be only be maintained in real value by a means of accumulative funding basis change larger than accumulative inflation over time after demographic adjustment. Particularly for a Pay-As-You-Go plan, the benefit for participants from funding basis increase over time will decrease in value when taking the inflation effect.
5. Inflation is irrelevant for a strictly balanced plan which achieved balance anywhere. But for any unbalanced plan and even temporarily unbalanced plan, the inflation over time will serve to reduce the plan unbalance in its real value. For unbalanced plan, realization of sign change for $[E_k \cdot P_i \Pi_{j=i+1,t}(1+b_j) - (g/S)\Pi_{j=i+1,t}(1+r_j)]$ in evolution is possibly the only way to achieve

accumulative zero balance given a constant demographic context. A strictly balanced plan is a neutral outcome for all age groups, income groups with various work participation track record. A overall balanced plan is balanced upon accounts of all members in a sum and may have disproportionate effect on different population subgroups.

6. The unbalance result from $[E_k P_i \Pi_{j=i+1,t}(1+b_j) - (g/S)\Pi_{j=i+1,t}(1+r_j)]$ will be expanded by a not-less -than-one exposure factor, $\Pi_{j=1,i}(1+b_j)$, which has been persistently expanding as the time passes in the real world. In another word, risk from future evolution on plan balance will have an exposure in term of current benefit (also funding) basis. This observation has multiple implications for plan design and its risk characteristics. Given constant S (a primary demographic factor) and g (a primary plan characteristic), the benefit grant percent, P, and credit rate, r over time shall be adjusted accordingly to achieve a balance result. For a Pay-As-You-Go system, it lies on the plan sponsor to provide an implicit credit rate to make the plan balance if the benefit granting percentage can not change in full to offset the future growth of benefit basis.

7. Plan unbalance at any time point will be growing into future due to the funding basis growth over time. It imply that unbalance will become more serious and harder in future without a sign change in the net plan balance. But the inflation rate in future will serve to reduce the unbalance growth in future in term of real value.

So far, we don't include relevant demographic factors in full. For a large and stable cohort, relevant demographic factors can be viewed a constant one. And the purpose of this article focuses on checking the inflation impact and other offsetting factors, which are independent with demographic factors. But an expansion of the forgoing formula to include relevant actuarial factors, such probability of vesting and forfeiture, the work status and survival status of a cohort considered can be made to achieve a similar observation if we can develop an expression based on linear relation rather than complex relations between all factors .

After retirement, the benefit will be enjoyed according to the benefit calculation for DB component and withdrawal setting from DC component. A generic formula can be given to consider the inflation effect on realization of pension benefit from diverse sources.

Pension benefit in a real value at the retirement point for each pension payment date of t

$=[B_0 P\Pi_{j=1,t}(1+a_j) + S_{t+1}B_0 P\Pi_{j=1,t}(1+a_j) + (C/S_0)\Pi_{j=1,t}(1+m_j) + C_{t-1}(1+c_t) - (C/S_0)\Pi_{j=1,t}(1+r_j) + A/S_0 + S_{t+1}A/S_0]/\Pi_{j=1,t}(1+i_j)$

$=[B_0 P\Pi_{j=1,t}(1+a_j) + S_{t+1}B_0 P\Pi_{j=1,t}(1+a_j) + C_{t-1}(1+c_t) + A/S_0 + S_{t+1}A/S_0]/\Pi_{j=1,t}(1+i_j)$……(11)

a_j is the post retirement benefit adjustment factor granted by plan sponsor for time j-1 to j, S_{t+1} is an actuarial factor representing the present value at time t of each dollar of benefit payment from time t+1, c_t is a credit rate for DC accumulative assets, C_{t-1}, from time t-1 to t, m_j is a factor representing the beneficiary's decision on whether the withdrawal from DC accumulative assets shall be deviating from the previous withdrawal, if any, to what extent. C is the accumulative DC assets at retirement, P is a finalized percentage imposed upon the benefit calculation basis at retirement, B_0, to calculate the benefit level under DB component. S_0 is an actuarial present value factor at the retirement representing the expected sum of each dollar of defined benefit can be received after retirement.

Certain conclusions can be drawn from formular (11):

1.The pension benefit from DC component depend on the withdrawal decisions over time and credit rates for remaining DC assets. To maintain the same purchasing power of each withdrawal, the remaining DC asset shall at least earn a credit rate at least of inflation rate over time. The risk

exposure to inflation will be decreasing in the process of DC assets exhausting.

2. The real value of current benefit payment and future benefit for DB component depends primarily on how the pension benefit will be adjusted according to the inflation over time. Given defined benefit component has been given a less than inflation adjustment after retirement, the pensioner will be deteriorating in his income position over time. Fortunately, the plan has a decreasing exposure to DB post retirement adjustment given a constant set of demographic factors.

3. Withdrawal pattern for DC assets can also significantly influence the result. It is more favorable for the pensioner to draw more when the net effect from credit rate against inflation rate is low, and draw less when the net effect from credit rate against inflation rate is high.

In a conclusion, the inflation will have an impact on both funding and liabilities of a public pension plan to the extent that it will not be exactly offset by certain plan characteristics and parameters. For a strictly balanced plan, inflation rate is irrelevant. But the inflation will serve to reduce the real value of any permanent and temporary plan unbalance. To the extent that the inflation offsetting parameters in the plan will not include the corresponding inflation effect in full, the inflation will serve to reduce the real value of other elements in the offsetting parameters which can be attributed to other sources, and lead to a tax equivalent function. When we assume an artificial parameter,r_j, for the DB funding accumulation, which is not the case for Pay-As-You-Go system, but may be appropriate as an equivalent to the function of Notional Individual Account in some jurisdictions, the implication from this assumption is quite interesting and complex beyond what the paper is primarily purposed to extend. One of these interesting implication involves we can conclude that the upper bound of r_j is b_j and the lower bound of r_j is the inflation rate i_j to achieve both a purchasing power maintenance and net zero plan balance for all participants. But the question remains where is the feasible source in practice for the plan sponsor to provide such required credit rate particularly for an expanding exposure over time?

Section 3 Background Information about Public Pension Plan in China

The social pension plan in China began in 90s as a state policy to facilitate restructuring of once inefficient State Owned Enterprises system in China as a consequence of open market economic reform in 80s, and as a method at that time to absorb a significant portion of layoffs and to transfer the existing retirement burden from state owned enterprises to a general social pooling without contribution payments from state owned enterprises undergoing the restructure. While some industry intensive regions, such as Shanghai, Beijing, began their pilot plan in early 90s, a nation wide uniform policy regarding social pension plan was established by the State Council in 1997, which required establishment of a hybrid type of pension plan with two standings, the social pooling and an individual account. Both social pooling and individual account were in fact controlled and managed by governmental administration, and some of the funding was attributed to participants through individual account, which was credited with a bank deposit interest rate annually, but the funding into individual account is actually used in entirety to pay current retirees' benefits, and leads to that the social pension plan ran as a Pay As You Go system in essence until 2005, when a new state policy focusing on reform of social pension scheme came into existence. The State Council enacted a revised social pension scheme in 2005 to address the IA loophole

issue by reducing the attribution rate to IA thereafter, requiring no further use of IA funding to support current retirement benefit payment, and a phase-in filling plan on IA loopholes, but without any timetable imposed. So far, only 18 of all 31 provinces have chosen to enforce the 2005 scheme.

The basic and relevant characteristics of the 2005 scheme have tabulated as follows:

Table 3.1 Summary on the 2005 scheme

General Narrative of the 2005 Scheme	
The 2005 scheme is mandatory for all types of employment, formal, informal, and self employment. The employer is required to make a contribution to a social pool based on a fixed percentage of his employee's monthly salary. The employee is required to make a matching contribution based on a fixed percentage of his monthly salary. All of the employee's contribution will be kept in an individual account and credited with the prevailing bank deposit interest rate annually.	
Benefit Calculation at retirement	$fB_t[(\sum_{i=0,t} P_i/t)+1]/2+\sum_{i=0,t}[C_i\Pi_{j=i+1,t}(1+c_j)]/S+A$
f	1%, which means 1% for each year's qualified service or contribution to social pool, a basic accrual rate.
B_t	The average monthly salary at the retirement in all industries in the region where the social pool operate . It will be updated in arrear annually. So in fact, the number is a last year one rather the current year one.
C_i	8% of the pensionable basis, the monthly pensionable salary (or earnings reported by self employed participants). The monthly pensionable salary for individual account is the same to for the social pooling.
P_i	An index decided by X_i/B_i, X_i is the actual pensionable salary at time i, B_i is the average monthly salary for all industry in the region quoted by the plan administration at time i.
c_j	The balance of Individual Account will be credited with the prevailing deposit interest rate quoted by bank for retail banking service annually.
S	Currently set at 139 (based on monthly withdrawal). It will vary over time to reflect change in life expectation after retirement, retirement age, interest rate.
A	An arbitrary factor decided by the plan sponsor. Currently most of time, it involves that if the retirement benefit for those initially covered under the 1997 scheme but retired according to the 2005 scheme is less than otherwise under the 1997 scheme, the retiree will be granted an addition up to the 1997 scheme level. This is a transitional arrangement for those affected work force between 1997 and 2005.
Other Characteristics	
Vesting Requirement	An accumulative fifteen years' qualified service or contribution is required.
Post retirement adjustment	No committed formula for post retirement adjustment has

	been explicitly given so far. The plan administration will decide in each year whether to adjust or not and to what extent, if any.
Post retirement use of Individual Account Savings	The Individual Account will be withdrew in a fixed amount determined at retirement. The balance of Individual Account will be credited with the prevailing one year bank deposit interest rate annually until exhausting. After exhausting, the retiree, if surviving, will be granted the DC benefit in nominal amount continuously until death. If the retiree dies before exhausting, the remaining IA savings will be given to the death's legal survivors.
Matching Contribution, g, from employer	*% imposed upon monthly pensionable salary of employee. It varies in different regions and with the participant status. For example in Shanghai, it is 22%; in Beijing, it is 20%. For those self employed or under specific types of informal employment, it is 12%.
Contribution %, c, from employee	8% imposed upon monthly pensionable salary.

In addition, the State Council has enforced a regulation since the beginning of 2010 that requires:

1.Participants in any region where they don't have a legal household registration will not have the right to quit the regional plan they participated any long.

2. Participants are now allowed to transfer their entitlement in one regional plan to other regional plan under due causes. The transfer between regional plans will result in a full transfer of Individual Account balance and 12% of monthly pensionable salary in the contribution history record. The monthly pensionable salary is based on history data without any adjustment up to current level. In numerical expression, the transfer of funding at transfer time of $k=H\sum_{i=0,k} gF^{b}_{i}+\sum_{i=0,k} [cF^{c}_{i}\Pi_{j=i+1,k}(1+c_j)]=\sum_{i=0,k}B_i[Hg+c\Pi_{j=i+1,k}(1+c_j)]$, where H is significantly less than 100%.

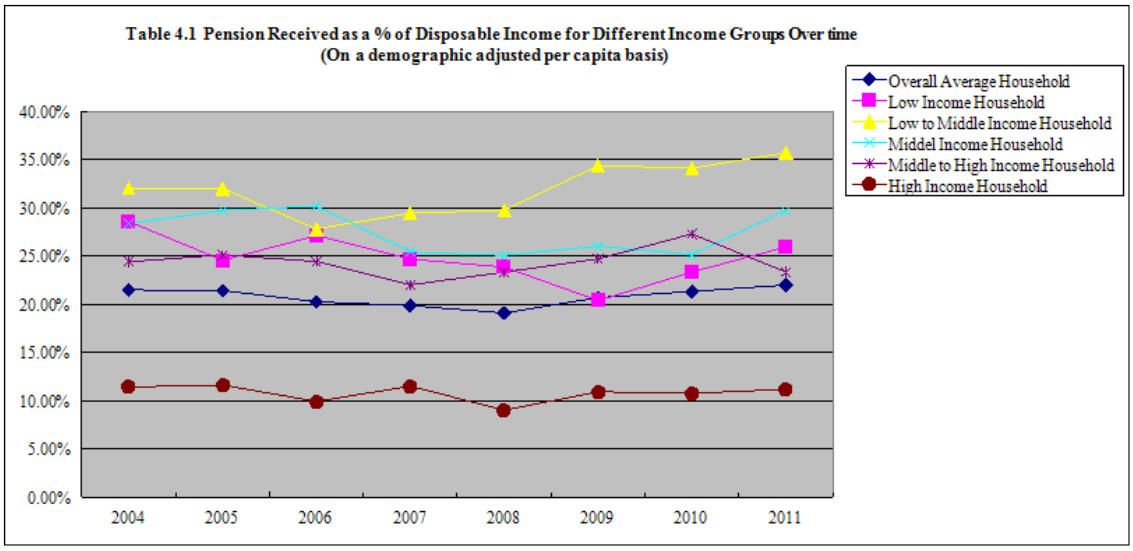
Section 4 Relevant Observations for the Public Pension Plan in China

China has undergoing an rapid process towards an aging society. The particular challenges for China in response to the aging issue involve insufficient coverage and low benefit, which will significantly jeopardize the objective of consumption smoothing and poverty reduction. With a large percentage of retirees depending primarily upon retirement benefit as their major income source, the inflation effect will produce a significant dilemma for the public pension plan. In addition, the change in the public pension schemes and the process of integration of regional public pension plan, will produce an unintended consequence on plan liability and its funding status, which will lead to jeopardize the specific interest of the population in transition and urbanization.

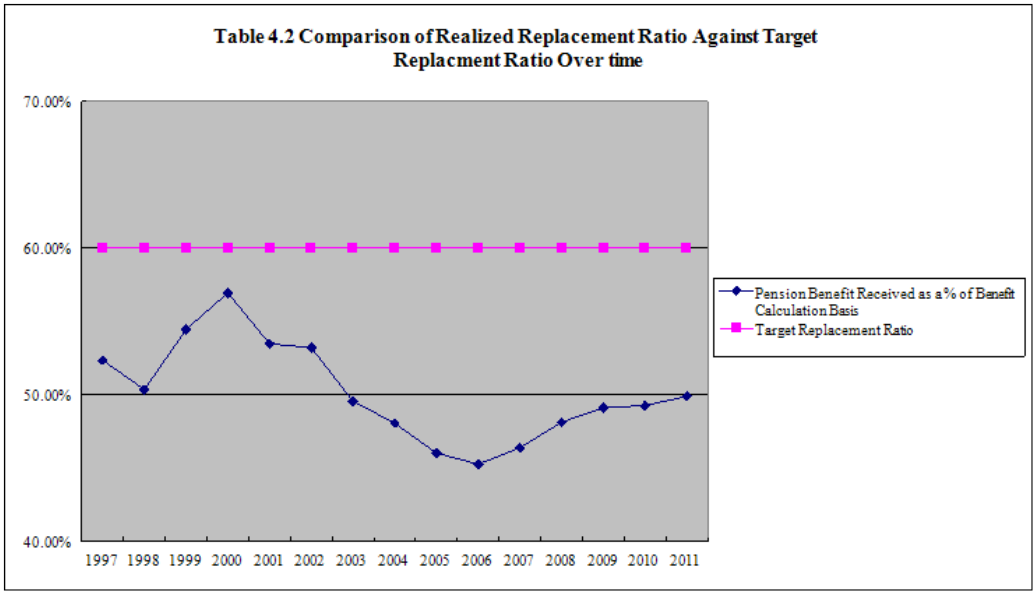
General observations for China public pension plan, from the example of Shanghai, have been given as follows.

1. About 80% of retirees' family has a material reliance on retirement benefit as an important

income source as you can see from the Table 4.1. Only high income household (20% of the sample) didn't rely upon the retirement benefit as the major income source. All other income classes had an income reliance from 20% to 36%. In particular, the low to middle income class is the most vulnerable one to retirement benefit. This vulnerable was increasing in amount and over time. The low income class showed a lower reliance on retirement benefit than the low to middle income class, but they had more access to other form of government transfer in fact than the low to middle income class over time. It's also very interesting that while the average percentage of retirement benefit in the disposable income; was consistently close to 20%. The low income class was facing a more volatility in retirement benefit against their total income, which evidenced they was the cohort crossing over official poverty threshold frequently and seeking other sources of governmental and private transfer. And their position in pension received against other income sources was deteriorating from Year 2004 to Year 2009. So both the low income class and the low to middle income class (representing 40% of the sample) were in fact the cohort heavily relying upon retirement benefit as their income source and the most vulnerable groups.



2. The achieved replacement ratio has been significantly lower than the target replacement ratio, 60%, as you can see from the Table 4.2. The replacement ratio on average has never achieved the target replacement ratio of 60%. The realized replacement ratio has been decreasing between Year 2000 to Year 2006, due to no sufficient post retirement adjustment was provided. From Year 2007, the State Council required at least 10% annual increase for retirement benefit for all retirees for the forthcoming five years. Nevertheless, the replacement ratio has not experienced a rapid revert back due to the accumulative effect will be more slow to show in a process of expanding exposure.



3. The new plan transfer regulation will produce an insufficient funding transfer issue along with liquidity concern issue. At any time before retirement for China plan, the accrued funding=$\sum_{i=0,k}[gB_0\Pi_{j=1,i}(1+b_j)\Pi_{j=i+1,k}(1+r_j)]+\sum_{i=0,k}[(cB_0\Pi_{j=1,i}(1+b_j)\Pi_{j=i+1,k}(1+c_j)]$ $=\sum_{i=0,k}B_i\ [g\Pi_{j=i+1,k}(1+r_j)+c\Pi_{j=i+1,k}(1+c_j)]$, while the funding transfer=$\sum_{i=0,k}B_i[Hg+c\Pi_{j=i+1,k}(1+c_j)]$. The shortfall in funding transfer is between $g\Pi_{j=i+1,k}(1+r_j)$ and Hg, where the r_j is a positive number set in practice or required in practice to make the plan balance. When H<100% and $\Pi_{j=i+1,k}(1+r_j)>$ 100%, the gap could be of significance. In addition, the retirement benefit will further grow at a rate of b_j up to the retirement,which will produce a gap between immediate entitlement and future entitlement, a non-zero value in term of real value, which will become particularly harsh in a process of increasing b_j and expanding exposure.

4. As it was the case, the inflation didn't make an explicit effect on the foregoing observations so far. While a significant portion of household has heavy reliance upon pension benefit, the inflation effect on pension benefit received will inevitably of importance and cannot be disregarded. The realized target replacement ratio which has been consistently lower than the target one, strongly suggested that we don't have efficient post-retirement adjustment mechanism to correct a dangerous trend, the room for pension benefit devaluation is also quite small, the accumulative result over time from non adjustment and insufficient adjustment could eventually grow to a extremely uncomfortable position.

Section 5 Analysis of Inflation Protection Effectiveness on the Three Critical Parameters

Under the analysis framework suggested in Section 2, the effectiveness of inflation protection mechanism in public plan lies on four critical factors, growth rate on Benefit Calculation Basis, credit rate on DB funding, growth rate of DC funding basis and credit rate for DC accumulated assets. In China, the Benefit Calculation Basis and DC funding basis are the same, the average salary for all industries in the region, where the local plan operates. So, under this Section, we will check the inflation protection effectiveness of these three critical parameters, including the growth rate for average salary for all industries in Shanghai and credit rate for DC assets (one year time

deposit interest rate quoted by Commercial Bank prevailing at the credit date). And the credit rate for DB funding is an artificial one, and to the extent that China plan operate as Pay-As-You-Go, it is not in existence. But it's very useful to check various candidates, including GDP growth, interest rate, stock market return, in term of providing a DB funding credit function in practice, which is relevant to pre-funding decision for DB component.

Table 5.1 Summary of Statistics on Relevant Factors

	μ	σ	Skewness	σ/μ	Correl with IR	R^2	Correl with ASNGR	Correl with GRAPE
ASNGR	0.0459	0.0138	0.4486	0.3006	0.1861	0.0346	1.0000	0.7140
GRAPE	0.0443	0.0251	1.0142	0.5662	0.4553	0.2073	0.7140	1.0000
PIR	0.0120	0.0043	1.8221	0.3621	0.2931	0.0859	-0.2469	-0.0965
EIR	0.0253	0.2033	-0.4707	8.0323	-0.4124	0.1701	-0.0701	0.0275
GDPGR	0.0462	0.0077	0.3317	0.1658	-0.0438	0.0019	0.2051	-0.0543
IR	0.0082	0.0080	0.7349	0.9774	1.0000	1.0000	0.1861	0.4553

Notes: ASNGR=Average Salary Nominal Growth Rate (Year toYear)

GRAPE=Growth Rate for Average Pension Benefit Per Retiree on nominal basis

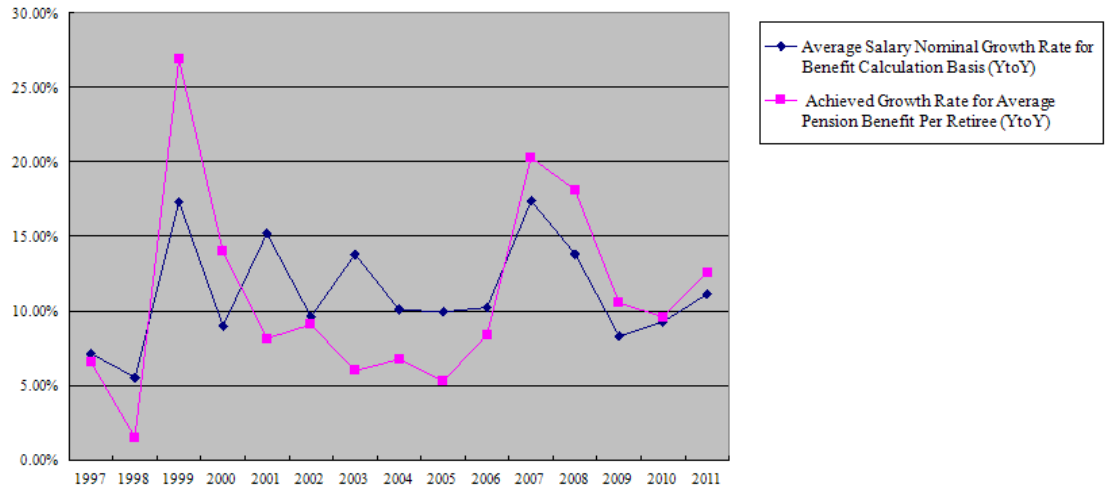
PIR=Prevailing Interest Rate

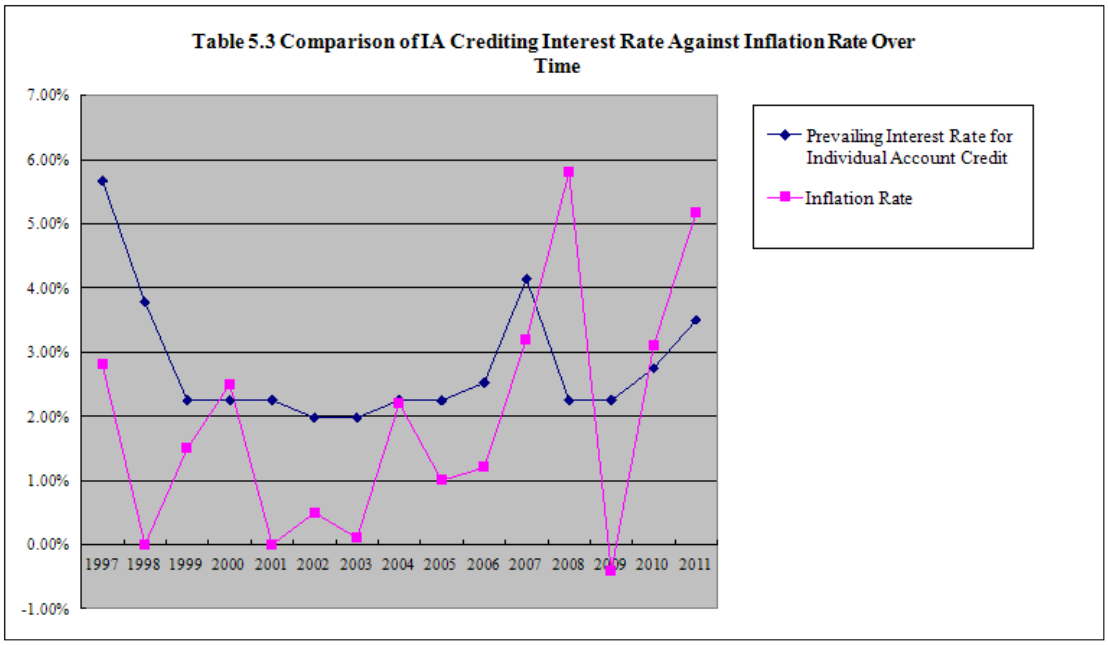
EIR=Equity Investment Return

GDPGR=GDP Growth Rate

IR=Inflation Rate

Table 5.2 Comparison Realized Increase for Retirement Benefit against the Growth Rate for Benefit Calculation Basis Over time





We retrieved all relevant data in the period from 1997 to 2011 for analysis. All data work in a multiplicative way. So all raw data have been changed into a log form in term of log(1+data). The Table 5.1 provided a summary on relevant statistics study on transformed data. The Table 5.2 gives out the historical track of Average Salary Nominal Growth Rate against Achieved Growth Rate for Average Pension Benefit Per Retiree. Table 5.3 gives out the historical track of Prevailing Interest Rate against Inflation Rate.

We have achieved some insights from the foregoing analysis:

1. While the prevailing time deposit interest rate quoted by commercial banks provides accumulative inflation protection in general, it did fall short of inflation rate at some times which may produce path depending distortion. The pattern also showed the prevailing interest rate react only partially to inflation change and more stable within a small range of 2% to 4% after excluding one extreme.

2. Change in prevailing interest rate has a negative correlation with benefit basis change implied that they evolved in different cycle over time, and suggested when the change in ASNGR affects DB and DC funding basis unfavorably, the prevailing interest rate as a credit rate for DC will provide corrective effect on DC component to a certain extent.

3. Average pension benefit per retiree has a strong positive correlation with pension benefit basis, ASNGR, but not in a strict and full way. This is consistent with the observation in Table 5.2 that the GRAPE evolved around ASNGR. But only half of volatility in GRAPE can be explained by ASNGR.

4.GRAPE has more positive correlation with inflation rate than ASNGR does, but still not in a strict and full way. The GRAPE has a tilt towards inflation adjustment rather than benefit basis change, while it doesn't include the changes from the other two in full either.

5. Equity investment return has a negative correlation with inflation suggested that it wasn't a good candidate to provide inflation protection for the case.

6. The correlation between GRAPE and PIR is near zero, which is consistent with the plan characteristics that DC withdrawal after retirement has been set in a fixed nominal amount at

retirement with no relationship with future credit rate evolution.

7. The correlation between GRAPE and EIR, between GRAPE and GDPGR was near zero respectively, and suggested that post retirement adjustment is neutral to GDP growth and equity market performance, while the ASNGR, in contrary, has a positive component to reflect the GDP growth.

In addition, in terms of effectiveness and reliability of inflation protection, we have some implications from the empirical study:

Table 5.4 Summary of Evaluating Inflation Protection Function of Relevant Parameters

	% of Time less than Inflation Rate	Testing on Average Value	Risk from Deviation	Skewness Matching	Ranking
ASNGR	0/15	Yes	Relatively Low	+	2
PIR	4/15	Yes	Relatively Low	+	3
EIR	8/15	Yes	Extremely High	−	4
GDPGR	All observations in the sample period showed a positive real value GDPGR. So 0/15.	Yes	Extremely Low	+	1

The ranking suggests that the GDP is an overwhelmingly good parameter to provide inflation protection for China case based on history record, but so far it hasn't been used in China. And equity investment return is not a good candidate from inflation protection perspective.

Section 6 International Experiences and Their Suitability to China

Basically, when we decide on making changes in the characteristics and parameters for a public pension plan, we shall consider influencing factors, and their offsetting or neutralizing sources available in different mechanisms in the real world, through evaluating their effectiveness and efficiency to achieve the the objectives of the plan, determining whether it will properly take account of consequences from plan historical evolution and implications from current status, assessing administration cost (including education cost) in various mechanisms, and properly addressing demographic factors change over time.

Within the basic objects of China plan, extensive coverage and basic benefit provision in a context of rapid aging society, currently small coverage and emerging current gap issues in plan operation, plan segmentation and less efficient market mechanism, the specific questions to the topic, which have a component of inflation concern, include among others:

1. The ultimate replacement ratio realized at retirement for these covered by the 2005 Scheme heavily relies upon the realized credit rate for DC component. Assuming the credit rate at current mechanism and regime, it is estimated that a full 30 years' work life will achieve an expected replacement ratio of 42%, a full 35 years' work life will produce an expected replacement ratio of 50%. And the larger the gap between the credit rate for DC component and the DB benefit basis growth rate, the lower the replacement ratio can be achieved, and the less effectiveness the DC component can produce. What will an appropriate mechanism to avoid this issue, particularly for a country with a large portion of informal employment?

2. The DC component credit rate issue provides additional challenge after retirement, the lower the credit rate, the sooner the DC account will be exhausted and leave the plan sponsor to more survival risk beyond exhaustion day in a process of aging. What is an appropriate alternative in practice to help address this concern?

3. When the expected replacement ratio is relatively low, the room for devalue of pension benefit after retirement is quite small, particularly in an environment of a large cohort of retirees in lower income ladder, what will be an appropriate adjustment arrangement in practice?

4. Whether pre-funding for DB component is desirable in practice? If yes, what will be appropriate sources to use pre-funding?

5. When the pre-funding from plan transfer involuntary from the plan sponsor's perspective, what will be appropriate sources to use the funding transferred?

The Table 6.1 gives out an introduction of some international practices related to the foregoing topics and a general discussion of their suitability to China case respectively.

Table 6.1 Summary on Relevant International Practices and Discussion of Their Suitability to China Case

	Sources	General Description	Required Context	Comments on Suitability
TIPS	US	A Treasury Bond provide a fixed coupon rate imposed upon an inflation indexed principal. The TIPS is more favorable in a context of inflation volatility. TIPS represents 10% of total government bond in the public market in US.	1. An efficient public market for government bonds shall exist. 2. The government shall have a reliable and offsetting revenue source to support the inflation protection commitment in the TIPS.	1.Currently, we don't have a sufficiently large public market for government bonds. 2. Bond issuance by lower level government is subject to a ceiling requirement so far. 3. The government debt, particularly for lower level government, adopts primarily a form of bank loan. 4. A good candidate for TIPS is municipal infrastructure bond in term of good offsetting and meeting expanding exposure.
Notional DC Account	Sweden	An artificial DC account is established in the public pension plan. An artificial credit rate is	1. A sound book record system exists. 2. The credit rate shall not be less than	1. Help to address portability issue in plan transfer. 2. Help to properly

		imposed upon Notional DC Account for the purpose to calculate final benefit. It's also useful to determine the cash balance upon plan termination. The NDC adopts the growth rate of average wages as the credit rate.	alternatives in market mechanism. 3. When portability is strongly desired due to the labor market context, it will be more favorable.	estimate the accrued liability for DB component. 3. Separate the benefit accrual and pre-funding decision more efficiently.
Adjustment formula using inflation rate as a benchmark	UK	Provide inflation adjustment of benefits during the period between leaving a job and the first receipt of benefits or to transfer the workers' benefits to a central clearinghouse. The inflation adjustment is equal to the rate of increase in the consumer price index, up to 5 percent annually.	This requirement is imposed upon employer sponsored pension plan but gives out a useful meaning for public pension plan.	This arrangement works to provide a floor of inflation protection for future evolution effect on accrued benefit, and serves to reduce the burden from evolution effect through a consistently higher alternative, such as salary growth rate.
DB component credit with earning basis growth over time	Suggested by Nicolas Barr and Peter Diamond	Use the average earning as the DB funding basis and the DB calculation basis to achieve average earning growth rate as an implicit credit rate for DB element.	1.A sound earning report and verification system shall exist. 2.There is an effective mechanism to allow earning change reflect relevant factors, such as inflation, productivity growth, GDP growth, etc.	Due to a large portion of informal employment and self employment in China, the introduction of earning basis should be based on a pre-condition of establishment of efficient earning report and verification system. But such suggestion does facilitate integration with resident's pension plan.

Section 7 Conclusions

The inflation risk, the most important financial risk in public pension scheme, needs to be seriously considered in a well structured manner, particularly for China case. Ping Tian [2011] has summarized in his independent empirical study that the resident's consumption has non significant correlation with pension expenditures from China government from Year 1985 to Year 2006 at the same time the consumption as a % of GDP has been deteriorating over time. It signals that introduction of public pension plan in 1997 doesn't contribute positive to the resident consumption, particularly in a period of rapid income rising cycle. It seems that the public pension plan doesn't function well on consumption smoothing. And the observations for Shanghai sample shows that the lowest income class has frequently crossed the poverty line even given their material reliance upon retirement benefit. This evidences the poverty reduction function of retirement benefit from public plan doesn't work well either even for the most developed region in China. And among others, the inflation effect, as an important benchmark for various parameters and characteristics, plays an irreplaceable role in addressing those distortions.

Based on the analysis herein, we extend relevant policy proposals as follow:

1. Development of more inflation protection vehicles in market mechanism. The priority will be GDP growth linked vehicle and inflation rate linked vehicle. The empirical study has shown the labor market is not efficient in full account of inflation effect. The bank deposit interest rate isn't efficient in term of inflation protection either. Under an economic system primarily driven by governmental sources, such as State Owned Enterprises, Government Investment in infrastructure, the government has stronger power and sources to provide relevant vehicles in market mechanism. Candidates can be Municipal Infrastructure Bond in a form of TIPS, Private Equity Investment in SOE, and etc. It will serve to develop and strengthen market mechanism in China, expand the financial sources for various local government to support its local development program.
2. Full pre-funding DC account shall be operated in an inflation protection efficient manner. Current crediting regime has significantly increased the inflation vulnerability of DC account. A credit rate with inflation rate as a benchmark is the minimum expectation from the participant's perspective. A sufficient inflation protection crediting regime for DC account will also serve to reduce the longevity risk burden for plan sponsor under current Scheme and improve the function of consumption smoothing and poverty reduction for the elder population.
3. Benefit accruals for population in migration and urbanization shall be calculated, maintained, continuously funding and finally paid separately by each regional plan which they actually participate. Current plan transfer arrangement isn't sound. An involuntary pre-funding of DB element as a result of plan transfer, particularly with obvious gaps in term of both funding accrual and benefit accrual with an rapidly expanding exposure, will add unintended pressure on seeking investment alternatives efficient in inflation protection along with the immediate liquidity concern for the plan sponsor subjecting to the transfer.
4. Involuntary pre-funding, particularly a consistent part over time, as a result from current surplus in DB element and plan transfer shall be invested in an inflation protection vehicle at least, which consequently call for more efficient investment alternatives from diverse mechanisms.
5. Establishment of a regular post-retirement adjustment policy is necessary. The benchmark can be a combination of salary growth rate, GDP growth rate and inflation rate after excluding overlapping account of inflation effect, to serve consumption smoothing and poverty reduction

function at the same time.

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Attachment

Table A.1 Summary of Inflation Impact Discussion

Benefit					
Inflation Offsetting Factors	Period of Influence	Exposure Factor	Offsetting Effectiveness	Overall Offsetting Requirement	Strict Offsetting Requirement
b_j	Up to the retirement.	$S \cdot B_0 \sum_{i=0,n} P_i$ Increasing over time due to additional P_i	Depending on the extent what the offsetting factor include corresponding inflation effect in each period.	$\Pi_{j=1,n}\ b_j \geqq \Pi_{j=1,n}\ i_j$	$b_j \geqq i_j$ for all j
f_j	Up to the most recent contribution day considered	$cF^c{}_0$		$\Pi_{j=1,n}\ f_j \geqq \Pi_{j=1,n}\ i_j$	$f_j \geqq i_j$ for all j
c_j	Beyond the most recent contribution day up to the retirement.	$cF^c{}_0 \cdot \Pi_{j=1,i}(1+f_j)$ Increasing over time.		$\Pi_{j=1,n}\ c_j \geqq \Pi_{j=1,n}\ i_j$	$c_j \geqq i_j$ for all j
Funding					
Inflation Offsetting Factors	Period of Influence	Exposure Factor	Offsetting Effectiveness	Overall Offsetting Requirement	Strict Offsetting Requirement
u_j	Up to each contribution day considered	$gF^b{}_0$	Depending on the extent what the offsetting factor include corresponding inflation effect in each period.	$\Pi_{j=1,n}\ u_j \geqq \Pi_{j=1,n}\ i_j$	$u_j \geqq i_j$ for all j
r_j	Beyond each day up to the retirement.	$gF^b{}_0 \Pi_{j=1,i}(1+u_j)$ Increasing over time.		$\Pi_{j=1,n}\ r_j \geqq \Pi_{j=1,n}\ i_j$	$c_j \geqq r_j$ for all j
Net Result for a unbalanced plan					
Inflation Offsetting Factors	Period of Influence	Exposure Factor	Offsetting Effectiveness	Overall Offsetting Requirement	Strict Offsetting Requirement
b_j	Up to each contribution day considered.	$E_k P_i \Pi_{j=i+1,t}(1+b_j) - (g/S)\Pi_{j=i+1,t}(1+r_j)$	Depending on the extent what the offsetting	$\Pi_{j=1,n}\ b_j \geqq \Pi_{j=1,n}\ i_j$	$b_j \geqq i_j$ for all j

b_j	Beyond each contribution day up to retirement.	E_kP_i Varying over time.	factor include corresponding inflation effect in each period.	Minimize the absolute value of $[E_kP_i\Pi_{j=i+1,t}(1+b_j) - (g/S)\Pi_{j=i+1,t}(1+r_j)]$	Maximize the possibility of achieving $[E_kP_i\Pi_{j=i+1,t}(1+b_j) - (g/S)\Pi_{j=i+1,t}(1+r_j)]=0$
r_j		(g/S)			
P_i	For each period considered.	$E_k\Pi_{j=i+1,t}(1+b_j)$ Being convergent to 1 over time.	Depending on the plan characteristics designed by the plan sponsor.		
Post Retirement Benefit Change over time					
a_j	Up to each period of benefit realized	B_0P	Depending on the extent what the offsetting factor include corresponding inflation effect in each period.	$\Pi_{j=1,n}\ a_j \geqq \Pi_{j=1,n}\ i_j$	$a_j \geqq i_j$ for all j
a_j	For future benefits to be received	$S_{t+1}B_0P$ Decreasing over time.		$\Pi_{j=1,n}\ a_j \geqq \Pi_{j=1,n}\ i_j$	$a_j \geqq i_j$ for all j
c_t	For all time from retirement to exhaustion of DC assets	C_{t-1}		$\Pi_{t=1,n}\ c_t \geqq \Pi_{t=1,n}\ i_t$	$c_t \geqq i_t$ for all t
C_t	For future benefits to be received.	C_{t-1} Decreasing over time.	Depending on the withdrawal pattern and credit rate ,c_t, over time up to the point considered.	The realized withdrawals up to exhaustion in real value and in sum shall be equal to the initial DC assets at retirement.	To maintain withdrawal in each period in a same real value.