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Practical Issues in Public Pension Design

Pension Policy and Risks to State and Local Budgets

Presenter:

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Yin: Okay. So, this is the joint work with my colleague Don Boyd, at the Center for Policy Research, the Rockefeller College, University at Albany. And I'd like to thank Kurt for inviting us to present the work here. And this paper is still work in progress, so your comments and suggestions will be valuable to us. So, in this presentation I'm trying to give a high level overview of the model structure we used and the summary of the useful results. And I have kept all of these technical details in the appendix. But, please feel free to ask me about the technical details if you are interested. So, okay.

So the public pension finance represents presents the single largest long-term threat to the finances of state and local governments that could be in the U.S. The funding status of the public pension system in the U.S. can be worse than that of the corporate pension system of the U.S. and a lot of pension plans in other developed countries. And the annual government contributions by state and local governments has been increasing rapidly in recent years, potentially crowding out spending on other public services. The pension finances can pose significant risk on state and local government finances, and it is crucial to evaluate pension-related risks. So currently, the pension finances heavily depend on the performance of financial markets, because pension assets are heavily invested in non-fixed income asset classes. So when investment returns fall short of expectation, the required contribution from the sponsoring government will also increase. The government just need to make up the gap really over an amortization period.

So, the resulting governmental fiscal stress depends upon the pension funding needs in relation to the governmental fiscal resources available at the time. But, the investment returns, pension finances, and the government finances are not independent from each other. Rather, they are largely affected by the same underlying economic conditions. So we and other researchers have examined the investment related risks to public pension funds and the sponsoring governments using stochastic simulation approaches.

But, most of these models use generally simple investment assumptions. It is usually assumed that investment returns just follow simple normal distribution. And perhaps more importantly, the asset returns and government tax revenues are assumed to be uncorrelated with each other. So, all of research suggests that the real world can differ from these simple assumptions. So, investment return can exhibit non-normality in it. For example, there can be fat tails, and the mean-reverted to some extent. And also, investment returns and tax revenue can be correlated with each other through business cycles.

So, the severe economic recessions really are usually accompanied by market downturns. So when the prices [inaudible 00:04:17], the investment returns usually fall short of expectation, and the required government contribution will also increase. By the same time, during recessions, the government fiscal revenue will also fall short. This will create additional fiscal pressure for the sponsoring government. So ignoring this kind of correlation will underestimate the pension-related risk to state and local governments.

So in this paper, we propose integrated simulation framework that takes into account the correlation between government finance and pension finance and the performance of financial market. So using this model framework, we can better understand and evaluate pension-related risk to the state and local government budget.

Okay. So, we do this by develop and link a small scale macroeconomic and investment return model to a pension fund simulation model, and models of governmental tax revenue. So this diagram gives a high level overview of the model structure. So the main driver of this model structure is an economic scenario generator, which generates stochastic path of real GDP growths, and returns on stock and bond investments.

So here we use a simulation horizon of 30 years, and each simulation we run 2,000 simulation runs. So, the generated stochastic economic scenarios will be fed into models of tax revenue variability. So here we estimated the relationship between tax revenue and the economic variables, so how the tax revenue will respond to business cycles. And we also construct two stylized government tax revenue structures. One is personal income tax dominant state government. And the other one is sales tax dominant state government.

So the same set of economic scenarios generated by the economic scenario generator will also be fed into a simulation model of pension finances. This pension simulation model will calculate the required pension contributions, this model will take the investment returns from the economic scenario generator as inputs and just calculate the resulting employer contributions for each simulation run.

So, now we have the government finance and the pension finance all generated within the coherent model framework. And we can use that simulation results to evaluate the pension-related risk to the government. And here we focus on two types of risks. The first one is the risk of high employer contribution related to tax revenue. And the second risk is the sharp increases in employer contribution relative to tax revenue.

So next, I will describe the different model components in greater detail. Okay. So let's first look at economic scenario generator. So, the economic scenario generator is basically a small-scale macroeconomic model that generate internally consistent stochastic scenarios of real GDP growth and returns on stock and bond investments. So the real GDP growth is modeled as a two regime Markov process that switches between economic expansion and recession regimes. So the model parameters are calibrated so that the model can capture the general historical pattern in real GDP growth, such as the average length and frequency of expansion and recession regimes.

And the stock returns are also modeled as a two regime process. There is a high return low volatility regime, and a low return high volatility regime. So the model allows for correlation between the GDP growth and stock return, by aligning the regimes of them. So, the economic expansion regime of GDP growth is aligned with high return low volatility regime of stock return. And the recession regime for GDP growth is aligned with low return high volatility regime of the stock return. It's because of this regime-switching feature of the stock return model we can generate actually a investment return distribution that has fatter tail than normal distribution.

Actually, a normal concern for this kind of model setting that aligns the regime of GDP growth and stock returns is that sometimes, the financial market is not a good predictor for economic recession. We all heard that the stock market can predict none out of the past five recessions. So, our response to that is that actually, because of the stochastic element in the stock return model and GDP growth model, actually the model framework can generate scenarios where there are financial downturns without economic recessions. And the [inaudible 00:10:40]. Some empirical studies suggest that the most severe economic downturns are highly correlated with market downturns. And, the most severe recessions have very large impact on the budget of state and local government. And that's what we are trying to capture in this model framework.

So for the bond returns, actually we do not model bond returns econometrically because of the weak historical relation between business cycle and bond returns, we found. Is that, when we do the simulation, and produce economic scenarios, we construct stochastic bond returns that have correlations to stock returns that are consistent with the historical correlation.

So basically we do two types of simulations in the paper. The first one is backward-looking simulation based on parameters estimated from historical data. And the backward-looking simulation is mainly for model validation purpose. So, using result of this simulation, we can check whether our model can capture the general historical pattern of the economic variables, based on the parameters estimated from historical data.

And then we also do a forward-looking simulation, with which we want to shed light on the pension-related risks for sponsoring governments in the future. So, in the forward-looking simulation, adjustments are made to the estimated model parameters, to ensure that simulation results are generally consistent with a set of forward-looking assumptions constructed based on our review of some external studies. And for forward-looking simulation, we use a simulation horizon of 30 years.

Okay. So now we have simulated economic scenarios generated from the scenario generator. And we'll feed that into models of tax revenue variability. So in this paper we estimate a cyclical relationship between taxes and

economy for major tax categories. The table on the right gives the share of major tax categories for state and local governments. So, because the primary source of tax revenue for local governments is property tax, which has a more complicated relationship to the business cycle, in this paper we just leave that out for future analysis, and only focused on state government. And here we look at the state personal income tax, the state general and selective sales tax, and all other state government taxes as a group. Okay.

So, in this tax revenue model, we first decompose tax revenue growth into two components. One is the cyclical growth component, and one is trend growth component. And the trend rates are estimated using [inaudible 00:14:09]. For the trend growth rate, individual taxes can have different long run behavior relative to the economy. So for example progressive income taxes generally will grow more quickly than the economy, while state sales tax bases have been declining relative to the economy. These changes actually can be easily affected by other policy changes which are very difficult to capture using model. So in our simulation, we assume that politicians will just adjust tax bases, and raised to maintain their shares of the economy over the long run. So basically, we assume that all major tax categories will grow at, we'll assume that the trend growth rate of all major tax categories will be the same as the trend GDP growth rate.

But we do allow for cycles around this trend. So for the cyclical growth rate, we estimate elasticities of the cyclical growth of tax revenue with respect to cyclical real GDP growth. And in the case of personal income tax, also respect to real asset returns. And this figure shows the cyclical components of main tax revenue sources, and the cyclical component of real GDP growth. And you can see that different categories of taxes respond to business cycle differently. But actually personal income tax and general sales tax show very cyclical behavior, with the personal income tax being more responsive to business cycle. And this pattern has become more prominent in recent years.

So some recent research suggests that one reason that personal income tax has been more responsive to business cycle in recent years is that it has been increasingly affected by capital gains, which is correlated with capital market performance and economic conditions. But in our simulation model we don't explicitly model capital gains. So in the simulation we use stock market returns as a proxy for the capital gains.

So in the simulation, the trend tax growth is the same as the GDP growth, which is assumed to be 1.9% based on the CEO projection. And the cyclical growth rate of real tax revenue is a function of the cyclical growth rate of real GDP. And in the case of personal income tax, the cyclical growth rate of the real stock market returns. And this table shows us the assumption on trend growth rate of major tax categories and the elasticities with respect to real GDP growth cycles and real stock return cycles.

Okay. So because different types of taxes respond to business cycle differently, so the tax revenue structure, so different tax revenue structures in the government can affect how the total tax revenue will be affected by business cycle. So here we constructed two stylized government tax revenue structures, the personal income tax dominant government, and the sales tax dominant government. So this figure compares the tax revenue structure for the 50 states in the US. So the horizontal axis is the share of individual income tax in the total tax revenue. And the vertical axis is the share of general sales tax in the total tax revenue. So we can see that, in upper left corner, there are states like Texas and Florida, where there is no personal income tax, and the sales tax revenue accounts for about 60% of their total tax revenue. And these states are represented by our sales tax dominant state government. And the lower right corner we can see states like California, Massachusetts, where the personal income tax accounts for about 55% of their total tax revenue, while general sales tax only accounts for about 20% of their total tax revenue. So these states are represented by personal income tax dominant state government. So this table gives us the tax revenue structure of the two stylized state government we used in the simulation.

Okay. So, now with the estimated relationship between tax revenue and the economic variables and the two stylized government tax revenue structures, we can generate paths of total tax revenue for these two stylized governments, based on the outputs from the economic scenario generator. So, same set of economic scenarios

will be fed into a pension simulation model we have constructed. So, this is overview of the structure of the pension simulation model. So we can see that the asset returns are from economic scenario generator. And we assume that portfolio structure is 70% stock and 30% bond, which is generally consistent with the risky assets, non-risky assets structure of typical portfolio of the public pension plan in the US. So we assume that year one funded ratio of this pension plan is 75%, which is around the average of the public pension plans in the US. And this model will calculate the required government contribution for each simulation run from the economic scenario generator. So here we'll assume that the sponsoring government will pay full required contribution. But, this assumption can be easily relaxed in a future analysis.

Okay. Now we can put all things together. So now we have government finances, and the pension finances, all generated within the coherent model framework. We can use these model results to evaluate the compounding of risks from the correlated investment returns and tax revenues. So we will compare the stylized governments with the baseline model where there is no linkage between different model components, and alternative model structures where there are only partial linkage between model structures. So this comparison will allow us to understand how pension-related risks can be understated if the link between different model components is ignored. And we can also see once the linkage is taken into account, how the increase in the risk can be attributed to different factors in the model.

So we look at two types of risks here. The first one is the risk that the required employer contribution become very high relative to fiscal resources available to the sponsoring government, which can cause fiscal pressure for the government, and potentially crowd out spending on other public services. And the second type of risk is the risk that required employer contributions rise sharply in a short period of time. This can cause difficulty in budget planning for the government, and the short-term financial stress.

Okay. So this table shows us the risk of high employer contributions. And this risk in the model is measured by the probability that employer contribution as a percentage of total tax revenue, being more than five percentage points above the year one value at any time during the 30 year simulation period. So, the three rows of this table represents three different amortization method used by the pension plan. So they have, these three amortization methods pays down unfunded liability at different speed, and have different smoothing effect for the employer contribution. So the first one is a 10-year constant dollar open amortization, which pays down the unfunded liability the fastest, and has the weakest contribution smoothing effect. And the 30-year open constant percent amortization method pays down the unfunded liability the slowest, and it has the strongest contribution smoothing effect, and is very common amortization method for a lot of severely underfunded pension plans in the US. So, the columns of this table are different model structures.

So let's first look at the first column. So the first column is the baseline model, where there's no linkage between different components of the model. So, no link between the business cycle and the government finance and no link between GDP cycle and asset investment returns. Here we'll assume that tax revenues will grow smoothly over time at a constant rate, and asset returns are drawn from a normal distribution. And we can see that the risk measure is the lowest among all columns.

And the second column will allow for correlation between the business cycle and investment returns, but there is still no correlation between GDP and the government finance. So recall that, because of the regime-switching feature of the stock return model, we actually can generate a stock return distribution that has fatter tail than normal distribution. So, comparing the results of column two to the results of column one actually shows us the pure effect of introducing non-normality to the model. So we can see the risk measure is moderately higher than that in the column one.

So in the third column, we have business cycle linked to government finance, but not asset returns. So comparing column three to column one actually gives us the pure effect of introducing tax revenue volatility that is not correlated with asset returns. So we can see that risk measure is also only moderately greater than that in column one.

Audience: I have a question about that. So just so I can understand these numbers better, what is year one employer contribution as a percent of total tax revenue? What percent of total tax revenue is employer contribution? Because, you're moving up by five percentage points, so five percentage points is a huge number if the employer contributions in year one are 1%. It's in some sense not that serious a number if employer contributions are 50%, let's say. But do you know how much they are in year one?

Yin: Okay. So, this is the joint work with my colleague Don Boyd, at the Center for Policy Research, the Rockefeller College, University at Albany. And I'd like to thank Kurt [SP] for inviting us to present the work here. And this paper is still work in progress, so your comments and suggestions will be valuable to us. So, in this presentation I'm trying to give a high level overview of the model structure we used and the summary of the useful results. And I have kept all of these technical details in the appendix. But, please feel free to ask me about the technical details if you are interested. So, okay.

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But, most of these models use generally simple investment assumptions. It is usually assumed that investment returns just follow simple normal distribution. And perhaps more importantly, the asset returns and government tax revenues are assumed to be uncorrelated with each other. So, all of research suggests that the real world can differ from these simple assumptions. So, investment return can exhibit non-normality in it. For example, there can be fat tails, and the mean-reverted to some extent. And also, investment returns and tax revenue can be correlated with each other through business cycles.

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So here we use a simulation horizon of 30 years, and each simulation we run 2,000 simulation runs. So, the generated stochastic economic scenarios will be fed into models of tax revenue variability. So here we estimated the relationship between tax revenue and the economic variables, so how the tax revenue will respond to business cycles. And we also construct two stylized government tax revenue structures. One is personal income tax dominant state government. And the other one is sales tax dominant state government.

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Actually, a normal concern for this kind of model setting that aligns the regime of GDP growth and stock returns is that sometimes, the financial market is not a good predictor for economic recession. We all heard that the stock market can predict none out of the past five recessions. So, our response to that is that actually, because of the stochastic element in the stock return model and GDP growth model, actually the model framework can generate scenarios where there are financial downturns without economic recessions. And the [inaudible 00:10:40]. Some empirical studies suggest that the most severe economic downturns are highly correlated with market downturns. And, the most severe recessions have very large impact on the budget of state and local government. And that's what we are trying to capture in this model framework.

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for sponsoring governments in the future. So, in the forward-looking simulation, adjustments are made to the estimated model parameters, to ensure that simulation results are generally consistent with a set of forward-looking assumptions constructed based on our review of some external studies. And for forward-looking simulation, we use a simulation horizon of 30 years.

Okay. So now we have simulated economic scenarios generated from the scenario generator. And we'll feed that into models of tax revenue variability. So in this paper we estimate a cyclical relationship between taxes and economy for major tax categories. The table on the right gives the share of major tax categories for state and local governments. So, because the primary source of tax revenue for local governments is property tax, which has a more complicated relationship to the business cycle, in this paper we just leave that out for future analysis, and only focused on state government. And here we look at the state personal income tax, the state general and selective sales tax, and all other state government taxes as a group. Okay.

So, in this tax revenue model, we first decompose tax revenue growth into two components. One is the cyclical growth component, and one is trend growth component. And the trend rates are estimated using [inaudible 00:14:09]. For the trend growth rate, individual taxes can have different long run behavior relative to the economy. So for example progressive income taxes generally will grow more quickly than the economy, while state sales tax bases have been declining relative to the economy. These changes actually can be easily affected by other policy changes which are very difficult to capture using model. So in our simulation, we assume that politicians will just adjust tax bases, and raised to maintain their shares of the economy over the long run. So basically, we assume that all major tax categories will grow at, we'll assume that the trend growth rate of all major tax categories will be the same as the trend GDP growth rate.

But we do allow for cycles around this trend. So for the cyclical growth rate, we estimate elasticities of the cyclical growth of tax revenue with respect to cyclical real GDP growth. And in the case of personal income tax, also respect to real asset returns. And this figure shows the cyclical components of main tax revenue sources, and the cyclical component of real GDP growth. And you can see that different categories of taxes respond to business cycle differently. But actually personal income tax and general sales tax show very cyclical behavior, with the personal income tax being more responsive to business cycle. And this pattern has become more prominent in recent years.

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So in the simulation, the trend tax growth is the same as the GDP growth, which is assumed to be 1.9% based on the CEO projection. And the cyclical growth rate of real tax revenue is a function of the cyclical growth rate of real GDP. And in the case of personal income tax, the cyclical growth rate of the real stock market returns. And this table shows us the assumption on trend growth rate of major tax categories and the elasticities with respect to real GDP growth cycles and real stock return cycles.

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about 20% of their total tax revenue. So these states are represented by personal income tax dominant state government. So this table gives us the tax revenue structure of the two stylized state government we used in the simulation.

Okay. So, now with the estimated relationship between tax revenue and the economic variables and the two stylized government tax revenue structures, we can generate paths of total tax revenue for these two stylized governments, based on the outputs from the economic scenario generator. So, same set of economic scenarios will be fed into a pension simulation model we have constructed. So, this is overview of the structure of the pension simulation model. So we can see that the asset returns are from economic scenario generator. And we assume that portfolio structure is 70% stock and 30% bond, which is generally consistent with the risky assets, non-risky assets structure of typical portfolio of the public pension plan in the US. So we assume that year one funded ratio of this pension plan is 75%, which is around the average of the public pension plans in the US. And this model will calculate the required government contribution for each simulation run from the economic scenario generator. So here we'll assume that the sponsoring government will pay full required contribution. But, this assumption can be easily relaxed in a future analysis.

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Okay. So this table shows us the risk of high employer contributions. And this risk in the model is measured by the probability that employer contribution as a percentage of total tax revenue, being more than five percentage points above the year one value at any time during the 30 year simulation period. So, the three rows of this table represents three different amortization method used by the pension plan. So they have, these three amortization methods pays down unfunded liability at different speed, and have different smoothing effect for the employer contribution. So the first one is a 10-year constant dollar open amortization, which pays down the unfunded liability the fastest, and has the weakest contribution smoothing effect. And the 30-year open constant percent amortization method pays down the unfunded liability the slowest, and it has the strongest contribution smoothing effect, and is very common amortization method for a lot of severely underfunded pension plans in the US. So, the columns of this table are different model structures.

So let's first look at the first column. So the first column is the baseline model, where there's no linkage between different components of the model. So, no link between the business cycle and the government finance and no link between GDP cycle and asset investment returns. Here we'll assume that tax revenues will grow smoothly over time at a constant rate, and asset returns are drawn from a normal distribution. And we can see that the risk measure is the lowest among all columns.

And the second column will allow for correlation between the business cycle and investment returns, but there is still no correlation between GDP and the government finance. So recall that, because of the regime-switching feature of the stock return model, we actually can generate a stock return distribution that has fatter tail than normal distribution. So, comparing the results of column two to the results of column one actually shows us the

pure effect of introducing non-normality to the model. So we can see the risk measure is moderately higher than that in the column one.

So in the third column, we have business cycle linked to government finance, but not asset returns. So comparing column three to column one actually gives us the pure effect of introducing tax revenue volatility that is not correlated with asset returns. So we can see that risk measure is also only moderately greater than that in column one.

Audience: I have a question about that. So just so I can understand these numbers better, what is year one employer contribution as a percent of total tax revenue? What percent of total tax revenue is employer contribution? Because, you're moving up by five percentage points, so five percentage points is a huge number if the employer contributions in year one are 1%. It's in some sense not that serious a number if employer contributions are 50%, let's say. But do you know how much they are in year one?

Yin: So, here we have a note about that. So in year one, the employer contribution is 5%.

Audience: Okay. All right. So we are basically talking about raising it from 5% to 10%. Right?

Yin: Because different amortization pattern will lead to different...

Audience: I understand. I understand that. So we're talking about a market probability that will go from 5% to 10%.

Yin: That's right. That's right. That's right.

Audience: That's good. That's a pretty significant increment.

Yin: Okay. So let's move to column four, where both government finance and asset returns are linked to the business cycle. So, actually here we can see the effect of the compounding of the correlation between the government finance and the asset returns. So although we see that isolated effects of linking investment returns or government finance are only limited, the compounding effects of these correlation can be significant. You can see a huge increase in risk measures compared to column one, two and three. So this shows us the importance of taking into account the correlation between government finance and investment returns when evaluating pension-related risks.

Audience: So, if you look at those four scenarios, and you sort of look at the different states and how they do planning, which of those buckets do they fit in?

Audience: I think that's the last two columns he's going to talk about.

Yin: Yeah, I'm going to talk about the...Because the government finance in these two models are not the stylized governments we constructed.

Audience: Got it. Got it. Okay.

Yin: We assume that they just grow at the same rate as GDP grows.

Audience: The current planning assumes no risk, I would argue.

Audience: Right, right.

Yin: Yeah. So, now we move to the two stylized governments we constructed here. And you can see for the

sales tax dominant government, the risk measure is pretty similar to that in the column four, but for the income tax dominant government, the risk measure is much higher than that in column four and five. That is because we allow asset returns to also affect income tax. So this will create higher volatility and higher correlation between government finance and business cycle. So, the risk measure is also higher here.

Okay. And this table show us the results for the second type of risk, the risk of sharp increases in pension contributions relative to tax revenues. And basically you can see the same pattern as we move from model one to model six. But the increase in risk measure is not as much as that we have seen for the first risk measure. But, as we move from column one to column three, the first row to the third row, we can see that the risk measure has been reduced dramatically. because we move from less stretched out amortization method to more stretched out amortization method. And this is because the risk of sharp increases in pension contributions can be considered as the short-term risk. And the amortization methods of pension plans actually are designed to dampen this short-term risk. So they can reduce this kind of risk dramatically.

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Okay. So basically this paper shows us the importance of taking into account the correlation between investment risk, pension finances and the government finances when evaluating the pension-related risks for the state and local governments. And the simulation results demonstrate that the pension-related risk can be even larger than commonly understood under some simple assumptions. And the risks can be further exasperated by how state tax revenue structures respond to economic conditions. And the model also shows that the choice of funding policies for public pension funds can also have a significant impact on the risks the sponsoring government faces.

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Audience: So if you are the random legislature, and you're saying, "Well, you know what? I really want to reduce distributions." then I think I actually want to go for 30 year smoothing. Right?

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Audience: Can I ask a question?

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Audience: It might be very useful to frame it in terms of how much will this affect the tax you're going to pay. Because then people will sort of, indeed they can understand that this correspond to tax increase, or whatever.

Yin: Yes, I understand. Right. Just add per capita analysis for this. Right? Yeah. Yep.

Audience: So the best way to mitigate contribution risk of both types is to employ a 30 year open custom percent of payroll approach, which seems to violate the principles of intergenerational equity, because the service lives of employees is far less than 30 years average. So how do you reconcile that?

Yin: So actually, this is the choice of a lot of severely underfunded pension plans, I think this is one reason there is underfunding. I don't think they just take into account the intergenerational equity into when they design these kind of pension rules.

Audience: If you want perfect intergenerational equity, you want immediate amortization.

Audience: Is this soon [inaudible 00:41:58].

Audience: What was the question?

Yin: Yes. [inaudible 00:42:03] yes. It seems for funding it is good.

Audience: No. I mean, does it start?

Yin: Starting 75%. Right.

Audience: Another thought on your smoothing periods. It depends on other assumption you have on increments on. Right? If you lower it, the number's going to be way bigger.

Yin: So, the growth rate...

Audience: My point is like, the assumption you put in there, when we want to make policy decision, well, the more I expect, the quicker I'm going to be out of [crosstalk 00:42:40].

Yin: Right. That's right. That's right.

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Yin: Yeah. Actually, a lot of the simulation is, the pension plan used a 7.5% discount rate when doing this, their liability, but liability evaluation. But actually, the simulation, the median investment return from the simulation is lower than 7.5%.

Audience: I continue to go [inaudible 00:43:08] I have this suspicion again, it's totally unproven. But even for example in Minneapolis, right. Minneapolis used to have almost more population in the 1950s and '60s. We really are now finally going up because people are moving inside. But, there's very little restrictions to move to Edina or other communities that are newer and have a lot of tax burden. So I think that part of the problem that a lot of these communities with really problem pension is that they cannot protect their population base. Isn't that Detroit? I mean for years you have had various suburbs that have been very successful, while Detroit has withered. So I wonder whether there is a lot to that, that creates a real problem, in addition to the issue that you are raising.

Yin: So, one of our next step is to look at the difference between different states more closely, to build the state or even city specific models, and just to recalculate these risk measures. That would be just to take of those concerns.

Audience: Good.

Audience: A comment. When you look at the corporate, you look at the covenants. Right? So that's sort of a credit risk assessment of the sponsor. I think you probably have to do the same here, thinking in the longer term trends and all of that. It's just going to be, when you go down, the model going to be less important but rather better understand the dynamics of the city or the region. So it's going to be almost a, I say, manual work credit assessment of the local government.

Yin: Right. Okay. Thank you.

Audience: I mean, there's a lot of risks. The real world risks are a lot bigger than anything that Yimeng and I have been able to deal with here. I mean, and the risks of, you know, the [inaudible 00:45:06] type effects are, you know, I mean, I think it's real. I mean, Illinois and Indiana you know, but we assume large contribution increases get paid with no negative impacts in here, but politicians clearly think otherwise.

Audience: It would be quite fun if you take and try to figure out if you have a state, and say, "What are the condition that would break this?" So, how much recession do you need? It's almost like a pre-mortem. If it's going to fail, what are the necessary things that's going to drive it to failure? Because then I think it's much easier to communicate with stakeholders, because they have something concrete. If this happened your basically fried. So how unlikely is it that this would actually happen? And people are going to realize it's more likely than they actually think.

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Yin: This is the business for my PhD dissertation, and my PhD advisor actually asked me to do that. So I have to.

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Audience: It's called a legacy problem.

Yin: Okay. So let's move to column four, where both government finance and asset returns are linked to the business cycle. So, actually here we can see the effect of the compounding of the correlation between the government finance and the asset returns. So although we see that isolated effects of linking investment returns or government finance are only limited, the compounding effects of these correlation can be significant. You can see a huge increase in risk measures compared to column one, two and three. So this shows us the importance of taking into account the correlation between government finance and investment returns when evaluating pension-related risks.

Audience: So, if you look at those four scenarios, and you sort of look at the different states and how they do planning, which of those buckets do they fit in?

Audience: I think that's the last two columns he's going to talk about.

Yin: Yeah, I'm going to talk about the...Because the government finance in these two models are not the stylized governments we constructed.

Audience: Got it. Got it. Okay.

Yin: We assume that they just grow at the same rate as GDP grows.

Audience: The current planning assumes no risk, I would argue.

Audience: Right, right.

Yin: Yeah. So, now we move to the two stylized governments we constructed here. And you can see for the sales tax dominant government, the risk measure is pretty similar to that in the column four, but for the income tax dominant government, the risk measure is much higher than that in column four and five. That is because we allow asset returns to also affect income tax. So this will create higher volatility and higher correlation between government finance and business cycle. So, the risk measure is also higher here.

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Audience: It's called a legacy problem.

Audience: Great. So I think we're a little ahead of schedule. But I want to thank Yimeng for presenting.

Yin: Thank you.