Municipal Finance Simulation Model (MFiSiM)

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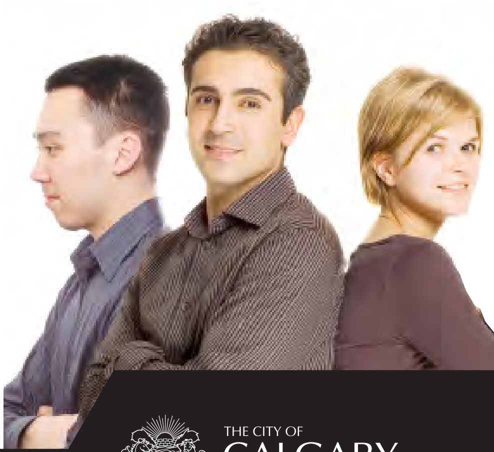


THE CITY OF
CALGARY
CHIEF FINANCIAL OFFICER'S DEPARTMENT

Table of Contents

1. Introduction

The Municipal Finance Simulation Model (MFiSi Model or MFiSiM) is a system dynamic model that was designed to assess the impact of potential changes on The City of Calgary's financial position. The MFiSi Model monitors the key financial indicators of The City and assists municipal planning by capturing the dynamics of the economy and local market through employment, housing and demographic changes, estimating the impacts of those changes on The City's revenues and service requirements, and providing 'what-if' analysis to show alternative scenarios under different assumptions.

The model has been inspired by two separate modelling efforts. The most notable influence was the BOOM town model and its extensions by Ford et al. from Los Alamos National Laboratories, which is described in several technical reports as well as peer-reviewed external papers (Ford 1976b, 1976c, 1977a, 1977c, 1978a; Rink and Ford 1978, Monts 1978). This stylized model investigated the dynamics of municipal boom and bust phenomena associated with the development of large energy projects on small municipalities, including consideration of construction-driven economic growth, city services, housing, retail and service space, migration and municipal financing. The second important precursor models were financial planning and impact assessment models developed for The City of Edmonton in the early 1990s (Walters & Jamal, 1996, Walters & Jamal 1999) and The City of Calgary in 2000s (Walters, Kongnetiman & Jamal 2002, Walters, Fan, Kongnetiman, and Osgood 2011). These models extended the application to municipalities of any scale, not just small municipalities. Thus, cities like Calgary and Edmonton could easily be analyzed through the system dynamic model.

Another motivating factor for the construction of the MFiSi Model was the financial crises for various orders of government in Canada, including federal, provincial and municipal levels in 1990s and 2000s. It is necessary for the governments to realize and prepare proactively for the impacts from changing economic factors such as rapid rise in oil prices, rapid population growth, failure of municipal revenues to keep pace with economic growth, and growing infrastructure gap, etc.

The MFiSi Model is cost effective, since municipalities can avoid expenditures on experiments where decisions cannot be reversed without significant financial, economic, or social loss. With MFiSiM, conditions can be varied to analyze the corresponding outcomes, critical situations can be investigated without risks, and behaviours can be studied over a long period of time. The dynamic system model is able to analyze a problem at different levels of abstraction. By approaching the system at a higher level of abstraction, the model user is better able to understand the behaviours and interactions of components in the municipal finance. The users are allowed to analyze specific problems at business unit level or at aggregate level. Since municipal finance is a complicated system by time and information delays, nonlinearity and feedback loops, it is difficult to predict the impacts from certain changes from either internal or external sources beforehand. The MFiSiM has the advantage of examining non-linear relationships between variables and thus providing more reliable results for decision makers.

The report is organized as follows: after the introduction the model structure is explained in section 2. Section 3 reports the model's calibration results and the base case. Section 4 shows the simulation results of the above four scenarios with the comparison to the base case. And the final section presents the conclusion.

2. Model Structure

The City is modeled as a system that is comprised of a number of parts. There are five key components in the MFiSi Model: the employment, population, residential housing, and non-residential spaces (including office, industrial and commercial spaces), and the municipality. Figure 1 provides a general idea of how the model works.

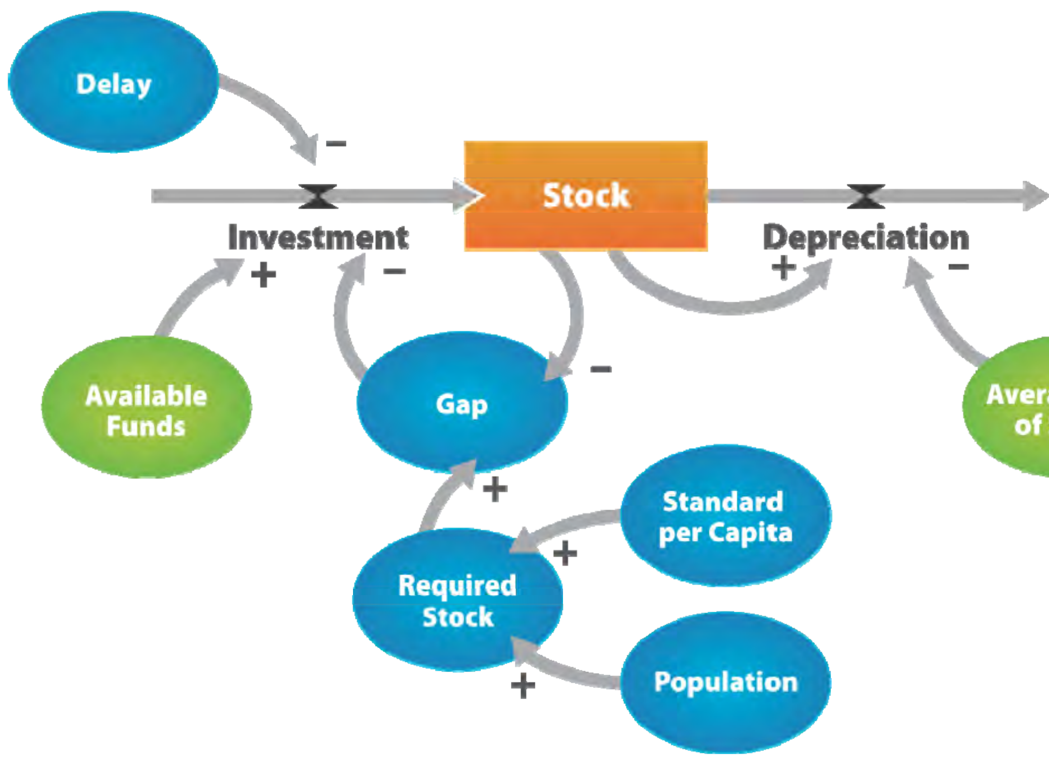
2.1 Model Framework

The components are developed with the Vensim software as a system with 26 modules. The model describes how municipal finance functions by getting revenues from housing and business stocks, and providing services that the municipal government is responsible for, including community services such as parks and recreation, transportation services such as roads, buses and LRTs (light rail transit) and safety services etc. The availability of services, as well as housing conditions and job market, would influence the population changes and employment in Calgary. At the same time, employment and population are the driving force for the demand of residential and non-residential spaces.

Figure 1: Key Components

We model municipal asset changes through the dynamic demand and supply for municipal services. Different business units are included to describe the functions of the municipal services. The MFiSiM is capable to capture the common features of business units.

Figure 2: Municipal Assets



For each business unit, the demand for services is determined by total population in the city and the standard levels of services. For a given period of time span, we assume the standards as constants. In that way, the demand function would be a monotonically increasing function of the total population.

$$Demand\ for\ services = f(Population, Standards) \qquad (1)$$

Supply of services follows the standard production function out of labour and capital inputs. Here labour is denoted as the total number of employees of The City, and capital is the stock of municipal assets[1].

$$Supply\ of\ services\ = f(Employees, Municipal\ assets) \qquad (2)$$

[1] This refers to the items recorded in The City's Annual Report balance sheet.

The stock of municipal assets is determined by the initial value of each period and the changes in that period, including investment and depreciation. Depreciation is influenced by the level of municipal capital and the average life of capital.

$$Stock = Initial\ stock + \int (Investment - Depreciation) \quad (3)$$

The gap between current services and required services generates the demand for investment, while it is not necessarily realized in each period. The realization of the investment depends on the available funds from municipal revenues, and how much the gap is.

$$Investment = Min\{Cost\ of\ gap, Available\ funds\} \quad (4)$$

We examine each business unit of The City, including customer-facing and non-customer-facing business units. The sum of labour costs and non-labour costs of all BUs would be the total operating costs.

$$Operating\ cost = Labour\ cost + Non\_labour\ cost \quad (5)$$

Labour cost is calculated as average salary of each full time equivalent (FTE) multiplied by the total number of FTEs in the City.

$$Labour\ cost = Employees * Average\ salaries \quad (6)$$

And non-labour cost measures the maintenance costs of capital. The costs not directly related with wages and other labour costs are defined as non-labour costs.

$$Non\_labour\ cost = f(Capital) \quad (7)$$

2.2 Housing Market Module

Among the 26 modules we have developed, the module of housing market is simplified and emphasized here, since it explains the dynamics of housing prices and quantities, and a significant portion of the property tax base. The non-residential module of the real estate market is the new contribution of the MFiSi model compared to the previous two generations of models. Rink and Ford (1978) first modelled the housing sector. The MFiSiM simulates price and quantity changes in both residential and non-residential sectors.

The model adopts the stock-flow methodology from previous studies to simulate the unstable and cyclic behavior of prices and to show that the lag in the supply is the major reason causing business cycles (Wheaton, 1999; Ford, 2009; Hanieh et al., 2010). The formulation of the stocks on the supply side in the model follows work by Mashayekhi et al. (2009) and Atefi et al. (2010). On the supply side, an increase in completed residential housing construction increases the vacancy stock on the market, which depresses the market housing prices. A lower price level results in a reduction in the number of housing units started, which leads to lower levels of the vacancy stock. If the demand for residential housing is the same, a lower vacancy stock will cause an increase in the price. The model is able to simulate the cycles in price changes in the residential market.

The demand for residential housing comes from the number of families in need of housing and the price of housing. The number of families who are in need of houses is determined by the difference between the total households in Calgary and the households which have housing. On the demand side, assuming all other things are equal, an increase in the total number of families will result in an increase in demand for housing which reduces the vacant stock of residential housing and causes the vacancy rate to decline. At a lower vacancy rate, upward pressure is exerted on the market price for housing. The higher housing price will cause the average mortgage payments to increase, thus resulting in a higher qualifying income for new home purchasers. As the qualifying income increases, the fraction of families that are qualified declines and as a result, the demand for housing will fall.

Figure 3: Housing Market

Housing price is determined by the demand and supply in the market.

$$Housing\ price = f(Housing\ demand, Housing\ supply) \tag{8}$$

Demand comes from the total number of families in the city, and the fraction of qualified families with the affordability, while affordability is again determined by household income and housing costs. In this model, housing costs include mortgage costs, utility costs, and property tax costs.

$$Housing\ demand = f(Fraction\ of\ qualified\ families, Total\ families) \tag{9}$$

In the above equation, fraction of qualified families is determined by the distribution of household income of families in the city and the average housing price.

$$Fraction\ of\ qualified\ families = f(Housing\ price, Household\ income) \tag{10}$$

Housing supply is determined by housing prices and construction costs. Delays between initiation and completion of a project include a planning and approval delay, and a construction delay. Higher housing prices would encourage home builders to build more and increase supply. Escalating development costs would negatively affect housing supply.

$$Housing\ supply = f(Housing\ price, Development\ costs) \tag{11}$$

Total families are estimated as the initial families at the beginning of the period in the city, plus the number of new families in-migrated within the period.

$$Total\ families = Initial\ families + \int(New\ families\ inmigrated) \tag{12}$$

The number of new families in-migrated is determined by the labour market in Calgary, especially the net employment changes during the period. Employment growth encourages people to move from other regions into Calgary, usually bringing in their families.

$$New\ families\ inmigrated = f(Net\ employment\ changes) \tag{13}$$

3. Model Validation

The MFiSi model went through an extensive and rigorous process to arrive at model parameter estimates, including an extensive parameterization phase and an iterated and intensive calibration phase. Calibration was conducted over the period 1990-2012 with respect to several dozen time series, spanning a wide variety of aspects of City of Calgary operations and aspects of the economic context. In 2002, the model was presented at the 20th International Conference of the System Dynamics Society in Palermo, Italy. The extended model was peer reviewed by Professor Nathaniel Osgood from the University of Saskatchewan in 2010, and presented at the 29th International Conference of the System Dynamics Society in Washington DC in 2011.

While simulation models evolve according to relationship between variables, the particulars of that evolution is shaped by model parameter values. Model parameters might give, for example, the elasticity of the price of housing based on demand, the cost required to construct a 1 km segment of road, or the amount of office space required for a single full-time employee. The behavior exhibited by the model in the first years of simulation will also tend to be significantly affected by the starting point of the model – the initial values of model "stocks" that capture the current state of the model. Because model behavior – and the relative desirability of policies – will generally depend on parameters and initial state, the construction of models to be used in planning seeks reliable estimates for these quantities.

The main objective of model calibration is to select model parameters to make model generated results as close as possible to historical data in the time period of 1990 to 2012 when the historical numbers are available. Firstly, a payoff function is defined as the weighted sum of squared discrepancies of key variables. Then, different key variables were assigned with different weights, to reflect the perceived importance of the data being matched to model purpose, and to the reliability of the data. Next, the constraint parameter ranges are defined to control the optimization. And finally, we run the model to maximize the payoff by searching the optimal parameters.

Several examples of the simulated values against historical data are shown below in figures 4-7. Here we show the key variables which describe how municipal finance functions, including the total labour cost, total expenditure and total debt of the City of Calgary, as well as the total full time equivalents (FTEs) working for the municipality. Figure 4 shows the results of total labour cost from model calibration, and compares the difference between it with the historical data. As it can be seen, the calibrated results are close to what had happened to labour cost in history.

Figure 4: Calibration Results: Total Labour Cost

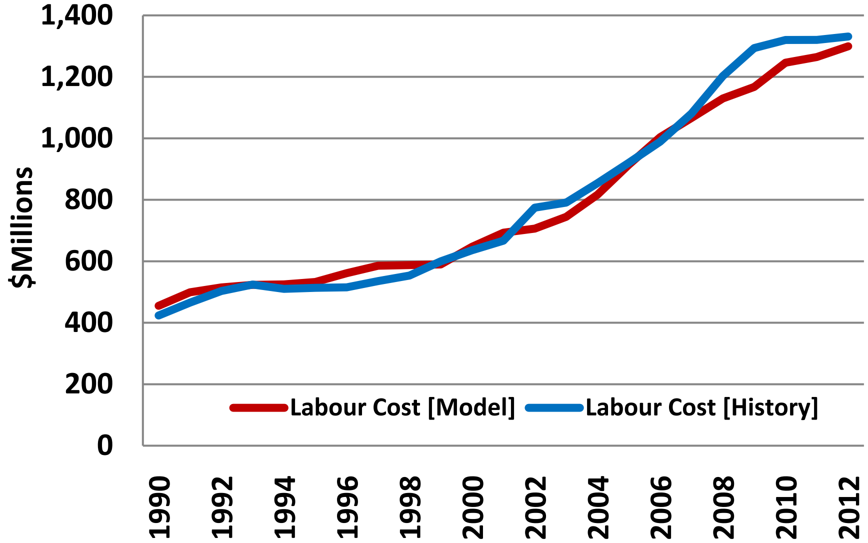


Figure 5 shows the calibration results of total expenditure of The City. From 1990 to 2007, the model generated trajectory fits well with the historical data. After 2008, the expenditure data generated by model is slightly lower than the historical numbers, but following the same upward trend.

Figure 5: Calibration Results: Total Expenditure

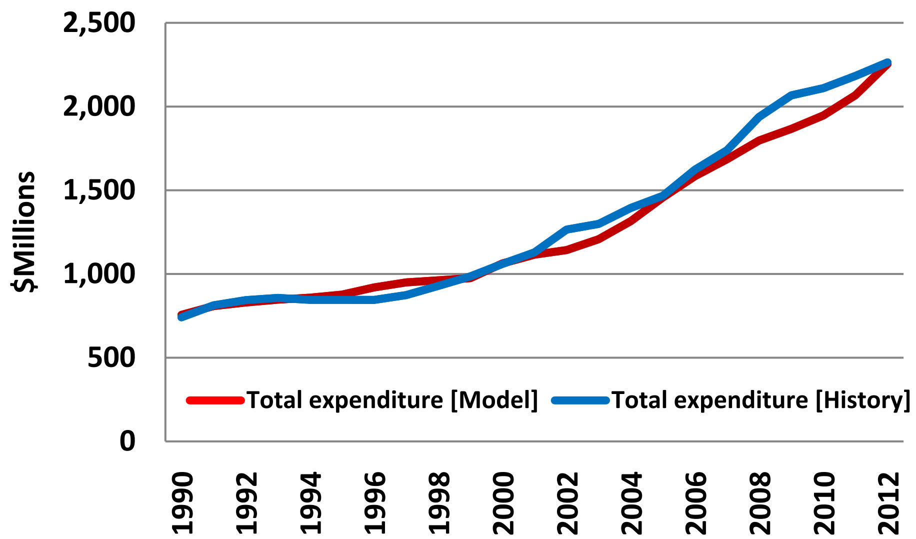


Figure 6 shows the calibration results of total debt. The model-generated results are slightly lower than historical data in the beginning of the calibration period. Around 2000 to 2004, the numbers generated by the model are very close to the historical data. From 2005, the results from the model are higher than history, but this changed after 2009. Overall, the discrepancies between model and historical data are within reasonable ranges.

Figure 6: Calibration Results: Total Debt

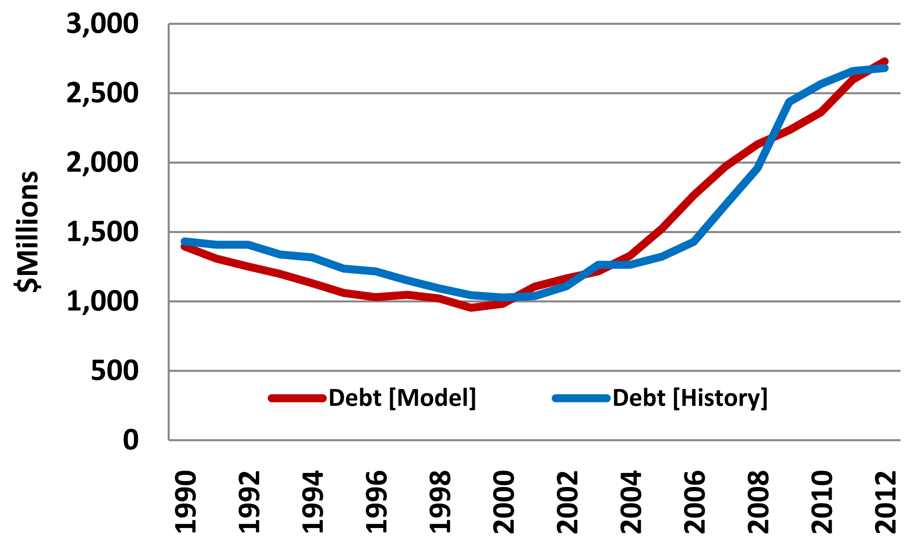
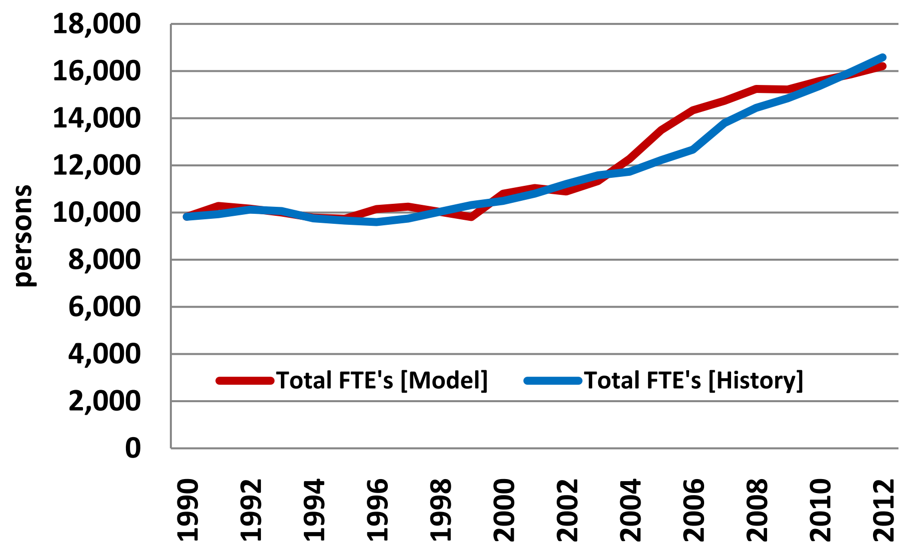


Figure 7 shows the difference between model and history for the total number of full time equivalents for The City of Calgary. Except the period from 2004 to 2008, the calibration results are very close to historical data.

Figure 7: Calibration Results: Total Full Time Equivalents



The above four graphs are just some examples of the calibration results. The results for other variables are available upon request. It is shown that the model provides a reasonable simulation of the past. It should be noticed that in the above examples, the results shown are from the standard setting of payoff function weights in the optimization process with no specific weights assigned putting extra emphasis on any key variables. However, we could control the weight of each variable in the optimization function, by assigning a higher weight to certain variable. For example, if we emphasise municipal finance variables more than others, we could assign higher weights to get better calibrated results of those specific variables.

4. Model Application

The MFiSi model is used to answer a number of what-if questions on how The City of Calgary's financial situation would have been different if various policies or economic conditions were different in the 1990 – 2011 period. The baseline values from 1990 to 2011 are compared with the what-if scenarios, to show how history would have been different if a particular policy was in place. This approach (ex-post) is superior to the alternative approach (ex-ante) because the analysis is able to avoid challenges about the reasonableness of forecast assumptions for the baseline scenario.

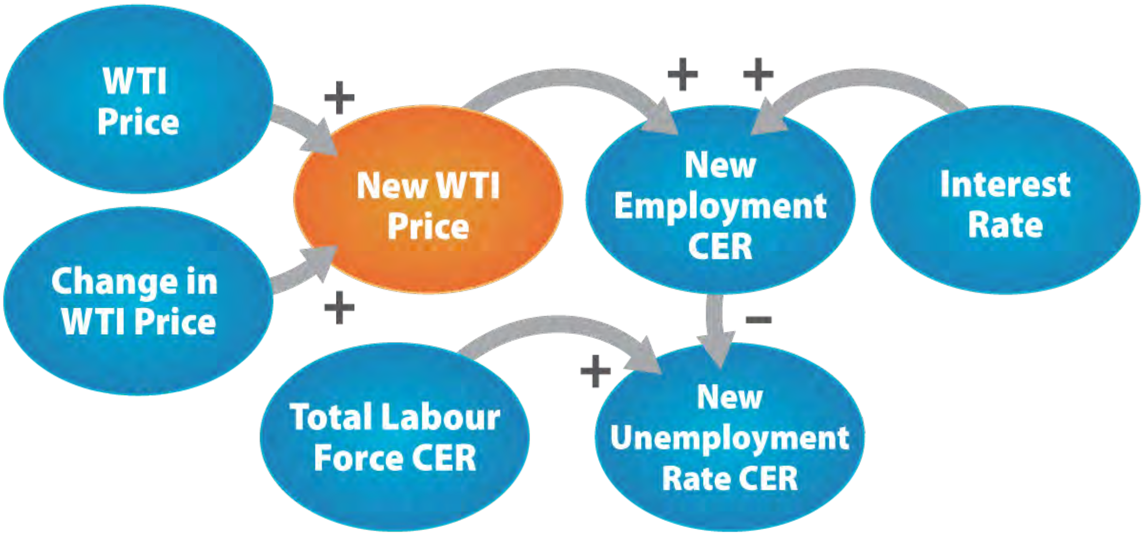
In this section, we are going to show four examples of model applications:

- What if WTI crude oil prices were 20% higher than its historical levels?
- What if the municipality was able to share 1% income tax revenues with the provincial government?
- What if the debt limit of the municipality was 3 times of total revenues instead of the current level of 2 times?
- What if the in-migration to Calgary gets doubled of its baseline scenario?

4.1 What-if Scenario 1: Higher crude oil prices

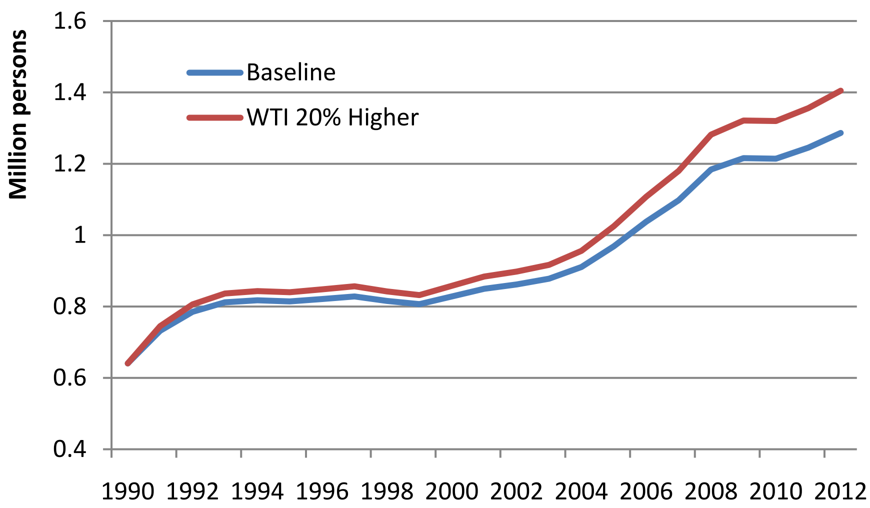
As an energy intensive economy, Calgary's labour market is directly impacted by WTI crude oil prices. Since Calgary is home to most of the energy companies operating in Alberta, higher crude oil prices will attract more investment in energy industry and its spinoff sectors. More cash flows will come in to finance the construction of infrastructure. Therefore, more employment will be created in Calgary Economic Region. The job growth will increase total employment in CER and attracts more people moving into Calgary. The simulation examines the financial impact on the municipality if the price of WTI crude oil had been 20% higher during the period of 1990 – 2011.

Figure 8: Higher Crude Oil Prices



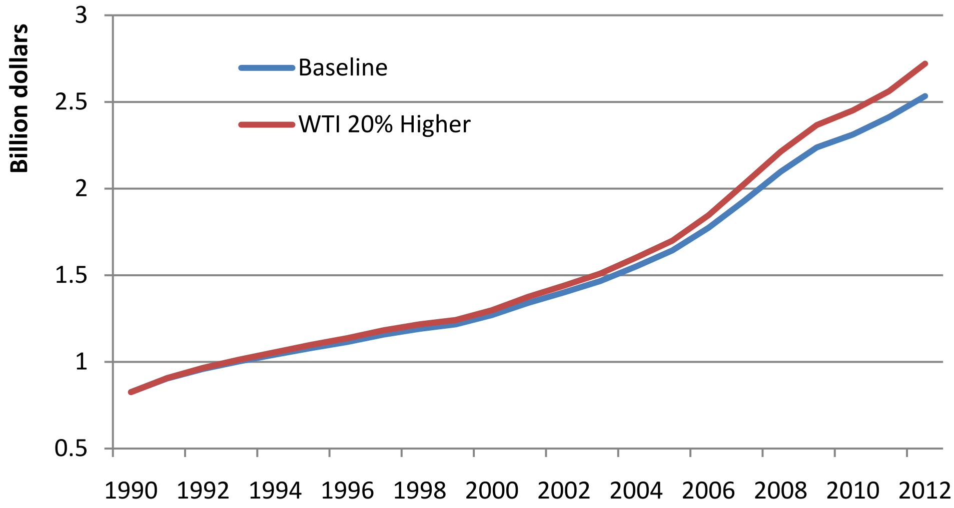
Total population would have grown faster compared to the baseline scenario. An increase in crude oil prices would have increased economic activity and produced a higher level of employment. This should improve the labour market and increase economic activity in Calgary. More migrants from outside of the region would have been attracted and therefore, total population would have increased.

Figure 9: Population of Higher Crude Oil Prices Scenario



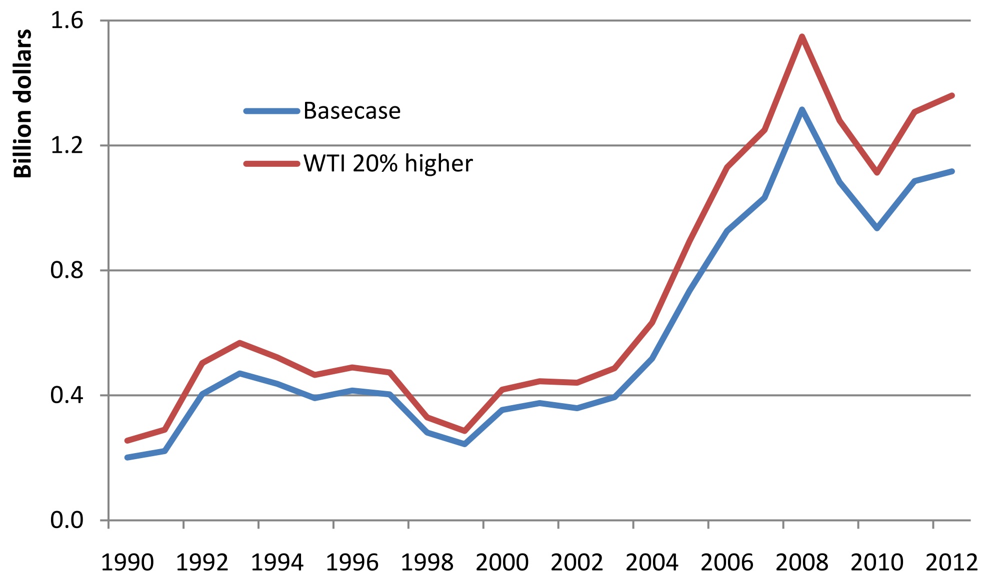
Total expenditure in the higher crude oil prices scenario would have been more than the baseline scenario. With higher population in the city, the demand for municipal services would have been higher, including the demand for public transit, parks and recreation, libraries, police and fire services etc. This would have unavoidably increased the investment in capital and thus the capital expenditure. To maintain the capital, total operating expenditure would have trended up too. Therefore, more population in the city would have led to higher total expenditure in the scenario of higher crude oil prices.

Figure 10: Total Expenditure of Higher Crude Oil Prices Scenario



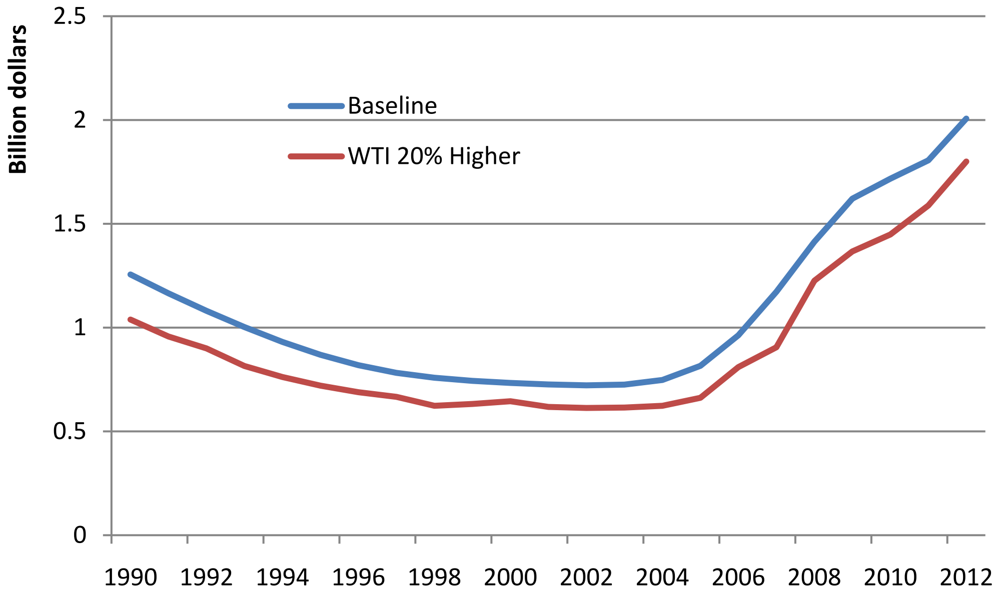
Total capital gap would have been higher under the scenario when oil prices were higher. The growth of total expenditure on capital generated by higher demand for municipal services would have outpaces the total revenue contributed by higher population. Therefore, it would have been more difficult for The City to close the gap with higher population growth.

Figure 11: Total Capital Gap of Higher Crude Oil Prices Scenario



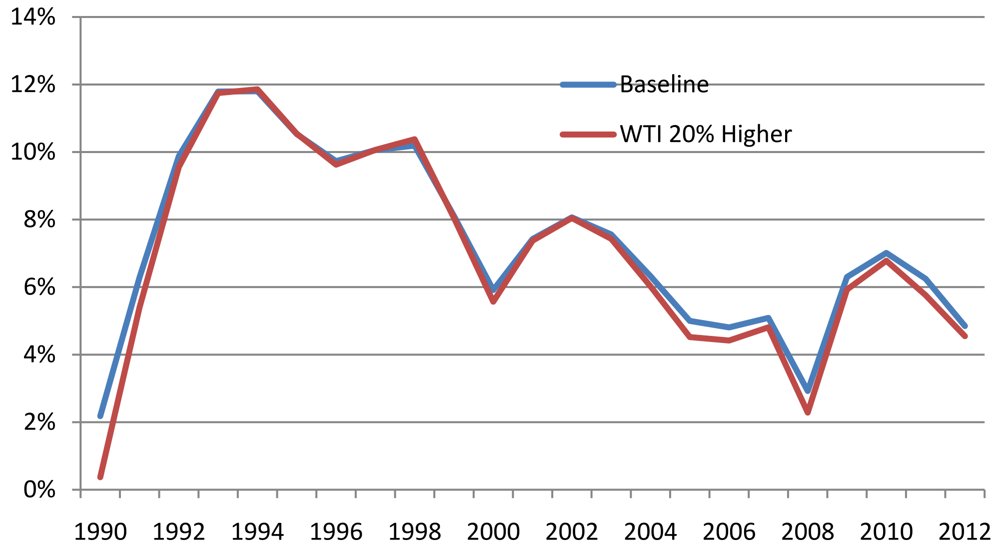
Total debt would have been lower than the baseline scenario as The City finances capital through taxes and debt. With total capital gap lower in this scenario, it would have required less in borrowing to finance the increased level of capital.

Figure 12: Total Debt of Higher Crude Oil Prices Scenario



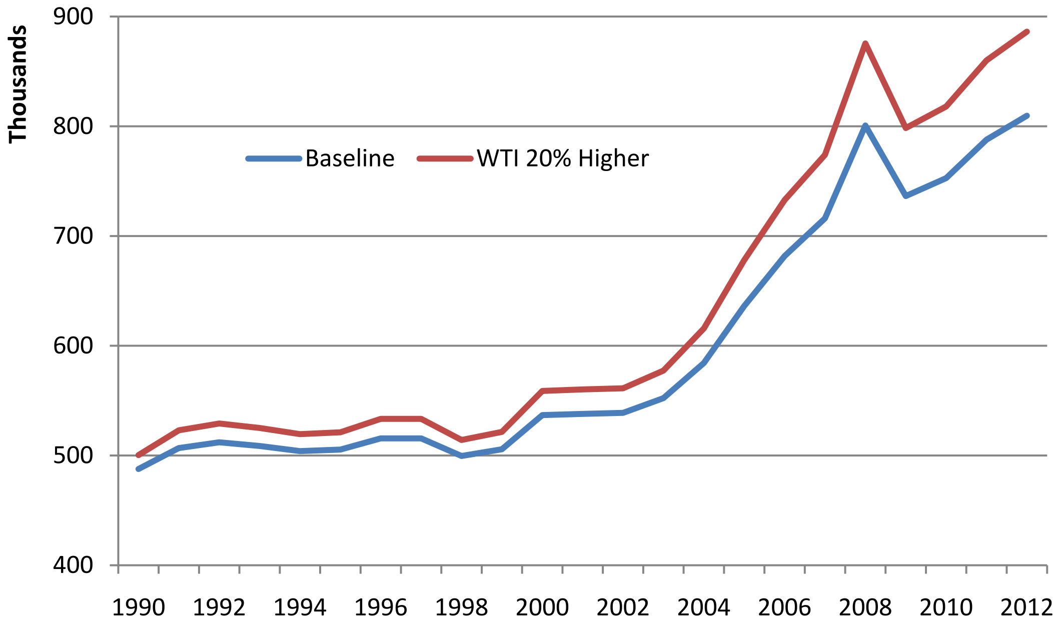
The unemployment rates under the two scenarios actually do not show much difference. In the beginning of the modelling period, unemployment rate under the higher crude oil prices scenario was lower than that of the baseline scenario. Higher energy prices would have attracted more investment to Calgary's market, which would have created more jobs. The shock would reduce the unemployment rate initially, but fade away gradually with more people entering the labour force. Overall, the unemployment rate would have stayed at a similar level as the base case.

Figure 13: Unemployment Rate of Higher Crude Oil Prices Scenario



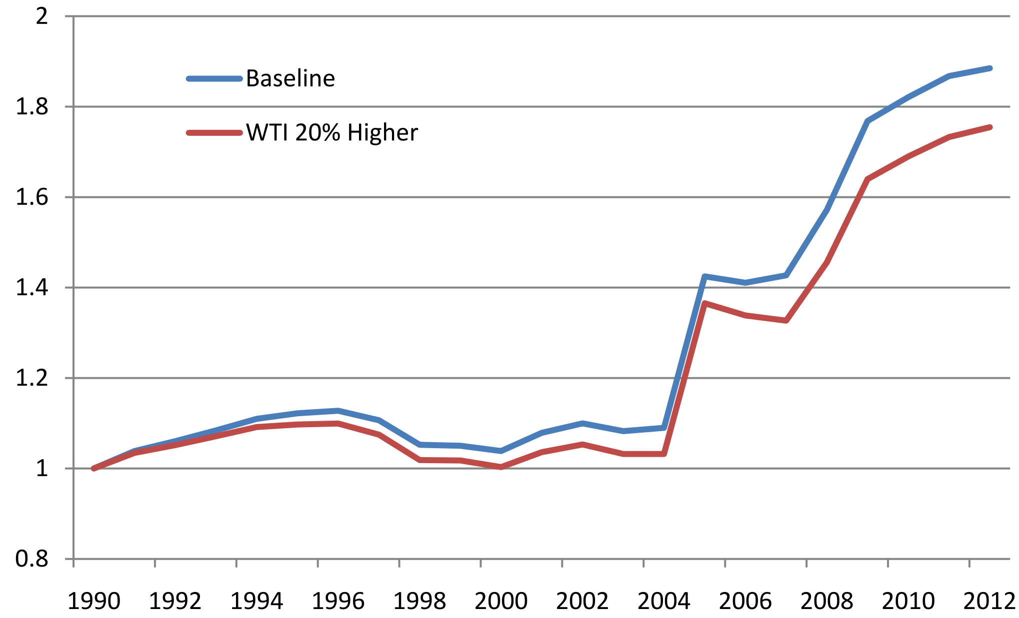
However, the total employment would have been higher. Although unemployment rates are similar in the two cases, total employment should be higher under the control scenario. With higher total population and higher energy prices, labour force in Calgary would have been more, and therefore the same unemployment rate implies more total employment.

Figure 14: Total Employment of Higher Crude Oil Prices Scenario



Under this scenario, tax levy per house index (1990 = 1) would have grown more slowly than the baseline case. This indicates that the municipality could enjoy the benefit of economic growth through total revenue growth. The lower total capital gap would have allowed each household in Calgary to enjoy a lower tax levy in the scenario of higher WTI prices.

Figure 15: Index of Tax Levy per house of Higher Crude Oil Prices Scenario

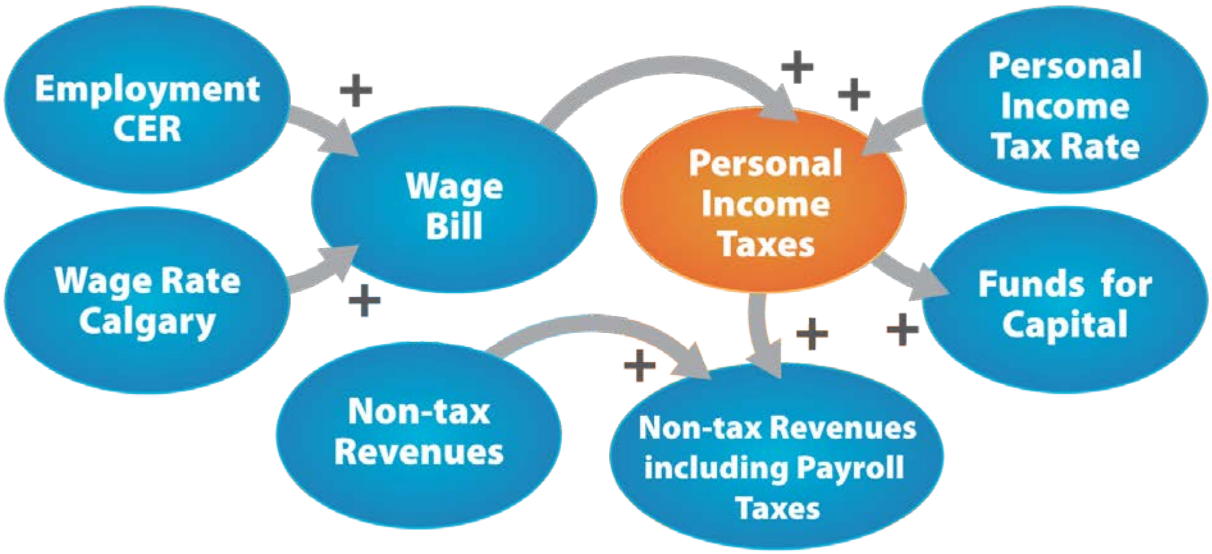


4.2 What-if Scenario 2: Sharing Personal Income Taxes

The simulation in the previous section shows that The City benefits from economic growth. The current simulation illustrates how this could be further extended by accessing to a growth sensitive revenue source. This scenario assumes that the municipality of Calgary could share 1% of personal income tax with the provincial government. In Alberta, the Province collects 10% of personal income tax. We assume that The City could share this tax revenue by collecting 1% of tax out of personal incomes (leaving 9% to the Province), without adding extra burdens to tax payers.

Under this scenario, The City could collect 1% taxes from the total employment in Calgary, which could be used as funds for capital, or for operating budgets together with other non-personal income tax revenues. We assume this revenue would be distributed evenly between financing capital projects and non-tax revenues. The model anticipates that an increase in funding and revenues would increase investment in capital and reduce The City's total debt level.

Figure 16: Sharing Personal Income Taxes Scenario



Increased level of funding and revenues would have placed less pressure on The City's budget. First of all, total revenues would have been higher under the sharing personal income tax scenario than the baseline case. Compared to property taxes, personal income taxes would have had a stronger link with economic performance and enjoyed more from economic growth. With access to personal income tax, total revenue of The City would have grown at a more robust rate, and accelerated across time. The extra tax revenues would have allowed The City to fund major capital projects and thereby reduced the total gap.

Under this scenario, tax levy per house index (1990 = 1) would have been lower than the baseline case. The extra revenues sharing with The Province would have allowed The City to collect less from property taxes. Thus tax levy per house in Calgary would have been lower than the baseline scenario.

Figure 17: Index of Tax Levy per house of Personal Income Taxes Scenario

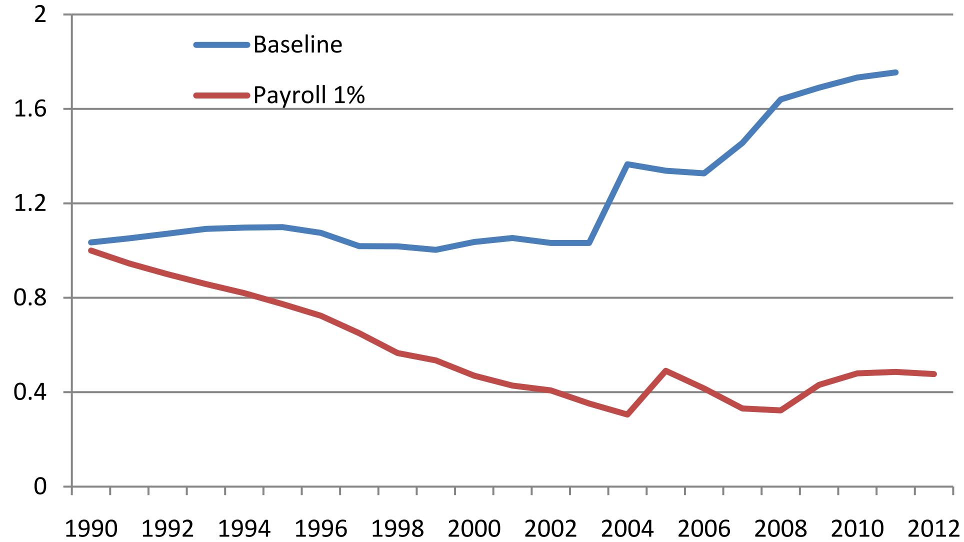
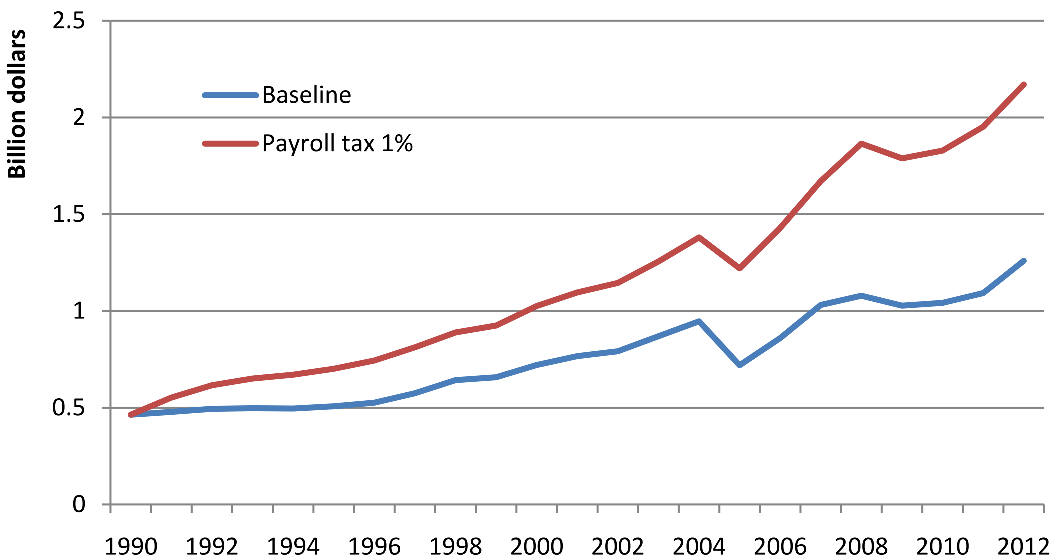


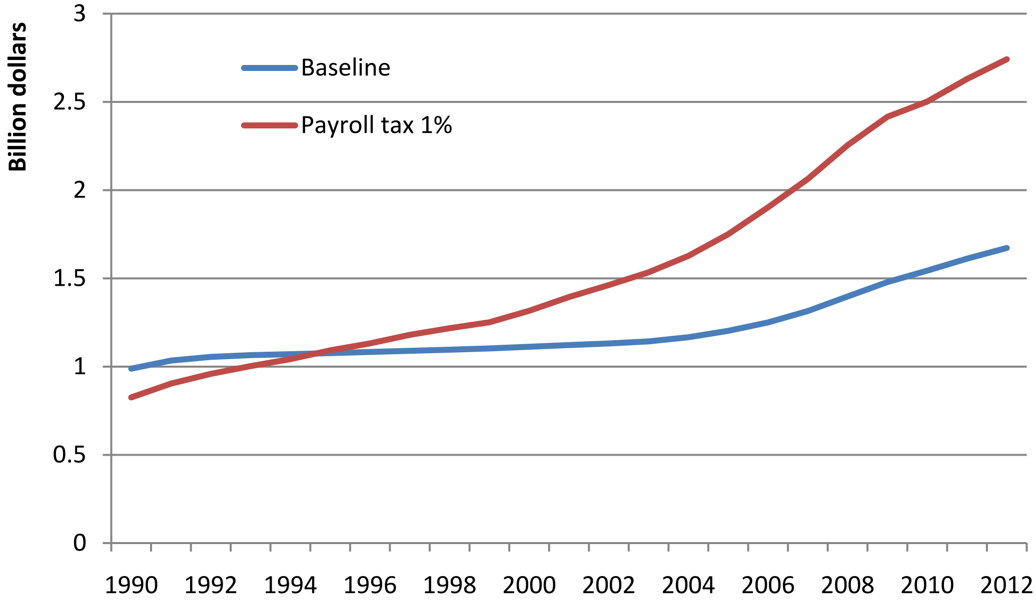
Figure 18 shows how much more revenues The City would have been able to access under the scenario of sharing personal income taxes, as the red line (control scenario) stays above the blue line (baseline scenario) all the time during the simulation period. Assume that The City had been able to reach a deal with the provincial government in 1990 to get 1% personal income tax revenues by giving up the same amount of revenues in other forms, i.e. government grants or property tax revenues. Then The City would have gained every year after 1990 from this deal by enjoying more revenues from personal income growth. This scenario clearly indicates sharing income taxes would allow The City to benefit more from economic growth.

Figure 18: Overall Revenue (with Payroll Taxes Share) of Personal Income Taxes Scenario



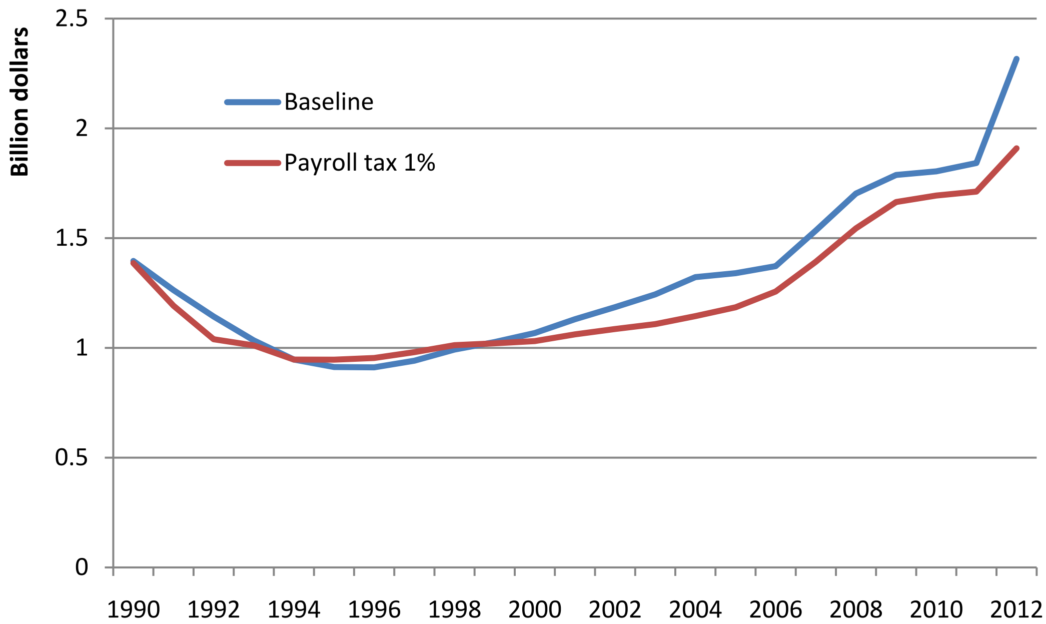
In the beginning of the simulation period, total expenditures tended to be slightly higher under the baseline scenario. The decrease in expenditures could have been caused by the saving on interest costs. With extra revenues, The City would have been able to borrow less debt, therefore to reduce the interest costs of debt. From 1990 to 1994, this would bring total expenditures down from the baseline scenario. After that, total operating expenditures would have been higher than the base case. Providing services to a higher level of population would have required increased investment in capital, causing operating expenditures to increase as well.

Figure 19: Total Expenditure of Personal Income Taxes Scenario



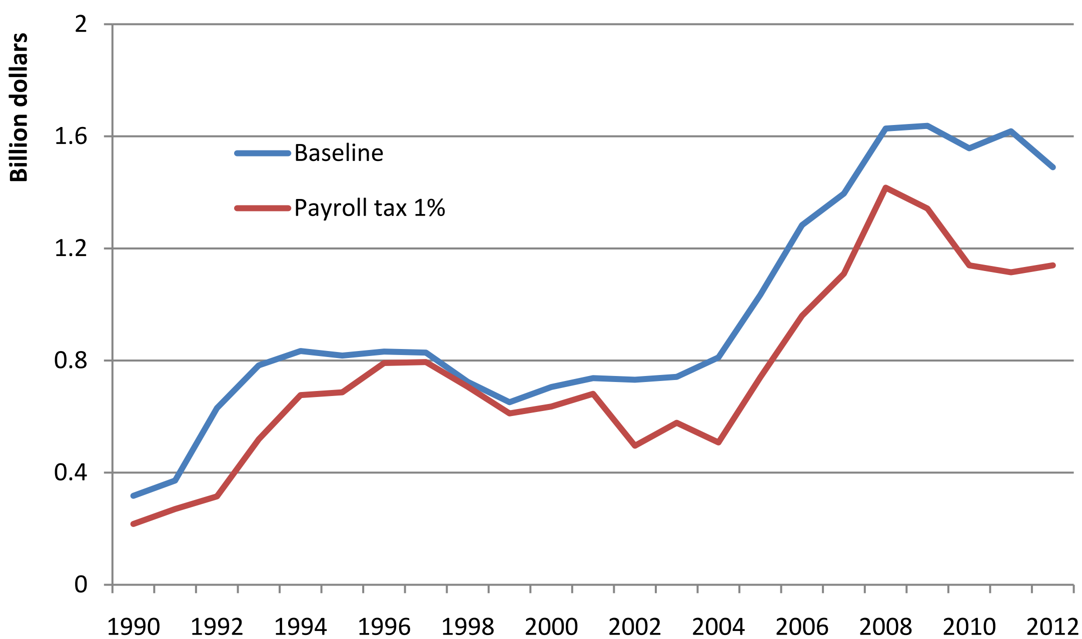
Total debt would have been lower in the payroll tax scenario compared to the baseline in the beginning of the simulation period. When extra tax revenues firstly came in, The City would need to borrow less debt. However, from 1994 to 1998, total debt would have been higher in the control scenario than the base case. With more revenues to fund capital, The City would have invested more on capital, thus increased the capital cost and its maintaining cost. The rise in total costs would be reflected in the higher debt level between 1994 and 1998. After that, total debt would have been lower compared to the base case as The City finances capital through an increase in funding.

Figure 20: Total Debt of Personal Income Taxes Scenario



Total capital gap would have grown more slowly under the sharing personal income tax scenario, due to additional funding and revenue. The gap would have been lower than the baseline scenario, because the increase in total revenue from extra revenue sources would have outpaced the expenditure generated by demand for services.

Figure 21: Total Capital Gap of Personal Income Taxes Scenario

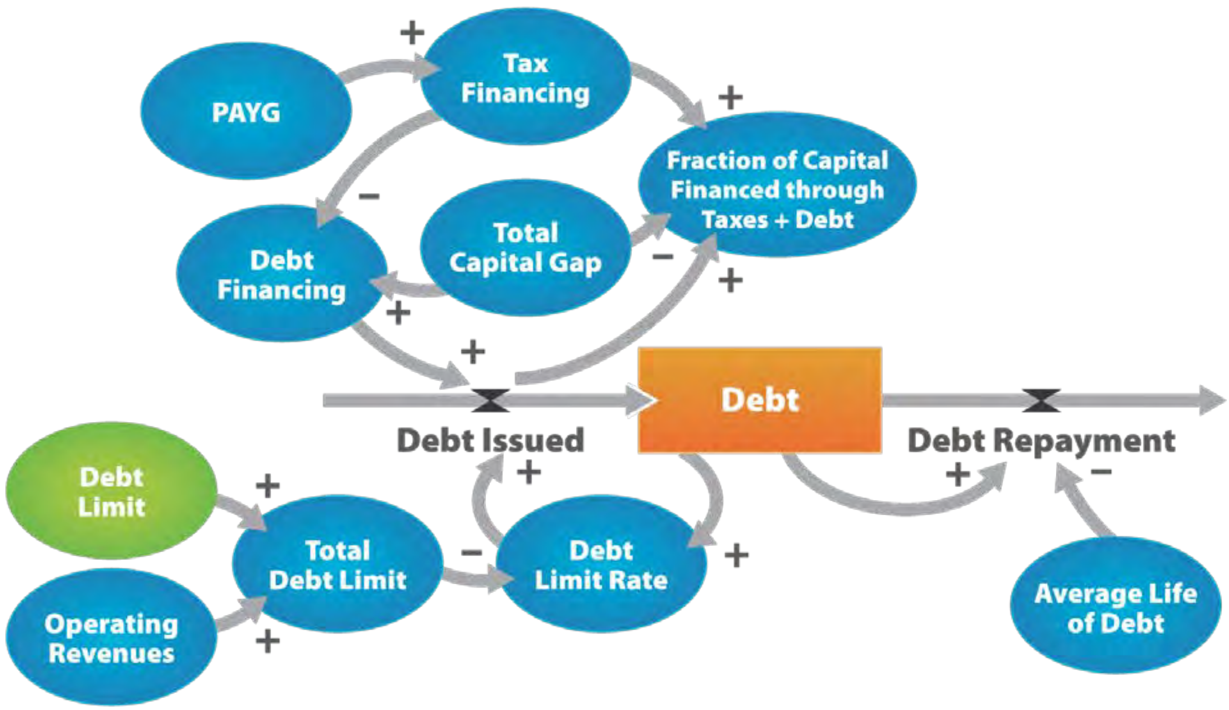


4.3 What-if Scenario 3: Higher Debt Limit

The amount of debt outstanding is increased by the amount of new debt issued and decreased by the amount of debt repayment. The municipality's ability to issue new debt is limited by its debt capacity, which is a function of the overall assessment base. Payment of The City's debt results in a reduction of the amount of money that the city sets aside each year to meet the payments on the principal (debt obligation) and interest (cost of debt). The municipal debt module is represented in Figure 22.

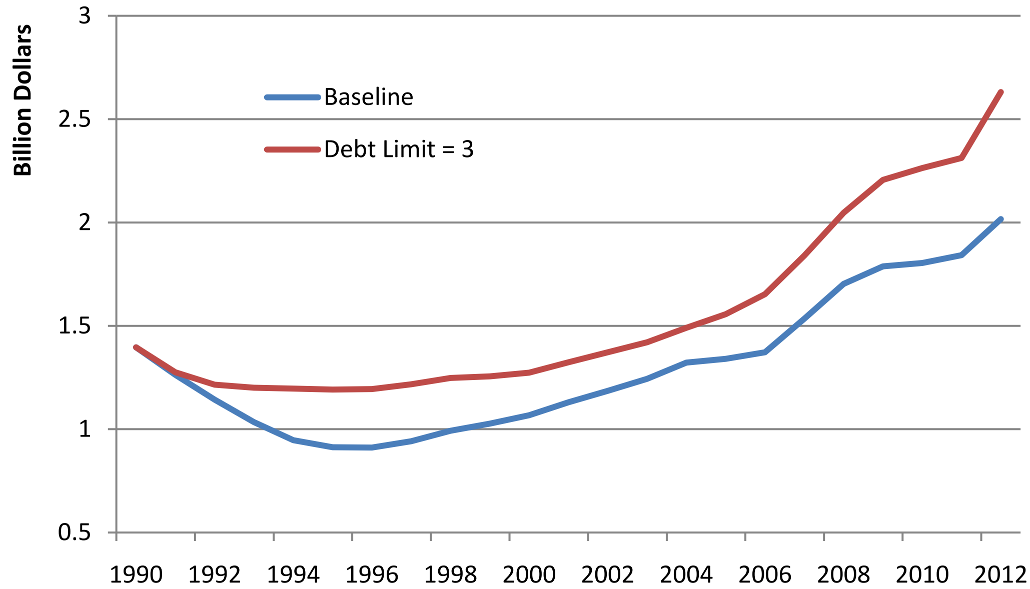
The City is subject to limit on the amount of debt and debt servicing costs it can incur (The City of Calgary, Long Range Financial Plan 2011). The debt limit is calculated at 2 times of total revenue of The City (as defined in Debt Limit Regulation 225/2000). The limit was established by the Minister of Municipal Affairs to identify municipalities which could be at financial risk if further debt incurred. Under this scenario, we assume that the debt limit could be set to be 3 times of total revenue, and analyze its impact on municipal finance.

Figure 22: Higher Debt Limit Scenario



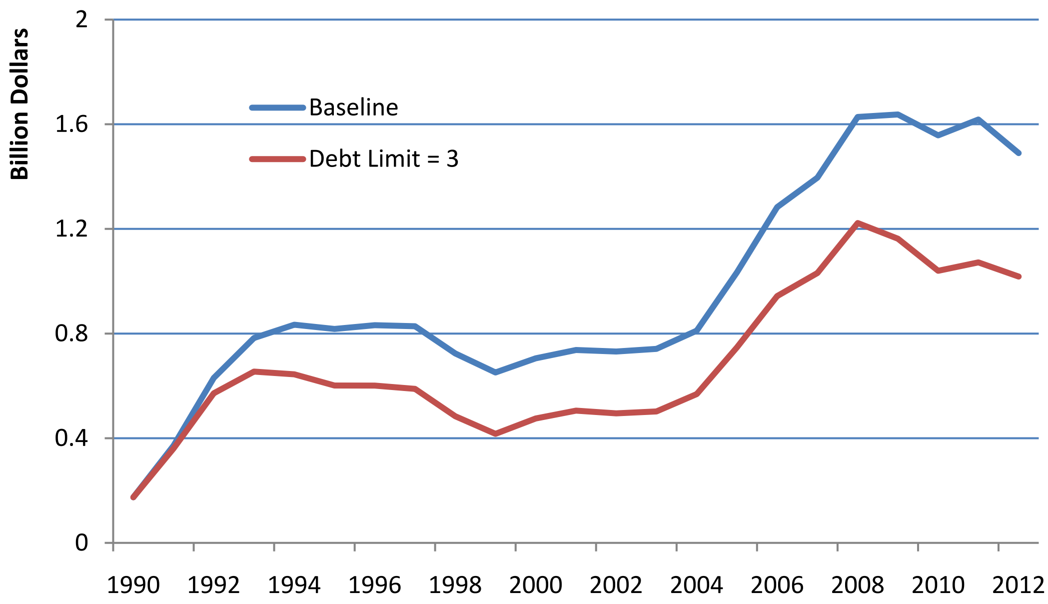
Raising debt ratio from 2 times to 3 times would cause the total debt level to be higher than the baseline scenario. When allowed with higher debt ratio, the direct impact for The City would be to borrow more to meet the increasing demand for municipal services. As a result, the total debt level would have grown faster than the base case.

Figure 23: Total Debt of Higher Debt Ratio Scenario



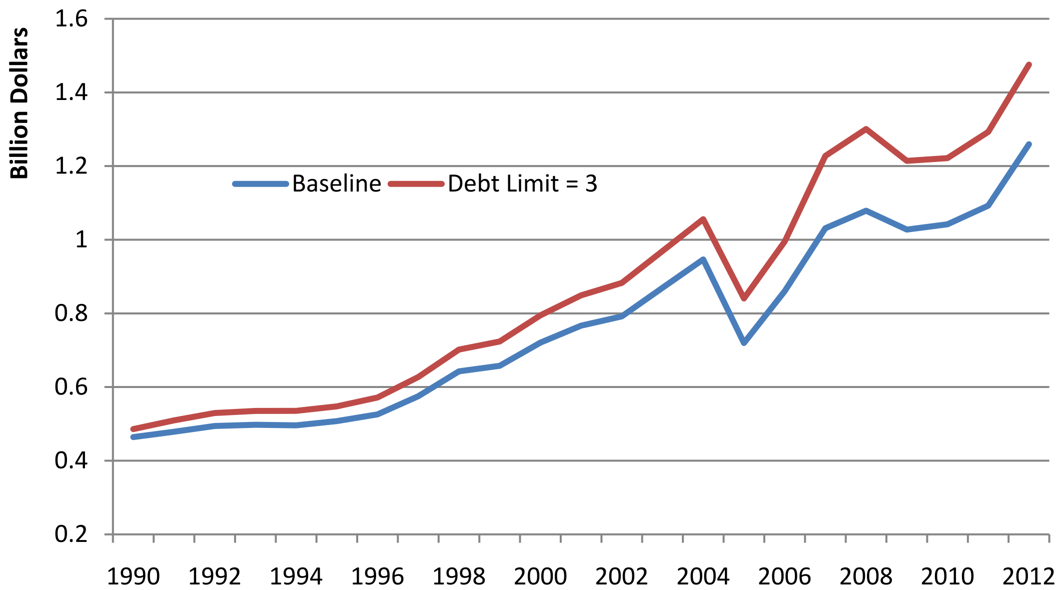
With higher debt ratio, The City would have had more sufficient debt capacity and provided funding for more capital requirements. Under the scenario of higher debt ratio, total capital gap would have been lower than the baseline case.

Figure 24: Total Capital Gap of Higher Debt Ratio Scenario



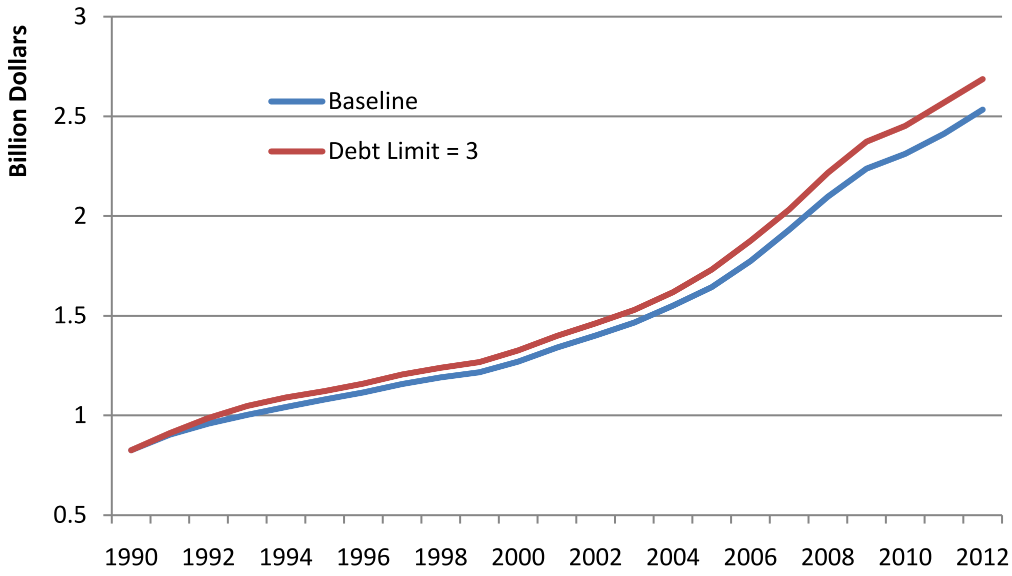
It is interesting to see the impact on total revenue of raising debt ratio to 3 times. Under this scenario, total revenue would have been higher than the baseline case. With higher debt ratio, The City would have been able to provide better infrastructure and services, and meet the demand of the total population better. The improvement in municipal services would have attracted more in-migration to Calgary. This would increase the tax base since population growth should increase the demand for both residential spaces and commercial offices. The City would have had higher total revenue under this scenario.

Figure 25: Total Revenue of Higher Debt Ratio Scenario



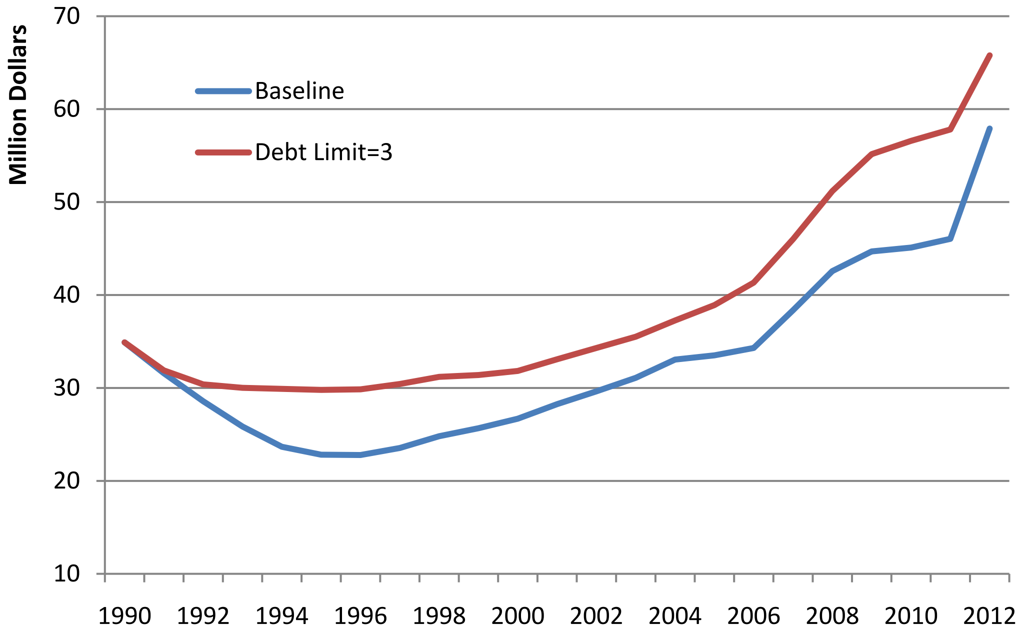
With higher revenue and more population, total expenditure would have grown faster under the higher debt ratio scenario. To maintain municipal service at higher quality, both capital expenditure and operating expenditure should be increased.

Figure 26: Total Expenditure of Higher Debt Ratio Scenario



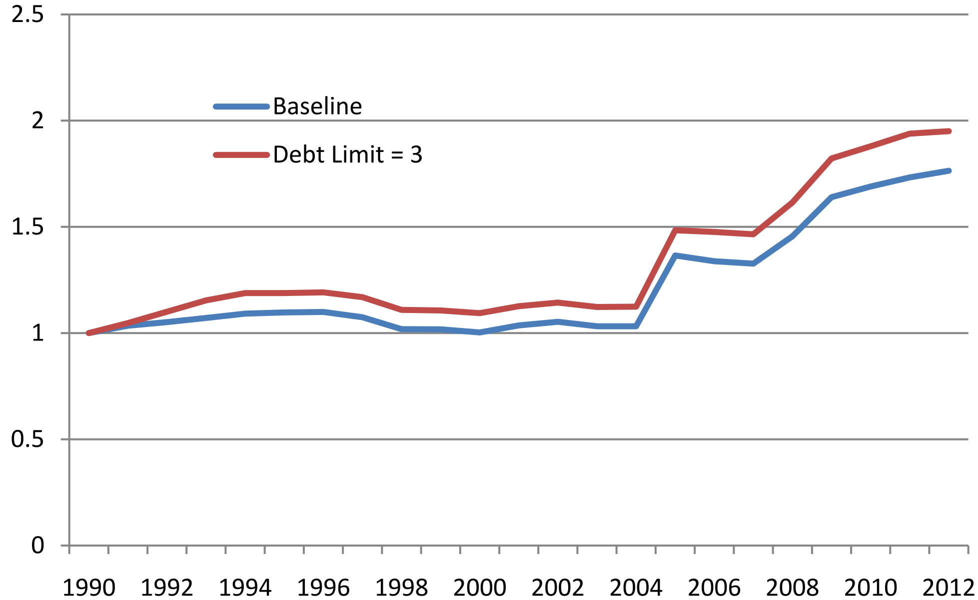
The increase in the total expenditure under this scenario could be explained by the increase in debt service cost. When debt limit ratio was higher, debt service cost would have been more since The City would have borrowed more.

Figure 27: Debt Service Cost of Higher Debt Limit Scenario



Under the scenario of higher debt limit, the index of tax levy per house would have been higher than the baseline scenario. Since The City borrowed more, the interest costs and total expenditures would have been higher. Thus, the demand for total revenues would have been higher as well. Each household had to pay more property taxes to compensate the extra costs.

Figure 28: Index of Tax Levy per house of Higher Debt Limit Scenario

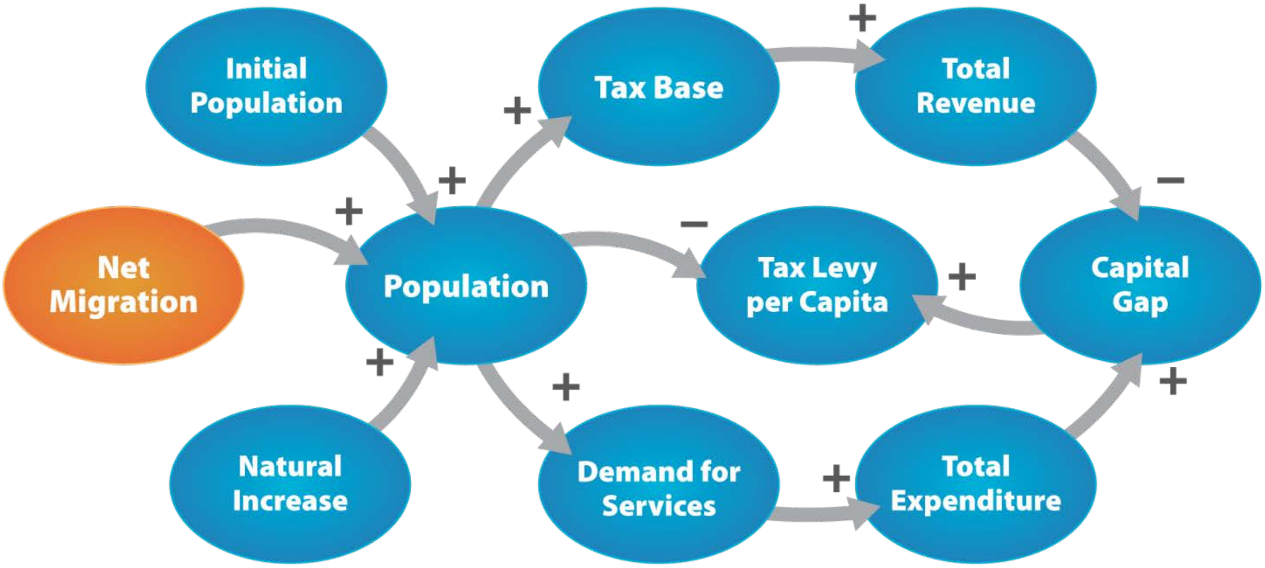


4.4 What-if Scenario 4: Higher In-migration in Next 30 Years

Calgary's aging population will put strong upward pressure on municipal expenditure in the areas of infrastructure requirements. These pressures will be compounded because the life expectancy of Calgarians is continually increasing. Population aging will also slow labour force growth, reduce GDP growth, and ultimately limit revenue growth to rates below those experienced historically.

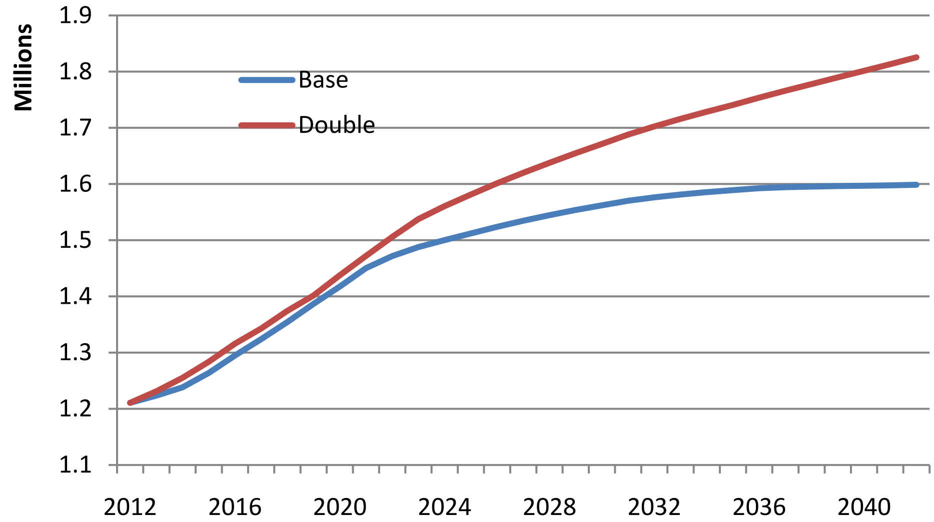
This scenario simulates the long-run municipal finance paths for The City by assuming two different growth rates of in-migration in the next 30 years. The analysis is conducted on a shock versus control basis, and hence two scenarios are established from 2012 to 2042. For the base scenario, in-migration assumption is based on historical calibration. For the control scenario, we assume in-migration to Calgary will be twice as much as the base case. Therefore we refer it as double scenario in the following analysis.

Figure 29: Impact of Higher In-migration on Municipal Finance



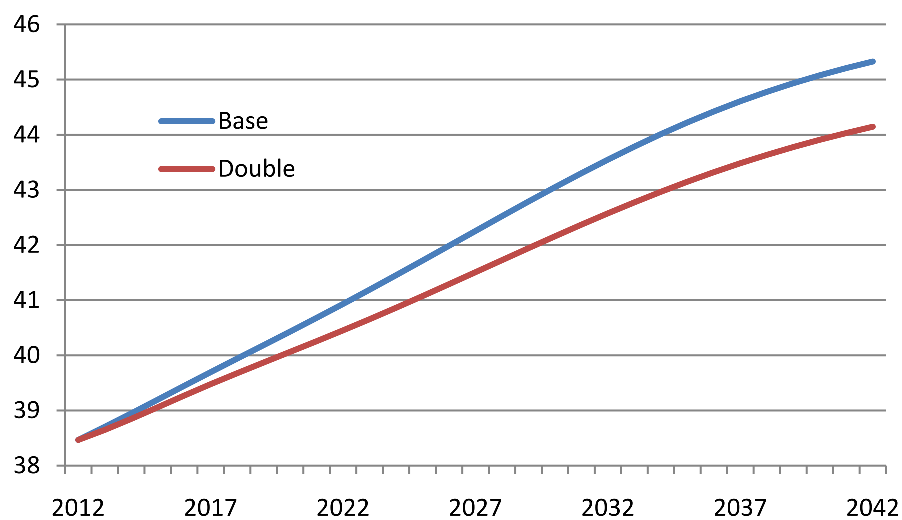
In base scenario, total population in city of Calgary is expected to increase to close to 1.60 million in the next 30 years. While in double scenario, total population should expect higher growth and reach 1.83 million by 2042. However, in both scenarios, population growth rates are going to slow. Especially in the base scenario with fewer in-migration, population increase in Calgary after 2035 should be limited, though remaining positive. This is caused by the aging problem. Natural increase of population follows a downward trend. The aging society will have lower births and higher deaths.

Figure 30: Total Population of Higher In-migration Scenario



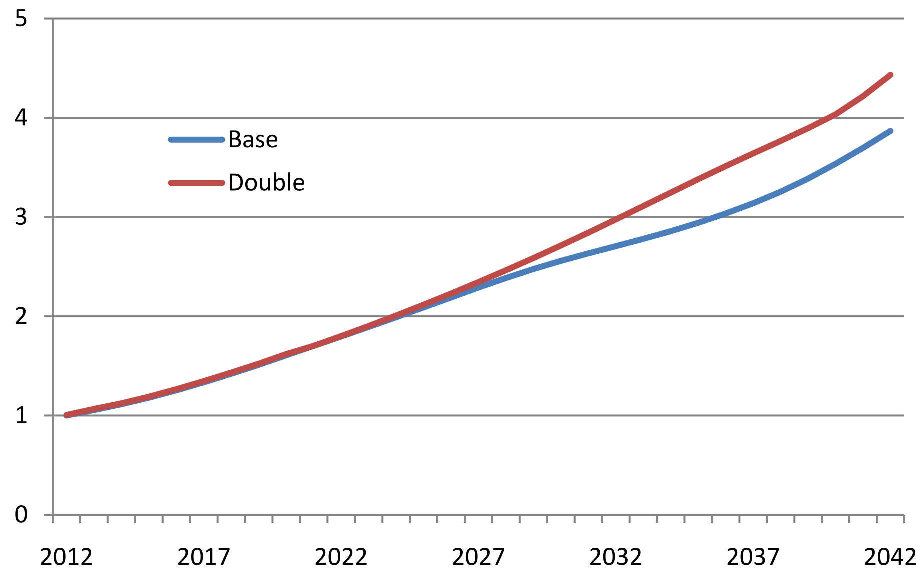
The aging problem can be reflected more directly by showing the changes of average ages across time. The average age in both scenarios will increase steadily to 2042. Calgary is getting older no matter how many in-migrations we get. In-migrants which are usually at younger ages could help to moderate the problem, but not enough to solve the aging caused by the great amount of baby boomers. In base scenario, the average age in Calgary will increase from 38.4 years old in 2012 to 45.3 years old in 2042. In double scenario, average age in 2042 is a bit lower, at 44.1 years old. This 1.2 years difference in average age reflects the improvement caused by higher in-migration.

Figure 31: Calgary's Average Age of Higher In-migration Scenario



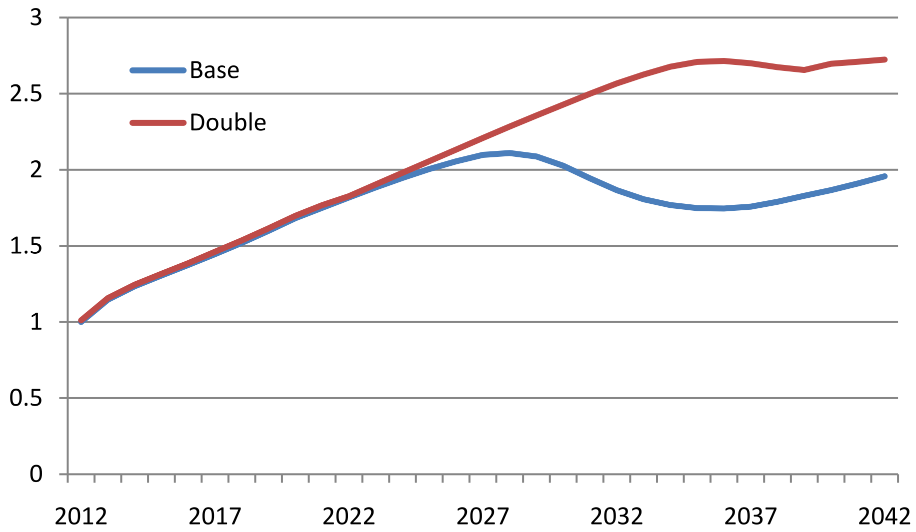
The most obvious channel through which demographic pressures will affect future municipal finance is the expenditure channel. The consumption of public goods is not uniform across generations, with the heaviest consumption from the seniors. For both scenarios, municipal expenditures will grow at accelerating speed. In the beginning period of forecasting, double scenario shows slightly higher expenditure. In the mid to long run, double scenario expects much higher municipal expenditure than base scenario as more population drives higher demand for public services.

Figure 32: Total Expenditure Indexes of Higher In-migration Scenario (2012 as base year)



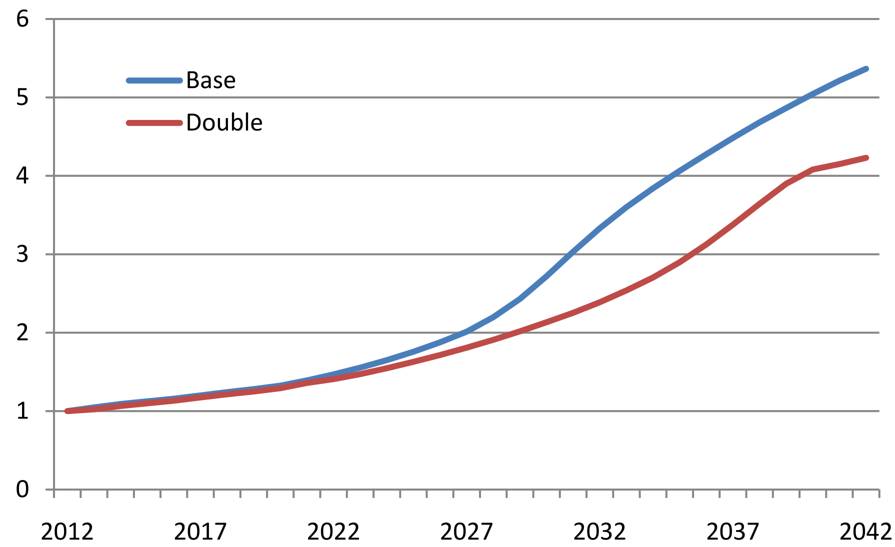
Aging population will also affect the municipal budget balance via revenue yields. It will slow down the growth of labour forces with fewer younger people getting into the labour force source population and more retirement leaving the pool. Another mechanism by which demographic forces may influence government revenue yields comes through typical lifetime income and consumption patterns, and their implications given the predominance of the baby-boom generation. With fewer working age population, revenue sources will become more limited in the future for different levels of governments, including municipalities. Figure 26 shows the trajectories of non-tax revenues for the two scenarios, which are not monotonic for both cases. For base scenario, total non-tax revenues will drop after 2028 and slightly pick up after 2036. In double scenario with more in-migration, the drop of total non-tax revenue will be postponed for a few years, but still experience growth slowdown and a dent by 2039.

Figure 33: Non-tax Revenue Indexes of Higher In-migration Scenario (2012 as base year)



With the accelerating requirement of public services and decelerating revenue growth, higher tax burden becomes unavoidable as desired tax levy outgrows population in Calgary. Desired tax levy per capita is simulated for both scenarios as indexes with 2012 being the base year. As we can see from Figure 27, both indexes will increase across the forecast period. Base scenario will experience higher tax levy per capita than double scenario, with the latter being 27 per cent lower by 2042. The simulation results show that with more in-migration to Calgary in the future, more revenues will be created for the municipality which will exceed the corresponding expenditure growth. This will help to moderate the financial pressures caused by aging problem and improve the municipal financial budget for The City of Calgary.

Figure 34: Tax Levy per capita Indexes of Higher In-migration Scenario (2012 as base year)



5. Conclusion

This paper provides a summary of Municipal Finance Simulation Model and the results of four applications of the model. Each simulation is judged against a base case. The first scenario assumes higher crude oil prices during the simulation period from 1990 to 2011. The results show increased economic activity which lead to an increase in the demand for labour, consequently increasing migration and total population. Providing services to a larger population requires a larger infrastructure stock. However, the municipality would have collected more revenues from the larger total population. The municipality's capital gap and debt would have decreased under this scenario since the growth of total revenue would have outpaced the growth of total expenditure under this scenario.

The second simulation assumes that The City could share 1 per cent of personal payroll taxes from the provincial government. The extra revenue would be distributed evenly between financing capital projects and operating budget. Total tax revenues would have been higher under the payroll tax scenario than the baseline case. Compared to property taxes, payroll taxes are less vulnerable to business cycles and grow at a faster rate. Total revenue would grow at a more robust rate, and accelerate across time. The City would have enjoyed more benefit of economic growth with the access to income taxes. The extra tax revenues would allow The City to fund major capital projects and thereby reduce the total gap.

The third simulation assumes that the debt limit of The City could be set to be 3 times revenue. The direct impact of higher debt ratio would cause the total debt level to be higher than the baseline scenario. When allowed with higher debt ratio, The City would borrow more to meet the increasing demand for municipal services. As a result, the total debt level would have grown faster than the base case. The City would have more sufficient debt capacity and provide funding for more capital requirements. Under the scenario of higher debt ratio, total capital gap would have been lower than the baseline case.

The fourth simulation is different from the other three cases. It forecasts the scenarios of the next 30 years with assumptions of endogenous factors of local economy and municipal finance. It compares the impact of different growth rates of in-migration in Calgary. Under both scenarios, natural increase of population should follow a downward trend. The aging society will have lower births and higher deaths. With higher in-migration, The City should access higher revenues which outpace the increase of municipal expenditures. As a result, tax levy per capita should be lower in higher in-migration scenario in the forecasting period.

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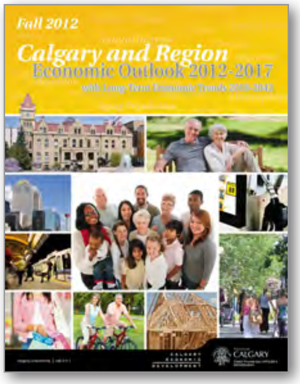

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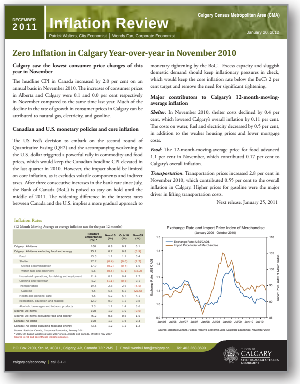

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