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SIMULATION OF TAX REVENUES FROM INDIVIDUALS RECEIVING ADVANCED COLLEGE DEGREES

Dejing Kong
University of Nebraska - Lincoln, nancykong315@hotmail.com

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by

Dejing Kong

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SIMULATION OF TAX REVENUES FROM INDIVIDUALS RECEIVING ADVANCED COLLEGE DEGREES

Dejing Kong, Ph. D

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Advisor: Michael W. Riley

State governments always want graduates who received higher education in universities and colleges to stimulate the economic growth of the state. Many state universities want to contribute more to the state's economy as well, and state universities frequently have relevant economic development activities and offices. The state universities normally receive annual budgeted financial support and occasional special funding from the state government while the state expects contributions to the economic growth and an educated citizen in return. In this research, the economic impact of a graduate degree funded by the state government was considered in the state of Nebraska.

Simulation models were utilized to attain the goal of the research. In the simulation models, the salaries of graduate engineers and the money spent by employed graduate engineers were considered, and the taxes paid by the graduate employees were used as the basic indicator to assess the direct economic impacts

received by the state government. The computer simulation model was validated and verified. The simulation model utilized historical spending data patterns and calculated the Nebraska state and federal income taxes directly paid by graduates and indirectly paid as a result a of their spending, and it was economically justified to support the advanced education. The state government can regain their financial support of the university via state taxes paid by the graduates alone. Using spending simulation, it was determined that it was not beneficial for the government to reduce the income tax rates in hope of generating secondary spending to recover the tax losses by a stimulation of spending. Even if the sales taxes obtained by the government were increased, the amount cannot make up for the decreases of the income taxes.

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Chapter 1 Introduction

Positive impacts of graduates to the state and national economy are sought for economic development. State governments want state supported institutions of higher education such as universities and community colleges to be economic engines to stimulate a state's economic growth. Many state universities have offices and functions that are expected to be a positive contributor to economic development. Intellectual property at universities is encouraged to be protected and marketed or developed to create new products, materials and enterprises. One vital economic driver of state institutions is the economic buying power of its students.

State universities are partially funded by the state budget, student tuition and fees, donations and gifts, endowments and contract overhead. This research has a focus on the economic impact measured by income and sales taxes paid by graduate students after they receive an advanced degree from a state university.

Nowadays, there are more and more people who have received higher education degrees. The historical data about the numbers of university students from 1970 to 2009 in the United States are shown in Table 1.1. As noted, the data included unclassified undergraduate and graduate students, and the data through 1995 were for institutions of higher education while the data from 2000 were for degree-granting institutions. As we can see in Table 1.1, in 1970 there were only 8.581 million people who enrolled into higher education, while in 2009 there were 20.427 million people. The total number of students participating in higher education had increased by 138% from 1970 to 2009. In 1970, there were 7.369 million students enrolling into undergraduate study, while there were 17.565 million students in 2009. The number of new undergraduates had increased by 138% from 1970 to 2009. In 1970, there were 1.212 million students enrolling into the graduate school, while there were 2.862

million students in 2009. The number of new graduate students had increased by 136% from 1970 to 2009.

Table 1.1 Total fall enrollment in degree-granting institutions, by student level: selected years, 1970 through 2009 [In Thousands] (Department of Education, National Center for Education Statistics., 2011; Digest of Education Statistics, 2010)

Student characteristic		Total	Undergraduate	Post baccalaureate
Institutions of higher education	1970	8,581	7,369	1,212
	1980	12,097	10,475	1,622
	1985	12,247	10,597	1,650
	1990	13,819	11,959	1,859
	1995	14,262	12,232	2,030
Degree-granting institutions	2000	15,312	13,155	2,157
	2001	15,928	13,716	2,212
	2002	16,612	14,257	2,355
	2003	16,911	14,480	2,431
	2004	17,272	14,781	2,491
	2005	17,487	14,964	2,523
	2006	17,758	15,184	2,574
	2007	18,248	15,604	2,644
	2008	19,103	16,366	2,737
	2009	20,427	17,565	2,862

As seen in the degree-granting institutions in Table 1.1, the students in higher education had increased by 33.4% from year 2000 to 2009. The number of new undergraduates had increased by 33.5% from year 2000 to 2009, while the number of new graduate students had increased by 32.7%. The increasing percentage of undergraduates was less than the increasing of graduate students, which meant the percentage of undergraduates interested in graduate studies was decreased from year 2000 to 2009. However, both the numbers of undergraduates and graduate students were increased. There were more and more students in graduate schools, which meant that more investments were needed in the universities including purchases of hardware devices, software devices, spaces, and so on. When the students received their master's or doctoral degree, they became employed or continued their study further. Eventually, the governments or communities gained financially from them due to employment.

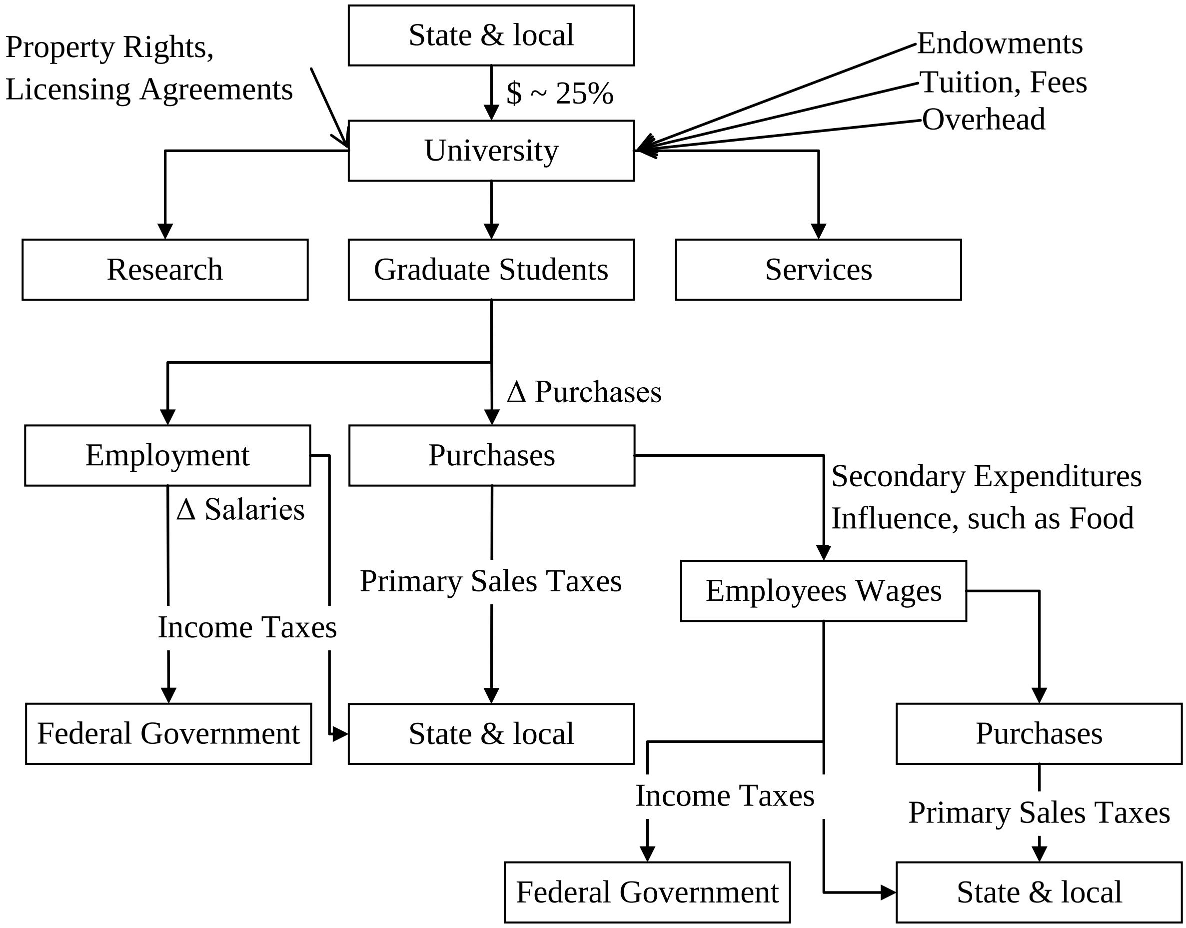


Figure 1.1 Flow of money associated with obtaining a graduate degree

It was a problem whether the governments were glad to see more undergraduates enrolling into graduate schools or not. As shown in Figure 1.1, though the government needed to pay for facilitates and general support for graduate students, they had more taxes paid to the government normally as rewards. The objective in this research was to determine the economic impact to the government taxes received due to an undergraduate student going into the graduate school and receiving an incremental income because of the graduate education. Economic impact was always utilized to analyze the effect of a policy, program, project, activity or event on the economy of a given area. The activity studied in this research was enrolling into graduate schools. The area studied was additional taxes paid to the Nebraska State government, local government and to the United States government.

The measurement of economic impact was always in terms of changes in economic growth, which was associated with jobs and income. The indication of the economic impact utilized in this research was the tax receipts of the US and state & local governments. Under normal circumstances, taxes consisted of income taxes and sales taxes for an individual, and income taxes included federal taxes and state taxes. Part of income taxes should be paid to the federal government, and part of income taxes should be paid to the state & local government. Sales taxes would be paid to the state & local government. If a taxpayer can contribute more to the society, she/he normally can obtain more remuneration. When the taxpayer had more income, she/he would pay more income taxes to the government and have more money to be spent on various kinds of consumptions. With more money spent, sales taxes receipts should be raised. As we can see, it should be worth it for governments to encourage graduate students because of the higher income that would result. The problem of interest in this research is how much impact in terms of primary and secondary taxes are paid by a person with a graduate degree.

By reviewing the previous research methods of the economic impact, mathematical models always were created to predict the impact. Different mathematical models were apt to have different problems, different aspects of the same problem or the problem under different conditions. Different parameters were utilized in different mathematical models. It was not easy to analyze individual cases by utilizing a mathematical model. In this research, a simulation model was utilized, and the parameters set in the model covered as many aspects as possible. Different situations were simulated by changing the value of parameters in the model and obtaining the results for analysis.

Several commonly used engineering economics methods were introduced into this research to measure the economic impact in different aspects, such as the payback period, net present value and benefit-cost ratio. If an investment was made on something, rewards of the same value would be expected from the investment within certain amount of time. The time when the investment was repaid was defined as the payback period. It was a useful tool because it was easy to understand for most people and simple to apply in the model. It could be an intelligible indicator to represent the speed of an economic impact.

Owing to the utilization of the taxes as the indicators, the changes of tax rates can influence the results. In the real world, tax rates were not invariable, while the government may change the rate and policy every several years. As well, the changes of other uncertain parameters in the simulation model can affect the results of the analysis. Therefore, at the end of the research, sensitivity analysis was utilized to consider these uncertainties. Sensitivity analysis can study how the uncertainties in a model input influenced the output of the model.

Finally, it was detected that it was beneficial for the government to encourage students to enroll into graduate schools. A simulation model was utilized to investigate and compare the economic impact of taxes paid by engineers who had advanced degrees, and the model gave the value of desired parameters under different conditions.

Chapter 2 Background

Graduate education appears to have profound effects on students, and their earnings. It also has economic impacts to the government and society through the increasing of their income and taxes paid.

2.1 Relationship between Education and Economic Growth

Economic growth was defined as a consistent increase of the output per capita in a country (or the income per capita) in a long time period (Hesapcioglu, 1984). Education was always related with one country's economic growth, since the productivity of workers was a significant factor to influence the economic growth, which can be raised through educating workers. To measure the return of the costs on education was important, and one of the measures was cost-benefit analysis (Cinkir, 2000). Another popular formula to analyze the economic growth was Cobb-Douglas Production Function (1928, 1979), which can be shown as

$$Q = AL^{\alpha} K^{\beta} ,$$

where

Q = total production in a specific time,

L = labor input,

K = capital input,

A = total factor productivity (the part not explained by labor and capital increase in production),

α = output elasticity of labor input,

and β = output elasticity of capital input.

Based on the datasets, A, α, and β always were estimated by regressing the formula

$$\ln Q = \ln A + \alpha \ln L + \beta \ln K ,$$

where datasets of Q, L, and K were historical data. The above expression was transferred to a linear regression model, which was easier to solve. The perfect model would be obtained if $\alpha + \beta = 1$, which meant returns to scale were constant or output increased by the same proportional change with the proportional changes of all inputs. As investigated by Schultz (1961) and Denison (1962), the contribution of education to total productivity caused about two thirds of economic growth except for the labor and capital inputs. As reviewed by Hava and Erturgut (2010), the contribution of education to the economy stood to reason. Another study indicated that a literacy rate of 40% was a pre-condition for exceeding $300 GNP (Gross National Product), and 90% for exceeding $500 GNP by Bowman and Anderson based on 85 countries (Blaug, 1972).

2.2 The Economic Impacts of Colleges and Universities in a Local Area

As reviewed by Siegfried, Sanderson, and McHenry (2007), there were many studies on the economic impacts of colleges and universities. In the initial phases of analyzing this problem, a systematic template to organize the measurement of economic impacts was created by Caffrey and Issacs (1971). Then more and more research was focused on this field, and the analysis became more and more complex and included more and more variables. But the basic procedure to analyze the economic impact was common. First, a summary of expenditures of the college community (students, faculty, staff, and visitors) was obtained. Then multipliers to account for the interdependency of economic activities in a specific area were utilized, such as the impact to a state or to a country. As listed in their studies, colleges and universities always had positive impact to their local areas. For example, Loyola University Chicago created a $1.04 billion economic impact and nearly 15,000 jobs in the Chicago-land area in 1994 [Chicago College News. August 1995, 4(12): pp.1, 4]. Another good result was from the University of Georgia System, as it generated $9.7 billion in ‘output impact’. Moreover, it took charge of 2.8 percent of Georgia’s workforce, or 106,831 full- and part-time jobs [www.gatech.edu, January 18, 2005].

An analysis, where inputs included direct employment and payroll, expenditures for equipment, supplies and services, construction costs, expenditures of the local community, support of research, and tuition and fees paid, was conducted by Siegfried, Sanderson, and McHenry (2007). Multipliers always were indicated in a similar pattern, and the impacts could be obtained by summing the inputs with corresponding multipliers. An example of the expression of the multipliers was: “For every $1 in state appropriations for the university, the University of Oregon generates nearly $10 in additional expenditures (www.uoregon.edu, 2004)”.

As represented by Siegfried, Sanderson, and McHenry (2007), there were at least 198 impact studies done covering more than 241 individual institutions. There were several main contributions shown as the followings. A new methodology, which can be utilized for short and long-run flows, was proposed by Beck, Elliott, Meisel, and Wagner (1995), and they also gave alternative ways of thinking about geographic regions. A study to discuss the traditional “economic-base” approach was done by Brown and Heaney (1997). A case study of Xavier University in Cincinnati was created by Blackwell, Cobb, and Weinberg (2002) to discuss traditional and human capital impacts. With the analysis more and more complex, the range of the multipliers was too wide. Leslie and Slaughter (1992) standardized economic impacts by dividing “business volume” by the college budget, since the measures were sensitive to the institution’s budget. The methodology was improved but not significantly for a large range of estimates.

2.3 The Effect of College Quality and Undergraduate Majors

There were many studies to measure colleges' impacts on earnings in one way or another, while most of them were about the effect of the college's quality and they gave positive results (Zhang, 2005). Weisbrod and Karpoff (1968), Reed and Miller (1970), Solmon (1975), and Wise (1975) were among the first to investigate the impact of perceived quality of an institution on earnings of its graduates.

In Reed and Miller's research (1970), the earnings of men with college degrees were studied and multiple regressions equations with dummy variables were utilized to do the analysis. As shown in their study, the rank of the colleges had positive effects on the earnings, and the factors included in the rank of the colleges were: where degrees were received, levels of degree, majors, student ages, and race (nonwhites or whites). The men with bachelor's degree majoring in engineering, physical sciences, and business and commerce were indicated as the ones with greater monetary rewards, while the holders of higher degrees major in medical sciences and law had greater monetary rewards. The difference at each degree level was over $2,400 per year.

Solmon's studies (1975) mainly focused on the effects of college quality to the human capital earnings functions. As shown, the quality of institutions of higher education had significant impacts on earnings of those who attended. The subjective evaluation of institutions (the Gourman Index) was utilized to measure quality in some of their estimated equations. A deformation of Cobb-Douglas Production Function was used to study the people no longer in school, and it was

$$\ln Y_t = \ln Y_0 + aEXP + bEXPSQ + cYRS + dIQ + eQUAL + f_i V_i + u$$

where

$ln\ Y_t$ = the log of observed earnings,

EXP = years of experiences in the full-time labor force (from the first job),

EXPSQ = the squared value of EXP (Mincer, 1970),

IQ = the level of ability (presumably affected by a combination of genetics and environment),

QUAL = the quality of college attended,

V_i = occupational dummy *i*,

f_i = the coefficient of V_i,

and *u* = errors.

Years compared included 1939-1940, 1953-1954, 1959-1960, and 1969-1970. As mentioned in his conclusions, the institutional variables were regarded as relating to student quality, and the part relating to faculty salaries counted as college quality.

The methodology utilized in Wise's study (1975) was also a regression model, and his model with x as the parameters to be estimated was:

$$\ln s = a_0 + a_i + b_j + dx_0 + [r_0 + \alpha_i + \beta_j + \gamma_k + \sum_{l=1}^{5} \delta_l x_l]t + \varepsilon$$

where

s = monthly salary,

t = years employed,

d and δ = coefficients,

a_0 = constant,

a_i = effect of having B.A. degree or not when start work at the firm,

b_j = effect of the undergraduate major,

r_0 = average rate of salary increase,

α_i = effect of undergraduate college in *i*th selectivity group,

β_j = effect of undergraduate grades in *j*th interval,

and γ_k = effect of being in *k*th rank in M.A. class (γ_0 was for B.A. only).

As resulted, job performances were related with academic achievement. The differences in estimated rates of salary increase by college selectivity and college grade point average were large, which was consistent with Weisbrod and Karpoff (1968).

Recent studies by Brewer and his colleagues (Brewer and Ehrenberg, 1996; Brewer, Eide, and Ehreberg, 1999; Eide, Brewer, and Ehrenberg, 1998), and Thomas and his colleagues (Thomas, 2000, 2003; Thomas and Zhang, 2001, 2002) have significantly improved the understanding of the economic effect of college quality. Furthermore, Brewer and his colleagues (1996 and 1999) utilized regression models to analyze the impacts, and Thomas and his colleagues (2000, 2001, 2002, and 2003) used similar models though the variables and formation of the equations were different from each other. All of the previous research showed that college quality had positive and significant effects on graduates' earning (e.g., Solman and Wachtel, 1975; Pascarella and Terenzini, 1991; Mueller, 1988; Thomas, 2000, 2003).

Though there were many previous studies on the impacts of the education on the economy, they were to detect the economic impacts of a college or university as the community or the education's effect on several factors related to an individual's salary. In this research, the object is the economic impact to the government (or community) in the form of taxes paid of an individual who holds a higher degree compared with only a bachelor's degree. As well, most of the studies were based on regression models utilizing different variables indicated in the literature research, while this study is based on a simulation model which shows the whole process of the cash flows and gives the corresponding impacts to the government (or community). In addition, the developed simulation model was used to perform a sensitivity analysis to consider the possible impact to society (total taxes paid) as result of reducing the individual tax rate and a variety of levels of increased spending by an individual. This latter application was an attempt to partially answer the question under what circumstances will reduce federal tax rates result in more total federal taxes being paid due to stimulation of other components of society.

2.4 The Principles of the Simulation

The mathematical model needed to embed the factors, while the drastic simplifications were required to keep the equation system solvable. The simulation model can combine more factors into account to detect the impacts one by one. (Pryor, 1973) A simulation is the imitation of the operation of a real-world process or system over time according to Banks and his colleagues (2009). Several authors have discussed when it was appropriate to use simulation as reported by Naylor et al. (1966) and Shannon (1998). Banks (2009) concluded that simulation had the following 11 purposes: to study complex systems, to detect the effect on the model from informational, organizational, or environmental changes observed, to give suggestions to improve the current system, to obtain better outputs by changing inputs, as a pedagogical device to reinforce analytic solution methodologies, to do experiments for new designs or policies before implementation, to verify analytic solutions, to determine a machine’s requirements, to provide training without cost and disruption, to visualize a plan , and to develop a realistic analysis of modern system too complex to be reviewed in any other manners.

The simulation has had wide applications, including manufacturing, wafer fabrication, business processing, construction engineering and project management, logistics with transportation and distribution, military, and health care. Simulation can help to save money by doing an analysis before implementation. For example, the project

"Simulation Implements Demand-Driven Workforce Scheduler for Service Industry" in 2007 saved about $80 million for client's US facilities (Banks, 2009).

A system was defined as a group of objects that were joined together in some regular interactions or interdependence toward the accomplishment of some purpose. A system can always be affected by the changes occurring outside the system, and by the system's environment (Gordon, 1978). In simulation it is also required to determine the boundary between the system and its environment. In simulation an entity, attribute, activity, state, and event should be defined. An entity was an object of interest in the system. An attribute was a property of an entity. An activity represented a time of specified length. The state of a system was defined to be the collection of variables necessary to describe the system at any time, relative to the objectives of the study. For example, the possible states of a counter in a shop can be busy or idle. An event was defined as an instantaneous occurrence which may change a state of the system. More examples were shown in Table 2.1, including the systems about banking, production, and inventory.

Table 2.1 Examples of Systems and Their Components (Banks, 2009)

System	Banking	Production	Inventory
Entities	Customers	Machines	Warehouse
Attributes	Checking-account balance	Speed, capacity, breakdown rate	Capacity
Activities	Making deposits	Welding, stamping	Withdrawing
Events	Arrival, departure	Breakdown	Demand
State Variables	Number of busy tellers, number of customers waiting	Status of machines	Levels of inventory, backlogged demands

The system can be categorized as discrete or continuous. The state variables in a discrete system changed only at a discrete set of points in time, while in a continuous system they were changing over time. "Few systems in practice are wholly discrete or continuous, but since one type of change predominates for most systems, it will usually be possible to classify a system as being either discrete or continuous" (Law, 2007).

The common steps in simulation were shown in Figure 2.1 (Shannon, 1975; Gordon, 1978; Law, 2007; Banks, 2009). The study always started with the statement of the problem. And then the objectives indicated the questions answered by the simulation and the overall plan should be determined. Model conceptualization and data collections were the following steps, which can be processed at the same time, and it was better to involve the model user in model conceptualization. After these two steps completed, the information of the real-world systems/problems should be translated into computer languages, and the model can be entered into the computer for processing. Then the prepared computer program for the simulation model should be verified. Verification meant whether the computer program's performing was proper or not. If it was verified, it can be processed to validation; otherwise, it should go back to model translation. Validation was to compare the simulation model with the actual model behavior. They need to be consistent. Otherwise, the model must be re-conceptualized and data collection re-done. After the model was found to be acceptable, experiments can be designed and run to obtain the results. Analysis should be based on the results, and the analyst can determine whether additional runs were needed or not. Documentation and reporting should be prepared when everything had been completed. The success of the implementation phase depended on the performance of the previous steps.

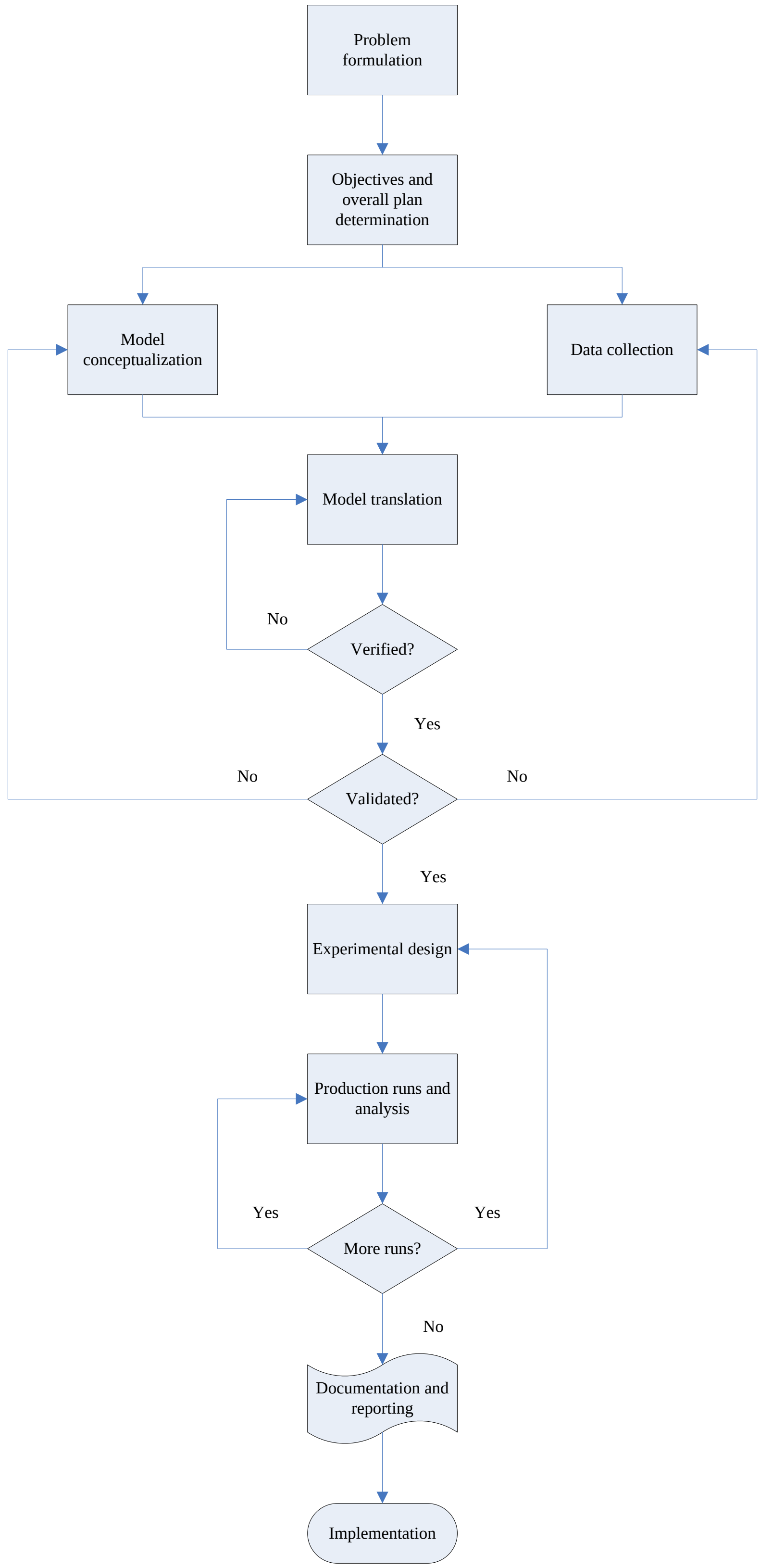


Figure 2.1 Steps in a simulation model

A simulation model can present a “real world” problem much better than a mathematic model, because it can combine more complicated variables into the model. It required having a clear understanding and idea of the goals and objectives of the problem, and the model can be created to analyze it. It tended to emphasis dynamic, quantitative analysis. It was easier and freer to change the values of the variables in a simulation model, and the results can be obtained with less inconvenience.

Chapter 3 Rationales

Following the steps shown in Figure 2.1, the problem should be stated. As more and more undergraduate graduates prefer to continue to graduate schools, the governments need to invest more on the graduate education theoretically. Some job positions require the employee with a higher degree than bachelors', and the salaries are higher. It is a reasonable question to ask whether it is worth an additional investment to obtain a master/PhD. Does he/she have positive economic impacts on the government taxes paid and community compared with a person who only has a bachelor's degree? To answer these questions, five specific objectives were formulated as follows.

1. Create a chain to show the cash flows for an individual to simulate their expenditures. In this chain, governments that eventually receive the taxes and some businesses in the communities that collect sales were represented to model the expenditures of an individual holding a bachelor's degree or an advanced degree. Using different values of the parameters with a higher degree, the difference of the economic impacts was obtained.
2. Estimate the economic impact of the income increasing for an individual with the graduate's degree on the annual taxes paid to governments. As collateral evidence, a regression model indicating the impact on the government income was obtained. The results and the trends of the outputs by changing the inputs were compared between the two models to see whether the simulation model was validated.
3. Estimate the total amount of taxes paid to the government for an individual by simulating the whole life of the career. And then obtain the economic impact of the income changed for an individual with the graduate's degree at the beginning of the career on the total taxes paid to government. The results and the trends of

the outputs by changing the inputs were compared between the two models to see whether the simulation model was acceptable.

4. Detect the trends of the impact to the government with the values of parameters changed.
5. Detect the impact to the government with the tax rate decreased. If the tax rate was decreased, the income after tax would be increased for an individual, and the individual can have more expenditures. Though the government has fewer income taxes, more expenditure can bring more consumer taxes to the government.

In this research, the individuals who were full time employees received bachelors' degrees or higher were selected to be the subject investigated.

Chapter 4 Methodology

A simulation model was utilized in this research. To achieve the objectives, the model included the income of an individual and his/her expenditures. The developed model defines the variables definition, the variables assignments, the cash flows, functions implementation, and the results.

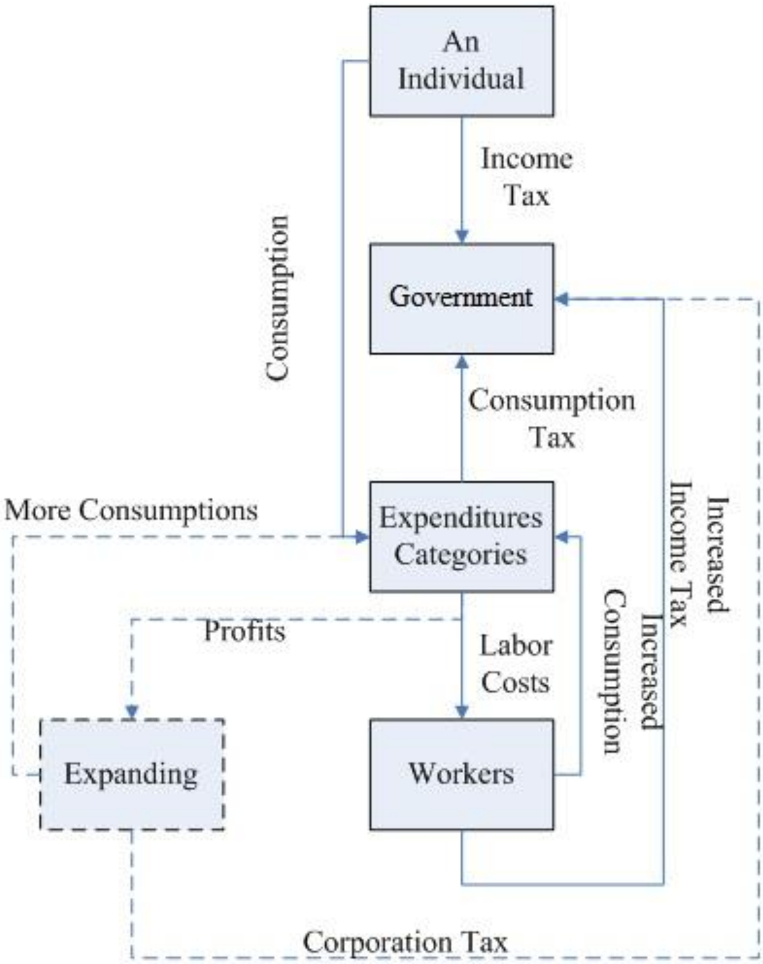


Figure 4.1 Flow chart for the contribution of an individual's income

The main variables in the model were characteristics of individuals (such as ages and education), incomes, income taxes, annual expenditures in various categories, and sales taxes. The cash flow shown in Figure 4.1 represented the income to the individual and the impact of money spent by the individual. Figure 4.1 includes income taxes, sales taxes on consumption of goods and services, payments to workers and the increased contributions of the workers caused by the individual spending, and the part of investments on expanding their companies contributed by the individual. The dashed lines show the impact of consumer spent on expanded facilities. The individual with different characteristics can have different levels of incomes and patterns of expenditures.

4.1 Data Collection

This research focused on the economic impact on the government/community of a Master's degree or PhD degree in engineering compared with a Bachelor's degree in engineering. The impact was focused on the increased taxed paid, and thus the increased taxable income and the taxable expenditures of an individual were the key values. To obtain the useful data, many federal documents available on websites providing survey results and statistics results were reviewed. The US Bureau of Labor Statistics was the most helpful source for the expenditures data, since the historical data there were official and comprehensive. The UNL Career Services office also provided individuals' immediate incomes into the career and US Bureau of Labor Statistics offered the statistical descriptions of persons' incomes.

The individuals' income goes to different cash flow streams, including income taxes to the government, savings, investments, and expenditures. As shown in US Bureau of Labor Statistics (2011), the seven major expenditure categories included for US intergroup were food, housing, apparel and services, transportation, health care, entertainment, and other expenditures. The part of expenditures focused on in this research was the taxable expenditures. The taxable foods included the food away from home and alcoholic beverages. The taxable housing included owned dwellings and some utilities. All apparel and services were taxable. The taxable transportation included vehicle purchases, gasoline, and vehicle rental, leases and licenses. The taxable health care was the cost of medications. All entertainments were taxable. The main part in the other expenditures focused in this research was the cash contribution, which can result in tax deductions or credits. The money for saving and investments would increase the personal income before taxes, but it was difficult to estimate how much it contributed to the taxable income.

Since analysis of money should include the time value of money through a long time period, this research considers money followed over only one year and the time value of money was not considered. The percentages of expenditures in the after taxes income were calculated from the historical data, and fitted to appropriate distributions. From the percentages and the after taxes incomes, consumptions on each expenditure component can be obtained, and the sales taxes were calculated with the corresponding tax rates. Individuals' incomes also were also fitted to an appropriate distribution from the historical data. The income taxes were obtained with the corresponding tax rate table for different individuals with different information.

4.2 Input Analysis

Historical data need to be analyzed and then be utilized in the simulation models. Input Analyzer in Arena was utilized to deal with the historical data. The software can give a statistical report for the data imported. In the statistical report, the sample size, the range, the minimum value, and the maximum value were indicated. Several intervals of the data were separated into, and the number of data in each interval called frequency was counted. The histogram was drawn based on the information. As well, in the software, various distributions were fitted for the histogram, and squared errors for each distribution were calculated. The best-fitted distribution can be selected with the smallest squared error.

The parameters generated in Input Analyzer were different from the parameters utilized in MATLAB for some of the distributions including the lognormal distribution, the Weibull distribution, and the triangular distribution. The parameters of the lognormal distribution in Input Analyzer were the mean value and the standard deviation value, while in MATLAB the parameters were the μ and σ in the corresponding normal distribution. The mean value was assumed to be N, and the standard deviation value was set to be M. For the lognormal distribution, there were

$$\begin{cases} N = e^{(\mu+\frac{1}{2}\sigma^2)} \\ M^2 = (e^{\sigma^2}-1)\times e^{(2\mu+\sigma^2)} \end{cases}.$$

By solving the system of equations, the parameters utilized in MATLAB can be obtained as

$$\begin{cases} \mu = \ln N - \frac{1}{2}\times\ln[(\frac{M}{N})^2+1] \\ \sigma = \sqrt{\ln[(\frac{M}{N})^2+1]} \end{cases}.$$

In Input Analyzer, the parameters for Weibull distribution were the scale parameter (λ) and the shape parameter (k). The distribution can be expressed as

$$f(x;\lambda,k) = \begin{cases} \frac{k}{\lambda}\times(\frac{x}{\lambda})^{k-1}\times e^{-(x/\lambda)^k}, x\geq 0 \\ 0, x<0 \end{cases}.$$

There was another expression of the Weibull distribution utilized in MATLAB with parameters α and β shown as

$$f(x;\alpha,\beta) = \begin{cases} \alpha\cdot\beta\cdot x^{\beta-1}\cdot e^{-\alpha\cdot x^\beta}, x\geq 0 \\ 0, x<0 \end{cases}.$$

By the comparison of the two expressions, the parameters can be transported to each other, and they were

$$\begin{cases} \alpha = (1/\lambda)^k \\ \beta = k \end{cases}.$$

There was no direct statement to generate random number from triangular distributions. The random number from the triangular distribution can be obtained as the value of the variable in the distribution corresponding to the specific cumulative probability generated randomly. The cumulative probability of the triangular distribution was

$$F(x;a,b,c) = \begin{cases} \frac{(x-a)^2}{(b-a)(c-a)}, a \le x \le c \\ 1 - \frac{(b-x)^2}{(b-a)(b-c)}, c < x \le b \end{cases},$$

where a was the lower limit, b was the upper limit, and c was the mode in the distribution.

The cumulative probability generated was assumed to be "*u*" which was in the range of [0, 1]. If *u* was larger than $F(c;a,b,c) = \frac{c-a}{b-a}$, the value of the variable was in the range of (c, b]; otherwise, the value of the variable was in the range of [a, c]. The value of the variable, *x*, can be solved from the expression of the cumulative function distribution as

$$x = \begin{cases} a + \sqrt{u \cdot (b-a) \cdot (c-a)}, 0 \le u \le \frac{c-a}{b-a} \\ b - \sqrt{(1-u) \cdot (b-a) \cdot (b-c)}, \frac{c-a}{b-a} < u \le 1 \end{cases}.$$

Then all distributions fitted in Input Analyzer can be realized in MATLAB.

4.3 The Basic Function Realization

In this research, the impact of education is an important component of the study. The following example is to indicate the effect with different levels of education, Bachelor

(0) and higher than Bachelor (1). It is assumed that the sunk cost of the initial cost of the university is ignored.

The tax revenues obtained by the governments were the main indicator to present the impacts. Total tax revenues received by the governments should be the sum of the tax revenues received by the federal government and the tax revenues received by the state & local government. The tax revenues can be presented by the following equations.

$$TR = FTR + STR$$

$$FTR = r_{if} \times Income$$

$$\begin{aligned} STR = {} & r_{is} \times Income + \sum_{j=1}^{18}\{r_{sj} \times [p_{c1j} \times (1 - r_{if} - r_{is}) \times Income]/(1 + r_{sj})\} + \\ & \sum_{j=1}^{18}\{r_{sj} \times \{p_{c2j} \times p_e \times \sum_{l=1}^{18}[p_{c1l} \times (1 - r_{if} - r_{is}) \times Income]\}/(1 + r_{sj})\} + \\ & \sum_{j=1}^{18}\{r_{sj} \times (p_{c3j} \times p_e \times \sum_{t=1}^{18}\{p_{c2t} \times p_e \times \sum_{l=1}^{18}[p_{c1l} \times (1 - r_{if} - r_{is}) \times Income]\})/(1 + r_{sj})\} + \ldots \end{aligned}$$

where

TR : the total tax revenues;

FTR : the federal tax revenues;

STR : the state tax revenues;

$Income$: an individual's income;

r_{if} : the federal income tax rate;

r_{is} : the state income tax rate;

r_s : the sales tax rate;

p_c : the percentage of the after taxes income on each category of the expenditures;

p_e : the percentage of the direct expenditures paid to the employees in the corresponding places;

p_s : the percentage of the individual's income to stop adding the indirect contributions. In the model, *Income* and p_c can be generated randomly from the corresponding distributions obtained from the raw data. The other parameters including r_{if}, r_{is}, r_s, p_e, and p_s were set to be specific values. The indirect tax revenues received by the government from one individual were stopped to be added when the expenditures of all employees were less than p_s of the individual's income.

Table 4.1 The summary of data for consumers with BD

Income before Taxes	Expenditures Categories	Percentages	Consumptions including Taxes	Sales Tax Rate
Normal Distribution (mean, variance) = Normal (74597, 256963703)	FoodH	*Uniform(0.048,0.091)*	$Percentage \times IncomeAfterTax$	*0*
	FoodAH	*Uniform(0.041,0.051)*		*7%*
	ABev	*Uniform(0.005,0.010)*		*7%*
	OHou	*Uniform(0.107,0.189)*		*0*
	RHou	*Uniform(0.030,0.090)*		*0*
	HR&M	*Uniform(0.049,0.131)*		*7%*
	Utilities	*Uniform(0.045,0.088)*		*0*
	Cloths	*Uniform(0.027,0.043)*		*7%*
	NVeh	*Uniform(0.022,0.040)*		*7%*
	UVeh	*Uniform(0.016,0.037)*		*7%*
	Gasoline	*Uniform(0.021,0.053)*		*7%*
	VehIns	*Uniform(0.012,0.023)*		*0*
	HeIns	*Uniform(0.019,0.026)*		*7%*
	HIns	*Uniform(0.018,0.034)*		*0*
	Ent	*Uniform(0.039,0.047)*		*7%*
	TobP	*Uniform(0.002,0.011)*		*7%*
	others	*Uniform(0.034,0.131)*		*7%*
	Saving	$1-\sum_{i=1}^{17} percentage_i$		*0*

The raw data were obtained from annual reports of the US Bureau of Labor Statistics. The history data utilized here was from 2000 to 2010. A sample of the raw data was shown in Appendix A. Part of the expenditure categories shown were taxable and the others were not. By combining some of categories, there were 18 categories indicating the different directions of their expenditures, including food at home (FoodH), food away home (FoodAH), alcoholic beverages (ABev), owned housing (OHou), rented housing (RHou), house repair and maintenance (HR&M), utilities, clothes, new vehicle (NVeh), used vehicle (UVeh), gasoline, vehicle insurance (VehIns), healthcare excluding insurance (HeIns), health insurance (HIns), entertainment (Ent), tobacco products (TobP), other expenditures (others), and saving. The data were the average money consumed on each category. After combining, the money also was added together for each category summarized above.

Table 4.2 The summary of data for consumers with higher than BD

Income before Taxes	Expenditures Categories	Percentages	Consumptions including Taxes	Sales Tax Rate
Normal Distribution (mean, variance) = Normal (96195, 382263178)	FoodH	*Uniform(0.039,0.070)*	$Percentage \times IncomeAfterTax$	*0*
	FoodAH	*Uniform(0.036,0.046)*		*7%*
	ABev	*Uniform(0.006,0.009)*		*7%*
	OHou	*Uniform(0.108,0.164)*		*0*
	RHou	*Uniform(0.020,0.054)*		*0*
	HR&M	*Uniform(0.066,0.123)*		*7%*
	Utilities	*Uniform(0.038,0.072)*		*0*
	Cloths	*Uniform(0.022,0.039)*		*7%*
	NVeh	*Uniform(0.020,0.036)*		*7%*
	UVeh	*Uniform(0.010,0.034)*		*7%*
	Gasoline	*Uniform(0.017,0.049)*		*7%*
	VehIns	*Uniform(0.010,0.024)*		*0*
	HeIns	*Uniform(0.018,0.024)*		*7%*
	HIns	*Uniform(0.017,0.033)*		*0*
	Ent	*Uniform(0.038,0.054)*		*7%*
	TobP	*Uniform(0.001,0.010)*		*7%*
	others	*Uniform(0.061,0.150)*		*7%*
	Saving	$1-\sum_{i=1}^{17} percentage_i$		*0*

Utilized the consumption on each category divided by the after tax income, the percentage of each category's expenditure was obtained. The percentages for each category from year 2000 to 2010 were fitted to an appropriate distribution. The average money spent by person with Bachelor's Degree (BD) and with higher than BD was shown respectively in the report, and as well as the all consumers units. Uniform distribution was considered to be utilized in this case. A summary of the distributions was shown in Table 4.1. The incomes were estimated as normally distributed with the sample mean and variance.

The persons with a degree higher than BD had both larger mean and variance if the income distributions compared to the persons only holding a BD. The other column should be the same based on the consistent policy.

There was also a summary of all consumers' data, which was not only including the consumer who was a college graduate but also including the consumer who was not a college graduate. The mean of their incomes' distribution was smaller than the above two means, but the variance was larger than the above two variances.

Table 4.3 The summary of data for all consumers units

Income before Taxes	Expenditures Categories	Percentages	Consumptions including Taxes	Sales Tax Rate
Normal Distribution (mean, variance) = Normal (56219, 49415145)	FoodH	*Uniform(0.057,0.073)*	$Percentage \times IncomeAfterTax$	*0*
	FoodAH	*Uniform(0.041,0.051)*		*7%*
	ABev	*Uniform(0.007,0.009)*		*7%*
	OHou	*Uniform(0.102,0.112)*		*0*
	RHou	*Uniform(0.042,0.049)*		*0*
	HR&M	*Uniform(0.122,0.137)*		*7%*
	Utilities	*Uniform(0.056,0.062)*		*0*
	Cloths	*Uniform(0.028,0.045)*		*7%*
	NVeh	*Uniform(0.020,0.042)*		*7%*
	UVeh	*Uniform(0.021,0.043)*		*7%*
	Gasoline	*Uniform(0.026,0.044)*		*7%*
	VehIns	*Uniform(0.015,0.019)*		*0*
	HeIns	*Uniform(0.021,0.026)*		*7%*
	HIns	*Uniform(0.024,0.030)*		*0*
	Ent	*Uniform(0.041,0.046)*		*7%*
	TobP	*Uniform(0.005,0.008)*		*7%*
	others	*Uniform(0.013,0.108)*		*7%*
	Saving	$1-\sum_{i=1}^{17} percentage_i$		*0*

The distributions shown in Table 4.3 were utilized for the normal consumers who were not specified by their education levels. The other columns were still kept the same according by the tax policy. For real estates, there was no sales tax but the mortgage tax stamp and deed taxes. In the first year, when a vehicle was bought, sales taxes should be paid. The tax rate for vehicle was about 7%. As well, motor vehicle taxation should be paid to the government every year for the motor vehicles owned. For the food away home and alcohol beverages, there was also occupation taxes except sales taxes, and the sales taxes were on the sales prices added the occupation taxes on it. The occupation taxes rate were 2.5% in Nebraska, and the occupation taxes were remitted to the city. The sales taxes rate was 7%, and the sales taxes were remitted to Nebraska Department of Revenue.

Table 4.4 Federal income tax brackets for singles in 2011

Single, 2011		
Marginal Tax Rate	Tax Brackets	
	Over	But Not over
10.0%	$ 0	$ 8,500
15.0%	$ 8,500	$ 34,500
25.0%	$ 34,500	$ 83,600
28.0%	$ 83,600	$ 174,400
33.0%	$ 174,400	$ 379,150
35.0%	$ 379,150	

In this example, the consumers were assumed to be single to simplify the analysis, and the income tax policy for singles in 2011 was utilized. The federal income tax brackets were shown in Table 4.4. The state income tax brackets were shown in Table 4.5. So the effective tax rates can be calculated as shown in Table 4.1, Table 4.2, and Table 4.3. The federal income taxes and the state income taxes can be calculated separately, and the income taxes were the sum of the two parts.

Half of the direct expenditures were estimated to be paid to the employees working at the corresponding places in the example. The indirect contribution of an individual was realized in the “while” loop. The indirect contributions would not be added if the increased expenditures of the workers were less than 1% of the individual’s income.

In the loop, the percentages of expenditures were obtained from the distributions for all consumers units, which were not specified by different characteristics.

Table 4.5 State income tax brackets in 2011

Effective Tax Rate	Tax Brackets	
	Over	But Not over
2.56%	$ 0	$ 2,400
3.57%	$ 2,400	$ 17,500
5.12%	$ 17,500	$ 27,000
6.84%	$ 27,000	

There was an example to show the cash flows about a restaurant for a consumer with a bachelor's degree in Figure 4.2.

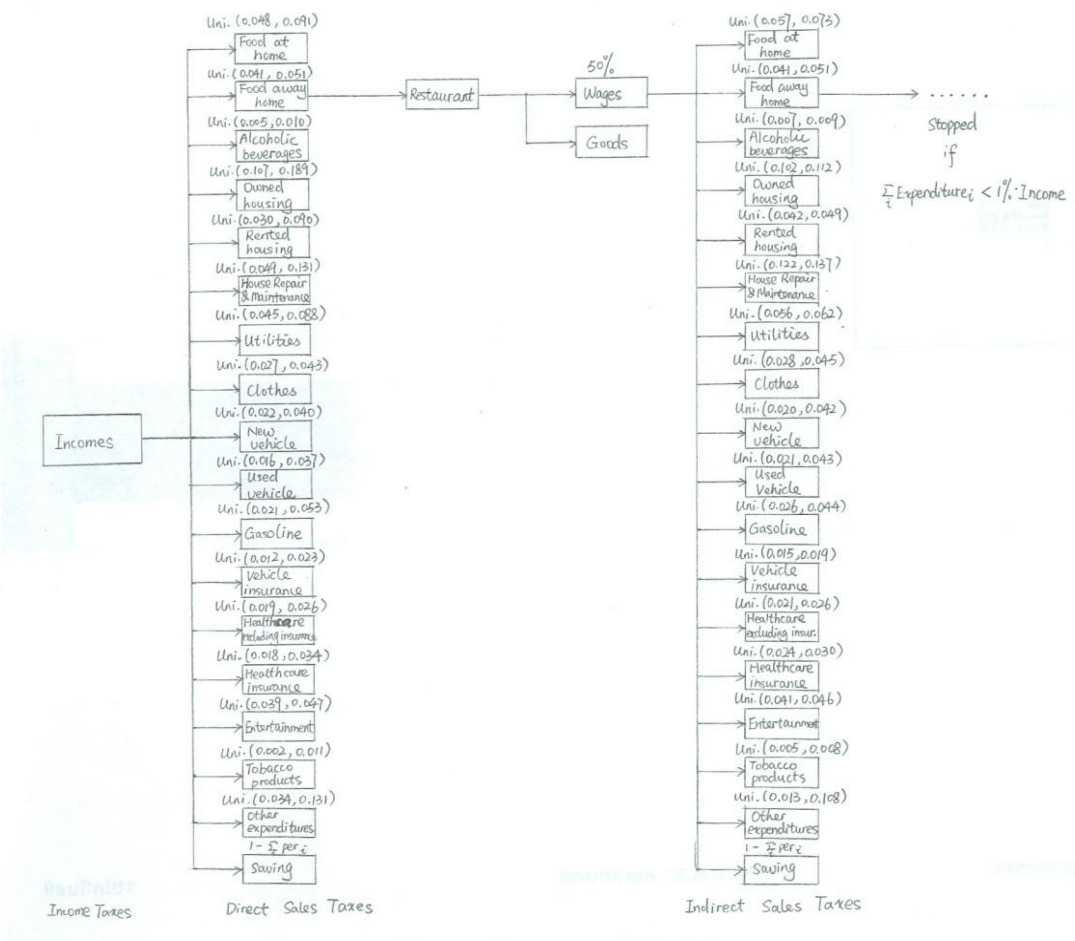


Figure 4.2 Cash flows about restaurant for a consumer with a bachelor's degree

One individual can have 18 categories of expenditures including saving, and the employees in the restaurant can get parts of the money as the source of their incomes. The employees would also have those 18 categories of expenditures, and sales tax revenues can be obtained from them as the indirect contributions from the individual. Each employee had those 18 categories of expenditures, and a tree for the expenditures level by level can be created.

All taxes were added together as the contribution of an individual to the government. As shown, the individuals were sorted out by holding BD or higher degree. The impact was indicated as the ratio of the contributions, the ratio of the difference of the contributions and the difference of the income, and the difference between the taxes.

$$impact1 = tax1 / tax0$$
$$impact2 = (tax1 - tax0)/(income1 - income0)$$
$$impact3 = tax1 - tax0$$

where 1 indicated the parameters were for an individual holding higher degree than BD, and 0 indicated the parameters were for an individual holding BD. The results of impacts were shown in Table 4.6 for the total 10 trials.

Because the amount on the consumptions generated in the program was the total amount paid by the individual, if there were sales taxes for the consumptions, and the amount was "C", the sales taxes would be

$$SalesTaxes = 0.07 \times \frac{C}{1.07}.$$

For the food away home and alcohol beverage items, the sales taxes were on the sales prices added by the occupation taxes, so the sales taxes calculated would be

$$SalesTaxes = 0.07 \times 1.025 \times \frac{C}{1.025 \times 1.07} = 0.07 \times \frac{C}{1.07}.$$

The mean of impact1 was 1.41, and the variance was 0.166. The mean of impact2 was 0.24 with the variance 0.00017. The average difference between taxes was 6125 dollars and the variance was 2.46×10^7. The contributions from an individual with higher degree than BD were increased by 1.41 compared with an individual with BD. With $ 1 increased for their incomes, $ 0.24 was expected to be increased as the contribution to the government.

Table 4.6 Summary of the results

	Income Taxes ($)		Sales Taxes ($)		Taxes ($)		Impact 1	Impact 2	Impact 3 ($)
	BD (0)	Higher (1)	BD (0)	Higher (1)	BD (0)	Higher (1)			
1	12140	16761	3335	4564	15475	21325	1.39	0.24	5849
2	8470	20074	2499	5511	10969	25585	2.33	0.23	14616
3	13801	15302	3805	4081	17606	19383	1.10	0.22	1777
4	14284	25365	3950	6785	18233	32150	1.76	0.23	13917
5	10015	16943	2790	4581	12805	21524	1.68	0.23	8720
6	16973	17852	4785	4910	21757	22762	1.05	0.21	1005
7	16968	21312	4593	5793	21561	27104	1.26	0.24	5543
8	13316	17654	3743	4947	17058	22601	1.32	0.24	5543
9	14402	17091	3961	4901	18363	21992	1.20	0.25	3629
10	13948	14416	3869	4053	17817	18469	1.04	0.26	653

There were three outputs in the basic model. The outputs of the impacts (*Impact1*, *Impact2*, and *Impact3*) were selected to provide rapid and discrete comparison between the bachelor's degree and the advanced degree.

For example, a $21,000 annual raise for a person holding a Master's Degree (MD) can result in approximately $5,040 per year in more total taxes. The taxes here were combined of federal taxes and state taxes together and they were estimated as the values in the state of Nebraska. Using a 5% cost of money and assuming the tax receipts being constant, the present worth of the taxes along *n* years can be estimated as

$$PW = A(P/A,i,n) = A\frac{(1+i)^n - 1}{i(1+i)^n}$$

where i was the interest rate, and A was the annuity amount each year.

Assume a student to obtain the MD were spent \$30,000 more by the government which was appropriately one third of the total costs on the degree, which was a present value. The government can be repaid in 8 years, which was got by solving

$$\$30000 = \$5040 \times (P/A, 5\%, n).$$

Normally in the real world, the individual income always can be grown year by year. The raise of the income can shorten the payback period, since there were more taxes paid to the government. It can be estimated by modeling the situation along the time. If a consistent rate of the taxes' growth paid to the government was assumed to be 3%, utilizing geometric gradient method, the payback period can be estimated by solving

$$PW = A_1 \frac{1-(1+j)^n(1+i)^{-n}}{i-j},$$

where $PW = \$30000$, $A_1 = \$5040$, $i = 5\%$, and $j = 3\%$. The government can be repaid in approximately 7 years, which was one year early.

4.3 Model for the Whole Life of Career

Based on the basic model in Section 4.2, the whole life of career can be simulated. Every 10 years were categorized as one stage. The first stage was in the period less than 25 years old, the second stage was in the period from 25 years old to 34 years old, and the third stage was in the period from 35 years old to 44 years old, and so on. The last stage of the career was defined as the period from 55 years old to 64 years old.

The individuals only with bachelor's degree would begin their career life from 22 years old, and the individuals with higher degree would start their career life from 25 year old. The initial incomes of different groups of people were from different distributions, and the income would be changed every stage by a rate obtained from a corresponding distribution. The distributions of percentages for each consumption category were different in different stages, and the distributions were simulated from the historical data. The annual taxes can be obtained for each year. Using the economic principle, the difference of the present worth of total taxes can be calculated to indicate the economic impact.

The taxes received by the government each year were obtained utilizing the method shown in Section 4.2. The present worth of the taxes received for the whole life of careers can be calculated based on the taxes received each year and the effective annual interest rate.

$$PW = \sum Tax_n \cdot (1+i)^{-n} ,$$

where PW was the net present worth of the taxes received each year, Tax_i was the taxes received in the n^{th} year, and i was the effective annual interest rate.

The economic impact for the whole life of careers was based on the present worth of the taxes. The difference of the present worth between the individual who only received a bachelor's degree and the individual who received a higher degree was utilized to indicate the impact of the higher than bachelor degree.

4.4 Tax Rates Changing

In the example, the individuals were assumed to be single and the income tax rates in 2011 for singles were utilized.

Income tax rates vary depending upon the filing status of the taxpayer. The five categories of filing status were single, married filling a joint return, married filling separate returns, head of household, and qualifying widower with dependent child. In the future study, these five categories should be included in the model, either as the factor which might affect the contribution, or as the structure of all individuals no contribution on the impacts.

As studies, the tax rates can be changed caused by time or other factors, such as to increase the income of the government, to stimulate consumptions, to stimulate investments. By changing the tax rates or tax policy, the corresponding impacts can be estimated. For example, if the government decreased the income tax rates, there would be more expenditure in the market. For the government, income taxes were reduced but sales taxes should be increased. It was difficult to conclude whether it was beneficial or not for the government's income.

4.5 Sensitivity Analysis

Sensitivity analysis should be conducted by changing the range of corresponding parameters. The parameters would include the percentage of direct expenditures paying to the workers, and the condition to stop the indirect contributions in the basic model. There was one more parameters changed in the whole career life model, which was the effective annual interest rate utilized for the present worth.

The method to show the sensitivity analysis was the figures of the corresponding indicators changed with the changes of the parameters. If the indicator was changed significantly with the changes of one parameter, the parameter was sensitive for this indicator. If there was no significant shift to the indicator with the changes of the parameter, the parameter was inferred to be insensitive for the parameter.

Chapter 5 Input Modeling

Input models can provide the driving force for a simulation. In the simulation in this research, the input models included the distributions of salaries for different groups of people, percentages of salaries changed from one stage to another, and percentages of expenditures on different categories of consumptions for different groups of people. The resources of the historical data collected were shown in Chapter 4. The models were developed from the data so that simulation can randomly select from the distribution with given parameters

5.1 Input models for the salaries of different groups of individuals

The input analysis in Arena (Banks, 2009) was utilized to obtain the distributions of history data. The history data included the individual salaries and individual expenditures. Input Analyzer can identify the distributions with data.

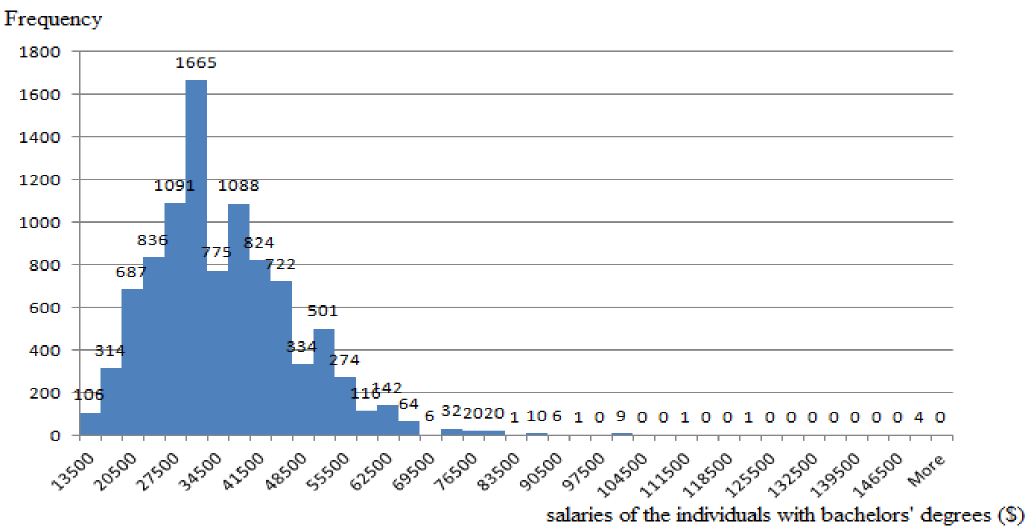


Figure 5.1 Histogram of the individuals' salaries with bachelor's degree

As indicated by Input Analyzer, different distributions from the census reports were fitted for the salary data of all individuals disregarding their majors who only received bachelor's degree. The histogram to present history data of their salaries was shown in Figure 5.1, and the squared errors for different distributions were shown in Table 5.1.

There were 9650 data points for the individuals' salaries with bachelor's degree. The range of their salary was from 1×10^4 dollars to 1.5×10^5 dollars per year. The sample mean of them was 3.41×10^4 dollars per year, and the standard deviation was 1.22×10^4.

Table 5.1 Squared error of different distributions for all bachelor' salaries

Functions	Squared Error
Beta	0.00619
Gamma	0.00816
Normal	0.00966
Weibull	0.01250
Lognormal	0.02850
Triangular	0.04600
Exponential	0.04860
Uniform	0.06950

As seen in Table 5.1, the best distribution with smallest squared error (0.00619) was $1 \times 10^4 + 1.4 \times 10^5 \times BETA(3.63, 18.1)$ dollars, where 3.63 was the α value and 18.1 was the β value of the beta distribution.

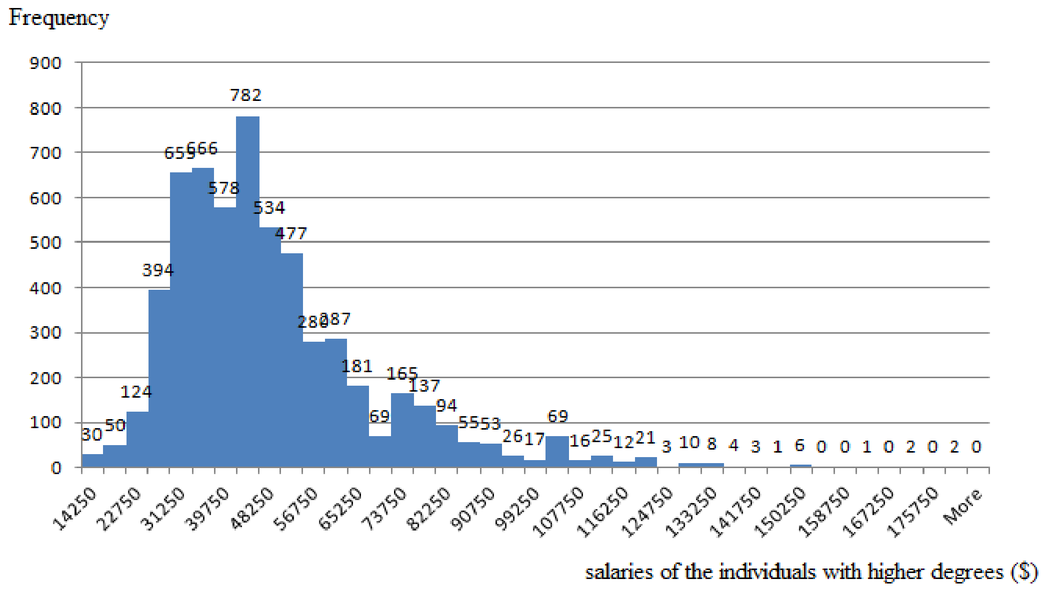


Figure 5.2 Histogram of the individuals' salaries with higher degree

In the database indicated in Figure 5.2, there were 5837 data points for the individuals' salaries with higher than bachelor's degree disregarding the majors. The range of their salary was from 1×10^4 dollars to 1.8×10^5 dollars per year. The sample mean of them was 4.63×10^4 dollars per year, and the standard deviation was 2×10^4.

Table 5.2 Squared errors of different distributions for all individuals' salaries with higher degree

Functions	Squared Error
Beta	0.00494
Gamma	0.00505
Weibull	0.01190
Normal	0.01320
Lognormal	0.01720
Triangular	0.03680
Exponential	0.04340
Uniform	0.05660

As shown in Table 5.2, the best distribution for all individuals who had higher degree than bachelor's with smallest squared error (0.00494) was $1\times10^4+1.7\times10^5\times BETA(3.73,13.7)$ dollars, where 3.73 was the α value and 18.1 was the β value of the beta distribution.

Table 5.3 Squared errors of different distributions for bachelor' salaries major in engineering

Functions	Squared Error
Normal	0.00410
Beta	0.00438
Gamma	0.00589
Weibull	0.01150
Lognormal	0.02310
Triangular	0.04960
Exponential	0.07620
Uniform	0.07840

After distributions fitted, the best distribution for individuals' salaries with bachelor's degrees was a normal distribution, and the parameters were shown in Table 5.3. As seen, the distribution with smallest squared error was a normal distribution with the mean being 4.54×10^4 and the standard deviation being 1.03×10^4.

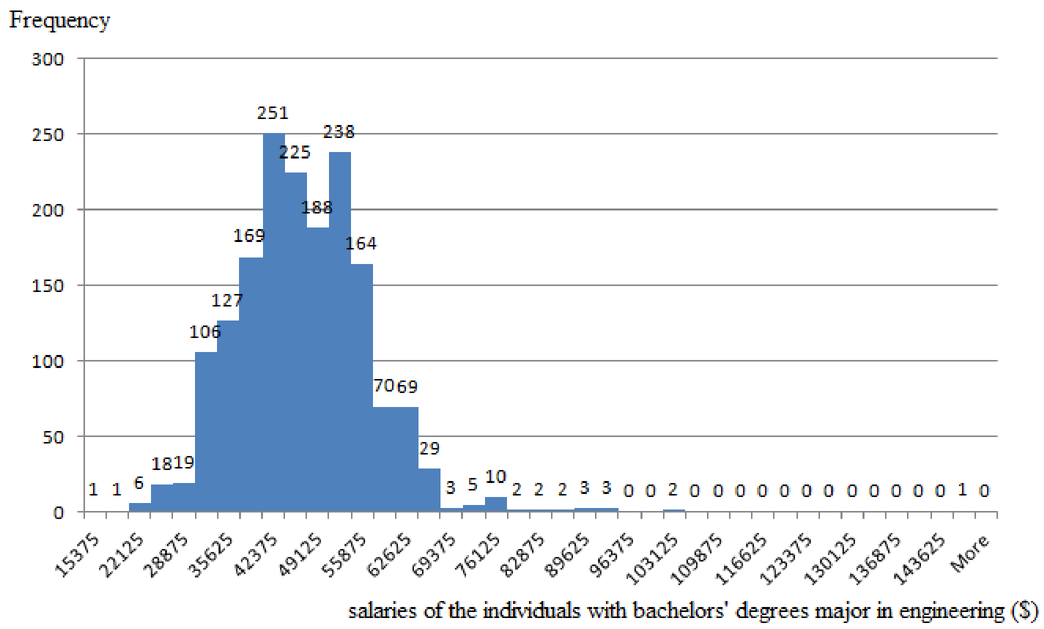


Figure 5.3 Histogram of the individuals' salaries with bachelor's degree major in engineering

The histogram was shown in Figure 5.3. The minimum salary for them was 1.2×10^4 dollars per year, and the maximum salary was 1.47×10^5 dollars per year for the individuals who just received bachelor's degrees.

Table 5.4 Squared errors of different distributions for individuals' salaries with higher degrees major in engineering

Functions	Squared Error
Normal	0.00652
Beta	0.00776
Weibull	0.00856
Gamma	0.01190
Triangular	0.02060
Lognormal	0.04000
Uniform	0.05370
Exponential	0.06190

The best distribution fitted for the annual salaries of individuals with higher degrees major in engineering was also a normal distribution with the smallest squared error equaling 0.00652. As seen in Table 5.4, the square error of the normal distribution was less than the others, and 0.00028 less than the second best distribution, the Beta distribution. There were 510 data points, and the minimum data value was 1.6×10^4 dollars each year. The maximum data value was 1.2×10^5 dollars each year. The maximum data value for the individuals with higher degrees was a little less than the maximum data value for the individuals with bachelor's degrees.

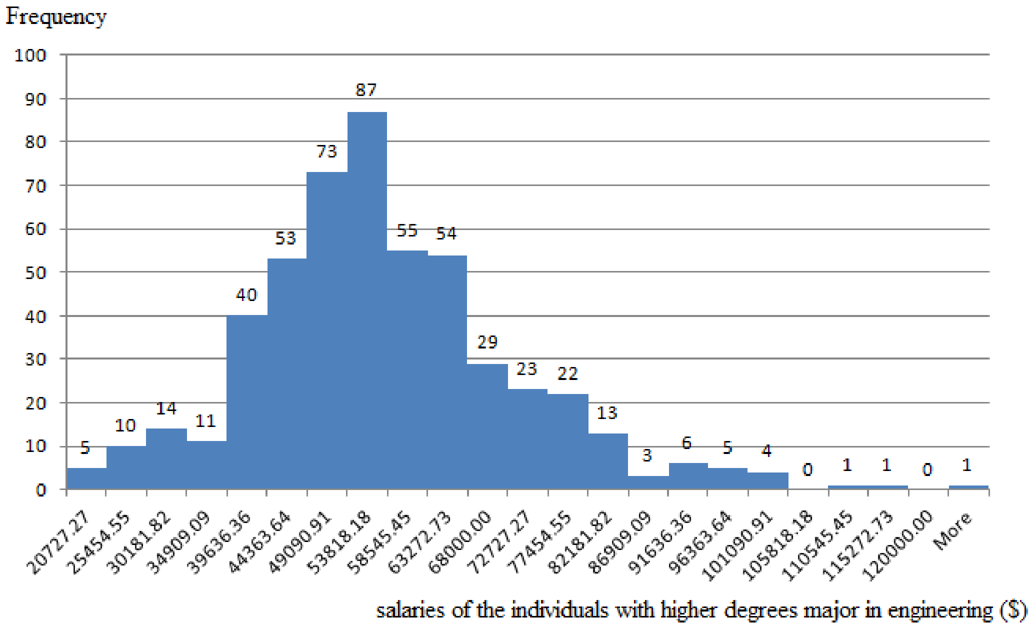


Figure 5.4 Histogram of the individuals' salaries with higher degrees major in engineering

As indicated in Figure 5.4, the normal distribution was with the mean being 5.31×10^4 and the standard deviation being 1.56×10^4.

5.2 Input models for the percentages of salaries changed from one stage to another

The individuals' salaries were fitted, and the distributions utilized were shown in Section 5.1. They were the same as the distributions utilized here to generate the initial salaries when he/she went into the career. The whole life of career was divided into five stages. The first stage was for the individual's age less than 25 years. The second stage was for the age from 25 years to 34 years. The third stage was for the age from 35 to 44 years. The fourth stage was for the age from 45 to 54 years. And the fifth stage was for the age from 55 to 64 years. An individual was estimated to retire when he/she became 65 years old, and the career was ended. For an individual who just received a bachelor's degree, it was normal to graduate at 22 years old, so the first stage was for the individual's age from 22 to 24 years. For an individual who received a higher degree, the earliest date to graduate was estimated to be 25 years old, so there were zero years in the first stage.

When the individual started the career, the salary may be changed year by year. In this research, the changes were estimated stage by stage. History data were analyzed and fitted to find a proper distribution to simulate its changes. Since there were only three years in the first stage for the individuals who received bachelor's degrees, the change from the first stage to the second one was ignored in the analysis to keep the consistence between the individuals with bachelor's degrees and with higher than bachelor's degrees. The education level was ignored to analyze the changes of salaries. There were 11 data points for every change to be fitted, and the history data were from 2000 to 2010.

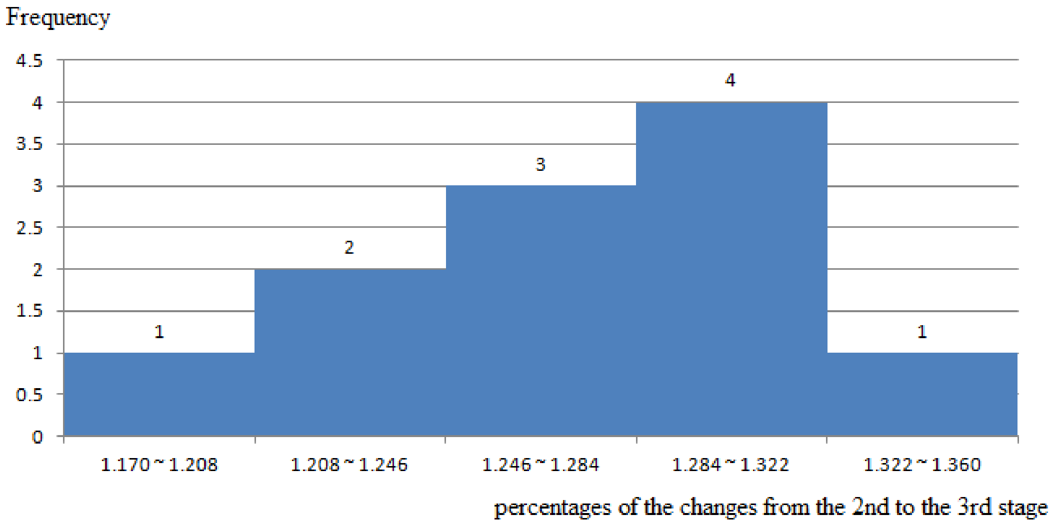


Figure 5.5 Changes from the 2nd to the 3rd stage

As seen in Figure 5.5, the distribution followed by the changes of salaries from the second stage to the third was triangular (1.17, 1.29, 1.36) with the smallest square error being 0.00514.

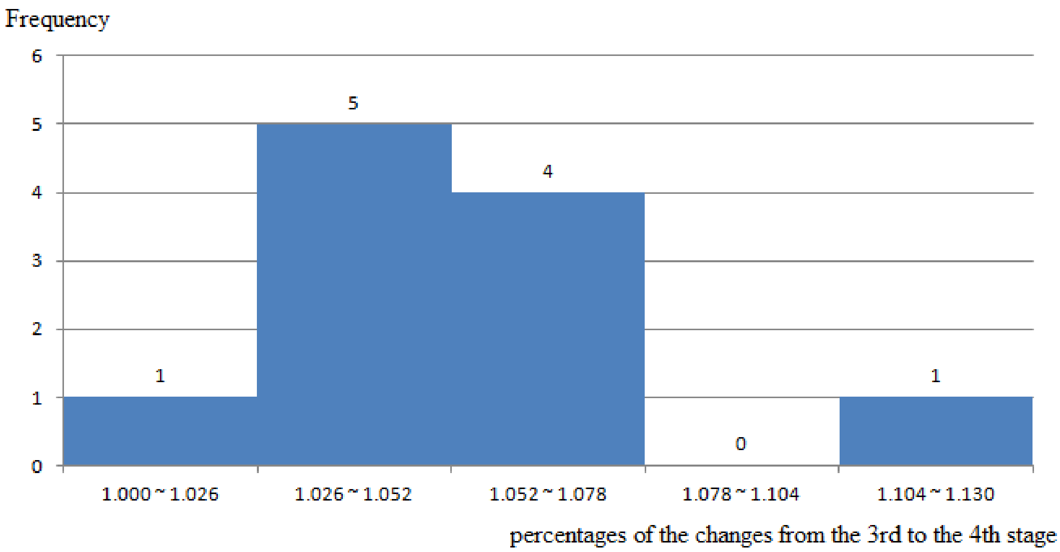


Figure 5.6 Changes from the 3rd to the 4th stage

As indicated in Figure 5.6, the proper distribution utilized for the changes of salaries from the third stage to the fourth was 1+gamma (0.00938, 5.65) with the smallest square error being 0.0170. In the gamma distribution, the rate parameter β was 0.00938, and 5.65 was the shape parameter α.

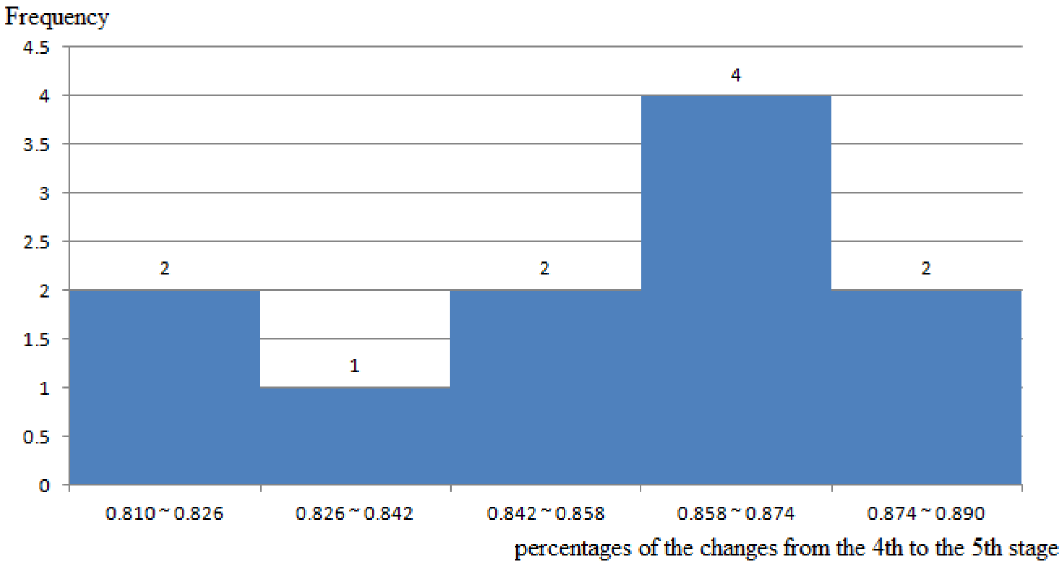


Figure 5.7 Changes from the 4th to the 5th stage

As shown in Figure 5.7, the distribution followed for the changes of salaries from the fourth stage to the fifth stage can be $0.81+0.08\times$beta (1.23, 0.986) with the smallest square error being 0.0343.

5.3 Input models for the percentages of expenditures

The expenditures distributions should be analyzed for different groups of people. For every distribution, there were 11 data points. Each data point indicated the average percentage per person of expenditures for the corresponding category in that year. The data points were for the years from 2000 to 2010 for each distribution.

The results for different groups of individuals categorized by their education levels were shown in Table 5.5, Table 5.6, and Table 5.7. Each set of data were fitted for the following common distributions including Exponential, Beta, Lognormal, Weibull, Gamma, Normal, Triangular, and Uniform distributions. The distribution with smallest squared error was selected to be utilized in the simulation model.

Table 5.5 Expenditures' Distributions fitted for the persons with Bachelor's Degree

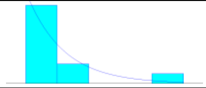
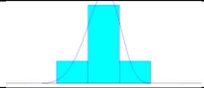
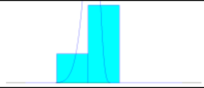
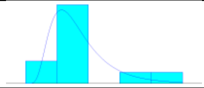
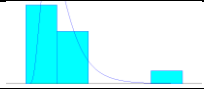
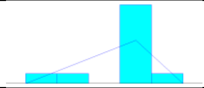
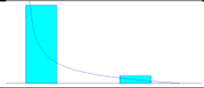
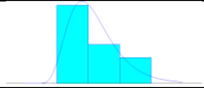
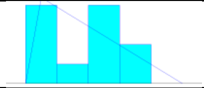
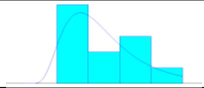
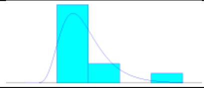
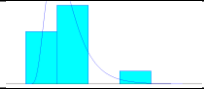
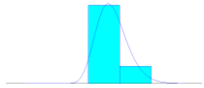
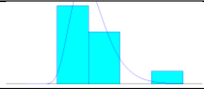
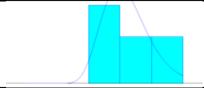
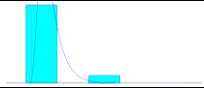
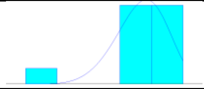
Categories	Distributions Selected	Squared Error	Histograms
Food at Home	0.04+Exponential(0.014)	0.0444	
Food away Home	0.03+Weibull(0.0159,5.29)	0.00174	
Alcohol Beverage	Weibull(0.00868,10.4)	0.0117	
Owned House	0.09+Lognormal(0.0374,0.0205)	0.0655	
Rented House	0.02+Lognormal(0.0183,0.00978)	0.0194	
House Repair & Maintenance	Triangular(0.04,0.11,0.14)	0.232	
Utilities	0.04+0.06*Beta(0.406,1.93)	0.0466	
Cloths	0.02+Lognormal(0.0131,0.0049)	0.0272	
New Vehicle	Triangular(0.02,0.023,0.05)	0.0784	
Used Vehicle	0.01+Lognormal(0.0151,0.00798)	0.0428	
Gasoline	0.01+Lognormal(0.0187,0.00736)	0.0502	
Vehicle Insurance	0.01+Lognormal(0.00519,0.00243)	0.0160	
Healthcare excluding Insurance	0.01+Lognormal(0.011,0.00199)	0.0336	
Health Insurance	0.01+Lognormal(0.0126,0.00368)	0.0197	
Entertainment	0.03+Lognormal(0.0129,0.00302)	0.0498	
Tobacco Product	Lognormal(0.00311,0.00149)	0.0658	
Other Expenditures	0.02+Weibull(0.104,5.18)	0.0572	

Table 5.6 Expenditures' Distributions fitted for the persons with Higher Degree

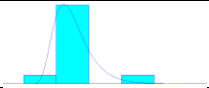
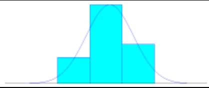
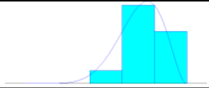
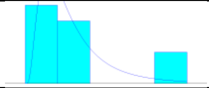
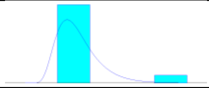
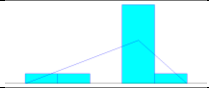
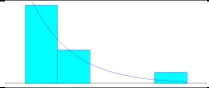
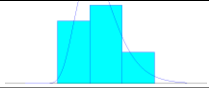
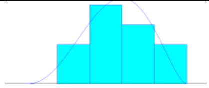
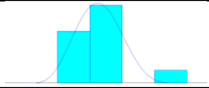
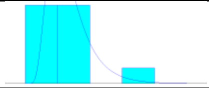
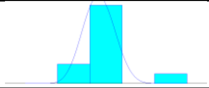
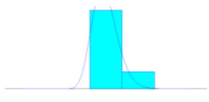
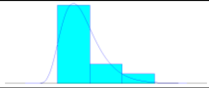
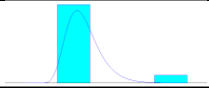
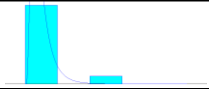
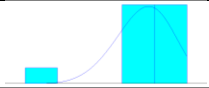
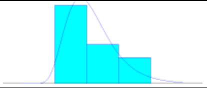
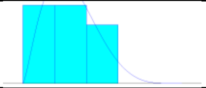
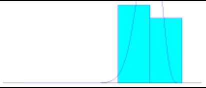
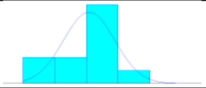
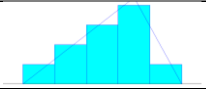
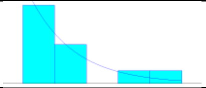
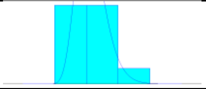
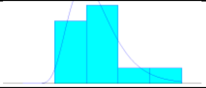
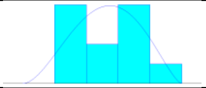
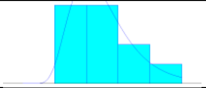
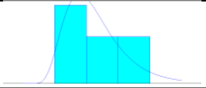
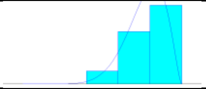
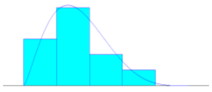
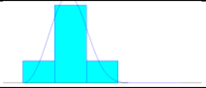
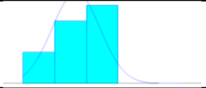
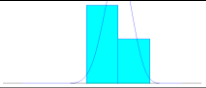
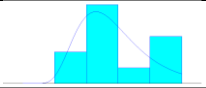
Categories	Distributions with Parameters	Squared Error	Histograms
Food at Home	0.03+Lognormal(0.015,0.00571)	0.0615	
Food away Home	Normal(0.0405,0.00292)	0.00296	
Alcohol Beverage	0.01*Beta(7.51,3.12248)	0.0211	
Owned House	0.1+Lognormal(0.0202,0.016)	0.0454	
Rented House	0.01+Lognormal(0.0162,0.00656)	0.150	
House Repair & Maintenance	Triangular(0.06,0.109,0.13)	0.232	
Utilities	0.03+Exponential(0.0126)	0.0279	
Cloths	0.01+Lognormal(0.0186,0.00538)	0.00559	
New Vehicle	0.01+0.03*Beta(3.53,2.7)	0.0112	
Used Vehicle	0.04*Beta(5.63,6.74544)	0.0339	
Gasoline	0.01+Lognormal(0.0134,0.00647)	0.0347	
Vehicle Insurance	0.03*Beta(11.7,13.9954)	0.0312	
Healthcare excluding Insurance	0.01+Lognormal(0.00989,0.00157)	0.0185	
Health Insurance	0.01+Lognormal(0.0106,0.00371)	0.0209	
Entertainment	0.03+Lognormal(0.0109,0.00315)	0.149	
Tobacco Product	Lognormal(0.00191,0.00127)	0.0120	
Other Expenditures	0.05+Weibull(0.0882,4.74)	0.0664	

Table 5.7 Expenditures' Distributions fitted for the all persons ignoring their education level

Categories	Distributions with Parameters	Squared Error	Histograms
Food at Home	0.05+Lognormal(0.013,0.00467)	0.0269	
Food away Home	0.04+0.02*Beta(2.42,5.5)	0.0196	
Alcohol Beverage	0.01*Beta(26.3,7.18603)	0.000399	
Owned House	Normal(0.108,0.00323)	0.0627	
Rented House	Triangular(0.04,0.047,0.05)	0.00334	
House Repair & Maintenance	0.12+Exponential(0.00559)	0.0214	
Utilities	0.05+Lognormal(0.00859,0.0018)	0.0145	
Cloths	0.02+Lognormal(0.0138,0.00477)	0.00745	
New Vehicle	0.01+0.04*Beta(2.85,2.53)	0.0532	
Used Vehicle	0.01+Lognormal(0.0201,0.00793)	0.00424	
Gasoline	0.02+Lognormal(0.0136,0.00565)	0.0314	
Vehicle Insurance	0.01+0.01*Beta(8.86,2.66)	0.0171	
Healthcare excluding Insurance	0.02+0.01*Beta(2.43,4.91)	0.00805	
Health Insurance	0.02+Weibull(0.00659,3.02)	0.000641	
Entertainment	Normal(0.0434,0.0015)	0.0414	
Tobacco Product	0.01*Beta(19.9,13.4509)	0.0351	
Other Expenditures	0.09+Lognormal(0.0115,0.00465)	0.0574	

The parameter in the exponential distribution generated by Input Analyzer was the mean value. For example, in Table 5.5, the preferred distribution for Food at Home was 0.04+Exponential (0.014), which meant the percentage of expenditures for Food at Home was the sum of 0.04 and a random number generated from an exponential distribution with the mean being 0.014.

The parameters in the normal distribution generated by Input Analyzer were the mean, μ, and the standard deviation, σ. For example, in Table 5.6, the percentage of expenditures for Food away Home was generated randomly from a normal distribution with μ = 0.0405 and σ = 0.00296, recorded as Normal (0.0405, 0.00296).

The parameters in the triangular distribution were the lower limit, a, the upper limit, b, and the mode, c. For example, in Table 5.5, the percentage of expenditures for House Repair & Maintenance was generated randomly from Triangular (0.04, 0.11, 0.14), where a = 0.04, b = 0.14, and c = 0.11.

Table 5.8 Transaction from Input Analyzer to Matlab for Weibull distributions

Groups of Persons	Categories	Expressions	
		Input Analyzer	Matlab
Bachelor's Degree	Food away Home	0.03+Weibull(0.0159,5.29)	0.03+Weibrnd(3.27×10^{9},5.29)
	Alcohol Beverage	Weibull(0.00868,10.4)	Weibrnd(2.75×10^{21},10.4)
	Other Expenditures	0.02+Weibull(0.104,5.18)	0.02+Weibrnd(1.24×10^{5},5.18)
Higher Degree	Other Expenditures	0.05+Weibull(0.0882,4.74)	0.05+Weibrnd(9.97×10^{4},4.74)
All Persons	Health Insurance	0.02+Weibull(0.00659,3.02)	0.02+Weibrnd(3.86×10^{6},3.02)

The parameters in the beta distribution were the two positive shape parameters, typically denoted by α and β. The expected value can be presented as $\frac{\alpha}{\alpha+\beta}$, and the variance can be $\frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}$. For example, in Table 5.5, the percentage of expenditures for Utilities would be generated based on a random number from a beta distribution with α=0.406 and β=1.93, and it equaled the sum of 0.04 and the random number multiplied by 0.06.

The parameters in the Weibull distribution were the shape parameter (k) and the scale parameter (λ). The mean of the distribution can be shown as $E(x)=\lambda\Gamma(1+1/k)$, and the variance was $Var(x)=\lambda^2\Gamma(1+2/k)-E^2(x)$. For example, in Table 5.5, the percentage of expenditures for Food away Home can be generated from the equation 0.03+Weibull (0.0159, 5.29). A random number in the expression was from the Weibull distribution with λ = 0.0159 and k = 5.29. But the parameters in the expression for Weibull distributions, "weibrnd (A, B)", in Matlab were different from the parameters in Input Analyzer of Arena. The value of B equaled the value of k, and the value of A can be expressed as $\mathrm{A}=(1/\lambda)^k$.

Utilizing the same example, the expression in Matlab should be weibrnd (3.27×10^9, 5.29) shown in Table 5.8.

The parameters in the lognormal distribution were the mean value (E) and the standard deviation (S.D.). For example, the percentage of expenditures for Owned House in Table 5.5 was fitted as 0.09+Lognormal (0.0374, 0.0205). It indicated that the percentage would equal the sum of 0.09 and a random number from a lognormal distribution with the mean being 0.0374 and the standard deviation being 0.0205. However, the parameters in Matlab to generate a random number from a lognormal distribution were the mean (μ) and the standard deviation (σ) in the corresponding normal distribution.

Table 5.9 Transaction from Input Analyzer to Matlab for Lognormal Dist.

Groups of Persons	Categories	Expressions	
		Input Analyzer	Matlab
Bachelor's Degree	Owned House	0.09+Lognormal(0.0374,0.0205)	0.09+Lognrnd(-3.42,0.513)
	Rented House	0.02+Lognormal(0.0183,0.00978)	0.02+Lognrnd(-4.13,0.501)
	Cloths	0.02+Lognormal(0.0131,0.0049)	0.02+Lognrnd(-4.40,0.362)
	Used Vehicle	0.01+Lognormal(0.0151,0.00798)	0.01+Lognrnd(-4.32,0.496)
	Gasoline	0.01+Lognormal(0.0187,0.00736)	0.01+Lognrnd(-4.05,0.380)
	Vehicle Insurance	0.01+Lognormal(0.00519,0.00243)	0.01+Lognrnd(-5.36,0.445)
	Healthcare ex. Insurance	0.01+Lognormal(0.011,0.00199)	0.01+Lognrnd(-4.53,0.179)
	Health Insurance	0.01+Lognormal(0.0126,0.00368)	0.01+Lognrnd(-4.41,0.286)
	Entertainment	0.03+Lognormal(0.0129,0.00302)	0.03+Lognrnd(-4.38,0.231)
	Tobacco Products	Lognormal(0.00311,0.00149)	Lognrnd(-5.88,0.455)
Higher Degree	Food at Home	0.03+Lognormal(0.015,0.00571)	0.03+Lognrnd(-4.27,0.368)
	Owned House	0.1+Lognormal(0.0202,0.016)	0.1+Lognrnd(-4.15,0.698)
	Rented House	0.01+Lognormal(0.0162,0.00656)	0.01+Lognrnd(-4.20,0.390)
	Cloths	0.01+Lognormal(0.0186,0.00538)	0.01+Lognrnd(-4.02,0.283)
	Gasoline	0.01+Lognormal(0.0134,0.00647)	0.01+Lognrnd(-4.42,0.458)
	Healthcare ex. Insurance	0.01+Lognormal(0.00989,0.00157)	0.01+Lognrnd(-4.63,0.158)
	Health Insurance	0.01+Lognormal(0.0106,0.00371)	0.01+Lognrnd(-4.60,0.340)
	Entertainment	0.03+Lognormal(0.0109,0.00315)	0.03+Lognrnd(-4.56,0.283)
	Tobacco Products	Lognormal(0.00191,0.00127)	Lognrnd(-6.44,0.605)
All Persons	Food at Home	0.05+Lognormal(0.013,0.00467)	0.05+Lognrnd(-4.40,0.348)
	Utilities	0.05+Lognormal(0.00859,0.0018)	0.05+Lognrnd(-4.78,0.207)
	Cloths	0.02+Lognormal(0.0138,0.00477)	0.02+Lognrnd(-4.34,0.336)
	Used Vehicle	0.01+Lognormal(0.0201,0.00793)	0.01+Lognrnd(-3.98,0.380)
	Gasoline	0.02+Lognormal(0.0136,0.00565)	0.02+Lognrnd(-4.38,0.399)
	Other expenditures	0.09+Lognormal(0.0115,0.00465)	0.09+Lognrnd(-4.54,0.389)

Table 5.10 Expenditures' Distributions for the all individuals younger than 25 years old

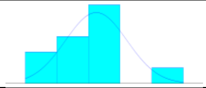
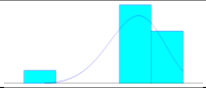
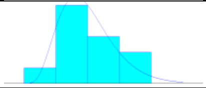
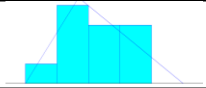
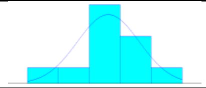
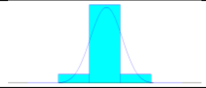
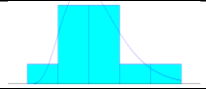
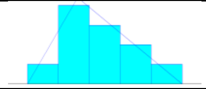
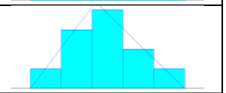
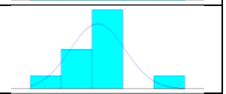
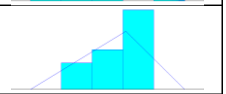
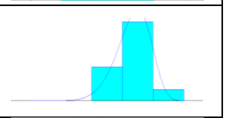
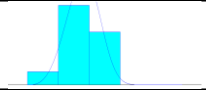
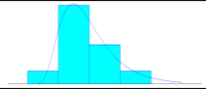
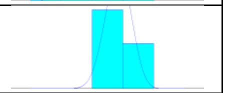
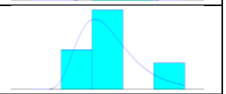
Categories	Distributions with Parameters	Squared Error	Histograms
Food at Home	Normal(0.0869,0.0117)	0.0516	
Food away Home	0.01+Weibull(0.0681,4.72)	0.0896	
Alcohol Beverage	0.01+Gamma(0.00147,5.42)	0.00946	
Owned House	Triangular(0.03,0.0401,0.06)	0.0143	
Rented House	Uniform(0.14,0.2)	0.122	
House Repair & Maintenance	Normal(0.136,0.01)	0.0234	
Utilities	0.05+0.03*Beta(13.2,12.7)	0.0279	
Cloths	0.04+Gamma(0.00323,5.53)	0.00706	
New Vehicle	Triangular(0,0.026,0.08)	0.00301	
Used Vehicle	Triangular(0.02,0.0581,0.11)	0.00164	
Gasoline	Normal(0.0518,0.00887)	0.0534	
Vehicle Insurance	Triangular(0.01,0.0224,0.03)	0.0719	
Healthcare excluding Insurance	Weibull(0.0143,7.06)	0.00178	
Health Insurance	0.01+Weibull(0.00397,3.88)	0.00169	
Entertainment	0.04+Lognormal(0.0119,0.00549)	0.00237	
Tobacco Product	Beta(19.9,15.1839)	0.000577	
Other Expenditures	0.09+Lognormal(0.0308,0.0118)	0.0683	

Table 5.11 Expenditures' Distributions for the all individuals from 25 to 34 years old

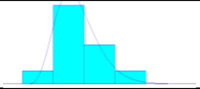
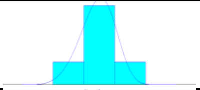
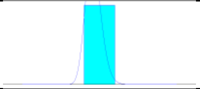
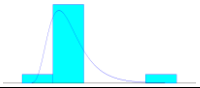
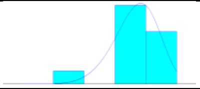
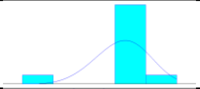
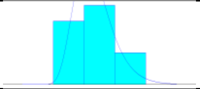
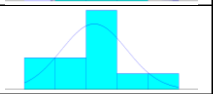
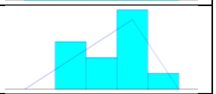
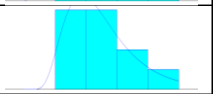
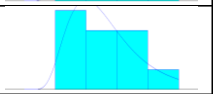
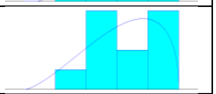
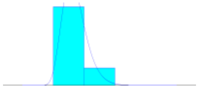
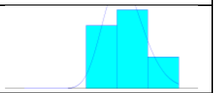
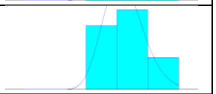
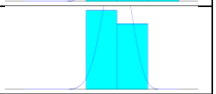
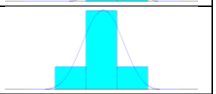
Categories	Distributions with Parameters	Squared Error	Histograms
Food at Home	0.05+Gamma(0.00148,7.21)	0.00272	
Food away Home	0.04+Weibull(0.0106,4.93)	0.00144	
Alcohol Beverage	Lognormal(0.00921,0.00101)	0.0260	
Owned House	0.07+Lognormal(0.0336,0.0142)	0.0910	
Rented House	0.04+Weibull(0.0396,5.94)	0.0363	
House Repair & Maintenance	0.09+Weibull(0.0284,4.22)	0.271	
Utilities	0.05+Lognormal(0.00465,0.00124)	0.0117	
Cloths	Normal(0.039,0.00423)	0.0397	
New Vehicle	Triangular(0.01,0.038,0.05)	0.0366	
Used Vehicle	0.02+Lognormal(0.0202,0.00957)	0.00262	
Gasoline	0.02+Lognormal(0.016,0.00743)	0.0176	
Vehicle Insurance	0.01+0.01*Beta(2.47,1.44)	0.0461	
Healthcare excluding Insurance	0.01+Lognormal(0.0034,0.000782)	0.00164	
Health Insurance	0.01+Gamma(0.000258,25.2)	0.00645	
Entertainment	0.03+Gamma(0.000513,25.2)	0.00677	
Tobacco Product	Beta(18.6,12.5365)	0.00427	
Other Expenditures	0.07+0.04*Beta(8.29,7.99)	0.00530	

Table 5.12 Expenditures' Distributions for the all individuals from 35 to 44 years old

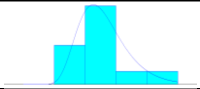
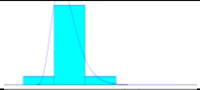
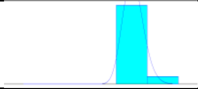
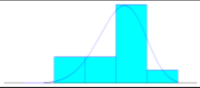
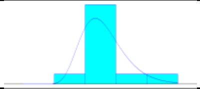
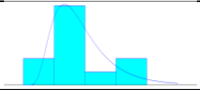
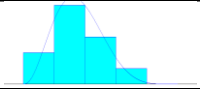
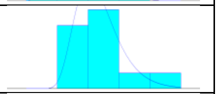
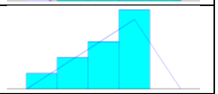
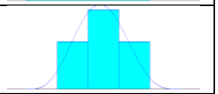
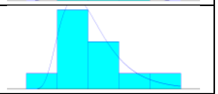
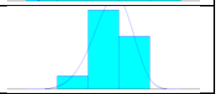
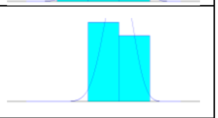
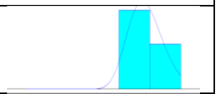
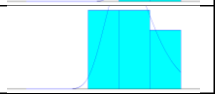
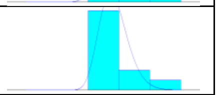
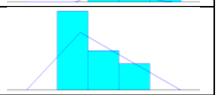
Categories	Distributions with Parameters	Squared Error	Histograms
Food at Home	0.05+Lognormal(0.0104,0.00323)	0.0196	
Food away Home	0.04+Lognormal(0.0056,0.00172)	0.0111	
Alcohol Beverage	Lognormal(0.0071,0.000664)	0.00327	
Owned House	0.1+Weibull(0.0206,4.93)	0.0426	
Rented House	0.03+Lognormal(0.0104,0.0029)	0.0654	
House Repair & Maintenance	0.11+Lognormal(0.00752,0.00384)	0.0380	
Utilities	0.05+0.01*Beta(3.4,6.1)	0.00333	
Cloths	0.02+Lognormal(0.0141,0.00434)	0.00760	
New Vehicle	Triangular(0.01,0.038,0.05)	0.0296	
Used Vehicle	0.01+0.04*Beta(4.79,5.17)	0.00481	
Gasoline	0.02+Lognormal(0.0126,0.00581)	0.00571	
Vehicle Insurance	0.01+Weibull(0.00601,5.14)	0.00176	
Healthcare excluding Insurance	0.01+0.01*Beta(18.3,12.5)	0.00233	
Health Insurance	0.01+Lognormal(0.00776,0.00116)	0.00809	
Entertainment	0.03+Lognormal(0.0139,0.00314)	0.0269	
Tobacco Product	Lognormal(0.00568,0.000925)	0.0328	
Other Expenditures	Triangular(0.08,0.094,0.12)	0.0636	

Table 5.13 Expenditures' Distributions for the all individuals from 45 to 54 years old

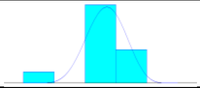
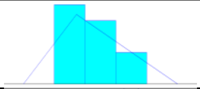
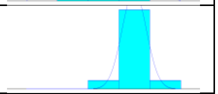
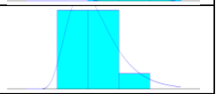
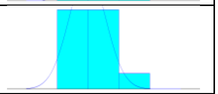
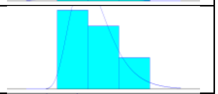
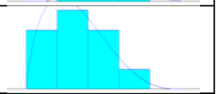
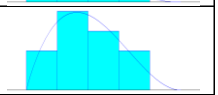
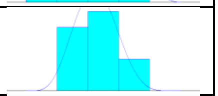
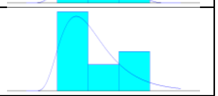
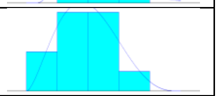
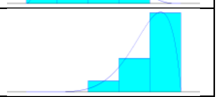
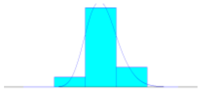
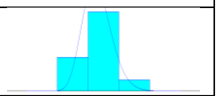
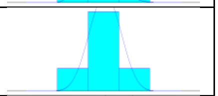
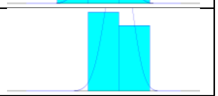
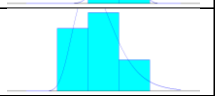
Categories	Distributions with Parameters	Squared Error	Histograms
Food at Home	0.03+0.05*Beta(8.48,7.35)	0.0354	
Food away Home	Triangular(0.03,0.0403,0.06)	0.0350	
Alcohol Beverage	Normal(0.00698,0.000784)	0.000651	
Owned House	0.1+Lognormal(0.00894,0.0034)	0.00788	
Rented House	Normal(0.0279,0.00237)	0.00518	
House Repair & Maintenance	0.1+Lognormal(0.0132,0.00429)	0.0103	
Utilities	0.05+0.01*Beta(1.79,3.78)	0.00329	
Cloths	0.02+0.03*Beta(1.97,2.99)	0.00249	
New Vehicle	0.01+0.04*Beta(5.92,7.22)	0.00537	
Used Vehicle	0.01+Lognormal(0.0172,0.00786)	0.0562	
Gasoline	0.02+0.03*Beta(2.71,4.1)	0.00507	
Vehicle Insurance	0.01+0.01*Beta(6.71,1.86)	0.0258	
Healthcare excluding Insurance	0.01+Gamma(0.000407,25.2)	0.00447	
Health Insurance	0.01+Gamma(0.000365,25.2)	0.000720	
Entertainment	0.03+0.02*Beta(12.6,12.1)	0.00327	
Tobacco Product	Beta(21.5,14.5575)	0.00287	
Other Expenditures	0.1+Lognormal(0.0189,0.00585)	0.00330	

Table 5.14 Expenditures' Distributions for the all individuals from 55 to 64 years old

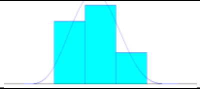
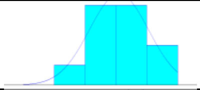
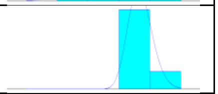
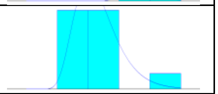
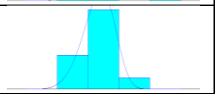
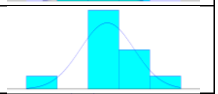
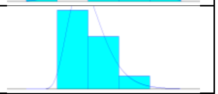
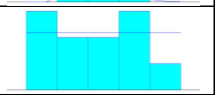
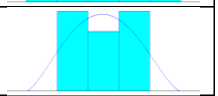
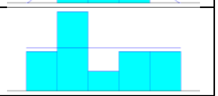
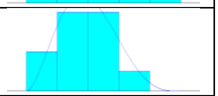
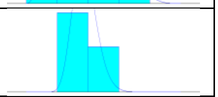
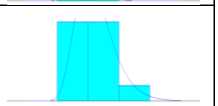
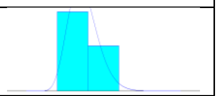
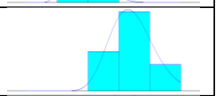
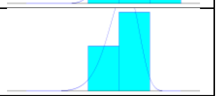
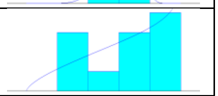
Categories	Distributions with Parameters	Squared Error	Histograms
Food at Home	0.04+0.04*Beta(5.4,6.19)	0.00486	
Food away Home	Normal(0.0424,0.00384)	0.00262	
Alcohol Beverage	Lognormal(0.00738,0.00078)	0.00421	
Owned House	0.09+Lognormal(0.0185,0.00578)	0.0301	
Rented House	0.01+Weibull(0.0152,5.28)	0.00161	
House Repair & Maintenance	Normal(0.127,0.0122)	0.0612	
Utilities	0.05+Lognormal(0.00818,0.00252)	0.00235	
Cloths	Uniform(0.02,0.04)	0.0231	
New Vehicle	0.01+0.05*Beta(2.56,2.61)	0.0372	
Used Vehicle	Uniform(0.01,0.04)	0.0397	
Gasoline	0.02+0.03*Beta(2.94,4.43)	0.00578	
Vehicle Insurance	0.01+Gamma(0.000301,25.2)	0.000200	
Healthcare excluding Insurance	0.02+Lognormal(0.00897,0.00248)	0.00700	
Health Insurance	0.02+Gamma(0.000485,15.2)	0.00204	
Entertainment	0.03+Gamma(0.000594,23.1)	0.00197	
Tobacco Product	Weibull(0.00656,7.37)	0.00383	
Other Expenditures	0.09+0.03*Beta(1.65,0.886)	0.0340	

Table 5.15 Transaction from Input Analyzer to Matlab for Lognormal distributions

Groups of Persons	Categories	Expressions	
		Input Analyzer	Matlab
Younger than 25 years old	Entertainment	0.04+Lognormal(0.0119,0.00549)	0.04+Lognrnd(-4.53,0.439)
	Other Expenditures	0.09+Lognormal(0.0308,0.0118)	0.09+Lognrnd(-3.55,0.370)
25 years old to 34 years old	Alcohol Beverage	Lognormal(0.00921,0.00101)	Lognrnd(-4.69,0.109)
	Owned Houses	0.07+Lognormal(0.0336,0.0142)	0.02+Lognrnd(-3.48,0.405)
	Utilities	0.05+Lognormal(0.00465,0.00124)	0.05+Lognrnd(-5.41,0.262)
	Used Vehicle	0.02+Lognormal(0.0202,0.00957)	0.02+Lognrnd(-4.00,0.450)
	Gasoline	0.02+Lognormal(0.016,0.00743)	0.02+Lognrnd(-4.23,0.442)
	Healthcare ex. Insurance	0.01+Lognormal(0.0034,0.000782)	0.01+Lognrnd(-5.71,0.227)
35 years old to 44 years old	Food at Home	0.05+Lognormal(0.0104,0.00323)	0.05+Lognrnd(-4.61,0.303)
	Food away Home	0.04+Lognormal(0.0056,0.00172)	0.04+Lognrnd(-5.23,0.300)
	Alcohol Beverage	Lognormal(0.0071,0.000664)	Lognrnd(-4.95,0.0933)
	Rented Houses	0.03+Lognormal(0.0104,0.0029)	0.03+Lognrnd(-4.60,0.274)
	House Repair & Maintenance	0.11+Lognormal(0.00752,0.00384)	0.11+Lognrnd(-5.01,0.481)
	Cloths	0.02+Lognormal(0.0141,0.00434)	0.02+Lognrnd(-4.31,0.301)
	Gasoline	0.02+Lognormal(0.0126,0.00581)	0.02+Lognrnd(-4.47,0.439)
	Health Insurance	0.01+Lognormal(0.00776,0.00116)	0.01+Lognrnd(-4.87,0.149)
	Entertainment	0.03+Lognormal(0.0139,0.00314)	0.03+Lognrnd(-4.30,0.223)
	Tobacco Products	Lognormal(0.00568,0.000925)	0.03+Lognrnd(-5.18,0.162)
45 years old to 54 years old	Owned Houses	0.1+Lognormal(0.00894,0.0034)	0.1+Lognrnd(-4.78,0.368)
	House Repair & Maintenance	0.1+Lognormal(0.0132,0.00429)	0.1+Lognrnd(-4.38,0.317)
	Used Vehicle	0.01+Lognormal(0.0172,0.00786)	0.02+Lognrnd(-4.16,0.435)
	Other Expenditures	0.1+Lognormal(0.0189,0.00585)	0.1+Lognrnd(-4.01,0.302)
55 years old to 64 years old	Alcohol Beverage	Lognormal(0.00738,0.00078)	Lognrnd(-4.91,0.105)
	Owned Houses	0.09+Lognormal(0.0185,0.00578)	0.09+Lognrnd(-4.04,0.305)
	Utilities	0.05+Lognormal(0.00818,0.00252)	0.05+Lognrnd(-4.85,0.301)
	Health excluding Insurance	0.02+Lognormal(0.00897,0.00248)	0.02+Lognrnd(-4.75,0.271)

Table 5.16 Transaction from Input Analyzer to Matlab for Weibull distributions

Groups of Persons	Categories	Expressions	
		Input Analyzer	Matlab
Younger than 25 years old	Food away Home	0.01+Weibull(0.0681,4.72)	0.01+Weibrnd(3.22×10^{5},4.72)
	Health excluding Insurance	Weibull(0.00868,10.4)	Weibrnd(2.75×10^{21},10.4)
	Health Insurance	0.01+Weibull(0.00397,3.88)	0.01+Weibrnd(2.07×10^{9},3.88)
25 years old to 34 years old	Food away Home	0.04+Weibull(0.0106,4.93)	0.04+Weibrnd(5.44×10^{9},4.93)
	Rented Houses	0.04+Weibull(0.0396,5.94)	0.04+Weibrnd(2.14×10^{8},5.94)
	House Repair & Maintenance	0.09+Weibull(0.0284,4.22)	0.09+Weibrnd(3.37×10^{6},4.22)
35 years old to 44 years old	Owned Houses	0.1+Weibull(0.0206,4.93)	0.1+Weibrnd(2.05×10^{8},4.93)
	Vehicle Insurance	0.01+Weibull(0.00601,5.14)	0.01+Weibrnd(2.61×10^{11},5.14)
55 years old to 64 years old	Rented Houses	0.01+Weibull(0.0152,5.28)	0.01+Weibrnd(3.98×10^{9},5.28)
	Tobacco Products	Weibull(0.00656,7.37)	Weibrnd(1.23×10^{16},7.37)

The two parameters of the lognormal distribution in Matlab can be presented as

$$\mu = \ln(E) - \frac{1}{2}\ln[(\frac{S.D.}{E})^2 + 1],$$

and $\sigma = \sqrt{\ln[(\frac{S.D.}{E})^2 + 1]}$.

For the same example, the percentage of expenditures for Owned House in Table 5.5 can be generated in Matlab utilizing 0.09+lognrnd (-3.42, 0.513) shown in Table 5.9. μ in the corresponding normal distribution was -3.42, and σ was 0.513.

The distributions to generate the percentages of expenditures on each category for different groups of individuals categorized by their ages were shown in Table 5.10,

Table 5.11, Table 5.12, Table 5.13, and Table 5.14. The expressions of different distribution were the same as above in Table 5.5, Table 5.6, and Table 5.7. Transferring the expressions of lognormal distributions and Weibull distributions was required to make them available in Matlab. The transaction results were shown in Table 5.15 and Table 5.16 for lognormal distributions and Weibull distributions, respectively.

5.4 Estimations of other parameters

The federal income tax rates utilized in the model were for the individual single without any child in 2011, and the state income tax rates utilized were updated on March 3rd, 2009 in Nebraska (Nebraska Income Tax Rates). In the model, 50% of the direct expenditures were estimated to be paid to the employees working at the corresponding places. The indirect contribution of an individual was realized in the “while” loop. The indirect contributions would not be added if the increased expenditures of the workers were less than 1% of the individual’s income. The model with the parameters above was called original model which was utilized to be compared in Chapter 6 to validate the model. The numbers of replicates (t) set for the model were 100, 500, 1000, 5000, and 10000 to detect the stability of the results.

Chapter 6 Verification and Validation

All simulation models need to be validated and verified. The normal method to validate a model was to set the parameters in the model to be the limiting values and to detect whether the results were the expected ones. In this part, the two main models, the basic model for only one year and the whole life of career model, were validated. The models to be verified by comparing the taxes obtained from the model and the taxes paid in the real world for a specified person to prove that it was correct.

6.1 Verification of the models

The core of the models was to obtain the income taxes and the sales taxes, and it was focused on the verification of the income taxes and the sales taxes in this section. The categories which had sales taxes were shown in the reports from Nebraska Department of Revenue. The federal income taxes brackets utilized in the research were for the individuals who were single and had no child in 2011, and the state income taxes brackets were also for the individuals single and without children in 2011. The teaching assistant major in engineering in University of Nebraska - Lincoln can earn $16,200 each year, which was a graduate student's wages. Using the model, the federal income taxes were $2,005 each year, and the state income taxes were $578 annually. The monthly federal income taxes should be $167, and it should be $48 as the monthly state income taxes. To check one's payroll, it showed that the monthly federal income tax was $166.25, and the monthly state income tax was $37.48. It was nearly the same for the federal income tax, while there were ten dollars difference between the model and the reality for the state income tax. Because the taxes rates used for the state taxes were estimated effective taxes rates but not the exact taxes rates. The certain error of the model was accepted.

6.2 Validation of the basic model

There were six main parameters in this model. They were individuals' incomes, the income tax rates (r_i), the percentages of expenditures on different categories (p_c), the sales taxes rates (r_s), the percentage of the individual's income to stop adding the indirect contributions (p_s), and the percentage of the direct expenditures paid to the employees in the corresponding places (p_e). The trials to run the model were 5000 times since it should give stationary results and the sample size was not too large to save the time for running the model.

If all individuals' incomes were set to be zero, taxes paid should to be zero, and the economic Impact1 and Impact2 would not exist. The model was run under the condition, it was proved that all taxes paid were zero, Impact1 and Impact2 did not exist, and Impact3 was also zero.

If the income tax rate was set to be zero, the income taxes would be zero, and the impacts to the federal and the state & local governments together and to the state & local government should be the same; if the income tax rate was set to be one, all expenditures and the sales taxes were supposed to be zero. When the income tax rate was set to be zero, the model was run and it showed that all income taxes were zero. The impacts for the federal and the state & local governments together and for the state & local government only were the same indicated in Figure 6.1, Figure 6.2, and Figure 6.3.

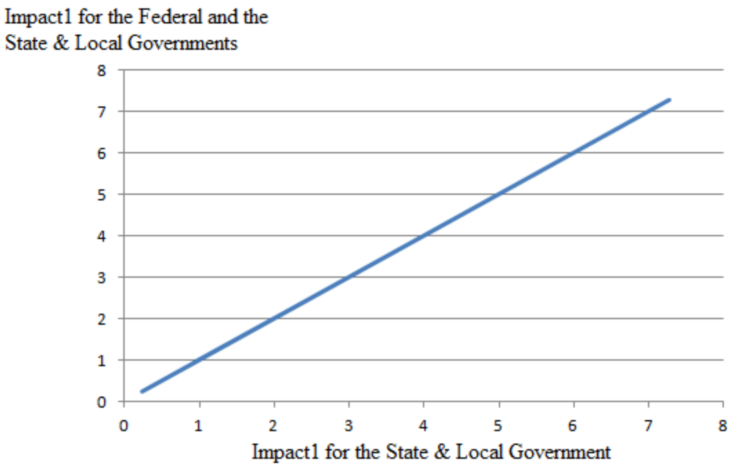


Figure 6.1 Scatters with the Straight Line for Impact1 when r_i=0

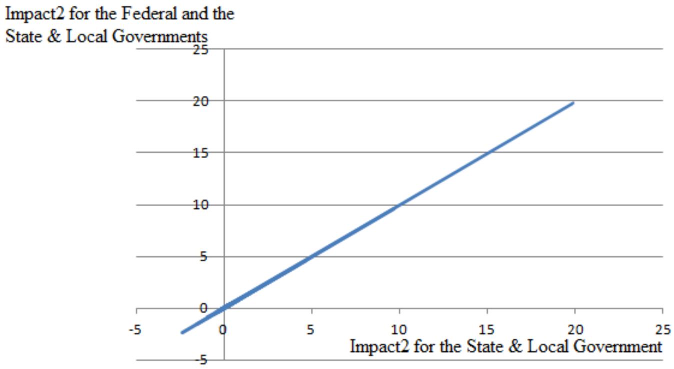


Figure 6.2 Scatters with the Straight Line for Impact2 when r_i=0

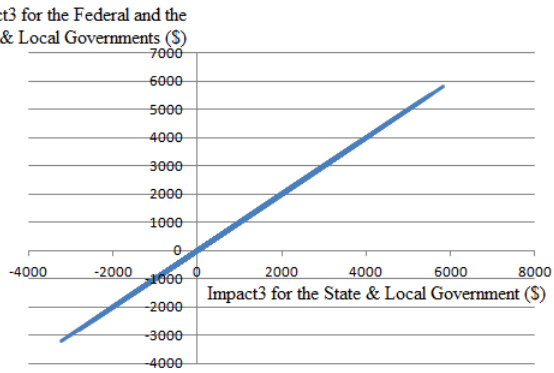


Figure 6.3 Scatters with the Straight Line for Impact3 when r_i=0

As shown in the figures, the slope of the straight lines was 45 degrees which meant that all the values in the horizontal axis were the same with the values in the vertical axis. For all individuals disregarding their majors, the average Imapct1 was 1.61 for the federal and the state & local governments together and the state & local government, the average Impact2 was 0.074, and the average Imapct3 was $881.08. When the income tax rate was set to be one, the income taxes equaled to the incomes and the sales taxes were zero. As indicated in the results, all Impact2 were shown to be one, since the income taxes were always the same as the incomes.

If the percentages of expenditures on different categories were zero, the sales taxes should be zero. The model was run, and the sales taxes were zero. For all individuals disregarding their majors, the average values of the economic impacts to the federal and the state & local governments together were 1.62, 0.19, and $2434.3 of Impact1, Impact2, and Impact3, respectively. The average values of the economic impacts to the state & local government were 1.55, 0.036, and $468.0 of Impact1, Impact2, and Impact3, respectively.

If all sales taxes rates were set to be zero, the sales taxes should be zero; if the sales tax rate were set to be one, the sales taxes should be the same as the cost on the corresponding categories. After the model was run, it was shown that the sales taxes were zero, and there were only income taxes utilized for the economic impacts. For all individuals disregarding their majors, the average values of the economic impacts to the federal and the state & local governments together were 1.60, 0.19, and $2346.7 of Impact1, Impact2, and Impact3, respectively. The average values of the economic impacts to the state & local government were 1.54, 0.036, and $454.6 of Impact1, Impact2, and Impact3, respectively.

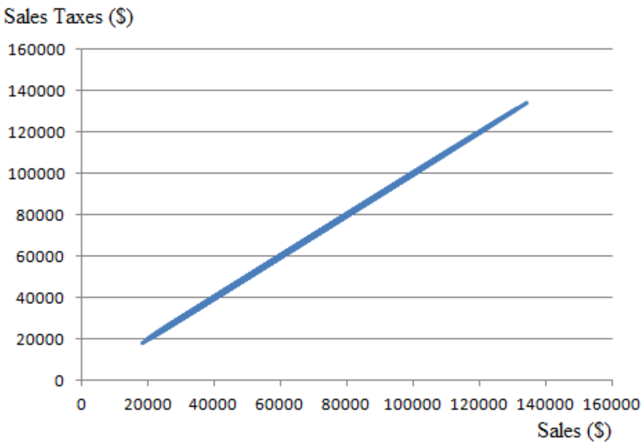


Figure 6.4 Scatters with the Straight Line for the individuals who were bachelors when r_s=1

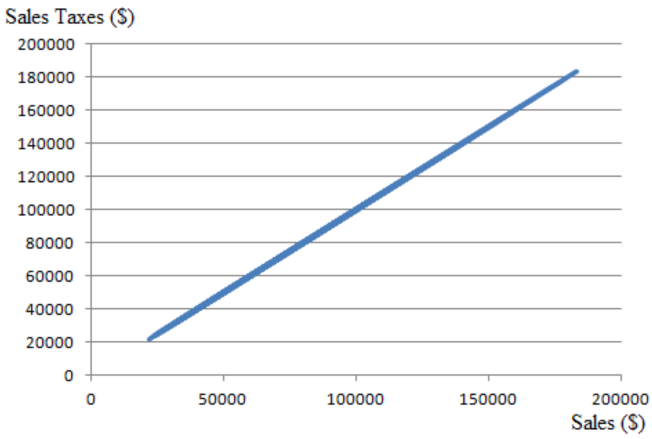


Figure 6.5 Scatters with the Straight Line for the individuals received higher degrees when r_s=1

When the sales taxes rates were set to be one, the results showed that the sales taxes equaled to the sales indicated in Figure 6.4 for the individuals who only received bachelors' degrees and Figure 6.5 for the individuals who received higher degrees. As shown in Figure 6.4 and Figure 6.5, the straight lines were equally spaced between the vertical and horizontal axes. The average impacts for the federal and the state & local governments together were 1.53, 1.81, and $22482 for Impact1, Impact2, and

Impact3, respectively. And the average values for the state & local government were 1.52, 1.66, and $20617 for Impact1, Impact2, and Impact3, respectively.

If p_s was set to be zero, the sales taxes should be increased significantly and the program would not be stopped naturally, since there would be more indirect expenditures and the condition to stop the program cannot be reached; if it was set to be one, the sales taxes would be decreased significantly, since there would be any indirect expenditures. When p_s was set to be zero and the model was run, it cannot be stopped naturally, because there were always little indirect contributions after several repetitions but zero cannot be reached.

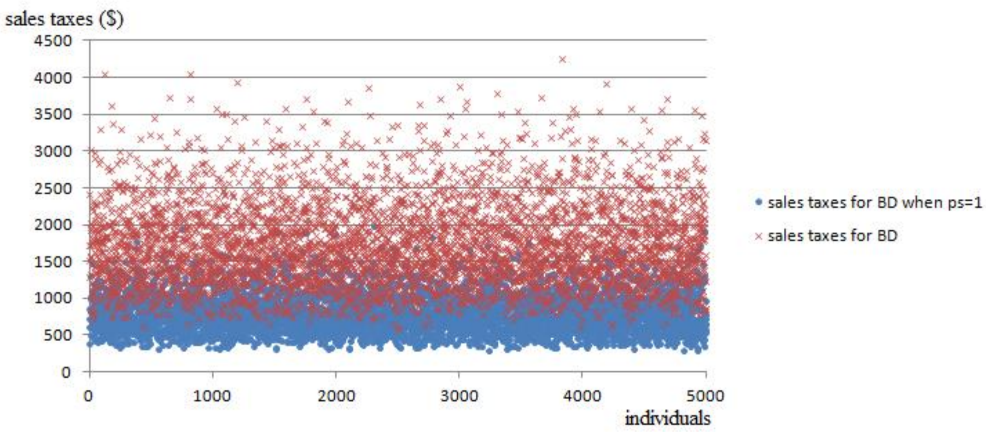


Figure 6.6 Scatters with markers for the bachelors when p_s=1 and p_s=0.01

When p_s was set to be one, it indicated that the sales taxes were less than the sales taxes in the original model when p_s=0.01 shown in Figure 6.6 for the individuals who were bachelors and Figure 6.7 for the individuals who received higher degrees. In the figures, the label of "sales taxes for BD" and "sales taxes for HD" was for the sales taxes when p_s=0.01. As seen in Figure 6.6 and Figure 6.7, the sales taxes calculated when p_s=0.01 was in a higher level than when p_s=1. The average sales tax paid by the individuals who were bachelors was only $805.05 when p_s=1, while it was $1709.19

when p_s=0.01. The average sales tax paid by the individuals who received higher degrees was $1042.32 when p_s=1, and it was $2384.24 when p_s=0.01.

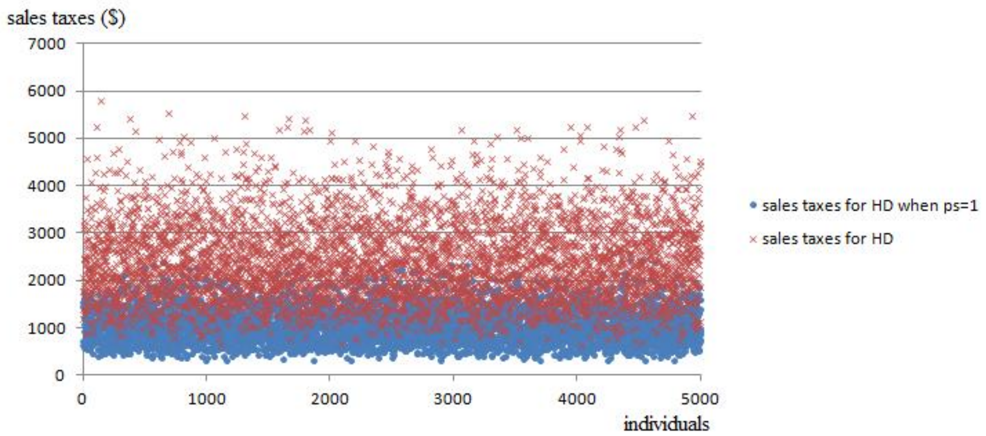


Figure 6.7 Scatters with markers for the individuals with higher degrees when p_s=1 and p_s=0.01

If p_e was set to be zero, the sales taxes were supposed to be decreased significantly, since no indirect expenditures were generated; if p_e was set to be one, the sales taxes should be increased significantly and the program cannot be stopped naturally, since all expenditures were supposed to be paid to the employees, there were more indirect expenditures, and the condition to stop the program cannot be reached. When p_e was zero and the model was run, the average sales tax paid by the individuals who only received bachelors' degrees was $842.20, and by the individuals who received higher degrees was $1210.28. Compared with the average levels when p_e=0.5, they were lower than $1709.19 and $2384.24, respectively.

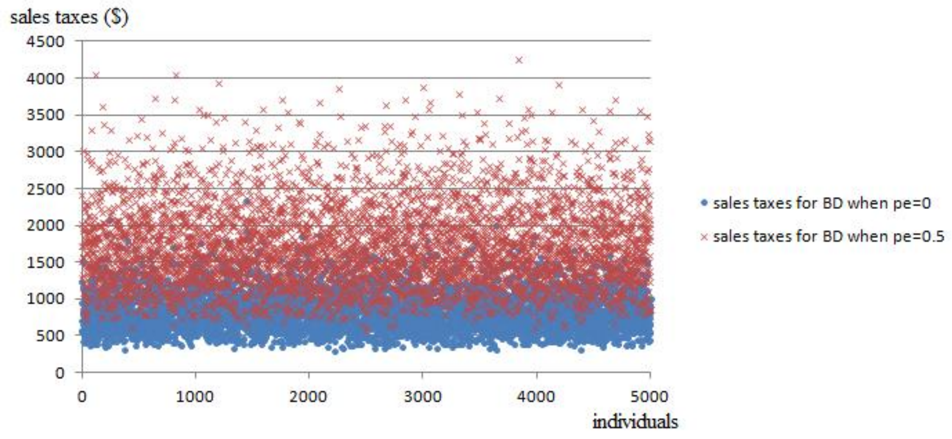


Figure 6.8 Scatters with markers for the bachelors when p_e=0 and p_e=0.5

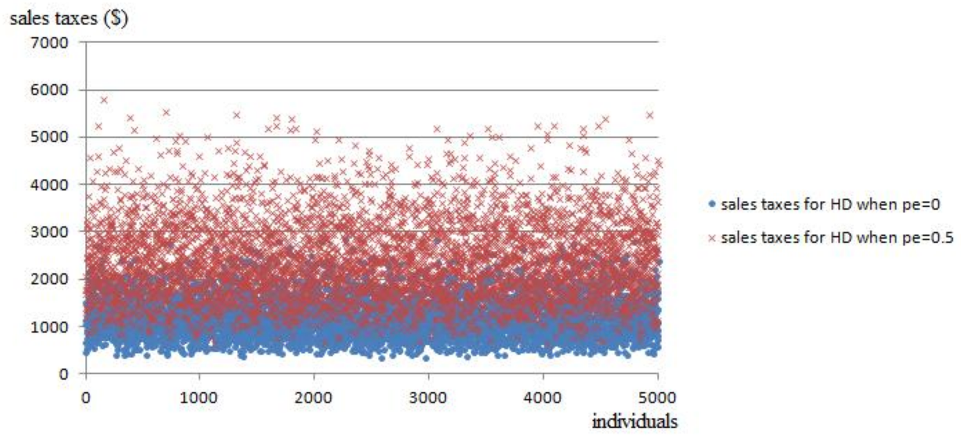


Figure 6.9 Scatters with markers for the individuals with higher degrees when p_e=0 and p_e=0.5

The scatters plots were drawn for all the 5000 individuals, and shown in Figure 6.8 and Figure 6.9. As indicated in Figure 6.8 and Figure 6.9, the sales taxes paid when p_e=0.5 were in a higher level than when p_e=0, which meant that the sales taxes had decreases when p_e was set to be zero. When p_e=1, the program went into an infinite loop shown in Figure 6.10.

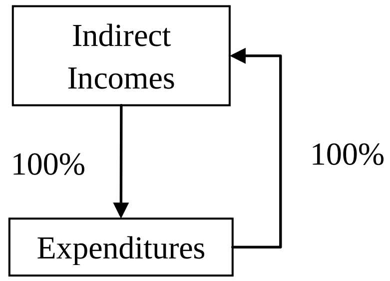


Figure 6.10 the Infinite Loop when p_e=1

When p_e=1, all expenditures in the upper level were contributed into the lower level as the indirect incomes, and the indirect incomes flew into the expenditures since there was no income taxes counted for the indirect incomes. This was an endless loop. The condition to stop the loop that p_s=0.01 would never be reached, and the percentage of contributions was kept as a constant.

As validated by changing the parameters to their limiting values, the results were as expected. The basic model was validated.

6.3 Validation of the whole life of the career model

There were eight main parameters in this model. They were the effective annual interest rate (i), the individuals' initial incomes, the increased rate of the incomes (r_{in}), the income tax rate (r_i), the percentages of expenditures on different categories (p_c), the sales taxes rates (r_s), the percentage of the individual's income to stop adding the indirect contributions (p_s), and the percentage of the direct expenditures paid to the employees in the corresponding places (p_e). The trials to run the model were 5000 times since it can give stationary results and the sample size was not too large to save the time for running the model. The model for the individuals who received bachelors' degrees disregarding their majors was utilized to do the validation.

If the effective annual interest rate was zero, the net present worth of taxes would be the sum of all taxes paid each year. The model was run after the interest rate was set to be zero.

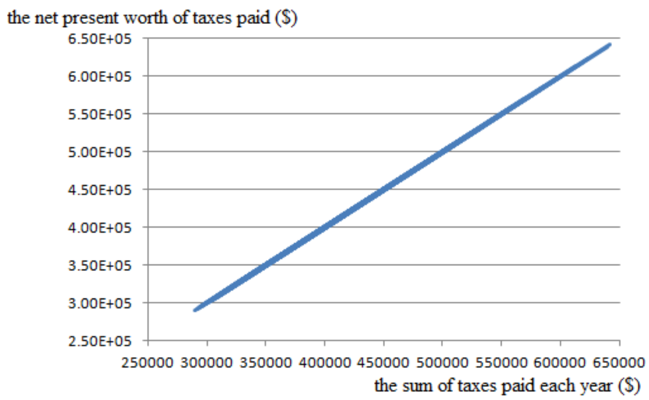


Figure 6.11 Scatters with Straight Line for PW vs. ΣTaxes when *i*=0

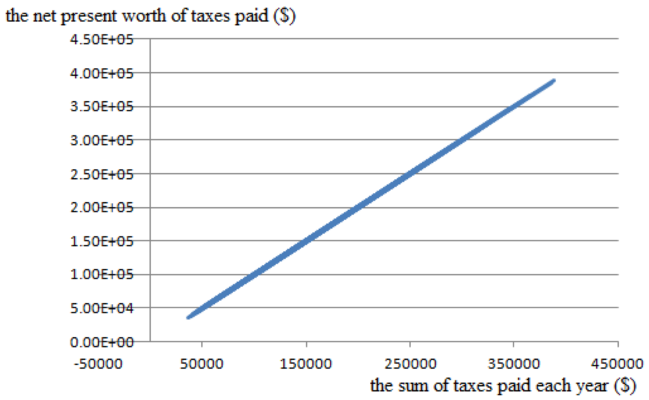


Figure 6.12 Scatters with Straight Line for sPW vs. ΣsTaxes when *i*=0

As indicated in Figure 6.11 and Figure 6.12, the sum of taxes paid to the federal and the state & local governments together (ΣTaxes) and to the state & local government (ΣsTaxes) each year for 43 years were shown on the horizontal axis, and the net present worth of the taxes paid (shorten by PW and sPW) for 43 years were shown on the vertical axis. The slopes of the straight lines were 45 degrees, which meant that *y*=*x* for every point on the line. The net present worth of taxes equaled the sum of taxes paid for 43 years for all the 5000 individuals.

If the individual's initial incomes were zero, the present worth of taxes paid should also be zero. The model was run under this condition, and it was proved that all income taxes and sales taxes were zero. The present worth of taxes paid for the federal and the state & local governments together were zero, and were the same with the results for the state & local government only.

If the increased rates of the incomes were zero, the present worth of taxes paid was supposed to be decreased, since fewer incomes were utilized for the expenditures.

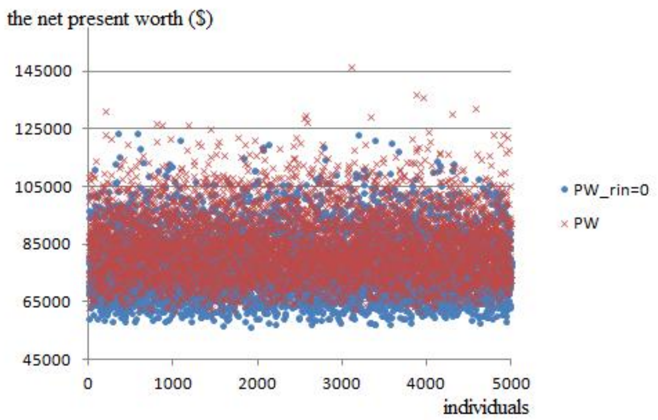


Figure 6.13 Scatters with markers for PW when r_{in}=0 and in the original model

When the increased rates of the incomes were set to be zero, the incomes in different stages were the same for a specific individual. The average net present worth for the 43 years to the federal and the state & local governments together (PW) was $77856, which was less than $84479, the average net present worth when the increased rates were not zero in the original model. The average net present worth to the state & local government (sPW) was $29885, which was also less than $31416, the average net present worth in the original model. The scatters of the 5000 individuals separately were shown in Figure 6.13 for the federal and the state & local governments together and Figure 6.14 for the state & local government.

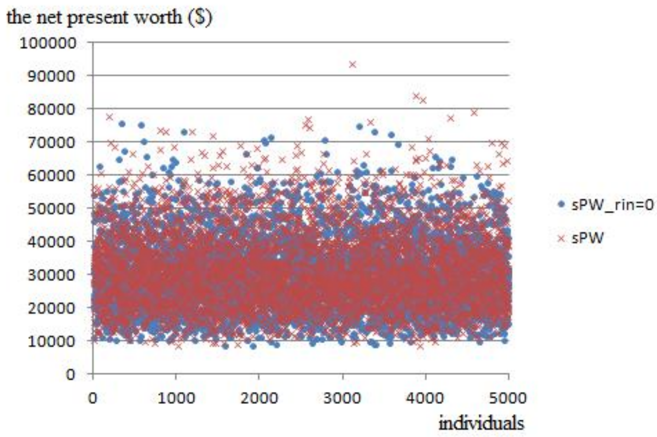


Figure 6.14 Scatters with markers for sPW when r_{in}=0 and in the original model

As indicated in Figure 6.13 and Figure 6.14, the net present worth of the total taxes from the original model were in a little higher level than the net present worth of the total taxes from the model when r_{in}=0.

If the income tax rate was set to be zero, the present worth of taxes paid should be less than the original results, and the present worth of taxes for the federal and the state & local governments together and for the state & local government should be the same; if the income tax rate was set to be one, all expenditures and the sales taxes were supposed to be zero. When the income tax rate was fixed to be zero, the average present worth of total taxes paid for 43 years was $23520, which were the same for the federal and the state & local governments together and for the state & local government only, while the average present worth of total taxes paid to the federal and the state & local governments was $84479 from the original model and it was $31416 to the state & local government, which were higher than the results when r_i=0.

The scatters were shown in Figure 6.15 for the federal and the state & local governments together and Figure 6.16 for the state & local government when r_i=0 for the 5000 individuals.

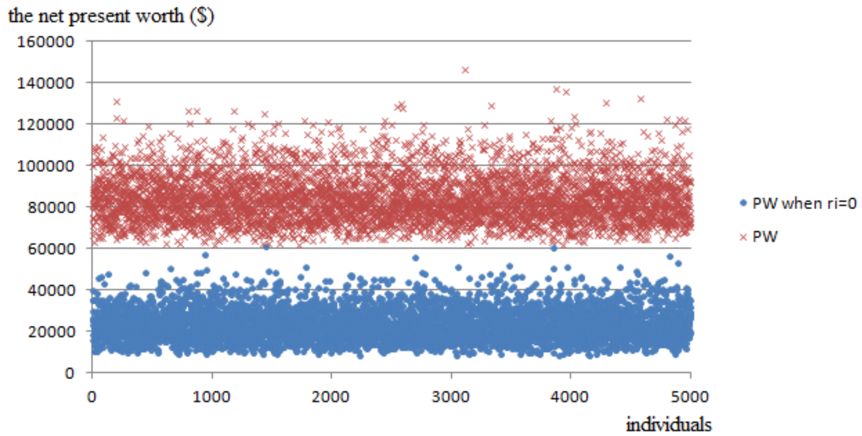


Figure 6.15 Scatters with markers of PW when r_i=0

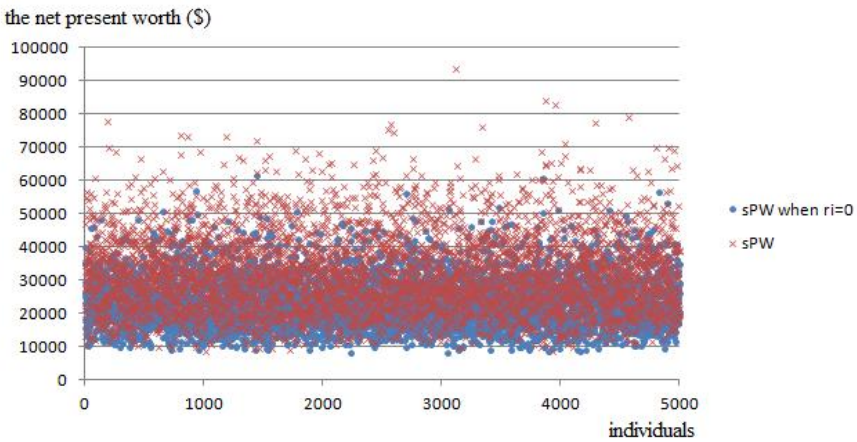


Figure 6.16 Scatters with markers of sPW when r_i=0

As indicated, PW from the original model was in a significantly higher level than from the model when r_i=0, and sPW from the original model was in a little higher level. The scatters with straight line to compare sPW and PW for the 5000 individuals were shown in Figure 6.17.

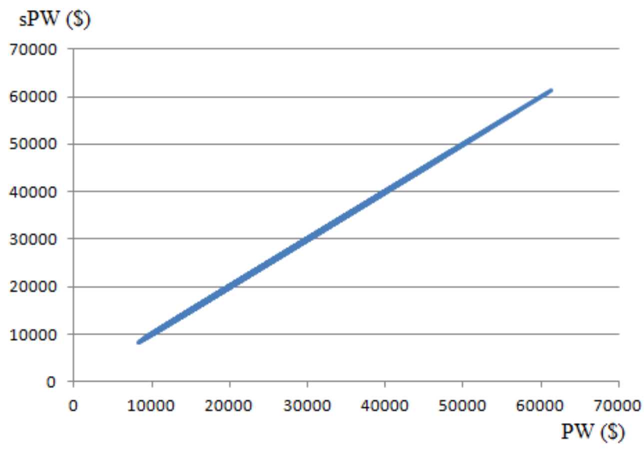


Figure 6.17 Scatters with straight lines of sPW vs. PW when r_i=0

As seen in Figure 6.17, the straight line was equally spaced between the vertical and horizontal axes, which meant the present worth of total taxes paid to the federal and the state & local governments were equivalent to the present worth of taxes paid to the state & local government for all the 5000 data points.

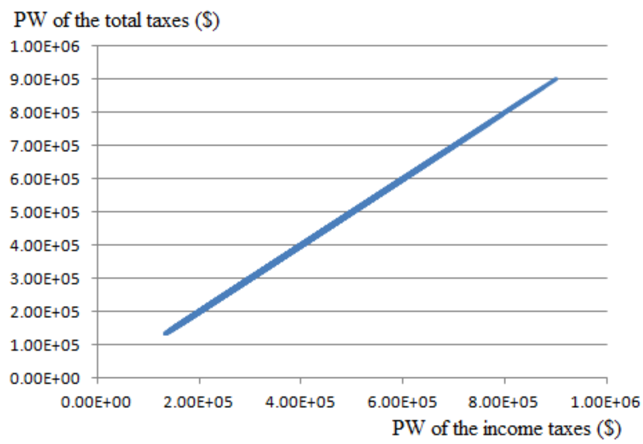


Figure 6.18 Scatters with straight lines for PW_3 vs. PW_1 when r_i=1

When the income taxes rate was set to be one, the sales taxes were proved to be zero and the present worth of total taxes (PW_3) were the same as the present worth of income taxes (PW_1) for all the 5000 individuals indicated in Figure 6.18.

If the percentages of expenditures (p_c) on different categories were zero, the sales taxes should be zero. When the percentages of expenditures on different categories were set to be zero, the results presented that the present worth of sales taxes were zero for all the 5000 data points, because the present worth of total taxes (PW_3) were equivalent to the present worth of income taxes (PW_1) indicated in Figure 6.19.

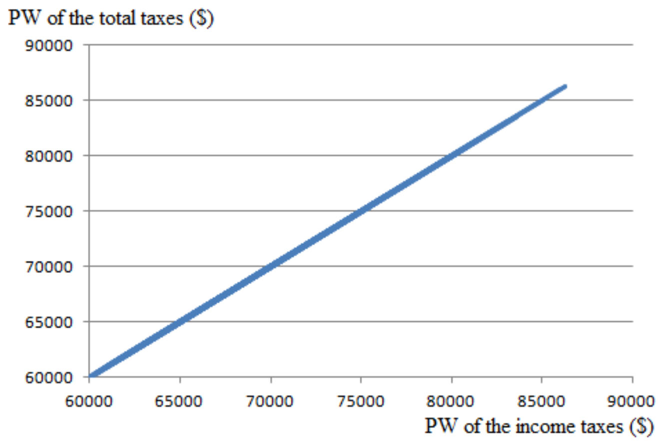


Figure 6.19 Scatters with straight lines for PW_3 vs. PW_1 when p_c=0

If all sales taxes rates were set to be zero, the sales taxes should be zero; if the sales tax rate were set to be one, the sales taxes should be the same as the cost on the corresponding categories. When the sales taxes rates were set to be zero, the sales taxes were zero and the net present worth of the sales taxes for 43 years was zero. So the net present worth of the total taxes (PW_3) should be equivalent to the net present worth of the income taxes (PW_1). As indicated in Figure 6.20, on the straight line, all values of PW of the total taxes equaled to the values of PW of the income taxes for the whole sample.

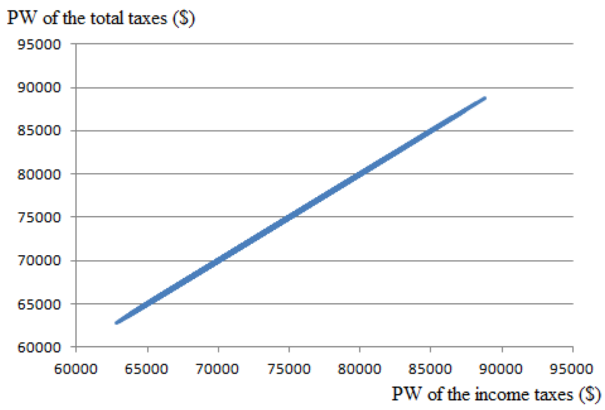


Figure 6.20 Scatters with straight lines for PW_3 vs. PW_1 when r_s=0

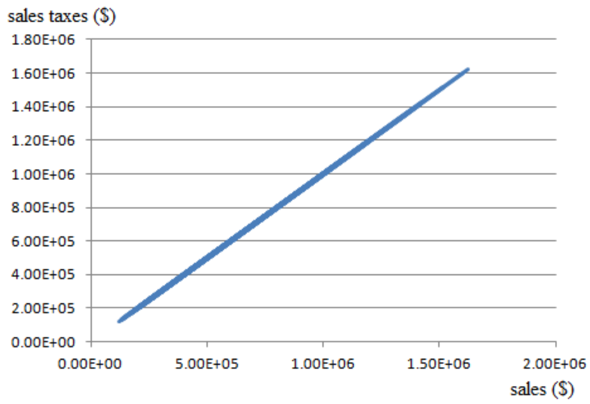


Figure 6.21 Scatters with straight lines for PW_2 vs. PW_{sales} when r_s=1

When the sales taxes rates were one, the relationship between the net present worth of sales taxes (PW_2) paid for 43 years and the net present worth of sales (PW_{sales}) was shown in Figure 6.21 for the 5000 individuals. The slope of the straight line was 45 degrees, and they were equal to each other on the straight line for all the 5000 data points.

If p_s was set to be zero, the sales taxes should be increased significantly and the program would not be stopped naturally, since there would be more indirect expenditures and the condition to stop the program cannot be reached; if it was set to be one, the sales taxes would be decreased significantly, since there would be any indirect expenditures. When the percentage to stop the program was set to be zero, the program cannot be stopped as inferred. When p_s was set to be one, the average net present worth of sales taxes (PW_2) for the 5000 individuals in their whole life of careers was \$9776, which was less than \$18881, the average net present worth of sales taxes when p_s=0.01.

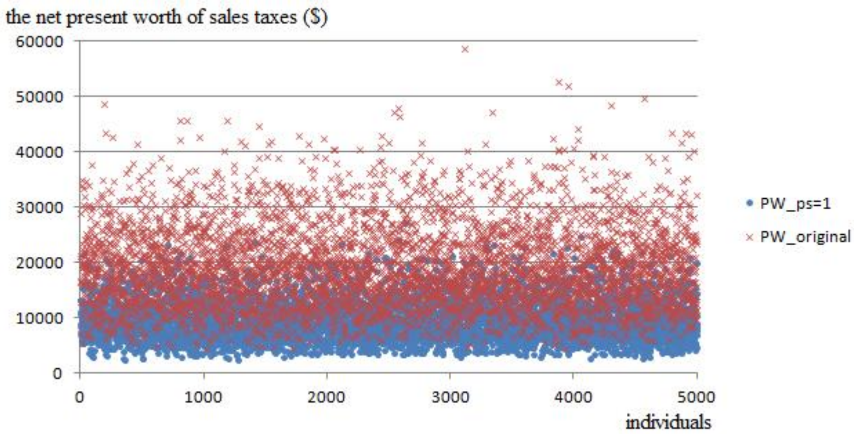


Figure 6.22 Scatters with makers of PW_2 for p_s=1 and p_s=0.01

As indicated in Figure 6.22, the net present worth of sales taxes for the 43 years when p_s=0.01 were in a correspondingly higher level than p_s=1 for all the 5000 data points. If p_e was set to be zero, the sales taxes were supposed to be decreased significantly, since no indirect expenditure was generated; if p_e was set to be one, the sales taxes should be increased significantly and the program cannot be stopped naturally, since all expenditures were supposed to be paid to the employees, there were more indirect expenditures, and the condition to stop the program cannot be reached. When p_e was zero, the average net present worth of sales taxes (PW_2) for the 5000 individuals in their whole life of careers was \$8683, which was lower than \$18881, the average net present worth of sales taxes when p_e=0.5. The scatters with markers were shown in Figure 6.23 to compare the net present worth of sales taxes individual by individual.

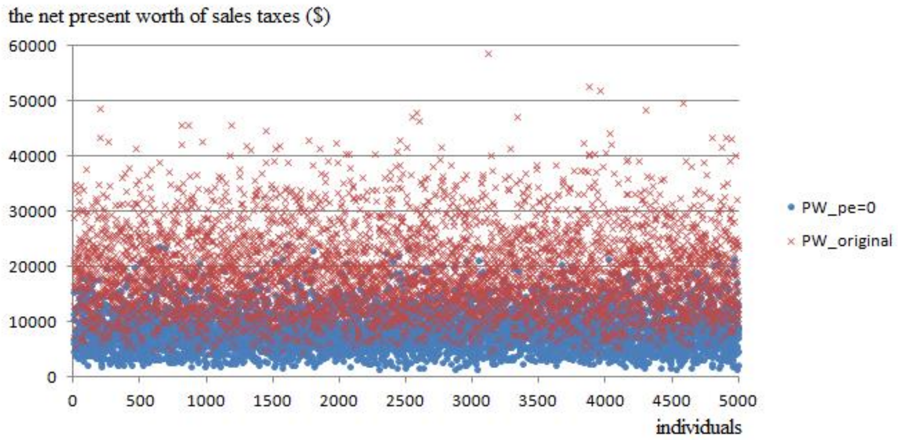


Figure 6.23 Scatters with makers of PW_2 for p_e=0 and p_e=0.5

As shown in Figure 6.23, the net present worth of sales taxes for the 43 years when p_e=0 were in a lower level than the net present worth of sales taxes when p_e=0.5 for all then 5000 data points. When p_e was set to be one, the program cannot be stopped naturally. The reason was the same as described in Section 6.1 for p_e=1. There was an endless loop in the program.

Chapter 7 Performances

The simulation models were run utilizing the corresponding input models under the proper conditions described in Chapter 5. The results were from two models for two groups of individuals, which were the group of the individuals disregarding their majors and the group of the individuals major in engineering. The two models were the basic model which detected the economic impacts of a higher degree than a bachelor's for the first year to the career, and the whole life of careers model which gave the economic impact of the higher degree from the first year to the career to the end of the career estimated as 64 years old. The tax revenues for an individual included the direct taxes paid to the government by the individual and the indirect taxes received by the government due to the contributions of the individual's expenditures

7.1 The basic model for individuals disregarding the majors

The input models were described in Chapter 5. And the other parameters utilized in the basic model included the percentage of contributions to the employees working at the corresponding places (50%) and the percentage of the indirect expenditures in the individual's salaries to stop the loop (1%). In the loop, the percentages of indirect expenditures for an individual were obtained from the distributions for all consumers units, which were not specified by their education levels shown in Table 5.7.

The numbers of replicates (*t*) set for the model were 100, 500, 1000, 5000, and 10000 to detect the stability of the results. There were three indicators to present the economic impact, including the ratio between taxes from the individuals holding higher degrees and taxes from the individuals holding only bachelor's degrees (Impact1), the taxes increased every one dollar more received for their incomes

(Imapct2), and the difference of taxes received between from the individuals holding higher degrees and from the individuals only holding bachelor's degrees (Imapct3).

$$impact1 = tax1/tax0$$
$$impact2 = (tax1 - tax0)/(income1 - income0)$$
$$impact3 = tax1 - tax0$$

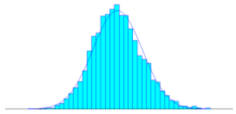
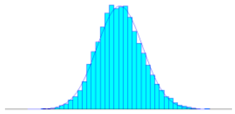
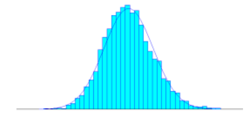
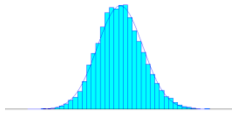
where 1 indicated the parameters were for an individual holding higher degree than BD, and 0 indicated the parameters were for an individual holding BD.

The model was run under the corresponding conditions, and the results were shown in Table 7.1. The results in Table 7.1 were the average numbers of the random samples.

Table 7.1 Average Economic Impacts for all individuals with the changes of replicates (t)

t	Annual Federal and State Taxes			Annual State Taxes		
	Impact1	Impact2	Impact3	Impact1	Impact2	Impact3
100	1.46	0.25	$ 2635.26	1.45	0.10	$ 1010.66
500	1.55	0.24	$ 2849.62	1.47	0.09	$ 945.92
1000	1.59	0.23	$ 3001.84	1.52	0.07	$ 1296.45
5000	1.61	0.24	$ 3179.63	1.55	0.09	$ 1156.55
10000	1.58	0.24	$ 3062.81	1.52	0.09	$ 1091.32

Table 7.2 Distributions for the random samples of Imapct3

Government	t	Distribution	Squared Error	Histogram
Both	5000	Normal (3.18×10^3, 4.64×10^3)	0.000393	
	10000	Normal (3.06×10^3, 4.58×10^3)	0.000211	
State & Local	5000	Normal (1.16×10^3, 1.69×10^3)	0.000379	
	10000	Normal (1.09×10^3, 1.67×10^3)	0.000203	

As seen, the average ratio for federal and state & local governments together was about 1.6, which meant if the governments can receive 1 dollar from the individual with a bachelor's degree, 1.6 dollars would be contributed to the governments by the individual with a higher degree. The average ratio for the state & local government was about 1.5, when t reached large enough. If one dollar was increased for their income, about 0.2 dollar more would be contributed to the federal and state & local governments together, and about 0.1 dollar more would be obtained by the state & local government. As indicated by the table, when t reached large enough, the difference of taxes received from between the individuals receiving a higher degree and a bachelor's degree became steady. It was about 3×10^3 dollars for the federal and state & local governments together, and about 1×10^3 dollars for the state & local government.

The random samples of Impact3 were fitted in Input Analyzer to find out proper distributions to present the results shown in Table 7.2. Since the sample size was large enough, normal distributions can be utilized to fit the samples. As indicated in Table 7.2, the mean values of the distributions no matter whether t equaled 5000 or 10000 seemed to be equivalent, while the standard deviations when t=10000 were less than the standard deviation when t=5000. When t=10000, the squared errors were smaller. The larger sample size made the results more consistent.

7.2 The basic model for individuals major in engineering

In this model, the distributions to generate incomes were changed, while the percentages on different categories for the groups of individuals were the same as the model in Section 7.1. The replicates set for the model also were 100, 500, 1000, 5000, and 10000 as the model for all individuals. The indicators to show the economic impacts were the same as the indicators in Section 7.1 as well.

As indicated in Table 7.3, the ratio between taxes from the individuals who received higher degrees and taxes from the ones who just received bachelor's degrees was about 1.25 for the federal and state & local governments together, and was also about 1.25 for the state & local government only. For the federal and state & local governments together, 0.25 dollars would be increased on the taxes if one dollar was raised for their incomes. For the state & local government, about 0.1 dollars more can be contributed to the taxes.

Table 7.3 Average Economic Impacts for individuals major in engineering with the changes of replicates (t)

t	Annual Federal and State Taxes			Annual State Taxes		
	Impact1	Impact2	Impact3	Impact1	Impact2	Impact3
100	1.36	0.30	$ 2537.39	1.37	0.15	$ 1029.88
500	1.25	0.23	$ 1739.55	1.25	0.08	$ 669.09
1000	1.26	0.39	$ 1910.29	1.23	0.24	$ 680.64
5000	1.24	0.23	$ 1646.06	1.19	0.08	$ 479.96
10000	1.28	0.25	$ 1904.78	1.28	0.10	$ 752.00

When t=1000, the results of Impact2 were a little abnormal and they were obviously larger than the results in other conditions.

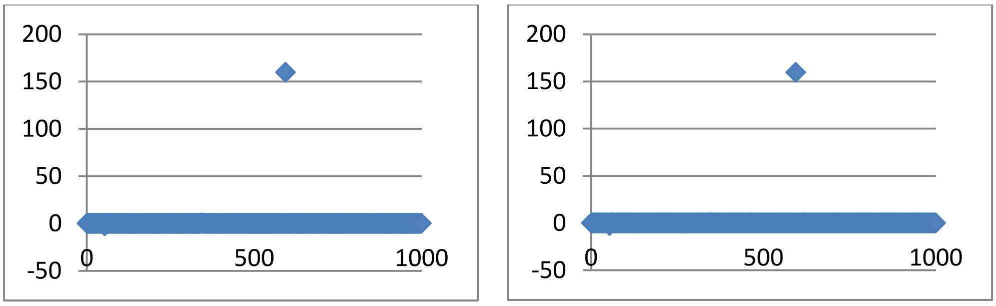


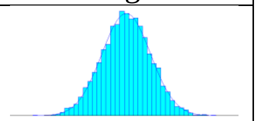
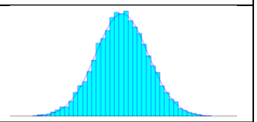
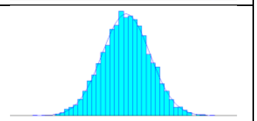
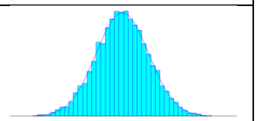
Figure 7.1 Scatters of Impact2 when t=1000

The left graph in Figure 7.1 was for the scatters of Impact2 to the federal and state & local governments together, and the right one was for the results to the state & local government. Obviously, there was one abnormal result for each of them, and it was about 160. Once the abnormal result was deleted from the sample, the mean value of

Impact2 was changed to be 0.23 for the federal and state & local governments together, and it was changed to be 0.08 for the state & local government. They were close enough to their corresponding results when t was set to be the other values. As well, the variances of the samples were reduced to be 0.00845 and 0.00845 from 25.45 and 25.45, respectively. Since the values were generated randomly, a little abnormal result can be accepted.

When the number of trials reached large enough, the results trended to be steady. The difference of taxes received by the federal and state & local governments together was about 2000 dollars each year, and it was about 700 dollars each year for only the state & local government. They were not changed no matter whether the abnormal point was kept or deleted.

Table 7.4 Distributions for the random sample of Impact3

Government	t	Distribution	Squared Error	Histogram
Both	5000	Normal (1.65×10^3, 4.32×10^3)	0.000107	
	10000	Normal (1.9×10^3, 4.39×10^3)	0.000057	
State & Local	5000	Normal (480, 1.54×10^3)	0.000106	
	10000	Normal (752, 1.57×10^3)	0.000080	

As seen in Table 7.4, larger sample size made the squared error less. All random samples of Imapct3 were following normal distributions with different parameters' values. The difference of the mean values for the taxes received by the federal and state & local governments together was not large between t=5000 and t=10000, and it was only 250 dollars. The difference of the mean values for the taxes received by the state & local government was also not large, and it was 272 dollars. The standard deviations were very close to each other in the two cases, while the standard deviation was a little less when t=10000 than when t=5000.

7.3 The whole life of career model for all individuals disregarding the majors

The indicator to represent the whole life of career utilized in the research was the present worth of taxes, shorten as PW for the federal and state & local governments together, and sPW for the state & local government only. The baseline for the present worth was in the year when the individual was 21 years old. The interest rate to obtain the present worth was estimated to be 0.10 to run the model. The other parameters were set the same as described in Chapter 5. The numbers of replicates to run the model were set to be 100, 500, 1000, 5000, and 10000.

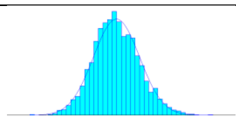
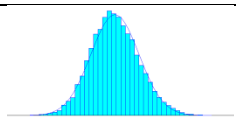
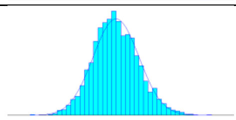
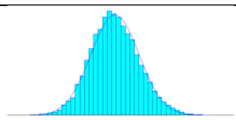
Table 7.5 Average present worth of total taxes

t	PW			sPW		
	BD	Higher	Difference	BD	Higher	Difference
100	$ 83,427	$ 122,748	$ 39,321	$ 31,186	$ 42,570	$ 11,384
500	$ 55,265	$ 73,552	$ 18,287	$ 33,494	$ 45,778	$ 12,284
1000	$ 74,311	$ 99,142	$ 24,831	$ 32,355	$ 44,349	$ 11,993
5000	$ 84,479	$ 130,334	$ 45,855	$ 31,416	$ 42,020	$ 10,604
10000	$ 72,517	$ 122,904	$ 50,387	$ 32,428	$ 42,726	$ 10,299

As seen in Table 7.5, the present worth of taxes received by the federal and state & local governments together for the individuals who only had bachelor's degree in the whole life of the career was about 70 thousand dollars, and it for the state & local government was about 32 thousand dollars 43 years' work. The present worth of taxes received by the federal and the state & local governments together for the individuals with higher degrees in their whole career life was about 122 thousand dollars, and it was about 42 thousand dollars to the state & local government for their 40 years' work. As represented in the previous sections, when the sample size was large enough, the results trended to be stable.

As indicated in Table 7.5, the differences of the average present worth between the individuals who just received bachelors' degrees and the ones with higher degrees were positive, which meant that the average present worth of the total taxes in the whole life of career from the individuals with higher degrees was more than from the one with only bachelors' degrees. The difference between the total taxes received by the federal and the state & local governments together from the individuals with bachelors' degrees and the individuals with higher degrees was about 45 or 50 thousand dollars, and it was about 10 thousand dollars by the state & local governments. The sample of the PW's differences was utilized to fit different distributions, and the results were shown in Table 7.6.

Table 7.6 Distributions for the random samples of the differences

Government	t	Distribution	Squared Error	Histogram
Both	5000	Normal (4.59×10^4, 2.05×10^4)	0.000501	
	10000	Normal (5.04×10^4, 2.04×10^4)	0.000208	
State & Local	5000	Normal (1.06×10^4, 2.05×10^4)	0.000491	
	10000	Normal (1.03×10^4, 2.04×10^4)	0.000208	

All of the samples were following normal distributions with different parameters' values. As seen, when the sample size was large enough, the distributions best fitted were almost the same. The mean values of the distributions for the governments together had 4500 dollars difference between t=5000 and t=10000, and the standard deviations had only 100 difference. For the state & local government, the difference between t=5000 and t=10000 of the mean values was 300 dollars, and it was 100 for the standard deviations. However, as the sample size became larger, the square error became less. The square error was 0.0002 when t=10000, compared with 0.0005 when t=5000.

7.4 The whole life of career model for the individuals major in engineering

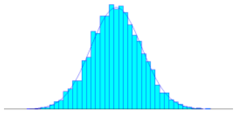
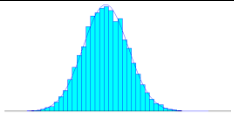
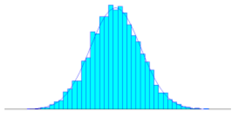
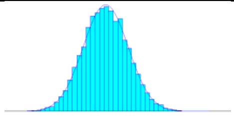
The distributions best fitted for the incomes of the individuals major in engineering were shown in Chapter 5, and the process to run the model was the same as shown in Section 7.3 with the income distributions for the individuals who were major in engineering. The values of other parameters in the model were set to be the same as in Section 7.3. The results were shown in Table 7.7.

Table 7.7 Average present worth of total taxes

t	PW			sPW		
	BD	Higher	Difference	BD	Higher	Difference
100	$ 87,301	$ 166,351	$ 79,050	$ 45,878	$ 47,614	$ 1,736
500	$ 114,278	$ 150,642	$ 36,364	$ 43,121	$ 48,224	$ 5,103
1000	$ 97,010	$ 110,018	$ 13,008	$ 44,444	$ 51,925	$ 7,481
5000	$ 79,764	$ 110,232	$ 30,468	$ 45,946	$ 50,741	$ 4,795
10000	$ 99,232	$ 111,622	$ 12,391	$ 44,306	$ 50,789	$ 6,483

As indicated in Table 7.7, the average value of the present worth of the taxes received by the federal and state & local governments together from the individuals who were bachelors was in ten thousand dollars, while the average level for the individuals who received higher degrees was in hundred thousand dollars. The difference between them was in ten thousand dollars. The average value of the present worth of the taxes received by the state & local government from the individuals who were bachelors was about 45 thousand dollars, and the average value for the individuals who received higher degrees was about 50 thousand dollars. The difference between the two groups of people was in thousand dollars and about 5 thousand.

Table 7.8 Distributions for the random samples of the differences

Government	t	Distribution	Squared Error	Histogram
Both	5000	Normal (3.05×10^4, 1.93×10^4)	0.000179	
	10000	Normal (1.24×10^4, 1.93×10^4)	0.000106	
State & Local	5000	Normal (4.79×10^3, 1.93×10^4)	0.000178	
	10000	Normal (6.48×10^3, 1.93×10^4)	0.000105	

As known in previous sections, the results should trend to be stable as t was increased. The differences were fitted for different distributions, and the best distributions were shown in Table 7.8. All distributions selected were normal distribution with different parameters, and the squared errors were smaller as t became larger. The mean values were not the same with the change of t, while the order of magnitudes was the same. Because the data were generated randomly, a degree of difference was accepted with the change of t.

7.5 Sensitivity Analysis

The major parameters assumed in the models were the percentage of the individual's income to stop adding the indirect contributions (p_s) and the percentage of the direct expenditures paid to the employees in the corresponding places (p_e). In the whole life of careers model, there was another parameter, which was the effective annual interest rate (i).

7.5.1 Sensitivity Analysis for the Basic Model

The sensitivity analysis was indicated by the average values of Impact1, Impact2, and Impact3 with the changes of p_s and p_e, with the sample size of 5000. The basic values of p_s and p_e were 0.01 and 0.5, respectively, which was marked as the 0% change in the diagrams.

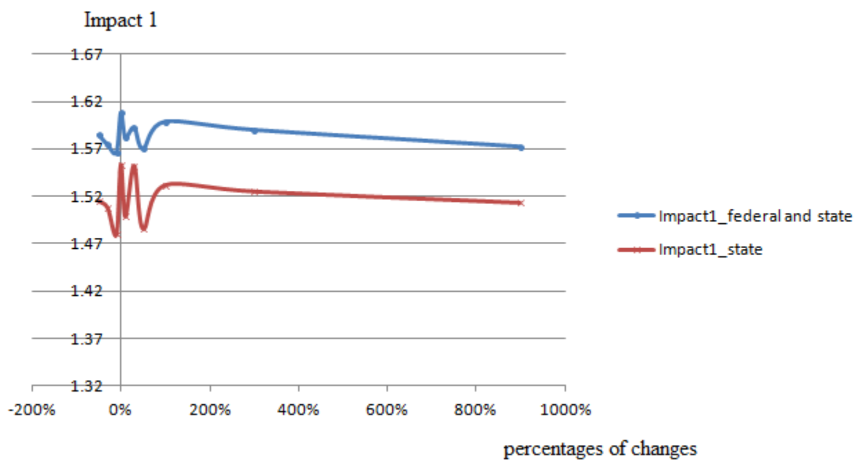


Figure 7.2 Changes of Impact1 for all individuals ignoring their majors with p_s

The changes of p_s in the basic model was from -50% to 900%. When there were -50% changes to p_s, it was 0.005. When 900% changes were made on p_s, it became 0.1. 0.1 was large enough for p_s, because the indirect impact of an individual was expected. The changes of the average values of Impact1, Impact2, and Impact3 for the individuals disregarding their majors were shown in Figure 7.2, Figure 7.3, and Figure 7.4, respectively.

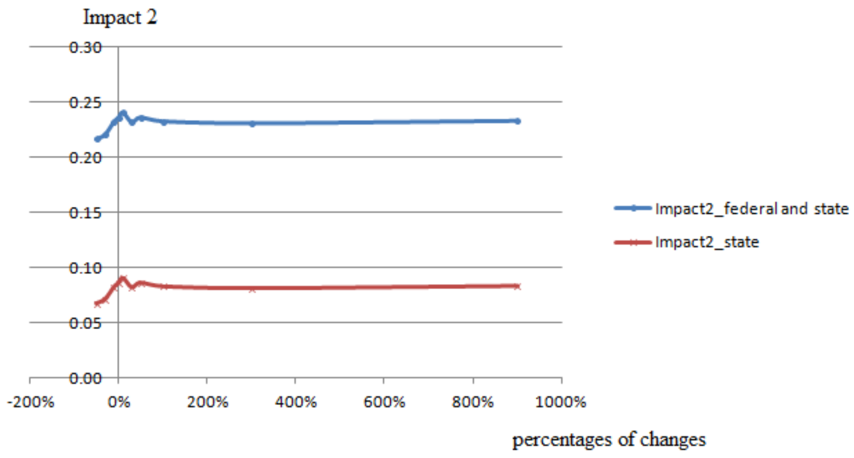


Figure 7.3 Changes of Impact2 for all individuals ignoring their majors with p_s

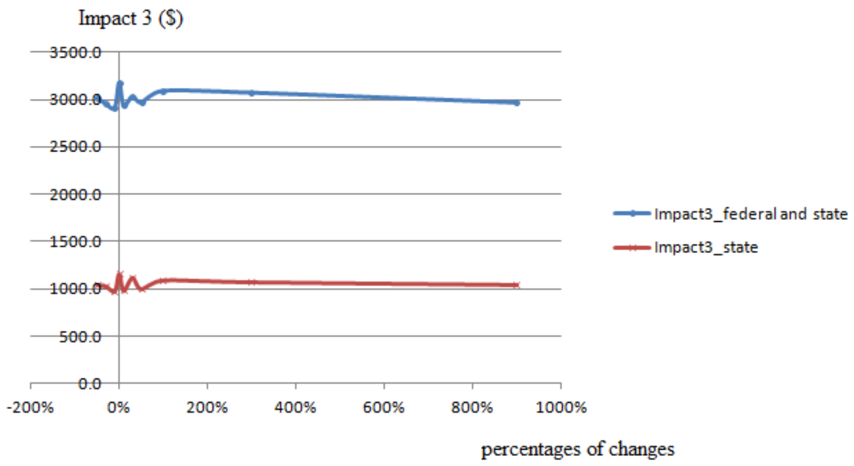


Figure 7.4 Changes of Impact3 for all individuals ignoring their majors with p_s

In the figures, "Impact#_federal and state" was for the impact to the federal and the state & local governments together, and "Impact#_state" was for the impact to the state & local government. As indicated, the undulation of the impacts was irregular and around a specific number for each line. The changes of p_s did not influence the results in the basic model for all individuals disregarding their majors significantly. The changes of the impacts in the basic model for the individuals major in engineering were shown in Figure 7.5, Figure 7.6, and Figure 7.7.

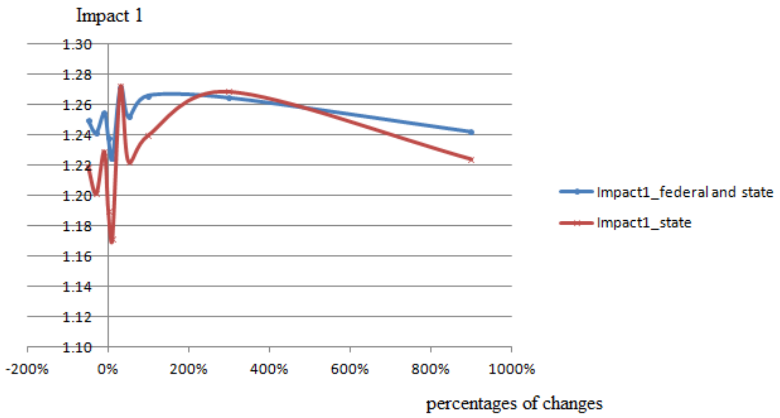


Figure 7.5 Changes of Impact1 for the individuals major in engineering with p_s

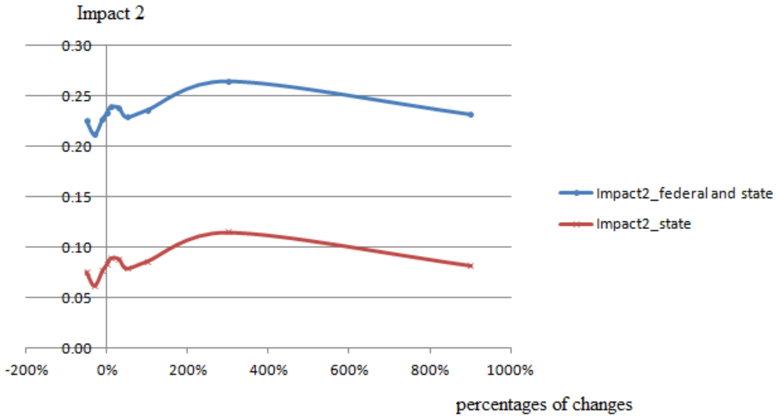


Figure 7.6 Changes of Impact2 for the individuals major in engineering with p_s

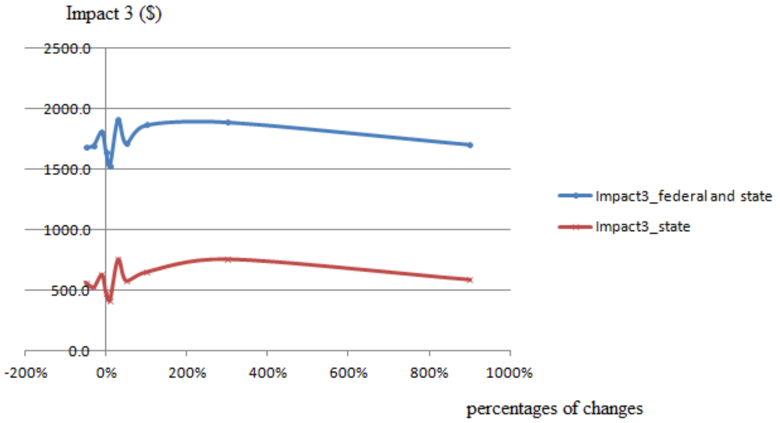


Figure 7.7 Changes of Impact3 for the individuals major in engineering with p_s

As seen, there was no significant trend of the fluctuations of the impacts for the basic model with the individuals major in engineering. Each impact was up and down around a specific value, and there was no significant effect of the changes of p_s.

It was indicated that p_s was an insensitive parameter for the basic model.

The changes of p_e in the basic model was from -90% to 90%. When there were -90% changes to p_s, it was 0.05. When there were 90% changes to p_s, it became 0.95.

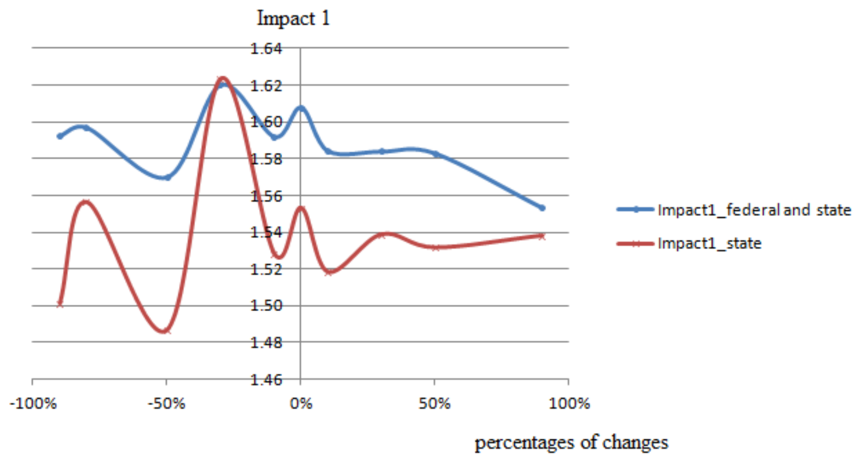


Figure 7.8 Changes of Impact1 for all individuals ignoring their majors with p_e

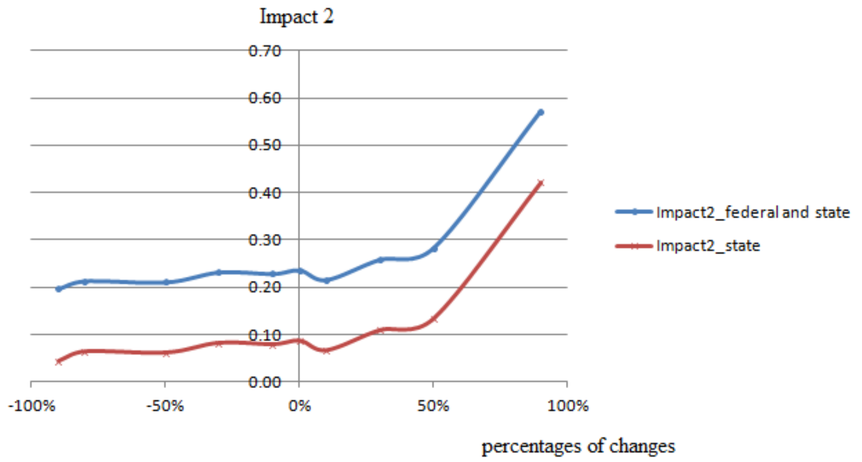


Figure 7.9 Changes of Impact2 for all individuals ignoring their majors with p_e

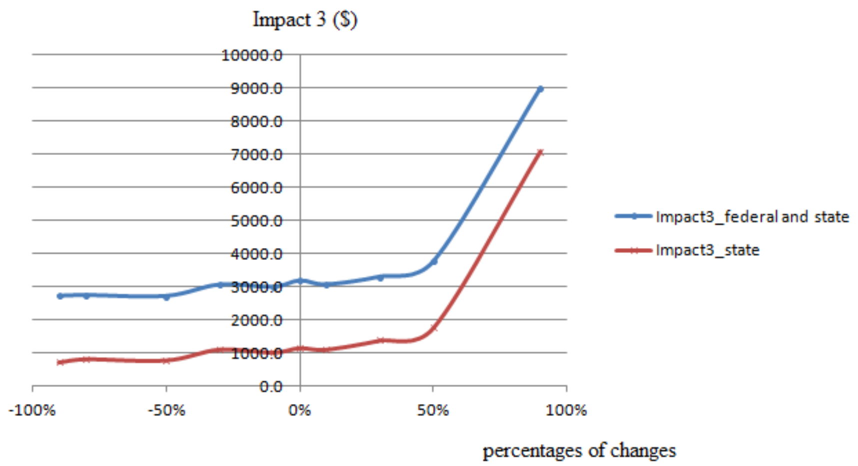


Figure 7.10 Changes of Impact3 for all individuals ignoring their majors with p_e

The changes of the average values of Impact1, Impact2, and Impact3 were shown in Figure 7.8, Figure 7.9, and Figure 7.10 for the individuals disregarding their majors. As indicated, there was no significant trend of the undulation of Impact1 with the changes of p_e, while the average values of Impact2 and Impact3 trended to be increased with the increasing of p_e. Impact1 was insensitive to p_e, but Impact2 and Impact3 were sensitive to it in the basic model for the individuals disregarding their majors.

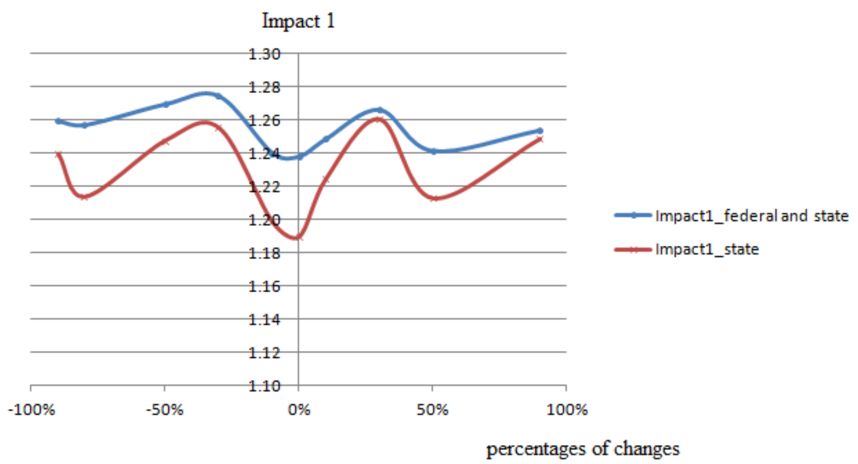


Figure 7.11 Changes of Impact1 for the individuals major in engineering with p_e

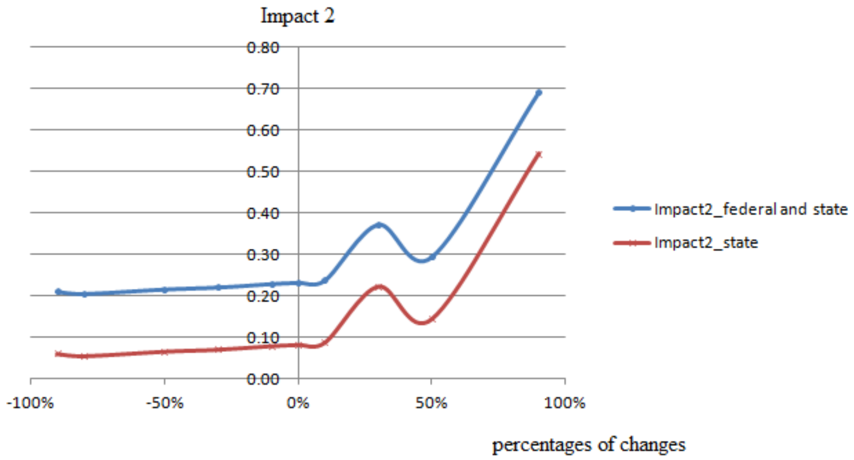


Figure 7.12 Changes of Impact2 for the individuals major in engineering with p_e

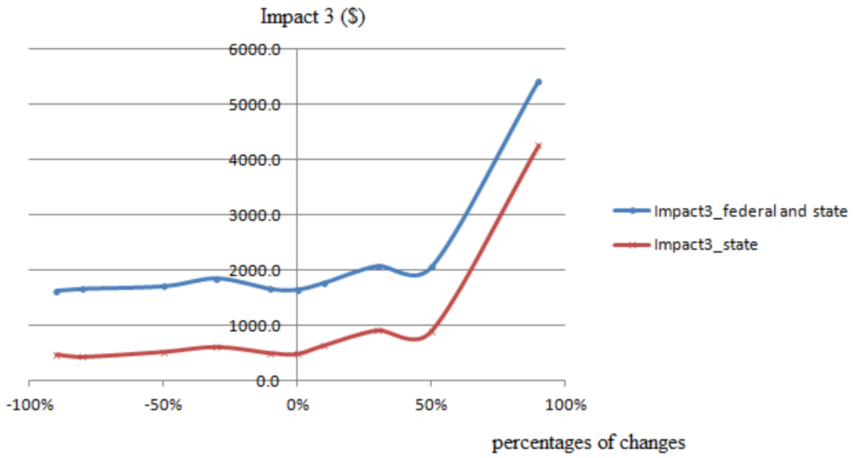


Figure 7.13 Changes of Impact3 for the individuals major in engineering with p_e

The changes of the average impacts in the basic model for the individuals major in engineering were shown in Figure 7.11, Figure 7.12, and Figure 7.13. As shown in Figure 7.11, the lines of Impact1 were shifted up and down with the changes of p_e in a small range. As seen in Figure 7.12 and Figure 7.13, the average values of Impact2 and Impact3 were in the significantly increasing trend with the raise of p_e.

As detected, p_e was a sensitive parameter for Impact2 and Impact3 in the basic model, but insensitive for Impact1.

7.5.2 Sensitivity Analysis for the Whole Life of Careers Model

The sensitivity analysis was indicated by the average values of the net present worth of total taxes paid to the federal and the state & local governments together (PW) and the net present worth of total taxes paid to the state & local government (sPW) with the changes of i, p_s, and p_e with the sample size of 5000. The basic values of i, p_s, and p_e were 0.1, 0.01, and 0.5, respectively, which was marked as the 0% change in the diagrams. As well, the difference of the average of the net present worth of total taxes received between by the federal and the state & local governments and the state & local government was recorded in the figures.

The changes of i in the whole life of careers model was from -90% to 100%. When there were -90% changes made to i, it was 0.01. When 100% changes were made on i, it equaled 0.2. The changes of the average values of PW and sPW were shown in Figure 7.14 and Figure 7.15 for all individuals disregarding their majors.

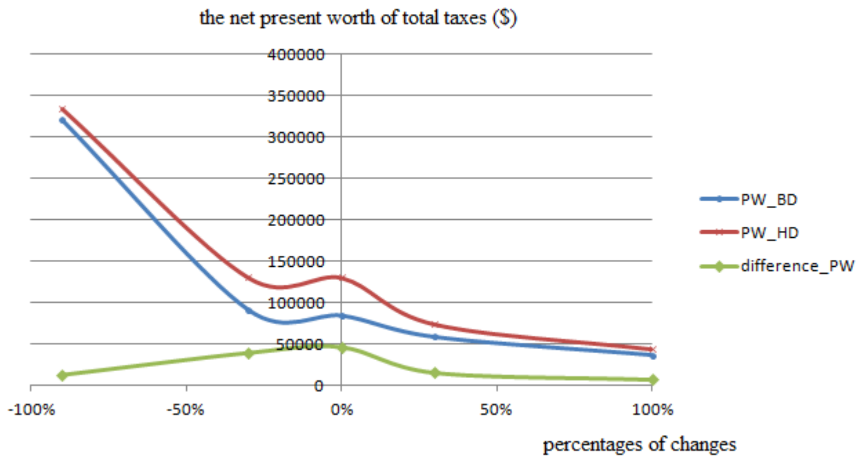


Figure 7.14 Changes of PW for all individuals disregarding their majors with *i*

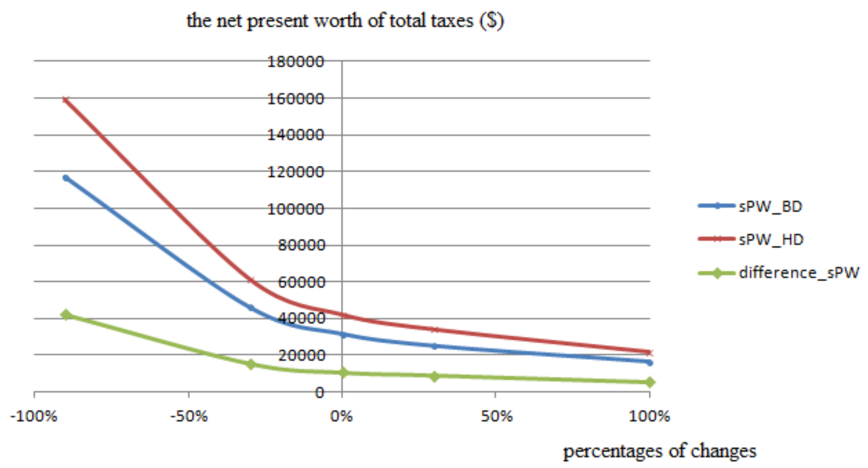


Figure 7.15 Changes of sPW for all individuals disregarding their majors with *i*

As indicated in Figure 7.14 and Figure 7.15, the average values of PW and sPW trended to be decreased with the increasing of *i* either for the individuals who were bachelors or for the individuals who received higher degrees. The difference of PW between them was shifted around -30% and 0% changes made to *i*. the difference of sPW between the two groups of individuals had the same trend as sPW. It was decreased sharply between -90% and -30% changes made, but kept decreasing gently from 0% changes to 100% changes made.

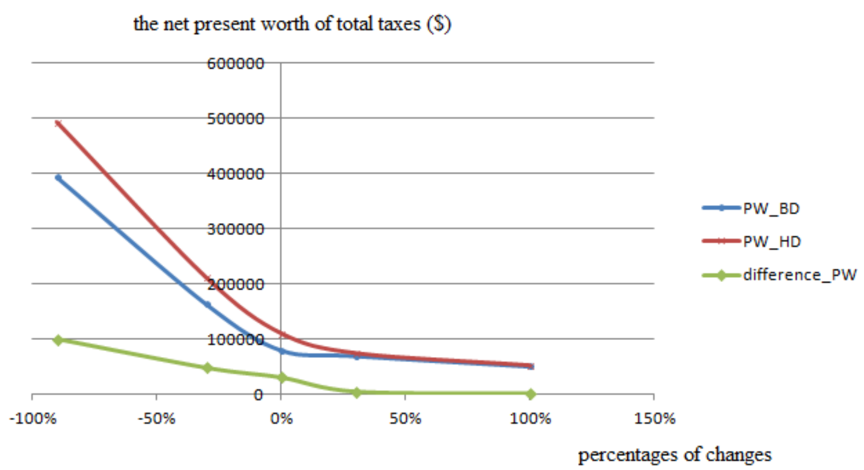


Figure 7.16 Changes of PW for the individuals major in engineering with *i*

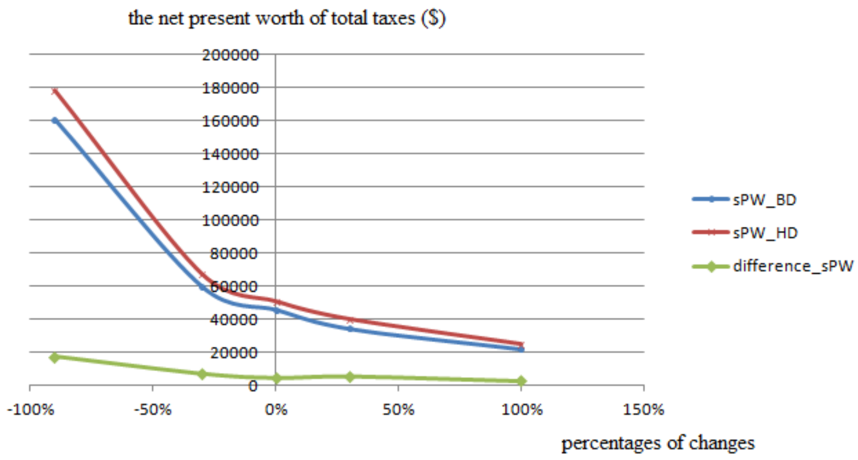


Figure 7.17 Changes of sPW for the individuals major in engineering with *i*

As indicated in Figure 7.16 and Figure 7.17, the average values of PW and sPW for the individuals major in engineering were decreased with the changing of *i*. The difference of PW and sPW between the two groups of individuals also trended to be decreased, while the decreasing was subdued.

As described above, the effective annual interest rate (*i*) was a sensitive parameter in the whole life of career model to affect the indicators, and the indicators trended to be decreased with its increasing.

The changes of p_s in the whole life of careers model was from -90% to 100%. When there were -90% changes made to p_s, it was 0.001. When 100% changes were made on p_s, it equaled 0.02. The changes of the average values of PW and sPW were shown in Figure 7.18 and Figure 7.19 for all individuals disregarding their majors.

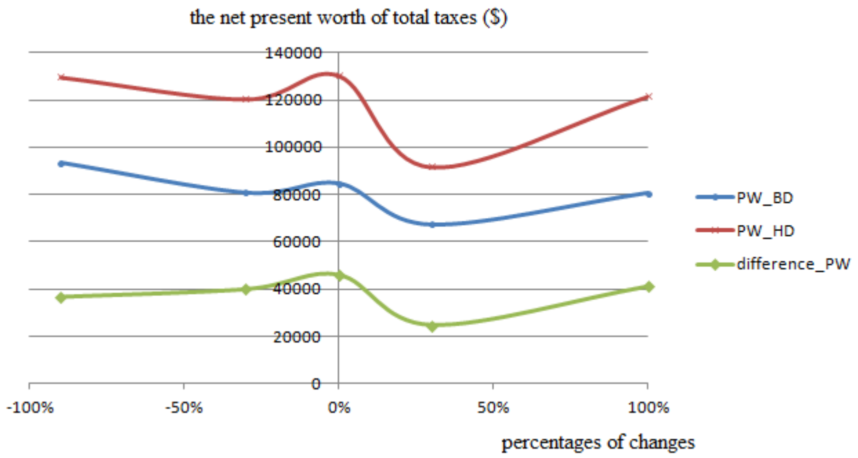


Figure 7.18 Changes of PW for all individuals disregarding their majors with p_s

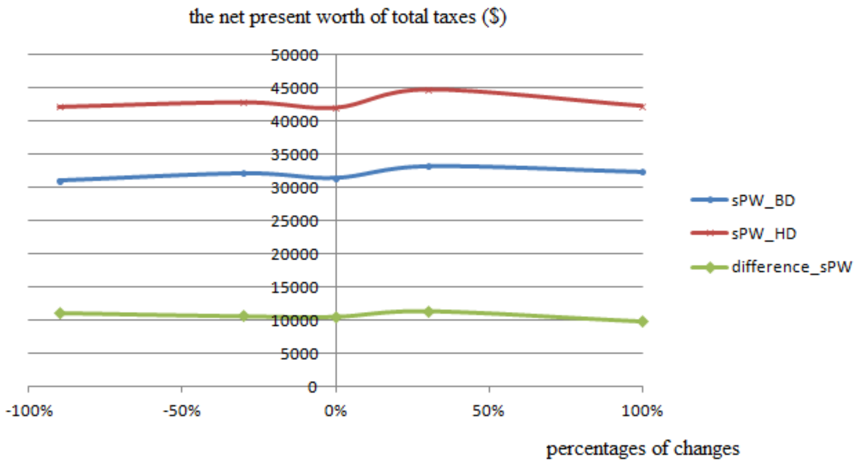


Figure 7.19 Changes of sPW for all individuals disregarding their majors with p_s

As seen in Figure 7.18 and Figure 7.19, there was no fixed trend of PW and sPW with the changing of p_s. The differences of PW and sPW between the two groups of individuals were not changed too much with p_s. the difference of PW was around $40,000, and the difference of sPW was around $10,000.

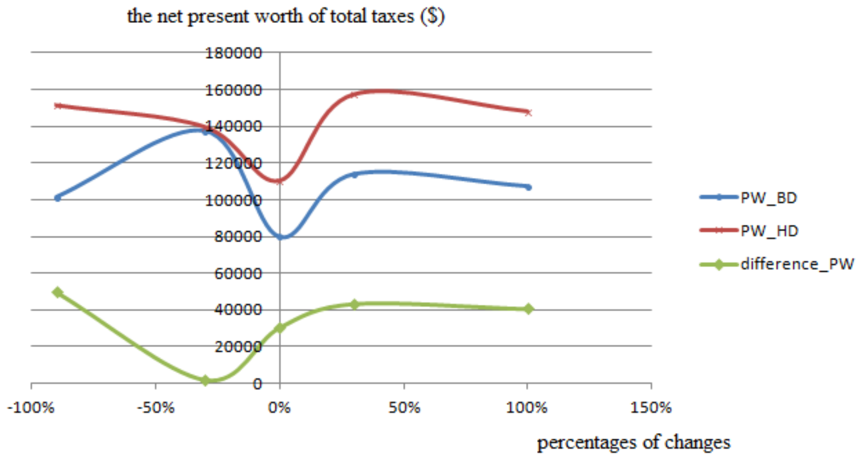


Figure 7.20 Changes of PW for the individuals major in engineering with p_s

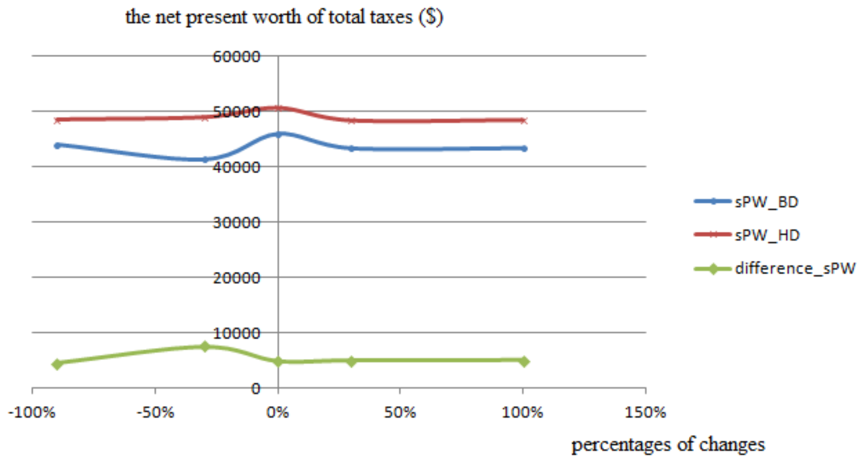


Figure 7.21 Changes of sPW for the individuals major in engineering with p_s

As indicated in Figure 7.20 and Figure 7.21, there were no trends on the shift of the PW and sPW for the individuals major in engineering with the changing of p_s. The shift was around a value as well. The difference of PW between the two groups of individuals was shifted around $40,000, but there was an abnormal point when -30% changes were made. The difference of sPW was shifted around $5,000.

As detected, p_s was an insensitive parameter for the whole life of careers model, and the indicators just were shifted up and down in the error range with its changes.

The changes of p_e in the whole life of careers model was from -90% to 80%. When there were -90% changes made to p_e, it was 0.05. When 80% changes were made on

p_e, it equaled 0.9. The changes of the average values of PW and sPW were shown in Figure 7.22 and Figure 7.23 for all individuals disregarding their majors.

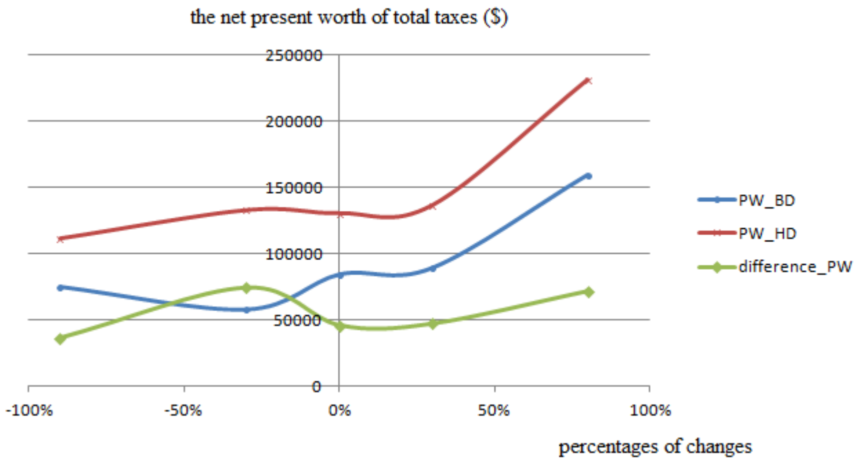


Figure 7.22 Changes of PW for all individuals disregarding their majors with p_e

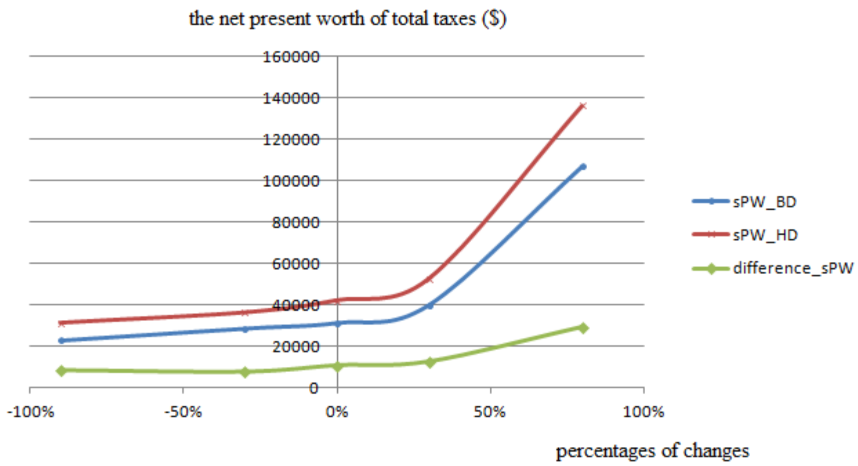


Figure 7.23 Changes of sPW for all individuals disregarding their majors with p_e

As indicated in Figure 7.22 and Figure 7.23, the average values of PW and sPW trended to be increased with the increasing of p_e. The difference of PW between the two groups of individuals was shifted up and down around $50,000 with the changing of p_e. The difference of sPW was around $10,000 between -90% and 30% changes, but had a sharp rise from 30% changes to 80%.

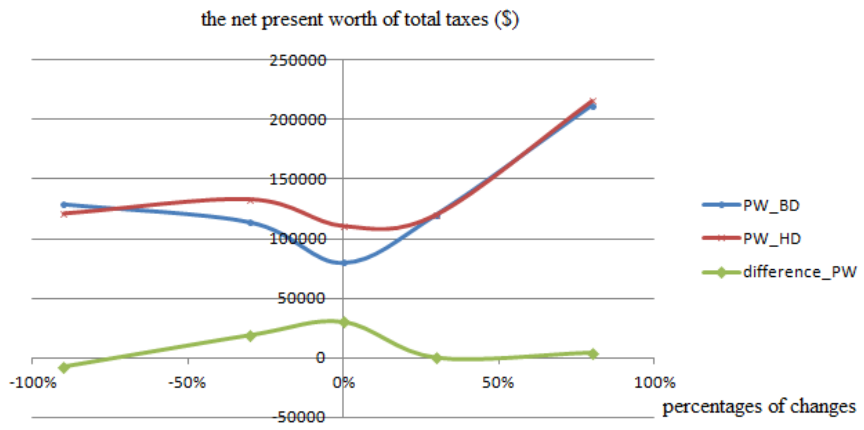


Figure 7.24 Changes of PW for the individuals major in engineering with p_e

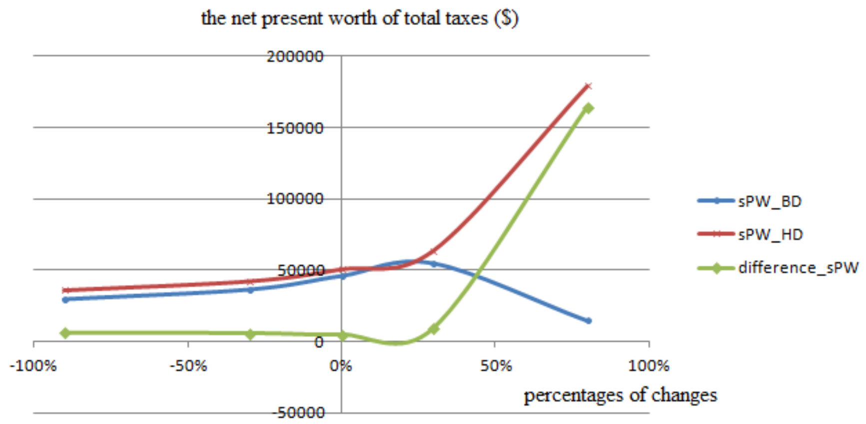


Figure 7.25 Changes of sPW for the individuals major in engineering with p_e

As indicated in Figure 7.24 and Figure 7.25, the average values of PW of the total taxes and sPW of the total taxes received from the individuals who received higher degrees trended to be increased with the changing of p_e, but the average value of sPW from the individuals who were bachelors had a sharp decrease when the change was from 30% to 80%. The reason why the abnormal point appeared should be the instability of the random generation. The difference of PW between the two groups of individuals was shifted up and down more sharply than the difference of sPW. And the difference of sPW between the two groups of individuals trended to be increased with the increasing of p_e.

As seen, p_e was a sensitive parameter in the whole life of career model for the indicators, and the indicators trended t be increased with its increasing.

7.6 Performances with the Tax Rate Changed

The tax was the way for the governments to receive rewards from the persons, and the tax rate was the direct parameter to influence the taxes. Normally, the government adjusted the tax rate every several years. In this section, the performances of the models were detected with the tax rate changed. There were two different kinds of taxes rates considered in this research, which were the sales tax rate and the income tax rate. The sales tax rate (r_s) utilized as the baseline was 7%, which was for the Lincoln city in Nebraska. The changes made were from -90% to 90%. When -90% changes were made to r_s, it became 0.007, and it was 0.133 with 90% changed to it.

Table 7.9 Federal income tax rates changed for singles in 2011

-90% changes	-30% changes	0% changes	Tax Brackets	
Marginal Tax Rate			Over	But Not over
1%	7%	10.0%	$ 0	$ 8,500
1.5%	10.5%	15.0%	$ 8,500	$ 34,500
2.5%	17.5%	25.0%	$ 34,500	$ 83,600
2.8%	19.6%	28.0%	$ 83,600	$ 174,400
3.3%	23.1%	33.0%	$ 174,400	$ 379,150
3.5%	24.5%	35.0%	$ 379,150	

The income tax rate brackets utilized in the research were for the single individuals who had no child. The brackets were not changed for the performance, but only the marginal federal income tax rates for each bracket and the effective state income tax rates of each bracket were changed by -90% and -30% as shown in Table 7.9 and Table 7.10.

Table 7.10 State income tax rates changed in 2011

-90% changes	-30% changes	0% changes	Tax Brackets	
Effective Tax Rate			Over	But Not over
0.256%	1.792%	2.56%	$ 0	$ 2,400
0.357%	2.499%	3.57%	$ 2,400	$ 17,500
0.512%	3.584%	5.12%	$ 17,500	$ 27,000
0.684%	4.788%	6.84%	$ 27,000	

The income taxes rates with the corresponding changes were utilized in the model to obtain the performances to detect its effects.

7.6.1 Performances of the Basic Model with the Tax Rate Changed

The performances of the basic model for all the individuals disregarding their majors were obtained when the sales tax rate (r_s) was changed, and the results of Impact1, Impact2, and Impact3 were shown in Figure 7.26, Figure 7.27, and Figure 7.28.

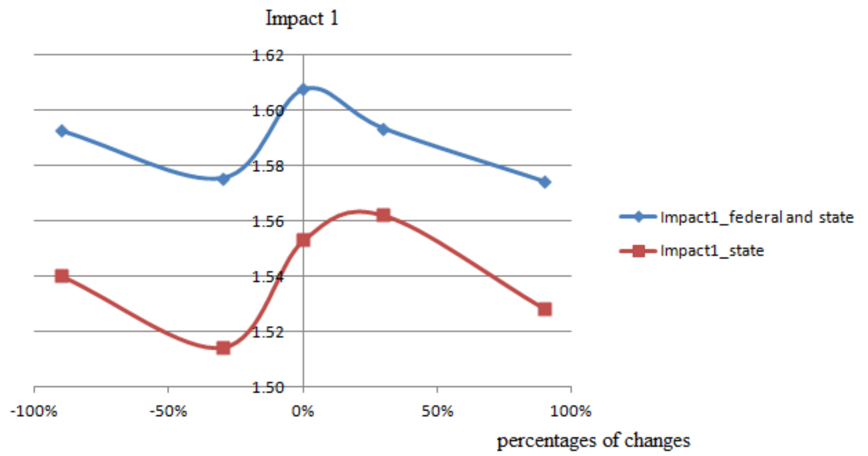


Figure 7.26 Performances of Impact1 for all individuals disregarding their majors with r_s

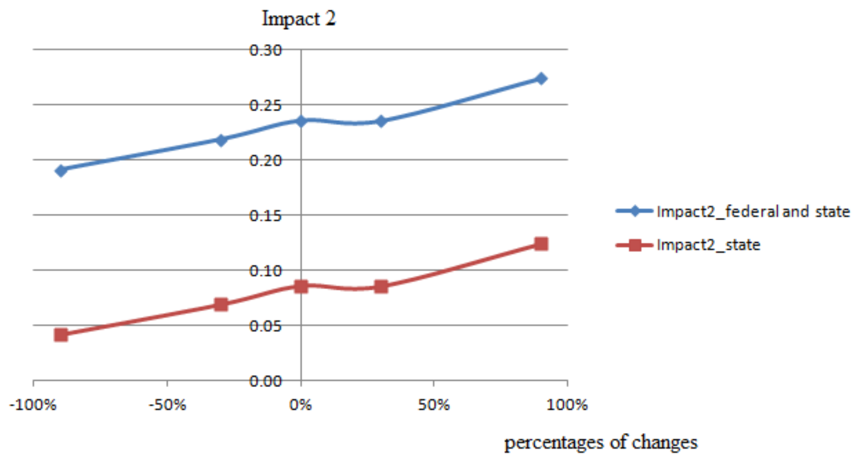


Figure 7.27 Performances of Impact2 for all individuals disregarding their majors with r_s

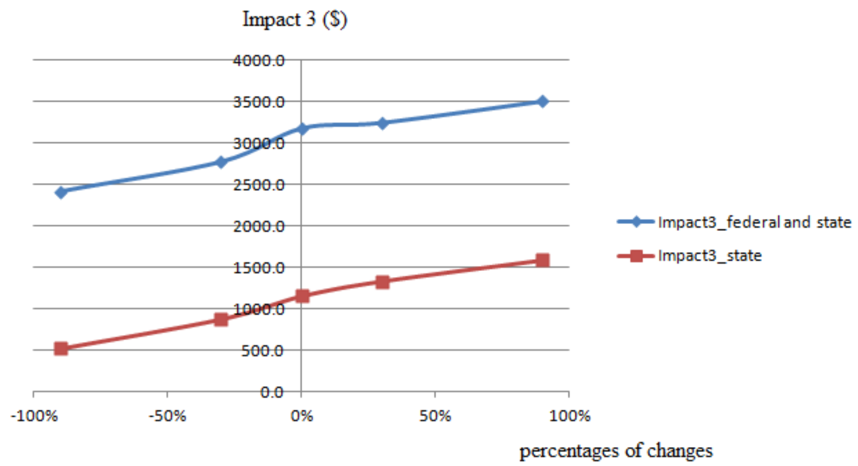


Figure 7.28 Performances of Impact3 for all individuals disregarding their majors with r_s

As indicated in Figure 7.26, the average Imapct1 was shifted up and down around 1.59 for the federal and the state & local governments together and around 1.54 for the state & local government. The average Impact2 and the average Impact3 were raised with the increasing of the sales tax rates as shown in Figure 7.27 and Figure 7.28.

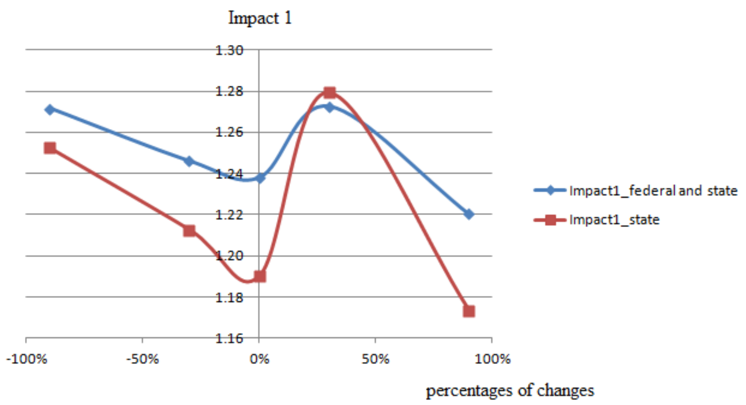


Figure 7.29 Performances of Impact1 for the individuals major in engineering with r_s

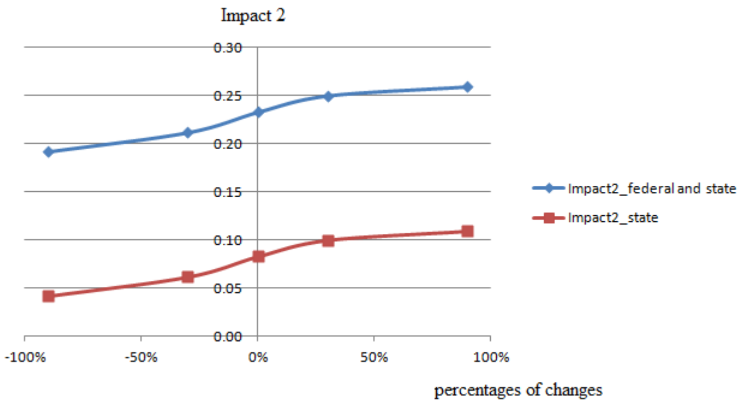


Figure 7.30 Performances of Impact2 for the individuals major in engineering with r_s

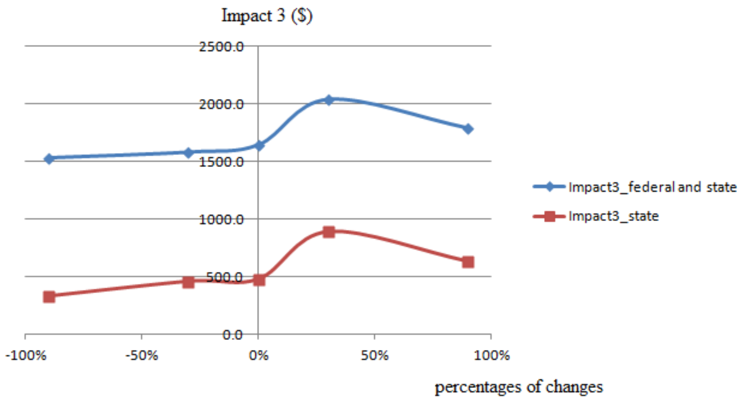


Figure 7.31 Performances of Impact3 for the individuals major in engineering with r_s

The performances of the basic model for the individuals major in engineering were shown in Figure 7.29, Figure 7.30, and Figure 7.31 with the changing of the sales tax rates.As seen in Figure 7.29, the average Impact1 were shifted around 1.25 for the federal and the state & local governments together, and around 1.22 for the state & local government. In Figure 7.30, the average Impact2 were raised with the increasing of r_s, especially from -30% changes to 30% changes. The average Impact3 shown in Figure 7.31 were increased from -90% changes to 30% changes, while it was decreased from 30% changes to 90% changes.

The changes of the three indicators with the changing of the income tax rate (r_i) were shown in Table 7.11 for all individuals disregarding their majors and Table 7.12 for the individuals major in engineering.

Table 7.11 Performances of impacts for all individuals disregarding their majors with r_i

changes	The federal and the state & local governments together			The state & local government		
	Impact1	Impact2	Impact3	Impact1	Impact2	Impact3
-90%	1.55	0.07	$ 997.4	1.53	0.060	$ 799.5
-30%	1.58	0.18	$ 2,330.2	1.49	0.071	$ 901.6
0%	1.61	0.24	$ 3,179.6	1.55	0.086	$ 1,156.5

Table 7.12 Performances of impacts for the individuals major in engineering with r_i

changes	The federal and the state & local governments together			The state & local government		
	Impact1	Impact2	Impact3	Impact1	Impact2	Impact3
-90%	1.22	0.10	$ 524.2	1.21	0.083	$ 401.7
-30%	1.27	0.20	$ 1437.5	1.26	0.091	$ 632.2
0%	1.24	0.23	$ 1646.1	1.19	0.083	$ 480.0

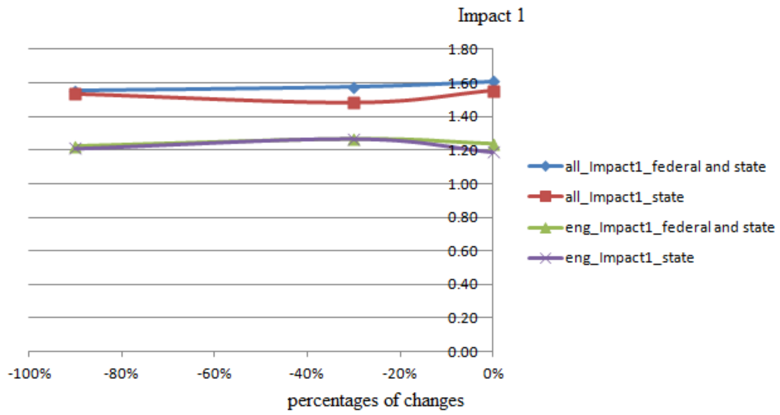


Figure 7.32 Performances of Impact1 with r_i

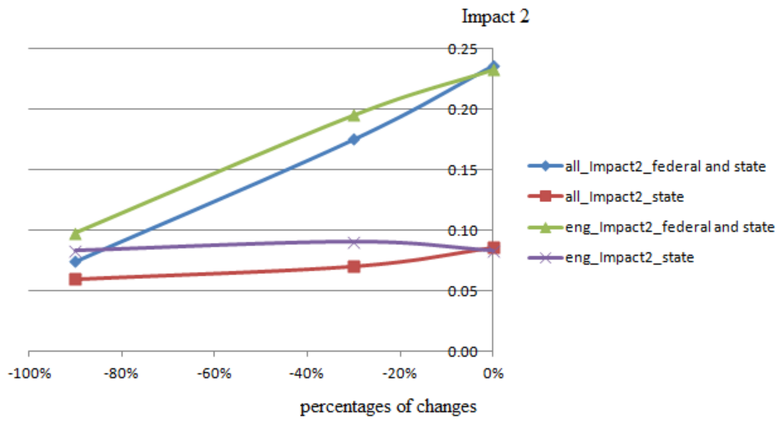


Figure 7.33 Performances of Impact2 with r_i

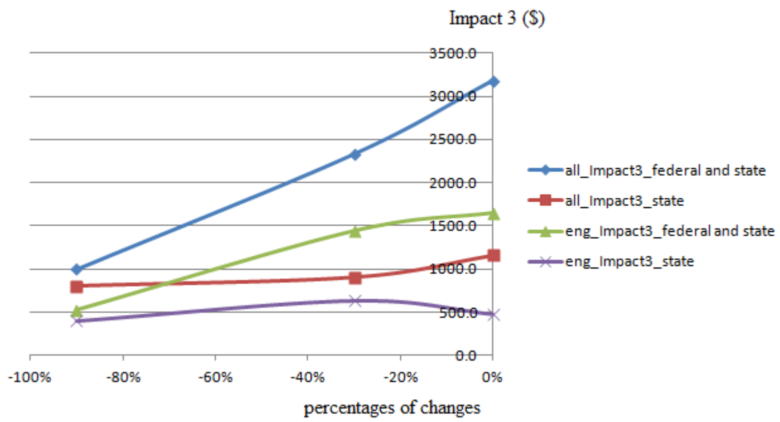


Figure 7.34 Performances of Impact3 with r_i

As seen in the tables, the average Impact1 was shifted in a small range with the changing of the income tax rate, while the average Impact2 and Impact3 trended to be decreased as r_i reduced. The abnormal points appeared for the taxes paid to the state & local government. The highest impact occurred when -30% changes were made. The trends can be seen more clearly in Figure 7.32, Figure 7.33, and Figure 7.34. In the figures, "all" was abbreviated for all individuals disregarding their majors, and "eng" was abbreviated for the individuals major in engineering.

As seen, the changing of taxes rates cannot affect Impact1 significantly, while the increasing of the tax rate can raise Impact2 and Impact3.

7.6.2 Performances of the Whole Life of Careers Model with the Tax Rate Changed

The performances of the whole life of careers model for all the individuals disregarding their majors were obtained when the sales tax rate (r_s) was changed, and the results of the present worth of the total taxes for their whole career life paid to the federal and the state & local governments together (PW) and the present worth of the total taxes paid to the state & local government (sPW) were shown in Figure 7.35 and Figure 7.36.

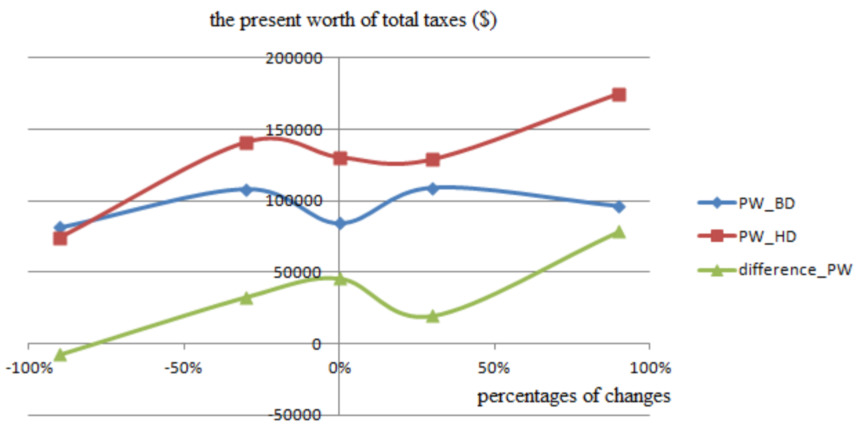


Figure 7.35 Performances of PW for all individuals disregarding their majors with r_s

As indicated in Figure 7.35, the average PW for the individuals who were bachelors were shifted up and down around $100,000, and the average PW for the individuals who received higher degrees were also shifted up and down but trended to be increased. So the differences between them trended to be increased with waves when the sales tax rate was increased.

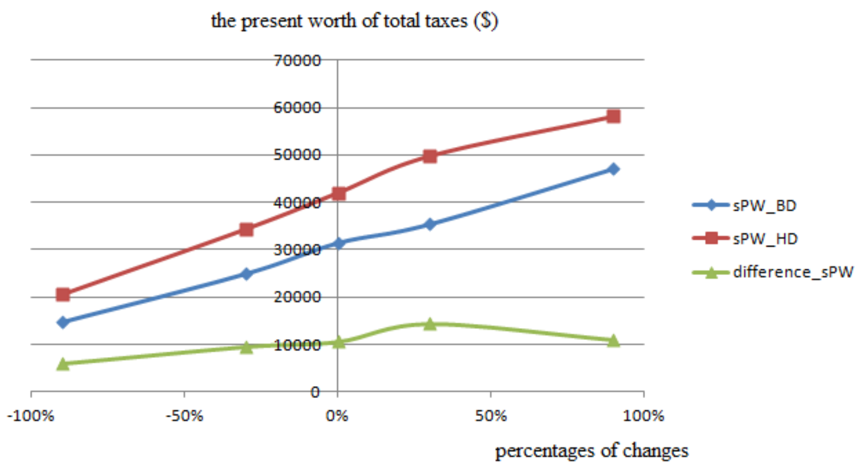


Figure 7.36 Performances of sPW for all individuals disregarding their majors with r_s

As seen in Figure 7.36, the average sPW were raised with r_s increasing, while the differences of sPW between the two groups of individuals were shifted around $10,000.

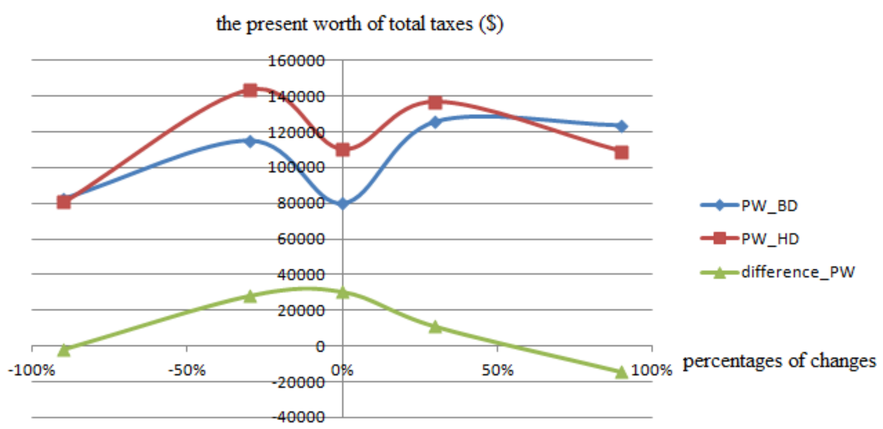


Figure 7.37 Performances of PW for the individuals major in engineering with r_s

The performances of the whole life of career model for the individuals major in engineering were shown in Figure 7.37 and Figure 7.38 with the changing of the sales tax rates. As shown in Figure 7.37, the average PW were shifted by a large margin, and the differences of PW between the two groups of individuals had the highest value near the baseline. When -90% and 90% changes were made, the differences were changed to be negative, where the difference was always the present worth of taxes from the individuals who received higher degrees subtracting the present worth of taxes from the individuals who were bachelors.

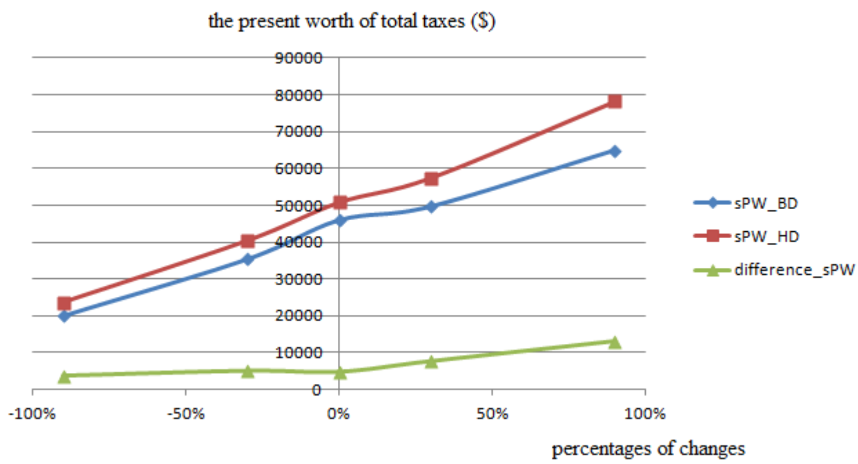


Figure 7.38 Performances of sPW for the individuals major in engineering with r_s

As shown in Figure 7.38, the average sPW were increased with the increasing of the sales tax rate, while the differences between the two groups of individuals were kept around $5,000, except the last point. When 90% changes were made, it had a sharp rise, and became higher than $10,000.

The changes of the indicators in the whole life of careers model with the changing of the income tax rate (r_i) were shown in Table 7.13 for all individuals disregarding their majors and Table 7.14 for the individuals major in engineering.

Table 7.13 Performances of PW for all individuals disregarding their majors with r_i

changes	The federal and the state & local governments together			The state & local government		
	PW_BD	PW_HD	difference	sPW_BD	sPW_HD	difference
-90%	$ 27,903	$ 38,904	$ 11,001	$ 24,227	$ 32,179	$ 7,951
-30%	$ 56,811	$ 69,414	$ 12,603	$ 29,887	$ 40,423	$ 10,536
0%	$ 84,479	$130,334	$ 45,855	$ 31,416	$ 42,020	$ 10,604

"BD" was abbreviated for "the individuals who were bachelors", and "HD" was for "the individuals who received higher degrees".

Table 7.14 Performances of PW for the individuals major in engineering with r_i

changes	The federal and the state & local governments together			The state & local government		
	PW_BD	PW_HD	difference	sPW_BD	sPW_HD	difference
-90%	$ 40,275	$ 45,447	$ 5,172	$ 32,778	$ 36,970	$ 4,192
-30%	$ 67,331	$110,023	$ 42,692	$ 41,148	$ 44,826	$ 3,678
0%	$ 79,764	$110,232	$ 30,468	$ 45,946	$ 50,741	$ 4,795

As seen in Table 7.13, the average PW paid for the whole life of their careers were decreased with the income tax rate reduced, and the difference of PW between the two groups had the same performance. The average sPW were also fallen with the r_i decreasing. But the differences of sPW for the federal and the state & local governments were increased from 0% to -30% changes made. From -30% to -90% changes made, the differences for the state & local government were raised.

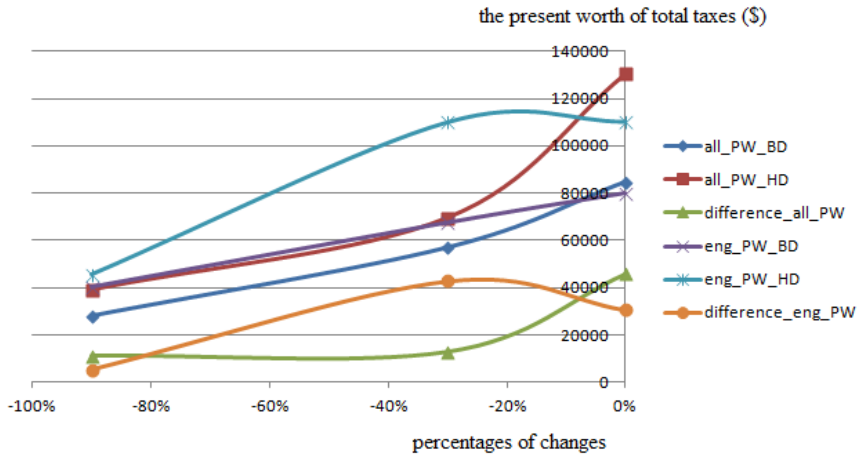


Figure 7.39 Performance of PW with r_i

As indicated in Figure 7.39, the performances of PW were increased with the increasing of r_i, except the difference of PW for the individuals major in engineering.

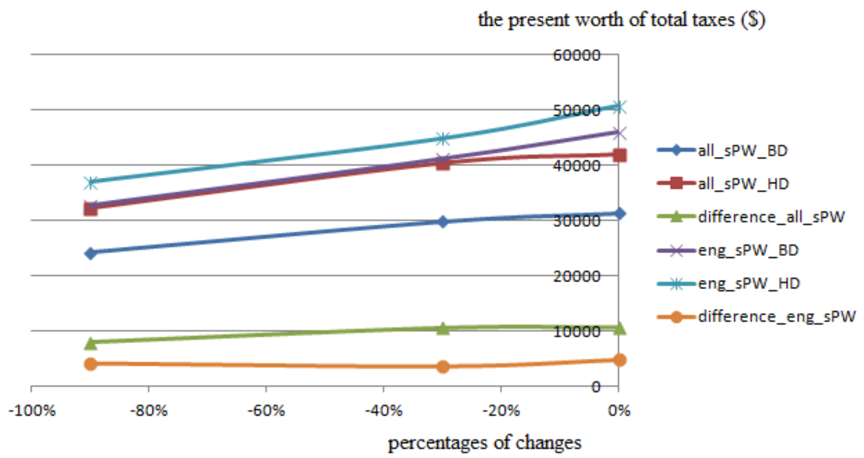


Figure 7.40 Performances of sPW with r_i

As shown in Figure 7.40, most of the sPW had smooth rise but not by large margins. There was one reaction on the line of the differences for the individuals major in engineering with -30% changes of r_i.

As expected in Chapter 3, the total taxes paid had potential to be increased when the income taxes rates were decreased, because more expenditure was made and more sales taxes should be paid to the governments. But as the indicated above, the present worth was decreased as the income interest rates were decreased. The average taxes paid in each year separately for the individuals who had higher degree disregarding the major were shown to discuss the details. The sample size was 5000.

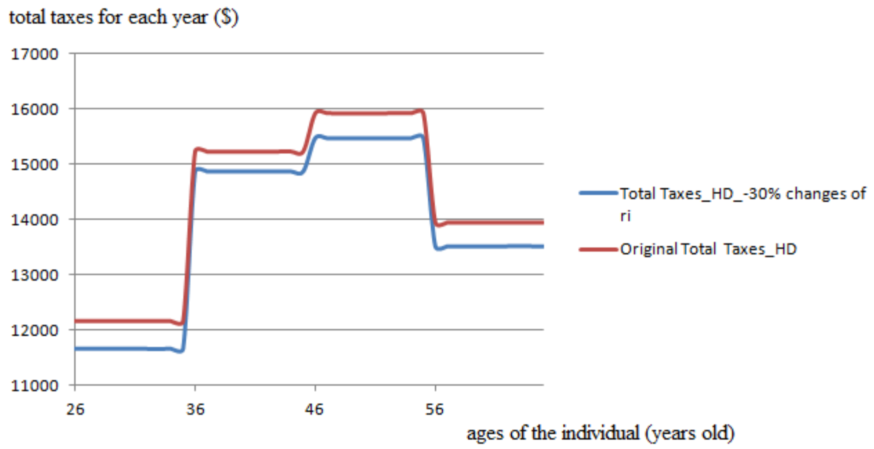


Figure 7.41 Total taxes in each year for the individual who received higher degree

As seen in Figure 7.41, the average total taxes which were the sum of the income taxes and the sales taxes were always lower when the -30% changes were made to the income taxes rates in the whole life of the career. The total taxes were decreased when the income taxes rates were declined.

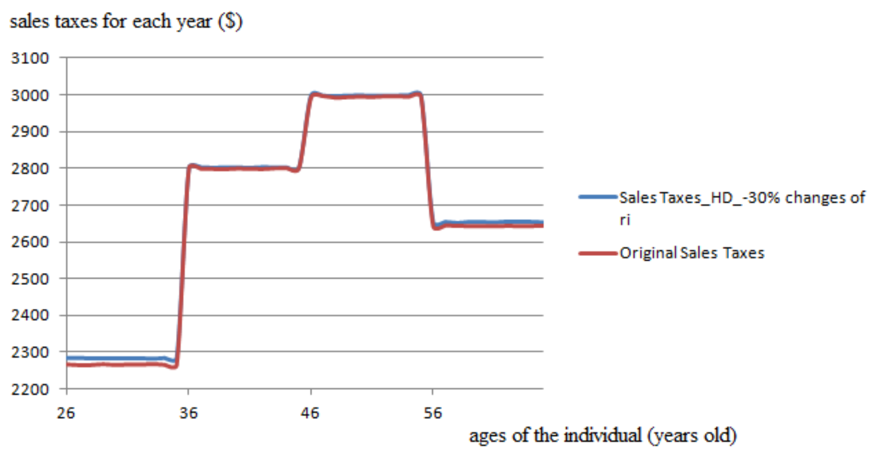


Figure 7.42 Sales taxes in each year for the individual who received higher degree

As indicated in Figure 7.42, the average sales taxes paid each year were little higher when -30% changes were made to the income taxes rates. It was proved that the expenditures were increased when the income taxes rates were decreased. But the amount of sales taxes' rise cannot make up the drop of the income taxes.

As seen the sales taxes should be increased when the income tax rates were decreased. A test was done by reducing the income tax rates in a 10% interval using the individuals who received higher degrees disregarding their majors. The results were shown in Table 7.15. Negative changes in tax rates shown in Table 7.15 and Table 7.16 were with respect to current rates.

Table 7.15 Performances of the present worth of the income tax revenues and sales tax revenues for the individuals with higher degrees disregarding their majors with *r_i*

Income tax rates changed	PW_2	percentage of PW_2 increased	PW_1	percentage of PW_1 increased	sPW_1	percentage of sPW_1 increased
0	$ 24,210	0.00%	$106,124	0.00%	$ 17,810	0.00%
-10%	$ 25,920	7.06%	$ 79,853	-24.75%	$ 16,078	-9.73%
-20%	$ 26,429	9.16%	$ 73,173	-31.05%	$ 14,337	-19.50%
-30%	$ 28,024	15.75%	$ 41,390	-61.00%	$ 12,398	-30.39%
-40%	$ 28,110	16.11%	$ 48,388	-54.40%	$ 10,806	-39.33%
-50%	$ 28,021	15.74%	$ 44,889	-57.70%	$ 8,918	-49.93%
-60%	$ 28,674	18.44%	$ 33,818	-68.13%	$ 7,127	-59.98%
-70%	$ 29,101	20.20%	$ 29,203	-72.48%	$ 5,370	-69.85%
-80%	$ 29,649	22.47%	$ 19,794	-81.35%	$ 3,577	-79.92%
-90%	$ 29,832	23.22%	$ 12,452	-88.27%	$ 1,772	-90.05%

As indicated in Table 7.15, PW_2 was the present worth of sales tax revenues, PW_1 was the present worth of income tax revenues received by the federal and the state & local governments together, and sPW_1 was the present worth of income tax revenues received by the state & local government. The percentage of the present worth increased was obtained as (the present worth with tax rates changed - the original present worth)/the original present worth. When income tax rates went down, the income tax revenues were decreased, meanwhile the sales tax revenues were increased. As shown, reduction in income taxes cannot be overcome by increases of the sales taxes paid. More detailed results were shown in Table 7.16.

Table 7.16 Performances of the present worth of the total tax revenues and the sales tax revenues for the individuals with higher degrees disregarding their majors with r_i

Income tax rates changed	PW_2	percentage of PW_2 increased	PW_3	percentage of PW_3 increased	sPW_3	percentage of sPW_3 increased
0	$ 24,210	0.00%	$130,334	0.00%	$ 42,020	0.00%
-10%	$ 25,920	7.06%	$105,773	-18.84%	$ 41,997	-0.06%
-20%	$ 26,429	9.16%	$ 99,602	-23.58%	$ 40,766	-2.98%
-30%	$ 28,024	15.75%	$ 69,414	-46.74%	$ 40,423	-3.80%
-40%	$ 28,110	16.11%	$ 76,498	-41.31%	$ 38,916	-7.39%
-50%	$ 28,021	15.74%	$ 72,910	-44.06%	$ 36,939	-12.09%
-60%	$ 28,674	18.44%	$ 62,491	-52.05%	$ 35,801	-14.80%
-70%	$ 29,101	20.20%	$ 58,304	-55.27%	$ 34,471	-17.97%
-80%	$ 29,649	22.47%	$ 49,444	-62.06%	$ 33,226	-20.93%
-90%	$ 29,832	23.22%	$ 42,284	-67.56%	$ 31,604	-24.79%

As indicated in Table 7.16, PW_3 was the present worth of total tax revenues received by the federal and the state & local governments together, and sPW_3 was the present worth of total tax revenues received by the state & local government. All of the percentages of PW_2 increased were positive, while all of the percentages of PW_3 and sPW_3 increased were negative. It meant that the sales taxes were increased while the total tax revenues were decreased when the income tax rates were reduced. If a 10% change was set to be the significant level, the present worth of sales taxes can be raised significantly when 30% of income tax rates were declined, while the present worth of total tax revenues to the state & local government had a significant drop when 50% of income tax rates were declined. The present worth of total tax revenues to the federal and the state & local governments was decreased significantly as soon as 10% of income tax rates were declined. There was one point special for PW_3 when 40% of income tax rates were declined. PW_3 with -40% changes of income tax rates were higher than PW_3 with -30% changes, and both of the percentages of decreasing were less than 50%. It can be seen more clearly in Figure 7.43.

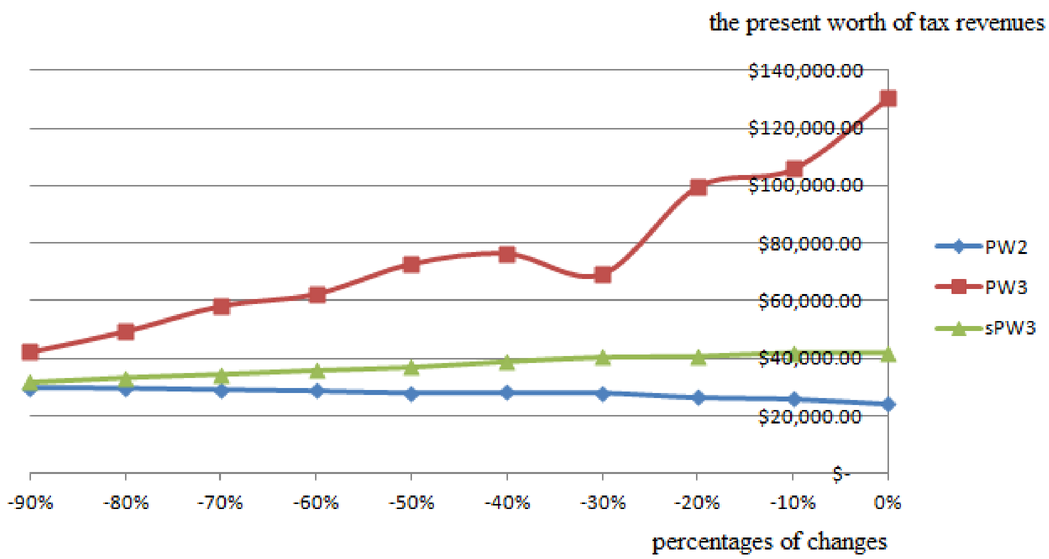


Figure 7.43 Performances of the present worth for the individuals with higher degrees disregarding their majors with r_i changing

The total tax revenues were supposed to be increased with the income tax rates falling, while the data showed an opposite results. The sales tax revenues were increased with the income tax rates falling as expected, but the incremental of the sales tax revenues cannot make up the decreases of the income tax revenues. In this research, the innovation or improvement of the communities contributed by the individuals and more money made by the communities because of the work of the individuals were not reflected, which can also give affects to the tax revenues. The affects to the tax revenues should be positive. So it was most possible that the point that 40% of the income tax rates reduced had the potential to give the most significant increases of the tax revenues.

In addition, when income tax rates were decreased, more expenditure was made by individuals and the corresponding communities can have more sales and profits. Corporate income tax revenues can result more tax revenues to the government due to the increasing of the expenditure.

The increasing of the taxes rates can give a significant rise to the present worth of total taxes in every case, but it cannot influence the difference between the two groups of individuals significantly.

Chapter 8 Conclusions

In this research, the simulation models were utilized to obtain the economic impacts for the government to support an individual to accept the higher than undergraduate education. The mathematical models in the literature research always focused on groups of peoples and the amount of money spent in the given area, while the simulation models in this research were about the individuals and the tax revenues received by the government. Five specified objectives were realized by the simulation models.

The chain to show the cash flows for an individual's expenditures was created, which was the first objective in Chapter 3. In the chain, it was seen that taxes were paid by the individuals and they were received by the government. The taxes received by the federal and the state & local governments were spent in different ways. Hence, specific values of the revenues should be meaningful and useful to understand the direct economic impact to cities, states and federal governments. The taxes revenue was a quantitative and measurable indicator which can link the individuals and the government. It should be varied due to the changes of the individuals' salaries from bachelors to masters or doctors. The taxes revenues were an understandable measure of economic impact. So the taxes received by the government were selected to be the indicators to express the impacts. The tax revenues from one individual in this research included the direct income taxes and the direct sales taxes paid to the government by the individual and also the indirect sales taxes received by the government due to the contributions of the individual's expenditures.

The second objective was to estimate the economic impact of the income increased by receiving a graduate degree for an individual new to the career. It was achieved by the basic model, and it was reflected on the annual tax revenues of the government in the first year when the individual went into the profession. There were three indicators utilized, including the ratio between the taxes received from the bachelor degreed engineer and the advanced degreed individuals (Impact1), the increases of taxes received by one dollar increased in their salaries (Impact2), and the difference of the taxes between the bachelor degreed engineers and the advanced degreed engineers and other professionals (Impact3). . The difference was obtained by utilizing the taxes received from the individuals who received higher degrees and subtracting the taxes from the individuals who only received bachelors' degrees.

In the basic model, the average level of Impact1 to the federal and the state & local governments together for all individuals disregarding their majors was 1.6, which meant if the individual who had a bachelor’s degree paid one dollar in taxes to the federal and the state & local governments, the individual who received a higher degree would contribute 1.6 dollars per year. The average level of Impact1 to the state & local government was 1.5. For the individuals major in engineering, the average levels of Impact1 both to the federal and the state & local governments and to the state & local government were about 1.3. The average level of Impact2 to the governments together for all individuals was about 0.2, and it was 0.3 for the individuals major in engineering, which meant that if one dollar was increased to the salaries for the individual who received a higher degree, 0.2 dollars more would be contributed in the taxes by a general person and 0.3 dollars more by a person major in engineering. The average levels of Impact2 to the state & local government were 0.1 from either the individuals disregarding their majors or the individuals major in engineering. The average value of Impact3 was about three thousand dollars to the federal and the state & local governments for the individuals disregarding their majors, and it was about one thousand dollars to the state & local governments in the first year when they went into their career. It was about two thousand dollars to the federal and the state & local governments for the individuals major in engineering, and around 0.7 thousand dollars to the state & local government.

It was expected that the government receive more taxes from the individuals who received masters' or doctoral degrees, because their salaries were always higher than the individuals who were only bachelors. The results can be used by the government to more clearly determine the return on investment in higher education especially engineering.

The third objective in the research was to estimate the total amount of taxes of the government including the primary and secondary taxes revenues in the whole life of the career for an individual. It was obtained by the whole life of careers model, and the present worth of taxes revenues were utilized as the indicator to show the results. The value of the present worth and the difference of the present worth between the two groups of individuals were the outputs in this model.

In the whole life of careers model, for all individuals disregarding their majors the average present worth of total taxes received from the individuals who received higher degrees were found. The federal and the state & local governments received approximately $50,000 more than from the individuals who got an incremental salary increase due to receiving an advanced degree, and of that $50,000approximately$11,000went to the state & local government. For the individuals major in engineering, the average difference between the individuals with higher degrees and the individuals with bachelors' degrees of taxes received by the federal and the state & local governments was approximately $30,000, and it was approximately $5000for the state & local governments. As seen in the results, the average differences of the taxes paid by all individuals ($50,000 and $11,000) were higher than the average difference by the individuals major in engineering ($30,000 and $5,000). A bachelor's degree major in engineering was valuable and the increase to an advanced degree was relatively small when compared to others. The increment from a non-engineering bachelor's degree to an advanced was eager.

The differences of the present worth of total tax revenues between the two groups of individuals were positive as indicated, since the individuals with higher degrees always can earn more. The tax revenues due to higher pay for advanced degrees cascaded through the spending chain even excluding the impact on secondary income taxes or innovations due to advanced education to result in a justification for support of higher education from taxing bodies. Economic analysis of cost of education to the student and contributions by governments in support of education can be made. Clearly more government support for graduate education could be justified based upon the economic returns assuming the addition tax revenues generated could be spent on the sources of the generation rather than other government spending needs. The suggested investments by the government on an advanced degree cannot be higher than the incremental of the total tax revenues. It was recommended that the highest funding on a graduate degree major in engineering should be $30,000 for the federal and the state & local government, and it was $5,000 for the state & local government. If the major can be disregarded, the funding from the federal and the state & local governments should be lower than $50,000, and it should be lower than $11,000 from the state & local government.

As University of Nebraska – Lincoln taken to be the example, the fees were $1504 per year for every graduate student. The resident tuition was $216 per credit hour for the people who were Nebraskan, and the non-resident tuition was $641 per credit hour. The minimum credits for a single graduate student should be nine hours per semester.

The tuition and fees were $5392 for the resident and $13,042 for the non-resident per year. It requires two years to receive a master’s degree normally. The funding needed to pay the total tuition and fees for a graduate student were $10,784 for the resident and $26,048 for the non-resident. As indicated in the whole life of careers model, the average difference of the present worth of tax revenues received by the federal and the state & local governments were higher than $26 thousand dollars. But the average difference of the present worth of tax revenues received by the state & local government were higher than $10784, but lower than $26048. It was affordable to give funding to the resident graduate student to achieve a master’s degree for the state & local government itself. Funding the non-resident graduate student could lead too much pressure on the state & local government itself. It suggested that the federal government needed to support a non-resident graduate student with the state & local government together. The additional funding support for graduate students would require that their employment be in Nebraska for the tax revenues to be used to recover the investment.

From the results of the two simulation models, the individuals with higher degrees can contribute more tax revenues to the governments than the individuals only with bachelors' degrees. It was suggested that the additional part of the revenues of the governments can be spent to educate more persons to receive advanced degrees. The governments can receive more taxes due to the number of masters or doctors increased. It was beneficial circulation for the governments.

The fourth objective was to obtain the trends of the impact to the governments due to the changing of the parameters' values. The sensitivity analysis was constructed for both of the models to attain it, which was to get the changes of the outputs with the parameters changing. The effective annual interest rate utilized to calculate the present worth in the whole life of careers model was a sensitive parameter, and it gave the negative effects, because this parameter was in the denominator in the equation to calculate the present worth. Both of the models were not sensitive to the percentage of the individual's income to stop adding the indirect contributions (p_s) in the range simulated. Most of the outputs in the models were sensitive to the percentage of the direct expenditures paid to the employees in the corresponding places (p_e), and p_e can give positive influences in most cases. Impact1 in the basic model was insensitive to p_e, and the reason should be the taxes received from the two groups of individuals had the nearly equivalent increases when p_e was increased. The model reinforced the importance of the cost of labor in the eighteen expenditure areas. Lower labor cost also reduces the income taxes paid to employees in the secondary levels which were not considered in the model. The sales taxes on the expenditures made by the secondary employees in the spending chain were considered. Thus the model emphasized the economic impact of spending through tax revenues.

The fifth objective was to obtain the impact on the tax revenues including the primary and the secondary tax revenues from one individual to the government with the tax rate going down. It was reached to obtain the changes of the outputs by reducing the taxes rates as desired. Most of the outputs in the models were sensitive to the sales tax rate, and they trended to be raised with the sales tax rate increasing, since the amount of sales taxes grew and more sales taxes were counted into the total taxes. Impact1 in the basic model was not sensitive to it, and the reason should be the rise of the sales tax rate can give closed increases to the taxes from the two groups of individuals. When the income tax rate was decreased, Impact2 and Impact3 were also decreased in the basic model, but Impact1 were kept nearly consistent. Most outputs of the whole life of careers model were dropped with the income tax rate decreasing. The difference of the present worth of taxes received by the federal and the state & local governments from the individuals major in engineering appeared to be highest when -30% changes made to the income tax rate. There were only little decreases of the difference of the present worth of taxes received by the state & local government when the income tax rate decreased. The total taxes paid were not increased by decreasing the income tax rate. The main reason should be that the income taxes had more contributions on the total taxes to the governments, and even if the income taxes were decreased, the individuals did not make significantly more expenditures.

As indicated by the whole life of careers model for the individuals who received higher degrees disregarding their majors with the income tax rates reduced in a 10% interval, a reduction in income tax rate for individual did not result in a net tax gain for the government.

There were some limitations in the research. The innovation or improvement that an individual contributed to their community or employer that could impact the local or state economy was not reflected in the model, excepting possible increase in salary for doing a good job. In addition, the same package of distributions of the percentages of the incomes on expenditures was utilized when the income tax rates were changed and spending patterns may have changed. In this research, the tax revenues from only the individuals were focused on. Corporate income tax revenues due to more expenditures should result in more total tax revenues, which was not included in the research. Even though the total tax revenues were not increased by the reduction of the income tax rates, it was recommended that 40% of income tax rates decreased should be the deduction limitation and have the greatest potential to give the most significant increase of the tax revenues for the government.

In addition, the simulation models were run based on several assumptions which led to some other limitations. All individuals in the model were full-time employees with a bachelor’s degree or higher, and all individuals were assumed to be single without children. But there were various individuals in the real world, such as the individuals married without children, and the individuals married with children, thus the many different scenarios including tax deductions and other revenues that could be possible impact tax revenues were not considered. The simplest and most normal situation was selected to be analyzed in the model. It cannot be guaranteed that all graduates can obtain a full time job immediately after graduation. It was assumed that an individual can receive a bachelor’s degree when he/she was 22 years old, and an individual can receive a higher degree when he/she was 25 years old, but the ages at which the degrees were received were varied for different individuals. The higher degree in the research can be a master's degree or a doctoral degree because the raw census data gave the classification in this way, but the situations should be different for the masters from the doctors in the real world. The income tax revenues from the employees in the secondary levels were not counted into the total tax revenues.

The future research can focus on the corporate income tax revenues to the governments due to the contributions of the individuals' salaries increased when an advanced degree is received. When more expenditure is made by an individual due to the incremental of the salary, more sales and profits can be obtained by the company. Therefore, there should be more corporate income tax revenues to the governments. Moreover, the individual who has received an advanced degree is expected to bring more innovation or improvement to the company, which can help the company to gain more money. The corporate income tax revenues can also be influenced by one's knowledge.

Chapter 9 Contribution to the body of knowledge

The research presents a simulation model to analyze the economic impacts of a graduate degree to the governments. In the simulation model, the outputs are indicated by the taxes received by the governments. The inputs are the salary, the expenditures patterns, and the taxes rates. The modeling of the spending chain to include the direct and indirect taxes paid as a result of an increase in salary due to obtaining an advanced degree is a new research topic. The spending chain includes eighteen areas of spending for an individual and those same eighteen areas of spending for individuals who have incomes as a result of the original individual's spending. Each of the eighteen areas of spending were represented by Monte Carlo simulation from a data distribution generated based upon an analysis of data from US Census spending patterns in each category. It is simple to change the values of the parameters and a complete a sensitivity analysis in the simulation model.. For different individuals, the model can have different inputs, and generatethe corresponding outputs. It is a convenience method to obtain the taxes paid to the governments. The economic impacts of a graduate degree to the governments can be obtained based on the taxes revenues.

The simulation model was created to obtain tax revenues. It can combine more factors into account, and it was not necessary to keep drastic simplifications as the mathematical model to make sure that the equation system can be solved. The model was built based on primary and secondary tax revenues (usually dollars spent in a community was used) to indicate economic impacts. The model of the spending chain using census data was new.

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Appendix A: A sample of the raw data for the individuals' expenditures

Table 10. Education of reference person: Average annual expenditures and characteristics, Consumer Expenditure Survey, 2010

Item	All consumer units	Less than college graduate					College graduate		
		Total	Less than high school graduate	High school graduate	High school graduate with some college	Associate's degree	Total	Bachelor's degree	Master's, professional, doctoral degree
Number of consumer units (in thousands)	121,107	85,128	17,303	30,921	25,460	11,443	35,980	22,877	13,103
Consumer unit characteristics:									
Income before taxes	$62,481	$47,858	$33,317	$47,029	$52,113	$62,618	$97,080	$88,003	$112,927
Income after taxes	60,712	47,148	33,288	46,507	51,066	61,120	92,805	84,625	107,086
Age of reference person	49.4	50.0	53.9	51.7	46.5	47.7	48.0	46.9	49.8
Average number in consumer unit:									
Persons	2.5	2.5	2.8	2.5	2.4	2.5	2.4	2.5	2.4
Children under 18	.6	.6	.8	.6	.6	.6	.6	.6	.6
Persons 65 and older	.3	.3	.5	.4	.3	.2	.3	.2	.3
Earners	1.3	1.2	1.1	1.2	1.2	1.4	1.4	1.4	1.4
Vehicles	1.9	1.8	1.5	1.8	1.9	2.2	2.1	2.1	2.1
Percent distribution:									
Sex of reference person:									
Male	47	45	44	44	47	43	51	51	52
Female	53	55	56	56	53	57	49	49	48
Housing tenure:									
Homeowner	66	61	54	64	59	70	76	73	81
With mortgage	41	35	23	34	39	48	54	53	56
Without mortgage	25	26	31	30	20	22	22	20	24
Renter	34	39	46	36	41	30	24	27	19
Race of reference person:									
Black or African-American	12	14	16	14	14	13	8	8	8
White, Asian, and all other races	88	86	84	86	86	87	92	92	92
Hispanic or Latino origin of reference person:									
Hispanic or Latino	12	15	33	11	9	9	6	6	5
Not Hispanic or Latino	88	85	67	89	91	91	94	94	95
Education of reference person:									
Elementary (1-8)	5	7	33	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
High school (9-12)	35	50	65	100	n.a.	n.a.	n.a.	n.a.	n.a.
College	60	43	n.a.	n.a.	100	100	100	100	100
Never attended and other	(1)	(1)	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
At least one vehicle owned or leased	88	86	77	86	88	93	94	93	95
Average annual expenditures	$48,109	$39,632	$29,753	$37,969	$43,144	$50,967	$68,189	$63,907	$75,752
Food	6,129	5,396	4,842	5,138	5,617	6,348	7,871	7,594	8,398
Food at home	3,624	3,368	3,342	3,291	3,308	3,739	4,233	4,055	4,583
Cereals and bakery products	502	465	467	452	455	519	589	570	625
Cereals and cereal products	165	152	168	144	144	168	195	192	201
Bakery products	337	313	299	308	311	351	394	379	424
Meats, poultry, fish, and eggs	784	763	795	754	744	782	836	811	887
Beef	217	218	216	206	237	209	214	219	206
Pork	149	149	166	153	131	158	149	141	163
Other meats	117	113	104	112	113	124	128	125	134
Poultry	138	134	144	134	123	144	148	146	152
Fish and seafood	117	103	112	104	98	102	150	133	184
Eggs	46	46	53	45	43	45	47	47	49
Dairy products	380	349	337	339	351	388	454	429	505
Fresh milk and cream	141	134	140	135	126	144	156	150	170
Other dairy products	240	215	197	205	225	244	298	279	335
Fruits and vegetables	679	607	626	582	597	673	851	793	966
Fresh fruits	232	196	211	180	194	222	319	291	373

Table 10. Education of reference person: Average annual expenditures and characteristics, Consumer Expenditure Survey, 2010 — Continued

Item	All consumer units	Less than college graduate: Total	Less than college graduate: Less than high school graduate	Less than college graduate: High school graduate	Less than college graduate: High school graduate with some college	Less than college graduate: Associate's degree	College graduate: Total	College graduate: Bachelor's degree	College graduate: Master's, professional, doctoral degree
Other food at home	$1,278	$1,184	$1,117	$1,164	$1,161	$1,377	$1,503	$1,452	$1,600
Sugar and other sweets	132	124	116	124	121	143	150	141	169
Fats and oils	103	100	103	95	98	114	108	104	117
Miscellaneous foods	667	607	552	593	593	742	810	790	848
Nonalcoholic beverages	333	322	327	322	311	336	362	349	387
Food prepared by consumer unit on out-of-town trips	43	31	19	29	38	42	72	68	79
Food away from home	2,505	2,028	1,500	1,847	2,309	2,609	3,638	3,539	3,815
Alcoholic beverages	412	293	141	271	361	411	694	722	638
Housing	16,557	13,659	10,647	13,378	14,635	16,750	23,419	21,968	25,977
Shelter	9,812	7,841	6,057	7,618	8,560	9,542	14,475	13,673	15,875
Owned dwellings	6,277	4,596	2,828	4,534	5,125	6,264	10,254	9,345	11,840
Mortgage interest and charges	3,351	2,415	1,442	2,249	2,797	3,483	5,567	5,149	6,297
Property taxes	1,814	1,363	874	1,404	1,444	1,809	2,881	2,617	3,342
Maintenance, repairs, insurance, other expenses	1,112	819	512	882	883	972	1,805	1,578	2,202
Rented dwellings	2,900	2,896	3,089	2,760	2,961	2,823	2,908	3,114	2,549
Other lodging	635	349	140	323	474	455	1,312	1,214	1,485
Utilities, fuels, and public services	3,660	3,462	3,098	3,525	3,431	3,915	4,127	3,990	4,367
Natural gas	440	394	352	396	395	447	549	511	615
Electricity	1,413	1,377	1,299	1,421	1,330	1,478	1,497	1,461	1,560
Fuel oil and other fuels	140	126	109	139	108	160	173	158	199
Telephone services	1,178	1,112	944	1,117	1,125	1,323	1,334	1,309	1,377
Water and other public services	489	453	394	451	472	507	574	551	615
Household operations	1,007	687	329	642	832	1,026	1,765	1,459	2,301
Personal services	340	207	86	184	243	375	653	481	954
Other household expenses	667	480	243	459	589	651	1,112	978	1,347
Housekeeping supplies	612	536	460	505	556	676	792	778	819
Laundry and cleaning supplies	150	145	160	140	137	157	162	153	180
Other household products	329	286	233	263	305	372	432	450	398
Postage and stationery	132	105	67	101	114	147	197	175	241
Household furnishings and equipment	1,467	1,132	704	1,088	1,256	1,591	2,260	2,069	2,616
Household textiles	102	88	64	85	100	107	136	126	155
Furniture	355	267	179	276	264	379	565	526	632
Floor coverings	36	23	11	19	32	34	67	67	66
Major appliances	209	169	94	185	195	181	305	305	302
Small appliances, miscellaneous housewares	107	90	44	97	99	115	146	125	185
Miscellaneous household equipment	657	495	312	427	566	774	1,042	919	1,276
Apparel and services	1,700	1,455	1,323	1,279	1,386	2,250	2,282	2,262	2,310
Men and boys	382	318	269	264	372	411	533	513	568
Men, 16 and over	304	245	192	195	301	327	444	430	468
Boys, 2 to 15	78	73	77	69	71	83	89	83	101
Women and girls	663	551	471	524	500	843	927	948	886
Women, 16 and over	562	457	369	435	408	741	810	828	775
Girls, 2 to 15	101	94	101	90	92	102	117	120	111
Children under 2	91	84	83	81	79	107	105	96	122
Footwear	303	279	366	238	253	329	361	377	329
Other apparel products and services	261	221	134	171	181	561	356	328	405
Transportation	7,677	6,756	4,894	6,455	7,388	8,960	9,859	9,525	10,470
Vehicle purchases (net outlay)	2,588	2,260	1,364	2,185	2,508	3,270	3,364	3,400	3,302
Cars and trucks, new	1,219	879	318	880	1,086	1,264	2,025	1,984	2,095
Cars and trucks, used	1,318	1,320	1,023	1,264	1,301	1,962	1,314	1,380	1,198
Other vehicles	51	62	[2]24	41	120	[2]44	26	36	[2]9
Gasoline and motor oil	2,132	2,041	1,647	1,988	2,155	2,526	2,349	2,358	2,333

See footnotes at end of table.

Table 10. Education of reference person: Average annual expenditures and characteristics, Consumer Expenditure Survey, 2010 — Continued

Item	All consumer units	Less than college graduate					College graduate		
		Total	Less than high school graduate	High school graduate	High school graduate with some college	Associate's degree	Total	Bachelor's degree	Master's, professional, doctoral degree
Other vehicle expenses	$2,464	$2,163	$1,676	$2,031	$2,391	$2,727	$3,178	$2,932	$3,633
Vehicle finance charges	243	226	141	222	236	346	282	289	271
Maintenance and repairs	787	665	490	605	795	806	1,077	1,002	1,210
Vehicle insurance	1,010	955	861	916	965	1,161	1,141	1,030	1,362
Vehicle rental, leases, licenses, and other charges	423	316	185	288	395	413	677	612	791
Public transportation	493	292	207	251	334	437	968	834	1,203
Healthcare	3,157	2,772	2,129	2,820	2,938	3,238	4,069	3,824	4,497
Health insurance	1,831	1,631	1,252	1,733	1,685	1,811	2,302	2,194	2,492
Medical services	722	585	403	533	672	805	1,048	976	1,173
Drugs	485	457	409	454	474	495	552	499	647
Medical supplies	119	99	66	100	107	127	166	156	186
Entertainment	2,504	2,011	1,174	1,864	2,425	2,710	3,673	3,366	4,226
Fees and admissions	581	328	113	296	442	487	1,179	1,002	1,492
Audio and visual equipment and services	954	869	620	878	943	1,050	1,155	1,144	1,179
Pets, toys, hobbies, and playground equipment	606	533	309	502	647	678	777	750	828
Other entertainment supplies, equipment, and services	364	280	132	189	394	495	562	470	727
Personal care products and services	582	478	352	433	520	683	829	786	907
Reading	100	70	35	67	90	90	169	143	213
Education	1,074	579	205	347	912	1,020	2,247	1,986	2,705
Tobacco products and smoking supplies	362	438	440	503	381	386	183	219	119
Miscellaneous	849	639	452	616	731	778	1,346	1,319	1,376
Cash contributions	1,633	1,250	882	1,128	1,471	1,644	2,540	2,243	3,058
Personal insurance and pensions	5,373	3,836	2,236	3,669	4,289	5,700	9,007	7,948	10,857
Life and other personal insurance	318	231	136	228	249	340	525	408	729
Pensions and Social Security	5,054	3,606	2,100	3,441	4,041	5,359	8,482	7,540	10,127
Sources of income and personal taxes:									
Money income before taxes	62,481	47,858	33,317	47,029	52,113	62,618	97,080	88,003	112,927
Wages and salaries	49,568	36,086	22,135	33,854	40,522	53,345	81,466	73,319	95,690
Self-employment income	2,820	2,199	1,745	2,608	2,433	1,261	4,289	4,030	4,743
Social Security, private and government retirement	7,173	6,977	6,946	7,912	6,530	5,491	7,636	6,896	8,927
Interest, dividends, rental income, other property income	1,182	689	340	757	795	794	2,348	2,245	2,529
Unemployment and workers' compensation, veterans' benefits	634	708	614	784	668	734	457	518	351
Public assistance, supplemental security income, food stamps	505	651	1,178	625	426	424	161	148	185
Regular contributions for support	407	345	179	295	492	400	555	658	375
Other income	192	203	181	194	246	168	166	189	126
Personal taxes	1,769	710	29	522	1,047	1,498	4,275	3,378	5,841
Federal income taxes	1,136	327	-136	191	582	829	3,048	2,257	4,429
2008 Tax stimulus (thru Q20091)	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])
State and local income taxes	482	272	109	225	348	476	981	867	1,180
Other taxes	151	111	57	106	117	193	246	254	232

See footnotes at end of table.

Table 10. Education of reference person: Average annual expenditures and characteristics, Consumer Expenditure Survey, 2010 — Continued

Item	All consumer units	Less than college graduate					College graduate		
		Total	Less than high school graduate	High school graduate	High school graduate with some college	Associate's degree	Total	Bachelor's degree	Master's, professional, doctoral degree
Income after taxes	60,712	47,148	33,288	46,507	51,066	61,120	92,805	84,625	107,086
Addenda:									
Net change in total assets and liabilities	- $4,458	- $2,658	- $1,163	- $2,245	- $3,596	- $3,942	- $8,717	- $9,768	- $6,882
Net change in total assets	5,503	2,872	1,524	2,247	3,453	5,308	11,727	9,953	14,824
Net change in total liabilities	9,960	5,530	2,687	4,492	7,049	9,251	20,444	19,721	21,706
Other financial information:									
Other money receipts	555	494	221	458	328	1,375	699	564	935
Mortgage principal paid on owned property	-2,013	-1,448	-842	-1,388	-1,650	-2,075	-3,352	-3,124	-3,749
Estimated market value of owned home	155,083	116,991	77,415	119,166	126,891	148,928	245,208	222,282	285,236
Estimated monthly rental value of owned home	849	682	481	691	719	880	1,244	1,149	1,410
Gifts of goods and services	1,029	700	366	702	748	1,065	1,810	1,548	2,274
Food	89	52	22	57	51	84	175	163	198
Alcoholic beverages	14	7	3	7	7	14	31	34	25
Housing	199	150	103	143	160	213	315	277	385
Housekeeping supplies	25	23	14	17	29	40	29	28	31
Household textiles	8	7	4	5	8	11	13	14	11
Appliances and miscellaneous housewares	22	16	[2]3	20	19	22	36	36	36
Major appliances	5	3	[2]2	4	3	[2]2	9	10	9
Small appliances and miscellaneous housewares	17	13	[2]1	16	15	20	27	27	27
Miscellaneous household equipment	47	30	17	24	33	56	86	67	123
Other housing	97	74	65	78	70	84	151	131	184
Apparel and services	212	187	131	172	213	250	270	273	264
Males, 2 and over	50	42	22	40	51	53	69	62	83
Females, 2 and over	73	62	39	54	70	95	101	109	84
Children under 2	47	43	42	42	46	43	55	49	67
Other apparel products and services	42	41	27	37	46	59	45	53	30
Jewelry and watches	17	14	[2]3	14	19	21	25	31	13
All other apparel products and services	25	27	24	23	28	38	20	22	16
Transportation	85	64	32	81	59	75	135	99	197
Health care	21	17	[2]5	11	19	43	32	14	63
Entertainment	95	72	20	80	91	76	151	136	179
Toys, games, arts and crafts, and tricycles	38	31	[2]8	32	41	35	53	52	56
Other entertainment	58	41	12	48	50	41	98	85	123
Personal care products and services	13	12	3	7	7	44	17	20	9
Reading	1	1	([1])	1	1	([1])	2	1	3
Education	221	83	16	75	86	196	548	382	838
All other gifts	80	56	30	67	55	71	136	149	113

[1] Value is less than or equal to 0.5.
[2] Data are likely to have large sampling errors.
[3] No data reported.
n.a. Not applicable.

Source: Consumer Expenditure Survey, U.S. Bureau of Labor Statistics, September, 2011

Appendix B: Programming code of the basic model for individuals disregarding their majors

```
clear;

% variable defination & initialization
t=5000; % number of trials
inc0 = zeros (1, t); % the before tax income for the individual with BD
inc1 = zeros (1, t); % the before tax income for the individual with higher than BD
tax0 = zeros (1, t); % total taxes for an individual including inctax and contax
tax1 = zeros (1, t);
stax0 = zeros (1, t); % total taxes for an individual contributing to the state government
stax1 = zeros (1, t);
imp = zeros (3, t); % the ratio between tax1 and tax0, the 3rd row indicates the difference
simp = zeros (3, t); % the impact for the state government
atinc0 = zeros (1, t); % the after tax income
atinc1 = zeros (1, t);
finctax0 = zeros (1, t); % federal income taxes
finctax1 = zeros (1, t);
sinctax0 = zeros (1, t); % state income taxes
sinctax1 = zeros (1, t);
inctax0 = zeros (1, t); % the income taxes
inctax1 = zeros (1, t);
% 18 as the number of categories and 18 estimated as the rountines of the impacts
perofcon0 = zeros (18, 10);
perofcon1 = zeros (18, 10);
% percentage of expenditures on each category in rows
con0 = zeros (18, 10); % expenditures on each category
con1 = zeros (18, 10);
contax0 = zeros (18, 10); % tax of corresponding expenditures
contax1 = zeros (18, 10);
sumcontax0 = zeros (1, t); % the concumption taxes totally
sumcontax1 = zeros (1, t);

% Assignment for the individuals
inc0 = 10000 + 140000*betarnd(3.63,18.1,1,t); % the distribution for all BD
inc1 = 10000 + 170000*betarnd(3.73,13.7,1,t); % the distribution for all Higher

% Income Taxes for Single
for i=1:t
   if inc0(1,i) <= 8500
      finctax0(1,i) = 0.10*inc0(1,i);
   elseif 8500<inc0(1,i)<=34500
      finctax0(1,i) = 0.10*8500 + 0.15*(inc0(1,i)-8500);
   elseif 34500<inc0(1,i)<=83600
      finctax0(1,i) = 0.10*8500+0.15*(34500-8500)+0.25*(inc0(1,i)-34500);
   elseif 83600<inc0(1,i)<=174400
      finctax0(1,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(inc0(1,i)-83600);
   elseif 174400<inc0(1,i)<=379150
      finctax0(1,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(174400-
83600)+0.33*(inc0(1,i)-174400);
   elseif inc0(1,i)>379150
      finctax0(1,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(174400-
83600)+0.33*(379150-174400)+0.35*(inc0(1,i)-379150);
   end;
   if inc0(1,i) <= 2400
      sinctax0(1,i) = 0.0256*inc0(1,i);
```

```
    elseif 2400<inc0(1,i)<=17500
        sinctax0(1,i) = 0.0357*inc0(1,i);
    elseif 17500<inc0(1,i)<=27000
        sinctax0(1,i) = 0.0512*inc0(1,i);
    elseif inc0(1,i)>27000
        sinctax0(1,i) = 0.0684*inc0(1,i);
    end;
    inctax0(1,i)=finctax0(1,i) + sinctax0(1,i);
    atinc0(1,i)=inc0(1,i)-inctax0(1,i);
    tax0(1,i)=tax0(1,i)+inctax0(1,i);
    stax0(1,i)=stax0(1,i)+sinctax0(1,i);
    if inc1(1,i) <= 8500
        finctax1(1,i) = 0.10*inc1(1,i);
    elseif 8500<inc1(1,i)<=34500
        finctax1(1,i) = 0.10*8500 + 0.15*(inc1(1,i)-8500);
    elseif 34500<inc1(1,i)<=83600
        finctax1(1,i) = 0.10*8500+0.15*(34500-8500)+0.25*(inc1(1,i)-34500);
    elseif 83600<inc1(1,i)<=174400
        finctax1(1,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(inc1(1,i)-83600);
    elseif 174400<inc1(1,i)<=379150
        finctax1(1,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(174400-
83600)+0.33*(inc1(1,i)-174400);
    elseif inc1(1,i)>379150
        finctax1(1,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(174400-
83600)+0.33*(379150-174400)+0.35*(inc1(1,i)-379150);
    end;
    if inc1(1,i) <= 2400
        sinctax1(1,i) = 0.0256*inc1(1,i);
    elseif 2400<inc1(1,i)<=17500
        sinctax1(1,i) = 0.0357*inc1(1,i);
    elseif 17500<inc1(1,i)<=27000
        sinctax1(1,i) = 0.0512*inc1(1,i);
    elseif inc0(1,i)>27000
        sinctax1(1,i) = 0.0684*inc1(1,i);
    end;
    inctax1(1,i)=finctax1(1,i) + sinctax1(1,i);
    atinc1(1,i) = inc1(1,i)-inctax1(1,i);
    tax1(1,i)=tax1(1,i)+inctax1(1,i);
    stax1(1,i)=stax1(1,i)+sinctax1(1,i);
end;


% Expenditures Determination based on income and education
perofcon0(1,1)=0.04+exprnd(0.014); % food at home
perofcon0(2,1)=0.03+weibrnd(3.27*10^9,5.29); % food away home
perofcon0(3,1)=weibrnd(2.75*10^21,10.4); % alcoholic beverages
perofcon0(4,1)=0.09+lognrnd(-3.42,0.513); % owned housing
perofcon0(5,1)=0.02+lognrnd(-4.13,0.501); % rented housing
u1=rand; perofcon0(6,1)=(u1<=(0.11-0.04)/(0.14-0.04)).*(0.04+sqrt((0.14-0.04)*(0.11-
0.04)*u1))+(u1>(0.11-0.04)/(0.14-0.04)).*(0.14-sqrt((1-u1)*(0.14-0.04)*(0.14-0.11))); % house
repairing and maintainance
perofcon0(7,1)=0.04+0.06*betarnd(0.406,1.93); % utilities
perofcon0(8,1)=0.02+lognrnd(-4.40,0.362); % clothes
u2=rand; perofcon0(9,1)=(u2<=(0.023-0.02)/(0.05-0.02)).*(0.02+sqrt((0.05-0.02)*(0.023-
0.02)*u2))+(u2>(0.023-0.02)/(0.05-0.02)).*(0.05-sqrt((1-u2)*(0.05-0.02)*(0.05-0.023))); % new
vehicle
perofcon0(10,1)=0.01+lognrnd(-4.32,0.496); % used vehicle
perofcon0(11,1)=0.01+lognrnd(-4.05,0.380); % gasoline
perofcon0(12,1)=0.01+lognrnd(-5.36,0.445); % vehicle insurance
```

```
perofcon0(13,1)=0.01+lognrnd(-4.53,0.179); % healthcare excluding insurance
perofcon0(14,1)=0.01+lognrnd(-4.41,0.286); % health insurance
perofcon0(15,1)=0.03+lognrnd(-4.38,0.231); % entertainment
perofcon0(16,1)=lognrnd(-5.88,0.455); % tobacco products
perofcon0(17,1)=0.02+weibrnd(123528.5,5.18); % other expenditures
perofcon = 0; % percentage of all expenditures
for l=1:17
   perofcon = perofcon + perofcon0(l,1);
end;
perofcon0(18,1)=1-perofcon; % percentage of after tax income for saving

perofcon1(1,1)=0.03+lognrnd(-4.27,0.368); % food at home
perofcon1(2,1)=normrnd(0.0405,0.00292); % food away home
perofcon1(3,1)=0.01*betarnd(7.51,3.12248); % alcoholic beverages
perofcon1(4,1)=0.1+lognrnd(-4.15,0.698); % owned housing
perofcon1(5,1)=0.01+lognrnd(-4.20,0.390); % rented housing
u3=rand; perofcon1(6,1)=(u3<=(0.109-0.06)/(0.13-0.06)).*(0.06+sqrt((0.13-0.06)*(0.109-
0.06)*u3))+(u3>(0.109-0.06)/(0.13-0.06)).*(0.13-sqrt((1-u3)*(0.13-0.06)*(0.13-0.109))); % house
repair and maintainance
perofcon1(7,1)=0.03+exprnd(0.0126); % utilities
perofcon1(8,1)=0.01+lognrnd(-4.02,0.283); % clothes
perofcon1(9,1)=0.01+0.03*betarnd(3.53,2.7); % new vehicle
perofcon1(10,1)=0.04*betarnd(5.63,6.74544); % used vehicle
perofcon1(11,1)=0.01+lognrnd(-4.42,0.458); % gasoline
perofcon1(12,1)=0.03*betarnd(11.7,13.9954); % vehicle insurance
perofcon1(13,1)=0.01+lognrnd(-4.63,0.158); % healthcare excluding insurance
perofcon1(14,1)=0.01+lognrnd(-4.60,0.340); % health insurance
perofcon1(15,1)=0.03+lognrnd(-4.56,0.283); % entertainment
perofcon1(16,1)=lognrnd(-6.44,0.605); % tobacco products
perofcon1(17,1)=0.05+weibrnd(99650.37,4.74); % other expenditures
perofcon = 0; % percentage of all expenditures
for l=1:17
   perofcon = perofcon + perofcon1(l,1);
end;
perofcon1(18,1)=1-perofcon; % percentage of after tax income for saving

% main procedure: cash flows
for i=1:t
   expen0=0; % the total expenditures including indirect individuals
   for j=1:18
      con0(j,1) = perofcon0(j,1)*atinc0(1,i);
      expen0 = expen0+con0(j,1);
         if j==1||j==4||j==5||j==7||j==12||j==14||j==18
           contax0(j,1)=0*con0(j,1);
         else
           contax0(j,1)=(0.07/1.07)*con0(j,1);
         end;
    end;
   m=0;
   while expen0 > 0.01*inc0(1,i)  % routines stoped when the total expenditures less than 1% of
income
      ininc0=0; % the indirect increased income from the expenditures
      m=m+1; %the m th routine
      ininc0 = 0.5*expen0; % assume 50% of the expenditures utilized to increase the workers' income
      % the distribution of overall cosumers utilized
      perofcon0(1,m+1)=0.05+lognrnd(-4.40,0.348); % food at home
      perofcon0(2,m+1)=0.04+0.02*betarnd(2.42,5.5); % food away home
      perofcon0(3,m+1)=0.01*betarnd(26.3,7.18603); % alcoholic beverages
      perofcon0(4,m+1)=normrnd(0.108,0.00323); % owned housing
```

```
        u4=rand; perofcon0(5,m+1)=(u4<=(0.047-0.04)/(0.05-0.04)).*(0.04+sqrt((0.05-0.04)*(0.047-0.04)*u4))+(u4>(0.047-0.04)/(0.05-0.04)).*(0.05-sqrt((1-u4)*(0.05-0.04)*(0.05-0.047))); % rented housing
        perofcon0(6,m+1)=0.12+exprnd(0.00559); % house repair and maintainance
        perofcon0(7,m+1)=0.05+lognrnd(-4.78,0.207); % utilities
        perofcon0(8,m+1)=0.02+lognrnd(-4.34,0.336); % clothes
        perofcon0(9,m+1)=0.01+0.04*betarnd(2.85,2.53); % new vehicle
        perofcon0(10,m+1)=0.01+lognrnd(-3.98,0.380); % used vehicle
        perofcon0(11,m+1)=0.02+lognrnd(-4.38,0.399); % gasoline
        perofcon0(12,m+1)=0.01+0.01*betarnd(8.86,2.66); % vehicle insurance
        perofcon0(13,m+1)=random('uniform',0.021,0.026); % healthcare excluding insurance
        perofcon0(14,m+1)=0.02+weibrnd(3.86*10^6,3.02); % health insurance
        perofcon0(15,m+1)=normrnd(0.0434,0.0015); % entertainment
        perofcon0(16,m+1)=0.01*betarnd(19.9,13.4509); % tobacco products
        perofcon0(17,m+1)=0.09+lognrnd(-4.54,0.389); % other expenditures
        perofcon = 0; % percentage of all expenditures
        for l=1:17
            perofcon = perofcon + perofcon0(l,m+1);
        end;
        perofcon0(18,m+1)=1-perofcon; % percentage of after tax income for saving
        expen0=0; % initial the expenditurs for the (m+1)th routine
        for j=1:18
            con0(j,m+1) = perofcon0(j,m+1)*ininc0;
            expen0 = expen0+con0(j,m+1);
            if j==1||j==4||j==5||j==7||j==12||j==14||j==18
               contax0(j,m+1)=0*con0(j,m+1);
            else
               contax0(j,m+1)=(0.07/1.07)*con0(j,m+1);
            end;
        end;
    end;

    expen1=0; % the total expenditures including indirect individuals
    for j=1:18
        con1(j,1) = perofcon1(j,1)*atinc1(1,i);
        expen1 = expen1+con1(j,1);
            if j==1||j==4||j==5||j==7||j==12||j==14||j==18
               contax1(j,1)=0*con1(j,1);
            else
               contax1(j,1)=(0.07/1.07)*con1(j,1);
            end;
     end;
    n=0;
    while expen1 > 0.01*inc1(1,i)  % routines stoped when the total expenditures less than 1% of income
        ininc1=0; % the indirect increased income from the expenditures
        n=n+1; %the m th routine
        inninc1 = 0.5*expen1; % assume 50% of the expenditures utilized to increase the workers' income
        % the distribution of overall cosumers utilized
        perofcon1(1,n+1)=0.05+lognrnd(-4.40,0.348); % food at home
        perofcon1(2,n+1)=0.04+0.02*betarnd(2.42,5.5); % food away home
        perofcon1(3,n+1)=0.01*betarnd(26.3,7.18603); % alcoholic beverages
        perofcon1(4,n+1)=normrnd(0.108,0.00323); % owned housing
        u5=rand; perofcon1(5,n+1)=(u5<=(0.047-0.04)/(0.05-0.04)).*(0.04+sqrt((0.05-0.04)*(0.047-0.04)*u5))+(u5>(0.047-0.04)/(0.05-0.04)).*(0.05-sqrt((1-u5)*(0.05-0.04)*(0.05-0.047))); % rented housing
        perofcon1(6,n+1)=0.12+exprnd(0.00559); % house repair and maintainance
        perofcon1(7,n+1)=0.05+lognrnd(-4.78,0.207); % utilities
        perofcon1(8,n+1)=0.02+lognrnd(-4.34,0.336); % clothes
```

```
        perofcon1(9,n+1)=0.01+0.04*betarnd(2.85,2.53); % new vehicle
        perofcon1(10,n+1)=0.01+lognrnd(-3.98,0.380); % used vehicle
        perofcon1(11,n+1)=0.02+lognrnd(-4.38,0.399); % gasoline
        perofcon1(12,n+1)=0.01+0.01*betarnd(8.86,2.66); % vehicle insurance
        perofcon1(13,n+1)=random('uniform',0.021,0.026); % healthcare excluding insurance
        perofcon1(14,n+1)=0.02+weibrnd(3.86*10^6,3.02); % health insurance
        perofcon1(15,n+1)=normrnd(0.0434,0.0015); % entertainment
        perofcon1(16,n+1)=0.01*betarnd(19.9,13.4509); % tobacco products
        perofcon1(17,n+1)=0.09+lognrnd(-4.54,0.389); % other expenditures
        perofcon = 0; % percentage of all expenditures
        for l=1:17
            perofcon = perofcon + perofcon1(l,n+1);
        end;
        perofcon1(18,n+1)=1-perofcon; % percentage of after tax income for saving
        expen1=0; % initial the expenditurs for the (n+1)th routine
        for j=1:18
            con1(j,n+1) = perofcon1(j,n+1)*ininc1;
            expen1 = expen1+con1(j,n+1);
            if j==1||j==4||j==5||j==7||j==12||j==14||j==18
              contax1(j,n+1)=0*con1(j,n+1);
            else
              contax1(j,n+1)=(0.07/1.07)*con1(j,n+1);
            end;
        end;
    end;
    % obtain the sum of the expenditures taxes and add it to tax
    sumcontax0(1,i)=sum((sum(contax0))');
    tax0(1,i)=tax0(1,i)+sumcontax0(1,i);
    stax0(1,i)=stax0(1,i)+sumcontax0(1,i);
    sumcontax1(1,i)=sum((sum(contax1))');
    tax1(1,i)=tax1(1,i)+sumcontax1(1,i);
    stax1(1,i)=stax1(1,i)+sumcontax1(1,i);
end;

% obtain the difference between tax0 and tax1
for i=1:t
    imp(1,i) = tax1(1,i)/tax0(1,i);
    simp(1,i) = stax1(1,i)/stax0(1,i);
    imp(2,i) = (tax1(1,i)-tax0(1,i))/(inc1(1,i)-inc0(1,i));
    simp(2,i) = (stax1(1,i)-stax0(1,i))/(inc1(1,i)-inc0(1,i));
    imp(3,i) = tax1(1,i)-tax0(1,i);
    simp(3,i) = stax1(1,i)-stax0(1,i);
end;
impact = mean(imp');
simpact = mean(simp');
```

Appendix C: Programming code of the whole life of careers model for individuals who only received bachelors' degrees disregarding their majors

```
clear;

% variable defination & initialization
t = 5000; % number of trials
r = 0.10; % the effective annual interest rate
inc = zeros (t, 5); % the before tax income for the individual
tax1 = zeros (t, 3); % annual total taxes for an individual including inctax and contax in the 1st stage
(younger than 25)
tax2 = zeros (t, 10); % annual total taxes in the 2nd stage (25 to 24)
tax3 = zeros (t, 10); % annual total taxes in the 3rd stage (35 to 44)
tax4 = zeros (t, 10); % annual total taxes in the 4th stage (45 to 54)
tax5 = zeros (t, 10); % annual total taxes in the 5th stage (55 to 64)
stax1 = zeros (t, 3); % annual total state taxes for an individual including inctax and contax in the 1st
stage (younger than 25)
stax2 = zeros (t, 10); % annual total state taxes in the 2nd stage (25 to 24)
stax3 = zeros (t, 10); % annual total state taxes in the 3rd stage (35 to 44)
stax4 = zeros (t, 10); % annual total state taxes in the 4th stage (45 to 54)
stax5 = zeros (t, 10); % annual total state taxes in the 5th stage (55 to 64)
atinc = zeros (t, 5); % the after tax income
inctax = zeros (t, 5); % the income taxes
finctax = zeros (t, 5); % the federal income taxes
sinctax = zeros (t, 5); % the state income taxes
% 18 as the number of categories and 18 estimated as the rountines of the impacts
perofcon = zeros (18, 10);
% percentage of expenditures on each category in rows
con = zeros (18, 10); % expenditures on each category
contax = zeros (18, 10); % tax of corresponding expenditures
sumcontax1 = zeros (t, 3); % annual consumption taxes totally in the 1st stage
sumcontax2 = zeros (t, 10); % annual consumption taxes in the 2nd stage
sumcontax3 = zeros (t, 10); % annual consumption taxes in the 3rd stage
sumcontax4 = zeros (t, 10); % annual consumption taxes in the 4th stage
sumcontax5 = zeros (t, 10); % annual consumption taxes in the 5th stage
PW = zeros(t,3); % the 1st column is for income taxes, the 2nd column is for consumption taxes, the
3rd column is for total taxes
sPW = zeros(t,3);

% begin the replication
for n=1:t

% Assignment for the individuals
inc(n,1) = 10000 + 140000*betarnd(3.63,18.1); % the distribution for salary
inc(n,2) = inc(n,1);
u=rand; perofincrease=(u<=(1.29-1.17)/(1.36-1.17)).*(1.17+sqrt((1.36-1.17)*(1.29-
1.17)*u))+(u>(1.29-1.17)/(1.36-1.17)).*(1.36-sqrt((1-u)*(1.36-1.17)*(1.36-1.29)));
inc(n,3) = perofincrease*inc(n,2);
inc(n,4) = (1+gamrnd(5.65,0.00938))*inc(n,3);
inc(n,5) = (0.81+0.08*betarnd(1.23,0.986))*inc(n,4);

% Income Taxes for Single
for i=1:5
   if inc(1,i) <= 8500
      finctax(n,i) = 0.10*inc(1,i);
   elseif 8500<inc(1,i)<=34500
      finctax(n,i) = 0.10*8500 + 0.15*(inc(1,i)-8500);
```

```
    elseif 34500<inc(1,i)<=83600
        finctax(n,i) = 0.10*8500+0.15*(34500-8500)+0.25*(inc(1,i)-34500);
    elseif 83600<inc(1,i)<=174400
        finctax(n,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(inc(1,i)-83600);
    elseif 174400<inc(1,i)<=379150
        finctax(n,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(174400-
83600)+0.33*(inc(1,i)-174400);
    elseif inc(1,i)>379150
        finctax(n,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(174400-
83600)+0.33*(379150-174400)+0.35*(inc(1,i)-379150);
    end;
    if inc(1,i) <= 2400
        sinctax(n,i) = 0.0256*inc(n,i);
    elseif 2400<inc(1,i)<=17500
        sinctax(n,i) = 0.0357*inc(n,i);
    elseif 17500<inc(1,i)<=27000
        sinctax(n,i) = 0.0512*inc(n,i);
    elseif inc(1,i)>27000
        sinctax(n,i) = 0.0684*inc(n,i);
    end;
    inctax(n,i) = finctax(n,i)+sinctax(n,i);
    atinc(n,i) = inc(n,i)-inctax(n,i);
end;
tax1(n,:) = tax1(n,:)+inctax(n,1); % add income taxes to total taxes
tax2(n,:) = tax2(n,:)+inctax(n,2);
tax3(n,:) = tax3(n,:)+inctax(n,3);
tax4(n,:) = tax4(n,:)+inctax(n,4);
tax5(n,:) = tax5(n,:)+inctax(n,5);
stax1(n,:) = stax1(n,:)+sinctax(n,1); % add state income taxes to state total taxes
stax2(n,:) = stax2(n,:)+sinctax(n,2);
stax3(n,:) = stax3(n,:)+sinctax(n,3);
stax4(n,:) = stax4(n,:)+sinctax(n,4);
stax5(n,:) = stax5(n,:)+sinctax(n,5);

% Expenditures Determination based on income for stage 1
for i=1:3
   m=0;
   expen = inc(n,1);
   while expen > 0.01*inc(n,1) % routines stoped when the total expenditures less than 1% of income
      ininc = 0; % the indirect increased income from the expenditures
      m = m+1; % the m th routine
      perofcon(1,m)=normrnd(0.0869,0.0117); % food at home
      perofcon(2,m)=0.01+weibrnd(321770.06,4.72); % food away home
      perofcon(3,m)=0.01+gamrnd(5.42,0.00147); % alcoholic beverages
      u1=rand; perofcon(4,m)=(u1<=0.0401/(0.06-0.03)).*sqrt((0.06-0.03)*(0.0401-
0.03)*u1)+(u1>0.0401/(0.06-0.03)).*(0.06-sqrt((1-u1)*(0.06-0.03)*(0.06-0.0401))); % owned housing
      perofcon(5,m)=random('uniform',0.14,0.20); % rented housing
      perofcon(6,m)=normrnd(0.136,0.01); % house repairing and maintainance
      perofcon(7,m)=0.05+0.03*betarnd(13.2,12.7); % utilities
      perofcon(8,m)=0.04+gamrnd(5.53,0.00323); % clothes
      u2=rand; perofcon(9,m)=(u2<=(0.026-0)/(0.08-0)).*(0+sqrt((0.08-0)*(0.026-0)*u2))+(u2>(0.026-
0)/(0.08-0)).*(0.08-sqrt((1-u2)*(0.08-0)*(0.08-0.026))); % new vehicle
      u3=rand; perofcon(10,m)=(u3<=(0.0581-0.02)/(0.11-0.02)).*(0.02+sqrt((0.11-0.02)*(0.0581-
0.02)*u3))+(u3>(0.0581-0.02)/(0.11-0.02)).*(0.11-sqrt((1-u3)*(0.11-0.02)*(0.11-0.0581))); % used
vehicle
      perofcon(11,m)=normrnd(0.0518,0.00887); % gasoline
      u4=rand; perofcon(12,m)=(u4<=(0.0224-0.01)/(0.03-0.01)).*(0.01+sqrt((0.03-0.01)*(0.0224-
0.01)*u4))+(u4>(0.0224-0.01)/(0.03-0.01)).*(0.03-sqrt((1-u4)*(0.03-0.01)*(0.03-0.0224))); % vehicle
insurance
```

```
      perofcon(13,m)=weibrnd(1.055*10^13,7.06); % healthcare excluding insurance
      perofcon(14,m)=0.01+weibrnd(2.07*10^9,3.88); % health insurance
      perofcon(15,m)=0.04+lognrnd(-4.53,0.439); % entertainment
      perofcon(16,m)=0.02*betarnd(19.9,15.1839); % tobacco products
      perofcon(17,m)=0.09+lognrnd(-3.55,0.370); % other expenditures
      per = 0; % percentage of all expenditures
      for l=1:17
         per = per + perofcon(l,m);
      end;
      perofcon(18,m)=1-per; % percentage of after tax income for saving

      % main procedure: cash flows
      if m==1
        expen=0; % the total expenditures inclding inirect individuals
        for j=1:18
          con(j,m) = perofcon(j,m)*atinc(n,1);
          expen = expen+con(j,m);
          if j==1||j==4||j==5||j==7||j==12||j==14||j==18
            contax(j,m) = 0*con(j,m);
          else
            contax(j,m) = (0.07/1.07)*con(j,m);
          end;
        end;
      else
        ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
        expen = 0; % initial the expenditures for the m th routine where m is larger than 1
        for j=1:18
          con(j,m) = perofcon(j,m)*ininc;
          expen = expen+con(j,m);
          if j==1||j==4||j==5||j==7||j==12||j==14||j==18
            contax(j,m)=0*con(j,m);
          else
            contax(j,m)=(0.07/1.07)*con(j,m);
          end;
        end;
      end;
    end;
    % obtain the sum of the expenditures taxes and add it to tax
    sumcontax1(n,i) = sum((sum(contax))');
    tax1(n,i) = tax1(n,i)+sumcontax1(n,i);
    stax1(n,i) = stax1(n,i)+sumcontax1(n,i);
  end;

  % Expenditures Determination based on income for stage 2
  for i=1:10
    m=0;
    expen = inc(n,2);
    while expen > 0.01*inc(n,2) % routines stoped when the total expenditures less than 1% of income
      ininc = 0; % the indirect increased income from the expenditures
      m = m+1; % the m th routine
      perofcon(1,m)=0.05+gamrnd(7.21,0.00148); % food at home
      perofcon(2,m)=0.04+weibrnd(5.44*10^9,4.93); % food away home
      perofcon(3,m)=lognrnd(-4.53,0.439); % alcoholic beverages
      perofcon(4,m)=0.07+lognrnd(-3.48,0.405); % owned housing
      perofcon(5,m)=0.04+weibrnd(2.14*10^8,5.94); % rented housing
      perofcon(6,m)=0.09+weibrnd(3365089,4.22); % house repairing and maintainance
      perofcon(7,m)=0.05+lognrnd(-5.41,0.262); % utilities
      perofcon(8,m)=normrnd(0.039,0.00423); % clothes
```

```
    u5=rand; perofcon(9,m)=(u5<=(0.038-0.01)/(0.05-0.01)).*(0.01+sqrt((0.05-0.01)*(0.038-
0.01)*u5))+(u5>(0.038-0.01)/(0.05-0.01)).*(0.05-sqrt((1-u5)*(0.05-0.01)*(0.05-0.038))); % new
vehicle
    perofcon(10,m)=0.02+lognrnd(-4.00,0.450); % used vehicle
    perofcon(11,m)=0.02+lognrnd(-4.23,0.442); % gasoline
    perofcon(12,m)=0.01+0.01*betarnd(2.47,1.44); % vehicle insurance
    perofcon(13,m)=0.01+lognrnd(-5.71,0.227); % healthcare excluding insurance
    perofcon(14,m)=0.01+gamrnd(25.2,0.000258); % health insurance
    perofcon(15,m)=0.03+gamrnd(25.2,0.000513); % entertainment
    perofcon(16,m)=0.01*betarnd(18.6,12.5365); % tobacco products
    perofcon(17,m)=0.07+0.04*betarnd(8.29,7.99); % other expenditures
    per = 0; % percentage of all expenditures
    for l=1:17
      per = per + perofcon(l,m);
    end;
    perofcon(18,m)=1-per; % percentage of after tax income for saving

    % main procedure: cash flows
    if m==1
      expen=0; % the total expenditures inclding inirect individuals
      for j=1:18
        con(j,m) = perofcon(j,m)*atinc(n,2);
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m) = 0*con(j,m);
        else
          contax(j,m) = (0.07/1.07)*con(j,m);
        end;
      end;
    else
      ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
      expen = 0; % initial the expenditures for the m th routine where m is larger than 1
      for j=1:18
        con(j,m) = perofcon(j,m)*ininc;
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m)=0*con(j,m);
        else
          contax(j,m)=(0.07/1.07)*con(j,m);
        end;
      end;
    end;
  end;
  % obtain the sum of the expenditures taxes and add it to tax
  sumcontax2(n,i) = sum((sum(contax))');
  tax2(n,i) = tax2(n,i)+sumcontax2(n,i);
  stax2(n,i) = stax2(n,i)+sumcontax2(n,i);
end;

% Expenditures Determination based on income for stage 3
for i=1:10
  m=0;
  expen = inc(n,3);
  while expen > 0.01*inc(n,3) % routines stoped when the total expenditures less than 1% of income
    ininc = 0; % the indirect increased income from the expenditures
    m = m+1; % the m th routine
    perofcon(1,m)=0.05+lognrnd(-4.61,0.303); % food at home
    perofcon(2,m)=0.04+lognrnd(-5.23,0.300); % food away home
    perofcon(3,m)=lognrnd(-4.95,0.0933); % alcoholic beverages
```

```
    perofcon(4,m)=0.1+weibrnd(2.05*10^8,4.93); % owned housing
    perofcon(5,m)=0.03+lognrnd(-4.60,0.274); % rented housing
    perofcon(6,m)=0.11+lognrnd(-5.00,0.481); % house repairing and maintainance
    perofcon(7,m)=0.05+0.01*betarnd(3.4,6.1); % utilities
    perofcon(8,m)=0.02+lognrnd(-4.31,0.301); % clothes
    u6=rand; perofcon(9,m)=(u6<=(0.038-0.01)/(0.05-0.01)).*(0.01+sqrt((0.05-0.01)*(0.038-
0.01)*u6))+(u6>(0.038-0.01)/(0.05-0.01)).*(0.05-sqrt((1-u6)*(0.05-0.01)*(0.05-0.038))); % new
vehicle
    perofcon(10,m)=0.01+0.04*betarnd(4.79,5.17); % used vehicle
    perofcon(11,m)=0.02+lognrnd(-4.47,0.439); % gasoline
    perofcon(12,m)=0.01+weibrnd(2.61*10^11,5.14); % vehicle insurance
    perofcon(13,m)=0.01+0.01*betarnd(18.3,12.5); % healthcare excluding insurance
    perofcon(14,m)=0.01+lognrnd(-4.87,0.149); % health insurance
    perofcon(15,m)=0.03+lognrnd(-4.30,0.223); % entertainment
    perofcon(16,m)=lognrnd(-5.18,0.162); % tobacco products
    u7=rand; perofcon(17,m)=(u7<=(0.094-0.08)/(0.12-0.08)).*(0.08+sqrt((0.12-0.08)*(0.094-
0.08)*u7))+(u7>(0.094-0.08)/(0.12-0.08)).*(0.12-sqrt((1-u7)*(0.12-0.08)*(0.12-0.094))); % other
expenditures
    per = 0; % percentage of all expenditures
    for l=1:17
      per = per + perofcon(l,m);
    end;
    perofcon(18,m)=1-per; % percentage of after tax income for saving

    % main procedure: cash flows
    if m==1
      expen=0; % the total expenditures inclding inirect individuals
      for j=1:18
        con(j,m) = perofcon(j,m)*atinc(n,3);
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m) = 0*con(j,m);
        else
          contax(j,m) = (0.07/1.07)*con(j,m);
        end;
      end;
    else
      ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
      expen = 0; % initial the expenditures for the m th routine where m is larger than 1
      for j=1:18
        con(j,m) = perofcon(j,m)*ininc;
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m)=0*con(j,m);
        else
          contax(j,m)=(0.07/1.07)*con(j,m);
        end;
      end;
    end;
  end;
  % obtain the sum of the expenditures taxes and add it to tax
  sumcontax3(n,i) = sum((sum(contax))');
  tax3(n,i) = tax3(n,i)+sumcontax3(n,i);
  stax3(n,i) = stax3(n,i)+sumcontax3(n,i);
end;

% Expenditures Determination based on income for stage 4
for i=1:10
  m=0;
```

```
  expen = inc(n,4);
  while expen > 0.01*inc(n,4) % routines stoped when the total expenditures less than 1% of income
    ininc = 0; % the indirect increased income from the expenditures
    m = m+1; % the m th routine
    perofcon(1,m)=0.03+0.05*betarnd(8.48,7.35); % food at home
    u8=rand; perofcon(2,m)=(u8<=0.0403/(0.06-0.03)).*sqrt((0.06-0.03)*(0.0403-
0.03)*u8)+(u8>0.0403/(0.06-0.03)).*(0.06-sqrt((1-u8)*(0.06-0.03)*(0.06-0.0403))); % food away
home
    perofcon(3,m)=normrnd(0.00698,0.000784); % alcoholic beverages
    perofcon(4,m)=0.1+lognrnd(-4.78,0.368); % owned housing
    perofcon(5,m)=normrnd(0.0279,0.00237); % rented housing
    perofcon(6,m)=0.1+lognrnd(-4.38,0.317); % house repairing and maintainance
    perofcon(7,m)=0.05+0.01*betarnd(1.79,3.78); % utilities
    perofcon(8,m)=0.02+0.03*betarnd(1.97,2.99); % clothes
    perofcon(9,m)=0.01+0.04*betarnd(5.92,7.22); % new vehicle
    perofcon(10,m)=0.01+lognrnd(-4.16,0.435); % used vehicle
    perofcon(11,m)=0.02+0.03*betarnd(2.71,4.1); % gasoline
    perofcon(12,m)=0.01+0.01*betarnd(6.71,1.86); % vehicle insurance
    perofcon(13,m)=0.01+gamrnd(25.2,0.000407); % healthcare excluding insurance
    perofcon(14,m)=0.01+gamrnd(25.2,0.000365); % health insurance
    perofcon(15,m)=0.03+0.02*betarnd(12.6,12.1); % entertainment
    perofcon(16,m)=0.01*betarnd(21.5,14.5575); % tobacco products
    perofcon(17,m)=0.1+lognrnd(-4.01,0.302); % other expenditures
    per = 0; % percentage of all expenditures
    for l=1:17
       per = per + perofcon(l,m);
    end;
    perofcon(18,m)=1-per; % percentage of after tax income for saving

    % main procedure: cash flows
    if m==1
      expen=0; % the total expenditures inclding inirect individuals
      for j=1:18
        con(j,m) = perofcon(j,m)*atinc(n,4);
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m) = 0*con(j,m);
        else
          contax(j,m) = (0.07/1.07)*con(j,m);
        end;
      end;
    else
      ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
      expen = 0; % initial the expenditures for the m th routine where m is larger than 1
      for j=1:18
        con(j,m) = perofcon(j,m)*ininc;
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m)=0*con(j,m);
        else
          contax(j,m)=(0.07/1.07)*con(j,m);
        end;
      end;
    end;
  end;
  % obtain the sum of the expenditures taxes and add it to tax
  sumcontax4(n,i) = sum((sum(contax))');
  tax4(n,i) = tax4(n,i)+sumcontax4(n,i);
  stax4(n,i) = stax4(n,i)+sumcontax4(n,i);
```

```
end;

% Expenditures Determination based on income for stage 5
for i=1:10
  m=0;
  expen = inc(n,5);
  while expen > 0.01*inc(n,5) % routines stoped when the total expenditures less than 1% of income
    ininc = 0; % the indirect increased income from the expenditures
    m = m+1; % the m th routine
    perofcon(1,m)=0.04+0.04*betarnd(5.4,6.19); % food at home
    perofcon(2,m)=normrnd(0.0424,0.00384); % food away home
    perofcon(3,m)=lognrnd(-4.91,0.105); % alcoholic beverages
    perofcon(4,m)=0.09+lognrnd(-4.04,0.305); % owned housing
    perofcon(5,m)=0.01+weibrnd(3.98*10^9,5.28); % rented housing
    perofcon(6,m)=normrnd(0.127,0.0122); % house repairing and maintainance
    perofcon(7,m)=0.05+lognrnd(-4.85,0.301); % utilities
    perofcon(8,m)=random('uniform',0.02,0.04); % clothes
    perofcon(9,m)=0.01+0.05*betarnd(2.56,2.61); % new vehicle
    perofcon(10,m)=random('uniform',0.01,0.04); % used vehicle
    perofcon(11,m)=0.02+0.03*betarnd(2.94,4.43); % gasoline
    perofcon(12,m)=0.01+gamrnd(25.2,0.000301); % vehicle insurance
    perofcon(13,m)=0.02+lognrnd(-4.75,0.271); % healthcare excluding insurance
    perofcon(14,m)=0.02+gamrnd(15.2,0.000485); % health insurance
    perofcon(15,m)=0.03+gamrnd(23.1,0.000594); % entertainment
    perofcon(16,m)=weibrnd(1.23*10^16,7.37); % tobacco products
    perofcon(17,m)=0.09+0.03*betarnd(1.65,0.886); % other expenditures
    per = 0; % percentage of all expenditures
    for l=1:17
       per = per + perofcon(l,m);
    end;
    perofcon(18,m)=1-per; % percentage of after tax income for saving

    % main procedure: cash flows
    if m==1
      expen=0; % the total expenditures inclding inirect individuals
      for j=1:18
        con(j,m) = perofcon(j,m)*atinc(n,5);
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m) = 0*con(j,m);
        else
          contax(j,m) = (0.07/1.07)*con(j,m);
        end;
      end;
    else
      ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
      expen = 0; % initial the expenditures for the m th routine where m is larger than 1
      for j=1:18
        con(j,m) = perofcon(j,m)*ininc;
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m)=0*con(j,m);
        else
          contax(j,m)=(0.07/1.07)*con(j,m);
        end;
      end;
    end;
  end;
  % obtain the sum of the expenditures taxes and add it to tax
```

```
  sumcontax5(n,i) = sum((sum(contax))');
  tax5(n,i) = tax5(n,i)+sumcontax5(n,i);
  stax5(n,i) = stax5(n,i)+sumcontax5(n,i);
end;

% calculate the present worth of taxes for the whole career life
PW(n,1) = inctax(n,1)*(((1+r)^3-1)/(r*(1+r)^3))+inctax(n,2)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^3)+inctax(n,3)*(((1+r)^10-1)/(r*(1+r)^10))/((1+r)^13)+inctax(n,4)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^23)+inctax(n,5)*(((1+r)^10-1)/(r*(1+r)^10))/((1+r)^33);
sPW(n,1) = sinctax(n,1)*(((1+r)^3-1)/(r*(1+r)^3))+sinctax(n,2)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^3)+sinctax(n,3)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^13)+sinctax(n,4)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^23)+sinctax(n,5)*(((1+r)^10-1)/(r*(1+r)^10))/((1+r)^33);
for i=1:43
  if i<=3
    PW(n,2) = PW(n,2)+sumcontax1(n,i)/((1+r)^i);
    PW(n,3) = PW(n,3)+tax1(n,i)/((1+r)^i);
    sPW(n,2) = sPW(n,2)+sumcontax1(n,i)/((1+r)^i);
    sPW(n,3) = sPW(n,3)+stax1(n,i)/((1+r)^i);
  elseif i>3&&i<=13
    PW(n,2) = PW(n,2)+sumcontax2(n,i-3)/((1+r)^i);
    PW(n,3) = PW(n,3)+tax2(n,i-3)/((1+r)^i);
    sPW(n,2) = sPW(n,2)+sumcontax2(n,i-3)/((1+r)^i);
    sPW(n,3) = sPW(n,3)+stax2(n,i-3)/((1+r)^i);
  elseif i>13&&i<=23
    PW(n,2) = PW(n,2)+sumcontax3(n,i-13)/((1+r)^i);
    PW(n,3) = PW(n,3)+tax3(n,i-13)/((1+r)^i);
    sPW(n,2) = sPW(n,2)+sumcontax3(n,i-13)/((1+r)^i);
    sPW(n,3) = sPW(n,3)+stax3(n,i-13)/((1+r)^i);
  elseif i>23&&i<=33
    PW(n,2) = PW(n,2)+sumcontax4(n,i-23)/((1+r)^i);
    PW(n,3) = PW(n,3)+tax4(n,i-23)/((1+r)^i);
    sPW(n,2) = sPW(n,2)+sumcontax4(n,i-23)/((1+r)^i);
    sPW(n,3) = sPW(n,3)+stax4(n,i-23)/((1+r)^i);
  else
    PW(n,2) = PW(n,2)+sumcontax5(n,i-33)/((1+r)^i);
    PW(n,3) = PW(n,3)+tax5(n,i-33)/((1+r)^i);
    sPW(n,2) = sPW(n,2)+sumcontax5(n,i-33)/((1+r)^i);
    sPW(n,3) = sPW(n,3)+stax5(n,i-33)/((1+r)^i);
  end;
end;
end;
```

Appendix D: Programming code of the whole life of careers model for individuals who only received higher degrees disregarding their majors

```
clear;

% variable defination & initialization
t = 5000; % number of trials
r = 0.10; % the effective annual interest rate
inc = zeros (t, 4); % the before tax income for the individual
tax2 = zeros (t, 10); % annual total taxes in the 2nd stage (25 to 24)
tax3 = zeros (t, 10); % annual total taxes in the 3rd stage (35 to 44)
tax4 = zeros (t, 10); % annual total taxes in the 4th stage (45 to 54)
tax5 = zeros (t, 10); % annual total taxes in the 5th stage (55 to 64)
stax2 = zeros (t, 10); % annual state total taxes in the 2nd stage (25 to 24)
stax3 = zeros (t, 10); % annual state total taxes in the 3rd stage (35 to 44)
stax4 = zeros (t, 10); % annual state total taxes in the 4th stage (45 to 54)
stax5 = zeros (t, 10); % annual state total taxes in the 5th stage (55 to 64)
atinc = zeros (t, 4); % the after tax income
inctax = zeros (t, 4); % the income taxes
finctax = zeros (t, 4); % the federal income taxes
sinctax = zeros (t, 4); % the state income taxes
% 18 as the number of categories and 18 estimated as the rountines of the impacts
perofcon = zeros (18, 10);
% percentage of expenditures on each category in rows
con = zeros (18, 10); % expenditures on each category
contax = zeros (18, 10); % tax of corresponding expenditures
sumcontax2 = zeros (t, 10); % annual consumption taxes in the 2nd stage
sumcontax3 = zeros (t, 10); % annual consumption taxes in the 3rd stage
sumcontax4 = zeros (t, 10); % annual consumption taxes in the 4th stage
sumcontax5 = zeros (t, 10); % annual consumption taxes in the 5th stage
PW = zeros(t,3); % the 1st column is for income taxes, the 2nd column is for consumption taxes, the
3rd column is for total taxes
sPW = zeros(t,3);

% begin the replication
for n=1:t

% Assignment for the individuals
inc(n,1) = 10000 + 170000*betarnd(3.73,13.7); % the distribution for salary
u=rand; perofincrease=(u<=(1.29-1.17)/(1.36-1.17)).*(1.17+sqrt((1.36-1.17)*(1.29-
1.17)*u))+(u>(1.29-1.17)/(1.36-1.17)).*(1.36-sqrt((1-u)*(1.36-1.17)*(1.36-1.29)));
inc(n,2) = perofincrease*inc(n,1);
inc(n,3) = (1+gamrnd(5.65,0.00938))*inc(n,2);
inc(n,4) = (0.81+0.08*betarnd(1.23,0.986))*inc(n,3);

% Income Taxes for Single
for i=1:4
   if inc(1,i) <= 8500
      finctax(n,i) = 0.10*inc(1,i);
   elseif 8500<inc(1,i)<=34500
      finctax(n,i) = 0.10*8500 + 0.15*(inc(1,i)-8500);
   elseif 34500<inc(1,i)<=83600
      finctax(n,i) = 0.10*8500+0.15*(34500-8500)+0.25*(inc(1,i)-34500);
   elseif 83600<inc(1,i)<=174400
      finctax(n,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(inc(1,i)-83600);
   elseif 174400<inc(1,i)<=379150
```

```
        finctax(n,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(174400-
83600)+0.33*(inc(1,i)-174400);
    elseif inc(1,i)>379150
        finctax(n,i) = 0.10*8500+0.15*(34500-8500)+0.25*(83600-34500)+0.28*(174400-
83600)+0.33*(379150-174400)+0.35*(inc(1,i)-379150);
    end;
    if inc(1,i) <= 2400
        sinctax(n,i) = 0.0256*inc(n,i);
    elseif 2400<inc(1,i)<=17500
        sinctax(n,i) = 0.0357*inc(n,i);
    elseif 17500<inc(1,i)<=27000
        sinctax(n,i) = 0.0512*inc(n,i);
    elseif inc(1,i)>27000
        sinctax(n,i) = 0.0684*inc(n,i);
    end;
    inctax(n,i) = finctax(n,i)+sinctax(n,i);
    atinc(n,i) = inc(n,i)-inctax(n,i);
end;
tax2(n,:) = tax2(n,:)+inctax(n,1); % add income taxes to total taxes
tax3(n,:) = tax3(n,:)+inctax(n,2);
tax4(n,:) = tax4(n,:)+inctax(n,3);
tax5(n,:) = tax5(n,:)+inctax(n,4);
stax2(n,:) = stax2(n,:)+sinctax(n,1); % add income taxes to state total taxes
stax3(n,:) = stax3(n,:)+sinctax(n,2);
stax4(n,:) = stax4(n,:)+sinctax(n,3);
stax5(n,:) = stax5(n,:)+sinctax(n,4);

% Expenditures Determination based on income for stage 1

% Expenditures Determination based on income for stage 2
for i=1:10
   m=0;
   expen = inc(n,1);
   while expen > 0.01*inc(n,1) % routines stoped when the total expenditures less than 1% of income
      ininc = 0; % the indirect increased income from the expenditures
      m = m+1; % the m th routine
      perofcon(1,m)=0.05+gamrnd(7.21,0.00148); % food at home
      perofcon(2,m)=0.04+weibrnd(5.44*10^9,4.93); % food away home
      perofcon(3,m)=lognrnd(-4.53,0.439); % alcoholic beverages
      perofcon(4,m)=0.07+lognrnd(-3.48,0.405); % owned housing
      perofcon(5,m)=0.04+weibrnd(2.14*10^8,5.94); % rented housing
      perofcon(6,m)=0.09+weibrnd(3365089,4.22); % house repairing and maintainance
      perofcon(7,m)=0.05+lognrnd(-5.41,0.262); % utilities
      perofcon(8,m)=normrnd(0.039,0.00423); % clothes
      u5=rand; perofcon(9,m)=(u5<=(0.038-0.01)/(0.05-0.01)).*(0.01+sqrt((0.05-0.01)*(0.038-
0.01)*u5))+(u5>(0.038-0.01)/(0.05-0.01)).*(0.05-sqrt((1-u5)*(0.05-0.01)*(0.05-0.038))); % new
vehicle
      perofcon(10,m)=0.02+lognrnd(-4.00,0.450); % used vehicle
      perofcon(11,m)=0.02+lognrnd(-4.23,0.442); % gasoline
      perofcon(12,m)=0.01+0.01*betarnd(2.47,1.44); % vehicle insurance
      perofcon(13,m)=0.01+lognrnd(-5.71,0.227); % healthcare excluding insurance
      perofcon(14,m)=0.01+gamrnd(25.2,0.000258); % health insurance
      perofcon(15,m)=0.03+gamrnd(25.2,0.000513); % entertainment
      perofcon(16,m)=0.01*betarnd(18.6,12.5365); % tobacco products
      perofcon(17,m)=0.07+0.04*betarnd(8.29,7.99); % other expenditures
      per = 0; % percentage of all expenditures
      for l=1:17
         per = per + perofcon(l,m);
      end;
```

```
      perofcon(18,m)=1-per; % percentage of after tax income for saving

      % main procedure: cash flows
      if m==1
        expen=0; % the total expenditures inclding inirect individuals
        for j=1:18
          con(j,m) = perofcon(j,m)*atinc(n,1);
          expen = expen+con(j,m);
          if j==1||j==4||j==5||j==7||j==12||j==14||j==18
            contax(j,m) = 0*con(j,m);
          else
            contax(j,m) = (0.07/1.07)*con(j,m);
          end;
        end;
      else
        ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
        expen = 0; % initial the expenditures for the m th routine where m is larger than 1
        for j=1:18
          con(j,m) = perofcon(j,m)*ininc;
          expen = expen+con(j,m);
          if j==1||j==4||j==5||j==7||j==12||j==14||j==18
            contax(j,m)=0*con(j,m);
          else
            contax(j,m)=(0.07/1.07)*con(j,m);
          end;
        end;
      end;
    end;
    % obtain the sum of the expenditures taxes and add it to tax
    sumcontax2(n,i) = sum((sum(contax))');
    tax2(n,i) = tax2(n,i)+sumcontax2(n,i);
    stax2(n,i) = stax2(n,i)+sumcontax2(n,i);
  end;

  % Expenditures Determination based on income for stage 3
  for i=1:10
    m=0;
    expen = inc(n,2);
    while expen > 0.01*inc(n,2) % routines stoped when the total expenditures less than 1% of income
      ininc = 0; % the indirect increased income from the expenditures
      m = m+1; % the m th routine
      perofcon(1,m)=0.05+lognrnd(-4.61,0.303); % food at home
      perofcon(2,m)=0.04+lognrnd(-5.23,0.300); % food away home
      perofcon(3,m)=lognrnd(-4.95,0.0933); % alcoholic beverages
      perofcon(4,m)=0.1+weibrnd(2.05*10^8,4.93); % owned housing
      perofcon(5,m)=0.03+lognrnd(-4.60,0.274); % rented housing
      perofcon(6,m)=0.11+lognrnd(-5.00,0.481); % house repairing and maintainance
      perofcon(7,m)=0.05+0.01*betarnd(3.4,6.1); % utilities
      perofcon(8,m)=0.02+lognrnd(-4.31,0.301); % clothes
      u6=rand; perofcon(9,m)=(u6<=(0.038-0.01)/(0.05-0.01)).*(0.01+sqrt((0.05-0.01)*(0.038-
0.01)*u6))+(u6>(0.038-0.01)/(0.05-0.01)).*(0.05-sqrt((1-u6)*(0.05-0.01)*(0.05-0.038))); % new
vehicle
      perofcon(10,m)=0.01+0.04*betarnd(4.79,5.17); % used vehicle
      perofcon(11,m)=0.02+lognrnd(-4.47,0.439); % gasoline
      perofcon(12,m)=0.01+weibrnd(2.61*10^11,5.14); % vehicle insurance
      perofcon(13,m)=0.01+0.01*betarnd(18.3,12.5); % healthcare excluding insurance
      perofcon(14,m)=0.01+lognrnd(-4.87,0.149); % health insurance
      perofcon(15,m)=0.03+lognrnd(-4.30,0.223); % entertainment
      perofcon(16,m)=lognrnd(-5.18,0.162); % tobacco products
```

```
    u7=rand; perofcon(17,m)=(u7<=(0.094-0.08)/(0.12-0.08)).*(0.08+sqrt((0.12-0.08)*(0.094-
0.08)*u7))+(u7>(0.094-0.08)/(0.12-0.08)).*(0.12-sqrt((1-u7)*(0.12-0.08)*(0.12-0.094))); % other
expenditures
    per = 0; % percentage of all expenditures
    for l=1:17
      per = per + perofcon(l,m);
    end;
    perofcon(18,m)=1-per; % percentage of after tax income for saving

    % main procedure: cash flows
    if m==1
      expen=0; % the total expenditures inclding inirect individuals
      for j=1:18
        con(j,m) = perofcon(j,m)*atinc(n,2);
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m) = 0*con(j,m);
        else
          contax(j,m) = (0.07/1.07)*con(j,m);
        end;
      end;
    else
      ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
      expen = 0; % initial the expenditures for the m th routine where m is larger than 1
      for j=1:18
        con(j,m) = perofcon(j,m)*ininc;
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m)=0*con(j,m);
        else
          contax(j,m)=(0.07/1.07)*con(j,m);
        end;
      end;
    end;
  end;
  % obtain the sum of the expenditures taxes and add it to tax
  sumcontax3(n,i) = sum((sum(contax))');
  tax3(n,i) = tax3(n,i)+sumcontax3(n,i);
  stax3(n,i) = stax3(n,i)+sumcontax3(n,i);
end;

% Expenditures Determination based on income for stage 4
for i=1:10
  m=0;
  expen = inc(n,3);
  while expen > 0.01*inc(n,3) % routines stoped when the total expenditures less than 1% of income
    ininc = 0; % the indirect increased income from the expenditures
    m = m+1; % the m th routine
    perofcon(1,m)=0.03+0.05*betarnd(8.48,7.35); % food at home
    u8=rand; perofcon(2,m)=(u8<=(0.0403-0.03)/(0.06-0.03)).*(0.03+sqrt((0.06-0.03)*(0.0403-
0.03)*u8))+(u8>(0.0403-0.03)/(0.06-0.03)).*(0.06-sqrt((1-u8)*(0.06-0.03)*(0.06-0.0403))); % food
away home
    perofcon(3,m)=normrnd(0.00698,0.000784); % alcoholic beverages
    perofcon(4,m)=0.1+lognrnd(-4.78,0.368); % owned housing
    perofcon(5,m)=normrnd(0.0279,0.00237); % rented housing
    perofcon(6,m)=0.1+lognrnd(-4.38,0.317); % house repairing and maintainance
    perofcon(7,m)=0.05+0.01*betarnd(1.79,3.78); % utilities
    perofcon(8,m)=0.02+0.03*betarnd(1.97,2.99); % clothes
    perofcon(9,m)=0.01+0.04*betarnd(5.92,7.22); % new vehicle
```

```
    perofcon(10,m)=0.01+lognrnd(-4.16,0.435); % used vehicle
    perofcon(11,m)=0.02+0.03*betarnd(2.71,4.1); % gasoline
    perofcon(12,m)=0.01+0.01*betarnd(6.71,1.86); % vehicle insurance
    perofcon(13,m)=0.01+gamrnd(25.2,0.000407); % healthcare excluding insurance
    perofcon(14,m)=0.01+gamrnd(25.2,0.000365); % health insurance
    perofcon(15,m)=0.03+0.02*betarnd(12.6,12.1); % entertainment
    perofcon(16,m)=0.01*betarnd(21.5,14.5575); % tobacco products
    perofcon(17,m)=0.1+lognrnd(-4.01,0.302); % other expenditures
    per = 0; % percentage of all expenditures
    for l=1:17
      per = per + perofcon(l,m);
    end;
    perofcon(18,m)=1-per; % percentage of after tax income for saving

    % main procedure: cash flows
    if m==1
      expen=0; % the total expenditures inclding inirect individuals
      for j=1:18
        con(j,m) = perofcon(j,m)*atinc(n,3);
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m) = 0*con(j,m);
        else
          contax(j,m) = (0.07/1.07)*con(j,m);
        end;
      end;
    else
      ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
      expen = 0; % initial the expenditures for the m th routine where m is larger than 1
      for j=1:18
        con(j,m) = perofcon(j,m)*ininc;
        expen = expen+con(j,m);
        if j==1||j==4||j==5||j==7||j==12||j==14||j==18
          contax(j,m)=0*con(j,m);
        else
          contax(j,m)=(0.07/1.07)*con(j,m);
        end;
      end;
    end;
  end;
  % obtain the sum of the expenditures taxes and add it to tax
  sumcontax4(n,i) = sum((sum(contax))');
  tax4(n,i) = tax4(n,i)+sumcontax4(n,i);
  stax4(n,i) = stax4(n,i)+sumcontax4(n,i);
end;

% Expenditures Determination based on income for stage 5
for i=1:10
  m=0;
  expen = inc(n,4);
  while expen > 0.01*inc(n,4) % routines stoped when the total expenditures less than 1% of income
    ininc = 0; % the indirect increased income from the expenditures
    m = m+1; % the m th routine
    perofcon(1,m)=0.04+0.04*betarnd(5.4,6.19); % food at home
    perofcon(2,m)=normrnd(0.0424,0.00384); % food away home
    perofcon(3,m)=lognrnd(-4.91,0.105); % alcoholic beverages
    perofcon(4,m)=0.09+lognrnd(-4.04,0.305); % owned housing
    perofcon(5,m)=0.01+weibrnd(3.98*10^9,5.28); % rented housing
    perofcon(6,m)=normrnd(0.127,0.0122); % house repairing and maintainance
```

```
      perofcon(7,m)=0.05+lognrnd(-4.85,0.301); % utilities
      perofcon(8,m)=random('uniform',0.02,0.04); % clothes
      perofcon(9,m)=0.01+0.05*betarnd(2.56,2.61); % new vehicle
      perofcon(10,m)=random('uniform',0.01,0.04); % used vehicle
      perofcon(11,m)=0.02+0.03*betarnd(2.94,4.43); % gasoline
      perofcon(12,m)=0.01+gamrnd(25.2,0.000301); % vehicle insurance
      perofcon(13,m)=0.02+lognrnd(-4.75,0.271); % healthcare excluding insurance
      perofcon(14,m)=0.02+gamrnd(15.2,0.000485); % health insurance
      perofcon(15,m)=0.03+gamrnd(23.1,0.000594); % entertainment
      perofcon(16,m)=weibrnd(1.23*10^16,7.37); % tobacco products
      perofcon(17,m)=0.09+0.03*betarnd(1.65,0.886); % other expenditures
      per = 0; % percentage of all expenditures
      for l=1:17
         per = per + perofcon(l,m);
      end;
      perofcon(18,m)=1-per; % percentage of after tax income for saving

      % main procedure: cash flows
      if m==1
        expen=0; % the total expenditures inclding inirect individuals
        for j=1:18
          con(j,m) = perofcon(j,m)*atinc(n,4);
          expen = expen+con(j,m);
          if j==1||j==4||j==5||j==7||j==12||j==14||j==18
            contax(j,m) = 0*con(j,m);
          else
            contax(j,m) = (0.07/1.07)*con(j,m);
          end;
        end;
      else
        ininc = 0.5*expen; % assume 50% of the expenditures utilized to increase the workers' income
        expen = 0; % initial the expenditures for the m th routine where m is larger than 1
        for j=1:18
          con(j,m) = perofcon(j,m)*ininc;
          expen = expen+con(j,m);
          if j==1||j==4||j==5||j==7||j==12||j==14||j==18
            contax(j,m)=0*con(j,m);
          else
            contax(j,m)=(0.07/1.07)*con(j,m);
          end;
        end;
      end;
    end;
    % obtain the sum of the expenditures taxes and add it to tax
    sumcontax5(n,i) = sum((sum(contax))');
    tax5(n,i) = tax5(n,i)+sumcontax5(n,i);
    stax5(n,i) = stax5(n,i)+sumcontax5(n,i);
  end;

  % calculate the present worth of taxes for the whole career life
  PW(n,1) = inctax(n,1)*(((1+r)^10-1)/(r*(1+r)^10))/((1+r)^3)+inctax(n,2)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^13)+inctax(n,3)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^23)+inctax(n,4)*(((1+r)^10-1)/(r*(1+r)^10))/((1+r)^33);
  sPW(n,1) = sinctax(n,1)*(((1+r)^10-1)/(r*(1+r)^10))/((1+r)^3)+sinctax(n,2)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^13)+sinctax(n,3)*(((1+r)^10-
1)/(r*(1+r)^10))/((1+r)^23)+sinctax(n,4)*(((1+r)^10-1)/(r*(1+r)^10))/((1+r)^33);
  for i=1:40
    if i<=10
      PW(n,2) = PW(n,2)+sumcontax2(n,i)/((1+r)^i);
```

```
      PW(n,3) = PW(n,3)+tax2(n,i)/((1+r)^i);
      sPW(n,2) = sPW(n,2)+sumcontax2(n,i)/((1+r)^i);
      sPW(n,3) = sPW(n,3)+stax2(n,i)/((1+r)^i);
    elseif i>10&&i<=20
      PW(n,2) = PW(n,2)+sumcontax3(n,i-10)/((1+r)^i);
      PW(n,3) = PW(n,3)+tax3(n,i-10)/((1+r)^i);
      sPW(n,2) = sPW(n,2)+sumcontax3(n,i-10)/((1+r)^i);
      sPW(n,3) = sPW(n,3)+stax3(n,i-10)/((1+r)^i);
    elseif i>20&&i<=30
      PW(n,2) = PW(n,2)+sumcontax4(n,i-20)/((1+r)^i);
      PW(n,3) = PW(n,3)+tax4(n,i-20)/((1+r)^i);
      sPW(n,2) = sPW(n,2)+sumcontax4(n,i-20)/((1+r)^i);
      sPW(n,3) = sPW(n,3)+stax4(n,i-20)/((1+r)^i);
    else
      PW(n,2) = PW(n,2)+sumcontax5(n,i-30)/((1+r)^i);
      PW(n,3) = PW(n,3)+tax5(n,i-30)/((1+r)^i);
      sPW(n,2) = sPW(n,2)+sumcontax5(n,i-30)/((1+r)^i);
      sPW(n,3) = sPW(n,3)+stax5(n,i-30)/((1+r)^i);
    end;
  end;
end;
```

Appendix E: Notation

BD: Bachelor's Degree

FTR : the federal tax revenues

HD: Higher than Bachelor's Degree (Higher Degree)

i: the effective annual interest rate

Impact1: the ratio between the tax revenues from the two groups of individuals

Impact2: the increase of tax revenues by one dollar increased in individuals' income

Impact3: the difference of the taxes revenues between the two groups of individuals

Income : an individual's salary

p_c : the percentage of the after taxes income on each category of the expenditures

p_e : the percentage of the direct expenditures paid to the employees in the corresponding places

p_s : the minimum percentage of the individual's income to stop adding the indirect contributions

PW: the net present worth of the tax revenues received by the federal and the state & local governments tougher

PW_1: the net present worth of the income tax revenues received by the federal and the state & local governments tougher

PW_2: the net present worth of the sales tax revenues received by the federal and the state & local governments tougher

PW_3: the net present worth of the total tax revenues received by the federal and the state & local governments tougher

r_i: the income tax rate

r_{if} : the federal income tax rate

r_{in}: the increased rate of the incomes from one state to another

r_{is} : the state income tax rate

r_s : the sales tax rate

sPW: the net present worth of the tax revenues received by the state & local government

sPW_1: the net present worth of the income tax revenues received by the state & local government

sPW_2: the net present worth of the sales tax revenues received by the state & local government

sPW_3: the net present worth of the total tax revenues received by the state & local government

STR : the state tax revenues

t: the replicates running the model

TR : the total tax revenues