SIMULACIÓN ESTOCÁSTICA DE LA CARRERA SALARIAL EN MÉXICO

STOCHASTIC SIMULATION OF CAREER SALARY IN MEXICO

RECIBIDO: marzo 19 de 2014
ACEPTADO: mayo 8 de 2014

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Abstract

The aim of this work is to test two different models to simulate the evolution of the career salary in Mexico. This topic is relevant to a country with frequent variations of the career salary over the working life of the individuals and to its wide economic impact. For this purpose, we follow the linear regression method and a stochastic model. The results are that no homogeneity is found in the variables that explain the salary per industry, and that the estimated salary is better fitted with the stochastic model if economical shocks are present.

Keywords: Career salary, Linear regression, Brownian motion simulations, Economical sectors.

Resumen

El objetivo de este trabajo es poner a prueba dos modelos diferentes para simular la evolución de la carrera salarial en México. Este tema es relevante para un país con variaciones frecuentes en esta temática por encima de la vida laboral de los individuos y de su alto impacto económico. Para ello, se seguirá el método de regresión lineal y un modelo estocástico. Los resultados son que no se encuentra homogeneidad en las variables que explican el salario por la industria, y que el salario estimado está mejor equipado con el modelo estocástico si los shocks económicos están presentes.

Palabras Clave: Carrera salarial, Regresión lineal, Simulaciones con movimientos Brownianos, Sectores económicos.

INTRODUCTION

The study of the labor market is particularly relevant in the context of the emerging economies, where the capacity to generate enough and well paid jobs is a major issue; due their increasing working population and the current employment scarcity in their formal sectors. As well as in most of Latin American countries, the main income of working class population in Mexico comes from their salaries, reason for which its analysis is a pertinent topic in order to identify some of the specific conditions of the Mexican job market (Huesca & Cambreros 2009).

Since the decade of 1980, Mexico has faced some major economic reforms that have had many impacts in the labor market of the country. For instance, the first of those reforms originated modifications in the general job market structure, with direct effects in salaries. In consequence, during that decade the salary's gap increased meaningfully, particularly between the highest and the lowest income levels (Castro & Morales 2011). In addition, during the decade of 1990, in Mexico was observed a slightly growth of the mean salaries; which was relative higher among the less educated population and simultaneous to a reduction of the higher education salary premium (Martínez, Aguilera & Miranda 2012).

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[3] Until 2013, when a major labor reform was promulgated in Mexico.

Unlike other Latin American countries, the Mexican reforms had not included any modification to the labor laws[3], which has not been any obstacle for the actual implementation of policies regarding the labor flexibility. Nevertheless, this market flexibility has not had the desired outcomes for the workers. For instance, this condition have contributed to the foresaid wages disparities among educational levels, economic activities, industries, genders, regions, and other categories (Islas-Camargo & Cortez, 2004). As a result, according to OECD as of 2011, Mexico is the country with the lowest mean income among their members, which barely reach the 17% of the average.

However, to describe the evolution of the Mexican labor market indicators, as well as their characteristics and main variables, is not an easy target; particularly, the measure and forecasting of salaries. Regarding this, is important to recall that Mexico is a country with more than 40 million of economically active population, with a diversity of wages and benefits affected by inflation, human capital investment, unemployment, widespread informality, working risks and many others considerations that makes the Mexican labor market a complex subject (Martínez, et al. 2012).

Due this complexity and the importance of this topic for the economic policy of the country, the aim of this work is to use statistical tools to simulate the evolution of the career salary in Mexico, from a stochastic perspective. For this purpose, the layout of this work is as follows. Section II shows the existent literature relative to the labor market and the existing techniques to project the career salary. Section III describes the methodology and assumptions used in this work, based on two different models: linear regression and the one proposed by Cairns, Blake and Dowd (2006). Section IV shows the results from the projections. Section V a comparison of the results from the two models and section VI the conclusions.

LITERATURE REVIEW

Most of the studies of the Mexican labor market have been focused in the income inequality; but recent research has proposed that is inappropriate to approach the Mexican job market as an integrated entity, rather than a group of independent sub-markets with their own distinctiveness depending on the educational level of the workers, the industry, the regional location and other segmentation criteria (Islas-Camargo & Cortez, 2004).

For instance, Martínez, *et al.* (2012) point that in the export-oriented states the salaries growth has been above the national average; while on other hand, Islas-Camargo & Cortez (2004) argue that the relative demand of high skilled workers is the fundamental factor behind the wages gap. At the same time, that demand could be explained by the industrialization process originated by the increase of export activities, the technological changes and the direct foreign investment, as well as by the economical policies that have privileged some industries over others (Islas-Camargo & Cortez 2004; Castro & Morales 2011).

In a general sense, the national salary's policy in Mexico of the last decades has been influenced by the inflation control predominant during the 80's (Castro & Morales 2011; Martínez, *et al*. 2012), the increasing productive population, the participation of women in the job market, the improvement of educational levels, the raise of working hours, the insufficient economic growth and the widespread informality. The sum of those factors have originated both low unemployment and salaries in the country, as well as the foresaid income inequality (Huesca & Cambreros 2009; Castro & Morales 2011).

Another attribute of Mexican labor market is that the labor costs are a fundamental issue for the determination of prices; and consequentially, the inflation rate and the competitiveness of corporations, industries and regions (CONASAMI). In addition, Cairns, et al. (2006) affirm that the variations in the salaries levels during the working life can be considered as a fundamental risk for pensions purposes.

However, is also evident that in many cases the official minimal wage is not longer a valid reference for planning, budgeting or negotiation purposes in Mexico (CONASAMI). So, is pertinent to identify the most appropriate technique to forecast the career salary in the country. The most accepted method for making such estimations or projections is through stochastic simulations, which consist of generating a range of possible outcomes based on probabilities in a specified future date, considering various assumptions, and with an acceptable level of statistical significance (Blake, Cairns & Dowd 2001).

To this end, in this work we compare two forecasting techniques: the well known multiple linear regression and the stochastic method proposed by Cairns, Blake & Dowd (2006). According to Gujarati (2004), the linear regression analysis consists in estimate the dependence of a variable from others, from the basis of the known values of the independent variables. The resulting predictions with this method are based on the linear equation, which can be gotten from the mean values of the dependent variable observed for each level of the independent variables. That is, that for this specific work, the linear equations represent the mean salaries for each time unit. The most accepted technique to obtain those equations is the minimal quadratic method, developed by Carl Gauss.

On the other hand, Cairns, Blake & Dowd (2006) propose a stochastic model to design defined contribution pension plans, which consider three sources of risk: assets prices, interests and salary rates. Of course, for the purpose of this work we only focus in the estimation of the future salaries. Regarding this method, the authors explain the implications of the salary risk and propose a model to stochastically simulate the behavior of the career salary. They also remark that when the labor market is under a perfect system, it is not necessary to simulate the salary increases stochastically; nevertheless, if it is assumed that the labor market is imperfect, there is a probability factor in the career salary that is relevant to model, which applies to the case of Mexico.

METHODOLOGY AND MODEL

In this paper, to simulate the career salary of a worker in Mexico we assume two techniques: multiple linear regressions and the stochastic model postulated by Cairns, Blake & Dowd (2006). The two methods and the assumptions used are described below.

A. Multiple linear regression model

a. Description of the multiple linear regression model

According to the National Minimum Salary Commission of Mexico (CONASAMI, for its initials in Spanish) (CONASAMI 2002), the determination of salaries in Mexico is associated with the influence of six components of the Mexican economy, which are the labor market, the aggregate demand, the financial system, the sectorial system, the prices and inflation system, and the international trade. In order to analyze, measure and predict the relationship between salaries and such components, CONASAMI (2002) argues that the most relevant factors for each component are shown in Figure 1.

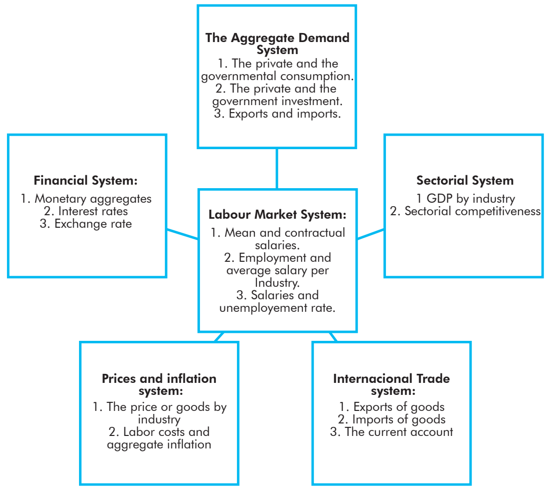

Figure 1. Structure of the macro-econometric model to measure the effect of the salary in Mexico

Taking the dimensions given in Figure 1 as a basis, several independent variables representing each factor were selected, based on macroeconomic theory, as well as the availability of information of the chosen variables. Table 1 shows the variables that are proposed in this paper to explain each model dimension of CONASAMI (2002). Subsequently they were defined as independent variables to conduct a multiple regression analysis in which the dependent variable is the salary of an average worker per sector from the Mexican economy.

The data used for the regression analysis are obtained as time series from the Bank of Mexico for the period of July 1998 to June 2013, for all variables listed in Table 1. It should be noted that the GIEA variable was used in substitution of the GDP, because the latter is published quarterly and reported two months after ending the quarter, making it difficult to use in econometric studies; while the GIEA is calculated on monthly basis and there is evidence that the growth rate of this index is a reasonably representative approximation of the observed trend of GDP (Elizondo 2012).

Representative/Independent variable	Dimension/ Component
Nationwide companies that conducted wage negotiations during the month (*COMP*)	Labor market
Workers benefited for wage negotiations in Mexico during the month (*WORK*)	Labor market
Global Index of Economic Activity (*GIEA*)	Aggregate demand
Prices and Quotations Index of the Mexican Stock Exchange (*PQI*)	Financial system
Index of Real Exchange Rate (*IRER*)	Financial system
Industrial Production (volume) Index (*IPI*)	Sectorial system and aggregate demand
National Consumer Price Index (*NCPI*)	Price-Inflation System
Gross Fixed Capital Formation volume (*GFCF*)	Sectorial system and aggregate demand
General Export Price Index in Dollars (*GEPI*)	International trade and price-inflation system
General Import Price Index in Dollars (*GIPI*)	International trade and Price-inflation system

Table 1. Variables considered in the multiple regression of the wage scale in Mexico

b. Accepted assumptions for the multiple linear regression

To model the salary with this methodology, the average salary contribution base to the Mexican Social Security Institute (IMSS) is divided by economic activities, since it is considered to be a more specific analysis. The sectors that were considered for the study are: *agriculture, farming, forestry, hunting and fishing; extractive industries; manufacturing industries; construction; power industry and water supply; commerce; transport and communications; services for businesses and individuals; and social services.*

For each series, monthly data provided by the Secretariat of Labor and Social Welfare of Mexico (STPS, by its initials in Spanish) is analyzed; covering the period between July 1998 and June 2013, in Mexican pesos. Although for a better understanding of the results some data are converted to U.S. Dollars when it is indicated[2]. Salaries are in real terms by discounting the effect of inflation, in order to study changes in the purchasing power rather than in nominal amounts, which do not represent the purchasing power of workers. Therefore, firstly a base year is established to choose a level of prices from a basket of consumer goods and services. June 2013 is the chosen base due to the latest data available for the analysis corresponds to it. With this reference, the purchasing power of nominal salaries in each period relative to the base period is calculated according to Formula (1):

$$Yreal_{2013}(t)=Ynom(t)\left(\frac{NCPI_{2013}}{NCPI_t}\right) \qquad (1)$$

Where:

$Yreal_{2013}(t)$ = Real salary in period t, with base 2013
$Ynom(t)$ = Nominal salary in t period
$NCPI_{2013}$ = National Consumer Price Index for June 2013
$NCPI_t$ = National Consumer Price Index for t period

B. Model of Cairns, Blake & Dowd (2006)

a. Model Description

In a simplified way, Cairns, Blake & Dowd (2006) propose that the salary career evolution of a worker is simulated based on Formula (2).

$$Y(t)=Y_H(t)\,Y_N(t) \qquad (2)$$

This model considers that salary variations clearly interfere in achieving an acceptable pension, so they should be treated as a risk. On this basis, career salary has two components: Y_H is the salary risk factor that is hedgeable and Y_N is the non-hedgeable salary risk factor. From this perspective, the risk associated with Y_H is the capital market, as part of the income of workers may be related to the evolution of the economy; while Y_N represents the wage developments independents of markets and economic situations. Equations (3) and (4) show the way in which these factors are calculated according to Cairns, Blake & Dowd (2006).

$$Y_H(t)=Y(0)exp\left[\left(r+\mu_Y-\frac{1}{2}\sigma_{Y1}^2\right)t+\sigma_{Y1}Z_1(t)\right] \qquad (3)$$

$$Y_n(t)=exp\left[-\frac{1}{2}\sigma_{Y0}^2+\sigma_0 Z_0(t)\right] \qquad (4)$$

Where:

$Y(0)$ = Last known salary
r = Real risk-free interest rate
μ_Y = Average real salary growth
σ_{Y0} = Standard deviation of the real salary growth
σ_{Y1} = Standard deviation of the actual performance of the capital market
$Z_1(t)$ y $Z_2(t)$ = Independent Brownian Movements

b. Assumptions

To model the salary with this methodology, the average salary contribution base to the Mexican Social Security Institute (IMSS) divided by sector is also taken as reference, as foresaid. In addition, Cairns, Blake & Dowd (2006) assume that the risk-free interest rate is constant, so the data set used in this work, corresponds to the historical returns of CETES[3] (28-Day duration) published by the Bank of Mexico between July 1998 and June 2013. While this information is presented in nominal annual data, it was required for this study to have the monthly actual data. Then, the series is transformed using Formulas (5) and (6).

[2] It is considered a parity of 13.03 Mexican Pesos per US Dollar, which is the average exchange rate at June 2013, according to the Bank of Mexico.
[3] Corresponds to a risk-free asset in Mexico.

$$r_{monthly}\ (t) = \sqrt[12]{1 + r_{annual}\ \ (t)} - 1 \quad (5)$$

$$r_{real}(t) = \left(\frac{1 + r_{nominal}\ (t)}{1 + i\,(t)}\right) - 1 \quad (6)$$

Where:

$r_{monthly}\ (t)$ = Risk-free interest rate in Mexico for a period t, on a monthly basis

$r_{annual}(t)$ = Risk-free interest rate in Mexico for a period t, in annual terms

$r_{real}(t)$ = Real risk-free interest rate in Mexico for a period t

$r_{nominal}\ (t)$ = Nominal risk-free rate in Mexico for a period t

$i(t)$ = Inflation rate in Mexico for a period t

The Formula (5) is used to convert annual data into monthly data, while Formula (6) is used to transform nominal rates into real interest rates. We assume r = 0.0025, which corresponds to the average monthly real risk free interest rate from July 1998 to June 2013.

RESULTS

A. Multiple Linear Regression

To perform the multiple regression analysis, the dependent variable y is defined as the salary of the worker by industry, shown as rows in Table 2. The independent variables $(x_1,x_2,\ldots,x_n)$ are defined as the representative variables shown as columns in Table 2. Thus, this analysis tries to determine whether the representative variables "explain" linearly the wage of a worker per industry using the least squares method.

In a first analysis, all independent variables were used for the multiple linear regression. The summarized results are shown in Table 2, from which it can be deduced that not all the representative variables explain the salary of a worker. That is, the statistical test performed to each variable per industry gives a p-value, which if p-value<0.05 we can conclude that the variable explains linearly the salary at a particular industry. On the other hand, if p-value≥0.05, we conclude that the variable does not explain linearly the salary at that industry[4]. From the previous analysis we can conclude also that there is no homogeneity on the variables that explain the salary per industry. For instance, the salary at extractive industries is explained by all the variables, but by IRER. However, only PQI, IPI, NCPI, GEPI and GIPI explain the agriculture industry.

Sector/Variable	R^2	P Value									
		COMP	WORK	GIEA	PQI	IRER	IPI	NCPI	GFCF	GEPI	GIPI
Agriculture, farming and others	0.759	0.953	0.157	0.419	0.00*	0.366	0.003	0.00*	0.444	0.001	0.002
Extractive Industries	0.979	0.007	0.035	0.047	0.003	0.710	0.00*	0.00*	0.00*	0.00*	0.00*
Manufacturing Industries	0.885	0.211	0.028	0.001	0.00*	0.121	0.00*	0.00*	0.128	0.00*	0.001
Construction	0.814	0.974	0.148	0.00*	0.012	0.029	0.00*	0.00*	0.010	0.002	0.001
Power industry and water supply	0.955	0.801	0.003	0.045	0.001	0.455	0.00*	0.00*	0.866	0.00*	0.00*
Commerce	0.835	0.004	0.037	0.00*	0.103	0.041	0.00*	0.00*	0.377	0.001	0.024
Transport and communications	0.701	0.261	0.018	0.008	0.00*	0.590	0.00*	0.00*	0.901	0.00*	0.00*
Services for businesses and individuals	0.792	0.002	0.022	0.00*	0.00*	0.009	0.00*	0.00*	0.550	0.00*	0.001
Social services	0.937	0.385	0.088	0.00*	0.00*	0.016	0.00*	0.00*	0.195	0.00*	0.00*

1) *It indicates that the value is p<0.001

Table 2. Results of the first multiple regression analysis

Given these results, it is then proceeded to conduct a second regression analysis taking into account only the variables that were significant per industry of the Mexican economy. The coefficient of determination (R^2) per each of the second regression equation is shown in Table 3.

Dependent variable	*R*
Agriculture, farming, forestry, hunting and fishing	0.8
Extractive industries	1.0*
Manufacturing industries	0.9
Construction	0.8
Power industry and water supply	1.0*
Commerce	0.8
Transport and communications	0.7
Services for businesses and individuals	0.8
Social services	0.9

1) * Indicates that the value is $R^2 > 0.95$

Table 3. Statistical R2 of the multiple regression analysis considering only the variables with acceptable significance

The results show that all the determination coefficients are acceptable . Derived from this analysis, the equations that determine the value of R^2 in Table 3, for the salary of each sector, are displayed in Equations (7) to (15).

agr=1664.191-.016PQI+12.168IPI+26.295NCPI+8.767GEPI-10.735GIPI (7)

extr = -3147.256-.380COMP+.018PQI+26.954IPI+61.604NCPI-18.984GEPI+41.041GIPI (8)

man = 2102.556-23.016GIEA-.023PQI+40.494IPI+58.498NCPI+17.454GEPI-17.513GIPI (9)

[4] The statistical test performed was H_0:β_i=0 vs H_1:β_i≠0, where β_i is the coefficient of the variable x_i at the regression model at a confidence interval of 90%.

[5] Statistically speaking it can be said that if the data explained 70% or more the variation of y, then the regression equation is "acceptable." This level of acceptance depends on the statistician or analyst using these techniques.

con=2637.501 - 29.345 GIEA - .012PQI - 5.429IRER + 31.452IPI + 37.374NCPI + 13.440GFCF + 10.074GEPI - 13.207GIPI (10)

pow=-2172.625-.001WORK-.047PQI+81.716IPI+152.622NCPI+38.006GEPI-41.503GIPI (11)

com=3304.714 + .228COMP - 43.552-GIEA-5.383IRER + 52.807IPI + 35.980NCPI +10.367GEPI - 10.035GIPI (12)

tra=4687.651 - 31.890GIEA - .024PQI+58.676IPI + 50.212NCPI + 23.911GEPI - 26.106GIPI (13)

sbi=3897.860 + .237COMP - 28.060GIEA - .015PQI - 5.747IRER + 46.394IPI + 30.239NCPI + 13.319-GEPI - 10.999GIPI (14)

soc=901.856 - 28.886GIEA - .024PQI + 7.124IRER + 56.432IPI + 74.842NCPI + 24.887GEPI - 29.215-GIPI (15)

Where:
agr = Real salary of agriculture, farming, forestry, hunting and fishing
ext = Real salary of the extractive industries
man = Real salary of the manufacturing industries
con = Real salary of the construction industry
pow = Real salary of the power industry and water supply
com= Real salary of the commerce
tra = Real salary of the transport and communications industry
sbi = Real salary of the services for businesses and individuals
soc = Real salary of the social services
COMP = Nationwide companies that conducted wage negotiations during the month
WORK = Workers benefited for wage negotiations in Mexico during the month
GIEA = Global Index of Economic Activity
PQI = Prices and Quotations Index of the Mexican Stock Exchange
IRER = Index of Real Exchange Rate
IPI = Industrial Production (volume) Index
NCPI = National Consumer Price Index
GFCF = Gross Fixed Capital Formation volume
GEPI = General Export Price Index in Dollars
GIPI = General Import Price Index in Dollars

As pointed out from Table 2, there is no homogeneity of the variables affecting the salary per industry. From previous Equations (7 to 15), the only variables that show a direct relationship in all cases are the Industrial Production Index (IPI) and the National Consumer Price Index (NCPI). While the ones that are less correlated with the salaries in most of the sectors are the nationwide companies that conducted wage negotiations during the month (COMP), the workers benefited for wage negotiations in Mexico during the month (WORK) and the Gross Fixed Capital Formation volume (GFCF). These results are displayed in Table 4. This is considered a first justification to assume that the salary should be divided per sector of the Mexican economy for its analysis.

Sector/Variable	COMP	WORK	GIEA	PQI	IRER	IPI	NCPI	GFCF	GEPI	GIPI
Agriculture, farming and others	0	0	0	-	0	+	+	0	+	-
Extractive Industries	-	0	0	+	0	+	+	-	-	+
Manufacturing Industries	0	0	-	-	0	+	+	0	+	-
Construction	0	0	-	-	-	+	+	+	+	-
Power industry and water supply	0	-	0	-	0	+	+	0	+	-
Commerce	+	0	-	0	-	+	+	0	+	-
Transport and communications	0	0	-	-	0	+	+	0	+	-
Services for businesses and individuals	+	0	-	-	-	+	+	0	+	-
Social services	0	0	-	-	+	+	+	0	+	-

Table 4. Relationship between the independent variables and the analyzed series

An economic, as well as an intuitive, explanation of the results shown in Table 4 is as follows. The fact that salaries for all the analyzed sectors show a positive relationship with the NCPI supports the economic intuition that salary adjustments offset the loss of the purchasing power; hence, this result. On the other hand, it emphasizes that the Industrial Production (volume) Index (IPI) is also found to be associated with all sectors, despite of that in the methodology used by the National Institute of Geography and Statistics of Mexico to calculate this index, is only considered the industries of mining, electricity, water and gas supply per pipeline to the final consumer, construction and manufacturing industries (INEGI 2010). For this reason, it is presumed that in Mexico these activities provide sufficiently significant economic benefits, that impact the other sectors of the economy.

Other variables that show important relationships with the salary level per industry are export prices and import prices. Contrary to the prices of imports, in the first case, a positive relationship with all industries is observed, except for the extractive industries. This phenomenon could be caused by the issues suggested by Hernandez (2012), who argues that exporting firms usually can pay better salaries. However, this hypothesis does not explain the context of extractive industries in which is content the country's most important economic activity: the oil industry. Certainly, the price of hydrocarbon varies according to the rates set out within international markets, while salaries in the oil sector of Mexico are influenced by political decisions, union negotiations, retirement and personnel senior severance pay and the increasing practice of outsourcing; to mention just some of the factors involved in this complex industry.

Another variable that shows relationships with most of the salary series is the performance of the capital market, represented by the Prices and Quotations Index of the Mexican Stock Exchange (PQI). Just as the prices of exports and imports, the PQI shows a positive relationship with the extractive industries and a negative relationship with the other sectors. The difference is that this last variable has no impact on commerce. In this regard, it is relevant to consider that the PQI is composed of a sample of 35 companies, which although are the most negotiated within the Mexican Stock Market, can hardly represent a significant sample of all companies established in the country. Finally, the analyzed variables that have a very limited impact on the real salary career of most industries in Mexico are: the nationwide companies that conducted wage negotiations during the month (COMP), the workers benefited for wage negotiations in Mexico during the month (WORK), the Global Index of Economic Activity (GIEA), the Index of Real Exchange Rate (IRER) and the Gross Fixed Capital Formation volume (GFCF).

B. Stochastic Model of Cairns, Blake y Dowd (2006)

To simulate the career salary of a worker in Mexico assuming the model of Cairns, Blake & Dowd (2006) Equations (2), (3) and (4) are used. A description of the calculations performed to obtain values for this model and the corresponding assumptions, are showed as follows.

a. Last known salary

As previously noticed, the salary information is provided by the Mexican Secretariat of Labor and Social Welfare (STPS for its initials in Spanish), corresponding to the period between July 1998 and June 2013. Then, the last known monthly salary for each of the sectors analyzed is assumed to be Y(0) at a period of June 2013. This is because Y(0) can be seen as the starting point of the projected values of the salary for each sector. These values are shown in Table 5.

Sector	Mexican pesos	U.S. Dollars
Agriculture, farming, forestry, hunting and fishing	3,789	291
Extractive industries	10,643	817
Manufacturing industries	6,876	528
Construction	4,713	362
Power industry and water supply	16,334	1,254
Commerce	5,737	440
Transport and communications	8,014	615
Services for businesses and individuals	6.565	504
Social services	7,123	547

Source: STPS 1) The exchange rate corresponds to June 2013

Table 5. Last known monthly salaries at June 2013

b. Mean, standard deviation and variance of the real salary growth

To determine the mean, standard deviation and variance of the real wage growth in each of the sectors analyzed, monthly increases in real salaries are obtained according to (16). After obtaining the series of salary increases; the mean, standard deviation and variance are calculated and shown in Table 6.

$$\Delta Y(t) = \ln\left(\frac{Y}{Y_{t\text{-}1}}\right) \quad (16)$$

Sector	$\mu_Y(t)$	σ_{Y0}
Agriculture, farming, forestry, hunting and fishing	0.001	0.016
Extractive industries	0.004	0.022
Manufacturing industries	0.002	0.015
Construction	0.001	0.014
Power industry and water supply	0.003	0.019
Commerce	0.001	0.026
Transport and communications	0.001	0.020
Services for businesses and individuals	0.001	0.015
Social services	0.002	0.010

Table 6. Mean, standard deviation, and variance of the real monthly salary growth from June 1998 to June 2013

c. Standard deviation and variance of the capital market performance

Cairns, Blake & Dowd (2006) suggest that there may be some relationship between the capital market performance and the salary growth. This is because this salary growth may be caused by the evolution of the economic situation and profitability of the firms. Then, the standard deviation and the variance of the real monthly returns of the Prices and Quotations Index of the Mexican Stock Exchange are calculated for the period from July 1998 to June 2013. The results are then assumed to be σ_Y1 and σ_Y1^2 with the corresponding values 0.0667 and 0.0044, respectively.

d. Independent Brownian motions

To estimate the independent Brownian motions, a normal distribution with mean $\mu = 0$ and standard deviation $\sigma = 1$ is assumed, obtaining a random number that corresponds to Z_j (t).

e. The Career Salary

We believe that before making any projections of the career salary assuming the model by Cairns, Blake & Dowd (2006), it is important to clarify that the purpose of this method it is not to predict the actual value of the salary at a given date, but to simulate the tendency that may follow this variable over time. To this end, the possibility of the presence of perturbations is assumed, which are incorporated to the model though the Brownian motions; as well as the relationship between salary increases and the capital market performance. Derived from this analysis and with the assumptions being mentioned, the equations used for the stochastic simulations are (17) to (25); the dependent variables being the same as for the defined variables in Equations (7) to (15) using the multiple regression model as follows:

$$agr(t)=3789.71\left[exp\left(\left[0.0025+0.0012-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{agr1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0003)+0.0164Z_{agr0}(t)\right)\right] \quad (17)$$

$$ext(t)=10643.41\left[exp\left(\left[0.0025+0.0039-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{ext1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0005)+0.0215Z_{ext0}(t)\right)\right] \quad (18)$$

$$man(t)=6876.00\left[exp\left(\left[0.0025+0.0018-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{man1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0002)+0.0148Z_{man0}(t)\right)\right] \quad (19)$$

$$con(t)=4713.04\left[exp\left(\left[0.0025+0.0014-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{con1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0002)+0.0141Z_{con0}(t)\right)\right] \quad (20)$$

$$pow(t)=16333.49\left[exp\left(\left[0.0025+0.0032-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{pow1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0004)+0.0192Z_{pow0}(t)\right)\right] \quad (21)$$

$$com(t)=5736.56\left[exp\left(\left[0.0025+0.0012-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{com1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0007)+0.0260Z_{com0}(t)\right)\right] \quad (22)$$

$$tra(t)=8013.85\left[exp\left(\left[0.0025+0.0008-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{tra1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0004)+0.0203Z_{tra0}(t)\right)\right] \quad (23)$$

$$sbi(t)=6565.30\left[exp\left(\left[0.0025+0.0007-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{sbi1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0002)+0.0152Z_{sbi0}(t)\right)\right] \quad (24)$$

$$soc(t)=7122.64\left[exp\left(\left[0.0025+0.0022-\tfrac{1}{2}(0.0044)\right]t+0.0667Z_{soc1}(t)\right)\right]\left[exp\left(-\tfrac{1}{2}(0.0001)+0.0096Z_{soc0}(t)\right)\right] \quad (25)$$

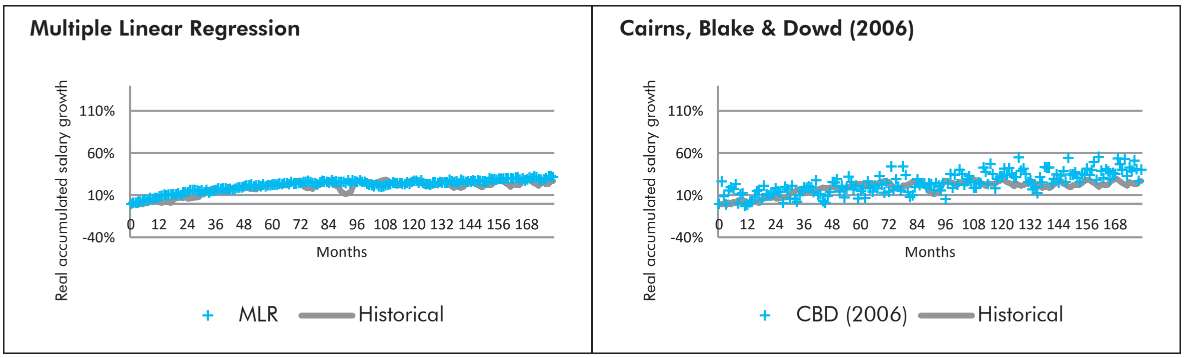

Figure 2. Agriculture, farming, forestry, hunting and fishing activities salary; using multiple regression and Cairns, Blake & Dowd model

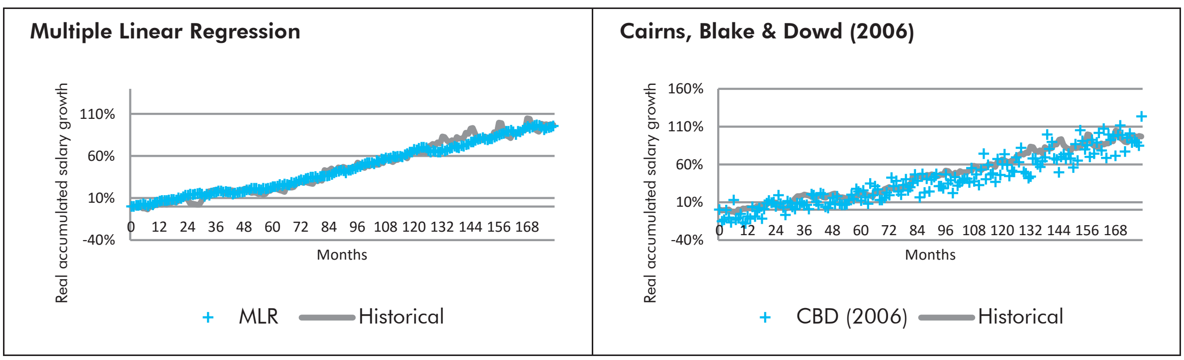

Figure 3. Extractive industries salary; using multiple regression and Cairns, Blake & Dowd model

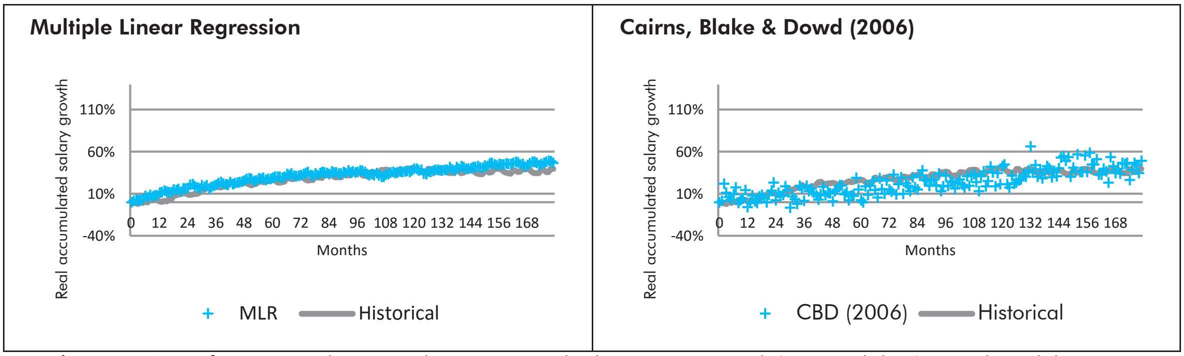

Figure 4. Manufacturing industries salary; using multiple regression and Cairns, Blake & Dowd model

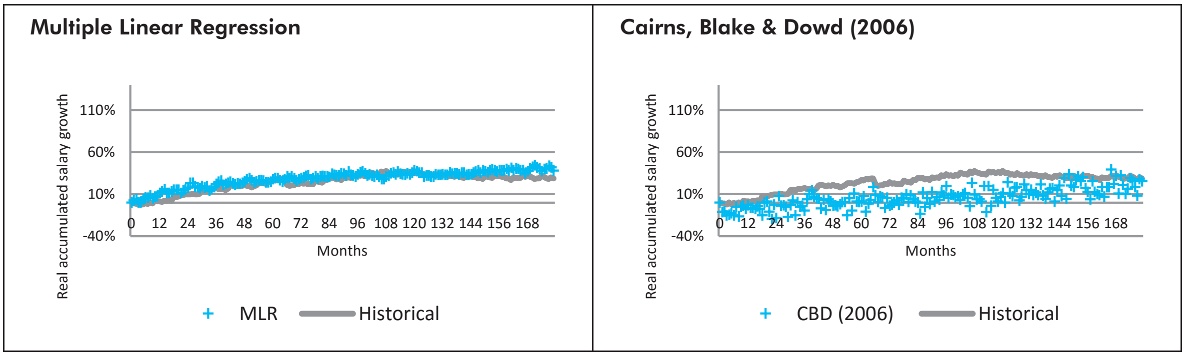

Figure 5. Construction industry's salary; using multiple regression and Cairns, Blake & Dowd model

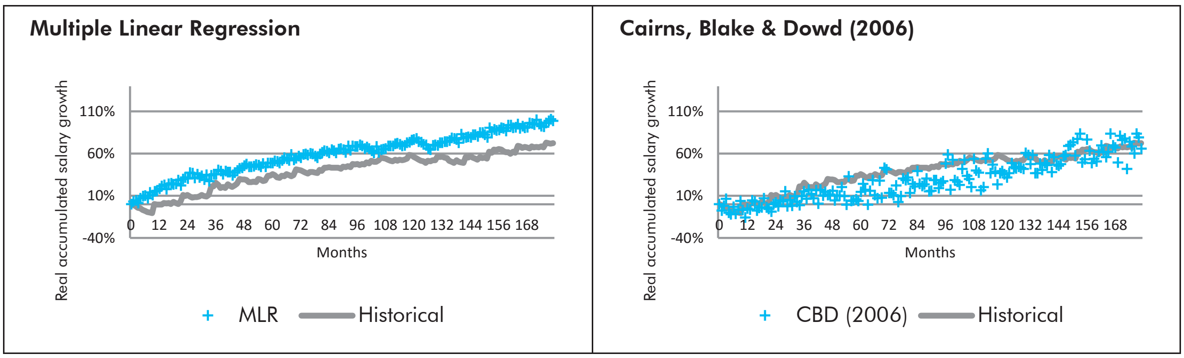

Figure 6. Power industry and water supply salary; using multiple regression and Cairns, Blake & Dowd model

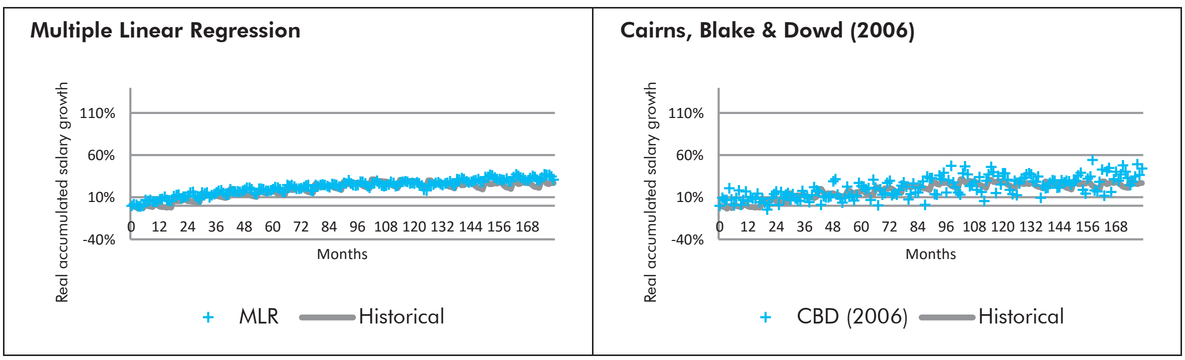

Figure 7. Commerce's salary; using multiple regression and Cairns, Blake & Dowd model

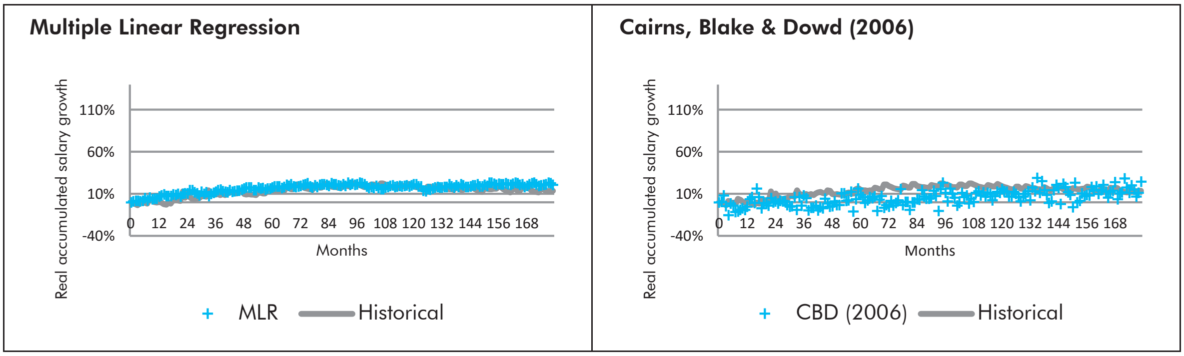

Figure 8. Transport and communications sectors salary; using multiple regression and Cairns, Blake & Dowd model

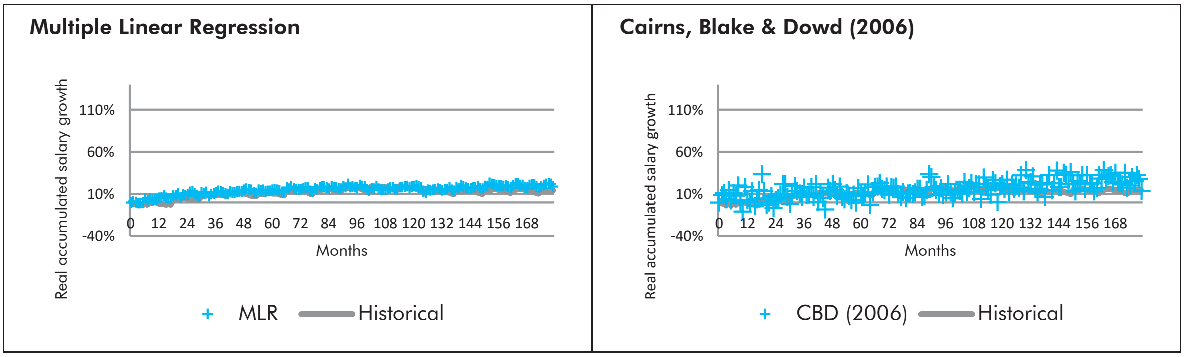

Figure 9. Services for businesses and individuals salary; using multiple regression and Cairns, Blake & Dowd model

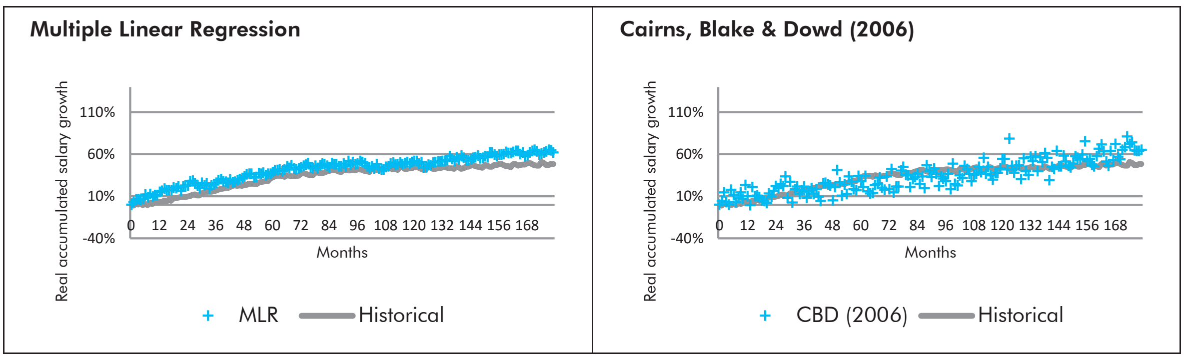

Figure 10. Social services salary; using multiple regression and Cairns, Blake & Dowd model

The results in Figures 2 to 10 show that when the multiple regression model and the Cairns, Blake & Dowd (2006) models are compared with the historical data, the latter has greater dispersion than the multiple regression model. Under this graphical result, we can conclude that the multiple regression model represents a better approximation to the historical data for the salary of all sectors in the case of Mexico. Of course, this is true only when the non-existence of shocks is assumed.

The only sector where a greater difference can be perceived between the multiple regression and the historical data is the power industry and water supply in Figure 6. This is consistent with the previous analysis, where it was determined that, under the multiple regression model, there was a smaller number of independent variables that were statistical significant in comparison with other sectors, so the value of R^2 was relatively high (see Table 3). This can also be confirmed with the results exposed in Table 6, where it was shown that the values of the mean and the standard deviation of this sector were among the highest. Thus, it may be concluded that this exercise of comparison shows that both methods have their strengths and weaknesses. For instance, we concluded that the multiple regression model is considered a good approximation to the historical data, as long as there are no economic shocks and that the salary trajectory remains with a stable growth.

On the other hand, we concluded that the Cairns, Blake & Dowd (2006) model, although it showed a wide dispersion with historical data, it represents a good approximation to the career salary when greater uncertainty is considered. Fortunately, the historical data for all sectors in Mexico shown in Figures 2 to 10, demonstrates that the salary trajectory for all activities has an upward trend in a somehow stable manner.

CONCLUSIONS

The proper estimation of the salary tendency is a relevant matter for a country as Mexico, where the labor cost is a fundamental element for the determination of prices; and consequentially, the inflation rate and the competitiveness of corporations, industries and even regions. In addition, those variables are taken in account for labor negotiations and other social benefits, as pensions. Nevertheless, the appropriate prediction of the future salaries is not an easy task in a country characterized by a meaningful wage gap, insufficient economic growth and a widespread informal sector.

For those reasons, in the present work we analyzed the pertinence of two techniques to predict the behavior of the career salary in Mexico: the multiple linear regression and the methodology proposed by Cairns, Blake & Dowd (2006). For the first method, it was important to define previously, the macroeconomic variables that explain the salary evolution for which it was possible to develop a projection model. In the second model, the presence of economic and financial market shocks was assumed, which were incorporated through the Brownian motion variables.

According to the results, we concluded that the multiple linear regression model is an effective tool to predict the salary trajectory, as long as an stable environment is assumed. For instance, if it is supposed that the future trend will be similar to the historical career salary, as well as the correlation of real salaries with the macroeconomic indicators, then this model represented a good approximation. On the contrary, if an uncertain future context is assumed, in which the behavior of salaries does not necessarily follow a linear trend, it was recommended to simulate the salaries using the Cairns, Blake & Dowd (2006) model, which incorporates such uncertainty.

It is important to point out that the existent heterogeneity between the salaries of different industries in Mexico, leaded us to divide our study by sector. In this regard, a variety of trends and dispersion was observed. Additionally, the variables that represented the career salary were quite different for each of the sectors. For this reason, we believe that was inappropriate to suggest the application of a single model to explain the salary evolution in the country in general terms, so the variables and the prediction technique must be adapted to the characteristics of the analyzed sector.

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