

ARE MEXICAN MANUFACTURING WORKERS UNDERPAID? SOME QUARTERLY TIME SERIES EVIDENCE

Vicente German-Soto

Autonomous University of Coahuila, Mexico

Gregory Brock

Georgia Southern University, U.S.A.

ABSTRACT

The quarterly empirical relationship between Mexican manufacturing labor productivity and salaries 1993-2015 is examined for causality and whether first order labor market equilibrium is evident. An equilibrium would mean salaries and labor productivity are cointegrated. Wages above productivity levels may lead to calls for government intervention in the labor market. Federal quarterly data cover the nine main divisions of the manufacturing sector (old classification) as well as manufacturing overall. We use two series: labor productivity and average salaries with adjustment for inflation using the US consumer price index (2010 = 100). The time series is from 1993.1 to 2015.3. Standard cointegration analysis with structural change is applied with structural breaks hypothesized in 2008 with the Great Recession and 1995 with the Peso crisis. Tests for stationarity are applied to potentially correct for problems using first differences. Results indicate a statistically significant and negative relationship between labor productivity and salaries early in the sample period that becomes positive after structural changes. Salaries are more sensitive to events and volatile while productivity exhibits stable growth during 1993-2015. Salaries were impacted by both the 1995 Peso crisis and the Great Recession (2008) but productivity was only impacted by the latter. Higher labor productivity has not been rewarded with higher salaries suggesting Mexican manufacturing workers are underpaid. The firms where they work therefore have excess profits that can be used for investment and/or pay raises. Only the Timber and Metals divisions are found to not have salaries and productivity cointegrated. Government intervention in the form of wage setting or wage protection to protect firms from higher labor costs is unnecessary as firms are underpaying their workers. The government should reduce its role in the manufacturing labor markets. Foreign firms can hire underpaid workers away from domestic industry and take advantage of the labor market disequilibrium. Unions can insist on higher salaries to match their highly productive members work.

JEL Classifications: C22, L60, O47

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Corresponding Author's Email Address: gbrock@georgiasouthern.edu

INTRODUCTION

Labor market disequilibrium suggests higher salaries without higher labor productivity could produce destabilizing inflation leading to macroeconomic instability. In some countries such as Mexico, the threat of such instability is addressed by governmental control of the growth of salaries and union wage bargaining within a given inflation rate ceiling. Such controls are believed to be essential to attract FDI in to manufacturing in a highly competitive global environment where high inflation can significantly reduce

incoming flows of FDI needed to improve labor productivity. Manufacturing is the focus as it is often seen in developing countries as the key to modernization and positive spillovers (Tybout 2000). In Mexico, however, the interference in the manufacturing labor market by the government and unions is excessive as real manufacturing salaries have fallen by 70% since the 1980s. As manufacturing labor productivity has grown over the same time period, there is ample room for salaries to increase without causing inflation. Improved human capital appears to benefit employers more than employees resulting in measured labor productivity being higher than in the 1990s (Lopez-Acevedo 2003 and González Martínez 2005) continuing through 2015. Discussions of how much salaries can increase in the future must consider the past quarter century of labor market disequilibrium.

We examine the economic history across nine divisions of the Mexican manufacturing sector plus the sector overall. We test the classical (Solow 1956) macroeconomic finding that productivity drives salary growth, though others have found just the opposite (Gordon 1987 and 2000, Bester & Petrakis 2003 & 2004). First, in our estimates causality is in the direction of productivity to salaries. Second, we believe that Mexican manufacturing is far away from the relatively extreme market structures of monopoly and perfect competition which are usually considered to justify the opposite causality from salaries to productivity. More recently, some authors have found that changes in the labor market can explain the behavior of productivity growth in the EU and US (Dew-Becker & Gordon 2008, Bester, Milliou & Petrakis 2012). Productivity causing salary increases appears in the Chinese manufacturing sector (Zhang & Liu 2013) though the relationship appears to weaken over time. Biesebroeck (2011) finds a similar result for some Sub-Saharan African countries if they are relatively rich. In the remainder of the paper we outline the method (section 2), describe the data (section 3), discuss the results (section 4) and conclude (section 5).

METHODOLOGY: STATIONARITY AND COINTEGRATION

Labor market equilibrium suggests workers should be paid the value of their marginal product. In developed countries, there is a strong positive relationship between real wages and productivity (Yildirim 2015). We examine whether this is true 1993-2015 both descriptively and with time series tests. Standard time series tests reveal if salary and labor productivity series are stationary over the sample period. If the mean and variance do vary over time, we conduct a standard first difference approach to potentially get a stationary series. If x_t is stationary then its distribution is characterized by the first (mean) and second moments (the variance and covariance) called a Gaussian process (for a discussion on these properties see Maddala & Kim 1998):

$$\begin{aligned}\mu_t &= E(x_t) \\ \sigma_t^2 &= \text{var}(x_t) \\ \gamma_{t_1, t_2} &= \text{cov}(x_{t_1}, x_{t_2})\end{aligned}\tag{1}$$

A time series is said to be strictly stationary if the joint distribution of $x_{t_1}, \dots, x_{t_n}$ is the same as the joint distribution of $x_{t_1+\tau}, \dots, x_{t_n+\tau}$ for all $t_1, \dots, t_n$, and τ lags. The distribution of the stationary process remains unchanged when shifted in time by an arbitrary value τ .

The parameters which characterize the distribution of the process do not depend on t but do depend on the lag value τ . If non-stationary variables have a linear combination that is stationary they are cointegrated. Structural breaks can change long run stationarity, so they must be controlled for.

SINGLE VARIABLE STATIONARITY WITH AND WITHOUT STRUCTURAL CHANGE

The presence of a unit root for a single variable is examined first. We apply the modified test of Ng & Perron (2001) because it addresses problems of serial correlation and has good statistical properties for the time period of our sample. We assume the following stochastic process:

$$\Delta \tilde{x}_t = \beta_0 \tilde{x}_{t-1} + \sum_{j=1}^k \hat{\beta}_j \Delta \tilde{x}_{t-j} + e_{tk} \quad (2)$$

Where $\Delta \tilde{x}_t$ is the variable of interest in first differences and the sum of k terms to the right of the equation are introduced to control for serial correlation. The coefficient of $\tilde{x}_{t-1}$ tests for stationarity. The Ng & Perron (2001) test is derived from the unit root tests of Elliot, Rothenberg & Stock (1996) and Perron & Ng (1996) who propose four modified unit root tests (known as M tests):

$$\begin{aligned} MZ_{\alpha}^{GLS} &= \left(T^{-1} \tilde{x}_T^2 - s_{AR}^2 \right) \left(2T^{-2} \sum_{t=1}^T \tilde{x}_{t-1}^2 \right)^{-1} ; \\ MSB^{GLS} &= \left(T^{-2} \sum_{t=1}^T \tilde{x}_{t-1}^2 \right)^{1/2} s_{AR}^2 ; \\ MZ_t^{GLS} &= MZ_{\alpha}^{GLS} \times MSB^{GLS} ; \\ MP_T^{GLS} &= \begin{cases} \left[\bar{c}^{-2} T^{-2} \sum_{t=1}^T \tilde{x}_{t-1}^2 - \bar{c} T^{-1} \tilde{x}_T^2 \right] s_{AR}^2 & \text{for a constant only} \\ \left[\bar{c}^{-2} T^{-2} \sum_{t=1}^T \tilde{x}_{t-1}^2 + (1 - \bar{c}) T^{-1} \tilde{x}_T^2 \right] s_{AR}^2 & \text{for constant and linear trend} \end{cases} \end{aligned}$$

In addition, we also calculate the ADF - GLS statistic. The regression equation in (2) requires the definition of the lag order for the autoregressive correction. Ng & Perron (2001) suggest selecting k like $k_{maic} = \arg \min_k MAIC(k)$, with

$$MAIC(k) = \ln \hat{\sigma}_k^2 + \frac{2(\tau_T(k) + k)}{T - k_{\max}} \quad (3)$$

Where $\tau_T(k) = \hat{\sigma}_k^{-2} \hat{\beta}_0 \sum_{t=k_{\max}+1}^T \tilde{y}_{t-1}^2$ and $\hat{\sigma}_k^2 = (T - k_{\max})^{-1} \sum_{t=k+1}^T \hat{e}_{tk}^2$ are calculated from the estimation of (2), and the maximum lag order $k_{\max}$ is selected such a way that $k_{\max}/T \rightarrow 0$ when $T \rightarrow \infty$. The literature suggests $k_{\max} = \text{int}(12(T/100)^{1/4})$ although other values that satisfied these conditions may be used. In Monte Carlo tests the authors find that the $MAIC(k)$ statistic produces the best results in the $ADF\text{-}GLS$ and P_T contrasts developed by Elliot, Rothenberg & Stock (1996). In all these tests, if the null hypothesis of a unit root is rejected the time series is stationary.

COINTEGRATION WITH AND WITHOUT STRUCTURAL CHANGE

A linear combination of two time series with unit roots may be stationary. We analyze residuals with and without structural change. If there is no structural change the Engle-Granger and Phillips-Ouliaris cointegration tests are used. Both determine whether single-equation estimates of the equilibrium error term appears to be stationary (Engle & Granger 1987). Suppose two series that are jointly correlated and contain a unit root. If residuals are $I(0)$ the two variables are cointegrated (i.e. there is an equilibrium relationship between them):

$$\begin{aligned} x1_t &= \alpha + \beta x2_t + u1_t \Rightarrow u1_t = x1_t - \alpha - \beta x2_t \\ x2_t &= \alpha + \beta x1_t + u2_t \Rightarrow u2_t = x2_t - \alpha - \beta x1_t \end{aligned} \quad (4)$$

The system of equations in (4) assumes that a priori it is not possible to know the endogenous variable so tests of cointegration must be done with each variable on the left hand side. Engle & Granger (1987) and Phillips & Ouliaris (1990) developed the critical values to test a cointegrated vector with residuals from these equations. However, they assume that the cointegrating vector is constant in the sample period which may not be the case here. As our sample period includes both the 1995 Mexican “Tequila” crises and the 2007-2009 global Great Recession we apply the Gregory & Hansen (1996) test allowing for one structural break and the Hatemi-J (2008) allowing for two structural breaks similar to the two structural break approach of Ramirez (2017) examining remittances. Using a general equation of standard cointegration:

$$x1_t = \alpha + \beta x2_t + u1_t \quad (5)$$

or

$$x2_t = \alpha + \beta x1_t + u2_t \quad (6)$$

with causality in either direction, the tests augment the equation with dummies to capture possible shifts in mean, slope or both. For example, if we assume that causality runs from $x2$ to $x1$ we apply equation (5). The next modified specification nests all possible results:

$$x1_t = \alpha_0 + \alpha_1 D1_t + \alpha_2 D2_t + \beta_0 x2_t + \beta_1 D1_t \cdot x2_t + \beta_2 D2_t \cdot x2_t + u_t \quad (7)$$

where $D1_t$ and $D2_t$ are dummies added with for two structural breaks occurring in the mean and/or in the slope including interaction with the variable of interest. A “regime” shift is when there are both statistically significant mean and slope shifts.¹ Gregory & Hansen (1996) developed the critical values to determine the existence of cointegration in residuals with one structural break for each test ADF , Z_α and Z_t , while Hatemi-J (2008) extended their methodology to include two structural breaks and therefore the possibility of three regimes in each series.

THE DATA AND DESCRIPTIVE STATISTICS

THE DATA

The Mexican federal level data are quarterly (1993.1 to 2015.3) and cover the nine main divisions of the manufacturing sector using an older classification due to the need to utilize many years of data. The older classification represents an internal classification that was eliminated as Mexico began collecting data using international norms. We also had to use only nine aggregate divisions to insure comparability across time with the classification changes. Two series covering labor productivity in 2008 pesos and average salaries in dollars are adjusted for inflation using the US consumer price index (2010 = 100). Because labor productivity 1993-2008 data are reported in 1993 pesos and 2007-2015 data are in 2008 pesos, we create a single 2008 pesos series by adjusting the 1993 pesos data forward to 2008 pesos by using the real growth rates of the 1993 series. Further, as 1993-2008 data are monthly averages we transform that more detailed series in to quarterly data as 2007-2015 is only available quarterly. The Mexican Institute of Statistics (INEGI, by its Spanish acronym) has the database for labor productivity which is an index number based on hours worked (2008 = 100) and the average salary (in nominal US dollars)². Salary is the payment by firms to labor (called “occupied personnel”). The US CPI data is from the Federal Reserve Economic Data web site.³

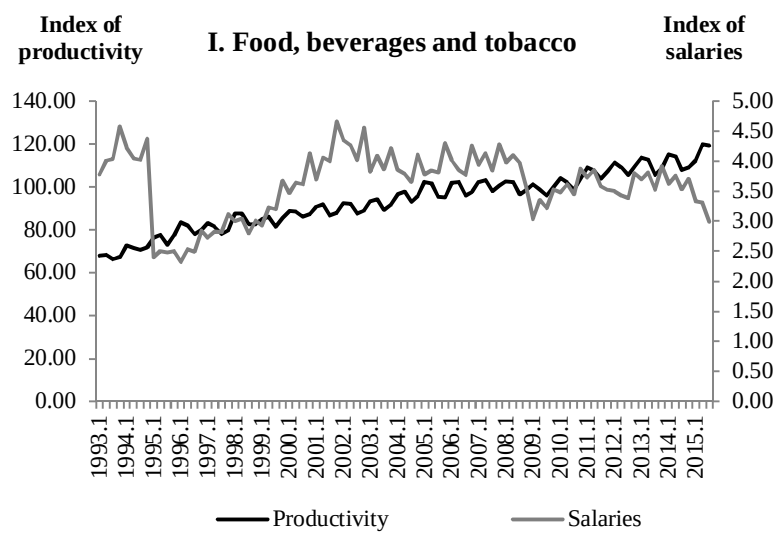
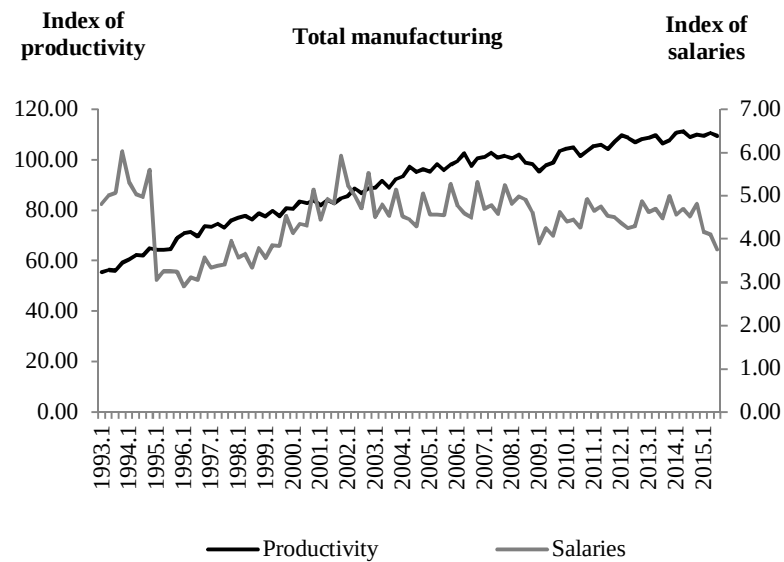
DESCRIPTIVE STATISTICS

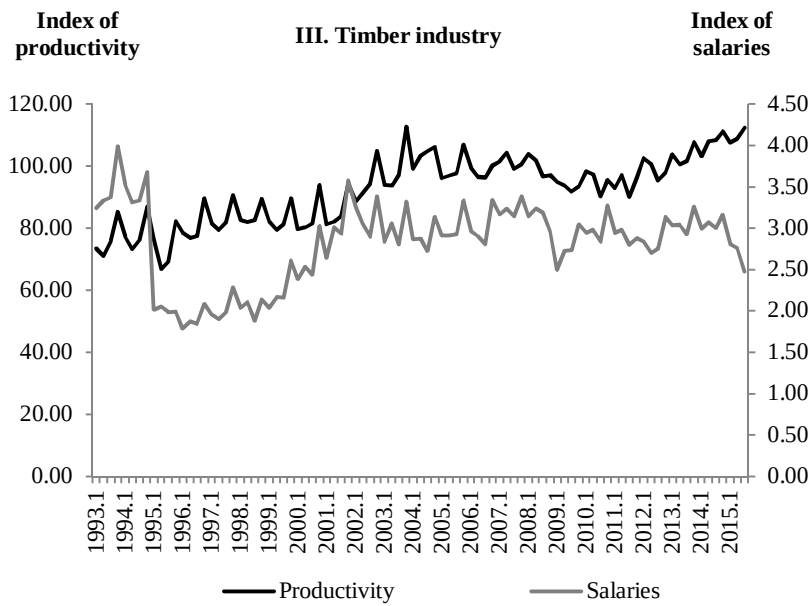
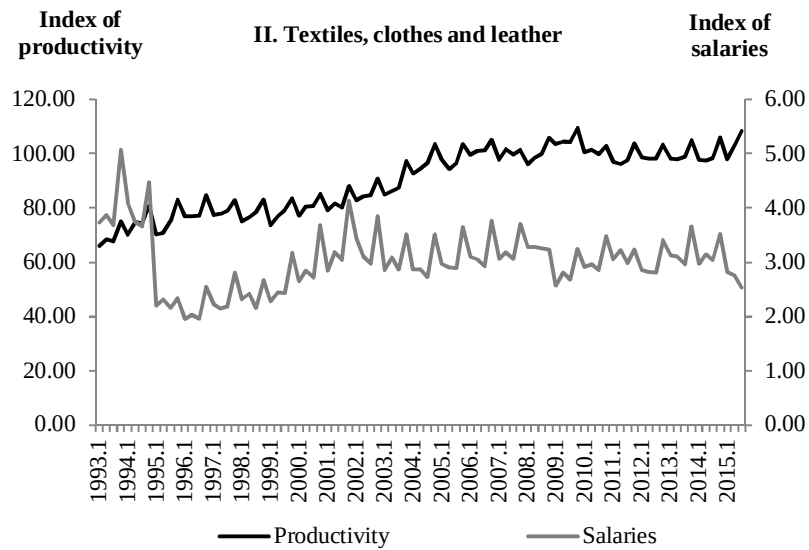
Table 1 shows basic sample descriptors. Both salaries and productivity are similar in levels across industries, but productivity averages much higher rates of growth that are at least twice as high. For example, productivity is almost seven times higher for non-metallic mineral products, six times higher for machinery and equipment and five times higher for textiles, clothes and leather. As theory predicts, a positive correlation between salaries and productivity is evident though only up to 0.5 with the outlier Metals sector having a negative correlation. The descriptive pattern is similar to China (Zhang & Liu 2013) with a widening gap between wages and productivity. Overall Table 1 shows a positive relation between salaries and productivity but with salaries falling behind over time.

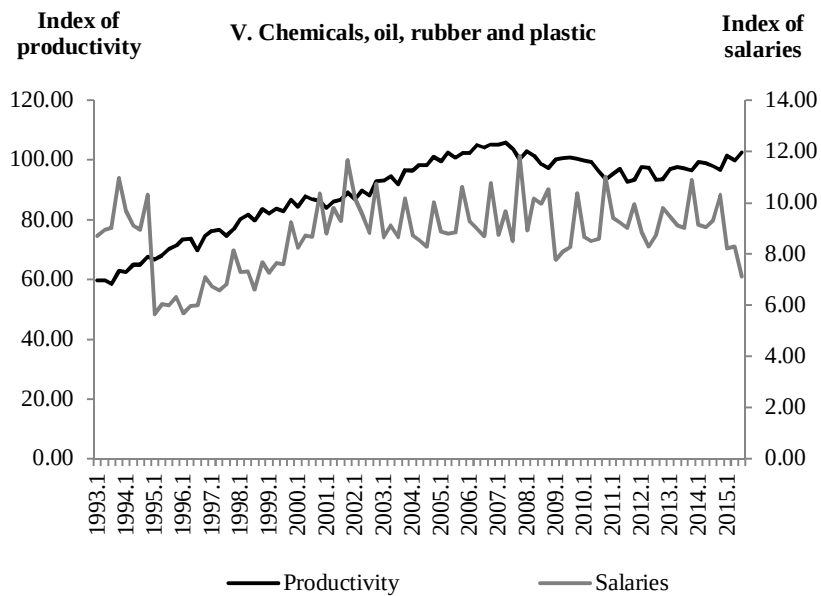
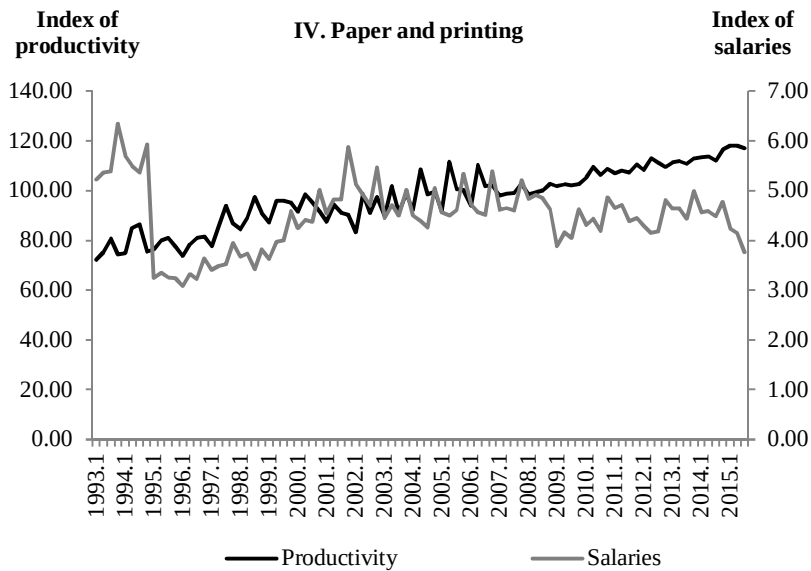
TABLE 1: DESCRIPTIVE STATISTICS OF THE MANUFACTURING SECTORS

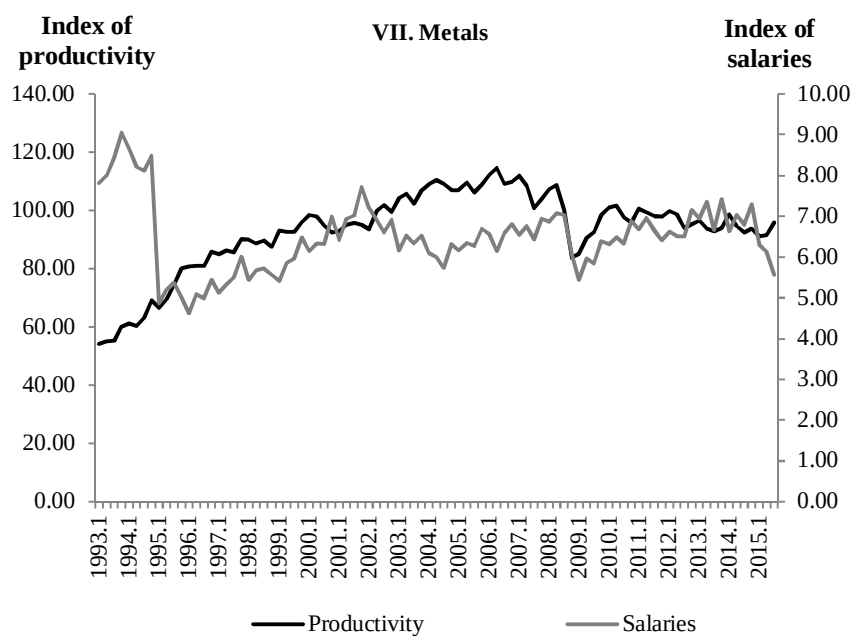
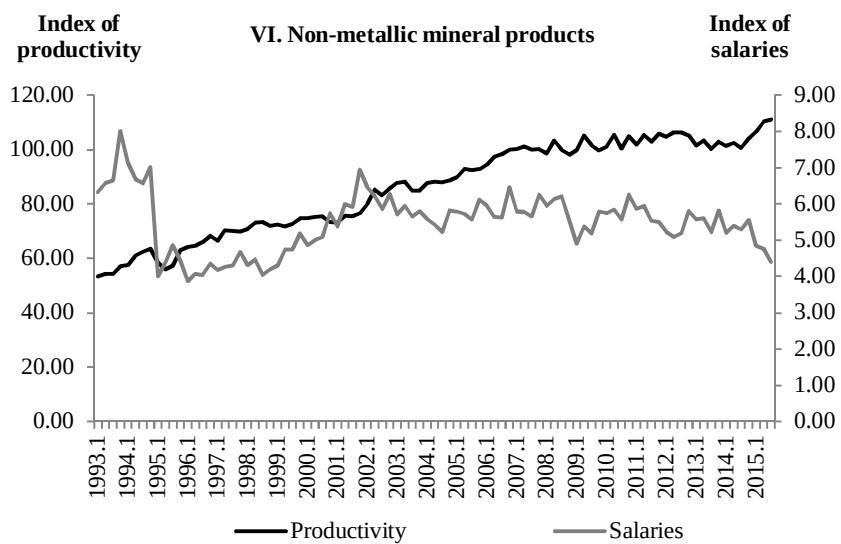
	Maximum	Minimum	Variance	Rates of growth	Ratio of rates of growth
Salaries (U.S. dollars per worker/hour, 2008=100)					
Total manufacturing	5.37	2.07	0.23	29.88	3.26
I. Food, beverages and tobacco	4.20	1.65	0.23	31.88	2.37
II. Textiles, clothes and leather	3.93	1.39	0.24	13.11	4.88
III. Timber industry	3.50	1.27	0.26	26.90	1.98
IV. Paper and printing	5.35	2.19	0.22	19.52	3.19
V. Chemicals, oil, rubber and plastic	11.70	3.90	0.26	36.21	1.97
VI. Non-metallic mineral products	6.30	2.75	0.22	15.72	6.88
VII. Metals	7.97	3.28	0.21	18.39	4.19
VIII. Machinery and equipment	5.70	2.12	0.25	38.63	5.66
IX. Other manufacturing	5.17	2.19	0.23	20.18	3.48
Productivity (index of pesos per worker/hour, 2008 = 100)					
					Correlation
Total manufacturing	111.40	55.51	0.18	97.28	0.23
I. Food, beverages and tobacco	119.85	66.30	0.14	75.48	0.16
II. Textiles, clothes and leather	109.55	66.01	0.13	64.03	0.16
III. Timber industry	112.78	66.84	0.12	53.39	0.44
IV. Paper and printing	118.05	72.17	0.13	62.19	0.07
V. Chemicals, oil, rubber and plastic	105.85	58.48	0.15	71.21	0.39
VI. Non-metallic mineral products	111.10	53.38	0.20	108.12	0.10
VII. Metals	114.66	54.18	0.15	76.99	-0.23
VIII. Machinery and equipment	134.75	41.83	0.26	218.57	0.24
IX. Other manufacturing	119.54	49.84	0.20	70.16	0.19

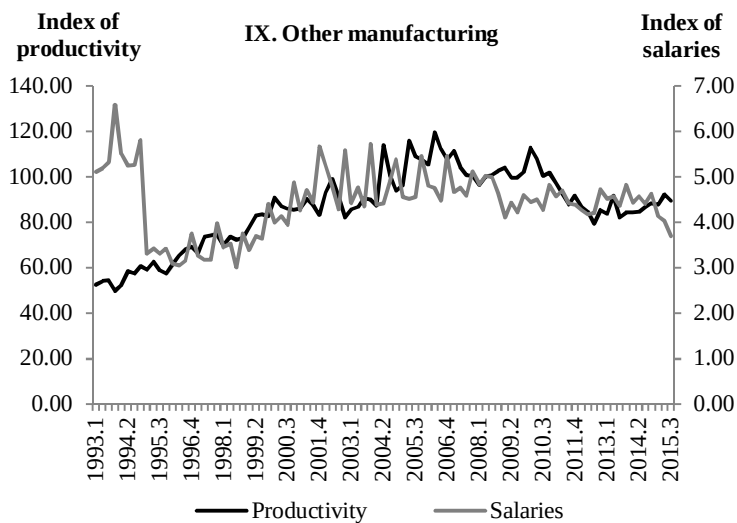
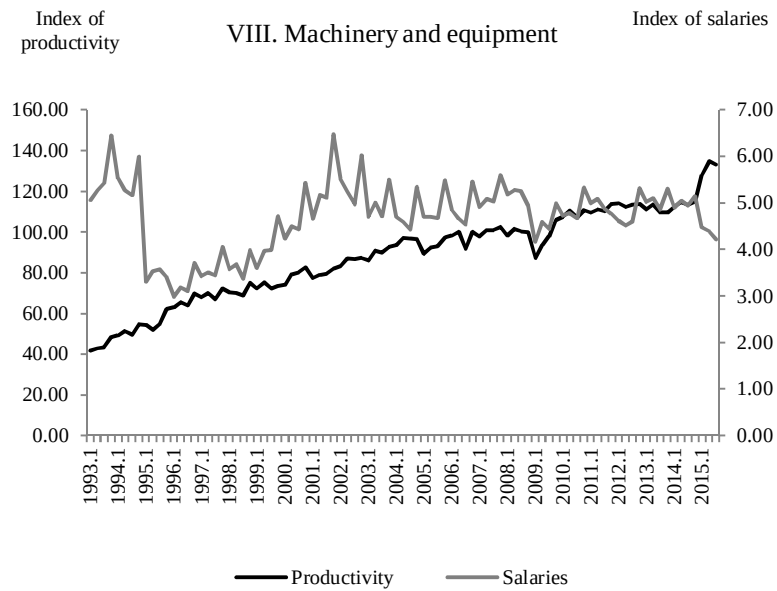
The trends in both variables (productivity and salaries) are exhibited in Figure 1. Three general trends are evident. First, salaries are more volatile and nonlinear than productivity because they are more sensitive to overall economic conditions. Second, for almost all divisions the productivity of the labor force has a positive trend despite severe crises during the sample period. Third, the first two trends illustrate that there is no need for further governmental interference in wage setting as wages are clearly not keeping up with labor productivity. We now turn to econometric results which will provide additional confirmation that these descriptive observations represent the labor market well.

FIGURE 1: MANUFACTURING PRODUCTIVITY AND SALARIES









ECONOMETRIC RESULTS

Initial Granger causality tests reveal causality running from productivity to salaries (Table 2). These initial causality results support the use of productivity as the independent variable and salaries as the dependent variable in the equation of cointegration defined in (7) except “Other manufacturing” where causality runs in both directions.

TABLE 2: GRANGER CAUSALITY TESTS BETWEEN PRODUCTIVITY AND SALARIES

Sector	Hypothesis		k
	Salaries do not cause productivity	Productivity do not cause salaries	
Total manufacturing	0.423 (0.655)	18.062 (0.000) **	2
I. Food, beverages and tobacco	0.768 (0.467)	7.289 (0.001) **	2
II. Textiles, clothes and leather	1.472 (0.178)	3.675 (0.001) **	9
III. Timber industry	1.389 (0.245)	7.228 (0.000) **	4
IV. Paper and printing	1.539 (0.177)	2.638 (0.022) *	6
V. Chemicals, oil, rubber and plastic	0.650 (0.524)	8.827 (0.000) **	2
VI. Non-metallic mineral products	0.725 (0.487)	3.164 (0.047) *	2
VII. Metals	0.914 (0.510)	3.371 (0.002) **	8
VIII. Machinery and equipment	1.511 (0.226)	5.818 (0.004) **	2
IX. Other manufacturing	4.805 (0.003) **	4.497 (0.005) **	3

Notes: *p*-values are in parentheses, *k* indicates the number of lags used in the test.

Superscripts ** and * indicate significance at 1% and 5%, respectively.

Evidence on the presence of unit roots is shown in on Tables 3 and 4 where industries are first examined assuming no structural breaks as discussed in section 3.1. As the results are mixed leaving the true underlying data generating process (DGP) in each division uncertain, we entertain both the possibility of a constant and linear trend DGP. All divisions contain a unit root.

TABLE 3: UNIT ROOT TESTS FOR MANUFACTURING SALARIES WITHOUT STRUCTURAL BREAKS

	Z_a	MZ_a	MZ_t	MSB	P_T	MP_T	ADF^{GLS}	k
	Constant							
Total manufacturing	-2.53	-2.19	-0.99	0.45	11.95	10.78	-1.53	8
I. Food, beverages and tobacco	-1.91	-1.70	-0.86	0.51	15.46	13.54	-1.48	8
II. Textiles, clothes and leather	-5.37	-3.58	-1.32	0.37	6.77	6.83	-1.81	8
III. Timber industry	-3.23	-2.99	-1.18	0.39	8.33	8.09	-1.68	8
IV. Paper and printing	-3.79	-3.36	-1.27	0.37	7.54	7.26	-1.81	8
V. Chemicals, oil, rubber and plastic	-1.56	-1.05	-0.66	0.63	24.26	20.65	-0.44	7
VI. Non-metallic mineral products	-3.36	-3.09	-1.23	0.39	8.26	7.88	-1.07	7
VII. Metals	-3.64	-3.37	-1.26	0.37	7.39	7.23	-1.07	7
VIII. Machinery and equipment	-2.54	-2.18	-0.96	0.44	11.71	10.58	-1.39	8

IX. Other manufacturing	-3.94	-3.32	-1.26	0.38	7.67	7.35	-1.53	8
Linear trend								
Total manufacturing	-10.36	-7.92	-1.92	0.24	11.85	11.69	-1.89	7
I. Food, beverages and tobacco	-9.29	-7.89	-1.90	0.24	11.71	11.76	-1.87	7
II. Textiles, clothes and leather	-10.60	-5.68	-1.65	0.29	16.99	15.98	-1.77	7
III. Timber industry	-8.66	-7.47	-1.89	0.25	13.07	12.26	-1.81	7
IV. Paper and printing	-9.84	-7.90	-1.94	0.24	12.15	11.66	-1.92	7
V. Chemicals, oil, rubber and plastic	-13.44	-6.76	-1.68	0.25	13.49	13.61	-1.86	7
VI. Non-metallic mineral products	-10.68	-9.51	-2.11	0.22	10.12	9.85	-1.89	7
VII. Metals	-14.31	-12.97	-2.52	0.19	7.72	7.17	-2.24	7
VIII. Machinery and equipment	-10.95	-8.17	-1.98	0.24	11.54	11.27	-1.92	7
IX. Other manufacturing	-9.80	-7.00	-1.82	0.26	13.55	13.08	-1.77	7

Notes: The lags number (k) is selected optimally with Modified Akaike Information Criterion (MAIC) of Ng and Perron (2001). Maximum lags (k_{max}) = 10. For a constant critical values (5%) are: z_a -8.35, Mz_a -8.1, MZ_t -1.98, MSB 0.233, P_t and MP_t 3.17, and ADF -GLS -1.98. Critical values for linear trend are: Z_a and MZ_a -17.3, MZ_t -2.91, MSB 0.168, P_t and MP_t 5.48 and ADF -GLS -2.91. $I(1)$ and $I(0)$ indicate that time series has a unit root and time series is stationary, respectively.

TABLE 4: UNIT ROOT TESTS WITHOUT STRUCTURAL CHANGE IN MANUFACTURING PRODUCTIVITY

	Z_a	MZ_a	MZ_t	MSB	P_T	MP_T	ADF^{GLS}	k
Constant								
Total manufacturing	0.36	0.53	0.51	0.94	82.93	57.67	0.41	8
I. Food, beverages and tobacco	1.18	1.36	1.39	1.02	108.58	77.87	1.54	8
II. Textiles, clothes and leather	0.57	0.76	0.67	0.87	74.57	52.70	0.80	8
III. Timber industry	0.17	0.50	0.30	0.61	37.74	27.97	0.38	8
IV. Paper and printing	0.94	1.17	1.33	1.13	128.49	91.31	1.37	8
V. Chemicals, oil, rubber and plastic	0.05	0.23	0.19	0.84	63.65	43.98	0.36	6
VI. Non-metallic mineral products	0.10	0.28	0.19	0.69	45.29	32.20	0.55	10
VII. Metals	-0.12	0.05	0.05	1.05	93.22	62.09	-0.10	2
VIII. Machinery and equipment	0.93	1.13	1.25	1.09	122.80	84.92	1.27	10
IX. Other manufacturing	-0.43	-0.28	-0.23	0.81	52.40	36.80	-0.31	4
Linear trend								
Total manufacturing	-5.75	-5.30	-1.45	0.27	20.46	16.62	-0.99	8
I. Food, beverages and tobacco	-10.13	-4.72	-1.53	0.32	21.63	19.26	-1.69	4
II. Textiles, clothes and leather	-8.41	-3.28	-1.25	0.38	30.20	27.14	-1.39	6

III. Timber industry	-17.70 *	-8.32	-2.03	0.24	11.00	10.94	-2.19	4
IV. Paper and printing	-24.30 *	-5.67	-1.67	0.29	17.78	16.01	-1.97	4
V. Chemicals, oil, rubber and plastic	-2.81	-2.53	-1.01	0.40	36.81	31.91	-0.96	4
VI. Non-metallic mineral products	-2.56	-2.05	-0.87	0.42	42.07	36.74	-0.75	5
VII. Metals	-1.49	-1.13	-0.59	0.52	68.40	55.49	-0.73	2
VIII. Machinery and equipment	-4.59	-4.04	-1.39	0.34	28.32	22.25	-1.27	8
IX. Other manufacturing	-2.74	-2.37	-0.93	0.39	35.26	32.07	-1.01	4

Notes: see footnotes of the Table 3.

The existence of unit roots contradicts the theory, so we then examine if there is cointegration with structural breaks to explain why. If two series are individually $I(1)$ then a linear combination of them should be stationary $I(0)$. Regimes with one and two structural breaks are examined with the two separate tests described above (Table 5). For ease of exposition, Table 5 is in two parts with the first part the value of the estimated tests and the breakpoints, while the second part contains the estimated coefficients of the regressions. All but two divisions exhibit cointegration with two structural breaks instead of one, the exceptions being Divisions IV and VI. For the eight divisions that are cointegrated with two structural breaks, six of them are statistically significant (Overall manufacturing and Divisions I, II, V, VIII, and IX). In each of these six cases, salaries fall when labor productivity increases. Standard first order conditions in the Mexican labor market are not evident (β_0). However, after the first structural break the estimated coefficient becomes positive indicating movement toward the expected equilibrium condition (β_1). With a second structural break, results are mixed in terms of the sign on the coefficient (β_2). Structural breaks occur within 1996, 1997, 1999, 2003 and 2007.

If we constrain to allowing only a single structural break, a statistically significant break only happens within the 1999-2000 period which corresponds to not only a new century but a new political environment with the first non-PRI president in the modern era. Other not statistically significant breaks center around the Peso macroeconomic crisis of 1995 as real wages fall but productivity does not. So if a second break is evident, the pattern will be first the mid-1990s Peso crisis followed by a new millennium break in the late 1990s or early 2000s. Two breaks here reflect the U-shaped fall and recovery of the real salary index discussed at the microeconomic level by Lopez-Acevedo (2003). Two divisions had no salary U-shape, IV and VI, causing two structural breaks. The Timber (III) and Metals (VII) divisions were never cointegrated even with structural breaks considered.

TABLE 5: COINTEGRATION WITH REGIME SHIFTS BETWEEN SALARIES AND PRODUCTIVITY

	Test statistic	TB1	TB2	Estimated test value
	ADF^{GLS}			-4.86
Total manufacturing	Zt	1996.3	1997.2	-7.13 ***
	Za	1996.3	1996.4	-65.61 *
	ADF^{GLS}			-5.08
I. Food, beverages and tobacco	Zt	1996.4	1997.2	-6.96 ***
	Za	1996.4	1997.2	-64.82 *
	ADF^{GLS}			-3.96
II. Textiles, clothes and leather	Zt	1999.3	2003.2	-6.96 ***
	Za	1999.3	2003.3	-54.54 *
	ADF^{GLS}			-3.69
III. Timber industry	Zt			-3.71
	Za			-22.63
	ADF^{GLS}			-3.40
IV. Paper and printing	Zt	200.4		-4.43 *
	Za			-30.64
	ADF^{GLS}			-4.56
V. Chemicals, oil, rubber and plastic	Zt	1996.4	2007.2	-7.22 ***
	Za	1996.4	2007.2	-66.37 *
	ADF^{GLS}			-4.28
VI. Non-metallic mineral products	Zt	1999.4		-4.89 *
	Za			-39.95
	ADF^{GLS}			-4.79
VII. Metals	Zt			-5.39
	Za			-43.02
	ADF^{GLS}			-4.74
VIII. Machinery and equipment	Zt	1996.4	1997.2	-6.85 ***
	Za	1996.4	1997.2	-62.80 *
	ADF^{GLS}			-5.35
IX. Other manufacturing	Zt	1996.2	1999.2	-8.12 ***
	Za	1996.2	1999.2	-77.17 **

Notes: *t*-values in parentheses. TB1 and TB2 indicate the first and second breakpoint, respectively.

Critical values for two breaks are from Hatemi-J (2008): for ADF and Zt are -6.503 (1%), -6.015 (5%) and -5.653 (10%); for Za are: -90.794(1%), -76.003 (5%) and -52.232 (10%). For one break are from Gregory and Hansen (1996). Model C/S: for ADF and Zt are -5.47 (1%), -4.95 (5%) and -4.68 (10%); for Za are: -57.17 (1%), -47.04 (5%) and -41.85 (10%).

Superscripts *, **, and *** indicate significance at 10%, 5% and 1%, respectively.

TABLE 5: CONTINUES

	Estimated coefficients					
	α_0	α_1	α_2	β_0	β_1	β_2
Total manufacturing	9.65 *** (6.45)	-8.17 (-0.19)	-6.23 (-0.15)	-2.07 *** (-5.75)	1.95 (0.20)	1.48 (0.15)
I. Food, beverages and tobacco	12.08 (0.08)	-3.14 (0.08)	-13.72 (-0.37)	-2.62 *** (-5.88)	0.75 (0.09)	3.17 (0.38)
II. Textiles, clothes and leather	5.12 *** (2.45)	-15.88 *** (-3.29)	5.29 (1.17)	-1.03 *** (-2.14)	3.68 *** (3.36)	-1.36 (-1.19)
III. Timber industry	0.22 (0.13)	-5.85 (-1.36)	3.77 (0.87)	0.07 (0.19)	1.34 (1.43)	-0.82 (-0.85)
IV. Paper and printing	-4.48 *** (-5.89)	0.006 (0.097)		1.28 *** (7.61)		
V. Chemicals, oil, rubber and plastic	8.85 *** (5.29)	-14.01 *** (-7.51)	15.94 *** (4.65)	-1.71 *** (-4.31)	3.29 *** (7.52)	-3.44 *** (-4.60)
VI. Non-metallic mineral products	-2.20 *** (-5.83)	11.64 *** (1.88)		-2.50 ** (-1.88)	0.85 *** (9.84)	
VII. Metals	6.83 *** (7.83)	-12.45 *** (-6.82)	10.88 *** (5.60)	-1.16 *** (-5.99)	2.84 *** (6.97)	-2.32 *** (-5.46)
VIII. Machinery and equipment	5.27 *** (6.32)	-7.64 (-0.30)	-0.82 (-0.03)	-1.05 *** (-5.02)	1.83 (0.31)	0.24 (0.04)
IX. Other manufacturing	10.43 *** (5.18)	-12.23 *** (-3.38)	2.32 (0.75)	-2.30 *** (-4.64)	2.94 *** (3.43)	-0.43 (-0.60)

Notes: t-values in parentheses. Superscripts *, **, and *** indicate significance at 10%, 5% and 1%, respectively.

However, as one consistently has salaries below productivity while the other has switching between which is higher, we have no general conclusions as to why these two divisions behave this way and leave the issue to further research including case studies of the firms within these two divisions. If the firms are all large in size, both world (Brown & Medoff 1989) and Mexico in particular experience (Lopez-Acevedo 2003) suggest wages could be high due to firm size. The finding of no link between productivity and real wages in manufacturing is found in other developing countries as well such as Turkey (Yildirim 2015).

CONCLUSIONS

Theoretically, salaries and productivity should be cointegrated – higher productivity corresponds to higher salaries. In the Mexican manufacturing industry, salaries are more sensitive and volatile to events in the economy while productivity shows a more stable growth trend during 1993-2015. Some movements seem to indicate a lack of synchronization. For example, salaries were impacted by both the 1995 Peso crisis and the Great Recession (2008) but productivity was only impacted by the latter. Both variables grew strongly after 1995 but had a more horizontal trend after 2008. Results using econometric methods with structural changes add further support to descriptive statistics highlighting a negative relationship between salaries and productivity indicating a deterioration of the Mexican workers salaries. Support for cointegration fails only for two sectors (Division III: Timber industry and Division VII: Metals). In summary, higher labor productivity has not been rewarded with higher salaries suggesting Mexican workers are underpaid and Mexican manufacturing firms have the higher productivity and profits that can support salary and benefit increases. These higher profits are likely to be one factor in the decline of emigration to the United States which has fallen to a net zero in the past few years suggesting that though Mexican workers are paid less than theory predicts, they are also staying in Mexico more.

Mexican economic growth has been unsatisfactory as the economy opened up following the joining of GATT in the 1980s. More specifically, the annual rate of growth of per capita gross domestic product between 1993 and 2015 averaged 1.3% which is below the population growth rate of 1.7%. Further, the growth has not been erratic. In 1995, the “tequila crisis” led to a -8.7% contraction, while 2001 and 2002 contracted at rates of -0.7% and -0.2%. More recently, the world crisis of 2008/2009 yielded a -6.3% contraction for 2009. At the same time, the federal government has prioritized rigid macroeconomic control especially with regards to inflation. Historically, the Mexican economy moved from high double digit inflations in the 1980s to low (below 5%) single digit rates in the 2000’s. Indeed, many macroeconomic rates such as the exchange rate, unemployment, and interest rates followed this pattern. Salaries also were cut by up to 70% in real terms. The facts highlight that Mexico needs sustained economic growth that includes sustained salary growth with the virtuous circle of increased consumption as workers earn more adding to sustainability. Mexico must move past an historic concern about inflation to the current reality that wages being below labor productivity means they can grow without causing a wage-price spiral.

During the sample period, public investment also fell. In the 1970’s public investment was 1.5% of GDP but by 2000 it was only 0.7% and remained low 2001-2008. The percentage is the lowest in over 70 years. Like the U.S., infrastructure has been neglected and needs repair. Public investment can be in part complemented by foreign direct investment which can be attracted by allowing foreign firms to participate in increasing manufacturing wages by bidding for high productivity workers along with domestic firms. If domestic firms insist on underpaying their workers, foreign firms can fill the gap. We see this with new car production in Puebla state for example. Higher wages will further drop immigration north which is quite low already. President Obrador’s \$30 billion aid initiative to support Central American countries will also help stem the flow of migrants flowing from further south who are not seeking to get to the U.S., but instead

want to work in Mexico. Further, as the new president is from one of the poorest southern regions of Mexico support for unionized workers demanding higher wages is likely.

ENDNOTES

¹ Two regime shifts in equation (7).

² The INEGI website is <https://www.inegi.org.mx>. More specifically, the data on productivity and salaries for the period 2005-2015 is found at: <https://www.inegi.org.mx/temas/productividadsec/>. For earlier years using the old classification (1993-2008) the data on nine industrial divisions was removed from the INEGI website but are available from the authors upon request.

³ <https://fred.stlouisfed.org>.

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