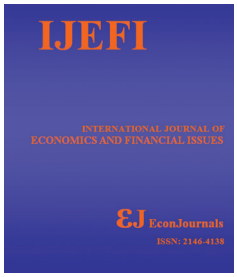

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Wage-profit Rate Schedules in Case of Saudi Arabia

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ABSTRACT

This paper uses the real wage-profit rate schedule to examine the direction of technical change in Saudi economy during 1990–2016. We find that technical change is Hicks-neutral (i.e., increasing both labor and capital productivity) between 1990 and 2004; and Marx-biased (i.e., increasing labor productivity with declining capital productivity) over the period 2005–2014. The most noteworthy aspect of the Saudi economy pattern of technical change is that it has started to enter a phase of steady decrease in the profit rate and increase in the real wage, as seems to be the historical experience of many developed countries. The growth of real wage continues to grow by increasing 9.6%, 19.5%, and by 130%, while the profit rate grows by 11.8%, 5.7%, and −20.5% in the first three periods, respectively.

Keywords: Productivity of Labor and Capital, Saudi Arabia, Capital-labor Ratio, Wage-profit Rate
JEL Classifications: E24, J3

1. INTRODUCTION

In Saudi Arabia, the unexpected revenues from oil booms in the mid- and late 1970s increased the expenditure on infrastructural programs which included the rehabilitation and construction of school buildings, and improvements in communication networks, transportation, and health centers, therefore creating substantial demand for construction labor. Due to revenues from oil, industrialization has been growing fast in Saudi; the oil sector grew 78% in 2011 (Ministry of Planning and Economics, 2012)[1]. Although economic growth reached 11% in 2011, unemployment is still a problem in Saudi Arabia. In 2011, the unemployment rate was about 12 percent with almost 28 million in the labor force[2]. However, Saudi Arabia is like many developing countries that are experiencing rapid technological change in the last three decades. This technological change may alter the sharing of output between workers and capitalists.

Since 1980s, Saudi Arabia has shifted from export to crude oil to oil industry and then to the petrochemical industry by utilizing new technologies[3]. This change may lead to an increase in wage sharing or the economy becoming more capital intensive, producing the same effects, but on a much larger scale.

This paper attempts to test the shape and the shift of wage and profit rate relation in Saudi economy by using input-output analysis. The input-output data used in this study is based on the Saudi economy during the period 1990–2016 in six phases. Some researchers have used this approach to examine the existence of switchingpoints and to show the existence of reswitching and capital deepening, a common puzzle in capital theory (Soklis, 2011; da Silva, 1987). Furthermore, the advantage of the input-output method is that we can find the real wage share and the profit margin for a specific year and observe the behavior (and relationship) of the inputs. As stated in the theory, we will attempt to observe whether the empirical data supports the theory that predicts that wage-profit rate relations are downward sloping. It is also interesting to investigate what has

1 Ministry of Commerce and Investment on https://mci.gov.sa/en/Pages/default.aspx.
2 Ministry of Labor and Social Development: https://mlsd.gov.sa/en/.
3 http://www.mci.gov.sa/en/Pages/Default.aspx.

happened to the productivity of labor, the productivity of capital, and the capital-labor ratio. The shift of the real wage share and profit rate will answer this question.

The rest of the paper is structured as follows. Section 2 reviews the empirical literature, section 3 derives the method of calculating real wage-profit rate schedule and discusses the different types of technical change, section 4 defines the data and the resources, and section 5 and 6 review the results and offer some conclusions.

2. REVIEW OF LITERATURE

Marquetti (2003) analyzes whether technical change follows the capital-using, labor-saving pattern. He finds that most of the world economy follows the Marx-biased technical change pattern over the period 1964–1990. He shows that labor productivity increases, while capital productivity falls in that period. However, he finds that in some countries in the 1980s the non-Marx-biased pattern happens.

Felipe et al. (2008) examine the total economy for India and China during the period 1980–2003. They show that both capital and labor productivity increase, but not in the same proportion. The change is close to the technical change of the Hicks-neutral pattern.

Felipe and Kumar (2010) use the real wage-profit rate schedule to study the direction of change in the economy of India over 1980–2007. They find that in most periods labor productivity increases, while capital productivity falls (Marx-biased technical change). However, post 2000, they find that both capital and labor productivity increase (Hicks-neutral pattern). This study favors the technical change of capital in India's organized manufacturing sector over all this period.

Ferretti (2008) uses classical theory of income distribution to examine the facts of economic growth. He makes use of a wage-profit frontier in order to explore the patterns of technical change in 18 industrialized economies during the period 1961–2005. This study reveals that even though there is an unequal development of technical change in those countries, there is a significant prevalence of labor-saving and capital-using changes (Marx-biased technical change).

3. THEORETICAL FRAMEWORK OF THE WAGE-PROFIT RATE SCHEDULE

It is not surprising that the social consumption-growth rate schedule is exactly the same as the wage-profit rate schedule. The social consumption-growth rate represents the distribution of output between gross investment in future output and consumption while the real wage-profit rate schedule represents the distribution of the value of output between wages and profit, including depreciation (Foley and Michl, 1999)[4].

Since the growth-distribution schedule describes both the distribution of output between consumption-investment (C-I) and wage-profit (W-π), it shows the aggregate national income and production accounts as following:

$$X \equiv C+I = C+(g_K+\delta)K \quad (1)$$

By dividing on labor force L, we find:

$$x \equiv c+i = c+(g_k+\delta)k \quad (2)$$

In general, net output is:

$$Y \equiv X-D = C+(I-D) = C+g_K K, \text{ where D is the depreciation}^5. \quad (3)$$

The cash flow is: $X = W+Z$, where W all wages go to workers, Z is gross profit, π is net profit, D is depreciation, and $Z = \pi+D$. Therefore, we know that gross output can be written as follows:

$$X = W+Z = W+\pi+D = W+\pi,$$

where $\pi = rK$, r is the net profit rate, and $D = \delta K$, δ is the depreciation rate. This equation implies:

$$X = W+rK+\delta K \quad (4)$$

$$X = wL+rK+\delta K, \text{ where } W, \text{ is the total wages for all labors L} \quad (5)$$

In other words, the wage-profit rate schedules, in terms of productivity of labor and capital, can be derived from equation 5 as:

$X/L = wL/L+rK/L+\delta K/L$, this equation implies to:

$$x = w + r\frac{K}{L} + \delta\frac{K}{L}, \text{ where profit rate, } v = r+\delta \quad (6)$$

We can write $\frac{K}{L} = \frac{X/L}{X/K} = \frac{x}{\phi}$ where $\phi = {}^{X}\!/_{K}$

is the capital productivity, and we can then plug it in equation 6 to get:

$$x = w + v\left(\frac{x}{\phi}\right) \text{ this equation implies:}$$

$$w = x\left(1-\frac{v}{\phi}\right) \quad (7)$$

Equation (7) is known as the real wage-profit rate schedule that shows the tradeoff between wages and profit, given the value of net output, labor and capital productivity (Katsinos and Mariolis, 2012). The procedure illustrates the relationship between real wages and the profit rate in a capitalist economy. This equation will construct curves that will enable us to observe changes in the shapes of the curves and the existence of a switching point between two technologies, as well as the possibility of re-switching[6].

4 This paper replicates the procedure in Foley and Michl (1999) to obtain the real wage-profit rate schedules for the case of Saudi economy.

5 All variable dividing on the price in 1990 purchasing power parity, except labor, so we talk about the real wage and profit rate.

6 The possibility of re-switching may be clear since this study takes into consideration the average for each five years between every two points of the time series during the period from 1990 to 2016 of this analysis.

The relationship between the real wage w and the profit rate v is presented by differentiating equation (7) with respect to v:

$$\frac{\partial w}{\partial v} = -\frac{x}{\phi} = -\frac{x}{\frac{x}{k}} = -k \tag{8}$$

A given methodology that comes from productivity inputs, equation 8 represents a straight line with slope equal to –k, the capital-labor ratio. When real wages are equal to the net product, y, the profit rate, $v = 0$. When the real wage is zero, the net profit rate is equal to ϕ.

In this paper, we study the technical change between labor productivity and capital productivity in the case of the industrial sector in Saudi Arabia. A change in the slope of real wage-profit rate schedule or a shift in the schedule is an indicator of the direction of technical change[7]. We use this approach to analyze the technical change as following:

- If labor productivity $x > 0$, then the productivity of labor has increased and technical change is labor-saving pattern.
- If the capital productivity $\phi > 0$, then the productivity of capital has increased and technical change is capital-saving pattern. Knowing this, we can classify the industry into one of following:
- If $x > 0$ and $\phi = 0$, then labor-saving technologies are used, i.e., the slope of wage-profit rate (k) is steeper. The vertical intercept shifts upwards while the horizontal intercept remains constant. This case is the Harrod-neutral technical change.
- If the technical change of labor and capital are equal (labor and capital-saving), this implies that slope of the wage-profit rate schedule remains unchanged, and both vertical and horizontal intercept move outwards. This case is called the Hicks-neutral technical change.
- If $x = 0$ and $\phi > 0$, then capital-saving technologies are used and the slope of the wage profit rate schedule is flatter, i.e., the vertical intercept remains unchanged while the horizontal intercept moves outwards. This case is called the Solow-neutral technical change.
- If $x > 0$ and $\phi < 0$, then labor-saving technologies are used. The slope is steeper where the vertical intercept moves upwards and the horizontal intercept moves inwards. This is called the Marx-biased technical change.
- The change in capital productivity between an original year and the next year can be calculated by $g_K = \frac{\phi+1}{\phi} - 1$, and the change in labor productivity between an original year and the next year by $g_L = \frac{x+1}{x} - 1$.

4. DATA

The real wage-profit rate schedule of Saudi's organized industrialization sector for the average years 1990–1994, 1995–1999, 2000–2004, 2005–2009, 2010–2014, and 2015–2016 are published from the Ministry of Commerce and Industry and the Ministry of Labor and Social Development[8]. This paper uses the variables as follows:

- X: Real gross domestic production in year 1990 purchasing-power-parity terms.
- K: Estimated net fixed standardized capital stock in purchasing power parity.
- L: Total number of employees.

Table 1 shows labor productivity, $x=X/L$, capital-labor ratio, $k=K/L$ and capital productivity, $\phi = X/K$. All data is accounted as a ratio so it does not depend on the measuring units.

5. RESULTS OF WAGE – PROFIT TECHNICAL CHANGE

We will show the tradeoff between wages and profit at a certain level of production. This study depends on two curves that will enable us to understand the shapes and the switching point between two technologies, productivity of labor and capital, during the period from 1990 to 2016 in six phases by taking the average of those years. Equation 7shows a positive solution for the maximum and minimum value of profit margin and wage, where $w = x(1-\frac{v}{\phi})$ Using this formula, Table 2 shows us the maximum and minimum value of profit margin and real wage in average years from 1990 to 2016. The changes in the productivity of labor and capital can be described in terms of shifts of the wage-profit schedule in Table 2. This table illustrates the relationship between profit (v) and wage (w) in different periods. This relationship is a straight line defined by two points (v, w). (0, x) corresponds to the minimum rate of profit and the maximum level of the real wage, and the point (ϕ, 0) corresponds to the minimum of the real wage and the maximum rate of profit.

In the original period, the maximum real wage and profit are $15,272 and 451%, respectively. In the second period, the maximum real wage and profit are $16733.57 and 504%, respectively. This value increased until they reach $20,001 and 533% for the wage rate and profit rate, respectively, in the third period. In period 5, the real wage reaches $46,111, while the profit rate decreases to 424%. The growth of real wage continues to grow by 9.6%, 19.5%, and by 130%, while the profit rate grows by 11.8%, 5.7%, and −20.5% in the first three periods, respectively, however, during 2015 and 2016, both real wage and profit rate decrease to $38,553 and 356%, respectively.

We know from the law of demand when price decreases, the quantity demanded of the good increases. But this does not happen in the case of re-switching. The decrease of the rate of interest does not lead to more capital- intensity for a certain technique. This analysis explains the situation when the relationship between the value of the capital-labor ratio and the rate of profit is increasing. This reverse capital intensity also implies that the demand curve for capital is not always downward sloping.

7 I follow the notation in Felipe and Kumar (2010) that is a different notation from the notation in Foley and Michl (1999).

8 Annual Survey of Industries, Ministry of commerce and industry and Ministry of Labor and Social Development from different years.

Table 1: Productivity of labor and capital and capital-labor ratio for Saudi Arabia

Years	Labor (L)	Labor productivity (x)	Capital – labor ratio (k)	Capital productivity (ϕ)	Average of labor productivity (x)*	Average of capital productivity (ϕ)**
1990	8019241.82	14668.50	2772.07	5.29	-	-
1991	8349912.53	14087.61	3213.26	4.38	-	-
1992	8641624.44	13612.06	3212.17	4.24	-	-
1993	8855042.88	13283.99	3281.57	4.05	-	-
1994	9024620.68	13034.37	2751.77	4.74	13737.30	4.54
1995	9067023.08	12973.42	3042.64	4.26	-	-
1996	9141642.10	12867.52	3004.14	4.28	-	-
1997	9252274.55	12713.66	3152.72	4.03	-	-
1998	9271389.09	12687.45	3248.96	3.91	-	-
1999	9663993.09	12172.02	3261.48	3.73	12682.81	4.04
2000	9800755.42	12002.16	3355.50	3.58	-	-
2001	9973490.03	11794.29	3371.47	3.50	-	-
2002	10288735.47	11432.92	3319.25	3.44	-	-
2003	10642121.38	11053.27	3710.99	2.98	-	-
2004	11010029.01	10683.92	4501.88	2.37	11393.31	3.17
2005	11312873.09	10397.91	5607.18	1.85	-	-
2006	11687965.47	10064.22	6595.17	1.53	-	-
2007	12053051.07	9759.38	8162.40	1.20	-	-
2008	12302928.50	9561.16	9634.54	0.99	-	-
2009	12860170.83	9146.87	8594.02	1.06	9785.91	1.33
2010	13485479.54	8722.74	9569.23	0.91	-	-
2011	14264717.86	8246.24	10633.10	0.78	-	-
2012	14927699.73	7880.00	10984.61	0.72	-	-
2013	15477700.67	7599.98	11413.50	0.67	-	-
2014	16164549.73	7277.05	11783.04	0.62	7945.20	0.74
2015	16602213.65	7085.22	11747.06	0.60	-	-
2016	17079002.65	6887.42	10007.51	0.69	6986.32	0.65

*x is calculated as average annual rate of labor productivity, **ϕ is calculated as average annual rate of capital productivity. Source: Author's calculations from 1990 to 2016

Table 2: Real wage-profit rate schedule for Saudi Arabia

Profit (v)	Wage					
	W 1990–1994	W 1995–1999	W 2000–2004	W 2005–2009	W 2010–2014	W 2015–2016
0	15272.40	16733.57	20001.43	34281.68	46111.59	38553.57
0.5	13755.91	15164.78	18181.50	30483.29	40675.07	33141.80
1	12239.43	13595.98	16361.57	26684.91	35238.55	27730.04
1.5	10722.95	12027.18	14541.64	22886.52	29802.03	22318.28
2	9206.47	10458.39	12721.70	19088.14	24365.51	16906.51
2.5	7689.99	8889.59	10901.77	15289.75	18928.98	11494.75
3	6173.51	7320.79	9081.83	11491.36	13492.46	6082.98
3.5	4657.02	5751.99	7261.91	7692.98	8055.94	671.21
3.56	4468.94	5557.42	7036.18	7221.87	7381.66	0
4.24	2409.87	3427.32	4565.10	2064.46	0	-
4.51	1585.62	2574.67	3575.94	0	-	-
5.04	0	934.32	1673.00	-	-	-
5.33	-	0	589.12	-	-	-
5.50	-	-	0	-	-	-

Source: Author's calculations from 1990 to 2016. *Average annual rate of wage that we calculated it by using average of labor productivity (x), average of capital productivity (ϕ) in Table 1, and profit rate (v) in this table

Figure 1 shows us the real wage-profit rate schedules for the period from 1990 to 2016. It illustrates the tradeoff between real wage and profit rates. Between 1990 and 2004, the vertical and horizontal intercepts of the real wage-profit rate schedule shifts outwards, i.e., both labor and capital productivity increase slowly, though they do not increase by the same proportion. The technical change in this period is called Hicks-neutral. However, between 2005 and 2014, the vertical of intercept of the real wage-profit rate schedule shifts outwards, i.e., labor productivity increases. At the same, the horizontal intercept shifts inwards, i.e. capital productivity decreases. In other words, the technical change is the labor-saving and capital-using pattern that is called Marx-biased. Between 2015 and 2016, both the vertical and horizontal intercepts of wage-profit schedule shift inwards, i.e. productivity of labor and capital fall, and this result may reflect the recent deterioration of oil prices.

As shown in Figure 1, the slope of the real wage-profit rate schedule derived via the plot of wage versus profit rate is equal to $-k$. This value gives the direction of technical change. It indicates that the direction of technical change is the result of both changes in labor productivity and capital productivity (x and ϕ) and illustrates the labor-capital ratio (k). As stated in the theory, this result shows that the empirical data supports the theory that predicts that the wage-profit rate relations are downward sloping.

Figure 2 shows the three variables ϕ, x, and k. In the periods from 1990 to 2002, both capital and labor productivity increase. This is reflected in Figure 1 by a near-parallel inwards shift in the real wage-profit schedule (Hicks-neutral technical change). However, in the period from 2004 to 2012, labor productivity increases, while capital productivity declines (Marx-biased technical change). This is the result of the increase of labor productivity because of an increasing capital-labor ratio ($K/L = x/\phi$). Post 2014, both labor and capital productivity decrease and the capital to labor ratio are constant. This gives our picture in Figure 1 a near-parallel inwards shift in the real wage-profit schedule (Hicks-neutral technical change).

It is important to compare the kind of technical change of the Saudi economy with other countries. Foley and Michl (1999) suggest a relationship between capital productivity and labor productivity across developed countries. They find that labor productivity increases and capital productivity decreases. Also, they find multiple switch-points between the two techniques. They state that entrepreneurs choose the capital technique when the slope of wage-profit rate is flatter and choose labor technique when the slope of real wage-profit rate is steeper. In the case of Saudi Arabia, in the beginning of the period, both labor and capital productivity increase, and entrepreneurs selected labor and capital-saving techniques (Hicks-neutral technical change). The switch-point between labor and capital starts in the period from 2004 to 2012. The vertical intercept of the real wage-profit rate

Figure 1: Real wage–profit rate schedule for Saudi

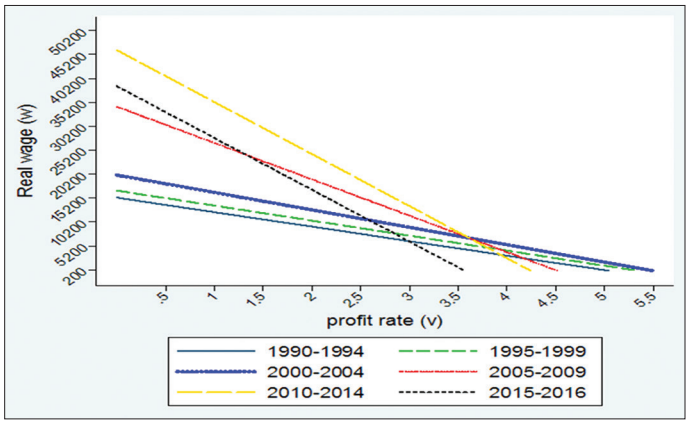
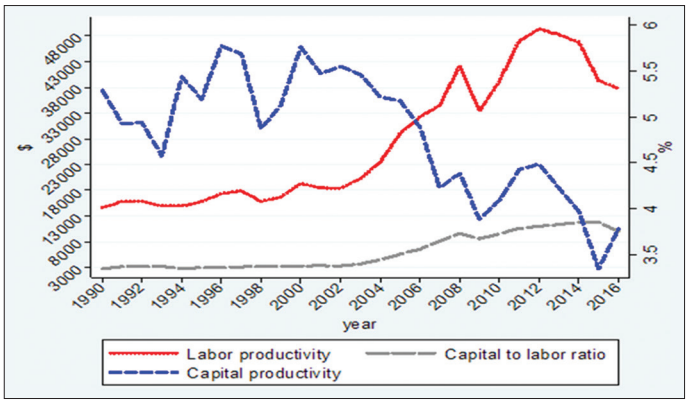


Figure 2: Labor productivity, capital productivity, and capital- labor ratio



shifts outwards and the horizontal intercept shits inwards. In this case, labor productivity increases and capital productivity falls ($x > 0$, $\phi < 0$). It shows that technical change is labor-saving and capital-using (Marx-biased).

6. CONCLUSION

Utilizing the real wage-profit rate schedule, we examine the direction of technical change in the case of the Saudi economy during the period from 1990 to 2016. We find that the productivity of labor and capital increases, and the technical change of labor and capital is almost equal (Hicks-neutral technical change) through the period from 1990 to 2004. However, Hicks-neutral may be only a passing phase before we see a return to the long-term trends of Marx-biased technical change. In the period from 2005 to 2014, labor productivity increases while capital productivity decreases (Marx-biased technical change). There is switching-point illustrated in this result since the vertical intercept moves outward and the horizontal intercept moves inward. During 2015 and 2016, both labor and capital productivity decrease. The decline may be caused by the increase in relative prices of other inputs such as raw materials that generate inefficiency (Michl, 1988). This assumption is reasonable since Saudi Arabia is experiencing relatively high inflation, around 4.5% in average, and high prices of oil that are still influential in the economy of Saudi Arabia during that period[9].

The most noteworthy aspect of the Saudi economy pattern of technical change is that it has started to enter a phase of steady decrease in the profit rate and increase in the real wage as seems to be the historical experience of developed countries. The growth of real wage continues to grow by 9.6%, 19.5%, and by 130%, while the profit rate grows by 11.8%, 5.7%, and −20.5%, in the first three periods, respectively.

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