Determination of Wages and Exchange Rate with Game Theory (Case Study: Iran)

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Abstract. In every country, wages are determined by Nash rule or governments determine wages. According to Nash equilibrium, policy of determination wages is respect to exchange rate and there is a game between NWC and MAS. In this paper, we survey a game theory method to survey policy of determination wages and exchange rate to stability economics. When exchange rate increases, import good's price rise and we have cost push inflation, therefore wages are increased and then we have unemployment. Then wages are determined respect to exchange rate changes. But in real world, some conditions affected on Nash equilibrium and wages are determined as non Nash method and government equals between benefits of workers and principals. In this paper, we survey wage making in Iran and reveal that in some courtiers such as Iran, government determines wages and create equilibrium in labor market.

Keywords. Wage, Exchange rate, Nash Equilibrium, Inflation, Game theory method.

JEL. Q30, Q31, Q32.

1. Introduction

Exchange rate and wage are economic variables. In some countries, wages are determined as negotiation between workers and principals. In this paper, NWC is worker's syndical or government which wants to equal between workers and principals. If wages are determined wrong, it is caused to inflation. In some countries, exchange rate is determined by government and it's value is affected on export, import, economic growth and employment. In other hand, exchange rate can affect on wages. Depreciation of inter money respect to foreign money is caused to expensive import of inputs, then we have cost push inflation and wages are increased.

In this paper, we survey game between NWC or wage makers and MAS or exchange rate determinations and show government is a wage maker and Nash equilibrium is not applied in Iran. As follow, model in second part, variables ad estimations in third part and conclusion in forth part are revised.

2. Model

Relation between NWC and MAS is affected on exchange rate and wages. In this game, NWC determines wages at first and then MAS determines exchange rate and player's payoff is defined respect to inflation and unemployment rate. Exchange rate is defined as price index of non oil

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products and ULC is cost of to employ each worker. Therefore, we can define relation between inflation and factors which affected on it, as equation (1);

$$LnCPI = a_1[LnNOP - LnNeer] + a_2[(1-\theta)LnW + \theta LnCPI] + a_3[(1-\theta)LnW + \theta LnCPI_{-2}] + a_4 LnOP_{-2} \quad (1)$$

Equation (1) is rewritten as;

$$\pi = \frac{a_1}{1-a_2\theta}\pi_{NOP} - \frac{a_1}{1-a_2\theta}g_{Neer} + \frac{a_2(1-\theta)}{1-a_2\theta}g_W + \frac{a_3(1-\theta)}{1-a_2\theta}g_{W-2} + \frac{a_3\theta}{1-a_2\theta}\pi_{-2} + \frac{a_4}{1-a_2\theta}\pi_{OP-2} \quad (2)$$

In equation (2), variables are; π Current inflation rate, π_{-2} inflation rate in two years ago, π_{NOP} inflation rate of foreign non oil products. g_{Neer} Appreciation tare of inter money respect to foreign money. g_W Growth rate of current wages and g_{W-2} growth rate of wages with two lags. π_{OP-2} Inflation rate of oil products with to lags, θ elasticity of ULC respect to CPI and g_{LP} is expected inflation rate.

We can rewrite equation (2) as below;

$$U = b_0 + b_1 g_w + b_2[\frac{a_1}{1-a_2\theta}\pi_{NOP} - \frac{a_1}{1-a_2\theta}g_{Neer} + \frac{a_2(1-\theta)}{1-a_2\theta}g_W + \frac{a_3(1-\theta)}{1-a_2\theta}g_{W-2} + \frac{a_3\theta}{1-a_2\theta}\pi_{-2} + \frac{a_4}{1-a_2\theta}\pi_{OP-2}] \quad (3)$$
$$+ b_3\theta g_{w-3} - b_3\theta\pi_{-3} + b_4 CPFC$$

In equation (3), we have; U unemployment rate, g_{w-3} third lag of growth of wage and π_{-3} third lag of inflation rate, CPFC unemployment insurance. Workers are negotiated with principals to determine wages in competitive markets and workers want to equal between their income and work hours. Therefore, workers want more wages respect to money which received.

Government knows that more wages is cussed to more inflation and less economic growth. Then government should determine wages which equal between inflation rate and unemployment. Therefore NWC wants to minimize equation (3);

$$\alpha_1[(1-\theta)g_w + \theta\pi + g_{Neer} - g_{ULCf}] + \alpha_2[\frac{1}{2}(U-\hat{U})^2 - \frac{\gamma}{2}(\pi-\hat{\pi})^2] + \alpha_3[\beta(g_w - \pi) + U] \quad (3)$$

In equation (3), $\alpha_1, \alpha_2, \alpha_3$ are negotiation power of workers, government and principals. γ is government benefits which decline from inflation ($\pi - \hat{\pi}$) and unemployment ($U - \hat{U}$). $\hat{\pi}$, $\hat{U}$ are wanted inflation and unemployment rates.

In equation (3), $\gamma > 0$, $\beta < 0$, $\alpha > 0$ and $\sum_{i=1}^{3}\alpha_i = 1$. In this equation, first part is cost of to employ workers and second part is government costs. When unemployment and inflation are deviated from it's wanted rates. In equation (3) third parameter is cost of rise of unemployment and inflation.

NWC minimize equation (3) respect to g_w and we have optimal growth of wages;

$$g_w* = \frac{A_1}{A_0} + \frac{A_2}{A_0}\pi_{NOP} + \frac{A_3}{A_0}g_{Neer} + \frac{A_4}{A_0}g_{w-2} + \frac{A_5}{A_0}\pi_{-2} + \frac{A_6}{A_0}\pi_{OP-2} + \frac{A_7}{A_0}g_{W-3} + \frac{A_8}{A_0}\pi_{-3} + \frac{A_9}{A_0}CPFC$$
$$+ \frac{A_{10}}{A_0}\hat{U} + \frac{A_{11}}{A_0}\hat{\pi} \tag{4}$$

Therefore;

$$g_w* = f(\pi_{NOP}, g_{ULCf}, \pi_{OP-2}, g_{w-2}, \pi_{-3}, g_{w-3}, \pi_{-3}, \hat{U}, \hat{\pi}, CPFC)$$

Edward (1980), Kamin (1998), Chei and Winkle (1999) revealed that depreciation of inter money respect to foreign money is caused to more export and less import. In this condition, if money is dependent to import of inputs, it is caused to inflation and more wages.

MAS defines exchange rate and minimize equation (5);

$$\frac{1}{2}(g_E - \hat{g}_E)^2 + \frac{\delta}{2}(\pi - \hat{\pi})^2 \tag{5}$$

In equation (5), g_E is exchange rate growth and δ is deviation of inflation from it's wanted rate. Therefore, we have a game between MAS and NWC. At first, wage (g_w) is determined by NWC respect to equation (4) and MAS minimize equation (5) respect to g_w. After NWC, MAS minimize equation (5) respect to optimal g_w* and we have $g_{Neer}*$ as equation (6);

$$g_{Neer}* = \frac{B_1}{B_0}g_{ULCf} + \frac{B_2}{B_0}g_w + \frac{B_3}{B_0}g_{w-2} + \frac{B_4}{B_0}\pi_{-2} + \frac{B_5}{B_0}\pi_{NOP} + \frac{B_6}{B_0}\pi_{OP-2} + \frac{B_7}{B_0}\hat{g}_E + \frac{B_8}{B_0}\hat{\pi} \tag{8}$$

Therefore;

$$g_{Neer}* = h(\pi_{NOP}, g_{ULCf}, \pi_{OP-2}, g_{w-2}, \pi_{-2}, g_{w-3}, \pi_{-3}, \hat{g}_E, \hat{U}, \hat{\pi}, CPFC)$$

Respects to Nash equilibrium, appreciation of inter money reveals reaction of MAS respect to optimal growth rate of wage (g_w*) which, that is response of NWC.

Therefore according to Nash rule, every agents determine their optimal instruments to achieve optimal benefits and equilibrium. At the end, Nash equilibrium is intersection of MAS and NWC strategies.

3. Variables and Estimation

In this paper, we use from data of 2000-2014 for Iran and these data are collected from international money fund, central bank and amar center[1]. In our estimation $Neer = \Pi_{i=1}^{10}(E_i)^{W_i}$, which W_i is weight of Iran trade with ten countries which has most trade with Iran in our period[2] and E is exchange rate. Variables in our model are;

CPI: Consumer price index

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[1] We do not have data of 2015
[2] Imaret Arabia, Germany, France, Italy, China, Korea, England, Russia, Japan, Spain.

ULC^f: Cost of worker ($\dfrac{W}{L_P}$)

$L_P = (\dfrac{W}{CPI})^{\theta}$: Productivity of worker

U: Unemployment rate

π : Inflation rate

CPFC: Unemployment insurance

W: Average wage in industry sector

ULC_i^f : Cost of foreign worker.

NOP: Price index of non oil import goods.

OP: Price index of oil import goods.

IP: Estimated exchange rate for non oil goods

π_{OP} : Inflation rate of oil products

π_{NOP} : Inflation rate of non oil products

g_{LP} : Growth of worker's productivity

g_W : Growth rate of wage.

g_{Neer} : Appreciation of Neer

As we said above, price index equation is as equation (7);

$$LnCPI = a_1 LnIP + a_2 Ln(ULC)_{-2} + a_3 Ln(OP)_{-2} \tag{7}$$

ULC is written as;

$$LnULC = (1-\theta)LnW + \theta LnCPI \tag{8}$$

θ Is a parameter in labor productivity function and ULC growth is;

$$g_{ULC} = (1-\theta)g_W + \theta\pi \tag{9}$$

According to Philips curve, we have;

$$U = b_0 + b_1 g_W + b_3 \pi + b_4 g_{LP-3} + b_5 CPFC \tag{10}$$

Estimation results of equation (7), (9) and (10) with OLS[3] method and with Eviews 7, are as below;

$$g_{ULC} = (1-0.612)g_W + 0.612\pi$$
$$(3/12) \qquad (4/46) \tag{11}$$
$$R^2 = 0/51$$
$$DW = 1/82$$

$$LnCPI = 0/285LnIP + 0/419LnULC + 0/408Ln(ULC)_{-2} - 0/0605Ln(OP)_{-2}$$
$$(3/81) \qquad (4/16) \qquad (6/35) \qquad (4/95) \tag{12}$$
$$R^2 = 0/95$$
$$DW = 1/87$$

[3] Ordinary Lease Square

$$U = 3/38 - 0/174 g_w - 0/1092\pi + 0/083 g_L - 0/00058 CPFC$$
$$\quad (9/8) \quad (4/75) \quad (1/92) \quad (2/88) \quad (3/62)$$
$$R^2 = 0/78$$
$$DW = 1/91$$

$$(13)$$

Respect to equation (12), $a_1 = 0/285$, $a_2 = 0/419$, $a_3 = 0/408$, $a_4 = -0/0605$ and respect to equation (13), $b_0 = 3/38$, $b_1 = -0/174$, $b_2 = 0/1092$, $b_3 = -0/00058$ which are used in equations (1) and (2). According to equations (5), (6), (12) and (13), we can write;

$$g_{Neer}* = \frac{0/672}{0/55 + 0/104\delta} g_{ULCf} + \frac{-0/41 + 0/054\delta}{0/55 + 0/104\delta} g_w + \frac{-0/106 + 0/089\delta}{0/55 + 0/104\delta} g_{w-2} + \frac{-0/187 + 0/154\delta}{0/55 + 0/104\delta} \pi_{-2} + \frac{-0/178 + 0/104\delta}{0/55 + 0/104\delta} \pi_{NOP} + \frac{0/041 - 0/023\delta}{0/55 + 0/104\delta} \pi_{OP-2} + \frac{0/672}{0/55 + 0/104\delta} \hat{g}_E + \frac{-0/743}{0/55 + 0/104\delta} \hat{\pi}$$

$$(14)$$

$$g_w* = CONS - \frac{0/054\gamma + 0/004}{0/043 + 0/046\gamma} \pi_{NOP} + \frac{0/054\gamma + 0/004}{0/043 + 0/046\gamma} g_{Neer} - \frac{0/031\gamma + 0/003}{0/043 + 0/046\gamma} g_{w-2} - \frac{0/006 + 0/06\gamma}{0/043 + 0/046\gamma} \pi_{-2} + \frac{0/003 + 0/036\gamma}{0/043 + 0/046\gamma} \pi_{OP-2} + \frac{0/007}{0/043 + 0/046\gamma} g_{W-3} - \frac{0/007}{0/043 + 0/046\gamma} \pi_{-3} - \frac{0/00007}{0/043 + 0/046\gamma} CPFC - \frac{0/383}{0/043 + 0/046\gamma} \hat{U} + \frac{0/26}{0/043 + 0/046\gamma} \hat{\pi}$$

$$(15)$$

Equilibrium strategy of Nash equilibrium is dependent to (4) and (5) equations. But in some conditions we do not arrive to Nash equilibrium, these conditions are as below;

1- If worker's negotiation power increases, wages rise and if principal dependent to government's negotiation power, inflation and unemployment rates.

2- If foreign inflation increases, price of import goods rise, we have inter inflation and wages increase. If unemployment insurance decreases, wages increase too.

3- If exchange rate increases, or inter money depreciate, import input prices are increased and is caused to inter inflation. Therefore arriving to Nash equilibrium is very hard and impossible.

4. Conclusion

In this paper, we survey a game theory method to survey policy of determination wages and exchange rate to stability economics. When exchange rate increases, import goods price rise and we have cost push inflation, wages are increased and we have unemployment. Therefore wages are determined respect to exchange rate changes. As we said, wages are determined as a game between MAS and NWC.

But in real world, some conditions affected on Nash equilibrium and wages are determined as non Nash method and government equals between benefits of workers and principals. In Iran government has important role in determination of wages.

References

Helmers, F.L.C.H. (1988). Real-exchange-rate indexes. Appendix C in The Open Economy, edited by R. Dornbusch and F.L.C.H. Helmers, EDI Series in Economic Development, 392-397.

Holmlund, B., & P. Skedinger. (1990). Wage bargaining and wage drift: evidence from the Swedish wood industry, in Wage Formation and Macroeconomic Policy in the Nordic Countries, edited by Lars Calmfors. SNS Forlag and Oxford University Press.

Wu, Y. (1999). Macroeconomic coordination of exchange rate and wage movements under Quasi-sterilization: Singapore experience. *Pacific Economic Review*, 4(2), 185-201. doi. 10.1111/1468-0106.00071

Ying, W., Goh, K.H., & Lee, B.K. (2004). The interplay of wage and exchange rate policies in Singapore: A case of collective bargaining in macroeconomic management, *Contemporary Economic Policy*, 22(1), 39-49. doi. 10.1093/cep/byh004

Young, A. (1992). A tale of two cities: Factor accumulation and technical change in Hong Kong and Singapore, in NBER Macroeconomics Annual 1992, Edited by O. J. Blanchard and S. Fisher. Cambridge, MA: MIT Press, pp. 13-54