Exchange Rate, Money Wages and Prices in Egypt (1991 – 2021)

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Abstract

Initial indicators from the Egyptian economy reveal that in recent years the Egyptian pound has suffered large and sudden devaluations. However, the overall final effect of devaluation on the Egyptian economy has been negative. The main concern of this research is to empirically explore and investigate the overall final effect of changes in the exchange rate on money wages and domestic prices in Egypt. Therefore, the main hypothesis we seek to test is that, due the wage-price spiral in the Egyptian economy, devaluation has an overall negative effect on money wages and domestic prices.

Data for the period 1991 – 2021 is used where; the Error Correction Model was found to be the most relevant model that suits Egyptian data in which long-run relationships exist. The results show that domestic price level in Egypt is, as expected by economic theory, positively related to money wage rate, negatively related to real income and positively related import prices. Money wage rate is positively affected by domestic price level and productivity and not significantly affected by the rate of unemployment.

This would imply that successive devaluation in Egypt would lead to explosive inflation due to the wage price spiral.

Keywords: Devaluation, money wages, prices, wage price spiral.

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سعر الصرف، الأجور النقدية والأسعار في مصر (1991–2021)

الملخص

نظريًا، على المستوى الكلي، من المتوقع أن يؤدي خفض قيمة العملة، في ظل ظروف معينة، إلى زيادة الطلب على الصادرات وتقليل الطلب على الواردات. من هذا المنطلق، سيولد خفض قيمة العملة، في ظل ظروف معينة، ميزة تنافسية في الأسعار تدعم الإنتاج المحلي وتخلق دخلاً حقيقيًا أكبر. ومع ذلك، قد يؤثر خفض قيمة العملة على الأسعار المحلية والأجور المحلية من خلال تأثيره على أسعار الواردات.

تشير المؤشرات الأولية من الاقتصاد المصري إلى أن الجنيه المصري قد تعرض لانخفاضات كبيرة ومفاجئة في السنوات الأخيرة. ومع ذلك، كان التأثير النهائي الإجمالي لخفض قيمة العملة على الاقتصاد المصري سلبيًا .تتمثل الشاغل الرئيسي لهذا البحث في استكشاف ودراسة التأثير النهائي الإجمالي لتغيرات سعر الصرف على الأجور النقدية والأسعار المحلية في مصر من خلال البيانات التجريبية. ولذلك، فإن الفرضية الرئيسية التي نسعى لاختبارها هي أنه، بسبب دوامة الأجور والأسعار في الاقتصاد المصري، فإن خفض قيمة العملة له تأثير سلبي إجمالي على الأجور النقدية والأسعار المحلية.

تم استخدام بيانات الفترة من 1991 إلى 2021 وافتراض وجود دوامة الأجور والأسعار. ووجد أن نموذج تصحيح الخطأ هو النموذج الأنسب الذي يلائم البيانات المصرية حيث توجد علاقات طويلة الأجل. تُظهر النتائج أن مستوى الأسعار المحلية في مصر يرتبط، كما تتوقع النظرية الاقتصادية، إيجابياً بمعدل الأجور النقدية، وسلبياً بالدخل الحقيقي، وإيجابياً بأسعار الواردات. ويتأثر معدل الأجور النقدية بشكل إيجابي بمستوى الأسعار المحلية والإنتاجية، ولا يتأثر بشكل كبير بمعدل البطالة. وهذا يعني أن خفض قيمة العملة المتتابع في مصر سيؤدي إلى تضخم متفجر بسبب دوامة الأجور والأسعار.

الكلمات المفتاحية: خفض قيمة العملة، الأجور النقدية، الأسعار، دوامة الأجور والأسعار.

1. Introduction

In theory, at the macro level, devaluation is expected to cause demand prices of exports (expressed in the foreign currency) to decrease and demand prices of imports (expressed in the home currency) to increase. Therefore, demand for exports is expected to increase and demand for imports is expected to decrease. In this respect, devaluation, under certain conditions, will generate price competitive advantage that, in turn, support domestic production and create more real income. However, devaluation might affect domestic prices and domestic wages through its impact on import prices.

Initial indicators from the Egyptian economy reveal that in recent years the Egyptian pound has suffered large and sudden devaluations. In November 2016, a sudden large devaluation of the Egyptian pound took place. The value of the pound was reduced by almost 50% against the US dollar. In October 2022 a second sudden and large devaluation took place where the value of the pound dropped by more than 17% against the US dollar. In January 2023 the Central Bank of Egypt announced a complete floating of the exchange rate. Again, another large and sudden devaluation (almost 50% devaluation over the last 10 months of 2022). GDP growth rate fell from 5.56% in 2018 to 3.57% in 2020 and only 2.5% in 2022. This would imply that the necessary conditions for effective devaluation have not been yet satisfied in the Egyptian economy and, consequently, the

overall final effect of devaluation on the Egyptian economy has been negative.

The main concern of this research is to empirically explore the extent to which the necessary conditions for successful devaluation are met and to investigate the overall final effect of changes in the exchange rate on money wages and domestic prices in Egypt. Therefore, the main hypothesis we seek to test is that, due the wage-price spiral in the Egyptian economy, devaluation has an overall negative effect on money wages (i.e., increasing in the money wage rate) and domestic prices (i.e., higher inflation rate).

2. The Theoretical Framework

All over the past decades, exchange rate reform policy has been a major component of the Structural Adjustment Programs led by the International Monetary Fund. For developing countries, an exchange rate reform policy normally implies devaluation of the home currency. In theory (see Gharseldin, 2022), devaluation leads to changes in relative prices of exports and imports and, under some specific conditions, would enhance export demand and restrain import demand. A devaluation will certainly cause price of exports in the foreign currency to decrease and cause price of imports in the home currency to increase. If export and import demand are price elastic, this will lead to higher demand for exports and lower demand for

imports. [2] If this turns out not to be true, devaluation will end up with negative impact on both domestic prices and money wage rate. Such a negative impact would persist in the long-run if there was a wage-price spiral. In other words, devaluation would generate continuous round after round of price and money wages increases if the wage-price spiral was explosive. To sum up, the final effect of devaluation will depend on:

1. The value of the price elasticity of demand for imports ε_m.
2. The value of elasticity of import price to changes in the exchange rate λ.
3. The magnitude of the wage-price spiral.

If there was a significant wage-price spiral coupled with low value of the price elasticity of demand for imports and high value of the elasticity of import price to changes in the exchange rate, this would result in a long-run negative effects where the economy would suffer from successive increases in domestic prices (i.e., inflation) and money wages (i.e., increases in cost of domestic production). This would certainly have negative impact on the competitive price advantages the economy might have. But how the wage-price spiral works?

In theory, as money wages represent a significant share of the firm's cost, persistent growth of the money wage rate is

[2] Devaluation will be an effective policy tool to cure a deficit in the balance of payment if (according to the Marshall-Lerner Condition) the sum of the price elasticity of demand for exports and the price elasticity of demand for imports is greater than one. (Gharseldin, 2022, p.119).

considered as one of the main drivers of the persistent increase in the domestic price level (i.e., inflation). Such that; firms could raise their prices in order to preserve their mark-ups if wages growth surpasses productivity growth. This could push inflation to a higher level. On the other hand, if inflation is high due to external forces, then the mechanism that shows the relationship between prices and wages which keeps the inflation increasing is that: as inflation increases, trade unions and workers call for higher wages which is expected to remain high for a prolonged period in order to offset the reduction in their purchasing power, and this increases the firm's cost.[3]

When aggregate demand surpasses aggregate supply, firms could easily increase prices, and this often leads to "demand-pull inflation". Furthermore, when the demand for labor exceeds its supply, trade unions and workers could easily ask for higher wages.

In fact, the mechanism that shows the relationship between wages and prices due to the demand side is the basis for different inflation models such as the mark-up model and the Phillips curve. Where, in the mark-up model, prices are determined at a mark-up to input costs and wages, while

[3] Again, productivity growth is not the only driver of money wages growth. It is most useful to consider a combination of factors such as competitive market forces (the efficiency of the labor market), bargaining power of workers and trad unions, and social and political factors (Strain, 2019, pp.169-179).

according to the Phillips curve, unemployment rate or the output gap determines prices and wages.

The Role of Aggregate Supply

So far, the analysis of the wage-price relationship has been concentrated on the demand side. It worth mentioning, however, that although prices and wages move in the same direction, there are some supply side factors that greatly affect the domestic price level and can invert its positive correlation with wages. When firms face cost-push inflation due to the increase in input costs (other than money wages), profit is reduced and the ability of firms to pay higher wages is also reduced. Consequently, firms could raise output prices and reduce growth of money wages in order to keep their mark-ups.[4]

In cases of supply shocks, the bargaining of labor to increase their wages as a trial to catch-up to inflation may not succeed in keeping their real wages, because the increase in nominal wages that aim to preserve the purchasing power could stimulate firms to increase prices further, which would abolish the catch-up effect of the increase in wages that occurred initially.

In most economies, the huge increase in nominal wages growth is still below their inflation. This could be explained by the lag

[4] This mechanism could be realized only if firms have pricing power that could enable them to keep their mark-ups, which actually will depend on the level of competitiveness of the firm in the market.

of responsiveness of wages to changes in prices through their mechanism, while the responsiveness of prices to changes in cost pressures or changes in demand is quicker and more frequent.

Although the supply shocks do generally affect inflation, still in some eras they weren't translated into wage-price spirals. This could be probably due to the influence of several factors that determine whether an initial shock to inflation will turn into a wage-price spiral or not. These factors include: the efficiency of the labor market, the balance of bargaining power between workers and firms, the pricing power of firms and inflation expectations.

A Tight labor market can support workers' effort to ensure that wages are consistent with inflation. In the environment where there is a tight labor market, labor have more bargaining power because it would be difficult for firms to find suitable workers. The opposite of this was shown after the global crisis that occurred in many economies when there was lack of wages growth.

Workers' bargaining power is affected by institutional factors. For instance, the number of collective trade unions would intensify the labor power. Likewise, economies having centralized wage setting would enable their workers to have more bargaining power and thus the wages would respond more easily to price changes. Moreover, the greater the

unemployment benefits and the minimum wages, the more bargaining power of workers and the more responsiveness of wages to changes in inflation. There are also other global factors that would impact the bargaining power, such as the probability of substituting the goods produced domestically with imports; which would knowingly control wages, also the imported inputs would reduce the effect of changing input costs on inflation.

Pricing power of firms: it would be more prevalent for the wage-price spiral to occur when firms have greater pricing power as firms can the transfer effect of increasing the cost of inputs to prices distinctly, and extending the spiral.

On the other hand, firms having less pricing power would have to absorb any increase in the cost of inputs instead of increasing prices and starting the spiral.

Inflation expectations: the occurrence of wage-price spiral is affected crucially by the inflation expectation. Where; if labor and firms are expecting persistent inflation, they would react by either bargaining for higher wages or increasing prices. Those expectations are affected by the nature of the inflation and also the expected response policy that would rectify any price fluctuations.

The increase in wages in the private sector can be explained by the increase in productivity. Therefore, one would not expect

the wage-price spiral in Egypt to be explosive in the private sector. However, money wages in the public sector are expected to increase annually in response to social and political pressure; mainly because of higher inflation. It follows that the wage-price spiral will probably be dominant in the public sector not the private sector in Egypt.

In developing countries, a great portion of imports is imports of intermediate goods which constitute a considerable part of the cost of production of goods and services produced at home. This will automatically implies that changes in the exchange rate in LDCs are expected to be directly reflected in domestic prices. But how is the impact transmitted from exchange rate to domestic prices? The answer is straight forward: through the cost of imports or simply import prices. This is also an empirical issue that will be resolved later in this research.

3. The Methodology

The main approach of analysis is the deductive; where data is collected and analyzed and, therefore, results and conclusions are realized.

4. The Model

The model we develop here is a simple two-equation model that expresses the simultaneous relationship between money wage rate and price level. Within the model, the impact of changes in the exchange rate is transmitted into price level and money wages through the impact of exchange rate on import prices.

The mechanism of the transmission of the impact is as follows: changes in the exchange rate, directly, affect import prices which, in turn, affect domestic prices followed by changes in money wages causing domestic prices, in case of wage-price spiral, to increase.

The model combines the analytical tools of both microeconomic and macroeconomic theory. However, the variables included are mainly macroeconomic variables. In this respect, it should be asserted that economic theories and hypotheses usually try to explain relationships among economic variables in the long-run. In reality, short-run fluctuations do exist and sometimes may not be regular as expected by theories or hypotheses. In time-series data one would expect macroeconomic variables to be either non-stationary or stationary at different levels. Moreover, macroeconomic variables seem to drift together over time (i.e., have trend). The most common non-stationary macroeconomic variables are GDP, price level, interest rate, inflation rate, exchange rate, wage rate and productivity. Therefore, the theoretical and empirical identification of the wage-price relationship must consider the non-stationarity nature of the variables included in the price and wage equations.

The Wage-Price Relationship

In the literature, different specifications of the wage-price relationship are some variants of the following two-equation model: (Libesy and Parkin 1970, Goldstien 1974, Smith 1968, and Alvarez et.al. 2022)

$$W = f(P, U, q) \quad (1)$$

$$P = f(W, P_m, Y)) \quad (2)$$

Where, W is the money wage rate, P price, U unemployment rate, Y real income, P_m, import price and q productivity.

The Wage Equation

Following Philips (1958), Samuelson and Solow (1960), Tobin (1972) and Goldstein (1974), the money wage equation can be best specified for estimation purposes as follows:

$$\frac{\partial W}{W} = \alpha_o + \alpha_1 \frac{\partial P}{P} + \alpha_2 U + \alpha_3 \frac{\partial q}{q} \quad (3)$$

The relationship between money wage rate W and unemployment rate U has been illustrated in the literature by what is known as the Philips Curve, that was first introduced by William Phillips in 1958 when he studied the relationship between the unemployment rate and the rate of change in the money wage rate in the UK. However, Irving Fisher (1926) was the first to address the negative relationship between unemployment rate and rate of change in the price level and, consequently, money wage rate. Over years there has been an extensive body of research to investigate the inverse

relationship between unemployment rate and money wage rate and its impact on the effectiveness of monetary and/or fiscal policies. The value of α_2 is expected to be negative and statically significant.

It should be noted, however, that the inverse relationship between unemployment rate and money wage rate will depend on the efficiency of the labor market. Inefficient labor markets would turn such a relationship into nonsense. This is an empirical issue that would differ from an economy to another.

The relationship between money wage rate W and price level P is expected to be positive. In economic theory, there is no such direct positive impact of price level on money wage rate. Higher prices is not a good economic reason for the money wage rate to increase. However, non-economic factors such as pressure by trade unions, social and/or political pressure will certainly have significant impact on money wage rate in cases of high inflation. Therefore, we conclude that the impact of price level on money wage rate is expected to be positive and, consequently, the value of α_1 is expected to be positive and statistically significant.

According to economic theory, the successful profit maximizing producer who is using two inputs (labor and capital) is the one who is able to realize the following profit maximizing conditions: $MP_L = \frac{W}{P}$ and $MP_K = \frac{r}{P}$ where MP_L and MP_K are the marginal productivity of labor and capital,

respectively, W and r are the price of labor (money wage rate) and capital, respectively and P is output price. It follows that, if output price is held constant, an increase in labor productivity MP_L will certainly result in a corresponding increase in the money wage rate W. Therefore, we conclude that the value of α_3 is expected to be positive and statistically significant.

The Price Equation

For convenience, the price equation is specified by following the mark-up pricing approach, where price of a product is expressed as average cost plus a profit margin. Average cost is broken down into labor cost, cost of imported inputs and other cost. Therefore, price of a product can be expressed as follows:

$$P = WL + P_m M + OT + \pi \qquad (4)$$

Where, L is the number of workers, M the quantity of imported inputs, O the price of other inputs (including material and capital inputs), T is the quantity of other inputs (including material and capital inputs) and π profit margin.

Assuming that number of workers, quantity of imports, cost of other inputs and profit margin are all given, domestic price P would be a function of money wage rate W and price of imports P_m. Following the expectation of macroeconomic theory, price

level is also a decreasing function of the level of real income Y.[5]

Therefore, the price equation can be expressed as follows:

$$\frac{\partial P}{P} = b_o + b_1\frac{\partial W}{W} + b_2\frac{\partial Y}{Y} + b_3\frac{\partial P_m}{P_m} \qquad (5)$$

Where, $b_1 > 0,\ b_2 < 0\ and\ b_3 > 0.$

Equations (3) and (5) cab be re-written as follows:

$$\dot{W} = \alpha_o + \alpha_1\dot{P} + \alpha_2 U + \alpha_3\dot{q} \qquad (6)$$

$$\dot{P} = b_o + b_1\dot{W} + b_2\dot{Y} + b_3\dot{P_m} \qquad (7)$$

Where, $\dot{W} = \frac{\partial W}{W},\ \dot{P} = \frac{\partial P}{P}, \dot{P} = \frac{\partial q}{q}, \dot{Y} = \frac{\partial Y}{Y}\ and\ \dot{P_m} = \frac{\partial P_m}{P_m}.$

Such a specification of the wage price equations implies the relationship between money wage rate and domestic price level is simultaneous. This wage-price simultaneous relationship has a number of critical implications:

- Changes in the exogenous variables $U, \dot{q}, \dot{Y}\ and\ P_m$ will create wage-price spiral. The magnitude of the spiral due to exogenous shocks caused by exogenous increase in $U, \dot{q}, \dot{Y}\ and/or\ P_m$ can be calculated by substituting $\dot{W}$

[5] Note that Y is output or the value of income at constant prices. If Y is nominal income it will represent aggregate demand and, therefore, it will have a positive impact on the price level, i.e., higher nominal

in equation (7) by equation (6) and solving, then obtain the first derivatives as follows:

$$\dot{P} = \frac{b_o + \alpha_o b_1 + \alpha_2 b_1 U + \alpha_3 b_1 \dot{q} + b_2 \dot{Y} + b_3 \dot{P_m}}{(1 - \alpha_1 b_1)} \qquad (8)$$

The impact of an exogenous increase in U:

$$\frac{\partial \dot{P}}{\partial U} = \frac{\alpha_2 b_1}{(1 - \alpha_1 b_1)}$$

The impact of an exogenous increase in $\dot{q}$:

$$\frac{\partial \dot{P}}{\partial \dot{q}} = \frac{\alpha_3 b_1}{(1 - \alpha_1 b_1)}$$

The impact of an exogenous increase in $\dot{Y}$

$$\frac{\partial \dot{P}}{\partial \dot{Y}} = \frac{b_2}{(1 - \alpha_1 b_1)}$$

The impact of an exogenous increase in $\dot{P_m}$:

$$\frac{\partial \dot{P}}{\partial \dot{P_m}} = \frac{b_3}{(1 - \alpha_1 b_1)}$$

- The magnitude of the wage-price spiral will depend on the product of the two coefficients $\alpha_1 b_1$. If the value of $\alpha_1 b_1$ is greater than one, the spiral will be explosive.

- The model predicts a long-run negative relationship between unemployment U and domestic price level P. This is consistent with the expectation of the Philips curve. Higher rates of unemployment will cause money wage rate to decrease and, consequently, domestic price will decrease. Such long-run trade off between unemployment and

domestic price level will depend on the values of the two coefficients α_2 and b_1.[6]

Similarly, the wage-price spiral due to external shocks (i.e., changes in $U, \dot{q}, \dot{Y}$ and/or P_m), can be restated by substituting $\dot{P}$ in equation (6) by equation (7) and solving, then obtain the first derivatives as follows:

$$\dot{W} = \frac{\alpha_o + \alpha_1 b_2 \dot{Y} + \alpha_1 b_3 \dot{P_m} + \alpha_2 U + \alpha_3 \dot{q}}{(1 - \alpha_1 b_1)} \qquad (9)$$

The impact of an exogenous increase in $\dot{Y}$:

$$\frac{\partial \dot{W}}{\partial \dot{Y}} = \frac{\alpha_1 b_2}{(1-\alpha_1 b_1)}$$

The impact of an exogenous increase in $\dot{P_m}$:

$$\frac{\partial \dot{W}}{\partial \dot{P_m}} = \frac{\alpha_1 b_3}{(1-\alpha_1 b_1)}$$

The impact of an exogenous increase in U:

$$\frac{\partial \dot{P}}{\partial U} = \frac{\alpha_2}{(1-\alpha_1 b_1)}$$

The impact of an exogenous increase in $\dot{q}$:

$$\frac{\partial \dot{P}}{\partial \dot{q}} = \frac{\alpha_3}{(1-\alpha_1 b_1)}$$

Exchange Rate and Import Prices

[6] The long-run effect will also depend on the time lag required for the final impact to take place. This will be discussed further when we estimate the model.

Changes in the exchange rate will certainly result in changes in the import prices expressed in the home currency. This is known in the literature as the Exchange Rate Pass-Through ERPT which is defined as "the percent change in local currency import prices resulting from a one percent change in the exchange rate…" (Campa and Goldberg, 2002, P.5). One easy way to estimate the exchange rate pass-through is to fit an equation that directly relates the exchange rate to import prices as follows:

$$\dot{P_m} = c_o + c_1 \dot{E} \qquad (10)$$

From which,

$$\frac{\partial \dot{P_m}}{\partial \dot{E}} = c_1 \qquad (11)$$

Where, $\dot{P_m}$ is the rate of change in the price level and $\dot{E}$ is the rate of change in the exchange rate. The value of c_1 will indicate the magnitude of the pass-through.

Exchange Rate and Domestic prices and Money Wages

According to equations (9) and (10), changes in the exchange rate will be transmitted to domestic prices through subsequent changes in import prices. According to equation (10), an increase in the exchange rate (expressed as the value of the foreign currency) will cause import prices (expressed in the home currency) to increase. The magnitude of this pass-through will depend on the value of the coefficient of sensitivity of import prices to changes in the exchange rate or $c_1$in equation

(10). According to equation (7), changes in import prices, in the short-run, will affect domestic prices. Such a short-run effect of changes in import prices on domestic prices is obtained by differentiating equation (7) with respect to $\dot{P_m}$:

$$\frac{\partial \dot{P}}{\partial \dot{P_m}} = b_3 \qquad (12)$$

In the long-run, however, if there was a wage-price spiral, the effect of changes in import prices on domestic prices would be obtained by differentiating equation (8) with respect to $\dot{P_m}$:[7]

$$\frac{\partial \dot{P}}{\partial \dot{P_m}} = \frac{b_3}{1 - \alpha_1 b_1} \qquad (13)$$

Combining equations (11) and (13) will give the final effect of changes in the exchange rate on domestic prices:

$$\frac{\partial \dot{P}}{\partial \dot{E}} = \frac{\partial \dot{P}}{\partial \dot{P_m}} \cdot \frac{\partial \dot{P_m}}{\partial \dot{E}} = \left(\frac{b_3}{1-\alpha_1 b_1}\right) c_1 \qquad (14)$$

Similarly, the long-run effect of changes in the exchange rate on real wages can be obtained by differentiating equation (8) with respect $\dot{P_m}$ and combining with equation (11):[8]

$$\frac{\partial \dot{W}}{\partial \dot{E}} = \frac{\partial \dot{W}}{\partial \dot{P_m}} \cdot \frac{\partial \dot{P_m}}{\partial \dot{E}} = \left(\frac{\alpha_1 b_3}{1-\alpha_1 b_1}\right) c_1 \qquad (15)$$

[7] Note that according to equations (11) and (12) the long-run effect of changes in import prices on changes in domestic prices is expected to be greater than the short-run effect due to the wage-price spiral. If the values of α_1 *and* b_1 are significantly positive, the long-run effect will be greater than the short-run effect by a factor that equal to $\frac{1}{(1-\alpha_1 b_1)}$.

[8] It is implicitly assumed that there will be no short-run effect of changes in import prices on real wages. The impact of changes in import prices on real wages will depend on the existence and magnitude of the wage-price spiral that, in turn depends on the impact of f import prices on domestic prices. This is a long-run issue.

5. Results

Using data from the Egyptian economy during the period 1991 – 2021, equations (6), (7) and (10) were estimated. The main intention has been to provide robust estimates of different coefficients of sensitivity that are statistically significant. In other words, the exact measurement of the values of the estimated parameters of equations (6), (7) and (10) is our main priority. Equations (6) and (7) imply that a simultaneous model estimation technique must be used. However, in such a simultaneous model estimation, and because of the possibility of a wage-price spiral, the distinction between short-run and long-run effect is essential. Moreover, because we use a small sample of time-series data of macroeconomic variables, the question of variable stationarity must be addressed. For all of these reasons it might be rational to employ a more robust technique that identifies a long-run relationship among variables, while allowing for short-run effect. This technique is the well-known Error Correction Model ECM.

The methodology we follow is summarized in three steps: First, a unit root test is performed in order to test for the stationarity of all variables (series) included in equations (6) and (7). In a second step, a choice has been made between traditional Two-Stage Least squares (2SLS) and Autoregressive Distributed Lag Model (ARDL) is made. In step three, a Long-Run Bounds Test is performed in order to finally either use the ARDL model or the Error Correction Model ECM.

Variables and Data

- P domestic price, measured by the Consumer Price Index CPI (2000 =100).
- W monthly money wage rate.

- Y GDP at current price in Egyptian pound (billion).
- q average labor productivity.
- u rate of unemployment.
- P_m value of imports price index.
- E nominal exchange rate.

Unit Root Test

Table (1) shows the results of the unit root test for variables included in equations (6), (7) and (10). The results of the test reveal that the variables included in equations (6), (7) and (10) are integrated of different order. Some of the variables are integrated of order I(0) or level, while other variables are integrated of order I(1) or first difference. This implies a long-run relationship and, therefore, ARDL is the relevant method of estimation, particularly if the sample is small.

ARDL model is normally suitable for analyzing the relationships among variables (macroeconomic variables represent a good example) where a change in a variable is not reflected immediately, rather its impact is transmitted and distributed over a number of time periods (i.e., lags).

Table (1) presents the results of the Augmented Dicky-Fuller test. The results show that variables in the model are not stationary at the same level. Therefore, OLS estimation of equations (6) and (7) is no longer relevant. Instead an ARDL model estimation is performed. The results are included in table (2) for the price equation and table (3) for the wage equation.

The results of the ARDL estimation for the price equation (i.e., table 2) show, initially, that domestic prices in Egypt, and consequently the inflation rates, are not following a pattern of random-walk. In other words, current price level is dependent on its past level. This is shown by the coefficient on P_{t-1} which is positive and statistically significant. The results of table (2) also show that money wage rate has a positive and statistically significant impact on domestic prices. Current real income (Y_t) has a negative impact and current import prices (p_{mt}) have a positive impact on domestic prices. All of these results are compatible with the expectation of economic theory as shown in section 2 above.

For the wage equation (i.e., table 3), the coefficient on lagged money wage rate (W_{t-1}) is negative and statistically insignificant. This would indicate that money-wage rate in Egypt is following a random-walk pattern. As expected, current domestic price level (P_t) and current productivity (q_t) both have a positive and significant impact on current money wage rate (W_t). Current unemployment rate (U_t) does not appear to

have any significant impact on money wage rate in Egypt. This might be attributed to the economic fact that the labor market in Egypt is not well-organized and, therefore, does not work efficiently in the way that excess labor supply (i.e., higher rate of unemployment) does not affect money wage rate.

Overall, the independent variables included in the price equation (equation 7) explain about 98% of the change in the domestic price level in Egypt. While the independent variables included in the money wage equation (equation 6) explain about 99% of the change in money wage rate in Egypt.

Table (1): Unit Root Test (Augmented Dicky-Fuller)

Variable (series)	***Series is stationary at:*** **Level**	**First difference**	***Value of*** $t-statistic$	***Probability***
P	√		-3.67	**5%**
W		√	-5.01	**1%**
P_m		√	-4.26	**1%**
Y		√	-3.64	**5%**
q	√		-5.22	**1%**
U		√	-4.51	**1%**
E		√	-4.09	**1%**

$P = domestic\ price$ $W = Money\ wage\ rate$ $P_m = import\ prices$

$\boldsymbol{Y = GDP}$ $\boldsymbol{q = Mlabor\ productivity}$ $\boldsymbol{U = unemployment\ rate}$

$\boldsymbol{E = exchange\ rate}$

ARDL Estimation

Tables (2) and (3)

Table (2): *Price Equation* (*ARDL estimation*)

DEPENDENT VARIABLE: CPI (2000 = 100)

Variable	*Coefficient*	*Standard Error*	*t − stattistic*	*Probability*
P_{t-1}	0.783677	0.275112	2.848579	0.02
P_{t-2}	0.546760	0.422763	1.293302	0.23
P_{t-3}	-0.760688	0.265053	-2.869947	0.02
W_t	0.137131	0.065277	2.100758	0.06
W_{t-1}	0.001885	0.068889	0.027366	0.97
W_{t-2}	-0.274134	0.086371	-3.173898	0.01
W_{t-3}	-0.098262	0.111018	-0.885101	0.40
W_{t-4}	0.497612	0.113959	4.366574	0.00
Y_t	-0.748390	0.176411	-4.242309	0.00
Y_{t-1}	0.828903	0.131010	6.327024	0.00
Y_{t-2}	0.187909	0.223891	0.839287	0.42
Y_{t-3}	-0.782751	0.248242	-3.153175	0.01
Y_{t-4}	0.404997	0.134528	3.010507	0.01
P_{mt}	0.086315	0.037042	2.330167	0.04
Pm_{t-1}	0.032873	0.072077	0.456078	0.66
Pm_{t-2}	0.003975	0.097071	0.040947	0.96
P_{t-3}	0.100963	0.094481	1.068603	0.31
Pm_{t-4}	-0.121867	0.085541	-1.424668	0.19
C	12.34763	7.794257	1.584195	0.15
R^2	0.98			
DW	1.93			
n	42			

Table (3): Wage *Equation* (*ARDL estimation*)

DEPENDENT VARIABLE: CPI (2000 = 100)

Variable	*Coefficient*	*Standard Error*	*t – stattistic*	*Probability*
W_{t-1}	-0.492436	0.279995	-1.758730	0.10
W_{t-2}	0.916608	0.308470	2.971468	0.01
W_{t-3}	1.078733	0.231556	4.658625	0.00
W_{t-4}	-1.359187	0.280564	-4.844488	0.00
P_t	2.137030	0.556900	3.837364	0.00
P_{t-1}	-1.113084	0.986033	-1.128851	0.28
U_t	0.072672	0.429644	0.169146	0.86
U_{t-1}	0.769853	0.537937	1.431120	0.17
U_{t-2}	-0.770818	0.502877	-1.532815	0.15
q_t	2.119883	0.370449	5.722469	0.00
q_{t-1}	-2.145644	0.731698	-2.932417	0.01
q_{t-2}	-0.557742	0.365181	-1.527300	0.15
q_{t-3}	2.392287	0.386316	6.192574	0.00
q_{t-4}	-0.745512	0.361253	-2.063684	0.06
C	-83.13773	93.23212	-0.891728	0.39
R^2	0.99			
DW	2.05			
n	42			

The lags of independent variables in the price and wage equations in tables (2) and (3) are included to capture the short-run relationship between domestic price level and its determinants, or between money wage rate and its determinants.

However, there might be, also, long-run relationships. In this respect, it would be useful to identify such long-run relationships and estimate the coefficient of adjustment that shows the deviation of the short-run relationship from the long-run relationship. This would require a Long-Run Bounds Test to conclude if there is a long-run relationship between domestic price level and its determinants, and between money wage rate and its determines. The results of this Long-Run Bounds Test are included in table (4) for the price equation and table (5) for the wage equation.

The results in both table show that the estimated values of the F-statistic are greater than their upper values I(1) at the 1% significance level. This would imply that domestic price level and its determinants are cointegrated (i.e., there is a long-run relationship between domestic price level and its determinants). Also, money wage rate and its determinants are cointegrated (i.e., there is a long-run relationship between money wage rate and its determinants).

Since the Long-run bounds Test for both the wage and price equation is statistically significant, the relevant model to

estimate the wage and price equations is the Error Correction Model ECM which gives a good estimation of the coefficients of adjustment that show the deviation of the short-run relationship from the long-run relationship. The results of estimating the Error Correction Model for price equation and wage equation are included in table (6) and table (7).

(4): *Price equation* (*Long − Run Bounds Test*)

DEPENDENT VARIABLE: CPI (2000 = 100)

F-Bounds Test Null Hypothesis: No levels relationship

Test Statistic	Value	Probability	I(0)	I(1)
F-statistic	7.96	10 %	2.37	3.2
k	3	5%	2.79	3.67
		2.5 %	3.15	4.08
		1%	3.65	4.66
Actual Sample Size 27		Finite Sample: n=35		
		10%	2.61	3.53
		5%	3.16	4.19

1%	4.42	5.81
Finite Sample: n=30		
10%	2.67	3.58
5%	3.27	4.30
1%	4.61	5.96

Table (5): Wage *equation* (*Long – Run Bounds Test*)

DEPENDENT VARIABLE: MONTHLY MONEY WAGE RATE

F-Bounds Test Null Hypothesis: No levels relationship

Test Statistic	Value	Probability	I(0)	I(1)
F-statistic	8.96	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	27	Finite Sample: n=35		
		10%	2.61	3.532
		5%	3.16	4.194
		1%	4.42	5.816

Finite Sample: n=30		
10%	2.67	3.586
5%	3.27	4.306
1%	4.61	5.966

The ECM Model

Table (6): *Price Equation (ECM Model)*

DEPENDENT VARIABLE: CPI (2000 = 100)

Variable	*Coefficient*	*Standard Error*	*t − stattistic*	*Probability*
DP_{t-1}	0.185992	0.181277	1.026012	0.3269
DP_{t-2}	0.351781	0.174182	2.019623	0.0685
DW_t	0.135527	0.029014	4.671126	0.0007
DW_{t-1}	-0.090284	0.048231	-1.871901	0.0880
DW_{t-2}	-0.289299	0.055758	-5.188516	0.0003
DW_{t-3}	-0.320846	0.066964	-4.791336	0.0006
DY_t	-0.629328	0.072588	-8.669852	0.0000
DY_{t-1}	0.153630	0.069660	2.205424	0.0496
DY_{t-2}	0.224504	0.084935	2.643249	0.0229

DY_{t-3}	-0.256648	0.069639	-3.685435	0.0036
DP_{mt}	0.141827	0.059539	2.382069	0.0364
ECC	-0.259171	0.035163	-7.370598	0.0000
R^2	0.99			
DW	1.91			
n	27			

Table (7): Wage *Equation (ECM Model)*

DEPENDENT VARIABLE: MONTHLY MONEY WAGE RATE

Variable	*Coefficient*	*Standard Error*	$t-$ *stattistic*	*Probability*
DW_{t-1}	-0.636155	0.139273	-4.567691	0.00
DW_{t-2}	0.280454	0.127699	2.196209	0.04
DW_{t-3}	1.359187	0.140055	9.704677	0.00
DP_t	2.137030	0.256431	8.333754	0.00
DU_t	0.072672	0.315258	0.230517	0.82
DU_{t-1}	0.770818	0.306050	2.518604	0.02
Dq_t	2.119883	0.225719	9.391686	0.00
Dq_{t-1}	-1.089034	0.211162	-5.157348	0.00
Dq_{t-2}	-1.646776	0.177801	-9.261919	0.00
Dq_{t-3}	0.745512	0.188234	3.960552	0.00
ECC	-0.856281	0.110778	-7.729732	0.00
R^2	0.96			

DW	2.04
n	27
	(included)

Exchange Rate and Import Prices (Pass Through)

The pass through here refers to the extent to which changes in the exchange rate are transmitted directly to import prices. For the Egyptian economy, over the period 1991-2022, the impact of changes in the exchange rate on import prices is obtained by estimating equation (10) as follows:

$$\dot{P_m} = 54.74 + 0.99\dot{E}$$

(1.47) (6.41)

$$R^2 = 0.59$$

(numbers between parentheses are the values of the $t - statistic$)

Exchange Rate and Money Wages and Domestic prices in Egypt

As mentioned in several parts of this research, the final impact of changes in the exchange rate on domestic prices and domestic wages will depend on the magnitude of the wage-price spiral which, in-turn, depends on changes in the exogenous determinants of both domestic prices and money wage rate as explained in equations (8) and (9) above. It follows that the long-run values of the parameters included in equations (8) and (9) will conclude the final effect of changes in the

exchange rate on domestic prices and domestic money wages. The ECM estimates of parameters in equations (8) and (9) are as follows:

$$\alpha_o = 0 \qquad \alpha_1 = 2.137 \qquad \alpha_2 = 0.07$$
$$\alpha_3 = 2.12$$

$$b_o = 0 \qquad b_1 = 0.136 \qquad b_2 = -0.63$$
$$b_3 = 0.142$$

- The impact of an exogenous increase in U on domestic prices: $\frac{\partial \dot{P}}{\partial U} = \frac{\alpha_2 b_1}{(1-\alpha_1 b_1)} = 0.03$
- The impact of an exogenous increase in $\dot{q}$ on domestic prices: $\frac{\partial \dot{P}}{\partial \dot{q}} = \frac{\alpha_3 b_1}{(1-\alpha_1 b_1)} = 0.99$
- The impact of an exogenous increase in $\dot{Y}$ on domestic prices: $\frac{\partial \dot{P}}{\partial \dot{Y}} = \frac{b_2}{(1-\alpha_1 b_1)} = (1.18)$
- The impact of an exogenous increase in $\dot{P_m}$ on domestic prices: $\frac{\partial \dot{P}}{\partial \dot{P_m}} = \frac{b_3}{(1-\alpha_1 b_1)} = 0.49$
- The impact of an exogenous increase in $\dot{Y}$ on money wages: $\frac{\partial \dot{W}}{\partial \dot{Y}} = \frac{\alpha_1 b_2}{(1-\alpha_1 b_1)} = (9.92)$
- The impact of an exogenous increase in $\dot{P_m}$ money wages: $\frac{\partial \dot{W}}{\partial \dot{P_m}} = \frac{\alpha_1 b_3}{(1-\alpha_1 b_1)} = 1.04$
- The impact of an exogenous increase in U money wages:

$$\frac{\partial \dot{P}}{\partial U} = \frac{\alpha_2}{(1-\alpha_1 b_1)} = 0.24$$

The impact of an exogenous increase in $\dot{q}$ money wages:

$$\frac{\partial \dot{P}}{\partial \dot{q}} = \frac{\alpha_3}{(1-\alpha_1 b_1)} = 7.28$$

Based on the proven hypothesis that there exists a wage-price spiral in Egypt, the following effects of changes in exogenous variables (exogenous shocks) are expected:

- Unemployment in Egypt does not have a clear impact on money wage rate nor domestic prices. This result might be attributed to the fact that the labor market in Egypt does not perform efficiently.
- Productivity would push domestic prices up due to its positive effects on money wages.
- Import prices are positively related to domestic prices and, therefore, would push money wages up.
- An increase real income would lead to negative changes in domestic prices and, consequently, money wages.

Based on the existence of a wage-price spiral in Egypt, the final impact of changes in the exchange rate on domestic prices and money wages can be estimated. This estimation is undertaken by applying equations (14) and (15). The final results of the effects on changes in the exchange rate and both domestic prices and money wages will be sensitive to the value of c_1, or the coefficient of exchange-rate –import prices pass through. Having estimated the value of c_1 at 0.99, a 10% devaluation in

Egypt (a 10% devaluation) would be reflected in domestic prices and money wages as follows: $\frac{\partial \dot{P}}{\partial \dot{E}} = \frac{\partial \dot{P}}{\partial \dot{P}_m} \cdot \frac{\partial \dot{P}_m}{\partial \dot{E}} = \left(\frac{b_3}{1-\alpha_1 b_1}\right) c_1 \gamma = \frac{0.142}{1-2.137\times0.136} \times 0.99 \times 0.10 \approx 2\%$

$\frac{\partial \dot{W}}{\partial \dot{E}} = \frac{\partial \dot{W}}{\partial \dot{P}_m} \cdot \frac{\partial \dot{P}_m}{\partial \dot{E}} = \left(\frac{\alpha_1 b_3}{1-\alpha_1 b_1}\right) c_1 \gamma = \frac{2.137\times0.142}{1-2.137\times0.136} \times 0.99 \times 0.10 \approx$

4.2%

The coefficient of adjustment in the price equation (ECC in table 6) is 0.259. this would imply that short-run effect converges into long-run effect within about 2.5 years. While such a conversion form short-run to long-run in the wage equation (the value of the ECC coefficient is 0.856) would require only 1.2 years.

Conclusion

The main concern of this paper was to investigate the extent to which changes in the exchange rate are transmitted to domestic prices and money wages in Egypt and by how much? We employed data for the period 1991 – 2021 and assumed the existence of a wage-price spiral. Several statistical tests were conducted in order to test for variables stationarity and select the most appropriate model for estimation. The Error Correction Model was found to be the most relevant model that suits Egyptian data where long-run relationships exist.

The results show that domestic price level in Egypt is, as expected by economic theory, positively related to money wage

rate, negatively related to real income and positively related import prices. Money wage rate is positively affected by domestic price level and productivity and not significantly affected by the rate of unemployment.

Based on these results and the exact value of estimated parameters of both price and wage equation, an initial 10% devaluation in Egypt would increase the rate of change in domestic price level (i.e., the rate of inflation) by almost 2% and would increase the rate of change in money wage rate by 4% every year. This would imply that successive devaluation in Egypt would lead to explosive inflation due to the wage price spiral.

In order to reduce the negative impact of devaluation on domestic prices and money wages, policy maker in Egypt would have to find ways to satisfy the Marshall-Lerner condition (by following polices that increase the value of the price elasticity of the demand for imports) and revise income policies in order to reduce the negative impact of non-economic factors (i.e., social and political pressure) that lead to higher money wages.

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