RISAD
REVISTA INTERNACIONAL
DE SALARIOS DIGNOS

Indexation system for wages in dollars: Uruguay 2003-2022

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Reception: 10/07/2022

Acceptance: 21/10/2022

Abstract

This article discusses the application of two alternative indexing systems for wages established in foreign currency. In particular, it assesses the impact of both on the average level and the variance of the purchasing power of wages. It presents a set of original models that correspond to different scenarios of price behavior, exchange rate, and salary adjustment system. It concludes that, under the most realistic assumptions, indexing based on the differential between inflation and depreciation of the national currency with respect to the foreign currency, without debugging the volatility of the variables, is the most appropriate to minimize the variance of the real wage. This result is confirmed by estimates made for Uruguay. The robustness of the same must be evaluated for scenarios that represent other behaviors of the variables.

Key Words

Wage indexation, real wage, inflation, exchange rate

Clasificación JEL: J30, J41

Introduction

In Uruguay there is a group of workers whose wages are established in foreign currency or directly linked to the contribution of any of them. This situation includes groups as diverse as fishing (capture), port practitioners, embassy and international agency officials, as well as employees in the computer area, international news agencies and the financial sector[2]. Their employers adopt this wage policy in order to keep up with the evolution of costs with that corresponding to their income, in general, also linked to a foreign currency. In this way they shift all exchange rate volatility to real wages. An appropriate indexation system for these situations should aim to reduce the variability of the purchasing power of wages.

When designing a system of wage adjustment of this type, account must be taken of the particularity that the consumption of workers will be made in a currency different from that in which they receive

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their wages[3]. For this reason, the formula for adjusting wages should consider the two variables that affect purchasing power: Inflation and the depreciation or appreciation of the national currency in relation to the foreign currency[4]. In particular, if the objective is to stabilize purchasing power, wages should be adjusted for the differential between price increases and the exchange rate.

The economic literature has analyzed in depth the functioning of the different adjustment systems, as well as their impact on the purchasing power of workers, in the case of wages established in national currency. However, when wages are established in a different currency this topic has other complexities that will be analyzed in this paper.

Specifically, the objective of this paper is to evaluate two alternative indexing systems applicable to wages established in foreign currency, seeking to identify the one that allows to reduce the variance of the purchasing power of the same, without disregarding their impacts on the average level of the real wage.

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2 Companies in this sector located in free trade zones set their wages mainly in dollars (Lalanne and Vaillant, 2014).
3 Workers of international land freight transport, as well as pilots of airlines and light aviation, are in a similar situation in that they receive their per diem in dollars while making the corresponding consumption in other currencies (Ministry of Labour and Social Security, 2022).
4 In the following of the text whenever reference is made to "depreciation of the national currency" it should be understood in respect of the foreign currency in which wages are fixed and that it is contemplated both possible depreciation and appreciation of the same.
This article is arranged in six sections: after this introduction, in the second section a brief review of the background of the subject is made; in the third, the basic concepts of the adjustment of remunerations in foreign currency are analyzed, as well as the particularities that the introduction of a relatively volatile variable such as the exchange rate in the adjustment formula has; In the fourth section, various models are presented that collect the main aspects of the subject matter and that allow the consequences of establishing different adjustment formulas to be derived; in the fifth, the conclusions derived from the models are compared with the results obtained for Uruguay; and finally, the last section summarizes the main conclusions of the paper.

Background of the topic

Economic research has dealt in depth with the subject of wage developments. It has mainly focused on determining whether they behave flexibly or are rigidities. The abundant empirical evidence collected so far suggests the presence of friction but differs in the nature of friction. In some countries wages show downward rigidity in nominal terms, while in others they show downward rigidity in real terms. (Barattieri, Basu y Gottschalk, 2014; Dickens, et al., 2007; Juarez y Cabada, 2018; Messina y Sanz-de-Galdeano 2014). Conversely, recent studies provide evidence in favour of nominal pay flexibility (Elsby y Solom, 2019).

These investigations also show that downward rigidity in nominal terms increases in low-inflation settings (Juarez and Cabada, 2018), while real rigidity tends to prevail in countries with a higher degree of unionization. Interestingly, there is no association between resistance to decline in real terms and the degree of wage indexing (Dickens, et al., 2007).

Studies that report the degree of wage indexing are limited to reporting the existence or otherwise of such clauses in different countries, without providing information on the degree of coverage of such clauses (Checchi, Lucifora, Boeri and van Ours, 2002; Chechnya-Westphal, 2022; Koester and Grapow, 2021). This could explain the difficulty of finding a positive association between the degree of indexation and the downward rigidity of real wages.

Another set of research has focused on analyzing the consequences of using different formulas and indicators for the indexing of income established in national currency, whether wages or pensions. Its main conclusions are: 1) In systems based on adjustments equal to past inflation, average real income is a decreasing function of the rate of inflation and an increasing function of the frequency of adjustment (Lopes, 1985); 2) systems that anticipate adjustments below past inflation do not necessarily lead to a fall in average real income, especially if they manage to slow the pace of price increases; 3) Systems in which adjustments are triggered each time real income has fallen below a threshold succeed in stabilizing real wages or pensions (Forteza, 1995); 4) Indexing systems should be evaluated on the basis of both average real income and variance, particularly if there is a *trade-off* between the two (Lluberas, 2019).

In contrast, the analysis of the indexing of wages established in foreign currency has not deserved due attention from the economic literature. This vacuum may lead, as in Uruguay, to a purely legal approach to the issue predominating and to pronouncements of justice being made without regard to its economic consequences.

In Uruguay, the issue had already been dealt with but gained notoriety from the fall of the dollar (2004-2008)[2] and, especially, from the call to the Wage Councils in 2005[3]. The wage agreements reached in this framework provided for increases by branch of activity for wages established in national currency4. However, there was a minority group of workers who received wages in foreign currency, leaving at least two questions raised: First, were the increases agreed in the Wage Councils applicable to workers with wages in foreign currency? and if so, secondly, what was the formula for implementing them?

Two conflicting legal positions emerged in response to these questions. On the one hand, there were those who understood, long ago and before these events, That it was appropriate to grant increases to wages in foreign currency to cover the gap that eventually arose between the adjustment agreed for wages in pesos and the change in the contribution of that one (Pla Rodriguez, 1994). However, from this position it was not suggested to reduce wages in dollars when the value of that currency grew above the agreed wage increases.

On the other hand, there were those who understood that wage adjustments emanating from the Wage Councils were not applicable to wages in foreign currency because the latter had their own mechanism of updating derived from the changing value of the exchange rate. They started from a fairly restrictive assumption explicitly assuming that the foreign exchange rate rises almost permanently. For this reason, they felt that, if the adjustments were applied, workers would receive a double benefit and companies would be affected by their competitiveness against those who pay their wages in national currency. In line with this position, the judiciary issued first instance judgments determining that the adjustments agreed in the Wage Councils were not applicable to remuneration in foreign currency (Bentancur, 2008).

The Government spoke on the issue in March 2009, determining that the above adjustments were applicable to wages in foreign currency and establishing a precise procedure for applying them. Specifically, such remuneration should be adjusted for the difference recorded, in each period, between the percentage of increase agreed in the Wage Councils for wages in pesos and the change in the contribution of the foreign currency (National Labour Directorate, 2009). Although the procedure did not explicitly establish it, some jurists understood that salaries should only be adjusted if the aforementioned factor was positive (Vásquez, 2011).

International organizations based in Uruguay, such as Asociación Latinoamericana de Integración (ALADI) and Mercado Común del Sur (MERCOSUR), were immersed in a similar problem. The fall in the value of the dollar resulted in the loss of purchasing power in the remuneration of its officials, established in this currency. This led MERCOSUR to approve a system of wage adjustment (Grupo Mercado Común del MERCOSUR, 2012) and to have ALADI conduct an annual review of inflation behavior and the change in the value of the dollar to, if necessary, adjust its remuneration (ALADI Committee of Representatives, 2012). For their part, the agencies dependent on the United Nations were already prepared for this situation by having a system of destination adjustments that provides for periodic wage revisions (International Civil Service Commission, 2005).

These systems introduce some novel technical aspects. First, the mechanisms of MERCOSUR and the United Nations incorporate a variable allocation that allows remuneration to be adjusted, upward or downward, without changing basic wages. In this way, a greater symmetry is given to the operation of the system, while having a relatively stable basic salary that serves as a reference for decision making[2]. Secondly, the MERCOSUR system foresees that for the purposes of calculating the dollar change, the annual averages of the variable will be compared. This allows to mitigate the impact of the volatility that will eventually exhibit it.

Basics on the indexation of wages established in foreign currency

The purchasing power of all wages is eroded daily by the effect of rising prices. For this reason, a wage indexing system for wages established in national currency that seeks to periodically recover a certain level of real wages must adjust them by a percentage equal to the accumulated inflation since the last adjustment.

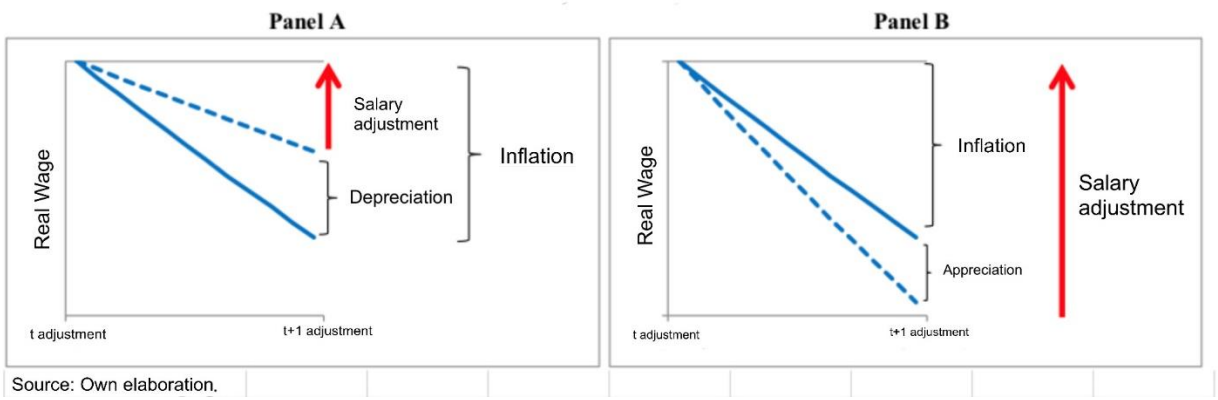
The purchasing power of wages established in foreign currency also suffers from the erosion caused by inflation, but is also affected by changes in the exchange rate. If they are established in dollars, their purchasing power decreases when the national currency appreciates against the American currency and increases when the national currency depreciates against the green note.

As a result, A wage indexing system for wages established in foreign currency that seeks to periodically return to a certain level of real wages should adjust nominal wages by the accumulated differential between inflation (*Inf*) and depreciation of the national currency (*Dep*) since the time of the last adjustment (Equation 1).

$$Adjustment\ factor = (1 + Inf)/(1 + Dep) \qquad (1)$$

Two situations can arise when adjusting nominal wages. If the national currency has depreciated against the dollar, the adjustment of wages will be less than the past inflation, because they will have already recovered part of the purchasing power thanks to the appreciation of the United States currency (Figure 1 Panel A)[2]. If, on the other hand, the national currency has appreciated against the dollar, the wage adjustment will be higher than past inflation because it will have to compensate not only for the effect of rising prices, but also for the deterioration of the dollar against the national currency (Figure 1 Panel B).

Graphic 1: Magnitud of the salary adjustment



Source: Own elaboration.

The two variables to be considered in the calculation of salary adjustments for salaries established in foreign currency have quite different behavior. On the one hand, inflation is measured through the Consumer Price Index (CPI). This indicator generally exhibits a steady upward trend and moderate volatility. Therefore, when calculating accumulated inflation, there is no inconvenience in considering the variation of the CPI between the last adjustment and the current adjustment[2].

On the contrary, the exchange rate between domestic and foreign currencies is a variable characterized by greater volatility. For this reason, if for the calculation of the accumulated depreciation, the variation in the exchange rate between the time of the last adjustment and the current adjustment is considered, any merely transitory upward or downward movement occurring at both ends of the period considered could be taken into account. One way to reduce this volatility is to calculate at both ends an average exchange rate for a relatively long period, a quarter or a year, and then calculate the variation between these volatility-depreciated averages.

The formula to be adopted for calculating the depreciation of the national currency must be evaluated in light of the behavior of the exchange rate in the period and in the economy under consideration. The formula that minimizes the variations in the purchasing power of remunerations should be adopted. The

[2] In each adjustment, CPI for the preceding month is available. Therefore, in practice, the CPI variation from the last month considered in the previous adjustment and up to the last month with information available at the time of the current adjustment should be considered.

different models presented in the following section are intended to provide guidance on which is the best option in each context.

The models

In this section we present a set of models that allow us to analyze the behavior of remunerations established in foreign currency that are indexed by the differential between inflation and depreciation of the national currency. The analysis focuses on the average purchasing power of wages, as well as their variability under different scenarios of behavior of the relevant variables.

Model I

In this first model we assume that prices (P_t) and the exchange rate (D_t) between domestic and foreign currencies grow at rates α and β, respectively. In both cases the variables undergo temporary shocks around their trend. These shocks are independent and identically distributed (iid) with zero mean and fixed variance. The independence assumption implies that they are not temporally correlated with each other.

$$P_t = e^{\propto t + \varepsilon_t} \qquad \varepsilon_t \sim iid\ (0, \sigma_\varepsilon^2) \quad (2)$$

$$D_t = e^{\beta t + \eta_t} \qquad \eta_t \sim iid\ (0, \sigma_\eta^2) \quad (3)$$

Salaries are established, in foreign currency, in the first period $(t = 1)$, but with information available up to the base period $(t = 0)$. Subsequently, all periods are adjusted by the accumulated differential between inflation and the depreciation of the national currency from the base period to the period prior to each adjustment. Thus, wages in foreign currency (s_t), defined for convenience as unit (1) for period one, will behave according to the following expression:

$$s_t = \frac{P_{t-1}/P_0}{D_{t-1}/D_0} \quad (4)$$

The true value of the real wage (a_t), or the purchasing power of wages measured in local currency, is obtained by multiplying wages in foreign currency by the current exchange rate index and then dividing the result by the current price index:

$$a_t = \frac{s_t * (D_t\ /\ D_0)}{(P_t\ /\ P_0)} \quad (5)$$

Substituting equations 2, 3 and 4 in equation 5, and taking logarithms, we obtain a simplified and summary expression of the determinants of the purchasing power of wages in each period:

$$Ln(a_t) = -\alpha + \beta - \varepsilon_t + \varepsilon_{t-1} + \eta_t - \eta_{t-1} \quad (6)$$

The expectation and variance of the above expression are, respectively:

$$E[Ln(a_t)] = -\alpha + \beta \quad (7)$$

$$Var[Ln(a_t)] = 2\left(\sigma_{\varepsilon}^2 + \sigma_{\eta}^2\right) \quad (8)$$

Equation 7 reflects the well-known relationship between real wages and inflation, although it is slightly modified for wages denominated in foreign currency. In this case, their purchasing power depends negatively on the inflation rate and positively on the depreciation rate of the national currency. In this model, this relationship derives from the fact that the adjustment of remunerations is made taking into account the prices and the exchange rate of a period prior to that in which the wage is spent by the worker. In practice, this relationship is linked to the fact that the wage is spent during a whole period in which prices continue to rise.

In turn, the variance of the real wage will depend positively on the variance exhibited by prices and the exchange rate, which is shown in equation 8. In particular, it is observed that the effect of both variances is twofold due to the fact that both the shocks suffered by the variables in the period taken into account for the determination of the adjustment and the time when the income is spent have an impact.

Model II

In this alternative model it is assumed that prices and the exchange rate have the same behavior as in the previous model. In turn, remunerations established in foreign currency are adjusted every period by the accumulated differential between inflation and the depreciation of the national currency, but with a formula that tries to eliminate the volatility of prices and the exchange rate. Specifically, prices and the exchange rate are averaged over a sufficiently long period prior to each adjustment and compared with an equally long average ending in the base period. In this way wages, expressed in foreign currency, will behave according to the following expression:

$$s_t = \left[\frac{\prod_{i=t-k}^{i=t-1} P_i/D_i}{\prod_{i=-k+1}^{i=0} P_i/D_i}\right]^{1/k} \qquad (4')$$

It is possible to show that when the length of the period over which the averages are taken grows infinitely the wage will be equal to the following:

$$\lim_{k\to\infty} s_t = e^{(\alpha-\beta)(t-1)} \qquad (9)$$

Using the above equation and making the same substitutions as in the previous model, a simplified expression of the determinants of the purchasing power of wages in each period can be derived:

$$Ln(a_t) = -\alpha + \beta - \varepsilon_t + \eta_t + \varepsilon_0 - \eta_0 \qquad (6')$$

Equation 6' shows that the consideration of long averages for the calculation of inflation and the depreciation of the national currency allows us to eliminate part of the effect of the volatility of the series on purchasing power, except for that which is linked to the period in which the wage is spent by the worker.

Taking the expectation and variance of the previous expression, we obtain:

$$E[Ln(a_t)] = -\alpha + \beta + \mathcal{E}_0 - \eta_0 \quad (7')$$

$$Var[Ln(a_t)] = \sigma_{\mathcal{E}}^2 + \sigma_{\eta}^2 \quad (8')$$

As shown in equation 7', the purchasing power expectancy varies with the new adjustment formula. It depends negatively on inflation and positively on the depreciation of the national currency, as in the previous case, but the deviations from the trend of the two relevant variables in the base period have an additional impact. Insofar as wage adjustments are made according to the trend behavior of prices and the exchange rate, they do not take into account, for example, that a positive price shock in the base period will cause prices to grow less in the medium term and return to their trend, which will improve the purchasing power of wages. In the same way, but in the opposite direction, it will affect an exchange rate shock in the base period.

On the other hand, the variance decreases by half, because a large part of the volatility of the series has been eliminated, remaining only that linked to the period in which income is spent (equation 8').

Model III

The assumption adopted in the two previous models that price and exchange rate shocks are temporally uncorrelated, behaving as "white noise", is at least questionable. In certain contexts the deviations exhibited by these variables from their respective trends show a certain degree of inertia, from which it follows that the shocks are temporally correlated (Wooldridge, 2010).

In order to capture the aforementioned behavior, this third model retains all the assumptions adopted in the first one, with the only difference that the shocks to prices and the exchange rate around their respective trends are assumed to be temporally correlated, following autoregressive processes of order one. In turn, the shocks of these processes are independent and identically distributed variables with zero mean and fixed variance:

$$\mathcal{E}_t = \lambda\, \mathcal{E}_{t-1} + \gamma_t \qquad 0 < \lambda < 1\,, \qquad \gamma_t \sim iid\left(0, \sigma_{\gamma}^2\right) \qquad (10)$$

$$\eta_t = \rho\, \eta_{t-1} + \theta_t \qquad 0 < \rho < 1\,, \qquad \theta_t \sim iid\left(0, \sigma_{\theta}^2\right) \qquad (11)$$

To the extent that the remaining assumptions are maintained and that remunerations are adjusted every period according to the accumulated differential between inflation and depreciation of the national currency, without previously eliminating its volatility, the equations derived for purchasing power and its expectation are identical to those corresponding to the first model:

$$Ln(a_t) = -\alpha + \beta - \mathcal{E}_t + \mathcal{E}_{t-1} + \eta_t - \eta_{t-1} \quad (6'')$$

$$E[Ln(a_t)] = -\alpha + \beta \quad (7'')$$

However, the expression of the variance of the logarithm of the purchasing power changes and results as follows:

$$Var[Ln(a_t)] = 2\left[\frac{\sigma_\gamma^2}{(1+\lambda)} + \frac{\sigma_\theta^2}{(1+\rho)}\right] \quad (8'')$$

Therefore, the variability that purchasing power will exhibit will depend directly on the variance of the shocks to the autoregressive processes corresponding to prices and the exchange rate, but it will also depend negatively on the degree of temporal correlation shown by the shocks. Indeed, the longer it takes for the exchange rate and prices to return to their respective trends after a shock, the more stabilizing it will be for the real wage to adjust wages based on the levels, away from their respective trends, recorded by the two series in the period prior to the adjustment, given that they will be perpetuated for some time.

Model IV

This fourth model includes the assumption that the shocks of the variables are temporally correlated, as well as all the others in the previous model, except that in this case it is assumed that the remunerations are adjusted with the formula that tries to eliminate the volatility of prices and the exchange rate, already presented in model II (equation 4').

Making the same substitutions as in the previous cases, we arrive at expressions of the logarithm of purchasing power and its expectation identical to those corresponding to model II:

$$Ln(a_t) = -\alpha + \beta - \mathcal{E}_t + \eta_t + \mathcal{E}_0 - \eta_0 \quad (6''')$$

$$E[Ln(a_t)] = -\alpha + \beta + \mathcal{E}_0 - \eta_0 \quad (7''')$$

However, the expression of the variance changes and becomes equal to:

$$Var[Ln(a_t)] = \frac{\sigma_\gamma^2}{(1-\lambda^2)} + \frac{\sigma_\theta^2}{(1-\rho^2)} \quad (8''')$$

As can be seen, in this case the variance of the real wage depends positively on the degree of temporal correlation of price and exchange rate shocks. Indeed, the adjustment of wages based on the trend values of inflation and depreciation of the national currency does not take into account the shocks suffered by both series in the period prior to the adjustment, thus causing a variation in purchasing power, which will be greater the more lasting the shocks are.

Model V

One way of making the models presented above more realistic is to lift the assumption of independence between prices and the exchange rate. With this orientation, this model takes up the assumptions considered in Model III (equations 2, 3, 4, 5 and 11) but incorporates a modification in the behavior of the shocks suffered by prices with respect to their trend by introducing the following pass-through mechanism from the exchange rate to prices:

$$\mathcal{E}_t = \pi \eta_t + \gamma_t \qquad 0 < \pi < 1\,, \qquad \gamma_t \sim iid\left(0, \sigma_\gamma^2\right) \qquad (10')$$

It can be shown that the expectation and variance of the logarithm of the purchasing power of wages are equal:

$$E[Ln(a_t)] = -\alpha + \beta \qquad (7''''')$$

$$Var[Ln(a_t)] = 2\left[\sigma_\gamma^2 + \frac{(1-\pi)^2}{(1+\rho)}\,\sigma_\theta^2\right] \qquad (8''''')$$

From the above results it can be seen that the expectation is equal to that corresponding to Models I and III, while the variance depends negatively on the level of temporal correlation exhibited by the shocks to the exchange rate and the degree of pass-through.

Model VI

This model takes up the assumptions considered in Model IV (equations 2, 3, 4', 5 and 11) and incorporates the pass-through mechanism predicted in equation 10'.

It can be shown that:

$$E[Ln(a_t)] = -\alpha + \beta + \mathcal{E}_0 - \eta_0 \qquad (7''''''')$$

$$Var[Ln(a_t)] = \sigma_\gamma^2 + \frac{(1-\pi)^2}{(1-\rho^2)}\,\sigma_\theta^2 \qquad (8''''''')$$

From these equations it is clear that the expectation of the purchasing power of wages is identical to that of Models II and IV, while the variance increases with the level of temporal correlation exhibited by the shocks to the exchange rate and depends negatively on the degree of pass-through.

Comparison of the models

Table 1 shows the main results derived from the different models analyzed above. In order to evaluate the two proposed indexation systems, it is necessary to compare models that assume the same behavior of the relevant variables (I with II, III with IV and V with VI).

In the case where the relevant variables -prices and exchange rate- behave as a trend plus white noise (Models I and II), it is observed that the elimination of the volatility of the series for the calculation of the adjustment has two consequences on the purchasing power of wages: on the one hand, it introduces the effect that base period shocks have on the average level; and on the other hand, it reduces the variance of the same. While the first effect is not desirable, the second clearly is.

Table 1
Summary of results derived from models I to VI

Behaviour of the variables: prices and exchange rate	Model	Wage adjustment	Purchasing power of salaries	
			Esperance	Variance
Trend plus temporally unrelated peturbations	I	Without removing volatility from the series	$-\alpha + \beta$	$2\left(\sigma_\varepsilon^2 + \sigma_\eta^2\right)$
	II	Removing volatility from the series	$-\alpha + \beta + \varepsilon_0 - \eta_0$	$\sigma_\varepsilon^2 + \sigma_\eta^2$
Trend plus temporally correlated shocks	III	Without removing volatility from the series	$-\alpha + \beta$	$2\left[\frac{\sigma_\gamma^2}{(1+\lambda)} + \frac{\sigma_\theta^2}{(1+\rho)}\right]$
	IV	Removing volatility from the series	$-\alpha + \beta + \varepsilon_0 - \eta_0$	$\frac{\sigma_\gamma^2}{(1-\lambda^2)} + \frac{\sigma_\theta^2}{(1-\rho^2)}$
Trend plus temporally correlated shocks and pass-though	V	Without removing volatility from the series	$-\alpha + \beta$	$2\left[\sigma_\gamma^2 + \frac{(1-\pi)^2}{(1+\rho)}\sigma_\theta^2\right]$
	VI	Removing volatility from the series	$-\alpha + \beta + \varepsilon_0 - \eta_0$	$\sigma_\gamma^2 + \frac{(1-\pi)^2}{(1-\rho^2)}\sigma_\theta^2$

When the shocks to prices and the exchange rate around their respective trends are temporally correlated (Models III and IV) the elimination of the volatility of the series for the determination of the adjustment also introduces the effect of the base period shocks on the average level of purchasing power, while having an ambiguous effect on the variance of purchasing power. However, it is clear from the formulas that the higher the correlation of shocks the more likely the variance of purchasing power increases when the volatility of the series is removed for the calculation of the adjustment.

Finally, when the shocks to the exchange rate are temporally correlated and there is a pass-through of these shocks to prices (Models V and VI), in addition to confirming the two conclusions mentioned

above, it is observed that the pass-through mechanism operates as a reducer of the variance of purchasing power.

Application to Uruguay 2003-2022[3]

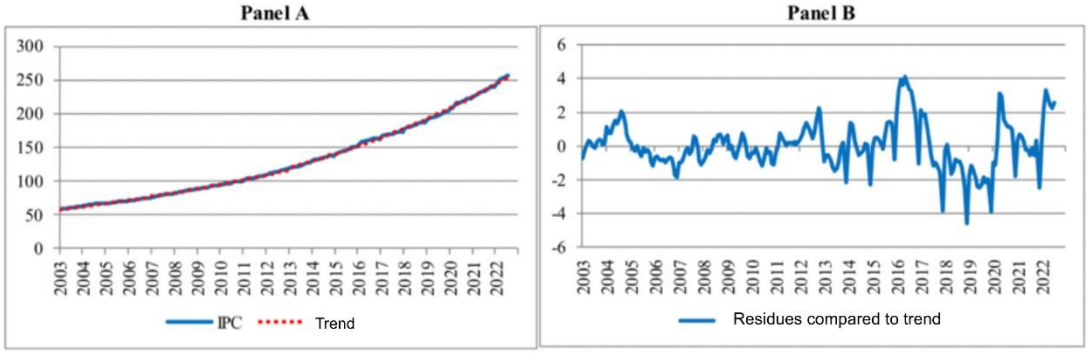
This section tests the results obtained from the models developed above. First, we simulate the behavior that would have been recorded in Uruguay over the last twenty years if the different wage adjustment systems proposed had been applied. Second, the mean and variance of their purchasing power are calculated, and the corresponding comparisons are made between the different systems.

Previously, it is necessary to analyze the behavior of prices and the exchange rate in this country, during the period 2003-2022, in order to identify which of the models presented above reflect or are closer to the reality of Uruguay and, therefore, which of these will be tested by means of the calculations.

Consumer prices in Uruguay have exhibited a steady growth trend during the period under analysis. In the first ten years they increased at a rate of 7.2% per year and, subsequently, in the last ten years they accelerated slightly to a rate of 8.2% per year (Figure 2 Panel A). The deviations from these trends did not follow a "white noise" behavior but, on the contrary, show a high degree of temporal correlation.[4]

This means that when prices in a given month were above or below their long-term trend, this deviation was perpetuated for several months (Graph 2 Panel B).

Graphic 2. Consumer Price Index, December 2010 = 100



Source: Own elaboration based on information from the National Institute of Stadistics

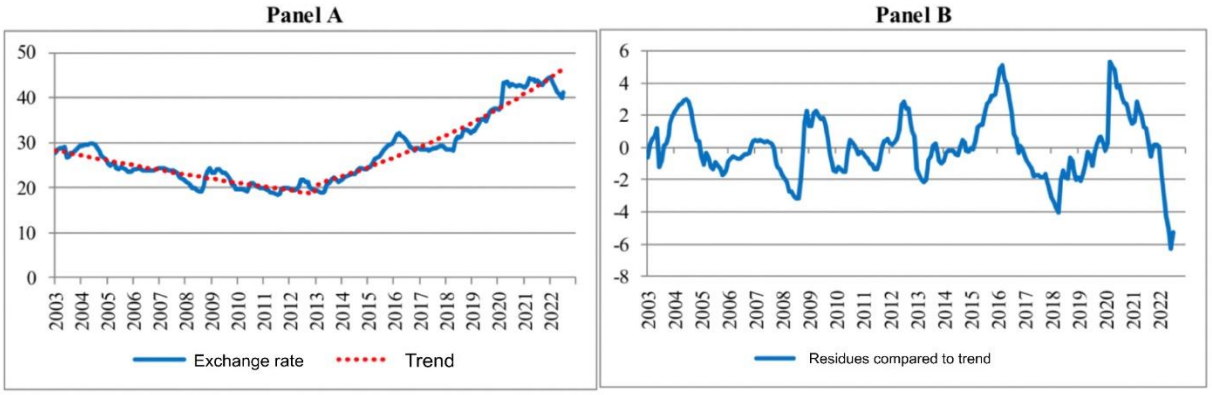
The nominal exchange rate, pesos per dollar, exhibited two markedly different trends during the period analyzed. In the first ten years it fell at an annual rate of 4.1%, while in the last ten years it grew at an annual rate of 8.8% (Graph 3 Panel A). In this case, the deviations from these trends are even more noticeable than in the previous one and also show a high degree of temporal correlation.[5] (Graphic 3 Panel B).

[3] Estimates include figures through July 2022.

[4] The estimation of the autocorrelation parameter of the residuals shows that it is high and significant in both periods: $\lambda = 0{,}88$ en 2003-2012 y $\lambda = 0{,}80$ in 2013-2022.

[5] The autocorrelation parameter of the residuals is also high and significant: $\rho = 0{,}93$ en 2003-2012 y $\rho = 0{,}96$ en 2013-2022.

Graphic 3. Exchange Rate, peso per dollar



Source: Own elaboration based on information from the National Institute of Stadistics

Regarding the relationship between both variables in Uruguay, empirical evidence supports the existence of an exchange rate pass-through to prices, although its speed has weakened since the mid-1990s. In turn, it is observed that the pass-through grows with the level of inflation and the output gap, while it is lower in episodes of exchange rate appreciation and in floating exchange rate regimes (Gianelli, 2012).

The analysis of the behavior of the two relevant variables -consumer prices and exchange rate- suggests that the models that most closely reflect the reality of Uruguay in the period analyzed are those that assume a temporal correlation of shocks (Models III, IV, V and VI). Therefore, these will be the Models that will be tested by means of the calculations, for which two periods will be distinguished (2003-2012 and 2013-2022), as suggested by the different trends exhibited by the variables.

Next, we proceeded to simulate the monthly evolution that the purchasing power of wages established in dollars in Uruguay would have registered if the different wage adjustment systems proposed had been applied in the two periods mentioned above. On the one hand, wage adjustments based on the accumulated differential between inflation and the depreciation of the national currency with respect to the dollar between the base period -December 2003 or 2013- and the month prior to each adjustment were used; this system is identical to the one represented by Models III and V. On the other hand, wage adjustments based on the differential between inflation and depreciation of the national currency with respect to the dollar were applied but previously eliminating the volatility of the series through two alternative methods: in the first, similar to that represented by Models IV and VI, the twelve-month averages of the series were used; and in the second, identical to that represented by Models IV and VI, the estimated time trends for both periods were used. The three systems were applied with monthly, semi-annual and annual adjustment frequency, in order to evaluate the sensitivity of the results to this aspecto.

It should be noted that these calculations deviate from the actual behavior of the purchasing power of wages in dollars of the various groups of workers. In fact, it should be recalled that some of them did not receive regular adjustments, others received the increases agreed upon in the Wage Councils, and the fewest had their own indexation system, with its own particularities, so that the evolution of wages in dollars differed in all cases from those predicted in the different models.

Table 2 shows the results of the calculations corresponding to the mean and variance of the purchasing power of dollar remunerations under the different indexation systems and frequencies. The values that can be directly compared with the results predicted by the models are those estimated by applying monthly frequency wage adjustments, both without eliminating the volatility of the series and using time trends for the same.

Three main findings emerge from the results that confirm the predictions of the models. First, it is worth noting that when adjustments are made without eliminating the volatility of the series, the average purchasing power of wages is equivalent, as predicted by Models III and V, to the difference between the depreciation rate of the national currency against the dollar and the inflation rate. In the first period both effects go in the same direction (-0.004 - 0.006 = -0.10) due to the appreciation of the national currency, while in the second period they go in the opposite direction and are fully compensated (+0.007 - 0.007 = 0.000) as a consequence of the depreciation of the national currency. In turn, when the frequency of salary adjustments is lower -semi-annually or annually- the negative effect of inflation and appreciation on purchasing power is amplified.

Table 2
Avarage and variance of wage purchasing power

Frequency of wage adjustments	Wage adjustment: Removing (yes or no) volatility from the series.		Purchasing power of wages (in logarithms)	
			Avarage	Variance
Period 2003-2012				
Monthly	No		-0.010	0.001
	Yes	12-month average	-0.061	0.004
		Trend	-0.078	0.004
	No		-0.044	0.004
	Yes	12-month average	-0.081	0.006
		Trend	-0.122	0.005
Annual	No		-0.071	0.004
	Yes	12-month average	-0.110	0.008
		Trend	-0.129	0.005
Period 2013-2022				
Monthly	No		0.000	0.000
	Yes	12-month average	-0.018	0.003
		Trend	0.035	0.004
	No		-0.006	0.002
	Yes	12-month average	-0.016	0.005
		Trend	0.023	0.005
Annual	No		-0.003	0.004
	Yes	12-month average	-0.012	0.006
		Trend	0.026	0.005

Second, it can be observed that when the adjustments are determined by eliminating the volatility of the series, the average purchasing power of wages changes significantly, as predicted by Models IV and VI, due to the effect of the choice of the base period. In the first period it deteriorates markedly (from -0.010 to -0.078) because the exchange rate in the base period was well above its trend (0.068), while prices were above it. On the contrary, in the second period it improves moderately (from 0.000 to 0.035) because in the base period the exchange rate was well below its trend (-0.046) but prices were also below its trend (-0.011). It should be added that the magnitude of these changes in average purchasing power is similar when the frequency of adjustments varies.

Third, it is observed that the variance of purchasing power increases significantly when adjustments are calculated eliminating the volatility of the series. As can be seen from the comparison (Model III versus IV and Model V versus VI), while the deviations of the series from their respective trends exhibit a certain degree of inertia, the adjustments calculated using the raw series, without removing their volatility, manage to stabilize the purchasing power of wages to a greater extent. However, this difference in the magnitude of the variances is markedly reduced when the frequency of adjustments decreases.

Conclusions

The main objective of a wage indexation system should be to reduce the volatility of the purchasing power of wages. In particular, when wages are established in foreign currency, the way to periodically restore a certain level of purchasing power is to adjust them according to the differential between inflation and the depreciation of the national currency with respect to the foreign currency.

Although the formula for calculating the adjustments seems to be precisely determined on the basis of the two variables mentioned above, its practical implementation raises certain questions. The need to consider the evolution of a relatively volatile variable such as the exchange rate, in addition to prices, raises the question of whether or not it is advisable to purge the statistical series of its volatility. This paper aims at answering this question and demonstrates that, from a theoretical point of view, there is no single correct answer, but that it will depend on the behavior of the variables in the concrete reality under analysis.

When the deviations of the variables from their respective trends do not show inertia, and look more like "white noise", it will be convenient to calculate the wage adjustments using the volatility cleaned series. However, in this case, care should be taken to choose a base period that has recorded exchange rate and price levels that are normal, or close to their respective trends, because such a choice will have long-lasting effects on the average level of the real wage.

If, on the other hand, as occurs in most cases, the deviations of the variables from their respective trends show a certain degree of inertia, it will be convenient to adjust wages according to a calculation of inflation and depreciation of the national currency that does not previously adjust for the volatility of the statistical series. In this case, there will be no lasting effect derived from the choice of the base period on the average level of the real wage, since the deviations of the variables from their trend, both in the base period and at the time of the adjustments, will be corrected by means of the indexation system.

The existence of a pass-through mechanism of the exchange rate to prices operates as a partial and automatic stabilizer of the purchasing power of remunerations established in foreign currency. The conclusions presented above, regarding the impact of the two indexation systems on the average level and variance of the real wage, will not be altered by the existence of a pass-through of this type, whatever its magnitude.

The conclusions drawn in this paper, based on theoretical models and empirical estimates, are valid both in periods of appreciation and depreciation of the domestic currency vis-à-vis the foreign currency. Notwithstanding this, their robustness should be evaluated considering other scenarios of price and exchange rate behavior, as well as other more complex pass-through mechanisms.

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