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## Contractionary effects of foreign price shocks (and potentially expansionary effects of inflation)

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## **Working Paper No. 1028**

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### **Contractionary Effects of Foreign Price Shocks (and Potentially Expansionary Effects of Inflation)**

by

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## **ABSTRACT**

Using the model proposed in Krugman and Taylor's "Contractionary effects of devaluation" (1978), we examine what macroeconomic effects of shocks to foreign prices. We show that these shocks can be contractionary for two reasons: (i) because they imply a loss of income if an economy has a trade deficit or import prices increase proportionally more than export prices; (ii) because there is a redistribution of income from wages to profits and rent, which leads to a decrease in consumption and output (as the wage earners' propensity to consume is higher than that of profit earners and rentiers). An endogenous reaction of nominal wages to the increase in the price level might lead to even higher increases in prices, but mitigates the negative macroeconomic effects of the foreign price shocks because it reduces their negative distributional effects. If the proportional increase in nominal wages is higher than that of domestic prices, the distributional effect becomes positive. The opposite is the case with markups. If they increase in reaction to higher prices, they contribute to further price increases but they also exacerbate the negative distributional effects. The paper also provides an analytical solution for a general case of the model of Krugman and Taylor.

**KEYWORDS:** Inflation, Foreign price shocks, Wages, Markups, Distribution

**JEL CLASSIFICATIONS:** D3, E12, E31, F4

## 1 INTRODUCTION

The period after the pandemic crisis in 2020 saw a sharp increase in inflation. For most economies, price increases originated abroad in international markets with sharp increases in the prices of oil and gas, commodity prices, the cost of transportation, the cost of microchips, etc. (BIS 2022; Storm 2022; International Monetary Fund 2022; Breinard 2022; Arce, Hahn, and Koester 2023). Given the importance of these products and services for the overall economy, these price increases were transmitted to domestic prices, as firms were able to protect (or in some cases even expand) their profit margins (Konczal and Lusiani 2022; Weber and Wasner 2023; Glover, Mustre-del-Rio, and Ende-Becker 2023). On the other hand, nominal wages did not react much. The result was a significant decrease in real wages and an overall redistribution toward profits (Rich, Tracy, and Mason 2022; Arce, Hahn, and Koester 2023; BIS 2023).

Despite their relative stability, nominal wages have been at the epicenter of the debates that have taken place on inflation, with the implicit assumption almost always being that a reaction of nominal wages to the foreign price shocks would be harmful. For example, those who argued that the inflationary shock would be persistent and called for aggressive action by the central banks to counter it (e.g., Domash and Summers 2022; Blanchard 2022) made their argument on the basis that the increase in the prices of imports, together with the low level of unemployment, would induce a wage-price spiral. The counterview, that inflation would be transitory, posited that the institutional characteristics of today's economies made a strong reaction of wages unlikely. However, the majority of the transitory camp accepted the premise that a nominal wage reaction would be harmful. A case in point is the reaction of the major central banks, which endorsed the "transitory" view in the early months of the inflation increase but then, in early 2022, moved to the "persistent" view and started increasing interest rates aggressively. However, in both phases, nominal wage growth was considered undesirable.

But is this position really valid? Are nominal wage increases necessarily harmful? As mentioned above, this situation—with high inflation but stagnant nominal wages—implies real income losses for the majority of the population in an economy. If nominal-wage increases lead to smaller losses (or even increases) in real wages, employees would be better off even if prices were to increase further. From a macro point of view, what are the effects of an increase in international prices and the resulting redistribution of income between wages and profits, and how would these effects change if wages increased?

To answer these questions, a useful entry point is Krugman's and Taylor's "Contractionary effects of devaluation" (1978), which examines critically the conventional view that a currency devaluation always has expansionary effects. Krugman and Taylor argue that, under certain conditions, devaluation can have "contractionary" effects on the level of macroeconomic activity.

They focus on two main transmission mechanisms: (i) the effect of devaluation on income distribution, and (ii) the effect resulting from an initial trade imbalance. Regarding the first one, a devaluation makes imported intermediate goods more expensive in domestic currency units. If firms can maintain their markups on the unit cost of production, devaluation leads to an increase in the domestic price level. If nominal wages do not change, the increase in the price level implies a decrease in the real wage and a redistribution of income toward profits. Given that workers' propensity to consume is higher than that of capitalists, this redistribution leads to a decrease in consumption and total income. Regarding the trade imbalance effect, if the volume of exports and imports does not react strongly to the exchange rate, a devaluation increases—in domestic currency units—the cost of imports and the revenues from exports. The overall effect of devaluation via this channel will depend on the initial trade balance. In a country with trade deficit, the negative effects related to the elevated cost of imports outweigh the positive effects of the increase in export revenues, and thus devaluation is contractionary.

A first contribution of our paper is to extend the results of Krugman and Taylor. In their paper, they examine the distributional and the trade imbalance effects of devaluation separately. The distributional effects are derived under the assumption of balanced trade, while the trade imbalance effects are derived under the assumption that workers' and capitalists' propensities to consume are the same. We show that their partial effects can be generalized into a more general effect which is decomposed into the two sub-effects of distribution and trade imbalance. We also interpret their results from a different angle which makes them more intuitive.

The discussion of Krugman and Taylor's model allows us to shift our focus to the effects of an increase in international prices. In principle, such an increase leads to an increase in the prices of both imports and exports. We show that the macroeconomic effects are analogous to those analyzed by Krugman and Taylor (1978), with similar transmission mechanisms.

From a distributional point of view, if firms can maintain their markups, the increase in import prices leads to an increase in the domestic price level, a decrease in the real wage, a redistribution of income toward profits, and a decrease in consumption and total income. Regarding the trade imbalance effect, the higher the trade deficit of a country, the more negative the macroeconomic

effects of an increase in international prices will be. A difference here compared to Krugman and Taylor is that the effect will also depend on how the increase in international prices affects import and export prices. It is intuitive that the higher the increase in import relative to export prices, the more negative will be the effect.<sup>1</sup>

We next go one step further, and allow for a change in nominal wages and the markup. We show that the higher the reaction of nominal wages to price increases, the more positive (or the less negative) the overall macroeconomic effect, although at the same time it leads to higher prices. The reason for that is intuitive: a strong reaction of wages contains or, in some cases, might even reverse the negative distributional effect in response to import price increases. For the same reason, the results go toward the other direction in the case of markups. The stronger the increase in the markups the more negative the overall macroeconomic effect will be (also accompanied by a further increase in the price level).

With regards to the trade-balance effect, the endogenous changes in nominal wages and markups lead to some interesting results. In this situation, the price level tends to increase more compared to the previous scenario (unless the increase in nominal wages is accompanied by a decrease in the markups). This higher increase in the price level weakens the real effects related to trade imbalance (positive or negative). In fact, if the domestic price increases are proportionally larger than the change in foreign prices the initial effect might even be reversed.

Two conclusions related to our original questions follow. First, in the face of increases in the import prices, increases in nominal wages have positive macroeconomic effects even if they lead to higher prices. Second, markups (and profits) are also a potentially important margin of adjustment. The effect of an increase in international prices on prices and the level of economic activity can also be mitigated through a decrease in the markups. On the other hand, an increase in the markups exacerbates both price increases and income declines.

The paper proceeds as follows. In Section 2, we present some stylized facts on the main variables of interest in our analysis: foreign prices, the rate of inflation, nominal and real wages and the markups for the US and the Eurozone. Section 3 summarizes the model of Krugman and Taylor and generalizes its results. Section 4 examines the effect of an increase in international prices (imports and exports). In Section 5, we allow for an endogenous reaction of nominal wages and markups. Section 6 concludes.

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<sup>1</sup> A change in the exchange rate leads to an equiproportional change in both imports and export prices, which is not necessarily the case when international prices change. The effect of the latter depends on which prices are affected and the structure of the trade of an economy.

## 2 POST PANDEMIC INTERNATIONAL PRICES, WAGES, MARKUPS, PROFITS AND DISTRIBUTION

### 2.1 International Prices

There is little disagreement that the recent increase in the rate of inflation was triggered by synchronized disruptions in global supply chains caused by the pandemic, which led to price increases of some essential goods and services, as well as sharp increases in the prices of commodities and oil that accompanied the post-pandemic recovery in the second half of 2020. This trend was further reinforced by the beginning of the war in Ukraine in early 2022 (Storm 2022; BIS 2022; International Monetary Fund 2022; Breinard 2022; Stiglitz and Regmi 2022; Arce, Hahn, and Koester 2023; Ferguson and Storm 2023). In some cases, the price increases were also reinforced by speculation in some markets.

Figure 1 presents some aspects of these price pressures. Panel (a) shows that the “Global price of Energy index” produced by the International Monetary Fund increased by 300 percent between its pre-pandemic level in January 2020 and its recent peak in August 2022. Over the same period the Global price of Food and Global price of Industrial Materials indices increased by around 60 percent (panels [b] and [c] respectively).

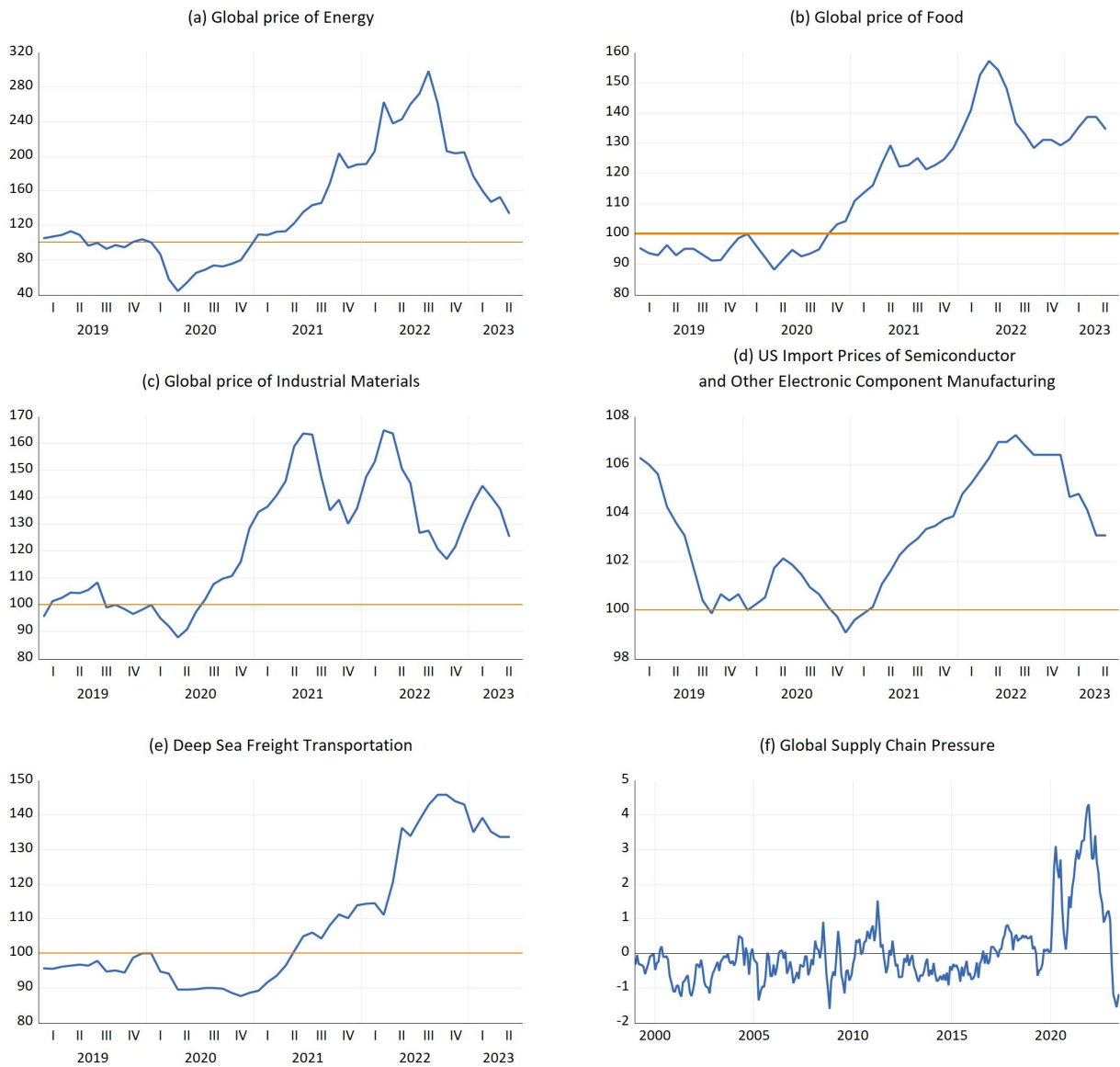
Another intermediate good that saw a price increase was semiconductors. Panel (d) shows that US Import Price Index for semiconductors and other electronic manufacturing components increased by 11 percent between January 2020 and mid-2022. It is worth noting that this price increase for semiconductors—which seems small relative to the other goods and services mentioned—came after 30 years of declining prices. Also, arguably, the problems in semiconductor production did not manifest themselves only in their prices but with shortages in their supply which pushed up the costs of production for several industries.<sup>2</sup>

The disruptions in global transportation networks led to an increase in the deep-sea freight transportation price index—produced by the Bureau of Labor Statistics—by 45 percent between January 2020 and the end of 2022 (panel [e]). Overall, there was very significant pressure on global value chains. Panel (f) presents an index constructed by the Federal Reserve Bank of New York on Global Supply Chain Pressure. It is evident that the pandemic-induced crisis and the recovery of the last years have been marked by a sharp increase in these pressures.

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<sup>2</sup> Car production is one of the most well-known cases here. In 2021 and 2022, the average waiting time for a new car delivery increased from a few weeks to many months or even more than a year. In turn, the increase in new and used car prices was a consequence of this.

**Figure 1: The Post-Pandemic Global Price Shock: Indices for Selected Categories of Goods and Services.**



**Note:** For panels (a)-(e): 2020=100

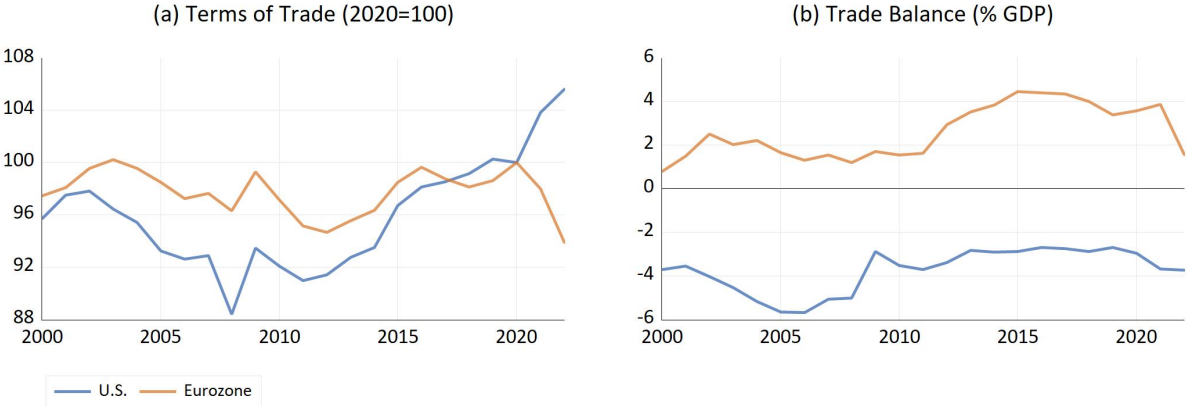
**Sources:** IMF, BLS, Federal Reserve Bank of New York



Two aspects of this process are particularly important. First, the prices of the aforementioned goods and services are determined in international markets, and therefore can be considered as quasi-exogenous for any individual economy. Such prices are very flexible and determined by global demand (Kalecki 1971, ch. 5; Dhyne et al. 2005). Second, all these goods and services are crucial inputs for the rest of the economy, with very low elasticity of substitution (at least in the short and medium runs). Therefore, the increase in their prices led to an increase in the costs of production of most goods and services.

Note also that these increases in international prices have a dual effect on any given economy, as they increase both their import and export prices. Therefore, their effect on the terms of trade of an economy depends on the structure of the trade (which goods are exported and imported, the trade balance for each of these goods, etc.). Figure 2(a) shows, for example, that the post-pandemic period saw an improvement for the US economy’s terms of trade but a deterioration for those of the Eurozone economy. To a large extent, this difference is due to the strong reliance of the Eurozone economy on energy imports.

**Figure 2: Terms of Trade and Trade Balance for the US and the Eurozone Economies, 2000–22**



Source: OECD.

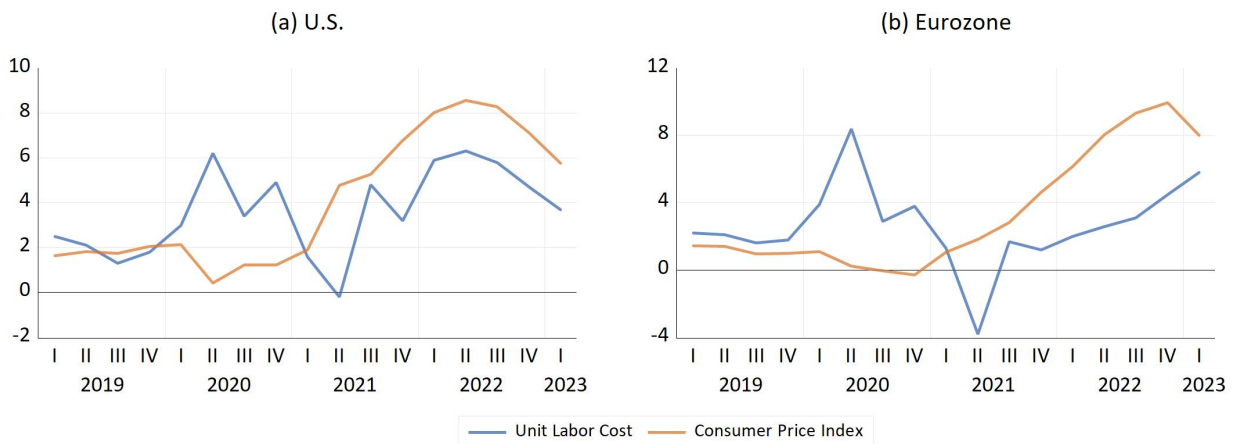
The changes in the import and export prices also affect the trade balance of an economy. One possible channel of transmission is through substitution effects: an increase in import/export prices reduces the respective volume. However, in reality this effect is small, at least in the short run. As we mentioned above the goods and services whose price increased in the wake of the pandemic are essential inputs to production with very low elasticity of substitution. What would a firm substitute oil or semiconductors for?

Even without substitution effects an increase in import and export prices affects the trade balance through its effect on the nominal value of imports and exports. This effect will depend on two factors, the trade balance of the economy and the relative change in import and export prices. The larger the trade deficit of an economy or the higher the increase in import prices relative to export prices are, the more negative impact of an increase in international prices will be (the larger the deterioration in the trade balance will be), *ceteris paribus*. Figure 2b shows that because the terms of trade shock was negative for the Eurozone but positive for the US, the trade balance (as a share of GDP) of the Eurozone deteriorated more than the trade balance of the US.

## 2.2 Wages, Markups, Profits, and Distribution

The result of these price shocks in foreign prices was a sharp increase in domestic prices (the Consumer Price Index, GDP deflator, etc.). The increase in domestic inflation led many economists and policymakers to express fears that the situation would lead to a wage-price spiral (Blanchard 2022; Domash and Summers 2022). As Figure 3 shows, this spiral did not materialize; nominal wage growth remained subdued, much below the rate of inflation, leading to a decline in real wages.

**Figure 3: Annual Growth Rates of Consumer Price Index and Unit Labor Cost.**

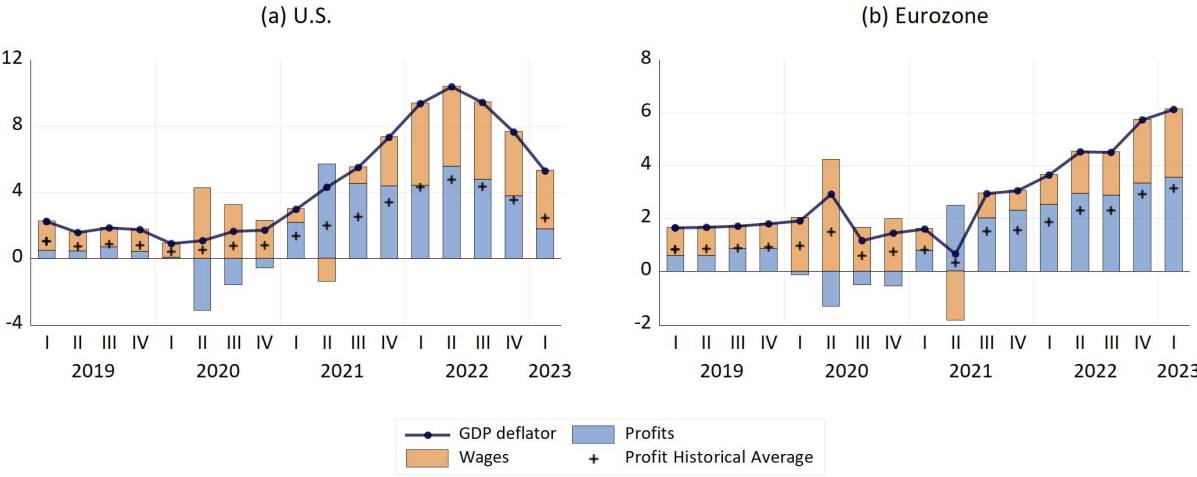


Sources: BLS, OECD.

On the contrary, the lion's share of the increase in prices was attributed to profits. Figure 4 presents the share of pre-tax profits and wages in the GDP deflator following the decomposition in Weber and Wasner (2023). Black crosses indicate historical averages. Hence, when the profit component bar exceeds the value indicated by the related black cross, the profit component in

price increases is above the historical average. As we can see, both in the US and in the Eurozone, the profit’s contribution to inflation was consistently above its historical average in the periods of high inflation and only falls below average in Q1 of 2023 in the US. Overall, it is now widely accepted by academic economists and policymakers that profits, as opposed to wages, played an outsized role in the post-pandemic increase in inflation (Konczal and Lusiani 2022; Breinard 2022; Glover, Mustre-del-Rio, and Ende-Becker 2023; Arce, Hahn, and Koester 2023; Lagarde 2023).

**Figure 4: Decomposition of GDP deflator**



**Sources:** BEA, Eurostat, authors’ calculations.

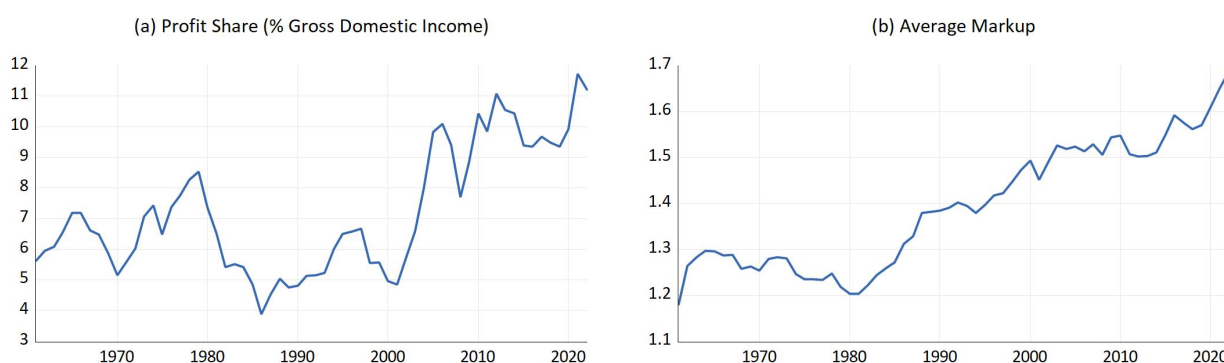
These processes also led to an increase in the share of profits. Figure 5A shows that, in 2021 and 2022, corporate profits as a share of gross domestic income climbed to their highest level of the last six decades.

A final question is related to the role of markups in this increase in inflation and profitability. Note that in the face of sharp increases in the price of imported intermediate inputs, and as long as nominal wages do not increase much, the profit share will tend to increase even with constant—or declining—markups as firms are able to pass the higher cost of intermediate inputs to prices leading to a decrease in the real wages (Lavoie 2023; Nikiforos and Grothe 2023). Indeed, Castro-Vincenzi and Kleinman (2022) find empirical evidence in favor of an inverse correlation between the labor share and the imported material prices in the US economy.

At the same time, there is evidence that markup increases have contributed to the increases in inflation and profitability in the post-pandemic period. Some studies arrive at that conclusion

using macroeconomic or sectoral data. Glover, Mustre-del-Rio, and Ende-Becker (2023), using Compustat data on publicly listed US firms, find that the markup rise explains half of the CPI growth in 2021 in the US. In a similar vein, Arce, Hahn, and Koester (2023) show that profits explain half of the GDP deflator in the fourth quarter of 2022 in the Eurozone, noting that the effect of unit profits on domestic price pressures was exceptional from a historical perspective. Hansen, Toscani, and Zhou (2023) found that the contributions of unit profits to the Eurozone’s GDP deflator were significantly higher compared to the inflationary period following the oil price shocks in the 1970s.

**Figure 5: Measures of Profitability**



**Sources:** BEA, Compustat.

Other studies use firm-level data to compute markups and then aggregate across industries or the entire economy. De Loecker, Eeckhout, and Unger (2020) find a sharp increase in the markup during the period 1980–2016. Konczal and Lusiani (2022), following their methodology, find that in 2021 firms in the US increased their markups at the fastest pace since data are available from 1950, bringing the markup rate to a historically high level. They also show that while the pre-2021 increase was mostly concentrated among the top 25 percent firms in the markup distribution, the increase of 2021 was broad-based across the distribution. Nikiforos and Grothe (2023) updated these estimates for 2022 and found that the average markup rate kept increasing in 2022 (Figure 5[b]). At the same time, the increase was not as broad-based as in 2021, and a significant portion of the increase in the average markup was driven by the increase in the market share of firms with high markups. Finally, Weber and Wasner (2023) provide case studies of large US corporations that increased their markups in the post-pandemic period.<sup>3</sup>

<sup>3</sup> At the same time, we should note that estimates of markups with data from the Industry Accounts of the BEA suggest a more moderate increase in the markups of private industries.

### 3 CONTRACTIONARY EFFECTS OF DEVALUATION

Krugman and Taylor (1978) investigate the effects of devaluation in a open economy with the use of a simple Keynes-Kalecki (demand-led) model.<sup>4</sup> In their model the economy has two sectors, a domestic sector serving domestic demand, and an export sector, producing for the rest of the world. The prices of exports and imports are determined exogenously at international markets in foreign currency. If we denote the exchange rate (expressed as units of domestic currency for foreign currency) as  $e$ , this implies that the prices of exports and imports denominated in domestic currency ( $P_X$  and  $P_M$  respectively) are:

$$P_X = eP_X^* \quad (1)$$

$$P_M = eP_M^* \quad (2)$$

where  $P_X^*$  and  $P_M^*$  are the prices of exports and imports denominated in foreign currency.

Domestic prices are determined by a markup on unit production cost, which in turn is assumed to be comprised by labor and imported intermediate inputs. This implies that

$$P_H = (1 + z) \cdot (a_{LH}w + a_{MH}P_M) \quad (3)$$

where  $P_H$  is the price level of domestic goods,  $a_{LH}$  and  $a_{MH}$  are the input coefficients for labor and imported inputs respectively,  $w$  is the nominal wage rate, and  $z$  is the markup factor.

The total nominal income is

$$Y = P_H H + P_X X - P_M M \quad (4)$$

where  $H$  is real domestic output and  $X$  and  $M$  are the volume of exports and imports respectively. An important assumption Krugman and Taylor make is that the volumes of exports and imports are not responsive to prices changes, thus changes in the import and export prices will not affect their volume.

Total income is distributed between two classes: wage- and profit/rent-earners. The assumptions outlined so far imply that the income of these two classes is determined as

$$Y_W = (a_{LH}H + a_{LX}X)w \quad (5)$$

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<sup>4</sup> Their model is an early (if not the first) formulation of the contemporary standard Structuralist/Kaleckian model. Other well-known related works which followed over the next decade includes Rowthorn (1981), Taylor (1983), Dutt (1984), Blecker (1989), and Bhaduri and Marglin (1990).

$$Y_R = z(a_{LH^W} + a_{MH}P_M)H + (P_X - a_{LX}w)X \quad (6)$$

where the subscripts  $W$  and  $R$  stand for wage- and profit/rent-income respectively, and  $a_{LX}$  is the input coefficient for labor in the production of exports.

Abstracting from the role of government, real domestic output is equal to the consumption of the two classes ( $C_W, C_R$ ) plus real investment ( $I$ ). The real consumption of each class is a positive function of its real income. To simplify their argument, Krugman and Taylor assume that there is no direct demand for imports; all imports are used as intermediate inputs to domestic production. This implies that the relevant price deflator for workers' and capitalists' income is  $P_H$ .

On the other hand, they assume that investment is a negative function of the interest rate, which has some implication when they examine potential effects of monetary policy in reaction to devaluation. Given that we are not discussing monetary policy in this paper, we will assume that investment is autonomous. Importantly, Krugman and Taylor—as well as our specification—abstract from potential effects of prices and current profitability on investment. This assumption conditions the distributional impact of the shocks that we will discuss. One could justify this assumption either on structural grounds (i.e., that in some economies in certain periods of time investment is not very responsive to current profitability [e.g., Nikiforos 2022]), or on cyclical grounds that during a downturn firms pay more attention to demand as opposed to current profitability (e.g., Nikiforos and Foley 2012; Marglin 2017) or that in periods of great uncertainty, as the last years have been, the investment decisions of firms react weakly to current profitability.

Given these assumptions, real domestic demand can be written as:

$$H = C_W\left(\frac{Y_W}{P_H}\right) + C_R\left(\frac{Y_R}{P_H}\right) + I \quad (7)$$

while demand for imports is equal to:

$$M = a_{MH} \cdot H \quad (8)$$

The marginal propensity to consume of each class with respect to their income are

$$\begin{aligned} \gamma_W &= \partial C_W / \partial \left(\frac{Y_W}{P_H}\right) \\ \gamma_R &= \partial C_R / \partial \left(\frac{Y_R}{P_H}\right) \end{aligned} \quad (9)$$

As several studies have shown, the propensity to consume of wage-earners is higher than that of profit/rent-earners. Thus, it is also assumed that  $\gamma_W > \gamma_R$ .

This model specification implies that an exogenous change in investment leads to a change in domestic real output equal to  $dH/dI = 1/D$  where  $D = 1 - \gamma_W a_{LH} w/P_H - \gamma_R z/(1+z)$ . Also, and more importantly, the fact that exports, imports, and investment are inelastic to prices and profitability implies that real output is wage-led. A redistribution of income from profits to wages will be contractionary, due to the different propensities of the two classes to consume.

Given this specification, Krugman and Taylor conduct the following exercises. First, they examine what the effect of devaluation is under the assumption that the propensities of the two classes to consume are the same ( $\gamma_R = \gamma_W = \gamma$ ). In this case they find an elasticity of real income to the exchange rate as:

$$\frac{dH}{de} \frac{e}{H} = K \frac{P_X X - P_M M}{P_H H} \quad (10)$$

where  $K = \frac{\gamma}{D} [1 - (1+z) \frac{P_M M}{P_H H}]$ . The result is intuitive. A devaluation of the currency increases both export and import prices (in domestic currency). If a country is running a trade surplus, devaluation will tend to increase domestic income. On the other hand, in countries with trade deficits (which are the countries that usually devalue) devaluation will be contractionary.

Next, Krugman and Taylor assume balanced trade ( $P_X X = P_M M$ ) and derive the distributional effects of devaluation. They show that, in this case, the elasticity of real domestic income with respect to the exchange rate is:

$$\frac{dH}{de} \frac{e}{H} = \frac{\gamma_R - \gamma_W}{D} \frac{Y_W}{P_H H} (1+z) \frac{P_M M}{P_H H} \quad (11)$$

Devaluation implies an increase in domestic prices, as firms pass through the cost of the increase in import prices to domestic prices. Given that nominal wages are assumed to remain constant, this implies a decrease of the real wage and a redistribution of income toward profits. Since the propensity to consume out of profits is lower than that out of wages ( $\gamma_R - \gamma_W < 0$ ), the overall distributional effect of devaluation is contractionary.

As Krugman and Taylor hint at several points in their paper, the algebra of the model is quite “complicated”; this is their justification of examining special cases, and then using numerical examples to highlight the overall contractionary effects of their model (451). The derivations are tedious indeed, but after a fair amount of algebra, we were able to derive a generic analytical

solution of the elasticity with respect to the exchange rate:

$$\frac{dH}{de} \frac{e}{H} = \underbrace{K' \frac{P_X X - P_M M}{P_H H}}_{\text{Trade Imbalance Effect}} + \underbrace{\frac{\gamma_R - \gamma_W}{D} \frac{Y_W}{P_H H} (1+z) \frac{P_M M}{P_H H}}_{\text{Distributional Effect}} \quad (12)$$

Essentially this result combines the partial results of equations (10) and (11). The only difference is that, instead of  $K$ , we now have  $K' = \frac{\gamma_R}{D} [1 - (1+z) \frac{P_M M}{P_H H}]$ . The term now contains  $\gamma_R$  as opposed to  $\gamma$  in (10). This difference highlights that the trade-imbalance effect works its way through its impact on the income of capitalists.

### 3.1 Elasticities

It is worth delving a little deeper. Using the price equation (3), it is straightforward to show that the elasticity of prices with respect to the exchange rate is:

$$\varepsilon_e = \frac{dP_H}{de} \frac{e}{P_H} = (1+z) \frac{P_M M}{P_H H} = (1+z) \frac{P_M a_{MH}}{P_H} \quad (13)$$

In other words, given the markup equation (3) the elasticity of the price level with respect to the exchange rate is equal to the share of the marked-up unit import cost in the price, which by definition is less than one. Using this elasticity we can rewrite equation (12) as:

$$\frac{dH}{de} \frac{e}{H} = \underbrace{\frac{\gamma_R}{D} (1 - \varepsilon_e) \frac{P_X X - P_M M}{P_H H}}_{\text{Trade Imbalance Effect}} + \underbrace{\frac{\gamma_R - \gamma_W}{D} \frac{Y_W}{P_H H} \varepsilon_e}_{\text{Distributional Effect}} \quad (12')$$

This version of the effect of devaluation is clearer because it distinguishes between the direct effects devaluation has on domestic incomes and the effects that are intermediated through changes in the price level— $\varepsilon_e$  shows up in the latter case.

So, how can we disentangle equation (12')? To answer this question we need to go back to the decomposition of output from the income and expenditure side:  $Y_W + Y_R = P_H H + P_X X - P_M M$ . In real terms we can write this:

$$\frac{Y_R}{P_H} = -\frac{Y_W}{P_H} + \frac{P_H H}{P_H} + \frac{P_X X - P_M M}{P_H} \quad (14)$$



This is just an accounting identity but it can be used to identify the main mechanisms at play. Starting from the workers' income (equation [5]) the devaluation of the currency works in two ways. First it changes the level of real domestic income and, therefore, employment. Second, as the unit-import cost rises, the price level increases and that decreases the real wage and the real income of workers. The effects of changes in real domestic income ( $H$ ) on the real income of workers and their feedback on  $H$  is captured through the multiplier term  $D$ .

When it comes to the real income of capitalists—based on equation (14)—we can distinguish the following *ceteris paribus* effects. First, as is the case with workers, changes in real domestic income ( $H$ ) will have a positive effect. The effects of changes in  $H$  on the real income of workers and capitalists and their feedback on  $H$  is captured through the multiplier term  $D$ .<sup>5</sup>

Second, the real income of capitalists is affected by the prices of exports and imports. As Krugman and Taylor (449) explain “devaluation gives with one hand, by raising export prices, while taking away with the other, by raising import prices.” Therefore, the overall effect of this channel on the income of capitalists depends on the trade balance,  $P_X X - P_M M$  (equations [12'] and [14]). All other things equal, the larger the trade deficit (surplus) is, the more negative (positive) the effect of devaluation will be. Finally, as equation (12') clarifies, this change—since it is a change in capitalist income—is transmitted to domestic income through the consumption of capitalists and the multiplier ( $\frac{\gamma_R}{D}$ ).

The last set of changes is related to the change in the domestic price level  $P_H$ . In equation (12') the effects of the change of  $P_H$  can be identified with the terms that are accompanied by the related elasticity  $\epsilon_e$ . The change in the domestic price level works its way through three channels on the income of capitalists. First of all, as we explained above, it will affect the real income of workers. A decrease (increase) in workers' income tends to increase (decrease) capitalists' income. As a result, all other things equal, the increase in  $P_H$  that decreases workers' income will increase the income of capitalists. It is exactly this distributional conflict that is captured by the distributional effect part of equation (12'). A devaluation will increase the price level (an effect captured through  $\epsilon_e$ ) and that will decrease the real income of workers (hence the term  $\frac{Y_W}{P_H H}$ ). The decrease in the real income of workers will—all other things equal—increase the income of capitalists. This will eventually affect income through the consumption propensities of the two

<sup>5</sup> Given the definition of the workers' and capitalists' income in equations (5) and (6) it is easy to show that  $d[Y_W/P_H] = (a_{LH}w/P_H) \cdot dH - (Y_W/P_H^2)dP_H$  and  $d[Y_R/P_H] = (z/(1+z)) \cdot dH - (Y_R/P_H^2)dP_H$ . The coefficients of  $dH$  in these equations intermediated with the related propensities to consume appear in  $D = 1 - \gamma_W a_{LH}w/P_H - \gamma_R z/(1+z)$ .

classes ( $\gamma_W$  and  $\gamma_R$ ). Thus, since the propensity to consume of workers is higher than that of capitalists, the overall effect of domestic output will be negative.

Second, the increase in  $P_H$  will have two exactly offsetting effect on the real domestic income ( $P_H H / P_H$ ). On the one hand, it will increase the *nominal* income in the numerator, on the other it will also increase the price level in the denominator. As a result this will have no effect on capitalists' real income, their consumption and the overall level of income.

Finally, the increase in  $P_H$  will mitigate whatever effect the change in exports and imports prices have on the real income of capitalists, since the nominal effect of devaluation on the trade balance is expressed in domestic price units ( $\frac{P_X X - P_M M}{P_H}$ ). That is the reason why the trade imbalance effect contains the (negative of the) price elasticity with respect to devaluation. In fact, the unity in the term  $(1 - \varepsilon_e)$  in the trade imbalance effect can also be interpreted as an elasticity; given the specification of import and export prices, the elasticity of these prices (in domestic currency) with respect to the exchange rate is equal to one ( $dP_X / P_X = dP_M / P_M = de / e$ ). Therefore the term  $1 - \varepsilon_e$  is showing the difference between (i) the elasticities of import and export prices with respect to  $e$ —which affect the numerator in  $\frac{P_X X - P_M M}{P_H}$ —and (ii) the elasticity of the domestic price level ( $\varepsilon_e$ )—which affects the denominator. Since by definition  $\varepsilon_e = (1 + z) \frac{P_M^a M^H}{P_H} < 1$ , the direct effect of the change in exports and imports prices will persist, albeit mitigated. Understanding the results in this way is more intuitive. It will also be helpful in understanding the results of the following sections.

#### 4 CONTRACTIONARY EFFECTS OF PRICE SHOCKS

An obvious extension of Krugman and Taylor' model is to examine the effect of a shock in the external prices of exports and imports. In other words, let's assume that the exchange rate remains constant, but now the prices of imports and exports increase. Let's also assume that the the ratio of export to import prices, and the ratio of the change in export and import prices are equal to  $\mu$  and  $\lambda$  respectively:

$$\begin{aligned} P_X^* &= \mu \cdot P_M^* \\ dP_X^* &= \lambda \cdot dP_M^* \end{aligned} \tag{15}$$

These should not be interpreted as causal relationships—although in certain cases export prices depend on import prices;  $\lambda$  and  $\mu$  are just scaling factors.

Given this, we can ask what is the effect of a foreign-price shock. Following the same process as before, we can derive the elasticity of real domestic income to import prices:

$$\frac{dH}{dP_M^*} \frac{P_M^*}{H} = \underbrace{K' \frac{P_X X - P_M M}{P_H H} + \frac{\gamma_R (\frac{\lambda}{\mu} - 1) P_X X}{D P_H H}}_{\text{Trade Imbalance Effect}} + \underbrace{\frac{\gamma_R - \gamma_W}{D} \frac{Y_W}{P_H H} (1+z) \frac{P_M M}{P_H H}}_{\text{Distributional Effect}} \quad (16)$$

This result is similar to the result of equation (12) with the exception of the term  $\frac{\gamma_R (\frac{\lambda}{\mu} - 1) P_X X}{D P_H H}$ , which adjusts for the different size of the proportional changes in the export and import prices. More precisely,  $\frac{\lambda}{\mu}$  expresses the percentage change in the export prices relative to the percentage change in the import prices. If  $\frac{\lambda}{\mu} = 1$ , the two prices have the same proportional change. In this case the new term disappears and the results of the external price shock are the same as the result of a devaluation.

If export prices increase proportionally less than the import prices ( $\frac{\lambda}{\mu} < 1$ ), it is intuitive that the overall effect on domestic output will be more negative because  $\frac{\gamma_R (\frac{\lambda}{\mu} - 1) P_X X}{D P_H H} < 0$ . In this case the foreign price shock will “give with one hand, while take away with the other” but the former positive effect on domestic income will be weaker. The opposite will happen in the case of export prices increasing more than proportionally compared to the import prices ( $\frac{\lambda}{\mu} > 1$ ).

Finally, by using the price equation (3) it is easy to show that the elasticity of domestic prices with respect to the foreign import prices ( $\epsilon_{pm}$ ) is the same as the elasticity of prices with respect to the exchange rate:

$$\epsilon_{pm} = \frac{dP_H}{dP_M^*} \frac{P_M^*}{P_H} = \epsilon_e = (1+z) \frac{P_M M}{P_H H} = (1+z) \frac{P_M a_{MH}}{P_H} \quad (17)$$

Given this result we can rewrite equation (16) as:

$$\frac{dH}{dP_M^*} \frac{P_M^*}{H} = \underbrace{\frac{\gamma_R}{D} (1 - \epsilon_{pm}) \frac{P_X X - P_M M}{P_H H} + \frac{\gamma_R (\frac{\lambda}{\mu} - 1) P_X X}{D P_H H}}_{\text{Trade Imbalance Effect}} + \underbrace{\frac{\gamma_R - \gamma_W}{D} \frac{Y_W}{P_H H} \epsilon_{pm}}_{\text{Distributional Effect}} \quad (16')$$

## 5 ENDOGENOUS NOMINAL WAGES AND MARKUPS

We can now allow for an endogenous increase in nominal wages and the markups. Nominal wages react to changes in the domestic price level as workers try to maintain their real income. We can write that  $w = w(P_H)$  with  $\phi = dw/dP_H = w'(P_H) > 0$ . It follows that the elasticity of the nominal wage with respect to the price level is  $\eta = (dw/dP_H)(P_H/w) = \phi \cdot (P_H/w)$ . On the other hand, markups might increase—as firms take advantage of the inflationary environment that is created by generalized price pressures—or decrease—as firms might absorb some of the cost related to import price increases, and not pass it through to prices. We can write that  $z = z(P_H)$  with  $\chi = dz/dP_H = z'(P_H) \leq 0$ , with the related elasticity of markups with respect to the domestic price level being  $\theta = (dz/dP_H)(P_H/z) = \chi \cdot (P_H/w)$ .

In this case, the price equation (3) implies that a shock to the import prices will have second-round effects on nominal wages, markups, and therefore prices. The original shock to imports will increase prices, which will then lead to an increase in nominal wages and a change in markups, and will further change prices and therefore wages and markups and so on. This is essentially a multiplier process—analogue to the usual income multiplier. It is easy to show that the overall change in the price level due to a change in import prices is equal to

$$dP_H = \frac{1}{1 - (1+z)a_{LH}\phi - (a_{LH}w + a_{MH}P_M)\chi} \cdot (1+z)a_{MH}dP_M^* \quad (18)$$

where the first term,  $\delta = (1/[1 - (1+z)a_{LH}\phi - (a_{LH}w + a_{MH}P_M)\chi])$ , is the price multiplier, which shows the overall effect of an increase in import prices on the domestic price level. Stability requires that  $(1+z)a_{LH}\phi + (a_{LH}w + a_{MH}P_M)\chi < 1$ , otherwise an increase in import prices would lead to an explosive price trajectory. Equation (18) tells us that the price multiplier will be higher the stronger the increases in nominal wages and markups in response to an increase in the price level are (the higher are  $\phi$  and  $\chi$  respectively).

Following the same steps as before, and after a fair amount of algebra, we can derive the elasticity of real domestic income with respect to import prices:

$$\frac{dH}{dP_M^*} \frac{P_M^*}{H} = \underbrace{K'' \frac{P_X X - P_M M}{P_H H} + \frac{\gamma_R}{D} \frac{(\frac{\lambda}{\mu} - 1) P_X X}{P_H H}}_{\text{Trade Imbalance Effect}} + \underbrace{\frac{\gamma_R - \gamma_W}{D} \frac{Y_W}{P_H H} (1 - \eta) \delta (1+z) \frac{P_M M}{P_H H}}_{\text{Distributional Effect}} \quad (19)$$

where  $K'' = \frac{\gamma_R}{D} [1 - \delta(1+z) \frac{P_M M}{P_H H}]$ . In relation to  $K'$  in the previous section  $K''$  only differs because of the presence of the price multiplier  $\delta$ .

Finally, by using the price equation (18)—it is easy to show that the elasticity of domestic prices with respect to foreign import prices when nominal wages and markups are endogenous ( $\epsilon_{wz}$ ) is:

$$\epsilon_{wz} = \frac{dP_H}{dP_M^*} \frac{P_M^*}{P_H} = \delta(1+z) \frac{P_M M}{P_H H} = \delta(1+z) \frac{P_M a_{MH}}{P_H} \quad (20)$$

It is obvious that the difference of this elasticity with respect to the elasticities derived above is the inclusion of the price multiplier  $\delta$ . In the special case, of wages and markups not reacting to price changes ( $\varphi = \chi = 0$ ), the price multiplier is equal to one ( $\delta = 1$ ), and therefore  $\epsilon_w = \epsilon_{pm} = \epsilon_e$ .

The definition of  $\epsilon_{wz}$  allows us to rewrite equation (19) as

$$\frac{dH}{dP_M^*} \frac{P_M^*}{H} = \underbrace{\frac{\gamma_R}{D} (1 - \epsilon_{wz}) \frac{P_X X - P_M M}{P_H H} + \frac{\gamma_R}{D} \left( \frac{\lambda}{\mu} - 1 \right) \frac{P_X X}{P_H H}}_{\text{Trade Imbalance Effect}} + \underbrace{\frac{\gamma_R - \gamma_W}{D} \frac{Y_W}{P_H H} (1 - \eta) \epsilon_{wz}}_{\text{Distributional Effect}} \quad (19')$$

In this form, it is easier to discuss the results and compare them with the model specification in the previous section. Starting with the trade imbalance effect, the result is similar with the very important difference that the elasticity of prices with respect to imports now contains the price multiplier  $\delta$ . This means that the elasticity  $\epsilon_{wz}$  is not necessarily smaller than one, and therefore the term in the parenthesis  $(1 - \epsilon_{wz})$  is not always positive. A strong reaction of wages and markups, and therefore a high multiplier, which lead to a high increase in domestic prices might reverse the nominal trade balance effects. For example, if an economy has a trade surplus, the increase in foreign prices will lead to an increase in the direct nominal net income from abroad due to exports and imports. However, the increase in the price level will tend to moderate the real effects of this nominal income increase. In the case of endogenous nominal wages this effect might even dominate and nominal effect.<sup>6</sup>

<sup>6</sup> Note that the aforementioned stability condition related to the price multiplier does not preclude that  $\epsilon_{wz} > 1$ . For the latter to happen we need  $(1+z)a_{LH}\varphi + (a_{LHW} + a_{MH}P_M)\chi > a_{LHW}/(a_{LHW} + a_{MH}P_M)$ . The term on the left hand side of the inequality is the share of unit labor cost in unit total cost and is less than one. On the other hand the stability condition requires that  $(1+z)a_{LH}\varphi + (a_{LHW} + a_{MH}P_M)\chi < 1$ . Therefore, as long as  $a_{LHW}/(a_{LHW} + a_{MH}P_M) < (1+z)a_{LH}\varphi + (a_{LHW} + a_{MH}P_M)\chi < 1$ , the stability condition is satisfied and  $\epsilon_{wz} > 1$ .

The distributional effect is also similar to the model of the previous section, with the difference that the overall effect of import price increases is affected by the elasticity of wages ( $\eta$ ), and that the elasticity of prices with respect to imports now contains the price multiplier  $\delta$ . As it is intuitive, all other things equal, the higher this elasticity is the lower the negative distributional effect will be. In fact, if  $\eta > 1$ , the distributional effect will be positive, because in this case, despite whatever increase there is in prices, nominal wages increase more, and therefore the real wage increases.

On the other hand, if  $\eta < 1$  the distributional effect is still better (less negative) as long as markups do not increase too much. More precisely, as long as  $(1 - \eta)\delta < 1$ , the distributional effect with endogenous wages and markups will be less negative compared to a situation where wages and markups do not change. Given the definition of  $\delta$  and with some rearrangements this condition can be rewritten as

$$z\theta(a_{LH}w + a_{MH}P_M) - \eta(1 + z)a_{MH}P_M < 0 \quad (21)$$

In this case, it is obvious that if  $\theta \leq 0$  (that is if markups decrease or do not change) this condition is always satisfied. However, this condition is also satisfied even if  $\theta > 0$  as long as it is not too big relative to wage elasticity ( $\eta$ ).<sup>7</sup>

Overall, these results show that:

1. An endogenous nominal-wage reaction leads to a higher price level but at the same time has positive macroeconomic effects through the distributional channel (and potentially through the trade imbalance channel).
2. Higher markups both lead to higher prices and have negative effects on real output. The opposite is true when firms absorb part of the increase in the foreign import prices through a lower markup.
3. Endogenous wages and markups have an impact on the trade-imbalance effect through their effect on prices. To the extent that they lead to a higher price level, they mitigate the trade imbalance effect (negative or positive).

<sup>7</sup> The inequality  $(1 - \eta)\delta < 1$  can be rewritten as  $\frac{(1 - \eta)P_H}{P_H - (1 + z)a_{LH}w\eta - (a_{LH}w + a_{MH}P_M)z\theta} = \frac{(1 - \eta)(1 + z)a_{LH}w + (1 - \eta)(1 + z)a_{MH}P_M}{[(1 - \eta)(1 + z) - z\theta]a_{LH}w + [(1 + z) - z\theta]a_{MH}P_M} < 1$ . Rearranging the latter inequality gives equation (21).

## 6 CONCLUSION

The recovery of the global economy from the pandemic-induced recession was marked by a large increase in foreign prices, which led to an increase in inflation. Using the model suggested by Krugman and Taylor (1978), we showed that the macroeconomic effects of this process can be contractionary through two main channels. First, the increase in import prices implies a loss of income for the domestic economy while the opposite is true for export prices. The overall effect will depend on the trade position of the country (the higher the trade deficit the more negative the effect will tend to be) as well as the relative change of import vis-à-vis export prices (the higher the proportional increase in import prices relative to export prices, the more negative the effect will be).

Second, the increase in import prices leads to an increase in the cost of production of firms and can have distributional effects. To the extent that firms can maintain their markups and pass through this price increase there is a redistribution of income from wages to profits and rents. Given that the propensity to consume of wage earners is higher than that of profit earners, this redistribution has a negative effect on consumption and the level of output.

We then examined the effects of an endogenous change in nominal wages and the markup. An increase in nominal wages or the markup lead to a higher price level. However, as one would expect, their macroeconomic impact goes in the opposite direction. The stronger the reaction of nominal wages, the less negative the distributional effect of the increase in the import prices on macroeconomic activity. In fact if the proportional increase in nominal wages is higher than that of domestic prices, the distributional effect becomes positive. On the other hand, higher markups exacerbate the negative distributional effect (while lower markups mitigate it). Finally, the higher price level resulting from higher nominal wages and markups weakens the trade imbalance effect, and in some cases it might even reverse it.

This analysis emphasizes the importance of distribution of income, as well as the structural characteristics of an economy in order to understand the effects of shocks to foreign prices. Our analysis showed that factors such as the distribution of income itself, the propensities to consume of different income groups, the trade position of a country, as well as the structure of exports and imports (which determine how foreign price increases affect import and export prices) are crucial determinants of the overall macroeconomic effect.

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