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A General Theory of Conflict Inflation

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Abstract

This paper develops a novel conflict inflation model to unify the analysis of stable and explosive inflation dynamics, addressing a central theoretical divide in the literature. After providing explicit foundations for wage and price setting behaviour, it is shown that inflation expectations interact multiplicatively with the aspiration gaps of workers and firms rather than add linearly to them as in previous models. As aspiration gaps grow and inflation rises, the conflicting claims of workers and firms accelerate rather than rise steadily. This is reflected in nonlinear wage and price inflation curves whose vertical asymptotes reflect what we call the barrier wages of workers and firms—the critical values of the real wage at which workers and firms are able to resist any further increases in their aspiration gap by matching any rate of inflation. Stable inflationary-distributional outcomes follow only when the barrier wage of workers remains below that of firms. Runaway exchange rate depreciation caused by a balance-of-payments crisis is shown to lead to the collision of barrier wages and thus hyperinflation within the model in a way that is fully consistent with some stylised facts of hyperinflation. The model thus explains how explosive inflation may take hold, what the limits to stable distributional outcomes are, and how a stable inflation regime may evolve into an unstable one, all while maintaining the parsimony of the simple linear conflict inflation models.

Keywords: Inflation, distribution, stability, hyperinflation, balance of payments

JEL: D33, E31, E12

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1. Introduction

Is the process of conflict inflation inherently stable or explosive? The debate divides authors into two main camps, as detailed by Hein (2023) and Hein and Häusler (2024). What these authors call the Blecker-Setterfield-Lavoie (BSL) approach views inflationary and distributional outcomes as generally stable, while the Hein-Stockhammer (HS) approach sees them as inherently unstable. These two approaches reach diametrically opposed conclusions regarding stability due to differences in how each treats the effects of lagged inflation. In the BSL camp, inflation persistence is attributed to indexation; since indexation is rarely complete, the coefficient on past inflation remains below one, resulting in stable outcomes. In contrast, the HS camp argues that current inflation depends on past inflation through adaptive expectations, and if these expectations are fully incorporated, a unit root process emerges, leading to explosive tendencies. Thus, the BSL approach implies inflation is inherently stable across all real wages, while the HS approach suggests inflation is inherently unstable for all real wages unless workers' and firms' targets are aligned.

The dichotomy fits ill at ease with a reality in which stable inflationary outcomes may evolve into high and hyperinflationary ones, where real wages may fall or rise but not indefinitely, and where indexation and expectations may both play a role rather than be considered mutually exclusive. This paper is thus motivated by the sense that each camp explains only special cases of a more general process, rather than providing a comprehensive account.

To this end, this paper develops a novel conflict inflation model to unify the analysis of stable and explosive inflation dynamics into a more general framework. The departure point is that, unlike the aforementioned models, we do not arbitrarily assume linear functional forms. Instead, by specifying explicit foundations for wage and price setting behaviour, we derive nonlinear wage and price inflation curves. These wage and price inflation curves both exhibit vertical asymptotes that we refer to as *barrier wages*, which provide the lower and upper boundaries for stable distributional and inflationary outcomes. The nonlinearity arises from the fact that inflation expectations have a multiplicative effect on the aspiration gap of either side, rather than an additive effect as in the linear conflict inflation models. At low inflation rates, this interaction between inflation expectations and the real wage remains minimal. This is because, under conditions of fundamental uncertainty, inflation expectations are held with low confidence when inflation is subdued, and, even if the low inflation rate is realised, it is not very impactful. However, as inflation rises and the real wage nears the barrier wage for either workers or firms, the effect becomes pronounced and potentially explosive. In such high-inflation environments, neither side can afford to ignore or reduce their expectations of persistent and accelerating inflation, amplifying the conflict dynamic..

While inflation expectations are at the heart of this generalised conflict inflation model, it does not imply that indexation is unimportant. Instead, like Serrano et al. (2024), we argue that indexation is just another kind of real wage resistance, alongside more frequent and more intense wage negotiations and price changes. Unlike Serrano et al. (2024), however, we view real wage resistance as being endogenously determined by inflation via the effect on inflation expectations. This makes sense of the empirical fact that an increase in the degree of wage indexation, for instance, often follows a bout of high inflation that erodes real wages, rather than some exogenous improvement in the bargaining position of workers. A slight rise in inflation that causes the real wage to fall by just one percent below workers' target may be met by workers with little more than a sigh and a shrug. However, should accelerating inflation erode the real wage until it is now just one percent above the barrier wage, bargaining effort tends to its maximum, which may imply a general strike with the aim of fully indexing wages to prices.

The most distinctive application of the generalised conflict inflation model is to the analysis of hyperinflation. We show that hyperinflation can emerge if the difference between the target wages of workers and firms becomes excessive leading to a convergence of the barrier wages of workers and firms. A prime candidate for the trigger behind this *hyperconflict* process is identified in the form of real depreciation caused by a balance-of-payments crisis, as is demonstrated in a highly stylised extension to our generalised conflict inflation model. We also show that this result holds regardless of whether inflation expectations are formed adaptively or if based on some other reference rate, most notably the exchange rate itself. Hence, we argue that the generalised conflict inflation model serves a simple yet rigorous framework for the balance-of-payments theory of hyperinflation, in contrast to the monetarist theory.[1]

The paper is structured as follows. The previous steps toward a general theory of conflict inflation are briefly reviewed in Section 2. Section 3 follows with the derivation of our generalised conflict inflation model, whereas Section 4 applies it the case of hyperinflation. Concluding remarks are offered in Section 5.

2. Previous Attempts to Generalise Across Stable and Unstable Equilibria

Some insightful attempts at building a generalised model precede the attempt that follows in this paper, but none is fully convincing. The first attempt can be found in the seminal work of Rowthorn (1977), where it is argued that inflation expectations only matter after a certain inflation threshold is breached. Below the threshold, "expected inflation is ignored completely and above which it is fully taken into account by all concerned" due to the effects of fundamental uncertainty: "Workers may expect prices to rise but, for a variety of reasons, may do nothing about it—they may have little faith in their own predictions, or may consider it easier to seek compensation in the future, if and when prices actually do rise" (Rowthorn 1977, pp.225-226). Hence, inflation and distribution are inherently stable below this threshold, and inherently explosive above it.

Rowthorn's assumption regarding the binary nature of the degree of real wage resistance is, however, made purely for modelling simplicity, and expressly not because he believes this is an accurate depiction of reality: "This is, of course, an extremely crude formalisation of a rather subtle relationship, its faults are only too obvious" (p. 226). Among the faults Rowthorn lists that "it makes no allowance for the certainty with expectations are held" and "the transition from one kind of behaviour to another is too abrupt" (*ibid.*). We could add that the inflation threshold is simply taken as given, leaving the reader in the dark as to how this important parameter is determined.

After Rowthorn (1977), the question of how to formally link stable and explosive equilibria within one model seems to have fallen off the research agenda for many years. In the interim, the aforementioned dichotomy of inherently stable versus inherently explosive conflict inflation models formed and solidified. Interestingly, the debate between the two camps has focused on whether lagged inflation enters the linear wage and price inflation equations partially due to incomplete indexation or fully due to completely adaptive expectations, rather than whether its effect is linear and additive at all. To explain stable inflation, models with fully incorporated inflation expectations require an additional explanatory mechanism, usually a kind of demand-management or wage-

[1] Though Kalecki (1971) established many aspects of conflict inflation theory, it is interesting to note his theory of hyperinflation (1991 [1955]) is a monetarist account. This further emphasises the need to incorporate hyperinflation into a conflict inflation framework that is as simple as the (problematic) quantity theory accounts.

coordination policy. To explain the emergence of explosive inflation, models with partial indexation must also incorporate additional mechanisms.

One such model that has contributed to the search for a generalised model that can explain different inflation regimes is that of Bastian and Setterfield (2015). A valuable distinction offered by these authors—and one we will also employ in our model—is between *bargaining effort* and *bargaining power*. Bargaining power is the usual concept, which can be viewed as a *potentiality* that is determined by institutions, regulations, and macroeconomic conditions. Bargaining effort, however, is an *actuality*, reflecting the extent to which that bargaining power is utilised in any given period. Bastian and Setterfield (2015, pp.641-642) offer three reasons as to why bargaining power is normally underutilised: Social democratic labour market institutions, the existence of trust between workers and firms, and satisficing behaviour. We can expand on these factors by further emphasising the role of fundamental uncertainty in tempering bargaining effort in the face of small aspiration gaps and a small increase in the inflation rate. Firstly, it takes time for workers to realise that the real wage has fallen and the extent to which other workers are dissatisfied. Second, referring back to Rowthorn (1977), confidence may be low as to whether the higher inflation rate is temporary or permanent. Lastly, engaging in negotiation is inherently costly in terms of time and effort, and may come at the risk of worsening workplace or industrial relations. Thus, we fully agree with Bastian and Setterfield (2015) that it is reasonable to suppose bargaining effort rises endogenously with the aspiration gaps of workers and firms, meaning the speed of adjustment of wages and prices increases as the gap between the real wage and either side's target grows.

To motivate their wider contribution, we first remind ourselves that wage growth ($\widehat{w}$) and price inflation ($\hat{p}$) in the linear conflict inflation model with partial indexation—i.e. the BSL category to which Bastian and Setterfield's model belongs—must satisfy the reduced form equations[2]

$$\widehat{w} = \frac{\Omega_1}{1-\Omega_2}\,(\tau_W - \omega) \tag{1}$$

$$\hat{p} = \frac{\Psi_1}{1-\Psi_2}(\omega - \tau_F). \tag{2}$$

Here τ_W and τ_F are the real wage targets of workers and firms, ω is the real wage, Ω_1 and Ψ_1 reflect the responsiveness of $\widehat{w}$ and $\hat{p}$ to an increase in either side's aspiration gap given no indexation, whereas Ω_2 and Ψ_2 reflect the degree of indexation. For the explicit solutions and more detail, see, for example, Lavoie (2022, pp. 601-604). However, for our discussion of Bastian and Setterfield (2015) and for the purposes of comparing this benchmark model to our own model in section 3, it is useful to leave them in this form.

Bastian and Setterfield (2015) argue that Ω_1 reflects workers' bargaining effort, which is a function of a sufficiently large aspiration gap. As long as labour's aspiration gap is greater than some "conventional constant", the slope of wage inflation curve rises with Ω_1 as increasingly dissatisfied workers grow increasingly militant in their attempts to close their aspiration gap. This prompts firms to retaliate and react to wage inflation to a greater extent, reflected in a rising Ψ_1 parameter, and thus

[2] The BSL approach starts from $\widehat{w}_t = \Omega_1\,(\tau_W - \omega_{t-1}) + \Omega_2\hat{p}_{t-1}$ and $\hat{p}_t = \Psi_1(\omega_{t-1} - \tau_F) + \Psi_2\widehat{w}_{t-1}$, from which the reduced forms in Equations 1 and 2 result from imposing the equilibrium condition $\hat{p}_t = \widehat{w}_t = \widehat{w}_{t-1} = \hat{p}_{t-1}$. Equations 1 and 2 could thus be interpreted as the hypothetical rates of wage and price inflation w^* and p^* that would result were any hypothetical real wage equilibrium ω^* to be obtained. This would imply w^*, p^*, and ω^* are treated as variables rather than fixed-point solutions, implying the actual solutions would have to be denoted by something else (e.g. w^{**}, p^{**}, and ω^{**}). Rather than discuss hypothetical equilibria and complicate the notation in this way, we ignore the technicality and follow the simpler convention seen in the literature where asterisks denote actual equilibrium solutions (e.g. Lavoie 2022, p.602; Serrano et al. 2024, p.1523).

a steepening of the price inflation curve. Assuming aspiration gaps continue to be excessive, this process continues until $\Omega_1 = \Omega_{max}$ and $\Psi_1 = \Psi_{max}$, which reflects the point at which the bargaining power of either side is fully utilised, which may be at an extremely high rate of inflation.

For all its innovative contributions, there are a number of limitations inherent to approach taken by Bastian and Setterfield (2015). First and foremost, although the model may explain virtually any arbitrarily high rate of inflation for a sufficiently high degree of bargaining effort, there is always a long-run equilibrium solution to this model that is approached when the finite bargaining power of either side is eventually fully utilised. This implies that the model can explain how low equilibrium inflation may evolve into strato-inflation, as defined by Jackson and Turner (1972, p. 34), but cannot truly explain how this may then evolve into the explosive, disequilibrium phenomenon of hyperinflation. As with other models in the BSL lineage, long-run stability remains baked in.

On the face of it, it seems one could address this critique by supposing that the degrees of indexation (Ω_2 and Ψ_2), which Bastian and Setterfield simply take as given, rise indefinitely with increased bargaining effort. This is precisely what Lavoie (2022, p. 607) does in his textbook treatment of Bastian and Setterfield's model. As Ω_2 and Ψ_2 tend to one, the equilibrium wage and price inflation curves become increasingly vertical at τ_W and τ_F respectively, and eventually there is no equilibrium inflation rate of which to speak. There is, however, something inherently very odd about this explanation as to how hyperinflation may arise. The problem with this amendment is that it implies that the bargaining power of either side is infinite, if we are to maintain Bastian and Setterfield's definitional distinction.[3] This is presumably why Bastian and Setterfield (2015) do not entertain the idea in their original formulation, instead imposing upper bounds on the slopes of the equilibrium wage and price inflation curves determined by either side's finite (and possibly unequal) bargaining power.

A second critique is that inflation expectations are entirely absent in Bastian and Setterfield (2015). While expectations may be negligible, as argued by Lavoie (2022, p. 601), when inflation is low and steady, this is far from the case when inflation is high and rising, as Carvalho (1993), Bastian et al. (2024), and others point out. Inflation expectations thus appear to be the prime contender to explain how the system evolves from the strato-inflationary equilibrium described above to a truly hyperinflationary outcome.

The third and final critique is that the it is unclear what the "conventional constant" is that triggers higher bargaining effort and what determines it. While the authors do state in a later paper (Bastian & Setterfield 2020, p. 13) that it depends on "cultural habits, historical patterns of welfare assistance and other institutions", it remains, like the inflation threshold in Rowthorn (1977), inherently vague and, as with any additional parameter, comes at the cost of the parsimony of the model. Moreover, the authors require additional parameters to determine how quickly the slopes of the wage and price inflation curve may rotate, further undermining the explanatory efficiency of the model. We will show in our model that a similar kind of increasing bargaining effort can be inferred in a model with the same number of parameters as the simplest linear conflict inflation model—that is, two real wage targets and two speed of adjustment parameters.

Clearly, both Rowthorn (1977) and Bastian and Setterfield (2015) offer important insights into the dynamics of conflict inflation, but each approach has significant limitations. Taken together, these critiques highlight the need for a more nuanced and integrated framework that can better explain both stable and explosive inflation regimes within a unified model.

[3] If we do not maintain this distinction, then another definition of bargaining power must be put in its place.

3. The Generalised Conflict Inflation Model

The root of the problem with linear conflict inflation models is the arbitrariness of the linear specification. While linearisation often increases tractability and ease of interpretation without a noticeable downside in many economic applications, a central point of this paper is that, in the theory of conflict inflation, the analytical cost of the arbitrary linearisation is significant and yet unnecessary. To motivate the specification offered here, we go back to first principles.

3.1 New Foundations

We begin by specifying the dynamics of nominal wages (w) and prices (p) over time according to

$$w_t = w_{t-1} + \lambda_W (w_t^* - w_{t-1}) \tag{3}$$

$$p_t = p_{t-1} + \lambda_F (p_t^* - p_{t-1}), \tag{4}$$

and expressed as growth rates, we get

$$\hat{w}_t = \lambda_w \left(\frac{w_t^*}{w_{t-1}} - 1 \right) \tag{5}$$

$$\hat{p}_t = \lambda_F \left(\frac{p_t^*}{p_{t-1}} - 1 \right). \tag{6}$$

The speed of adjustment parameters must be such that $0 < \lambda_W, \lambda_F < 1$, and so could be said to reflect the share of the gap between the current wage or price and its nominal target that is closed each period. They shall be taken to be determined by conventions around wage and price setting, and the usual institutional forces. w_t^* and p_t^* are the desired money wage of workers and nominal target price of firms respectively in any given period. These nominal targets are determined by

$$w_t^* = \tau_W p_t^e \tag{7}$$

$$p_t^* = w_t^e / \tau_F \tag{8}$$

where p_t^e and w_t^e are the expected price level and expected wage rate in period *t* respectively, while τ_W and τ_F are the real wage targets of workers and firms, as in the preceding section.

The determinants of the real wage targets are kept broadly in line with the literature.[4] The former we will take to be positively affected by the employment rate (E) and the latter is assumed to depend negatively on the real exchange rate (ε) and on firms' target markup (m_τ), which itself depends on factors we take as exogenously given such as the degree of market concentration and product differentiation

$$\tau_W = \tau_W \left(\overset{+}{E} \right) \tag{9}$$

$$\tau_F = \tau_F \left(\overset{-}{m_\tau}, \overset{-}{\varepsilon} \right). \tag{10}$$

Holding these underlying factors constant, we suppose for now that the real wage targets are time invariant. Note that throughout this paper, we define the real exchange rate such that $\varepsilon \equiv s p_f / p$, where s is the nominal exchange rate and p_f is the foreign price level.

While it can be shown explicitly that firms' target depends negatively on their target markup, technical coefficients, and the real exchange rate, some authors suppose that the real exchange rate

[4] Though we acknowledge some disagreement exists in the literature, e.g. while Hein (2023), Blecker and Setterfield (2019) and others see workers' target as dependent on the employment rate as we do here, Lavoie (2022) supposes it depends on the *change* in the employment rate.

also positively affects workers' wage target. Bastian and Setterfield (2020) argue workers recognise that a real depreciation will put downward pressure on the real wage, and that, in response, workers should either (a) increase their real wage target or (b) update their inflation expectations in light of real exchange rate movements. The authors opt for the former, whereas the model developed here implicitly incorporates the latter since depreciation leads to domestic inflation which informs workers' inflation expectations. That changes in the real exchange rate indirectly affects the inflation expectations of workers rather than their target is shown to be more realistic in light of the stylised facts to be presented in the next section, where real depreciation is seen to go hand-in-hand with high inflation but falling real wages.

Returning to Equations 7 and 8, we definitionally relate the expected price and wage levels to expected inflation rates, $\hat{p}_t^e$ and $\widehat{w}_t^e$, by

$$p_t^e = p_{t-1}(1 + \hat{p}_t^e) \tag{11}$$

$$w_t^e = w_{t-1}(1 + \widehat{w}_t^e) \tag{12}$$

which, plugging into Equations 5 and 6, yields

$$\widehat{w}_t = \lambda_W \left[\frac{\tau_W}{\omega_{t-1}}(1 + \hat{p}_t^e) - 1\right] \tag{13}$$

$$\hat{p}_t = \lambda_F \left[\frac{\omega_{t-1}}{\tau_F}(1 + \widehat{w}_t^e) - 1\right] \tag{14}$$

where $\omega = w/p$ is the actual real wage. Hence, our wage and price inflation equations depend on the speed of adjustment parameters as well as the actual and target real wages as usual. However, contrary to most conflict inflation models, expected inflation interacts with, rather than adds to, the aspiration gaps. Importantly, this captures what Rowthorn (1977) had called for, namely a non-abrupt and non-arbitrary way of showing that inflation expectations are tamed when inflation is low and aspiration gaps are small (e.g. if $\omega_{t-1} = \tau_W$, expectations are attenuated by $\lambda_W < 1$) and dominant when inflation is high and aspiration gaps are excessive.

Assuming adaptive expectations ($\hat{p}^e = \hat{p}_{t-1}$ and $\widehat{w}^e = \widehat{w}_{t-1}$) and given the conditions for stable inflation and an equilibrium real wage, whereby $\hat{p}_t = \widehat{w}_t = \widehat{w}_{t-1} = \hat{p}_{t-1}$, yields the following wage and price inflation curves

$$\widehat{w} = \frac{\lambda_W(\tau_W - \omega)}{\omega - \lambda_w \tau_W} \tag{15}$$

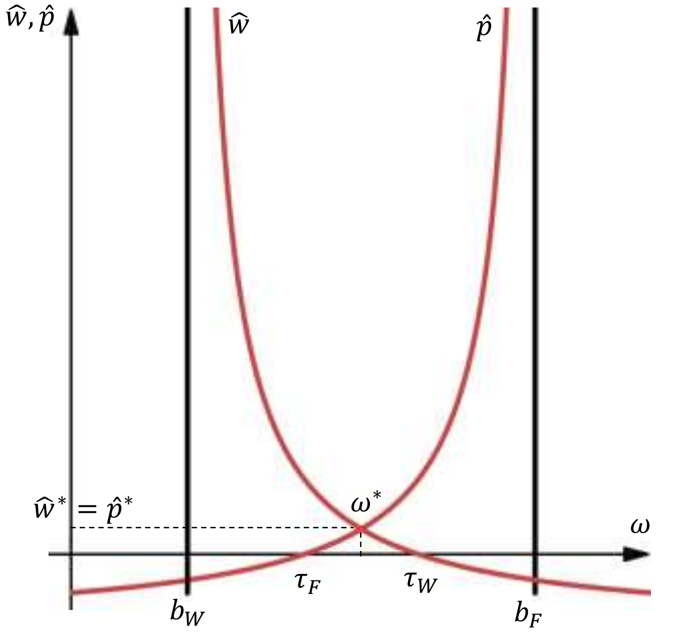
$$\hat{p} = \frac{\lambda_F(\omega - \tau_F)}{\tau_F - \lambda_F \omega}. \tag{16}$$

These are graphed in Figure 1. Note that to reduce notational clutter, we (a) suppress the time subscript as all variables are now contemporaneous and (b) continue to use asterisks only to denote actual equilibrium values that arise when Equation 15 and 16 are equal rather than the hypothetical equilibria each curve is based upon.[5] The wage (price) inflation curve shows the combinations of wage (price) growth and real wage rates where workers' (firms') inflation expectations are met. There is a clear asymmetry in possible inflation outcomes in that there is no upper bound on positive rates of wage and price inflation, but there are finite lower bounds of $-\lambda_W$ and $-\lambda_F$ respectively.[6] As usual, finding the intersection of the two curves allows us to explicitly derive the resulting equilibrium

[5] This ensures we are consistent with the convention adopted in the literature; see footnote 2.

[6] These lower bounds are purely hypothetical, given by the evaluation of the wage and price inflation curves as $\omega \to \infty$ and $\omega \to 0$ respectively, which cannot arise. The relevant point is that there is not even a theoretical possibility of hyper*deflation*, matching our empirical reality in way that linear conflict inflation models cannot.

Figure 1. The Generalised Conflict Inflation Model



inflation rate ($\hat{w}^* = \hat{p}^*$) and real wage rate (ω^*), as shown graphically in Figure 1 and algebraically in Section 3.3.

Regarding the intuition for the model, negative and low rates of inflation beget minimal bargaining effort for the reasons laid out in the previous section, implying relatively flat wage and price inflation curves given small or negative aspiration gaps. Greater aspiration gaps and higher rates of inflation lead to higher (more frequent and more intense) bargaining effort, reflected in the rising steepness of both curves. This comes to a head at the vertical asymptotes denoted by the solid lines at b_W and b_F, which we will now turn to in greater detail.

3.2 Bargaining Effort, Bargaining Power, and Barrier Wages

The wage and price inflation curves both blow up at a unique value of the real wage. Recognising the link to Robinson (1962)—one we will come back to in section 4—we refer to the position of these vertical asymptotes as the *barrier wages of workers and firms*, b_W and b_F respectively, which are determined by

$$b_W = \lambda_W \tau_W \tag{17}$$

$$b_F = \frac{\tau_F}{\lambda_F}. \tag{18}$$

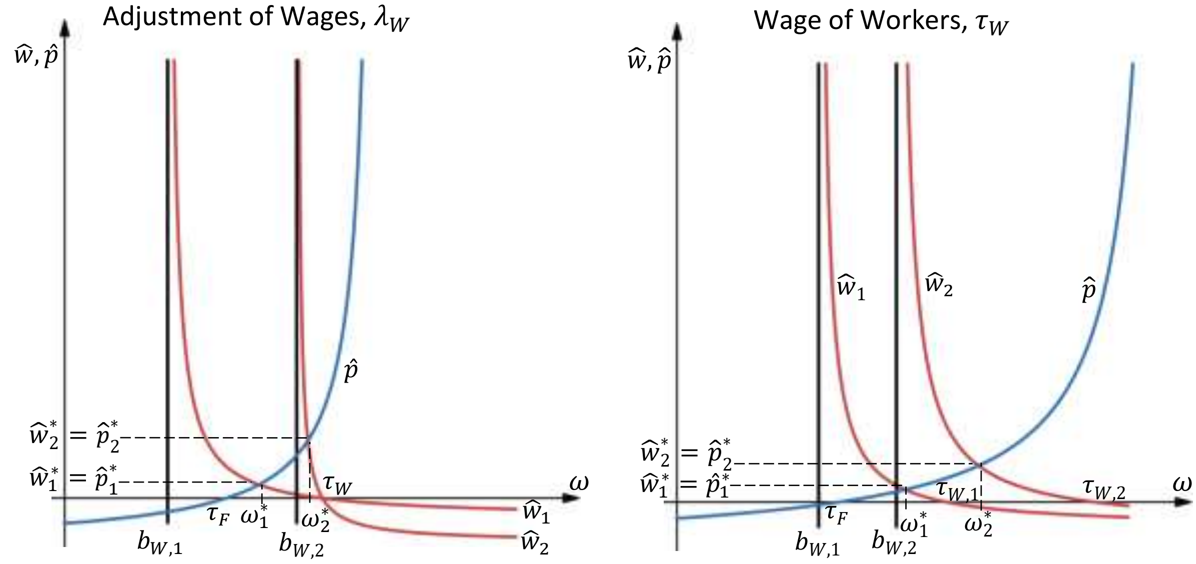
It follows that an increase (decrease) in the target wage of workers (firms) shifts the wage (price) inflation curve to the right (left). An increase in the speed of adjustment of wages makes for a more L-shaped wage inflation curve whereby b_W tends upward towards τ_W as $\lambda_w \to 1$. An increase in the speed of adjustment of prices makes for a more ⅃-shaped (reverse L-shape) price inflation curve, whereby b_F tends downward towards τ_F as $\lambda_F \to 1$. Hence, the higher the bargaining power of workers (firms), the higher (lower) the barrier wage of workers (firms), whether due to a higher (lower) target wage or a higher speed of adjustment of wages (prices).

To make this more concrete, the effect of increased bargaining power of workers is illustrated in Figure 2. Panel 2a shows the effects of an exogenous increase in λ_W due to, for example, a newly elected pro-labour government that enables and encourages an increased frequency of contract

Figure 2. Improved Bargaining Position of Workers Due to…

Panel 2a. Higher Speed of Adjustment of Wages, λ_W

Panel 2b. Higher Target Wage of Workers, τ_W



renegotiations per period at the prevailing real wage. While workers' target remains the same at τ_W, this increase in workers' *dynamic* bargaining power leads to increases in the barrier wage (from $b_{W,1}$ to $b_{W,2}$), the steady state rate of inflation (from $\hat{w}_1^* = \hat{p}_1^*$ to $\hat{w}_2^* = \hat{p}_2^*$), and the equilibrium real wage (from ω_1^* to ω_2^*). Panel 2b shows that the same qualitative results follow from an increase in workers' *positional* bargaining power reflected in an increase in the target wage from $\tau_{W,1}$ and $\tau_{W,2}$ following, say, a boom in employment. While not depicted, an increase in firms' bargaining power, whether due to an increase in λ_F or a decrease in τ_F, essentially mirrors the cases seen in Panel 2a and 2b: an increase in λ_F or a decrease in τ_F leads to a decrease in firms' barrier wage and the equilibrium real wage as well as an increase in the equilibrium rate of inflation.

If the actual real wage is equal to workers' barrier wage or firms' barrier wage, then we see from Equations 13 and 14 that the rate of wage and price inflation is

$$\hat{w} = \hat{p}^e + (1 - \lambda_W) \tag{19}$$
$$\hat{p} = \hat{w}^e + (1 - \lambda_F). \tag{20}$$

In other words, inflation becomes completely unanchored and driven by expectations at either barrier wage. As the barrier wages are approached, all bargaining effort is employed toward the goal of achieving the highest possible speed of wage and price adjustments. For firms, this may imply daily or hourly price changes and, for workers, the struggle to achieve full indexation or payment in an alternative, stable currency.

The *stable-inflation equilibrium real wage* thus cannot be below workers' barrier wage nor above firms' barrier wage. These critical wages bookend the domain of stable conflict over distribution such that

$$b_W < \omega^* < b_F. \tag{21}$$

Intuitively, if workers' barrier wage is greater than that of firms, it implies there simply is no real wage that will satisfy both parties and hence no equilibrium exists. Mathematically, looking back to Equations 13 and 14, we see that inflation expectations are tamed by a coefficient below unity if and only if this condition is fulfilled. Expressing $b_W < b_F$ in terms of its constituent parts and rearranging, stability implies a limit to the degree of conflict between the target wages imposed by the speed of adjustment parameters

$$\frac{\tau_W}{\tau_F} < \frac{1}{\lambda_W \lambda_F}. \tag{22}$$

For example, if $\lambda_W = \lambda_F = 0.5$, then the real wage targeted by workers would need to be less than four times that targeted by firms for an equilibrium real wage and stable inflation rate to exist.

With our terms so defined, we can express the wage and price inflation curves exclusively in terms of target and barrier wages, which offers another view of the same phenomenon,

$$\hat{w} = \frac{b_W}{\tau_W}\left(\frac{\tau_W - \omega}{\omega - b_W}\right) \tag{23}$$

$$\hat{p} = \frac{\omega - \tau_F}{b_F - \omega}. \tag{24}$$

Comparing this to the linear conflict inflation system in Equations 1 and 2 and collecting parameters now such that $\Omega \equiv \Omega_1/(1-\Omega_2)$ and $\Psi \equiv \Psi_1/(1-\Psi_2)$, our model suggests that these composite parameters are not constants, but are endogenously determined by $\Omega = [b_W/\tau_W(\omega - b_W)]$ and $\Psi = [1/(b_F - \omega)]$.

3.3 Equilibrium Real Wage and Inflation Rates: Precise and Approximate

The precise solutions to the model, found by setting Equations 15 and 16 equal, involve solving the following quadratic

$$\omega^2 + \omega\tau_F(\lambda - 1) - \lambda\tau_F\tau_W = 0 \tag{25}$$

where the speed of adjustment parameters have been collected in the composite parameter

$$\lambda \equiv \frac{\lambda_W(1-\lambda_F)}{\lambda_F(1-\lambda_W)}. \tag{26}$$

Intuitively, λ could be said to reflect the relative *dynamic* bargaining power of workers vis-à-vis firms, which tends to infinity as $\lambda_W \to 1$ or $\lambda_F \to 0$, to zero as $\lambda_W \to 0$ or $\lambda_F \to 1$, and is equal to one when $\lambda_W = \lambda_F$. Since the real wage must be nonnegative, the solution real wage must be the positive root

$$\omega^* = \frac{\tau_F(1-\lambda) + \sqrt{\tau_F^2(\lambda-1)^2 + 4\lambda\tau_F\tau_W}}{2}. \tag{27}$$

A few special cases are worth pointing out. Firstly, if workers' relative dynamic bargaining power is absolute such that $\lambda \to \infty$, then it follows that $\omega^* \to \tau_W$. If firms' relative dynamic bargaining power is absolute and thus $\lambda \to 0$, then $\omega^* \to \tau_F$. Lastly, if dynamic power is balanced such that $\lambda_W = \lambda_F$ and so $\lambda = 1$, then the equilibrium real wage is the geometric mean of the two targets, $\omega^* = \sqrt{\tau_F\tau_W}$.

The equilibrium inflation rate is found by plugging Equation 27 into either Equation 15 or 16

$$\hat{w}^* = \hat{p}^* = \frac{\lambda_F\left[1 + \lambda - \sqrt{(\lambda-1)^2 + 4\lambda\tau}\right]}{\lambda_F\left[1 - \lambda + \sqrt{(\lambda-1)^2 + 4\lambda\tau}\right] - 2} \tag{28}$$

where $\tau \equiv \tau_W/\tau_F$, which can be thought of as the relative *positional* bargaining power of workers vis-à-vis firms. Condition 22, which states that $\tau < 1/\lambda_F\lambda_W$, assures a nonzero denominator. It is as expected then, that $\hat{p}^* \to \infty$ as $\tau \to 1/\lambda_F\lambda_W$. Lastly, one can also see another expected result, namely when $\tau = 1$ (i.e. when the two targets are equal), equilibrium inflation is zero, $\hat{p}^* = 0$.

While the precise solutions are straightforward to derive, they are more cumbersome to interpret than solutions to linear conflict inflation models. Fortunately, one can show, as is done in the appendix, that these equilibrium values can be well approximated by

$$\omega^* \approx \tau_F^{\frac{1}{1+\lambda}} \tau_W^{\frac{\lambda}{1+\lambda}} \tag{29}$$

$$\hat{p}^* \approx k\left(\frac{\tau_W - \tau_F}{b_F - b_W}\right), \tag{30}$$

which are much more intuitive, offering a greater ease of interpretation. Beginning with the equilibrium real wage, we see that it is essentially a weighted geometric mean of the two targets, where $\lambda/(1+\lambda)$ is the weight. This approximation is exactly equal to the precise real wage at the three special cases mentioned above ($\lambda \to 0$, $\lambda = 1$, and $\lambda \to \infty$) and is the basis for the approximation by interpolation seen in the appendix, which introduces remarkably small error outside of the matching points. Since the equilibrium real wage in linear conflict inflation models is a weighted arithmetic mean of the target wages, it is quite satisfying to see the weighted geometric mean parallel here. The approximate inflation rate is similarly derived from the method of interpolation, where *k* is shown in the appendix to be a scaling factor that depends on λ_F and λ_W that is chosen to minimise the interpolation error. The approximate inflation rate offers the much more intuitive understanding that inflation is negative when $\tau_W < \tau_F$, zero when $\tau_W = \tau_F$, and tends to infinity as the gap between the barrier wages fall.

Our generalised conflict inflation model can thus be said to resolve the conflict between the HS and BSL approaches. It supposes that, unlike the BSL approach, there are distributional outcomes outside of the corridor set out in Inequality 21 that are inherently explosive and thus untenable. However, the range of stable inflationary-distributional outcomes are likely far wider than the knife-edge seen in the basic HS models. While, as in the HS approach, we suppose inflation expectations are adaptive in our model, unlike the HS approach, we find that the extent to which inflation expectations are converted into actual inflation depends on the size of the aspiration gaps. The intuition for this, based on the reasons presented in section 2, runs as follows: Small aspiration gaps and low rates of inflation spur low confidence, high indifference, and thus low bargaining effort. As aspiration gaps grow and inflation rises, the weight placed on expectations rise as confidence grows that high inflation will persist (if not continue to rise), indifference is increasingly replaced by desperation, and bargaining effort rises. Indeed, if the conflict becomes excessive, inflation may become truly explosive.

4. Hyperconflict Inflation

We are now well positioned to offer a simple theory of hyperinflation from a conflict inflation perspective. The preceding model suggests that explosive inflation emerges as the gap between the barrier wages of workers and firms vanishes. Given our definition of the barrier wages in Equations 17 and 18, collision of the barrier wages can occur in of three ways:

1. Given fixed conflicting wage targets, increases in λ_W and λ_F could, in theory, lead to the coincidence of barrier wages and explosive inflation.
2. Given fixed speed of adjustment parameters, a growing gap between the target wages also forces an ever-smaller gap between the barrier wages.
3. A combination of cases one and two.

We will argue that the primary cause behind hyperinflation tends to be more closely related to growing gap between the target wages seen in case two. More specifically, we will argue that it is a falling target wage of firms driven by real depreciation of the domestic currency that is usually at the root of the problem.

4.1 Stylised Facts of Hyperinflationary Episodes

The evidence that hyperinflationary episodes are associated with real depreciation is strong. Real depreciation has proven to be so common in high inflation economies that Paldam (1994, p.138) has called it "Bernholz's Law" after the empirical work of Peter Bernholz—see Bernholz (2003, p.73) for a summary. It is also reflected in the more recent analysis of empirical regularities in hyperinflating economies by Saboin (2018). Not only does the rate of nominal depreciation tend to surpass that of domestic inflation in size, but it also tends to precede it temporally. Dornbusch et al. (1990), Fischer *et al.* (2002), and Seghezza & Morelli (2020) find that nominal depreciation granger causes inflation and monetary growth during episodes of high inflation and hyperinflation. Real depreciation matters not only for imported inflation, but also, given the prevalence of "original sin" among the majority of the world's economies (Eichengreen and Hausmann, 1999), for the cost of servicing foreign-denominated external debt. Indeed, Saboin (2018) also shows that external debt interest payments are significantly higher among hyperinflating economies than stable-inflation economies.

All else equal, real depreciation implies a rising claim on output by the foreign sector, exacerbating the conflict over distribution between workers and firms. Real depreciation lowers firms' target real wage in their attempt to pass on the higher cost of imported materials and, if their debt is denominated in a foreign currency, the cost of higher debt servicing. This is reflected in our model by a leftward shift of the price inflation curve, which should lead to large losses in the real wage at first followed by smaller real wage losses and ever higher inflation rates should real depreciation continue, as workers update their expectations and increase their resistance. This also matches the empirical reality wherein real wages have been repeatedly found to fall during high and hyperinflationary episodes (Dornbusch *et al.* 1990, Bernholz 2003, Braumann 2004, Cardoso 1992).

Hence, the stylised facts on hyperinflation of falling real exchanges rates and real wages can be explained within our model by a sufficient leftward shift of the price inflation curve. What about the other oft-cited stylised facts of hyperinflation, such as the rapid growth of money and government deficits? The former can be easily explained by accommodationist monetary policy. As inflation takes off, the money supply endogenously grows to keep up. Large public deficits can also be readily explained through the Keynes-Olivera-Tanzi effect[7], whereby high inflation automatically implies higher public deficits due to the lag in tax collection and reduced real value of specific taxes, but also possibly through other channels such as reduced tax compliance (Dornbusch *et al.* 1990).

Hence, the theory of hyperinflation supported by the generalised conflict inflation model and these stylised facts belongs not the monetarist approach, which takes the preceding chain of events roughly in reverse order, but the balance-of-payments theory of hyperinflation.[8] It is aligned with the account of Karl Helfferich[9], one the best-known proponents of the balance-of-payments school, and even more closely mirrors that of Joan Robinson, a point to which we shall return. Like the formal model of hyperinflation offered by Charles and Marie (2016), we emphasise problems with the balance of payments at the root of the matter, but unlike this model, we do not need to rely upon the

[7] For more on the intellectual heritage of the term, see Dornbusch (1992, p.20).

[8] For a comparison of the two schools of thought on hyperinflation, see, for example, Kindleberger (1984, pp. 310-311), Dornbusch *et al.* (1990), and Dornbusch (1992).

[9] For a neat summary of Helfferich's account, see, for example, Seghezza & Morelli (2020, p. 162).

many complications it introduces nor questionable assumptions such as fixed or rising real wages, which do not coincide with the stylised facts of hyperinflation mentioned above.

4.2 The Root of Hyperconflict

The trigger behind the process of this hyperconflict and explosive inflation has been hinted at but yet to be made explicit. The most obvious culprit is a balance-of-payments crisis wherein an excessive level of foreign-denominated debt relative to domestic output or exports leads lenders abroad as well as domestically based foreign investors to suddenly withdraw the supply of foreign exchange for fear of widespread defaults. Of course, it is that same fear which may motivate capital flight and thus additional demand for a foreign, safe haven currency. The result is rapid depreciation, which the domestic government may find impossible to stop without external assistance or, failing that, sacrificing internal macroeconomic stability.

We can model this process in a highly simplified and stylised way. Denoting the ratio of foreign-denominated external debt to exports[10] by d and borrowing the concept of foreign credit constraint d_{max} discussed by, for example, Charles and Marie (2016), Behring et al. (2019), Morlin (2022), and others, we suppose that the rate of nominal depreciation, $\hat{s}$, is virtually unaffected by d until d_{max} is approached at which point it completely dominates in the determination of $\hat{s}$

$$\hat{s}(d) = \frac{\alpha}{d_{max} - d}. \tag{31}$$

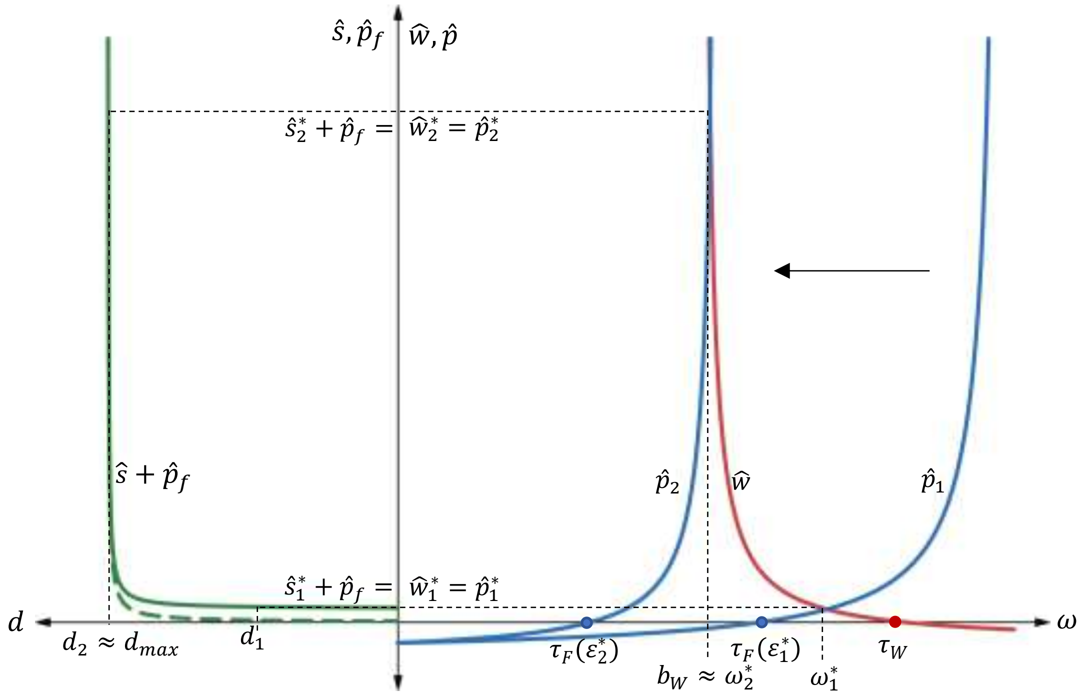
Here, α is a parameter that reflects the extent to which depreciation sets in before d_{max} is breached, which could be said to be determined by the extent to which all market participants (a) share the same estimate of the credit constraint and (b) expect it to be violated, as well as by (c) the efforts of the central bank to prevent depreciation. Note that we ignore all other determinants of exchange rate as they are not the focus here.

The left panel of Figure 3 graphs Equation 31 with the dashed line, while the solid line adds the foreign rate of inflation, $\hat{p}_f$, which we take as an exogenous constant. The generalised conflict inflation model developed in the previous section is seen in the right panel. For a steady real exchange rate equilibrium, the rates of wage and price inflation must also equal the sum of depreciation and foreign inflation. In the first period, the foreign-denominated debt ratio d_1 is small and thus generates essentially zero depreciation, $\hat{s}_1^* \approx 0$. As we ignore all other factors that could generate depreciation, the initial domestic inflation rate is roughly equal to the foreign inflation rate, the equilibrium real wage is ω_1^*, and the firms' target real wage τ_F is determined by the real exchange rate ε_1^*.

We now suppose that the foreign-denominated debt ratio grows. This could be due to persistent deficits in the current account or, if domestic agents borrow in a foreign currency, in the private and public sectors. In any case, the balance-of-payments-constraint (Thirlwall 1979) is not respected and, unlike in Morlin (2022) for instance, there is no policy response to rein in the unsustainable build-up of external debt. As d approaches d_{max}, a currency crisis erupts, reflected in the rapid depreciation of the domestic currency. The price inflation curve shifts leftward from $\hat{p}_1$ to $\hat{p}_2$ with the rising real exchange rate until the latter settles at the higher rate ε_2^*, which determines the lower wage target of firms $\tau_F(\varepsilon_2^*)$. The new equilibrium is marked by much higher inflation rate

[10] We could, for our purposes, equally have defined the denominated by domestic output or perhaps foreign reserves, but we follow the argument put forward by Behring *et al.* (2019) and others that exports are best suited as they usually represent the main source of foreign exchange earnings.

Figure 3. Balance-of-Payments Crisis and Hyperinflation



$\hat{w}_2^* = \hat{p}_2^*$ and a lower real wage ω_2^*. This process may continue until the barrier wages collide, at which point, as we know from Equations 19 and 20, explosive inflation sets in.

As mentioned, this explanation of hyperinflation supports Robinson's (1938) account of the German hyperinflation, which is worth quoting at length for the purposes of comparison:

> "With the collapse of the mark in 1921, import prices rose abruptly, dragging home prices after them. The sudden rise in the cost of living led to urgent demands for higher wages… [as] workers were faced with starvation… Rising wages, increasing both home costs and home money incomes, counteracted the effect of exchange depreciation in stimulating exports and restricting imports. Each rise in wages, therefore, precipitated a further fall in the exchange rate, and each fall in the exchange rate called forth a further rise in wages. This process became automatic when wages began to be paid on a cost-of-living basis" (Robinson 1938, p. 510).

The chain of events as Robinson lays out is essentially that which we describe in our formal model. Robinson identifies the currency crises as the trigger, as do we. She also clearly implies what our model makes explicit, namely that the resulting real depreciation eventually comes to a halt when domestic inflation catches up with ever-rising nominal depreciation, "counteracting" the effect on net exports. What Robinson writes of the deprivation of workers is reflected in our model by a falling real wage, and the implied endogeneity of the real wage resistance, including the degree of indexation, is also fully congruent with our model here. Hence, we can view our model as a formalisation of Robinson's famous account.

The eventual halt to the real exchange rate implied by Robinson and made explicit in our model is particularly important as it means that, even if the Marshall-Lerner condition holds, one cannot expect net exports to rise indefinitely, which might otherwise serve as an automatic stabiliser of the balance of payments by reducing d below d_{max}. Indeed, this is at the root of Robinson's critique in her review of Bresciani-Turroni's monetarist account of the German hyperinflation. This critique is bolstered by the recognition that real depreciation also increases the real value of foreign-currency debt servicing, which acts against any improvement in the BOP that increased net exports may have. Of course, there may be further reasons to doubt the existence of an automatic BOP-stabiliser, such as elasticity pessimism (i.e. Marshall-Lerner condition does not hold), constraints on the supply of exports, or the negative effects of the increased uncertainty on the demand for exports.

Lastly, let us emphasise that the relevance of this explanation is not limited to the German hyperinflation. As Vernengo and Pérez Caldentey (2020) and Charles and Marie (2016) conclude more generally, hyperinflations go hand-in-hand with balance-of-payments crises. Given that Eichengreen et al. (2023) show that the vast majority of developing and emerging economies continue to issue nearly all their debt in a foreign currency, the spectre of balance-of-payment crises and thus hyperinflation as described here remains widely relevant today.

4.3 Changes in the Process of Expectation Formation

Our wage and price inflation curves were hitherto said to be built upon the premise of adaptive expectations. However, if the inflation rate is rising for a number of periods, past inflation repeatedly underestimates future inflation and so becomes recognised as an increasingly poor guide to the future. Moreover, at very high rates of inflation, price indices are simply not published often enough to guide expectations in the interim. So how do workers and firms form expectations of future inflation in the face of high and accelerating inflation?

Empirically, it has been noted by Carvalho (1993), Vera (2013), and Bastian et al. (2024) that the exchange rate itself tends to serve as the index upon which expectations and contracts are based in such an environment. This addresses the aforementioned problem of uncertainty in a way consistent with the ultimate cause of the inflation problem identified here, while also offering a continuously published reference rate as is required when price and wage indices cannot be published often enough.

What is the effect of the change in reference rate used for expectations? Suppose that workers and firms take the current rate of nominal depreciation as the reference rate for wage and price inflation expectations, such that $\hat{p}_t^e = \widehat{w}_t^e = \hat{s}_t$ in Equations 13 and 14. We also now simplify by assuming dynamic bargaining power is balanced such that $\lambda_W = \lambda_F$. It thus follows that the real wage is given by $\omega^* = \sqrt{\tau_W \tau_F}$ and the inflation rate given depreciation-driven inflation expectations is

$$\widehat{w}^* = \hat{p}^* = \lambda_F\left(\sqrt{\tau}(1+\hat{s}) - 1\right), \tag{32}$$

where, as before, $\tau = \tau_W/\tau_F$.

Suppose that expectations are based upon the depreciation rate due to the emergence of hyperconflict inflation as depicted in Figure 3. Equation 32 tells us that, even if mass bankruptcies or austerity were now to bring the wage targets in line such that $\tau = 1$, inflation may continue to be stubbornly high since now $\hat{p}^* = \lambda_F \hat{s} = \lambda_W \hat{s}$ despite the lack of conflict over distribution. Worse still, real depreciation would continue once again since $\hat{\varepsilon} = \hat{s}(1-\lambda_F) > 0$, assuming foreign inflation ($\hat{p}_f$) is relatively negligible. This puts downward pressure on firms' target wage, once again reigniting the conflict over real wages. Thus τ rises as τ_F falls, and continues to do so until the real exchange rate comes to rest ($\hat{\varepsilon} = 0$) when $\hat{s} = \lambda_F(\sqrt{\tau}(1+\hat{s}) - 1)$. Solving for τ^*, the ratio of conflicting targets which generates enough inflation to halt the real deprecation, we find that

$$\tau^* = \left(\frac{\hat{s} + \lambda_F}{\lambda_F(1+\hat{s})}\right)^2. \tag{33}$$

Since the rate of depreciation $\hat{s}$ may increase without bound, it follows that τ^* converges to

$$\lim_{\hat{s}\to\infty} \tau^* = \frac{1}{\lambda_F \lambda_W}. \quad (34)$$

Referring back to Condition 22, this is equivalent to saying $(b_F - b_W) \to 0$, i.e. that the barrier wages once again collide. Interestingly, then, despite having stipulated inflation expectations as depending upon the rate of depreciation rather than lagged inflation, the outcome is much the same: The real wage approaches the barrier wage of workers (equal to that of firms in the final position) and inflation increases indefinitely.

Of course, an accelerating-inflation equilibrium cannot truly be considered a long-run equilibrium. As inflation rises without end, domestic money ceases to function as a store of value and so it is increasingly substituted out for alternatives—foreign currencies and other foreign assets, precious metals, certain goods, etc. (Robinson 1938, Bastian et al. 2024). The authorities may try to mandate its continued use but, as Jackson and Turner (1972, p.54) warn, hyperinflation "is economically and socially intolerable, … and if the government cannot master it, the government will be overthrown." Thus, even if distribution tends to settle around the barrier wage of workers, in the long run, hyperinflation cannot be tolerated, and the system breaks down.

All of what precedes serves to emphasise the extreme difficulty for the domestic government to recover from hyperinflation. Of course, fiscal and monetary policy should have been steered so as to respect the balance-of-payments-constraint in the first place, but such advice is useless after the fact. Moreover, it should be kept in mind that the temptation to disregard the balance-of-payments-constrained growth rate is all the greater the lower it is relative to the growth rate of the labour supply since rising unemployment may be politically untenable. Even before inflation expectations become stubbornly unanchored, there is no easy option for domestic policymakers. Weakening workers' dynamic or positional bargaining power may produce further discontent and poverty. Weakening firms' dynamic or positional bargaining power may tip the currency crisis into a banking crisis as more firms go under. Clearly, external financial assistance in the form of debt write-offs and restructuring as well access to foreign exchange all get to the root of the problem, yet leave the domestic economy at whim of the sentiments of policymakers in the rest of the world.

5. Concluding Remarks

Before we sum up the contribution made in this paper, a few final remarks are reserved for the implications for policy. However, since our model can be seen a bridge between the stable (partial indexation) BSL and unstable (adaptive expectations) HS linear models, it is perhaps unsurprising that the policy recommendations fall between what these two camps suggest. For instance, while we would caution against government over-empowering either side of the distributional bargain for fear of provoking instability, it is not quite the knife-edge the HS authors suppose it is yet nor can we conclude that every real wage is equally stable, as the BSL authors imply. In any case, whatever the distributional goals of the government, they must be set against a risk of provoking escalating conflictual claims and inflation, if not hyperconflict and hyperinflation.

We can, however, better differentiate between problems developing and emerging economies face vis-à-vis advanced economies. While the concepts of barrier wages apply equally in both sets of economies, the risk of a currency crisis driving real deprecation and thereby the convergence of barrier wages is a greater threat to the many countries below the top rungs of the currency ladder. Our model then supports many aspects of the post-Keynesian critique of Modern Monetary Theory laid out by, for instance, Vernengo and Pérez Caldentey (2020). Advanced economies whose currencies sit atop the hierarchy enjoy the exorbitant privilege of pursuing expansionary fiscal policy without foreign-denominated debt nor the threat of sudden stops. In advanced economies, overly ambitious fiscal spending leads to higher inflation as well if rising employment increases workers' target wage, but the fear of invoking explosive tendencies seems misplaced unless spending was so excessive as to fundamentally alter how expectations are formed.

In conclusion, we have shown that conflict inflation is an inherently nonlinear process. A linear approximation may be useful at low rates of inflation, but will underestimate how quickly inflation may rise given an increase in the difference between workers' and firms' targets. A linearisation fails to explain how truly explosive inflation may take hold, what the limits to stable distributional outcomes are, and how a stable inflation regime may evolve into an unstable one. Moreover, by finding a role for both inflation expectations and indexation, our generalised conflict inflation model resolves the apparent dichotomy between the two (BSL and HS) camps of conflict inflation models. It should be stressed that we do so without introducing a greater number of parameters, thereby offering the same high degree of parsimony as the simplest linear conflict inflation models. This should prove useful in future model extensions and applications, as well as for pedagogical purposes.

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Appendix – Approximating the equilibrium real wage and inflation rates

We begin the precise real wage solution

$$\omega^* = \frac{\tau_F(1-\lambda) + \sqrt{\tau_F^2(\lambda-1)^2 + 4\lambda\tau_F\tau_W}}{2}. \tag{A1}$$

Since $\omega^* = \tau_F$ when $\lambda = 0$, $\omega^* \to \tau_W$ when $\lambda \to \infty$, and $\omega^* = \sqrt{\tau_F\tau_W}$ (i.e. the geometric mean of the two wage targets) when $\lambda = 1$, a natural approximant is the weighted geometric mean, where λ determines the weight. The approximant

$$\omega^*_{app.} = \tau_F^{\frac{1}{1+\lambda}}\tau_W^{\frac{\lambda}{1+\lambda}} \tag{A2}$$

matches the exact solution at $\lambda = 0$, $\lambda = 1$, and asymptotically as $\lambda \to \infty$, and is also positive and monotonically increasing over the entire domain. The quality of the approximation outside of the three matching points improves as $|\tau_W - \tau_F|$ falls and the approximant is precisely equal to the approximand when $\tau_F = \tau_W$. More precisely, the absolute relative error given by

$$E(\lambda) = \left|\frac{\omega^*(\lambda) - \omega^*_{app.}(\lambda)}{\omega^*(\lambda)}\right| \tag{A3}$$

can be shown to have a maximum of just 2.3% when $\tau_W = 2\tau_F$ or when $\tau_W = 0.5\tau_F$, and 12.9% maximum relative error when $\tau_W = 5\tau_F$ or when $\tau_W = 0.2\tau_F$. Hence, the approximating function fits well even when the size of the difference between the wage targets is very high.

To approximate the equilibrium inflation rate with a more intuitive expression, we proceed by a similar method of interpolation seen above. The precise inflation rate

$$\hat{p}^* = \frac{\lambda_F\left[1 + \lambda - \sqrt{(\lambda-1)^2 + 4\lambda\tau}\right]}{\lambda_F\left[1 - \lambda + \sqrt{(\lambda-1)^2 + 4\lambda\tau}\right] - 2} \qquad \text{where } \tau \equiv \frac{\tau_W}{\tau_F} < \frac{1}{\lambda_F\lambda_W} \tag{A4}$$

is zero when $\tau = 1$, negative when $\tau < 1$ and positive when $\tau > 1$, tends to infinity as $\tau \to 1/\lambda_F\lambda_W$, and is monotonically increasing over all permissible values of τ, as is a rational function of the form

$$\hat{p}^*_{app.} = \frac{q(\tau - 1)}{1 - \lambda_F\lambda_W\tau}. \tag{A5}$$

All that remains is to find a value q which reduces the error when $\tau \neq 1$ and when τ is not near its boundary of $1/\lambda_F\lambda_W$. One could set $\hat{p}^* = \hat{p}^*_{app.}$ at $\tau = 0$ to yield a value for q, but, while mathematically convenient, this approach serves to minimise the error around an economically meaningless point where workers' target is zero or firms' target is infinite. Instead, we let $\hat{p}^* = \hat{p}^*_{app.} = 1$, and back out the value for q which is

$$q = \frac{\lambda_F\lambda_W(\lambda_F\lambda_W + \lambda_F + \lambda_W - 3)}{3\lambda_F\lambda_W - \lambda_F - \lambda_W - 1}. \tag{A6}$$

Substituting in q and the expressions for the barrier wages, we can reduce $\hat{p}^*_{app.}$ to the more intuitive

$$\hat{p}^*_{app.} = k\left(\frac{\tau_W - \tau_F}{b_F - b_W}\right) \qquad \text{where } k = \frac{q}{\lambda_F}. \tag{A7}$$

For all permissible τ, the maximum absolute relative error tends to zero as $\lambda_W/\lambda_F \to \infty$ and as $\lambda_W/\lambda_F \to 0$. When $\lambda_W/\lambda_F = 1$, the maximum relative error is 11.7% assuming τ cannot fall below 0.5 (otherwise the max relative error approaches 30% at $\tau = 0$). The approximation thus fits well.

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