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Go Slow to Go Far: When Should Inflation Stabilization Plans be Gradual?

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Abstract

We look to determine when interest rate-based stabilization plans should be gradual. We use a standard open economy DSGE model and consider three extensions that focus on the labor market. We find that gradualism is advised when sticky wages adjusted to past inflation generate inflationary inertia and the policymaker is credible. On the contrary, when the policymaker is not credible, a shock plan is more successful in lowering inflation.
We contribute to the literature on stabilization plans that has mostly focused on exchange rate-based (ERBS) plans by extending the analysis to interest rate-based stabilization plans.

Keywords: Inflation, Stabilization, Interest Rates, Small Open Economy.
JEL Classification: E520, F410, E240.

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1 Introdution

Standard New-Keynesian DGSE models show that shock inflation stabilization plans are often better than gradual plans, as convergence to the target inflation is faster and output loss is minimized. However, this contradicts the observation that policymakers tend to favour gradual plans. To reconcile both facts we explore extensions focused in the labor market and credibility. We find that backward-looking wage indexation can justify a gradual plan, as long as the commitment to low inflation is perceived as credible. To show this, we fit an otherwise standard small open economy DSGE with sticky wages which are indexed by past inflation. This introduces inertia and makes a shock plan costly, as dispersion increases, thus inducing a recession. This result hinges on the policymakers being credible. In the opposite case we find that a shock plan might be advised, as inflation gets closer to its target.

The inflation stabilization plans considered are interest rate-based and resemble many inflation targeting schemes now in place around the world. They are gradual, in the sense that the annual targets converge slowly to the final target from an initial level of medium or high inflation. While stabilization plans of this kind have received widespread attention from policymakers and media, literature is somewhat scarce. There is, however, a rich literature on exchange rate-based stabilization (ERBS), on both, empirical and theoretical level. We draw heavily from it by taking inspiration from the features it considered relevant to explain the dynamics of ERBS in emerging countries. Sergio Rebelo and Carlos Vegh (1995) showed that labor market frictions and lack of credibility were the only factors that could match all of the stylized facts about ERBS plans. Our findings add support to theirs and points to a larger role these features may be playing in emergent market economies.

We first show that a standard New-Keynesian DSGE favours a shock plan, as all nominal variables adjust and real variables do not suffer changes. Transition is therefore costless. We then introduce lack of credibility to asses whether this may alter the conclusions. Under this scenario, both gradual and shock plans induce recessions. While the recession generated by the latter is marginally bigger, inflation reaches its

target. We also experiment with three modifications to the labor market block of the model: shutting off the wealth effect, adding another market for labor and sticky wages with backward-looking indexation. We focus on the last modification as it is the one that departs further from the baseline model. In this scenario, the choice of plan depends crucially on credibility. Credible policymakers can implement a gradual plan, that minimizes output loss and reaches the inflation target. Instead, non-credible policymakers face a trade-off between low inflation and output growth.

This paper is structured as follows. Section 2 provides a brief review of the literature that helps to place the contributions of this article. Section 3 sets out the baseline model and shows its responses to the different stabilization plans. Section 4 then introduces possible modifications to the model that could help match the expected dynamics and shows its results. Section 5 discusses what could be the best plan under different scenarios. Lastly, section 6 concludes.

2 Inflation Stabilization Plans

A vast literature has studied stabilization plans in emergent countries. Especially active in the 90's it is therefore mostly concerned with exchange rate-based plans, as most plans implemented before or during that time were so. Stanley Fischer, Ratna Sahay and Carlos Vegh (2002) have an excellent survey on this topic.

One fact the literature tried to explain was the puzzling dynamics of exchange-rate based plans as they were often followed by an output expansion, opposite to the usual output loss in money-based plans. This expansion was followed by a crisis later on as Carmen Reinhart and Carlos Vegh showed (1999). As standard models did not replicate these facts, several explanations were put forward. Rebelo and Vegh (1995) propose a horse-race between the different explanations finding that only the lack of credibility and sticky wages could account for all of the facts. They use a standard open economy model which is very similar to ours, except for the inclusion of capital as a production factor. Amartya Lahiri (2001) also proposes endogenous labor supply as a

cause of the “boom and bust” cycle.

Interest rate-based plans (IRBS) have not received nearly as much attention, with the sole exception being Guillermo Calvo (2007) who argues than ERBS are chosen over IRBS as the initial expansion provides much needed credibility to the policymaker. This paper then adds to the small literature on IRBS by testing if some of the features that proved to be important for ERBS also matter for IRBS.

3 Baseline Model

To study the impact of the different choices of stabilization plans we use a DSGE model. Since they have been the target of some criticism[1] in recent times, we believe a brief justification may be in order.

As Larry Christiano, Martin Eichenbaum and Mathias Traband (2017) claim:

> Macroeconomic policy questions involve trade-offs between competing forces in the economy. The problem is how to assess the strength of those forces for the particular policy question at hand. One strategy is to perform experiments on actual economies. This strategy is not available to social scientists. As Lucas (1980) pointed out roughly forty years ago, the only place that we can do experiments is in our models.

Moreover, as Olivier Blanchard (2016) says, these models offer a common structure around which to build and organize discussions. Since the questions asked in this paper require assessing different hypothesis, it is natural to use a DSGE as the common core.

3.1 Baseline Model

The baseline model is an infinite time small open economy, featuring uncertainty due to different shocks and incomplete markets. The model is then similar to a discrete

[1] See, for example, Joseph Stiglitz (2018)

time version of the Calvo model (1986, 2007). Additional differences are microfounded pricing decisions and a closing device.

In this economy, a single good is consumed. This good is made using two other goods, one imported and the other non-tradable. The non-tradable good, along with an exportable one, is produced domestically. There are 4 agents in this economy: Households, Firms, Government and the Rest of the World.

Households

Households maximize the present discounted value of lifetime value, which is given by the following equation:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\frac{{c_t}^{1-\sigma}}{1-\sigma} - \chi \frac{{h_t}^{1+\varphi}}{1+\varphi} \right] \right\}$$

Where utility at time t is given by the expression between brackets and is an additive and separable function of c_t and h_t. In solving this problem, they face the following budget constraint:

$$P_t c_t + S_t R^*_{t-1} D^*_{t-1} + R_{t-1} D_{t-1} + M_t + T_t = W_t h_t + S_t D^*_t + D_t + M_{t-1} + \Omega_t$$

Where D and D^* represent internal and external debt respectively. Its interest rates are given by R and R^*. S_t is the nominal exchange rate, which is relevant because external debt is denominated in foreign currency. Households can also hold money, M, which bears no interest. There is also a *lump sum* tax T. It can take negative values, in which case T is interpreted as a transfer from the government. Households also receive a wage W and the benefits of the firms Ω.

A fraction of consumption is required to be paid using money. This constraint, commonly known as cash-in-advance, can be expressed as :

$$M_t \geq \kappa P_t c_t$$

As prices may exhibit long-run growth, nominal variables are potentially not station-

ary. However, there is a steady state level of inflation. This means that real variables are stationary. Real variables are obtained dividing nominal variables by the price level P and are expressed in lowercase letters.

Let $\beta^t \frac{\lambda_t}{P_t}$ and $\beta^t \frac{\lambda_t \xi_t}{P_t}$ the lagrange multipliers associated with the budget and cash-in-advance constraints respectively. The first order conditions are:

$$c_t^{-\sigma} = (1 + \xi_t \kappa)\lambda_t \tag{E.1}$$

$$\chi h_t^{\varphi} = \lambda_t w_t \tag{E.2}$$

$$\lambda_t = \beta R_t^* E_t \left\{ \frac{\lambda_{t+1} \pi_{t+1}^s}{\pi_{t+1}} \right\} \tag{E.3}$$

$$\lambda_t = \beta R_t E_t \left\{ \frac{\lambda_{t+1}}{\pi_{t+1}} \right\} \tag{E.4}$$

$$\lambda_t (1 - \xi_t) = \beta E_t \left\{ \frac{\lambda_{t+1}}{\pi_{t+1}} \right\} \tag{E.5}$$

Where $w_t \equiv W_t / P_t$, $\pi_t \equiv P_t / P_{t-1}$ and $\pi_t^s \equiv S_t / S_{t-1}$

Firms

The economy has three different kinds of firms, each producing a different good: final goods, non-tradable goods and exportable goods. Exportable goods are a endowment y_t^x which is sold at an international price P_t^{x*}. Benefits are then given by:

$$S_t P_t^{X*} y_t^X$$

Final goods are produced in a competitive market using a technology that combines imported and non-tradable goods:

$$y_t^C = \left[\omega^{1/\eta} (c_t^N)^{1-(1/\eta)} + (1 - \omega)^{1/\eta} (c_t^F)^{1-(1/\eta)} \right]^{\frac{\eta}{\eta - 1}} \tag{E.6}$$

These firms maximize profits given by:

$$B_t^c = P_t y_t^C - P_t^N c_t^N - P_t^F c_t^F$$

Its first-order conditions are then:

$$c_t^N = \omega (p_t^N)^{-\eta} y_t^c \tag{E.7}$$

$$c_t^F = (1-\omega)(p_t^F)^{-\eta} y_t^c \tag{E.8}$$

Where lowercase prices mean they are relative to the general price level P.

Non tradable-goods, y_t^N, are produced combining a continous of varieties $j \in [0,1]$ á la Dixit-Stiglitz with the technology:

$$y_t^N = \left[\int_0^1 (c_{jt}^N)^{1-\frac{1}{\epsilon_N}} dj \right]^{\frac{\epsilon_N}{\epsilon_N - 1}}$$

Demand for each variety j is given by:

$$y_{jt}^N = \left(\frac{P_{jt}^N}{P_t^N} \right)^{-\epsilon_N} y_t^N$$

Where P_{jt}^N is the variety price and P_t^N the index price.

Variety j production can be described by the following production function:

$$y_{jt}^N = z_t^N h_{jt}$$

Where z_t^N is common productivity for all varieties and follows a stochastic process:

$$ln\left(\frac{z_t^N}{z^N}\right) = \rho_z ln\left(\frac{z_{t-1}^N}{z^N}\right) + \epsilon_t^{z^N} \tag{E.9}$$

Price setting follows Calvo (1983). Firms are not allowed to set prices freely, having a $1-\theta_N$ chance of choosing their price. Firms that cannot set their price index it to a fraction of steady state inflation. The equation below summarizes the price setting

process.

$$P_{jt}^N = \begin{cases} \tilde{P}_{jt}^N & \text{with probability. } 1-\theta_N \\ P_{jt-1}^N(\pi)^{\mu_N} & \text{with probability. } \theta_N \end{cases}$$

Optimality conditions are:

$$p_t^N mc_t^N z_t = w_t \tag{E.10}$$

$$f_t^{1N} = (\tilde{p}_t^N)^{1-\epsilon_N} y_t^N \left(\frac{\epsilon_N - 1}{\epsilon_N}\right) + \theta_N E_t \left\{ r_{t,t+1} \left(\frac{\tilde{p}_t^N \pi^{\mu_N}}{\tilde{p}_{t+1}^N}\right)^{1-\epsilon_N} (\pi_{t+1}^N)^{\epsilon_N} f_{t+1}^{1N} \right\} \tag{E.11}$$

$$f_t^{2N} = (\tilde{p}_t^N)^{-\epsilon_N} y_t^N mc_t^N + \theta_N E_t \left\{ r_{t,t+1} \left(\frac{\tilde{p}_t^N \pi^{\mu_N}}{\tilde{p}_{t+1}^N}\right)^{-\epsilon_N} (\pi_{t+1}^N)^{1+\epsilon_N} f_{t+1}^{2N} \right\} \tag{E.12}$$

$$f_t^{1N} = f_t^{2N} \tag{E.13}$$

$$1 = \theta_N \left(\frac{\pi_t^N}{\pi^{\mu_N}}\right)^{\epsilon_N - 1} + (1-\theta_N)(\tilde{p}_t^N)^{1-\epsilon_N} \tag{E.14}$$

Rest of the World

Domestic prices of imported goods satisfy the law of one price:

$$P_t^F = S_t P_t^{F*}$$

Terms-of-trade are defined as:

$$tot_t = \frac{P_t^{X*}}{P_t^{F*}}$$

And follow the process:

$$ln\left(\frac{tot_t}{tot}\right) = \rho_{tot} ln\left(\frac{tot_{t-1}}{tot}\right) + \epsilon_t^{tot} \tag{E.15}$$

International inflation is:

$$\pi_t^* = \frac{P_t^{F*}}{P_{t-1}^{F*}}$$

And is determined by:

$$ln\left(\frac{\pi_t^*}{\pi^*}\right) = \rho_\pi^* ln\left(\frac{\pi_{t-1}^*}{\pi^*}\right) + \epsilon_t^{\pi^*} \tag{E.16}$$

The interest rate paid by external debt is:

$$R_t^* = R_t^W exp\{\phi(d_t^* - \bar{d})\} \tag{E.17}$$

Where $d_t^* \equiv \frac{D_t^*}{P_t^{F*}}$. The intuition is that external creditors charge a higher interest rate the higher the stock of debt is, as protection against a potential default[2]. R^W represents a risk-free interest rate and follow the process:

$$ln\left(\frac{R_t^W}{R^W}\right) = \rho_{R^W} ln\left(\frac{R_{t-1}^W}{R^W}\right) + \epsilon_t^{R^W} \tag{E.18}$$

Government

The government uses *lump sum* taxes T_t to rebate the benefits or losses that arise from money and debt creation such that:

$$R_{t-1}D_{t-1} + M_t + T_t = D_t + M_{t-1}$$

Two monetary policy rules are specified:

$$\text{Rule 1: } \frac{R_t}{R} = \left(\frac{\pi_t}{\pi}\right)^{\alpha_\pi} \tag{E.19a}$$

$$\text{Rule 2: } \pi_t^S = \pi^S \tag{E.19b}$$

$$\tag{E.19}$$

The first is a Taylor Rule, used in an inflation-targeting scheme. The second is a rule that fixes the exchange-rate devaluation rate. Stabilization plans are assumed to be carried on with the first rule.

[2]This is also needed as a closing device for the model to prevent an unit root in consumption. See Stephanie Schmitt-Grohé and Martin Uribe (2003)

Aggregation and Market Clearing

Clearing conditions have to be satisfied in equilibrium:

$$y_t^N = c_t^N \tag{E.20}$$

$$c_t = y_t^c \tag{E.21}$$

$$\frac{p_t^N}{p_{t-1}^N} = \frac{\pi_t^N}{\pi_t} \tag{E.22}$$

$$z_t^N h_t = c_t^N s_t \tag{E.23}$$

$$s_t = \theta_N \left(\frac{\pi_t^N}{\pi^{\mu_N}} \right)^{\epsilon_N} s_{t-1} + (1-\theta_N) \tilde{p}_t^{N^{-\epsilon_N}} \tag{E.24}$$

$$\frac{R_{t-1}^*}{\pi_t^*} d_{t-1}^* = d_t^* + tot_t y_t^X - c_t^F \tag{E.25}$$

$$rer_t = p_t^F \tag{E.26}$$

$$\frac{rer_t}{rer_{t-1}} = \frac{\pi_t^s \pi_t^*}{\pi_t} \tag{E.27}$$

$$tb_t = tot_t y_t^X - c_t^F \tag{E.28}$$

$$y_t = c_t + y_t^X - c_t^F \tag{E.29}$$

$$p_t^Y = \frac{c_t + rer_t tb_t}{y_t} \tag{E.30}$$

$$\Delta M_t = \frac{m_t}{m_{t-1}} \pi_t \tag{E.31}$$

The equilibrium is then characterized by equations (E.1) to (E.31). There are 27 endogenous variables: $c_t, \lambda_t, h_t, w_t, R_t^*, \pi_t^s, \pi_t, \pi_t^N, R_t, m_t, \Delta M_t, y_t^c,$
$c_t^N, c_t^F, p_t^N, p_t^F, mc_t^N, f^{1N}, f^{2N}, \tilde{p_t^N}, d_t^*, s_t, rer_t, tb_t, p_t^y, y_t, y_t^N$;
and 5 exogenous variables: $z_t, R_t^W, \pi_t^*, y_t^X, tot_t$.

The solution to this system does not have a closed form so we log-linearize around a steady-state. The parameters are calibrated and its values are indicated by Table 1.

Most of the parameters are standard in the literature. y^x and $\bar{d}$ were chosen so that the share of the trade balance over GDP, $s^t b$ is equal to 0.05, Argentina's average over

2004-2016. The cash-in-advance parameter, κ, matches the average ratio $M1/C$ for Argentina between 2004 and 2016. Lastly, quarterly inflation is the fourth root of 40%, which was the inflation rate the year before the stabilization plan announcement.

Table 1: Baseline Calibration

σ	φ	κ	ω	η	ϵ_N	θ_N	μ_N	ϕ
2	1	0.23	0.7	0.5	6	0.7	1	0.001
h	y^X	tot	R^W	π^*	z^N	$\bar{d}$	π	α_π
1/3	0.1679	1	1.0366	1.005	1	0.83996	$1.4^{1/4}$	1.5

3.2 Stabilization Plans in the Baseline Model

It is useful to first study the reaction of the economy described by the baseline model to different stabilization plans in which the new target will be $\pi = 1.1^{1/4}$. In particular, two kinds of plans will be analyzed: Shock plans and gradual plans. In the first one, the monetary policy role instantaneously adopts the new target. In the second plan, the quarterly inflation target gradually converges to the long-run target. In this case, we assume that the plan is carried on over 10 quarters or two and a half years.

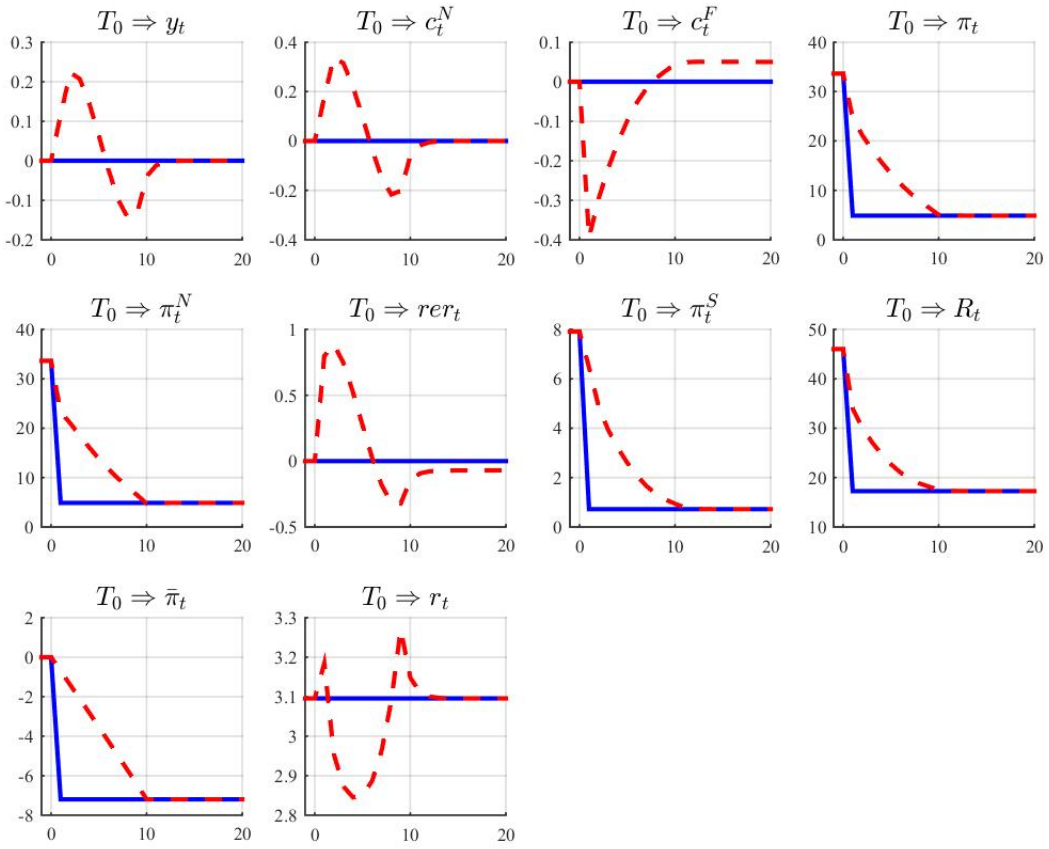
Because the implementation of the model requires a change of parameters[3], solution is not trivial. To solve the model, we follow Mariano Kulish and Adrian Pagan (2016) and use backward induction. The model was run on Matlab using DYNARE[4].

Figure 1 shows the impulse-response functions (IRFs) of the model to the announcement of the stabilization plan in $T = 2$. Because the model was log-linearized, the variables represent percentage deviations from their initial values steady state.

[3]Strictly speaking, the inflation target or steady inflation. In this model, additional parameters change because we impose a change in the policy function.

[4]Code available upon request.

Figure 1: IRFs to Credible Stabilization Plan- Baseline Model



Solid Blue: Shock Plan. Dashed Red: Gradual Plan.

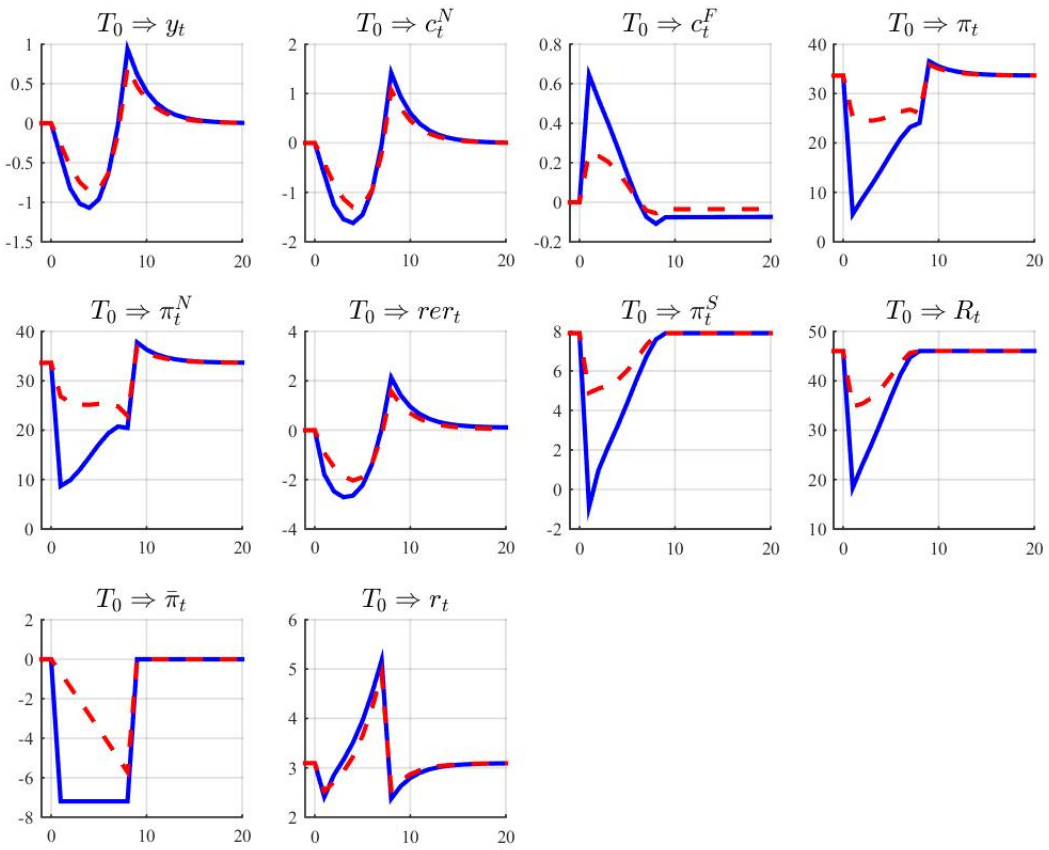
As figure 1 shows, there does not seem to be a big justification for gradualism in this economy. While it is true that gradualism generates an expansion in output in the first quarters of expansion, it also suffers a brief recession. This resembles the boom-and-bust cycle experimented by exchange rate-based stabilization plans. This is generated at the cost of greater volatility in the interest rate and the real exchange rate, which could mean that this economy is more vulnerable to external shocks.

As the literature on stabilization plans suggests, credibility might be an important issue. We model lack of credibility following Calvo (1986) as temporariness. That is: In $t = 1$, the government announces a stabilization plan for $t \geq 1$. However, because the government lacks credibility, people expect a return to the old regime in $t = T$. For simplicity, we assume that these expectations are ex-post realized. In our analysis,

$T = 8$, which is two years and corresponds to the mid-term elections in many countries. Figure 2 shows the responses of the economy to non credible plans. In this case, both plans generate a boom-and-bust cycle. Moreover, this cycle is more volatile in the case of the shock plan. However, the shock plan manages to reach its inflation target, while the gradual plan does not. Because we assume that agent's expectations are correct, this does not have an effect on the economy. It could be argued that reaching the target gives a boost to credibility, so this could weigh in favor of the shock plan.

As mentioned in Section 2, credibility is not the only feature that helps matching the dynamics of emergent economies. In the next section, we propose some modifications to the baseline model in line with the existing literature.

Figure 2: IRFs to Non Credible Stabilization Plan- Baseline Model



Solid Blue: Shock Plan. Dashed Red: Gradual Plan

4 Labor Market Extensions

Some characteristics make the labor market an interesting area to explore in emerging markets. In many of them, the market is relativey concentrated, with wages negotiated between unions and trade associations. Moreover, several stabilization plans have included wage controls (Rebelo and Vegh, 1995), which hints at the importance of the market, at least from the policymakers point of view. The following 3 sections detail three extensions:

- No wealth effect in the labor supply.
- Exportable goods require labor.
- Sticky Wages

For simplicity, only the main modifications will be discussed, leaving the full characterization to the appendix.

4.1 No Wealth Effect

The wealth effect in the labour supply may damp some of the transmisions mechanisms. To turn it off we use a GHH[5] utility function.

$$U(c_t, h_t) = \frac{\left[c_t - \chi \frac{h_t^{1+\varphi}}{1+\varphi}\right]^{1-\sigma} - 1}{1-\sigma}$$

Household first order conditions are modified, particularly (E.1) and (E.2).

$$\left(1 + \kappa\left(1 - \frac{1}{R}\right)\right)\lambda_t = \left(c_t - \frac{\chi h_t^{1+\varphi}}{1+\varphi}\right)^{-\sigma} \tag{E.1}$$

$$\left(c_t - \frac{\chi h_t^{1+\varphi}}{1+\varphi}\right)^{-\sigma} \chi h_t^{\varphi} = \lambda_t w_t \tag{E.2}$$

In this case, calibration is not significantly altered. χ is left as a free parameter so as to achieve $h = 1/3$ in the steady state.

[5] Greenwood, Hercowitz y Huffman, 1988

4.2 Exportable Goods Production

One of the stylized facts of stabilization plans is a worsening in the balance of payments. To explore this mechanism, we no longer model the exportable good as an endowment but as a domestically produced good. Its production function can be expressed as:

$$y_t^X = z_t^X \ (h_t^X)^{\alpha_X}$$

Where z_t^X represents productivity, which follows the process:

$$ln\left(\frac{z_t^X}{z^X}\right) = \rho_z ln\left(\frac{z_{t-1}^X}{z^X}\right) + \epsilon_t^{z^X}$$

Additionally, in equilibrium the labor market must clear so that:

$$h_t^X + h_t^N = h_t \tag{E.28}$$

Exporters now maximize their benefits, given by:

$$S_t \ P_t^{X*} z_t^X \ (h_t^X)^{\alpha_X} - W h_t^X$$

And their first order conditions are:

$$S_t P_t^{X*} z_t^X \alpha^X (h_t^X)^{\alpha_X - 1} - W = 0$$

After some manipulation, its possible to express labor demand as:

$$h_t^X = \left(\frac{w}{\alpha_X \ rer_t \ tot_t \ z_t^X}\right)^{\alpha_X - 1} \tag{E.29}$$

Finally, (E.18) y (E.19) are modified.

$$tb_t = tot_t z_t^X \ (h_t^X)^{\alpha_X} - c_t^F \tag{E.18}$$

$$y_t = c_t + z_t^X \ (h_t^X)^{\alpha_X} - c_t^F \tag{E.19}$$

In the calibration, parameters χ, $\bar{d}$ y z^X are free, so as to match the steady state values of h^N, p^N y s^{tb} where $s^{tb} \equiv \frac{rerxtb}{p^y xy}$. Chosen values are summarized in Table 2.

Table 2: Exportable Goods Calibration

α^x	h^N	p^N	s^{tb}
0.4	$5/18$	1	0.005

4.3 Sticky Wages

The baseline model and the two extensions developed so far assume a competitive labor market, where wages equal marginal productivity at all times. A growing literature shows that wage stickiness is significant, even in developed countries[6].

Wage stickiness is modeled in the same way as price stickiness. There is a continuum of labor markets. Firms use labor for all markets and aggregate them. In every market there is an union with market power. These unions can change their wages with probability $1-\theta^W$. The unions that can't choose index their wages to past inflation such that:

$$W_{i,t} \ = W_{i,t-1} \ \pi_{t-1}^{\mu_N}$$

As a result, optimal conditions are modified. More specifically (E.2) is now:

$$\chi(h_t)^{\varphi} = \lambda \ w_t \ mc_t^W \tag{E.2}$$

Where mc_t^W is the difference from the flexible wages assignation. The following equilibrium conditions, that capture the wage-setting process, are also added:

$$f_t^{1W} = \tilde{w_t}^{1-\epsilon_W} \ h_t \ \left(\frac{\epsilon_W - 1}{\epsilon_W}\right) + \theta_W \ \beta E \left\{ \frac{\lambda_{t+1}}{\lambda_t \pi_{t+1}} \left(\frac{\tilde{w_t} \ (\pi^{IW})^{\mu_N}}{\tilde{w}_{t+1}} \right)^{(1-\epsilon_W)} (\pi_{t+1}^W)^{\epsilon_W} \ f_{t+1}^{1W} \right\} \tag{E.28}$$

$$f_t^{2W} = \tilde{w_t}^{-\epsilon_W} h_t mc_t^W + \theta_W \beta E \left\{ \frac{\lambda_{t+1}}{\lambda_t \pi_t} \left(\frac{\tilde{w_t} (\pi^{IW})^{\mu_N}}{\tilde{w}_{t+1}} \right)^{-\epsilon_W} (\pi_{t+1}^W)^{\epsilon_W + 1} f_{t+1}^{2W} \right\} \tag{E.29}$$

[6] See, for example: Barattieri et al (2014), Kahn (1997), Sigurdsson y Sigurdardottir (2016).

$$f_t^{1W} = f_t^{2W} \tag{E.30}$$

$$1 = \theta_W \left(\frac{\pi_t^W}{(\pi_t^{IW})_N^{\mu}} \right)^{\epsilon_W - 1} + (1 - \theta_W)(\tilde{w_t})^{1-\epsilon_W} \tag{E.31}$$

$$h_t^o = \Delta_t^W h_t \tag{E.32}$$

$$\Delta_t^W = \theta_W \left(\frac{\pi_t^W}{(\pi_t^{IW})^{\mu_N}} \right)^{\epsilon_W} \Delta_{t-1}^W + (1 - \theta_W)(\tilde{w_t})^{-\epsilon_W} \tag{E.33}$$

Table 3 shows the parameters values chosen for calibration.

Table 3: Sticky Wages Calibration

θ_W	ϵ_W	μ_N
0.7	6	1

In the following section we analyze the dynamics of the different extensions proposed.

4.4 Stabilization Plans Under the Extensions

The next sections analyze the outcomes of the stabilization plans for each of the extensions proposed. Shock plans are shown first, distinguishing between credible and non credible scenarios. The same distinction is made when looking at gradual plans.

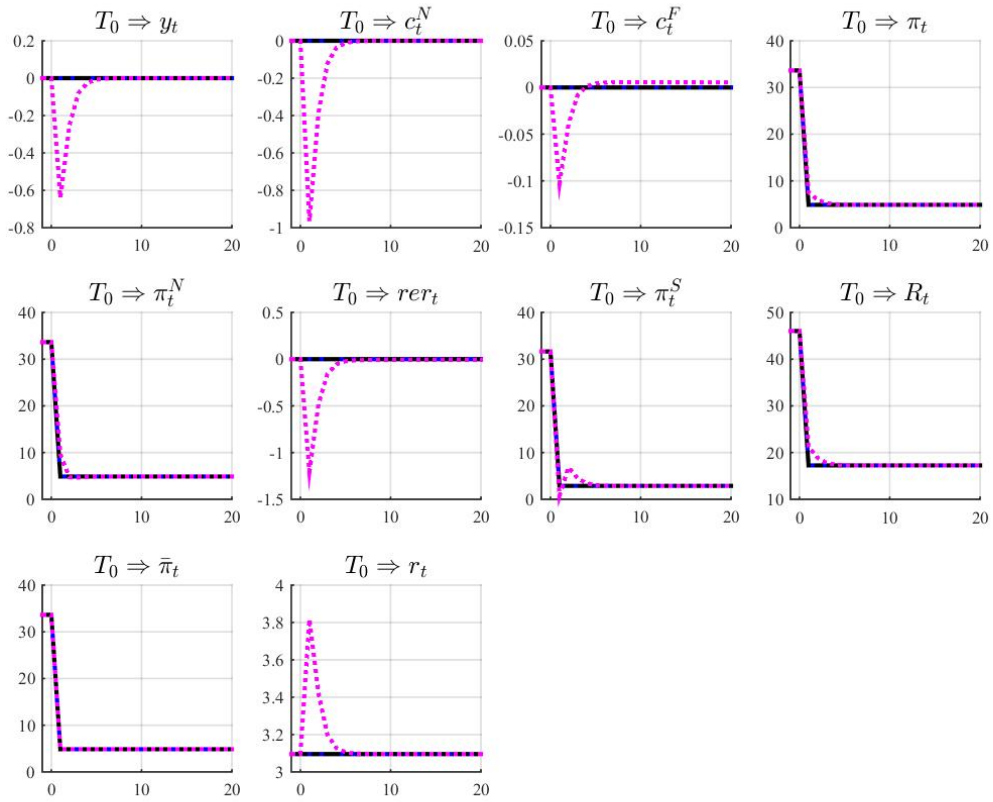
Shock Plan

Credible Plan

Figure 3 shows the response of the baseline model (Solid Blue) and the three extensions. In this case, only the introduction of sticky wages (Dot Magenta) generates a difference. Because wages that are not adjusted are indexed to past inflation, real wages rise. This increases production costs and therefore goods production decreases. At

the same time, the policy rule rises the interest as response to the deviation of inflation from the target, further decreasing output. This *inertia* is short-lived, and the sticky wages model soon converges to the baseline model results. However, the short duration of this divergence should not hide the fact that sticky wages generate a recession even when policymakers are perfectly credible.

Figure 3: IRFs to Credible Shock Plan



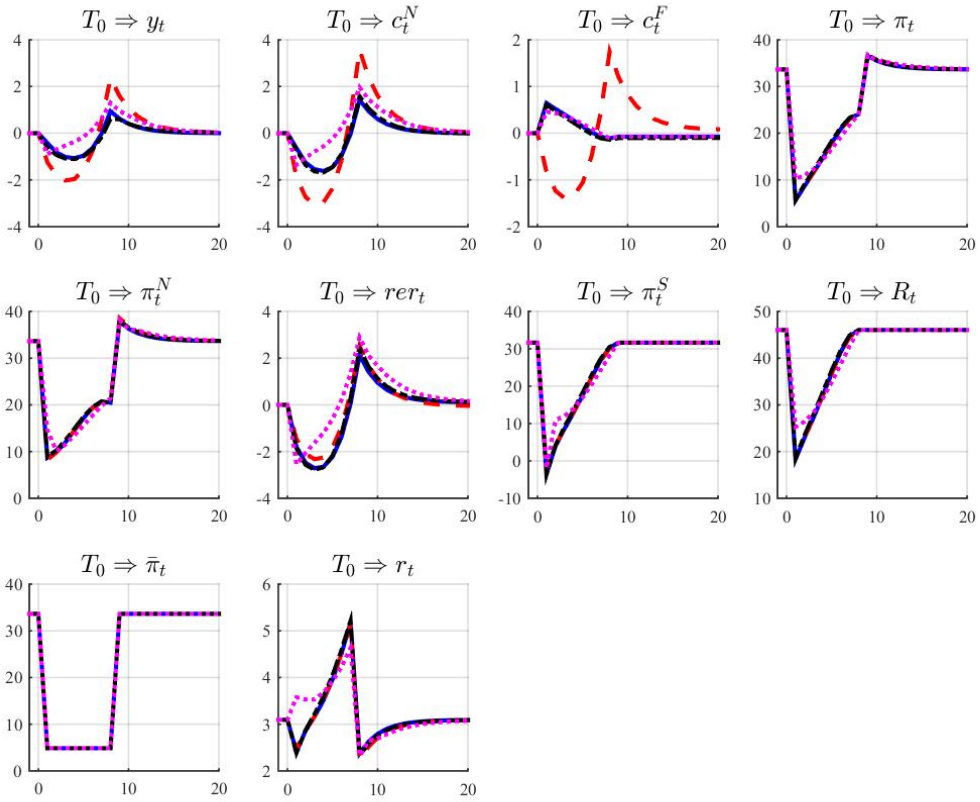
Solid Blue: Baseline Model. Dash Red: No Wealth Effect. Dash-dotted Black: Exportable Goods. Dot Magenta: Sticky Wages.

Non Credible Plan

Figure 4 shows the responses to a shock plan which is perceived as temporary by the agents. Once again, exportable goods (Dash-dotted black) which require labor do not change the dynamics of the model. On the other hand, using a GHH utility function does alter the dynamics of the economy. The lack of a wealth effect in the labour supply amplifies the cycle, evidenced in the stronger recession and subsequent recovery.

When wages are sticky, the cycle is smoother. This is a result of the increasing inflation. Because wages are indexed to past inflation, real wages fall as long as inflation is increasing. As a result, the recovery speeds up.

Figure 4: IRFs to Non Credible Shock Plan



Solid Blue: Modelo base. Dash Red: Primer extensión. Dash-dotted Black: Segunda extensión. Dot Magenta: Tercer extensión.

Gradual Plans

We now turn to gradual plans. As before, we assume that the plan will be carried over 10 quarters or two and a half years.

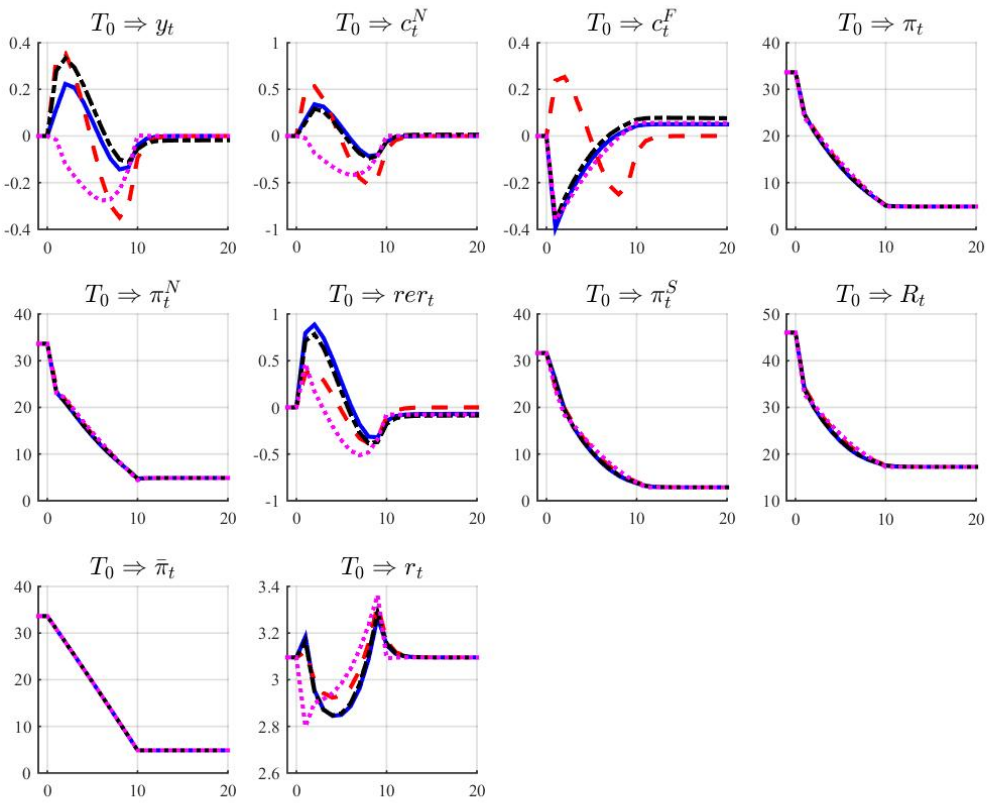
Credible

Figure 5 shows the responses of the economy to a credible gradual plan. As was the case before, introducing GHH preferences amplifies the cycle. Because labor supply

does not decrease as output increases, the expansion is bigger. Moreover, the depreciation of the real exchange rate is smaller, which allows for more extensive use of imported goods. Conversely, when the economy reaches the bust stage of the cycle, the recession is also bigger. In the scenario where the production of exportable goods is endogenous, the depreciation of the exchange encourages an increase of exports, which finally leads the output expansion.

In the sticky wages world Inflation follows a decreasing path, although not identical to the inflation target. The fact that it is decreasing causes real wages to increase, as those indexed increase by more than actual inflation. This inertia generates a recession instead of output growth. As more and more unions are able to set their wages according to the inflation target, this recession starts to wear off. Moreover, because the rate of disinflation is decreasing, the disadjustment caused by indexation gets smaller as quarters pass.

Figure 5: IRFS To Credible Gradual Plan



Solid Blue: Baseline Model. Dash Red: No Wealth Effect. Dash-dotted Black: Exportable Goods. Dot Magenta: Sticky Wages.

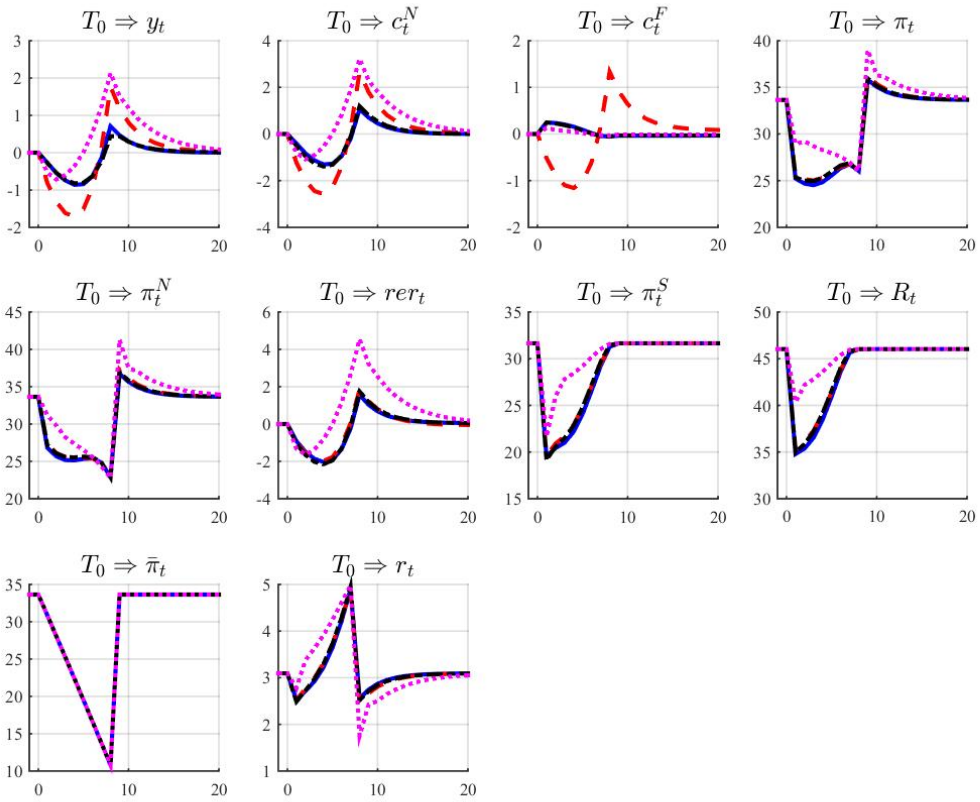
Non Credible

Figure 6 shows the dynamics of the economy after the implementation of a gradual plan that is not credible. In this scenario, the exportable goods extension shows no difference with the baseline model. As expected, using a GHH utility function amplifies the cycle, but the responses are not qualitatively different to those of the baseline model. Interestingly, these dynamics are not extremely different from the ones experienced under a non credible shock plan, as Figure 4 shows. This hints to the fact that credibility or lack thereof may matter more than the timing for implementation.

Under sticky wages, however, the reactions of the economy are different. Because of the inflationary inertia imposed by the wage indexation, inflation never reaches its target. Because a fraction of prices are adjusted according to target inflation, goods

become cheap and output starts to grow, driven by an increased consumption of non tradables. This expansion lasts until the plan is abandoned and firms adopt a more consistent target. However, because inflation overshoots, output growth continues for as long as inflation departs from its target, although at a diminishing rate.

Figure 6: IRFs to Non Credible Gradual Plan



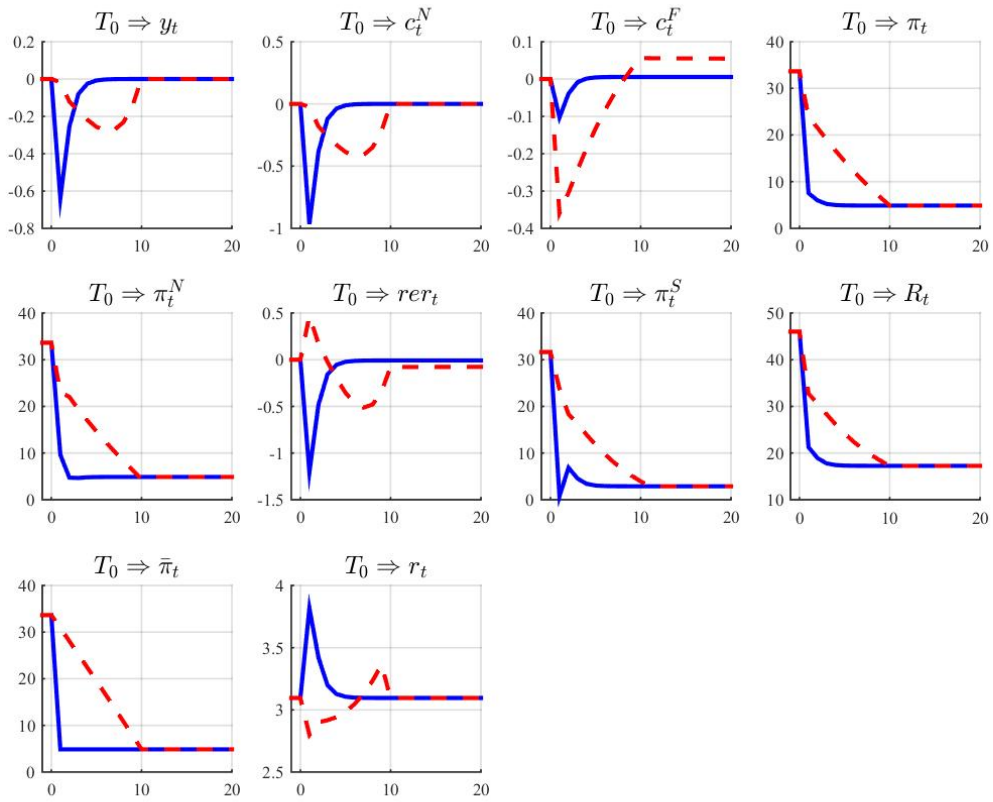
Solid Blue: Baseline Model. Dash Red: No Wealth Effect. Dash-dotted Black: Exportable Goods. Dot Magenta: Sticky Wages.

5 Choosing a Plan

One of the questions that drive this paper is in which circumstances a gradual plan could be justified. Having studied some extensions that were promising, we repeat the exercise we performed with the baseline model in figures 1 and 2. We choose the sticky wages extension as it is the one that showed the bigger differences with the baseline model.

Figure 7 shows the responses to credible plans in an economy with sticky wages. While both plans induce recessions, the recession is bigger for the shock plan. The mechanism is the following. Because wages that can't be set are indexed to past inflation, a sharp decrease in prices generates a big distortion, because while some wages are set with the target inflation (10%) in mind, others are adjusted according to past inflation (40%). The more gradual the plan is, the less big this effect will be, as the difference between past inflation and the current target gets smaller. However, the fact that the plan is gradual means that inflation will be decreasing for some time. As was discussed before, decreasing inflation means rising real wages. This generates a recession in the gradual plan, although a bit later in time.

Figure 7: IRFs for Credible Plans Under Sticky Wages



Solid Blue: Shock Plan. Dash Red: Gradual Plan.

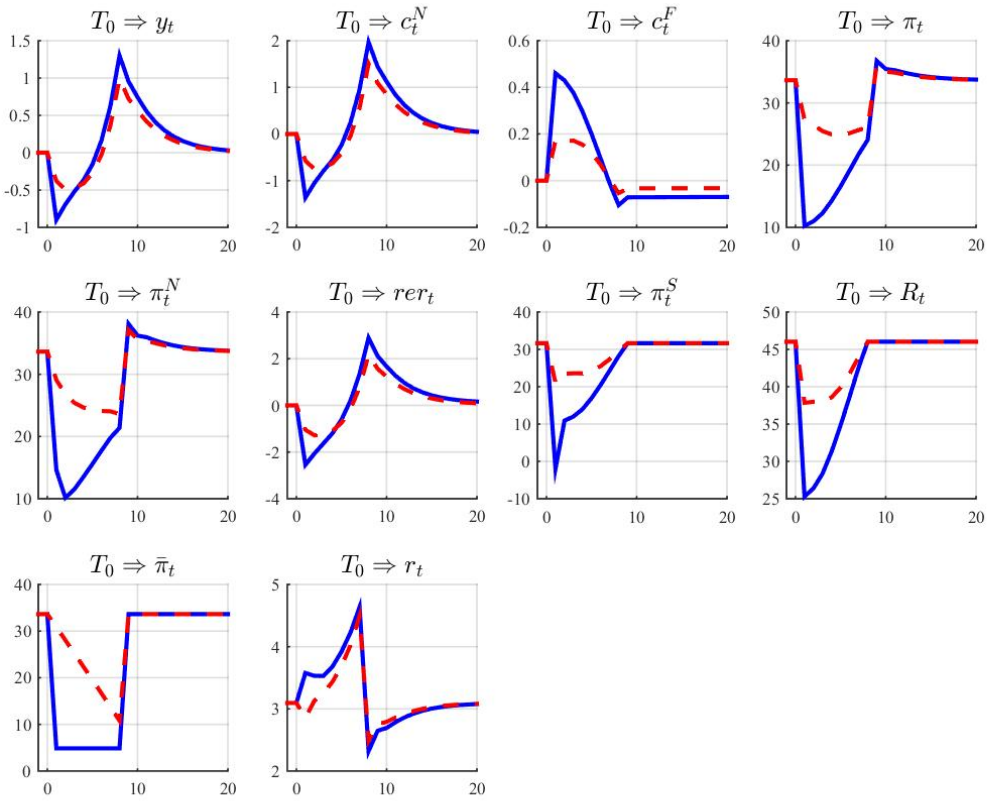
As has already been discussed, it could be the case that the policymakers lack credibility. Figure 8 shows the results under this scenario. In this case, the lack of

credibility seems to be more important than the choice of plan as dynamics are similar. Focusing on the behaviour of output, it is difficult to pick the better plan. While the initial recession is bigger under the shock plan, so is the subsequent recovery. Inflation, however, has different paths under the two plans. While it is true that in both cases inflation converges to its old steady state level, this is a consequence of the way in which we model credibility, in which the government abandons its plan under all scenarios.

If we allowed the policymakers to earn their trust, it is easy to see that those who implemented a shock plan would be in a better position. In this point we are at odds with Calvo (2007) who conjectures that credibility is earned through output growth. This is true when considering for example midterm elections that may influence on the plan being carried on. Another scenario would be that of a government that needs output growth as a signal of sustainability towards foreing investors. In the end, however, a inflation stabilization plan should be judged by its ability to lower inflation. In this case, the shock plan manages to get inflation down to 10 %, while the gradual plan only reaches 25% before it starts raising again.

The results can be intuitively interpreted as follows. Policymakers who are credible can afford to be gradual, for agents know that they intent to lower inflation. Non credible policymakers need to act fast, so as to convince the market and therefore should implement a shock plan.

Figure 8: *IRFs for Non Credible Plans Under Sticky Wages*



Solid Blue: Shock Plan. Dash Red: Gradual Plan.

6 Conclusion

In this paper we contributed to the literature on inflation stabilization plans by focusing on interest rate-based plans, which have not been explored thoroughly before. We distinguish between shock and gradual plans and evaluate the impact each of these plans have. We find that a standard DSGE new-keynesian model favours using a shock plan. Drawing from the existing literature, we add some features that reflect characteristics of labor markets in emergent countries. In particular, we cancel the wealth effect, model exportable goods in a richer way and include sticky wages that are indexed to past inflation. The latter alters the responses of the economy in a significative way. More importantly, when the plan is credible, the costs of desinflation

are lower for the gradual plan.

We draw from Calvo (1986) and use the concept of temporary plans to model lack of credibility. We show that introducing temporariness greatly modifies the responses to stabilization, a fact that had already been established for exchange rate-based plans. A model with sticky wages and lack of credibility does not yield clear results regarding the convenience of shock or gradual plans. However, we argue that if bringing down inflation is the main consideration then the shock plan seems more effective.

When comparing the effects of credibility and labor market features, such as sticky wages, the former seems to be the important factor determining the dynamics of emergent economies. This emphasizes the need for more work on the determinants of credibility and its implications.

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A Appendix

For the three extensions the equations that differ from the baseline model are colored in red.

A.1 GHH Utility Function

Households

$$\left(1+\kappa\left(1-\frac{1}{R}\right)\right)\lambda_t = \left(c_t - \frac{\chi h_t^{1+\varphi}}{1+\varphi}\right)^{-\sigma} \tag{E.1}$$

$$\left(c_t - \frac{\chi h_t^{1+\varphi}}{1+\varphi}\right)^{-\sigma} \chi h_t^{\varphi} = \lambda_t w_t \tag{E.2}$$

$$\lambda_t = \beta R_t^* E_t \left\{\frac{\lambda_{t+1}\pi_{t+1}^s}{\pi_{t+1}}\right\} \tag{E.3}$$

$$\lambda_t = \beta R_t E_t \left\{\frac{\lambda_{t+1}}{\pi_{t+1}}\right\} \tag{E.4}$$

$$m_t = \kappa c_t \tag{E.5}$$

Firms

$$y_t^C = \left[\omega^{1/\eta}(c_t^N)^{1-(1/\eta)} + (1-\omega)^{1/\eta}(c_t^F)^{1-(1/\eta)}\right]^{\frac{\eta}{\eta-1}} \tag{E.6}$$

$$c_t^F = (1-\omega)(p_t^F)^{-\eta} y_t^c \tag{E.7}$$

$$c_t^N = \omega(p_t^N)^{-\eta} y_t^c \tag{E.8}$$

$$p_t^N mc_t^N z_t^N = w_t \tag{E.9}$$

$$f_t^{1N} = (\tilde{p}_t^N)^{1-\epsilon_N} y_t^N \left(\frac{\epsilon_N - 1}{\epsilon_N}\right) + \theta_N E_t \left\{ r_{t,t+1} \left(\frac{\tilde{p}_t^N \pi^{\mu_N}}{\tilde{p}_{t+1}^N}\right)^{1-\epsilon_N} (\pi_{t+1}^N)^{\epsilon_N} f_{t+1}^{1N} \right\} \tag{E.10}$$

$$f_t^{2N} = (\tilde{p}_t^N)^{-\epsilon_N} y_t^N mc_t^N + \theta_N E_t \left\{ r_{t,t+1} \left(\frac{\tilde{p}_t^N \pi^{\mu_N}}{\tilde{p}_{t+1}^N}\right)^{-\epsilon_N} (\pi_{t+1}^N)^{1+\epsilon_N} f_{t+1}^{2N} \right\} \tag{E.11}$$

$$f_t^{1N} = f_t^{2N} \tag{E.12}$$

$$1 = \theta_N \left(\frac{\pi_t^N}{\pi^{\mu_N}}\right)^{\epsilon_N - 1} + (1-\theta_N)(\tilde{p}_t^N)^{1-\epsilon_N} \tag{E.13}$$

Aggregation and Market Clearing

$$y_t^N = c_t^N \tag{E.14}$$

$$z_t^N h_t = c_t^N \Delta_t^N \tag{E.15}$$

$$\Delta_t^N = \theta_N \left(\frac{\pi_t^N}{\pi^{\mu_N}}\right)^{\epsilon_N} \Delta_{t-1}^N + (1-\theta_N)\tilde{p}_t^{N^{-\epsilon_N}} \tag{E.16}$$

$$c_t = y_t^c \tag{E.17}$$

$$tb_t = tot_t y_t^X - c_t^F \tag{E.18}$$

$$y_t = c_t + y_t^X - c_t^F \tag{E.19}$$

$$p_t^Y = \frac{c_t + rer_t tb_t}{y_t} \tag{E.20}$$

$$rer_t = p_t^F \tag{E.21}$$

$$\frac{p_t^N}{p_{t-1}^N} = \frac{\pi_t^N}{\pi_t} \tag{E.22}$$

$$\frac{rer_t}{rer_{t-1}} = \frac{\pi_t^s \pi_t^*}{\pi_t} \tag{E.23}$$

$$\pi_t^F = \pi_t^s \pi_t^* \tag{E.24}$$

$$\Delta M_t = \frac{m_t}{m_{t-1}} \pi_t \tag{E.25}$$

$$R_t^* = R_t^W exp\{\phi(d_t^* - \bar{d})\} \tag{E.26}$$

$$\frac{R_{t-1}^*}{\pi_t^*} d_{t-1}^* = d_t^* + tot_t y_t^X - c_t^F \tag{E.27}$$

A.2 Exportable Goods Requiring Labor

Households

$$c_t^{-\sigma} = (1 + \mu_t \kappa)\lambda_t \tag{E.1}$$

$$\chi h_t^{\varphi} = \lambda_t w_t \tag{E.2}$$

$$\lambda_t = \beta R_t^* E_t \left\{ \frac{\lambda_{t+1} \pi_{t+1}^s}{\pi_{t+1}} \right\} \tag{E.3}$$

$$\lambda_t = \beta R_t E_t \left\{ \frac{\lambda_{t+1}}{\pi_{t+1}} \right\} \tag{E.4}$$

$$m_t = \kappa c_t \tag{E.5}$$

Firms

$$y_t^C = \left[\omega^{1/\eta} (c_t^N)^{1-(1/\eta)} + (1-\omega)^{1/\eta} (c_t^F)^{1-(1/\eta)} \right]^{\frac{\eta}{\eta-1}} \tag{E.6}$$

$$c_t^F = (1-\omega)(p_t^F)^{-\eta} y_t^c \tag{E.7}$$

$$c_t^N = \omega (p_t^N)^{-\eta} y_t^c \tag{E.8}$$

$$p_t^N mc_t^N z_t^N = w_t \tag{E.9}$$

$$f_t^{1N} = (\tilde{p}_t^N)^{1-\epsilon_N} y_t^N \left(\frac{\epsilon_N - 1}{\epsilon_N} \right) + \theta_N E_t \left\{ r_{t,t+1} \left(\frac{\tilde{p}_t^N \pi^{\mu_N}}{\tilde{p}_{t+1}^N} \right)^{1-\epsilon_N} (\pi_{t+1}^N)^{\epsilon_N} f_{t+1}^{1N} \right\} \tag{E.10}$$

$$f_t^{2N} = (\tilde{p}_t^N)^{-\epsilon_N} y_t^N mc_t^N + \theta_N E_t \left\{ r_{t,t+1} \left(\frac{\tilde{p}_t^N \pi^{\mu_N}}{\tilde{p}_{t+1}^N} \right)^{-\epsilon_N} (\pi_{t+1}^N)^{1+\epsilon_N} f_{t+1}^{2N} \right\} \tag{E.11}$$

$$f_t^{1N} = f_t^{2N} \tag{E.12}$$

$$1 = \theta_N \left(\frac{\pi_t^N}{\pi^{\mu_N}} \right)^{\epsilon_N - 1} + (1-\theta_N)(\tilde{p}_t^N)^{1-\epsilon_N} \tag{E.13}$$

Aggregation and Market Clearing

$$y_t^N = c_t^N \tag{E.14}$$

$$z_t^N h_t = c_t^N \Delta_t^N \tag{E.15}$$

$$\Delta_t^N = \theta_N \left(\frac{\pi_t^N}{\pi^{\mu_N}} \right)^{\epsilon_N} \Delta_{t-1}^N + (1-\theta_N)\tilde{p}_t^{N-\epsilon_N} \tag{E.16}$$

$$c_t = y_t^c \tag{E.17}$$

$$tb_t = tot_t z_t^X \ (h_t^X)^{\alpha_X} - c_t^F \tag{E.18}$$

$$y_t = c_t + z_t^X \ (h_t^X)^{\alpha_X} - c_t^F \tag{E.19}$$

$$p_t^Y = \frac{c_t + rer_t tb_t}{y_t} \tag{E.20}$$

$$rer_t = p_t^F \tag{E.21}$$

$$\frac{p_t^N}{p_{t-1}^N} = \frac{\pi_t^N}{\pi_t} \tag{E.22}$$

$$\frac{rer_t}{rer_{t-1}} = \frac{\pi_t^s \pi_t^*}{\pi_t} \tag{E.23}$$

$$\pi_t^F = \pi_t^s \pi_t^* \tag{E.24}$$

$$\Delta M_t = \frac{m_t}{m_{t-1}} \pi_t \tag{E.25}$$

$$R_t^* = R_t^W exp\{\phi(d_t^* - \bar{d})\} \tag{E.26}$$

$$\frac{R_{t-1}^*}{\pi_t^*} d_{t-1}^* = d_t^* + tot_t y_t^X - c_t^F \tag{E.27}$$

$$h_t^X + h_t^N = h_t \tag{E.28}$$

$$h_t^X = \left(\frac{w}{\alpha_X rer_t tot_t z_t^X} \right)^{\alpha_X - 1} \tag{E.29}$$

A.3 Sticky Wages

Households

$$c_t^{-\sigma} = (1 + \xi_t \kappa)\lambda_t \tag{E.1}$$

$$\chi(h_t)^{\varphi} = \lambda \; w_t \; mc_t^W \tag{E.2}$$

$$\lambda_t = \beta R_t^* E_t \left\{ \frac{\lambda_{t+1} \pi_{t+1}^s}{\pi_{t+1}} \right\} \tag{E.3}$$

$$\lambda_t = \beta R_t E_t \left\{ \frac{\lambda_{t+1}}{\pi_{t+1}} \right\} \tag{E.4}$$

$$m_t = \kappa c_t \tag{E.5}$$

Firms

$$y_t^C = \left[\omega^{1/\eta} (c_t^N)^{1-(1/\eta)} + (1-\omega)^{1/\eta} (c_t^F)^{1-(1/\eta)} \right]^{\frac{\eta}{\eta-1}} \tag{E.6}$$

$$c_t^F = (1-\omega)(p_t^F)^{-\eta} y_t^c \tag{E.7}$$

$$c_t^N = \omega (p_t^N)^{-\eta} y_t^c \tag{E.8}$$

$$p_t^N mc_t^N z_t^N = w_t \tag{E.9}$$

$$f_t^{1N} = (\tilde{p}_t^N)^{1-\epsilon_N} y_t^N \left(\frac{\epsilon_N - 1}{\epsilon_N} \right) + \theta_N E_t \left\{ r_{t,t+1} \left(\frac{\tilde{p}_t^N \pi^{\mu_N}}{\tilde{p}_{t+1}^N} \right)^{1-\epsilon_N} (\pi_{t+1}^N)^{\epsilon_N} f_{t+1}^{1N} \right\} \tag{E.10}$$

$$f_t^{2N} = (\tilde{p}_t^N)^{-\epsilon_N} y_t^N mc_t^N + \theta_N E_t \left\{ r_{t,t+1} \left(\frac{\tilde{p}_t^N \pi^{\mu_N}}{\tilde{p}_{t+1}^N} \right)^{-\epsilon_N} (\pi_{t+1}^N)^{1+\epsilon_N} f_{t+1}^{2N} \right\} \tag{E.11}$$

$$f_t^{1N} = f_t^{2N} \tag{E.12}$$

$$1 = \theta_N \left(\frac{\pi_t^N}{\pi^{\mu_N}} \right)^{\epsilon_N - 1} + (1-\theta_N)(\tilde{p}_t^N)^{1-\epsilon_N} \tag{E.13}$$

Aggregation and Market Clearing

$$y_t^N = c_t^N \tag{E.14}$$

$$z_t^N h_t = c_t^N \Delta_t^N \tag{E.15}$$

$$\Delta_t^N = \theta_N \left(\frac{\pi_t^N}{\pi^{\mu_N}} \right)^{\epsilon_N} \Delta_{t-1}^N + (1-\theta_N) \tilde{p}_t^{N^{-\epsilon_N}} \tag{E.16}$$

$$c_t = y_t^c \tag{E.17}$$

$$tb_t = tot_t y_t^X - c_t^F \tag{E.18}$$

$$y_t = c_t + y_t^X - c_t^F \tag{E.19}$$

$$p_t^Y = \frac{c_t + rer_t tb_t}{y_t} \tag{E.20}$$

$$rer_t = p_t^F \tag{E.21}$$

$$\frac{p_t^N}{p_{t-1}^N} = \frac{\pi_t^N}{\pi_t} \tag{E.22}$$

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$$\pi_t^F = \pi_t^s \pi_t^* \tag{E.24}$$

$$\Delta M_t = \frac{m_t}{m_{t-1}} \pi_t \tag{E.25}$$

$$R_t^* = R_t^W exp\{\phi(d_t^* - \bar{d})\} \tag{E.26}$$

$$\frac{R_{t-1}^*}{\pi_t^*} d_{t-1}^* = d_t^* + tot_t y_t^X - c_t^F \tag{E.27}$$

$$f_t^{1W} = \tilde{w}_t{}^{1-\epsilon_W}\ h_t \left(\frac{\epsilon_W - 1}{\epsilon_W}\right) + \theta_W\ \beta E \left\{ \frac{\lambda_{t+1}}{\lambda_t \pi_{t+1}} \left(\frac{\tilde{w}_t\ (\pi^{IW})^{\mu_N}}{\tilde{w}_{t+1}}\right)^{(1-\epsilon_W)} (\pi_{t+1}^W)^{\epsilon_W}\ f_{t+1}^{1W} \right\} \tag{E.28}$$

$$f_t^{2W} = \tilde{w}_t{}^{-\epsilon_W} h_t mc_t^W + \theta_W \beta E \left\{ \frac{\lambda_{t+1}}{\lambda_t \pi_t} \left(\frac{\tilde{w}_t (\pi^{IW})^{\mu_N}}{\tilde{w}_{t+1}}\right)^{-\epsilon_W} (\pi_{t+1}^W)^{\epsilon_W + 1} f_{t+1}^{2W} \right\} \tag{E.29}$$

$$f_t^{1W} = f_t^{2W} \tag{E.30}$$

$$1 = \theta_W \left(\frac{\pi_t^W}{(\pi_t^{IW})_N^{\mu}}\right)^{\epsilon_W - 1} + (1 - \theta_W)(\tilde{w}_t)^{1-\epsilon_W} \tag{E.31}$$

$$h_t^o = \Delta_t^W h_t \tag{E.32}$$

$$\Delta_t^W = \theta_W \left(\frac{\pi_t^W}{(\pi_t^{IW})^{\mu_N}}\right)^{\epsilon_W} \Delta_{t-1}^W + (1 - \theta_W)(\tilde{w}_t)^{-\epsilon_W} \tag{E.33}$$