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27 January 2021

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January 27, 2021

Abstract

Changes in prices and especially in aggregate price levels are subjected to complex dynamics and extreme endogeneity, as expectations, current conditions, policies, and the rules of the game combine to form inflationary outcomes. This paper explores how inflationary expectations are set – and limited – via an exploration of the role of institutions in corralling expectations. Using a continuous time formulation of the second derivative of the price level, we introduce expectations and institutional related variables to understand how expectations can become unstable. Testing the model on monthly institutional and macroeconomic data for several countries, we find that one institution in particular, property rights, keeps inflationary expectations in check and stops high inflation from becoming hyperinflation. In a situation where property rights have broken down, however, expectations are allowed to roam free and quickly become unstable.

Keywords: Institutions; property rights; expectations; inflation

JEL Classification: E02, E31, E42, E52

1 Introduction

The study of hyperinflations, a subject of great interest in the 1980s alongside then-occurring episodes in Latin America, has lain dormant for several years as the world moved towards predictable and stable inflationary paths. This does not mean that hyperinflation has not disappeared as a monetary phenomenon, as both Venezuela and Zimbabwe (twice) over the past 15 years have experienced hyperinflations according to the classic Cagan (1956) definition of inflation increases greater than 50% a month. But an already rare phenomenon – Hanke et al. (2020) note that there have been 60 episodes of hyperinflation globally, including repeat offenders such as Hungary and Zimbabwe – has grown increasingly rare from its two heydays in the 1920s-30s and 1980-90s.

Indeed, it is perhaps a paradox why *more* hyperinflations have not occurred, especially in the previous decade. With the extraordinary shocks of the global financial crisis and its ensuing quantitative avalanche from central banks, the rise of populism and revival of socialist ideas around the world, and the ongoing COVID-19 pandemic pushing budgets to the brink, the specter of hyperinflation (narrowly limited to price indexes or exchange rates) appears to be lurking in the shadows. And yet, hyperinflationary pressures (at least at the time of this writing) have not materialized.

Canonical models of hyperinflation (Cagan, 1956; Olivera, 1967b, 1967a; Sargent & Wallace, 1973; Christiano, 1987; Marcet & Sargent, 1989) would trace this state of affairs to inflationary expectations, noting that expectations, whether rational, adaptive, or subjected to least-squares learning, are the key to understanding when high inflation rockets to a hyperinflationary state. In classical terms, inflationary expectations, shaped by prior period inflationary paths, feed into both money balance decisions and the policies of a central bank, forcing prices higher and, subsequently, expectations higher as well. If expectations of future inflation are tame or slow to adapt, this upward spiral can be avoided, and merely high inflation emerges as a stable path rather than hyperinflation.

This explanation for the absence of hyperinflation is also unsatisfying, however, as the big question is thus, what can serve to dampen expectations? Taking place in a money demand framework, and often using atheoretical econometric tools, these canonical models fashion expectation formation as a function of previous experience and forward-looking forecasts, carefully filtered through a narrow set of macroeconomic determinants. Work has been extended beyond these parsimonious determinants to include behavioral and psychological biases into these models, with papers such as Capistran and Timmerman (2009) noting the presence of asymmetric loss functions and Cavallo et al.(2017) noting that weighting of inflationary expectations are heavily biased in favor of one's own personal experience. However, as Yellen (2017, p.197) noted, "our framework for understanding inflation dynamics could be misspecified in some fundamental way, perhaps because our econometric models overlook some factor that will restrain inflation in coming years."

We assert that the overlooked factor in restraining inflation is a country's incentive structure, in particular the fundamental role that country-level institutions would have in shaping expectations. Put another way, if institutions are the creatures which mediate incentives in an economy and shape "the rules of the game" (North, 1990), they must have a part to play in the formation of expectations regarding inflation. In a country with strong property rights, for example, the idea of hyperinflation could be unthinkable, where in a country rife with expropriation and a corrupt judiciary, hyperinflation might actually be much easier to fathom (or actually be expected)[1].

This paper builds on recent work (Hartwell, 2018, 2019) examining the interplay between economic and political institutions and hyperinflation and extends it to further explore precisely these interactions of monetary policy, institutional development, and expectations formation. Unlike these earlier papers, which dealt with the effects of monetary policy on the development of new and untested institutions, this paper looks explicitly at established institutional orders and their implications for inflationary expectations – and what happens when these institutions degrade. It is our assertion that institutions act as a corral for inflationary expectations, keeping them within certain boundaries during "normal" monetary policy. While the bounds of the corral may expand or shift over time, for the most part, the shepherding effect of institutions is what may allow for the avoidance of hyperinflation, setting expectational bounds and even encouraging rational inattention to small price movements. However, if institutions are subjected to a sustained assault by a political leader or party, then the removal of existing economic institutions also removes the boundaries for expectations; alternately, institutions need not be attacked directly, as in the current wave of populism, but may erode over time, akin to an iceberg showing cracks and generating a feedback loop which results in more cracks and more degradation. In either case, the loss of existing institutions, unmoored from previous experience and without the guardrails of stable institutions, may cause expectations to feed in on themselves and lead to hyperinflationary spirals.

The centerpiece of this paper is a new model fashioned on one of these canonical examinations of the effect of expectations in hyperinflation, that of Olivera (1967a, 1967b), building on this with insights from more recent physics-based modelling on the dynamics of hyperinflations (Mizuno, Takayasu, & Takayasu, 2002; Szybisz & Szybisz, 2009, 2017; Sornette, Takayasu, & Zhou, 2003). The model examines how institutional instability, arising from political targeting of a previous institutional order which was good for growth, leads to unbounded inflationary expectations, bereft of any reference points. In particular, property rights, by creating a complex contract network (Leijonhufvud & Heymann, 1995), help to hold inflationary expectations in check (Sornette et al., 2003), but the breakdown of contract enforcement can precipitate uncertainty around monetary institutions (Carare & Stone, 2006) and cause a fundamental reassessment of expectations. In this atmosphere, we surmise, it is much easier to break through to the situation of monetary instability noted by Olivera (1967a, 1967b) than to remain on a high inflation – but not hyperinflationary – path.

The channel via which this operates is a mismatch in informational frequency, as agents tend to perceive and act on higher frequency information (i.e. the inflation rate), rather than examining the slower-moving information regard-

[1] Cavallo et al. (2017) actually allude to an effect such as this, noting that environments of weak inflation cause rational inattention to price changes; basically, that if things have been good in the past, as a product of institutions, policies, and the like, there is little need to update one's priors and so expectations remain low.

ing institutional change. In a structure dominated by endogeneity, the limits of institutions may not be clear, leading to the temptation to assign the causes of hyperinflation to short term variables like expectations, interest rates, and money quantities among others. Policymakers then focus on short term policies to cope with inflation, not realizing that a feedback loop has already been set in motion from institutional degradation to inflationary expectations to more hyperinflation and more institutional degradation in the manner of Hartwell (2018).

We confirm the results of this model with an econometric exercise, performing a vector error correction model which uses monthly data to find the parameter that links monetary, expectational, institutional variables with the CPI. With this data we are able to solve the differential equation that arise from solving the model. We work with a broad set of countries some of who have experienced either high or hyperinflation, and focusing on property rights as the key economic institution of interest. Our results show that property rights do indeed matter highly for corralling inflationary expectations. Our results show that the model provides a framework which is able to give insights for cases Argentina and Venezuela, high inflation countries; Japan, low inflation; UK and US, advanced economies with no experience of hyperinflation; and Poland, transition economy with experience of hyperinflation.

In sum, institutions are crucial for understanding why hyperinflation does – and does not – occur.

2 Literature Review and Theory

The extant literature exploring the behavior of money, money demand, and expectations under hyperinflation is, in some sense, derived almost entirely from Cagan's (1956) canonical work, with its reliance on the quantity theory of money. The Cagan model was essentially a model of money demand with an emphasis on inflationary expectations as the determinant of real cash balances; formalized in 2.1 where M represent a measure of money, P a measure of prices, π_e represents the expected rate of change in prices, assumed to be a function of the actual rate of change and γ which is a constant.

$$log\left(\frac{M}{P}\right) = \gamma - \pi_e \tag{2.1}$$

Building on this basic relationship, Sargent and Wallace (1973) also incorporated income as a determinant of real money demand (attributing it to Cagan but which was absent from Cagan's model):

$$log\left(\frac{M_t}{P_t}\right) = \alpha\pi_{e,t} + \gamma Y + \Phi + u_t \tag{2.2}$$

Where, like in the Cagan model, the α is a negative number to show the inverse relationship between expectations of inflation (shown here as $\pi_{e,t}$) and money demand, γ is a necessarily positive parameter showing the relationship between income Y and money balances, Φ is a parameter and u_t is a stochastic variable centered on zero. As can be seen by these early models, expectations were the fundamental driver of early models. Cagan (1956) posited changes in expectations dependent on a "coefficient of expectations" (i.e. the elasticity of expectations) versus the gap between observed prices π and expectations 2.3.

$$\frac{d\pi}{dt} = \beta(\pi - \pi_e) \tag{2.3}$$

In the extended Sargent and Wallace (1973) version of Cagan, this meant that expectations were a distributed lag of current and past actual rates of inflation, one with geometrically declining lag weights with $X_t = log\left(\frac{P_t}{P_{t-1}}\right)$ and $0 \geq \lambda > 1$:

$$log\left(\frac{M_t}{P_t}\right) = \alpha(1-\lambda)\sum_{i=0}^{\infty}\lambda^i X_{t-1} + \gamma Y + \Phi + u_t \tag{2.4}$$

The key issue of these early papers, and which dominated the 1970s, was the manner in which agents revised their expectations regarding inflation and especially what form such a learning function took during hyperinflationary episodes. As shown in Equation 2.4, the Cagan model assumed that inflationary expectations were adaptive, in that actors formed shifting expectations of future price movements on the basis of observed current and previous price movements. Sargent and Wallace (1973) asserted that Cagan's adaptive expectations were actually rational expectations (in the sense that agents did not have to continually deceive themselves), as inflation Granger-caused money creation but not the other way around; this was contingent on avoiding the least squares approach of estimation of expectations that Cagan utilized, as the autoregressive tendencies of expectations would have made Equation 2.4 inconsistent.

These assumptions of adaptive-but-rational expectations appeared to be somewhat problematic in a dynamic and rapidly-unfolding situation, especially given the feedback loop between subsequent inflation and expectations. In particular, these early models assumed a stable money demand functions throughout the hyperinflation, an approach which was criticized first by Jacobs (1975), who used the original models of Cagan, Barro (1970), and Allais (1966) to show that inflations could become self-generating.

In the first instance, the Cagan model and its successor variants had the assumption that money demand disturbances, manifested in shocks to velocity of money, followed a random walk, i.e. being non-stationary but with drift. Work undertaken in the 1990s showed that this was not in fact the case and that money balance and inflation were cointegrated, implying that velocity shocks were stationary (Engsted, 1993, 1994).

However, "stationary" does not mean "non-negligible," and Goodfriend (1982) showed that substantial velocity shocks a) could occur and b) would render the Cagan model problematic. A brief example, based on the quantity theory of money, can illustrate the problematic role of velocity shocks. Cagan (1956) uses a modified Cambridge version of the quantity money of theory, using $\frac{1}{k}$ instead of velocity, with k representing a constant of the proportionality of cash balances to real income. We can reinterpret Cagan using velocity more explicitly as:

$$\hat{m} + \hat{v} = \hat{p} + \hat{y} \tag{2.5}$$

In any interpretation, velocity can be expressed as a function of nominal interest rate:

$$\hat{v} = a(i) \tag{2.6}$$

While, by the Fisher equation

$$i = a(r) + b(\pi_e) \tag{2.7}$$

If we take Equation 2.5 and, for the sake of this exposition, normalize income to zero and then do the same for Equation 2.7 with regards to the real interest rate [2], the Cagan money demand formulation for the case of high inflation may be cast in the form of:

$$\hat{m} - \hat{p} = b(\pi_e) \tag{2.8}$$

Where $b(\pi^e)$ may have any form, including the formulations of Cagan (1956) or Sargent and Wallace (1973). As Equation 2.8 shows, velocity of money is embedded into money demand mainly through its relationship to inflationary expectations; if velocity of money is a function of nominal interest rates, which are then determined by inflationary expectations, changes in expectations could also influence velocity, feeding through to money balances. In this sense, velocity shocks could be substantial via various channels, reinforcing the explosive nature of hyperinflation. While velocity may have a long-term stability associated with various institutional arrangements (see Bordo et al. (1997) on the stability of velocity in advanced developed economies), in a short-term environment such as a country approaching hyperinflation, a velocity shock could be related to expectations and become highly unstable (with ramifications for the solution of any Cagan-type model). In a sense, the presence of non-negligible velocity shocks can also show that money demand is essentially non-linear in its form.

Indeed, this potentially explosive feedback of velocity and expectations is a product of non-linearities and dynamism not captured in more static models of hyperinflation.

Such a reality was already noted by Olivera (1967b, p.5), who stated that "the main consequence of introducing dynamic expectations into the previous schema is the possibility of ... if the rate of price-increase is pushed beyond this point by some exogenous disturbance, then (whatever the character of the impulse factor) the system becomes explosive and hyperinflation sets in." Additional work by Khan (1977) explicitly tackled the variability of expectations in

[2] These assumptions are made for ease of exposition, in reality neither need be zero, we can also assume that they take any constant or any functional form.

a hyperinflation, noting how higher levels of inflation variability would change the dynamic of expectations formation, altering the coefficient of expectations in Equation 2.3 (shown as β) from constant to variable. Friedman (1978) extended this work to critique both of the Cagan and Sargent-Wallace models as actually exhibiting instability in price generation, another blow to beliefs that money demand functions were stable in a hyperinflationary environment; if price generation itself is not a random walk model, how can expectations be formed based on prices which are then generated by a dynamically unstable process?

Work since the heyday of hyperinflations has been given impetus by new episodes in the 1990s (the former Yugoslavia) and the 2000s (Zimbabwe and Venezuela), returning to the idea of expectation formation and how this plays into money demand (and subsequent hyperinflationary paths). Much of this work continues to search for the elusive stable money demand function, with many pieces finding that the traditional semi-log function of Cagan fails to explain behavior during a hyperinflation, especially in its later stages (see especially Petrovic and Vujosevic (1996), Engsted (1998), and Sokic (2012)). In a similar vein, Ashworth and Evans (1998) tested a variety of non-traditional functional forms of money demand, finding that a strong case could be made for absolute inflation elasticity as a decreasing function of inflation (i.e. as inflation increases, elasticity decreases). Zhao (2017), examining the Chinese hyperinflation of 1945-48, also shows that the Cagan model of money demand is less effective than one exploring "perfect foresight" for understanding the path of inflation. Kostyshyna (2012) uses an adaptive model which, while similar in spirit to the Cagan model, shows how expectations based on a simple rule can also contribute to explosive hyperinflation, as well as the persistence of wary expectations after a hyperinflation has ended.

Throughout all of these models, however, the feedback loop regarding inflation, prices, and money demand is essentially a closed one, with reactions and expectations being determined solely by these attributes of the system (or, as in the Sargent-Wallance (1973) formulation, real income also playing a role). Olivera's (1967b) quote above, however, shows the perils of conceptualizing the process of expectations formation as a closed loop, as any shift from stability to instability must be the fault of "some exogenous disturbance." Expectations formation does not only rely on expectations regarding prices as some function of their past trend, but is also related to expectations regarding the monetary authority, the fiscal policies of current and future governments, the resilience of the economy to absorb extreme policies, and the ability of individual actors to protect their own wealth and income: in short, expectations need to be understood as generated within the overall institutional matrix of an economy.

Recent previous research has danced around this idea, mainly focused on the overall institutional environment as encapsulated in political institutions. As Sokic (2012, p.157) notes, the institutional framework is crucial for understanding the dynamics of expectations because "the institutional framework also may contribute to the essentiality of money for the transactions," a precondition for inflation to achieve an explosive path. Indeed, the political institutional matrix of a country creates monetary institutions and sets the legal and policy expectations for conduct of monetary policy, generating expectations via credibility and repeated interactions with the economy. Indeed, although political institutions can then be profoundly influenced by the course of monetary processes (Hartwell, 2018, 2019), from the start at least, political institutions set the "rules of the games" regarding money itself, effectively endogenizing the process of expectations formation via rendering money essential and excluding alternatives.

While political institutions may set the broader rules of the game regarding money and the broader expectations a polity may have regarding monetary policies, it is economic institutions which are the enforcers of the rules and which, in aggregate, set the bounds for expectations. The key economic institution, the central bank, is responsible for setting inflationary policies, thus influencing expectations, while additional economic institutions within the economy play substantial roles in price transmission and pass-through. As noted in the introduction, one of the most important economic institutions is property rights, thought of in the broad sense as contract enforcement and right of ownership, but in reality is a web of relationships (Leijonhufvud & Heymann, 1995) which buttresses multi-period interactions amongst individuals with no known pre-existing relationship. In an environment of strong property rights, inflationary expectations may be lower or delayed via this web of contracts, which assumes that inflation (as a deliberate policy of value destruction) is unlikely at high levels and which simultaneously guards against inflation via contractual mechanisms. Property rights also create competition within a society, and increased competition also keeps price increases to a minimum, once again generating a low baseline of inflationary expectations.

On the other hand, a country with low levels of property rights is likely to see a panoply of other economic and political distortions, and thus is likely to have a higher (and even unbounded) level of inflationary expectations. If one considers the seven major hyperinflations which Cagan (1956) examined, it is easy to make this connection, especially when one considers that hyperinflations came about as a chase for seignorage in order to expand government expenditures: for example, the Russian hyperinflation from 1921 to 1924 came under a period of Bolshevik consolidation of rule under communism, Greece's hyperinflation was driven by a profligate occupation authority, while Poland's, Germany's, Hungary's first, and Austria's hyperinflation around the same time was set by a new government overseeing massive subsidies at the beginning of a (re)new(ed) country (Hartwell, 2016). The largest hyperinflation in history, Hungary's second between 1945 and 1946 also occurred under the specter of communist takeover, in an environment where even public announcements of stabilization had little credibility (Paal, 2000).

Given this reality, it is plausible that stronger property rights may have a salutary effect on inflationary expectations by keeping them corralled within "acceptable" bounds. This could work directly via influence on expectations and indirectly via velocity, where institutions could both place boundaries on nominal interest rates and on overall velocity:

$$\hat{v} = \frac{a(i)}{f(\Lambda)} \tag{2.9}$$

where Λ is a measure of institutional strength.

Thus, with competitive pressures and contractual arrangements keeping time horizons longer, property rights may stave off encroaching hyperinflations by slowing inflationary expectations, leading to lower velocity and more willingness to hold cash. This may even hold in the longer-term, as in the case of Japan, where money created is still retained by agents in the economy because of an overall belief in the efficacy of economic institutions.

However, once the institution of property rights is removed – in many cases due precisely to profligate monetary policy (Koyama & Johnson, 2015; Hartwell, 2018) – these checks on expectations are also removed and inflationary expectations can be expected to set themselves on an explosive path. Indeed, what merely was a high inflation can then turn into the unstable hyperinflationary case of Olivera (1967b), where even concerted stabilization programs can have little success (as in Hungary, shown in Paal (2000), and in Bolivia, see Sachs (1986)). In such a situation, where time horizons are compressed fantastically and existing contractual arrangements have been destroyed, expectations are no longer reliant on institutional cues but instead are updated rapidly based on smaller and smaller information sets (Mladenović & Petrović, 2010). Money demand would asymptotically approach zero (never reaching zero because of the need for cash for some transaction and, more realistically, because of the strictures put in place by political institutions, such as payment of tax bills) and, as Kostyshyna (2012) showed, this lingering distrust of institutional cues can result in expectations remaining elevated for a time even after hyperinflation has been defeated. Once the (hyper)inflationary horse has been set free from its enclosed pasture, it is incredibly difficult to get it back into the corral.

3 The assumptions of the model

This section formalizes this hypothesis on the role of institutions in inflationary expectations by developing a model which links money and prices, expectations, and institutional strength. Our model explicitly includes property rights as the basis by which agents form expectations, which then translate into inflationary performance. The model is based on Olivera (1967a) but extends it to incorporate both the insights of standard (hyper)inflationary models and the role of institutions in expectations formation. At its heart, like with other (hyper)inflationary models, is a set of monetary relations, linked to money demand.

3.1 Monetary model

Monetary imbalances may be cast in the form (see appendix A for a deduction):

$$\Gamma = \frac{\sigma - \delta}{\epsilon + \eta} \tag{3.1}$$

where the price dynamics depending on monetary sector factors depends explicitly on the situation of demand and supply of the monetary sector;$\epsilon = \frac{\partial D_t}{\partial P_t}\frac{P_t}{S_t}$ is the price demand elasticity of the good (money), $\eta = \frac{\partial S_t}{\partial P_t}\frac{P_t}{S_t}$ is the price supply elasticity of the good (money), $\delta = \frac{1}{S_t}\frac{\partial D_t}{\partial t}$, is the demand rate of growth of the good (money) and $\sigma = \frac{1}{S_t}\frac{\partial S_t}{\partial t}$ is the supply rate of growth of the good (money).

Equation 3.1 shows the dependencies of the variables of the monetary sector for which price evolution is defined (note that taking the elasticities $\epsilon+\eta$ expands the possible range of applications given by standard monetary theories, as in Equation 2.5).

Of course, prices may move not only because of monetary dynamics. Relative prices changes due to switches in technology, costumers needs or wants in an institutional framework are also an important sources of price dynamics. Indeed, these relative price changes may not be done by lowering the price of the less wanted or needed product; adjustment could come from higher prices of the more sought goods. As simple way to incorporate other motives of price changes is to sum a factor $\pi_{f,t}$ to the imbalances of the monetary sector given by Equation 3.1. In any event, allowing this term also points to the expansion of the possibilities of the velocity equation 2.5.

3.2 A tale of two values

The relation between money quantity and price changes (and economic activity), as stated in sections 1 and 2 expressed in Equation 2.5, has been challenged in many ways. As early as 1970, in the context of a simple IS LM model, Pool (1970) shows that the choice between interest rate and money quantity depends on stability of the good and services sector vs the monetary one; hence, it is not possible to use (only) a monetary aggregate for policy proposes (to control prices or output); or to explain the dynamic path of an economy. Furthermore, money demand instability does not allow a direct check of prices by controlling M (as stable money demand broke down in the 1970s, see (Goldfeld, Fand, & Brainard, 1976; Woodford, 2011; Galí & Gertler, 2007)).

In terms of microeconomic incentives, in this formalization, agents are attentive of future price variations which is equivalent to assume that these changes affect their welfare. In particular, different future price paths change the money demand of the agent and she would need to adjust to that. We do not use any of the usual expectations schemes[3], rather we assume that a change in the interest

[3]In his standard form, rational expectations have been criticized because they imply learning impossibility (agents essentially works with the relevant economic theory), the incorporation of future policy shocks should be done from the outset. Also, the common knowledge proposition implies that agents need not only to know their own model, but they also believe (know) that all other agents use the same model (Woodford, 2013). Information is not a free good (see below).

in inflation may lead to changes in prices. Agents invest more time to investigate inflation when changes in inflation may appear. In this sense, expectations are prospective, but not necessarily rational and uncertainty is present.

Information is a valuable good for financial markets but one which brings its own costs in collection, meaning that agents must perceive some value from various forms of information in order to seek it out (Grossman & Stiglitz, 1980). Bernanke (1983) argues that, if investments are irreversible, information is valuable since it allows to calculate expected returns more accurately, the more uncertainty the more valuable information is. Ritter (2003) states that, even with asset misvaluation, investors may avoid the market, due the risk that the price may take a long time to correct. With this background, it is possible to propose that agents may gather information of issues that affect their economic decisions, in particular prices changes. We express this interest in information gathering (data interest) as $D_{e,t}$. We assume that it will be related positively to price changes; the more prices change, the more interest (information gathering) on price changes we can expect.

Wicksell (1922) shows that a higher use of "credit" diminishes the necessity of base money use (M_0), increasing the amount of other money measures such as M_2 or M_3. Technological innovations (Judd & Scadding, 1982) are another source of lower use of M_0 or M_1, although not in a way that allow a predictable relation between money supply and demand. Finally, the complex contract network and use of money alluded in section 1 develops in a framework which is necessarily structured by institutions. These institutions guarantee (in different degrees) private property, as shown in section 2 (in many ways, this is similar to Sornette et. al. (2003), who mention explicitly that prices are affected by institutions, but their model focuses on the nature of the time trajectory and does not formalize institutional variables) and condition the use and demand for money. Indeed, money has been used as a measure of respect of property rights (a core institution), with the objective metric of property rights proposed by Clague et al. (Clague, Keefer, Knack, & Olson, 1996), "contract-intensive money," capturing the amount of money inside the formal banking sector as a percentage of all money.

Based on the preceding theory and evidence, we would expect that stronger institutions tend to be related to higher amounts of money holdings, when money amount is measured as M_2 or M_3. We use Λ to represent the condition of institutions; as they tend to elevate money holdings or equivalently to lower money velocity (see below) in terms of Equation 2.5 or, alternately, slowing down price adjustments at higher levels. In this sense, institutions truly corral price changes. Put into a generalization of Olivera's model (1967a)[4], this would appear as

$$\pi_{m,t} = \Gamma + \pi_{f,t} \tag{3.2}$$

where we define a "pure monetary inflation" $\pi_{m,t}$ (PMI) and a "institutional feedback inflation" $\pi_{f,t}$ (IFI).

[4]Olivera works with only two sectors, agricultural and industrial.

Further, suppose

$$\left(\frac{\hat{D_{e,t}}}{\Lambda}\right)_t = \psi \pi_{m,t-\Delta t}, \tag{3.3}$$

where $D_{e,t}$ represents a measure of expectations for future price changes and where Λ express the perceived effectiveness (strength) of the institutional framework.

Parameter ψ defines the adjustment sensibility of expectations and institutions $\left(\frac{\hat{D_{e,t}}}{\Lambda}\right)_t$ to $\pi_{m,t-\Delta t}$.

Finally, prices changes $\pi_{f,t}$ may be cast in the form

$$\pi_{f,t} = \phi \left(\frac{\hat{D_{e,t}}}{\Lambda}\right)_t \tag{3.4}$$

which leads to define A as:

$$A = \phi\psi \tag{3.5}$$

linking $\pi_{f,t}$ and $\pi_{m,t-\Delta t}$ via A through

$$\pi_{f,t} = A\pi_{m,t-\Delta t} \tag{3.6}$$

Plugging Equation 3.3 into Equation 3.4 and replacing the result in Equation 3.2 for approximations m and f lead to Equation 3.7.

A pure monetary inflation would thus be

$$\pi_{m,t} = \Gamma + A\pi_{m,t-\Delta t} \tag{3.7}$$

whereas by taking into account the other factors it would lead for f,

$$\pi_{f,t} = A\Gamma + A\pi_{f,t-\Delta t} \tag{3.8}$$

Additionally, in terms of the original formulation of Olivera given by Equation 3.2, $\pi_{f,t}$ is a measure of relative price changes; with no changes in the amount of money and/or real income, higher relative prices implies an effect in the same direction as higher velocity in terms of Equation 2.5. However, it only implies the same direction of change and not the same magnitude, because of differing elasticities and especially due to the parameter A.

Furthermore, we are able to explicitly link this formulation to the quantity theory of money. Note that by setting $\epsilon + \eta = 1$, $\delta = \hat{y}$, $\sigma = \hat{m}$, $A = 1$ and $A\pi_{f,t-\Delta t} = \hat{v}$ we recover Equation 2.5. Indeed, velocity in the quantity theory cited in section 2 has among its possible determinants interest rates and inflation, as showed by Cagan, and credit availability (Wicksell (1922)); technological transformations with an impact on velocity also have an influence, especially with regard to expectations of institutional strength as stated above.

3.3 Solutions

The link with the quantity equation shows that this formulation follows from earlier work on price movements but also is able to take into account further facts of the price formation process. Most important among these new attributes is the parameter A, which is a link between expectations and price formation, and which contributes as well to velocity. Indeed, a solution for the system depends on the assumption about what are the variables and parameters that constitute A and the time lags as seen in subsection 3.2.

The simplest case would be $\pi_{f,t} = A\pi_{m,t}$ in Equation 3.6, by replacing it in 3.7 leads to

$$\pi_{m,t} = \frac{\Gamma}{1-A}; \pi_{f,t} = \frac{A\Gamma}{1-A} \tag{3.9}$$

The original formulation of Olivera $\pi_{f,t} = A\pi_{m,t-\Delta t}$ leads in continuous time to

$$\frac{d\pi_{m,t}}{dt} + \frac{\pi_{m,t}}{2\Delta t} = \frac{\Gamma + A\pi_{m,t+\Delta t}}{2\Delta t} \tag{3.10}$$

As equation 3.10 may be cast in the form of a linear differential equation we get the solution:

$$\pi_{m,t} = \pi_{m,0} e^{\frac{-(t-t_0)}{2\Delta t}} - Be^{\frac{-(t-t_0)}{2\Delta t}} + B \tag{3.11}$$

with $B = \frac{\Gamma + A\pi_{m,t+\Delta t}}{2\Delta t}$,
and for f

$$\pi_{f,t} = \pi_{f,0} e^{\frac{-(t-t_0)}{2\Delta t}} - B_f e^{\frac{-(t-t_0)}{2\Delta t}} + B_f \tag{3.12}$$

with $B_f = \frac{A(\Gamma + \pi_{f,t+\Delta t})}{2\Delta t}$.

In Equations 3.11 and 3.12, $\pi_{m,t}$ and $\pi_{f,t}$ are defined in continuous time. We can see that both Equations 3.11 and 3.12 converge to B and B_f. The difference of both solutions is that for B_f the monetary sector formulation is also affected by A.

Note that $\frac{d\pi_{f,t}}{d\pi_{m,t-\Delta t}} = A$ says that A is the rate of change in inflation due to changes in monetary inflation; the greater the imbalances of money measured by Γ and in $\pi_{f,t-\Delta t}$, the greater the f inflation.

The difference between Equations 3.11 and 3.12 is that in Equation 3.12 A affects the entire B_f whereas for B; Γ is not affected by A. In this context, an agent may choose between a inflation projection in which they assume that A does not affect the monetary model(B) and one in which the entire price changing structure is affected by A, (B_f). The clue of this differentiation lies in the extent to which monetary conditions, restrictions, and decisions are independent of both prevailing institutions and the interest in agents in gathering information (about inflation in our case), i.e., whether or not searching out information regarding inflation is regarded as useful or necessary.

In B_f a feedback loop develops; as changes in the monetary structure affects the general process of price formation (including relative price changes), and this general process feedback it changes to the monetary structure. In other words, the difference between B_f and B shows the believe in (is a measure of) the independence of the monetary structure from the rest of price dynamics.

This model has some significant differences with the original Olivera (1967a) formulation, as we are working in continuous time taking the continuous limit of the difference of inflation. Additionally, we are not working with two sectors, rather instead we have included two expressions of possible inflation: in our solution, we can see the *expected* inflation rate and our parameter A is constructed with expectations and institutions as the links for price formation, while in the original, inflation was driven by wage and profit variations. Finally, our work extends the formal framework of (Olivera, 1967a) using the second continuous time derivative in order to reach a solution.

4 The Quest for A

Undoubtedly, the most important aspect of our model is to understand the role of A, the institutional measure. This requires the use of a methodology that allows us to isolate the contribution of institutions in the long run. A vector error-correction model (VECM) is suitable for this, as it allows us to understand both the short-run relationships and long-term dynamics among institutions, prices, and inflation. While the VECM model is atheoretical in its assumptions, it utilized here to capture first the endogeneity of all of the variables in a complex economic system, and second, to deal with the reality that many of the variables of interest are non-stationary but can exhibit cointegration. To explore the possibility of cointegration[5] in our data, we use the Johansen test (Johansen, 1988, 1991).

For the test we use

$$y_t = F_1 y_{t-1} + F2 y_{t-2} + ... + Fp y_{t-p} + G x_t + u_t \tag{4.1}$$

where y_t is a vector of $I(1)$ non-stationary variables, x_t is a vector of deterministic variables suchlike constant, trend, seasonals or intervention dummies and u_t are innovations.

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Upsilon_i \Delta y_{t-1} + G x_t + u_t \tag{4.2}$$

where

$$\Delta y_t = \Pi = \sum_{i=1}^{p} A_i - I, \Upsilon_i = - \sum_{j=i+1}^{p} A_j \tag{4.3}$$

[5]Two by two as indicated later in this section.

we use the case for which the variables have trends and the cointegrating Equation have only intercept.

$$\Pi y_{t-1} + Gx_t = \eta(\beta' y_{t-1} + \rho_0) + \alpha_{\perp}\gamma_0 \tag{4.4}$$

Upon normalizing for $y_{1,t-1}$ we obtain the long term relation of one variable respect to the other;

$$y_{1,t-1} = \beta_2 y_{2,t-1} + \rho_0 + u_t \tag{4.5}$$

so we obtain for each country,

$$ln\left(\frac{D_{e,t}}{\Lambda}\right)_{t-1,est} = \beta_{m2,est} m2_{t-1} + \rho_0 + u_t \tag{4.6}$$

and,

$$cpi_{t-1} = \beta_{\frac{D_{e,t}}{\Lambda},est} ln\left(\frac{D_{e,t}}{\Lambda}\right)_{t-1,est} + \rho_0 + u_t \tag{4.7}$$

In order to utilize the VECM method, we have created a new monthly database of six countries, chosen precisely for their variegated experiences with inflation. In particular, we include Argentina, who has had a long-standing issue of elevated inflation levels, and, at the other end of the spectrum, Japan (De Michelis & Iacoviello, 2016), which has seen a continuous risk of deflation despite persistent quantitative easing. As two important examples of one particular set of institutional arrangements, the UK and the US are also included, while a country in transition (and with a history of hyperinflation), namely Poland, is utilized to show the impact of institutions in flux. Finally, we also use Venezuela, a country which continues to be plagued by hyperinflation. The data for each country runs from January 2012 to December 2019, subject to limits noted below. Utilizing Olivera (1967a), we employ M_2[6] as the variable that represent the monetary aggregate over which prices are formed. Friedman argues that the relation is direct (M. Friedman, 1969b), leading to the Chicago rule of a negative rate of money quantity growth equal to the positive real rate of interest (M. Friedman, 1969a). For the empirical examination, we use the log of M2 [7], CPI[8]. Following Section 3.2 above, we assume that the change in $\left(\frac{D_{e,t}}{\Lambda}\right)_{est}$ is

[6] $\pi_{m,t-\Delta t} \sim \hat{M}2_{t-\Delta t}$. Note that we state that these are proportional, not equal, compare Equations 2.5 and 3.4. In other words, saying that M_2 is the principal component of prices (changes) does not indicate that it is the only one.

[7] Data are retrieved from (Board of Governors of the Federal Reserve System (US), 2012-2019, (accessed July 15, 2020)), (Bank of England, 2012-2019, (accessed July 15, 2020)), (Bank of Japan, 2012-2019, (accessed July 15, 2020)), (Narodowy Bank Polski, 2012-2019, (accessed July 15, 2020)), (Banco Central de Argentina, 2012-2020, (accessed July 15, 2020)), (Banco Central de Venezuela, 2012-2019, (accessed July 15, 2020)b), monthly data in all cases, we use lowercase notation to indicate logarithm.

[8] Data sources are:(U.S. Bureau of Labor Statistics, 2012-2019, (accessed July 15, 2020); Office for National Statistics, 2012-2019, (accessed July 15, 2020); Portal Site of Official Statistics of Japan, 2012-2019, (accessed July 15, 2020); Główny Urząd Statystyczny, 2012-

related to the change of $m2_t$ as a proxy for "pure monetary" inflation, $\pi_{m,t}$, of which $m2_t$ is the proportional principal component as stated above. We further assume that $m2_t$ is the proportional principal component as stated in sections 1, 2 and 3) of Γ.

Importantly, $\left(\frac{D_{e,t}}{\Lambda}\right)_{est}$ [9] is utilized as a stand-in for $\frac{D_{e,t}}{\Lambda}$; as the reader recalls from Equation 3.3, the D parameter is a measure of data interest. Given the difficulty in seeing inflationary expectations in real-time (and the endogeneity issues which come with distilling expectations ex post), to fill this hole empirically we rely on real-time data derived from Google searches to understand where concerns are concentrated. For all countries, searches for "inflation" (in both local language and English) are used, apart from Venezuela, where we use Google searches for "dollar"[10]; for example, in the case of Poland, we use data on searches for the terms inflacja (inflation) as a proxy for inflationary expectations, based on the assumption that increased worries about inflation would manifest themselves in higher searches using these terms.

An example of this is shown in Figure 1, which shows the 6-month moving average of searches for "inflacja" charted against actual changes in the CPI in Poland year-on-year; as can be seen, while there is still some seasonality to the searches of agents, in general the number of searches around the term "inflation" predate or are coincident with actual increases in inflation (simultaneous searches and CPI changes are correlated at r = 0.4498, significant at the 0.001% level, while the lag of searches is correlated at 0.4589, also significant at the 0.001% level), making this a plausible proxy for real-time expectations.

To return to the role of institutions, the denominator in Equation 3.3, Λ, is an expression of the perceived effectiveness (strength) of the country's institutional framework. To model the institutional framework of a country, we have chosen an institutional variable with monthly coverage from the International Country Risk Guide (ICRG), their indicator of "financial risk" (FRR, or financial risk rating). The FRR (International Country Risk Guide, 2012-2019, (accessed July 15, 2020)) measure is generally used in the literature as a proxy for overall financial stability and/or probability of a financial crisis, but in this instance it is instead utilized as a crude proxy for overall property rights using the logic of Rajan (1998): that is, financial institutions themselves function as a form of property rights, especially in an incomplete contracting environment, and thus the overall financial stability or profligacy of a country can give a sense of the overall stance towards property rights.

As part of the empirical examination, we test each of these variables for structural breaks using a simple AR1 model, performing the Bai Perron (Bai & Perron, 1998) test in all cases. The breaking points that we found are consistent

2019, (accessed July 15, 2020); INDEC (Instituto Nacional de Estadísticas y Censo, 2012-2020, (accessed July 15, 2020); Banco Central de Venezuela, 2012-2019, (accessed July 15, 2020)a) for the US, UK, Japan, Poland, Argentina, Venezuela respectively, we use lowercase notation to indicate logarithm.

[9] We introduce the subindex *est* to indicate that the variable or parameter is an estimation.

[10] For the econometric analysis we utilize Eviews, while Excel is used for supplementary calculations. A 0.05 p-value is used, except explicitly indicated otherwise.

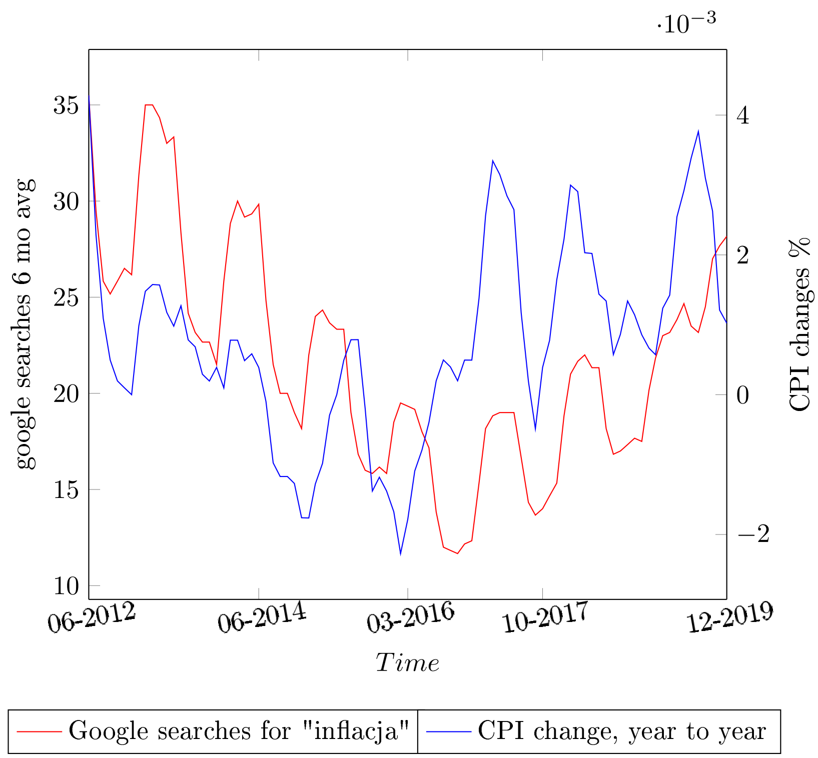

Figure 1: Google searches for inflation in Poland vs actual inflation. Data from Narodowy Bank Polski(NBP) and Google Analytics, author's calculations.

with those that may have been expected from a economic point of view, the 2015m04 Japan point (for $ln\left(\frac{D_{e,t}}{\Lambda}\right)_t$) may be linked to a slow recovery path and the effect of growing taxes from 2014m04, the 2017m02 for inflation in the UK corresponds nearly to the execution of the brexit mandate, the 2018m04 for Argentina (for $ln\left(\frac{D_{e,t}}{\Lambda}\right)_t$) variable is the date when Argentina went to the IMF due to a developing crisis. For the unit root test[11] we used an augmented Dickey-Fuller test. We confirm that the series are non-stationary but are stationary at their first differences.

Table 1 present the results for each country. We interpret the slopes of the long term Equation as the values that determines A by $\beta_{\frac{D_{e,t}}{\Lambda}}, \beta_{m2}$. Note that in the context of this work, we cannot strictly speak of long term cointegrations but rather the longest possible relations due to data constraints.

Table 1: Estimated ψ and ϕ for each country

Variable relations	US	Pl	Uk	Jp	Ar
Period	2012m01	2012m02	2017m02	2015m04	2018m04
	2019m12	2019m12	2019m12	2019m12	2020m02
ψ_{est}	0.3001	-0.7625	0.5660	-2.3431	1.799476
st dev	0.12261	0.32591	0.27123	0.58705	0.83023
t-student	2.44792	-2.33972	2.08683	-3.9914	2.16745
ϕ_{est}	0.610854	0.107655	-0.25439	-0.07192	-0.389382
st dev	0.11703	0.02678	0.04665	0.01185	0.13877
t-student	5.21959	4.01966	-5.45339	-6.06873	-2.80600
A_{est}	0.183337	-0.08209	-0.14399	0.168528	-0.6981

For the $\frac{D_{e,t}}{\Lambda} \leftrightarrow m2_t$ Uk relation we are able to take the entire period since only *cpi* has a breaking point at 2017m2.

Note that in the case of Venezuela, we work with the *dcpi* $dm2$, both indicating the difference of the log-variable with the log of $\left(\frac{D_{e,t}}{\Lambda}\right)_{t,est}$. The characteristic of data from 2017m6 onwards for Venezuela is not suitable for use, given data collection and accuracy issues.

Note that due to the structural breaks in the series have reduced data points, which may lead to a micronumerosity problem, especially for the Argentinean case. In this sense, the numerical results for Argentina and in a lesser degree for the other countries should be taken only as "possible operational approximations," given data constrains.

[11]For the sample space of each variable that are free of structural breaks.

Table 2: Venezuelan case

Variable relations	Ve
2012m01-2017m06	
ψ_{est}	4.8966
st dev	4.49423
t-student	1.08952
ϕ_{est}	0.248783
st dev	0.0487
t-student	5.10885
A	1.218183

4.1 Results and Simulations

Using the model from section 4, we are able to generate results. The $\hat{m}$-$\hat{y}$, the difference between money and real income growth, proxies $\sigma - \delta$ the imbalance of supply and demand of money. We use factual data for each period[12].

For the money model elasticities (supply and demand $\epsilon + \eta$) we use the data of Barro, MacCandless and Gertler (Barro, 1997; McCandless, Weber, et al., 1995; Gertler & Hofmann, 2018) all of which find that the elasticity lies between 0.6 for low inflation economies to 1 for high inflation ones. Based on this support, we use 0.6 for low inflation countries, 0.8 for Argentina and 1 for the case of hyperinflation (Venezuela). In some cases a non-zero elasticity of money supply may be taken in account, as the money supply reacts to prices, especially when it is needed to finance a public deficit (Sargent & Wallace, 1973). Indeed Patinkin[13] confirming that nominal money demand rises less than the price level. We expect therefore that the higher the growth of inflation the nearer the elasticity of money would be to one, since, in this case, money is used primarily only for transaction proposes. Additionally, agents have no mechanism to send a signal to the market of their lower power to buy goods.

[12] For real GDP changes, retrieved from Saint Louis FRED for each country, quarterly data (FRED using national sources, 2018-2019, (accessed December 18, 2020)), expect for Venezuela where we use data from IMF (annual data) (IMF Datamapper, 2015-2017, (accessed December 18, 2020)) and Argentina where we used INDEC data(INDEC (Argentina), 2018-2019, (accessed December 18, 2020)). Money data sources are the same as those cited in section 4.

[13] "There is a wealth effect generated by the resulting decline in the real value of his fixed initial money balances. This negative real balance effect causes the individual to decrease the amount he demand of various commodities. Thus an individual free of money illusion will definitively react to such a changes."

confirmed by Fischer

"An increase in the price level reduces real wealth and therefore the demand for real balances: accordingly, the demand for nominal balances will rise by less than the price level" (Fischer, 1993).

Wealth (income) variations due to inflation exacerbate the coordination problem triggered by the absence of the auctioneer (Leijonhufvud, 1969). Indeed, as we argue, the practical counterpart of the theoretical construction of the auctioneer may be found in institutions which provide stability to contracting frameworks, i.e., property rights.

To find the factor A we work with the VECM method showed in section 4.

The π_0 parameter is the initial inflation data whereas $\pi_{e,est}$ is the *expected* rate of change of prices which need to be set. Note that in the original formulation of Olivera (discrete time) expected data does not appear, but once we go to the continuous range we need to set it. To set $\pi_{e,est}$ we use a simplified method based on the theory of Sargent and Wallace of Equation 2.4[14].

Time is set at the date mentioned for each series, where ξ represents the sum of elasticities $\epsilon + \eta$ and time. Due to the number of parameters to calibrate the model, it should be suitable to work with the system as a General Computable Equilibrium model, in the sense of providing simulations more than an explicit forecast.

We calibrate the parameters as presented in table 3 to solve Equation 3.11. We use months as unit of time.

Table 3: Listed parameters for each country

Parameter								
	π_0	A_{est}	$\hat{m}$-$\hat{y}$	ξ_{est}	t_0	$\pi_{e,est}$	B_{est}	$B_{f,est}$
Us	-0.0006	0.18334	0.00269	0.6	2018m01	0.00106	0.00466	0.001014
Pl	0.0017	-0.0821	0.004	0.6	2018m01	0.00223	0.00643	-0.00073
Uk	0.0029	-0.14399	0.00169	0.6	2018m01	0.00256	0.00244	-0.0008
Jp	0.003	0.168523	0.00261	0.6	2018m01	0.00166	0.00463	0.001012
Ar	0.02314	-0.6981	0.03019	0.8	2018m04	0.02068	0.02331	-0.04079

In the following plots the blue line indicates what we have denominated "pure monetary inflation" and in red what we have designated "institutional feedback inflation", each line with error bars of the same color (see footnote 14).

The trajectories display the importance of the parameter A for the price changes path. For values of the parameter lower to one, which correspond to advanced economies (the cases of the US, UK and Japan) or transition economies like Poland; the combined force of a passive interest in prices, conditioned by strong institutions, implies that prices have a tendency to grow at lower rates

[14] We take an average of the last six data points and two standard deviation supposing a normal distribution as a measure of uncertainty, which is consistent with range reported by (Siklos, 2013; Coibion, Gorodnichenko, Kumar, & Pedemonte, 2020). Especially for the cases of Argentina and Venezuela shrinking time horizons may be taken in account (Leijonhufvud & Heymann, 1995). To be precise, it should be noted that the expectation formation method may be set in different ways, although, both the value to which inflation converge in both projections (PMI and IFI) and the confidence interval is compressed/expanded by the Value of the parameter A. This reflects the intuition that ranges of expectations are determined by institutional development.

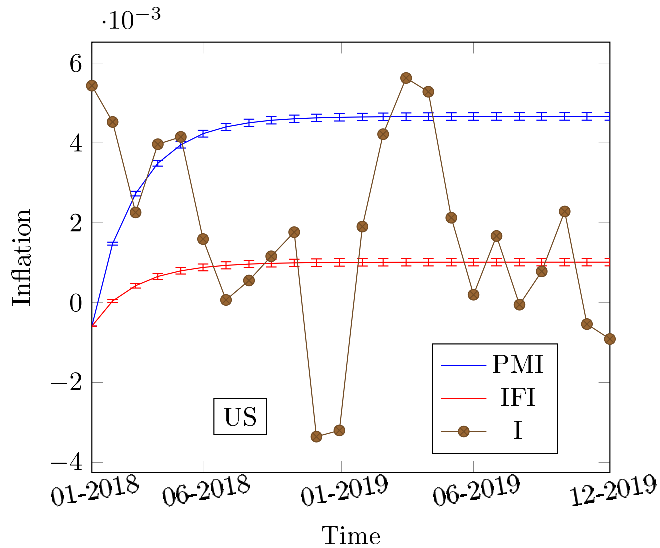

Figure 2: Us inflation (I) 2018-2019 and projected band between projected pure monetary inflation (PMI) and institutional feedback inflation (IFI)

than the quantity theory of money would suggest. With a growing interest in price changes and a deteriorating institutional framework (typically what we may expect in high inflation countries), the effect of A is to expand the possible rates at which prices may grow.

The cases of US, Uk of figures 2 and 3 (advanced economies with no experience of hyperinflation) and Poland in figure 4 (transition economy with experience of hyperinflation) show that the corridor between PMI and IFI constitute a robust interval in which actual inflation dynamics develop; given the time frame. Also the low values of parameter A_{est} does not allow inflationary expectation to expand.

The tendency of Japan show that actual inflation tends to be bellow the model estimation[15]. In spite of prolonged Quantitative Easing effort a tendency to deflation can't be overturn. The outcome presented in figure 5 may suggest that agents tent to review the parameters of the model downward due to a combined lack of reaction of price expectation π_e in combinations with low $\pi_{f,t,est}$ in a frame characterized by extreme stable institutional framework. This may lead to the necessity of investigate relative price movement which in this context is related to $\pi_{f,t,est}$. On this point more investigation is needed.

The overshooting of real inflation over its expected path in the Argentinean case (figure 6) reflects the fact that agents in a high inflationary regime may build buffers at even the smallest indications that inflation may spike; this is a rational

[15]Contrary to Argentina where agents subject to extended periods of high inflation may have a tendency to overshoot, see bellow.

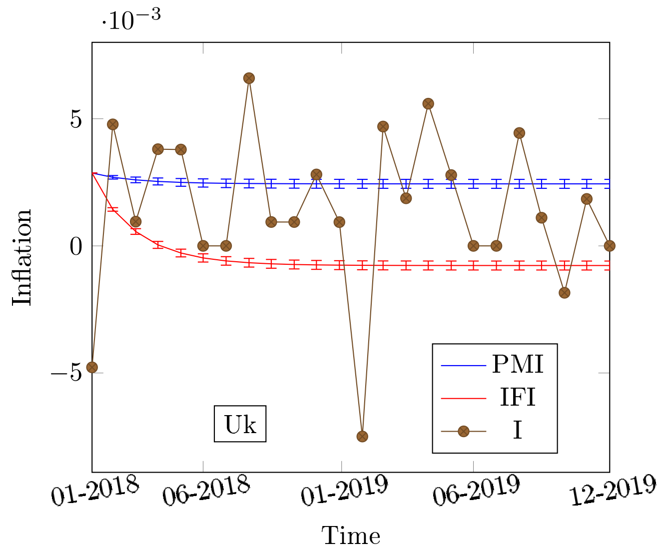

Figure 3: Uk inflation (I) 2018-2019 and projected band between projected pure monetary inflation (PMI) and institutional feedback inflation (IFI)

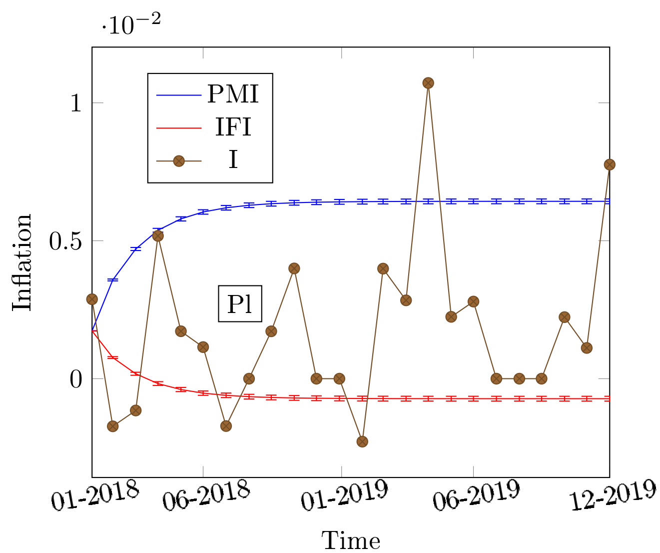

Figure 4: Pl inflation (I) 2018-2019 and projected band between projected pure monetary inflation (PMI) and institutional feedback inflation (IFI)

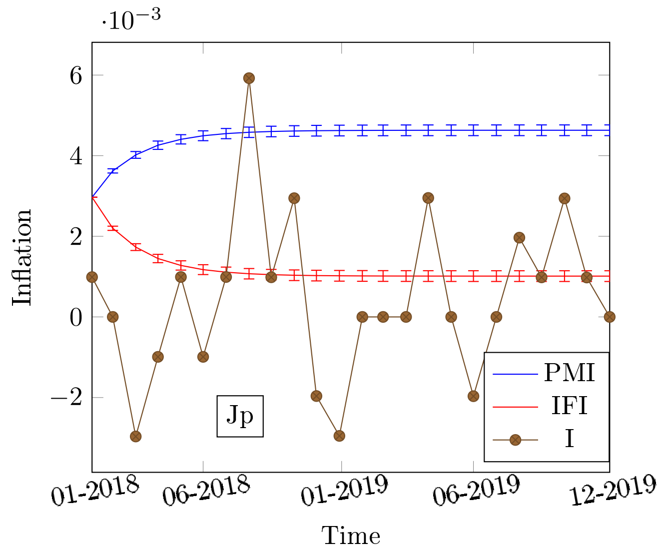

Figure 5: Jp inflation (I) 2018-2019 and projected band between projected pure monetary inflation (PMI) and institutional feedback inflation (IFI)

defensive behavior that may be expected in countries with an experience of hyperinflation. This also may be an indication that frequent revision of inflation projections should not be ruled out; and the recalibration of parameters by the agents occurs relatively frequently.

Table 4: Parameters for the Venezuelan case

Parameter								
	$d\pi_0$	A_{est}	$\hat{dm}$-$\hat{dy}$	ξ_{est}	t_0	$d\pi_{e,est}$	B_{est}	$B_{f,est}$
Ve	-0.022	1.21	0.0538	1	2016m01	-0.0017	0.05178	0.06307

For the case of Venezuela of figure 7, only the differences of money and prices are integrated of order one and therefore cointegrated. The result is in line with the works of (Mizuno et al., 2002; Szybisz & Szybisz, 2009, 2017; Sornette et al., 2003). Thus, we solve a third order differential Equation in order to reach a solution for $d\pi_{m,est}$ and $d\pi_{f,est}$ based on the same procedure of subsection 3.3. The natural logarithm of $\left(\frac{D_{e,t}}{\Lambda}\right)_{est}$ remains integrate of order one[16].

From these examples, we see that convergence is reached within a year (as the time units are months) which is a range where expected structural changes may occur. Moreover, we find that a corridor between "PMI" and "IFI" inflation develops, inside which we may find the factual dynamic path. For "small A" countries (like the US, UK, Poland) we observe a general tendency of inflation

[16]Only CPI factual data is used form 2017m06 onwards in the case of Venezuela.

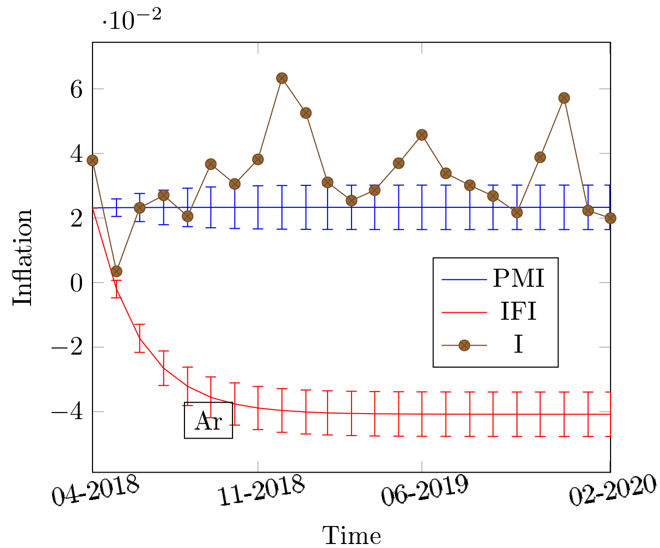

Figure 6: Arg inflation (I) 2018-2019 and projected band between projected pure monetary inflation (PMI) and institutional feedback inflation (IFI)

to lie inside the corridor, which is an indication that institutions contribute significantly to forming the range of the corral. On the other hand, the Venezuelan case is a confirmation of the need of working with changes of inflation rather than levels of inflation in understanding expectations in the context of hyperinflation.

5 Conclusions

This paper examined the idea of institutions as setting the boundaries of inflationary expectations. Extending a model proposed by Olivera (1967a) to incorporate both expectations and institutions (in particular property rights), we showed how institutions are crucial for keeping inflationary expectations within certain limits; more importantly, when these institutions are degraded or removed, expectations become unmoored and unstable, and profligate monetary policy can lead directly to hyperinflation. This was further illustrated by a series of empirical exercises over a broad set of countries with very different inflationary experience, showing the flexibility of the model to explain the role of property rights in dampening inflationary expectations. The work done in this paper may be seen as a first step towards better comprehending the elusive money demand function and what additional drivers may be determining money demand. As the first paper to explicitly incorporate institutional mechanisms into models of inflationary expectations, we expect that there will be a plethora of research which can further investigate these relationships. In the

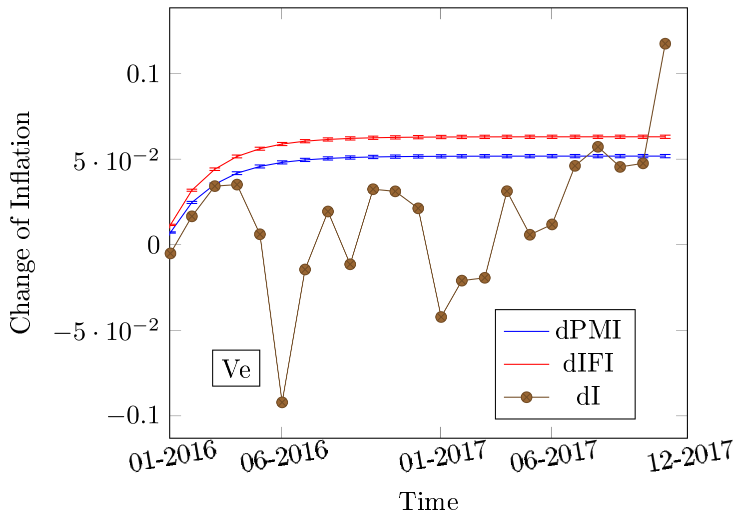

Figure 7: Venezuelan change of inflation (dI) 2018-2019 and projected band between projected pure monetary change of inflation (dPMI) and institutional feedback change of inflation (dIFI)

first instance, we have selected property rights as it appears to rule supreme among economic institutions, but other political and economic institutions can also be examined to see if they too have a similar impact on expectations (for example, central bank independence or democracy). At the same time, the precise channels via which institutions can influence expectations formation, either at a cognitive or aggregated level, could also be an area for future research. Finally, the empirical application of this model could also be expanded beyond the countries shown here and with techniques which allow for more causal inference.

In any event, the importance of institutions in setting the rules of the game and, by extension, setting the boundaries of expectations, needs to be incorporated into both economic and policy models regarding monetary policy. Without understanding how current conditions and expectations are filtered by the prevailing institutional environment, a crucial aspect of individual decision-making processes is overlooked.

A Olivera's formulation

Suppose the following process for expected price changes with supply-demand imbalances taking into account only monetary supply-demand asymmetries (quantity of money changes):

$$D_t = f(P_t, t) \wedge S_t = f(P_t, t) \tag{A.1}$$

Differentiating both sides,

$$\frac{\partial D_t}{\partial t} + \frac{\partial D_t}{\partial P_t}\frac{dP_t}{dt} = \frac{\partial S_t}{\partial t} + \frac{\partial S_t}{\partial P_t}\frac{dP_t}{dt} \tag{A.2}$$

In term of elasticities and using the fact that in equilibrium,$D_t = S_t$

$$\frac{1}{P_t}\frac{dP_t}{dt}\left\{\frac{\partial D_t}{\partial P_t}\frac{P_t}{S_t} + \frac{\partial S_t}{\partial P_t}\frac{P_t}{S_t}\right\} = \frac{1}{S_t}\left\{\frac{\partial S_t}{\partial t} - \frac{\partial D_t}{\partial t}\right\} \tag{A.3}$$

leading to

$$\Gamma = \frac{\sigma - \delta}{\epsilon + \eta} \tag{A.4}$$

where we employ the definitions of 3.1.

In Olivera (1967a) the variables that form prices are a structural sector wedge, wages and mark up, as common elements of the economy sectors expanding or contracting price changes by the mechanism shown in this section[17].

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[17] We do not work with sectors, but we try to separate a pure monetary effect (via m) of other price movements (via f).

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