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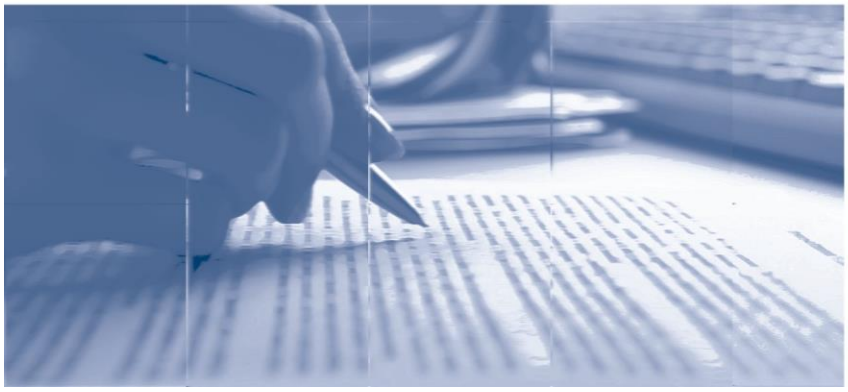

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Do Financial Crises Erode Potential Output? a cross country analysis of industrial and emerging economies

Fernando N. de Oliveira*

Myrian Petrassi**

Abstract

Our objective in this paper is to analyze empirically if financial crises have decreased potential output for a selected group of economies. We estimate different stylized Phillips curves to verify if inflationary pressures were stronger on the recovery periods after financial crises, relative to the recovery periods after recessions. Our results, in general, do not show any clear empirical evidence that financial crises erode potential output. Moreover, there are no apparent differences in terms of the effects of financial crises over potential output between emerging and industrial economies.

Keywords: Financial Crises, Potential Output, Inflation, Hyperinflation, Phillips Curve

JEL Classification: E3, E30, E31

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1. Introduction

Financial crises are related to relevant changes in credit volume and asset prices, severe disruptions in financial intermediation, balance sheet problems of firms and households, and the need for large scale government intervention. The macroeconomic implications of crises are typically harsh, with large output losses and other macroeconomic variables typically experimenting significant declines.

Financial crises may also impair aggregate supply. As Blinder (1987) points out widespread credit rationing can constrain current production by restricting the availability of working capital for firms, and also reduce future production by inhibiting investment spending and the future capital stock.[1]

What is still an open empirical question in the literature is if financial crises also erode potential output. If so, this would show up through decreasing the amount of spare capacity, which normally opens up following economic downturns, such that inflationary pressures would be stronger than otherwise.

Our objective in this paper is to analyze empirically if financial crises have affected potential output for a selected group of economies. For this, we estimate different Phillips curve to verify if inflationary pressures, as mentioned above, were stronger on the recovery periods after the financial crises relative to the recovery periods after normal downturns, such as recessions. [2]

Our definition of financial crises is taken from Laeven and Valencia (2010), who define a systemic banking crisis as relevant signs of financial distress in the financial system, followed by significant financial policy intervention measures.

As Cechetti et al show (2007) both the volatility and level of inflation have decreased in industrial economies. In these economies, the decades of 1960 and 1970 were considered periods of high and persistent inflation, while the more recent decades, 1990 and 2000, have low levels of inflation as well as low persistence.

Contrary to industrial countries, emerging economies have experienced high levels of inflations for a longer period. Some of these countries, such as Brazil,

[1] An economy's potential output is generally defined as the production level consistent with stable inflation. At this level, the economy is considered to be at full employment or unemployment is at the natural rate. In the course of the past decades, several methods have been employed to estimate potential output and the output gap.

[2] There are other ways to verify empirically how financial crises affect potential output. See Cecchetti et al (2009), Cerra and Saxena (2008) and Benati (2012) for some papers that investigate whether financial crises constitute adverse long term supply shocks to trend output with different approaches from our paper.

Argentina, Peru, Mexico, among others have had periods of hyperinflation in the last thirty years. Only recently, in the decade of 1990, the levels of inflation have started to decrease in these countries. This, in part, is due to the important changes in the conduct of their macroeconomic policies.[3]

Considering these differences in the behavior of inflation, we ponder that inflationary pressures may differ depending on the fact that the country is industrial or emerging. We think that in the case of latter, differences of inflationary pressures between recovery periods after financial crises and after recessions should be more pronounced that those observed for the former.

We select a representative group of 16 industrial and 10 emerging economies. In the case of emerging economies, we separate them among those that have and have not experienced hyperinflation in the recent years.

We use quarterly data of inflation, GDP and foreign exchange rate for each of our countries. The sample period for each country varies, depending of the availability of these data. For most countries, we have very long sample periods for the inflation series. For some we have almost 50 years of quarterly data.[4]

Our results, in general, do not show any clear evidence that financial crises erode potential output. Depending on the Phillips curve model used, one or another economy shows a loss in potential output. But the majority of economies do not show any loss at all. Moreover, there are no apparent differences between emerging, either with or without hyperinflations episodes and industrial economies in terms of the effects of financial crises over potential output.

Several factors may lead financial crises to affect potential output. Traditional crowding out might lead to higher longer-term risk-free real interest rates following the sharp increases in government debt arising from the combination of fiscal stimulus and support for the banking system. Actual and expected inflation could rise because of the inflationary impact of central bank balance sheet expansion.

Increased risk aversion could lead to lower capital accumulation in the long run. In addition, reduced leverage and slower financial innovation may prevent financing for projects that otherwise would have added to productivity growth. Finally, a possible

[3] As examples of some macroeconomic policies we can list: inflation targeting adoption, reduction of budget deficits, improvement of financial regulation, trade liberalization and flexible exchange rate policies among others. It is also important to add that for Latin American countries the renegotiation of the external debt was a pre-condition and basis for inflation stabilization, particularly in Brazil.

[4] The following countries have inflation series starting at the second quarter of 1960: Finland, Greece, France, Japan, New Zealand, Switzerland, United Kingdom and United States.

reversal of financial globalization may reduce growth by inhibiting trade and development.

Furthermore, by reducing labor demand, financial crises can lead to an increase in the structural unemployment rate. The high unemployment rate may discourage workers to search for a new position. Workers exiting the labor force will reduce human capital accumulation, hence decreasing potential output in the short if not in the longer run.

Finally, the effect on total factor productivity is a priori uncertain. On one hand, spending on innovation is pro cyclical and is likely to be massively reduced at times of crisis. On the other hand, firms may have stronger incentives to restructure and improve their efficiency in periods of crisis to limit their losses.

Our paper is in line with Bijapur (2012). Bijapur uses a panel specification and tests for erosion of potential output in the aftermath of financial crises for a group of 11 industrial economies. The conclusions are that financial crises affect negatively potential output. We think the differences from our results may occur because we estimate a more comprehensive group of individual and panel Phillips curves, taking in consideration in all of them other possible structural breaks rather than financial crises and recessions. We also contribute to the empirical literature by looking at a greater and more diversified group of countries, including several emerging ones, and by using a much longer sample period for all economies in our sample.

Cechetti et al (2009) studies the output costs of 40 systemic banking crises since 1980. Most, but not all, crises coincide with a sharp contraction in output from which it took several years to recover. Cechetti et al find that the output losses of past banking crises were higher when they were accompanied by a currency crisis or when growth was low at the start of the crisis. [5]

Reinhart and Rogoff (2009) examine the depth and duration of the slump that invariably follows severe financial crises. The authors general findings are that: asset market collapses are deep and prolonged; banking crises are associated with profound declines in output and employment; the unemployment rate rises an average of 7% over

[5] Cecchetti et al (2009) highlight a number of complementary linkages from the financial to the real economy that may cause output losses Increases in funding costs reduces investment. So does decreased credit availability. Higher risk aversion drives up risk premia, leading to flights to quality. The worsening of firms' net worth leads to an impairment of their borrowing capacity from lower equity and property prices.

the down phase of the cycle, which lasts on average over four years and output falls an average of over 9%.

The rest of the paper is the following. Section 2 describes the data. Section 3 presents the empirical analysis. Section 4 concludes.

2. Data

Our data are quarterly and the sample periods differ depending on the country. We select 27 countries: 16 industrial and 10 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline CPI inflation. We also use as exogenous the following variables: growth of real seasonally adjusted GDP and GDP gap, which is the difference between seasonally adjusted real GDP and potential GDP, obtained through Hodrick-Prescott filtering.[6]

For the purpose of our analysis, we separate our sample of countries in three groups. The first group is comprised of industrial countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Netherlands, Norway, Portugal, Sweden, Switzerland, United Kingdom and United States). The second group has emerging countries that did not experience hyperinflation in the recent past (Colombia, Czech Republic, South Korea, Philippines, South Africa, and Thailand). The third group has emerging economies that have had hyperinflation, such as Argentina, Brazil, Peru and Mexico.

Table 1 Panel A shows the sample periods of data for all countries in our sample. Panel B lists the Financial Crises and Panel C the recessions. As one can observe, most countries experienced more than one Financial Crisis and several recessions.

Table 2 Panel A shows descriptive statistics of inflation for industrial economies. As one can observe, average inflation is 1.30%, while average standard deviation was 0.70%. Table 2 Panel B presents descriptive statistics of inflation for the group of emerging economies that did not have hyperinflation episodes in the last thirty years. We can see that average inflation was 2.09% and average standard deviation was 2.09%. Table 2 Panel C shows descriptive statistics of inflation for the group of

[6] Growth is the first difference of log (real adjusted GDP).

emerging economies that have had some hyperinflation episode recently. We can see that average inflation for this group was much higher than in the previous groups, 13.08%, and the same happened for average standard deviation, 0.26%.

Our definition of financial crises comes from Laeven and Valencia (2010), who define a systemic banking crisis as significant signs of financial distress in the banking system, accompanied by significant banking policy intervention measures. We characterize recessions by the adopting the familiar technical definition of 2 consecutive quarters of decline in real GDP with seasonal adjustment. [7]

Finally, the recovery period for financial crises and recessions is a ten quarters period that starts at the end of the recession or financial crisis. We think that this is a reasonable length of time to estimate the effects that we want. Extending it further may make the results affected by other events.

In the next section, we will present our empirical analysis based on the estimation of reduced form inflation dynamics for the groups of countries of our sample.

3. Empirical Analysis

The dynamics of macroeconomic and financial variables around crises have been extensively studied. Empirical studies have documented the various phases of financial crises, from initial, small-scale financial disruptions to large-scale global crises. They have described how asset prices and credit growth can remain depressed for a long time and how crises can have long-lasting consequences for the real economy.

However, the empirical challenge of measuring the impact of financial crises on potential GDP is far from trivial. The presence of structural breaks, such as those that might be created by financial crises, poses significant difficulties. Temporarily lower growth immediately after a crisis as well as the higher growth rates during the recovery period will probably distort estimates for trend growth for many years after the crisis.

To deal with the possibility of structural breaks, we first follow Kim and Perron (2009) and test for the presence of unit roots in the first difference of the inflation processes of all countries in our sample, taking in consideration possible endogenous

[7] In the case of South Africa, we use Catão and Milesi-Ferretti (2013).

structural breaks in these series. In all our tests, we consider the possibility of a structural break at the intercept.

As it is well known, unit root tests are very sensitive to the possibility of breaks. So the appropriate test should include this possibility, comparing the hypothesis of unit roots with breaks versus deterministic trend with breaks, or some other alternative hypothesis. This is exactly what the test of Kim and Perron (2009) does.

Table 3 shows that we reject unit root for all countries. It also shows the endogenous breaks of the processes chosen by Kim and Perron (2009). The breakpoints are then explicitly included in our specifications below (the name of the regressor is break).

We estimate several Phillips curve types of models. The following were estimated: models with growth of GDP or with growth of GDP gap, models with lags of inflation, new Keynesian Phillips curves with or without the first difference of the foreign exchange rate. In all models, we used a control variable related to the first difference of international price of oil market or to the first difference of a commodity index. [8]

We include in all specifications a dummy variable equal to one when it is a recovery period after a financial crisis and zero otherwise (named crises in the regressions below) and a dummy variable equal to one on a recovery period after a recession and zero otherwise (named recessions in the regressions below). A final control variable is the first difference of the logarithm of price of oil.

Equation (1) below presents the first Phillips curve model that we estimated for each country. It is not a standard Philips curve in first difference, as we use GDP growth (dy_t) in place of the growth of gap of GDP.

(1)

$$d\pi_t = \beta_0 + \mu break_t + \left(\sum_{j=1}^{L} \lambda_j + \sum_{j=1}^{L} crises_j \delta_{t-j} + \sum_{j=1}^{L} recessions_j \theta_{t-j} \right) * dy_{t-j}$$
$$+ \left(\sum_{j=1}^{L} \phi_j + \sum_{j=1}^{N} crises_j \delta_{t-j} + \sum_{j=1}^{N} recessions_j \gamma_{t-j} \right) * dlpetrol_t + \varepsilon_t, E[\varepsilon_t] = 0, \text{var}(\varepsilon_t) = \sigma_\varepsilon^2$$

where $d\pi_t$ is the first difference of headline consumer inflation and .

[8] In the case of oil, we use the international price of Brent oil. In the case of the commodity index, we used CRB.

Equation (2) is similar to Equation (1), except that we use the growth of GDP gap in place of GDP growth (dh_t).

(2)

$$\pi_t = \beta_0 + \mu break_t + \left(\sum_{j=1}^{L} \lambda_j + \sum_{j=1}^{L} crises_j \delta_{t-j} + \sum_{j=1}^{L} recessions_j \theta_{t-j} \right) * dh_{t-j}$$
$$+ \left(\sum_{j=1}^{L} \phi_j + \sum_{j=1}^{N} crises_j \delta_{t-j} + \sum_{j=1}^{N} recessions_j \theta_{t-j} \right) * dlpetrol_t + \varepsilon_t, E[\varepsilon_t] = 0, \text{var}(\varepsilon_t) = \sigma_\varepsilon^2$$

Lagged inflation can capture true persistence in the price setting process. So in equation (3), we include the lags of the first difference of inflation in a model with the growth of GDP gap.

(3)

$$d\pi_t = \beta_0 + \mu break_t + \left(\sum_{j=1}^{L} \phi_j + \sum_{j=1}^{N} crises_j \delta_{t-j} + \sum_{j=1}^{N} recessions_j \theta_{t-j} \right) * dh_{t-j}$$
$$+ \sum_{j=1}^{N} \eta_{t-j} \pi_{t-j} + \left(\sum_{j=1}^{L} \phi_j + \sum_{j=1}^{N} crises_j \delta_{t-j} + \sum_{j=1}^{N} recessions_j \theta_{t-j} \right) * dlpetrol +$$
$$\varepsilon_t, E[\varepsilon_t] = 0, \text{var}(\varepsilon_t) = \sigma_\varepsilon^2$$

Mishkin (2007) makes it clear that inflation expectations must be a key driving force behind inflation. This dependence has long been implicit in traditional Phillips curve analysis but now expectations are explicit and are also a central feature of new Keynesian Phillips curves in which current period inflation is a function of expectations next period and output gap.

If inflation has indeed become less persistent because monetary policy has anchored inflation expectations more solidly the monetary authorities may find they have less need to induce large swings in economic activity to control inflation. This is a key benefit of establishing a strong nominal anchor. If this is correct, cyclical movements in interest rates need not be as great as it was necessary when expectations are anchored. To try to capture this possibility we will estimate new Keynesian models of inflation that incorporate inflation expectations.

The most important implication of the pure new Keynesian model of inflation is that there is no intrinsic persistence in inflation in the sense that there is no structural

dependence of inflation on its own lagged values. Instead, inflation is determined in a forward-looking manner. One implication of this model in contrast to traditional ones is that it is much easier to quickly reduce inflation in this model than in the traditional one. In fact, according to the new Keynesian model, inflation can be costless controlled by a credible commitment to keep output close to its potential. [9]

Due to the difficulty of fitting the data with new Keynesian pure forward-looking model, a vast literature that incorporates lags of inflation in the new Keynesian Phillips curve (NKPC) has emerged[10]. For many, this class of models represents a sort of common-sense middle ground that preserves the insights of standard rational expectations models while allowing for better empirical fit by dealing directly with a well-known deficiency of the pure forward looking model of inflation. As a result, this class of models has been widely used in applied monetary policy analysis.

The structural equations for inflation that we estimate are in the spirit of hybrid new Keynesian Phillips curve as in Equation (4) and (5). The difference between Equations (4) and (5) is that the latter has the first difference of logarithm of foreign exchange rate (lforex) as a control variable.

These models add a dependence of inflation on its lagged values to otherwise purely forward-looking models. Such models are often considered as a compromise between the need for rigorous micro foundations of the sort underlying the pure new-Keynesian Phillips curve and the need to fit the data empirically.

We estimate equation (4) and (5), using lags of the first difference of consumer headline inflation as instruments. In the estimations of equations (1) to (5), we check for serial correlation with LM test and correct for heteroskedasticity with Newey-West. In the presence of serial correlation, we include more lags of regressors, until there is no more evidence of serial correlation. Finally, we test for stability of the parameters using Andrews-Quandt and when possible incorporate the breaks observed with this test in the models.

[9] The most popular formulation of the new Keynesian framework is based on Calvo (1983) model of price random adjustment. The model assumes that in each period a random fraction of firms reset their price while all other firms keep their prices unchanged. Calvo assumes an imperfectly competitive market structure as well. These two hypotheses generate the basic new Keynesian model of inflation.

[10] See Fuhrer and Moore (1995), Dossche and Everaert (2005), Gali and Gerler (1999) and Christiano et al (2005) for some theoretical models that justify the inclusion of lags of inflation in the new Keynesian Phillips curves.

(4)

$$d\pi_t = \beta_0 + \left(\sum_{j=1}^{L} \phi_j + \sum_{j=1}^{L} crises_j \delta_{t-j} + \sum_{j=1}^{L} recessions_j \theta_{t-j} \right) * dhy_{t-j}$$
$$+ \sum_{j=1}^{L} \eta_{t-j} \pi_{t-j} + (1-\rho) E_t[\pi_{t+1}]$$
$$+ \left(\sum_{j=1}^{L} \phi_j + \sum_{j=1}^{L} crises_j \pi_{t-j} + \sum_{j=1}^{L} recessions_j \pi_{t-j} \right) * dlpetrol + \delta break_t + \varepsilon_t, E[\varepsilon_t] = 0, \text{var}(\varepsilon_t) = \sigma_\varepsilon^2$$

(5)

$$d\pi_t = \beta_0 + \left(\sum_{j=1}^{L} \phi_j + \sum_{j=1}^{L} crises_j \delta_{t-j} + \sum_{j=1}^{L} recessions_j \theta_{t-j} \right) * dh_{t-j}$$
$$+ \sum_{j=1}^{L} \eta_{t-j} \pi_{t-j} + (1-\rho) E_t[\pi_{t+1}] + \left(\sum_{j=1}^{L} \phi_j + \sum_{j=1}^{L} crises_j \pi_{t-j} + \sum_{j=1}^{L} recessions_j \theta_{t-j} \right) * dlpetrol$$
$$+ \left(\sum_{j=1}^{L} \chi_{t-j} \right) * dlforex + \delta break_t + \varepsilon_t, E[\varepsilon_t] = 0, \text{var}(\varepsilon_t) = \sigma_\varepsilon^2$$

Our test of erosion of potential output after a financial crisis is the following. Following a recession, a large amount of spare capacity opens up, and therefore the economy can grow faster without inflation taking off. Thus, the predicted signs of the sum of the interactive dummy recessions are negative. However, if a financial crisis leads to erosion of potential output, then the margin of spare capacity would be smaller, and hence an increase in the growth rate would lead to a larger increase in inflation relative to a normal downturn. Thus, in the presence of this effect, the sum of the interactive dummy coefficients crises would be greater, that is less negative, than the sum of the interactive dummy recessions.

More specifically, we take as our null hypothesis, H0 that financial crises do not affect potential output; and as alternative hypothesis, H1, that financial crises decrease potential output because of higher inflationary pressure in periods of recovery following financial crises compared to recovery following recessions. These Hypotheses for all models estimated are the following:

$$H0: \Sigma_{j=1}^{L} \delta_{t-j} = \Sigma_{j=1}^{L} \vartheta_{t-j}$$
$$H1: \Sigma_{j=1}^{L} \delta_{t-j} > \Sigma_{j=1}^{L} \theta_{t-j}$$

Table 4 presents the t statistics of the Wald test above for each economy in our sample and for the 5 stylized Phillips curves (Equations (1) to (5)). As one can see, in

very few economies do financial crises decrease potential output. In the great majority of cases, we do not reject the null. Only in the cases of Sweden for equations (1), (3) and (5), Germany for equation (1), and South Africa for equation (1) and Philippine for equation (3) do we reject the null in favor of the alternative. Moreover, one cannot distinguish any differences in the estimated models of industrial, emerging with and without hyperinflation experiences in terms of loss of potential output in the after financial crises.

We do several robustness tests. In the first place, we substitute the first difference of the logarithm price of oil for the first difference of the logarithm of a commodity index, CRB. The results are shown in Table 5. They confirm the results we show in Table 4.

In a second attempt to see the robustness of our results, we exclude from the models the endogenous breaks chosen by the unit root tests of Kim and Perron (2009). Table 6 presents the results that very much confirm the fact that for very few countries and only some specific Phillips curve do financial crises erode potential output.

In a third attempt to verify our previous results, we estimate a panel model such as (6) below, similar to the one Bijapur (2012) estimated. We use the Wooldridge test for correlation of the residuals to select the number of lags of the model and correct for heterocedasticity with White (a_i is the fixed effect).

(6)

$$\pi_{it} = \beta_0 + \delta break_{it} + \left(\sum_{j=1}^{L} \phi_{ij} + \sum_{j=1}^{L} crises_{ij}\pi_{it-j} + \sum_{j=1}^{N} recessions_{ij}\pi_{it-j} \right) * dy_{it-j}$$
$$+ \left(\sum_{j=1}^{L} \lambda_j \pi_{it-j} + \sum_{j=1}^{L} \alpha_j \pi_{it-j} \right) * dlpetrol_t + a_i + \varepsilon_t, E[\varepsilon_t] = 0, \text{var}(\varepsilon_t) = \sigma_\varepsilon^2$$

Table 7 presents the Wald tests. Once again, we observe no erosion of potential output for our group of economies, independently of them being industrial, emerging with or without hyperinflation experience.

The results that we find are impressive and seem to indicate that despite its huge impact both to aggregate demand as well as short run aggregate supply, financial crises seem not to affect potential output.

The fact that for most stylized Phillips curve models that we estimate, we do not reject the null of erosion of potential output after financial crises is somewhat puzzling. What they suggest is that the margin of spare capacity does not tend to be smaller following financial crises relative to other downturns.

4. Conclusion

This paper sheds light on the widely debated issue of whether financial crises constitute adverse supply shocks that lead to impairment in an economy's productive potential. We investigate whether inflationary pressures tend to be stronger in the aftermath of financial crises compared to non-crisis economic downturns.

We estimate several stylized Phillips curve models. Our results show that there is no empirical evidence that such a thing occurs. Even emerging economies that experienced hyperinflation in the recent past showed no loss of potential output after financial crises.

In interpreting our results, we must first recognize that all of them are based on reduced-form relationships. Thus, they are about correlations and not necessarily about true structural relationships. Explanatory variables in our inflation estimations are themselves influenced by changes in economic conditions. So, changes in the underlying monetary policy regime are likely to be a source changes in reduced-form inflation dynamics. This problem is especially acute for structural relationship involving expectations or other factors that are not directly observable and so cannot be included in reduced form regressions. In such cases, we cannot use the reduced form equations to disentangle the effects of such unobserved factors which themselves may be driven by changes in monetary policy from that of other influences.

Anchoring of inflation expectations must be related to monetary policy. During the past years most central banks have increased their commitment to price stability in both words and action. The Federal Reserve, the European Central Bank and several central banks of emerging economies have been committed to keep inflation under control. The result has been low and stable inflations but also, as we report in this paper, low and stable inflation persistence.

The pursuit of more aggressive monetary policy to control inflation and the achievement of anchored inflation help explain in part our results. With expectations of inflation anchored the sacrifice ratio becomes lower and monetary policy much more

effective to improve the welfare of the economy even in the presence of severe financial crises.

References

Benati, L. 2012. “Estimating the financial crisis’ impact on potential output.” Economics Letters 114, 113–119.

Blinder, A.S. 1987. “Credit Rationing and Effective Supply Failures”. Economic Journal 97, 327–352.

Bijapur, M. 2012. “Do Financial Crises Erode Potential Output? Evidence from OECD Inflation Responses.” Economics Letters 117, 700-703.

Calvo, Guilherme. 1983. “Staggered Prices in a Utility Maximizing Framework.” Journal of Monetary Economics, 12, 383-398.

Cechetti, G. Stephen., Peter Hooper, Bruce Kasman, Kermit Schoenholtz, and Mark Watson. 2007. “Understanding the Evolving Inflation Process”. U.S. Monetary Policy Forum, Brandeis University, February.

Cerra, V., Saxena, S.C., 2008. Growth dynamics: The myth of economic recovery. American Economic Review 98, 439–457.

Christiano, Lawrence, Einchenbaum, Martin. Evan, Charles 2005. “ Nominal Rigidities and the Dynamics Effects of Shocks to Monetary Policy.” Journal of Political Economy, 113, 1-45.

Dossche, M. and Everaert, G. 2005. “Measuring Inflation Persistence.A Structural Time Series Approach.” ECB Working Paper No 495.

Fuhrer, C., Moore, George. 1995. “Inflation Persistence.” Quartely Journal of Economics, 110, 127-159.

Gali, Jodi and Gerler, Mark 1999. “A Structural Econometric Analysis.” Journal of Monetary Economics, 44, 195-222.

Laeven, L.A., Valencia, F.V., 2010. Resolution of banking crises: The good, the bad, and the ugly. IMF Working Papers No. 10/146.

Mishkin, S. Frederick (2007). “Inflation Dynamics”. Working Paper Series National Bureau of Economic Research, NBER, No 13147.

Reinhart, C.M., Rogoff, K.S., 2009. The aftermath of financial crises. American Economic Review 99, 466–472.

Table 1. Sample Periods, Quarters of Financial Crises and Recessions

Our data are quarterly and the sample periods differ depending on the country. We select 26 countries: 16 industrial and 10 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. Panel A shows the sample periods we use in our empirical analysis for each country. Panel B presents the quarters of Financial Crisis for each country. We follow Laeven and Valencia (2012) and Catao and Milesi-Ferreti (2013) for this selection. Panel C shows the quarters of recession for each country. We consider a recession when we observe two consecutive quarters of negative GDP growth.

Panel A. Sample Periods

Emerging Economies		Industrial Economies	
Argentina	1993Q1-2010Q4	**Austria**	1964Q1-2010Q4
Brazil	1993Q3-2010Q4	**Belgium**	1980Q1-2010Q4
Colombia	1990Q1-2010Q4	**Denmark**	1977Q1-2010Q4
Czech Republic	1990Q1-2010Q4	**Finland**	1970Q1-2010Q4
Mexico	1981Q1-2010Q4	**France**	1965Q1-2010Q4
Peru	1979Q1-2010Q4	**Germany**	1960Q1-2010Q4
Phillipines	1980Q4-2010Q4	**Greece**	2000Q1-2010Q4
South Africa	1960Q1-2010Q4	**Iceland**	1997Q1-2010Q4
South Korea	1960Q1-2010Q4	**Italy**	1960Q1-2010Q4
Thailand	1993Q1-2010Q4	**Netherlands**	1977Q1-2010Q4
		Norway	1961Q1-2010Q4
		Portugal	1977Q1-2010Q4
		Sweden	1980Q1-2010Q4
		Switzerland	1970Q1-2010Q4
		United Kingdom	1960Q1-2010Q4
		United States	1960Q1-2011Q1

Panel B. Financial Crisis[1\]

Argentina	1980-1982	1989-1991	1995	2001-2003
Austria	2008-2013			
Belgium	2008-2013			
Brazil	1990-1998			
Colombia	1982	1998-2000		
Czech Republic	1996-2000			
Denmark	2008-2013			
Finland	1991-1995			
France	2008-2013			
Germany	2008-2013			
Greece	2008-2013			
Hungary	1991-1995	2008-2013		
Iceland	2008-2013			
Israel	1977			
Italy	2008-2013			
Mexico	1981-1985	1994-1996		
Netherlands	2008-2013			
Norway	1991-1993			
Peru	1983			
Philipines	1983-1986	1997-2001		
Portugal	2008-2013			
South Africa 2\	1985-1987			
South Korea	1997-1998			
Sweden	1991-1995	2008-2013		
Switzerland	2008-2013			
Thailand	1983	1997-2000		
United Kingdom	2007-2013			
United States	1988	2007-2013		

1\ Based on Laeven and Valencia (2012).

2\ Based on Catão and Milesi-Ferretti (2013).

Panel C. Recessions

Part 1.

Argentina	1995Q2	1999Q1-1999Q3	2000Q3-2000Q4	2001Q4-2002Q3	2009Q1-2009Q2			
Austria	1999Q3	2000Q2-2000Q4						
Belgium	1981Q1-1981Q3	1982Q2-1982Q4	1983Q3-1983Q4	1985Q1	1991Q2	1993Q1	1993Q4	1996Q2
Brazil	1991Q4	1992Q3	1994Q1	1995Q3	1998Q4	1999Q1	2001Q1-2001Q3	2002Q3-2002Q4
Colombia	1998Q1-1998Q4	1999Q1-1999Q3	2001Q2	2002Q4	2003Q1	2008Q4	2009Q1	
Czech Republic	1997Q1-1997Q3	1999Q2	2000Q2-2000Q4	2005Q3-2005Q4	2009Q1	2010Q2	2011Q4	
Denmark	1980Q2	1981Q1-1981Q3	1982Q4	1983Q4	1984Q3-1985Q1	1989Q2	1991Q3	1993Q1
Finland	1975Q4	1981Q1-1981Q3	1991Q2-1991Q4	1992Q1	1993Q1	1993Q4	1996Q2	1997Q2-1997Q3
France	1969Q4	1976Q3	1981Q1-1981Q3	1983Q3-1983Q4	1984Q1	1984Q4-1985Q1	1991Q2-1991Q3	1993Q1
Germany	1974Q1	1981Q1-1981Q3	1982Q4	1983Q3-1985Q1	1989Q2	1991Q3	1993Q1	1993Q4
Greece	2000Q3-2000Q4	2005Q2	2008Q4-2009Q1	2010Q2-2010Q3	2011Q4			
Hungary	1996Q2	1997Q3	2000Q2-2000Q4	2006Q1	2008Q4-2009Q1	2010Q2-2010Q3	2011Q4	
Iceland	2000Q4-2001Q2	2008Q2-2009Q2	2010Q2					
Israel	1971Q4	1975Q4	1976Q3	1977Q2	1978Q1	1983Q4-1984Q1	1985Q1	1993Q1
Italy	1976Q2	1981Q1-1981Q3	1982Q4	1983Q3	1984Q4-1985Q1	1991Q3	1993Q1	1993Q4
Mexico	1982Q2-1982Q3	1985Q3-1985Q4	1994Q3-1995Q1	1998Q3	2009Q1			
Netherlands	1981Q1-1981Q3	1982-1982Q4	1983Q3-1984Q1	1984Q4-1985Q1	1989Q2	1991Q2-1999Q3	1993Q1	1993Q4
Norway	1966Q1	1981Q1-1981Q3	1982Q3-1982Q4	1984Q3-1985Q1	1991Q2-1991Q3	1993Q1	1993Q4-1994Q1	2002Q1
Peru	1982Q3-1983Q3	1985Q1-1985Q3	1988Q1	1989Q4	1989	1990Q3-1992Q3	1992Q3-1993Q1	1998Q2-1999Q2
Philipines	1983Q2-1983Q4	1984Q3-1984Q4	1990Q4	1993Q2	1993Q3	1997Q4	1998Q1	2000Q2-2001Q2
Portugal	1981Q1-1981Q2	1982Q2-1982Q4	1983Q3-1984Q1	1997Q1-1997Q3	1999Q2-2000Q4	2005Q3-2005Q4	2008Q4	2009Q1
South Africa	1975Q3-1975Q4	1981Q3	1984-1985Q1	1985Q4	1988Q2-1988Q3	1993Q1	1996Q2-1996Q4	1997Q4-1998Q1
South Korea	1960Q3-1961Q4	1964Q2-1964Q3	1971	1997Q2-1998Q1	2000Q4-2001Q2	2008Q2-2009Q1		
Sweden	1981Q2-1982Q4	1984Q3	1991Q3	1993Q1	1993Q4	1997Q1-1997Q3	2000Q2-2000Q4	2001Q3
Switzerland	1974Q1	1975Q3	1981Q1-1981Q3	1982Q2-1982Q4	1983Q3	1984Q4-1985Q1	1988Q3	1989Q2
Thailand	1997Q1-1998Q1	1999Q2	2000Q3-2001Q2	2008Q4-2009Q1				
United Kingdom	1967Q4-1968Q1	1974Q1	1976Q2	1981Q2-1981Q3	1982Q3-19883Q1	1984Q1-1985Q1	1989Q2	1991Q3
United States	2009Q1	2009Q2						

Cont.

Argentina								
Austria								
Belgium	1997Q1-1997Q3	1999Q2	2000Q1-2000Q4	2002Q1	2005Q3-2005Q4			
Brazil								
Colombia								
Czech Republic								
Denmark	1997Q1-1997Q3	1999Q2-2000Q4	2005Q3-2005Q4	2008Q4-2009Q1				
Finland	1996Q2	1997Q2-1997Q3	1999Q2-1999Q4	2000Q3-2000Q4	2002Q1	2005Q3-2005Q4	2008Q4	2009Q1
France	1993Q4	1995Q4	1997Q1-1997Q3	1999Q2-2000Q4	2005Q3-2005Q4	2008Q4-2009Q1		
Germany	1995Q4-1996Q2	1997Q1-1997Q3	1999Q2-2000Q4					
Greece								
Hungary								
Iceland								
Israel	2000Q2-2002Q2							
Italy	1997Q1-1997Q3	1999Q2-2000Q4	2005Q3-2005Q4	2008Q1-2009Q1	2010Q2			
Mexico								
Netherlands	1996Q2	1997Q1-1997Q3	199Q2	2000Q1-2000Q4	2005Q3-2005Q4	2008Q4-2009Q1	2012Q2	
Norway	2008Q4-2009Q1							
Peru	2000Q3-2000Q4	2009Q1	2013Q3					
Philipines	2009Q1	2013Q3						
Portugal	2010Q2	2011Q4						
South Africa	2000Q2	2001Q1-2002Q1	2006Q3-2006Q4	2008Q2	2011Q4			
South Korea								
Sweden	2005Q2-2005Q4	20008Q4-2009Q1	20011Q4					
Switzerland	1991Q3	1993Q1	1996Q2	1997Q1	1999Q2	2000Q4	2005Q3-2005Q4	2008Q1-2009Q1
Thailand								
United Kingdom	1993Q1	1993Q4	1995Q4	1999Q2	2000Q3-2000Q4	2005Q3-2005Q4	200Q2-2009Q1	
United States								

Table 2. Descriptive Statistics of Inflation

Our data are quarterly and the sample periods differ depending on the country. We select 26 countries: 16 industrial and 10 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. Panel A presents the descriptive statistics of inflation for industrial economies. Panel B presents the descriptive statistics for emerging economies that did not have hyperinflation. Panel C presents the descriptive statistics of inflation of countries that experienced hyperinflation in the recent past according to our criteria.

Panel A. Industrial Economies

	Average	Max	Stand. Dev.	No. Obs
Austria	0.84%	8.50%	1.14%	196
Belgium	0.97%	4.29%	0.88%	171
Denmark	1.23%	5.72%	1.18%	177
Finland	1.26%	5.86%	1.27%	205
France	1.12%	4.14%	0.99%	205
Germany	0.49%	2.72%	0.50%	81
Greece	2.12%	13.24%	2.66%	205
Iceland	2.31%	20.25%	2.89%	113
Italy	1.73%	6.94%	1.51%	166
Netherlands	0.81%	3.11%	0.95%	156
Norway	1.18%	6.81%	1.17%	205
Portugal	2.42%	11.85%	2.51%	166
Sweden	1.18%	6.33%	1.21%	205
Switzerland	0.70%	5.62%	0.83%	205
UK	1.43%	9.96%	1.44%	205
USA	0.99%	4.22%	0.91%	205
AVERAGE	**1.30%**		**0.70%**	

Panel B. Emerging Economies without Hyperinflation

	Average	Max	Stand. Dev.	No. Obs
Colombia	3.67%	14.39%	0.0282	205
Czech Republic	1.10%	4.72%	0.0118	73
Hungary	2.62%	15.82%	0.0285	141
Phillipines	2.21%	14.85%	0.0261	205
South Africa	2.01%	6.35%	0.014	205
South Korea	1.82%	13.03%	0.0217	164
Thailand	1.20%	10.64%	0.0163	185
AVERAGE	**2.09%**		**2.09%**	

Panel C. Emerging Economies with Hyperinflation

	Average	Max	Stand.Dev.	OBS
Argentina	11.45	173.35	0.2947	105
Brazil	23.78	225.67	0.35	126
Peru	4.42	29.41	0.056	205
Mexico	12.69	222.29	0.32	92
	13.08		0.26	

Table 3. Unit Root Tests with Structural Breaks of First Difference of CPI Inflation

Our data are quarterly and the sample periods differ depending on the country. We select 26 countries: 16 industrial and 10 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. The unit root test with unknown breaks both at the null and at the alternative hypotheses based on Kim and Perron (2009).

Country	tstatistics	Break	Lambda
Argentina	-12.9000	1995Q2	0.0833
Austria	-17.3621	2000Q1	0.041
Belgium	-17.3168	1982Q2	0.0376
Brazil	-8.9676	2001Q1	0.291
Colombia	-21.1292	1996Q4	0.0469
Czech Republic	-2.5427	1997Q4	0.197
Denmark	-4.9802	1994Q4	0.3898
Finland	-4.0855	1971Q1	0.3415
France	-5.7291	1998Q4	0.4585
Germany	-12.7321	1961Q1	0.033
Greece	-5.2086	2012Q4	0.2439
Iceland	-6.2500	2006Q1	0.3097
Italy	-14.6253	1961Q2	0.0321
Korea	-5.3819	1971Q4	0.2805
Mexico	-15.1300	2008Q3	0.5117
Netherlands	-13.2451	1994Q1	0.988
Norway	-16.2730	1970Q4	0.1784
Peru	-9.9013	1981Q3	0.0882
Phillipnes	-13.1343	1981Q4	0.0141
Portugal	-12.8830	1965Q2	0.0996
South Africa	-16.8000	1977Q1	0.9906
Sweden	-16.4900	2009Q4	0.554
Switzerland	-16.0393	1983Q3	0.2488
Thailand	-4.8960	2009Q3	0.3514
United Kingdon	-4.9217	1990Q3	0.3951
United Kingdon	-14.9875	2008Q3	0.9061

Table 4. Estimation with Oil Prices

Our data are quarterly and the sample periods differ depending on the country. We select 26 countries: 16 industrial and 10 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. Wald tests (t statistics) of the test of erosion of potential output are presented. Equations (1) to (5) are in the text. We estimate equation (4) and (5), using lags of the first difference of consumer headline inflation as instruments. In the estimations of equations (1) to (5), we check for serial correlation with LM test and correct for heteroskedasticity with Newey-West. In the presence of serial correlation, we include more lags of regressors, until there is no more evidence of serial correlation. Finally, we test for stability of the parameters using Andrews-Quandt and when possible incorporate the breaks observed with this test in the models.

Country	tstatistics	Break	Lambda
Argentina	-12.9000	1995Q2	0.0833
Austria	-17.3621	2000Q1	0.041
Belgium	-17.3168	1982Q2	0.0376
Brazil	-8.9676	2001Q1	0.291
Colombia	-21.1292	1996Q4	0.0469
Czech Republic	-2.5427	1997Q4	0.197
Denmark	-4.9802	1994Q4	0.3898
Finland	-4.0855	1971Q1	0.3415
France	-5.7291	1998Q4	0.4585
Germany	-12.7321	1961Q1	0.033
Greece	-5.2086	2012Q4	0.2439
Iceland	-6.2500	2006Q1	0.3097
Italy	-14.6253	1961Q2	0.0321
Korea	-5.3819	1971Q4	0.2805
Mexico	-15.1300	2008Q3	0.5117
Netherlands	-13.2451	1994Q1	0.988
Norway	-16.2730	1970Q4	0.1784
Peru	-9.9013	1981Q3	0.0882
Phillipnes	-13.1343	1981Q4	0.0141
Portugal	-12.8830	1965Q2	0.0996
South Africa	-16.8000	1977Q1	0.9906
Sweden	-16.4900	2009Q4	0.554
Switzerland	-16.0393	1983Q3	0.2488
Thailand	-4.8960	2009Q3	0.3514
United Kingdon	-4.9217	1990Q3	0.3951
United Kingdon	-14.9875	2008Q3	0.9061

Table 5. Estimation with Commodity Index

Our data are quarterly and the sample periods differ depending on the country. We select 26 countries: 16 industrial and 10 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. Our data are quarterly and the sample periods differ depending on the country. We select 30 countries: 16 industrial and 14 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. Wald tests (t statistics) of the test of erosion of potential output are presented. Equations (1) to (5) are in the text. We substitute the first difference of the logarithm of oil price for the first difference of the logarithm of CRB index. We estimate equation (4) and (5), using lags of the first difference of consumer headline inflation as instruments. In the estimations of equations (1) to (5), we check for serial correlation with LM test and correct for heteroskedasticity with Newey-West. In the presence of serial correlation, we include more lags of regressors, until there is no more evidence of serial correlation. Finally, we test for stability of the parameters using Andrews-Quandt and when possible incorporate the breaks observed with this test in the models.

	Wald Test t statistic				
Industrial	(1)	(2)	(3)	(4)	(5)
Belgium	-0.0891	-8.7363	0.1408	0.1132	-0.9839
Denmark	1.5791	-4.0653	1.1053	1.1398	0.3127
Finland	-0.3240	-6.3690	0.6658	1.4866	0.3911
France	0.3358	-5.6109	0.8090	0.8979	0.5477
Germany	1.4522	-6.3983	2.1835**	0.8278	0.4617
Greece	1.5456	-2.9198	-0.4646	-0.6449	-1.2900
Iceland	-0.6048	-2.4076	-0.6993	NA	NA
Italy	0.5593	-3.0430	1.0426	1.0373	1.0619
Netherlands	-0.2514	-20.9890	0.9055	1.0976	0.0083
Norway	0.2916	-7.5316	-0.1302	-0.5944	0.2114
Portugal	0.1780	-7.2445	0.4816	0.1150	0.0602
Sweden	1.5575	-10.2075	2.4655	2.6633**	1.5685
Switzerland	0.4717	-8.4717	0.7619	1.8105*	1.4340
United Kingdom	-0.2862	-7.6283	0.0583	0.3747	0.2887
United States	0.7780	-6.1537	0.8082	-0.1494	0.6965
Emerging					
Colombia	1.0908	-2.6304	1.0491	0.7818	0.1118
Czech Republic	-1.3731	-4.7187	-1.4893	-1.3315	-2.6183
Phillipines	0.513252	-3.725415	1.433696	NA	-0.179373
South Africa	2.8271**	-7.505614	-0.649173	-0.303143	1.897915
South Korea	0.336997	-10.58679	-0.289048	-0.237017	-0.56834
Thailand	1.539179	-3.386123	2.088939*	2.0415**	NA
Emerging with HyperInflati	1.5392	-3.3861	2.088939*	2.0415**	NA
Argentina	-1.543131	-0.41064	-1.184686	NA	NA
Brazil	-3.888924	-1.767222	-4.647436	-4.500474	-4.257022
Peru	0.43099	-1.375049	0.110151	NA	NA
Mexico	-0.821852	0.917914	-2.102386	-1.898988	-1.413378

* significant 1%

**significant 5%

Table 6. Estimation without Kim and Perron (2009) Breaks

Our data are quarterly and the sample periods differ depending on the country. We select 26 countries: 16 industrial and 10 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. Equations (1) to (5) are in the text. We take away in all equations from the specifications the breaks of the Kim and Perron (2009) tests for unit roots. the first difference of the logarithm of CRB index. We estimate equation (4) and (5), using lags of the first difference of consumer headline inflation as instruments. In the estimations of equations (1) to (5), we check for serial correlation with LM test and correct for heteroskedasticity with Newey-West. In the presence of serial correlation, we include more lags of regressors, until there is no more evidence of serial correlation. Finally, we test for stability of the parameters using Andrews-Quandt and when possible incorporate the breaks observed with this test in the models.

	Wald Test t statistic				
Industrial	(1)	(2)	(3)	(4)	(5)
Austria	-0.4100	-4.3000	0.2300	0.3300	-0.5300
Belgium	-0.0900	-8.7400	0.1400	0.1100	-0.9800
Denmark	-0.3200	-4.0700	1.1100	1.1400	0.6100
Finland	-1.5800	-5.3000	0.6700	1.4900	0.3900
France	0.3400	-5.5100	0.8100	0.9000	0.5500
Germany	1.4500	-5.4000	2.1800**	0.8500	0.4600
Greece	1.5500	-2.9200	-0.4600	-0.6400	-1.2900
Iceland	-0.6000	-2.4100	NA	NA	-0.5000
Italy	0.5600	-3.0400	1.0400	1.0400	1.0600
Netherlands	-0.2500	-20.9900	0.9100	1.1000	0.0100
Norway	0.2900	-7.5300	-0.5900	-0.5900	0.2100
Portugal	0.1800	-7.2400	0.4800	0.1200	0.0600
Sweden	1.5600	-10.2100	2.47**	2.6600**	1.5700
Switzerland	0.4700	-8.4700	0.7600	1.8100	1.4300
United Kingdom	0.7800	-5.1500	0.8100	-0.1500	0.7000
United States	-0.2900	-7.6300	0.0500	0.3700	0.2900
Emerging					
Colombia	1.0900	-2.6300	1.0500	0.7300	0.1100
Czech Republic	-3.3000	-4.7200	-1.4900	-1.3300	-2.6200
Phillipines	0.5100	-3.7300	1.1100	1.2000	-0.1000
South Africa	2.8300	-7.5100	-0.6500	-0.3000	-0.1800
South Korea	0.3400	-10.5900	-0.2900	-0.2400	-0.5700
Thailand	1.5400	-3.3900	2.0900	2.0400	1.9000
Emerging with HyperInflation					
Argentina	-1.5400	-0.4100	-1.1500	-1.6300	0.5100
Brazil	-3.8900	-1.7700	-4.6500	-4.5000	-4.2600
Peru	0.4300	-1.3800	-0.1500	NA	NA
Mexico	-0.8200	0.9200	-2.1000	-1.9000	-1.4100

*significant 10%

** significant 5%