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**Article**

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**Potential output, output gap and high inflation in Argentina (2007-2015)\***  
*El producto potencial, la brecha del producto y la inflación en Argentina (2007-2015)*

LUCIANO CAMPOS\*\*

**Abstract**

*I investigate the causes of the high inflation Argentina experienced from 2007 to 2015. To do so, I estimate the potential output and the output gap using the Blanchard-Quah decomposition for this country and compare it to the estimations I obtained for other economies in the region where inflation was kept under control. I find that there are some country specific patterns in Argentina that can explain the high inflation observed during the analyzed years. First of all, Argentinean potential output grew at a slower pace than the rest of the countries, most notably since 2011. Second, there has been in Argentina a positive and increasing output gap since 2007, which was highly correlated with the inflation rate. Last, a comparison between the actual interest rate and the one derived from an ex-post monetary policy rule reveals that monetary policy was too loose in Argentina but that has not been the case in the rest of the countries. The policy implications of these findings are straightforward: Argentina could have reduced inflation by following a monetary rule, just like the rest of the Central Banks in the region seem to have done.*

Key words: *Potential output, Output gap, Inflation, Argentina, Structural VARs.*

JEL Classification: *C32; E31; E58.*

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## Resumen

*Este trabajo investiga las causas de la alta inflación que experimentó Argentina de 2007 a 2015. En particular, se calcula el producto potencial y la brecha del producto utilizando la descomposición de Blanchard-Quah para este país y se la compara con las de otras economías de la región donde la inflación se mantuvo bajo control. Se evidencia que Argentina experimentó un estancamiento en su producto potencial, así como una brecha del producto altamente correlacionada con la tasa de inflación. Asimismo, se muestra que la política monetaria fue demasiado laxa en este país.*

Palabras clave: *Producto potencial, Brecha del producto, Inflación, Argentina, Vectores autorregresivos estructurales.*

Clasificación JEL: *C32; E31; E58.*

“To people who have to live through them, high inflation becomes a source of highly costly, constant disruptions of their daily lives in the present and an obstacle to a better life in the future”. Heyman & Leijonhufvud (1995)

## 1. INTRODUCTION

Latin American countries have been struggling with high inflation for several decades with varied success. Inflation averaged 25% after World War II, during the import substitution era, and reached skyrocketing levels in the hyperinflationary episodes of the 1970's and 1980's. Later on, around the mid 1990's, all countries managed to control inflation, bringing it down to 10% or less, which was quite an achievement for the region. Since then, there were important hikes in prices which were only sporadic events that typically responded to exchange rate devaluations rather than to systematic inflationary processes. So, it seemed that, at last, high inflation in Latin America was gone for good.

While the above paragraph holds true for most of the region, Argentina has been an exception to the rule. In the 2000's, the country experienced an inflation significantly above 10% which contrasted with the lower and more stable inflation in the rest of Latin America. As shown in Figure 1, inflation in Argentina remained constantly above the Latin American average, using inflation data from: Brazil, Mexico, Colombia, Chile and Peru. And this comparison still holds if these countries are taken separately. The difference in inflation between 2007 and 2015 is quite striking: while in Argentina it averaged 25% during that time, in the rest of the region it remained typically around 5%. Why couldn't Argentina control inflation relative to similar countries in the region? Why was Argentinean inflation around five times higher than that of other economies during those years?

In this work, I intend to answer these questions by estimating the potential output and the output gap in the major Latin American economies. To perform this estimation I use a structural Vector Autoregressive (VAR) model and impose long-run restrictions as in Blanchard and Quah (1989) (BQ henceforward). My results reveal that Argentina had specific features which can help to explain its distinct inflationary outcome between 2007 and 2015. These are: first, Argentinean potential output grew at a slower pace than that of the rest of the countries; second, there was a positive and increasing output gap only in this country which was highly correlated to its inflationary path; and, third, I find that monetary policy was extremely passive in Argentina but not in the rest of the region.

The relation between output gap and inflation is in the heart of Keynesian economics and it is explicitly stated in the Phillips curve. While the empirical existence of the output-price trade off has been debated for a long time, this has not prevented the New Keynesian Phillips Curve (NKPC) from becoming the standard function to model the optimal firm's pricing decisions in imperfect competitive markets - see Galí (2008) for a detailed derivation of the NKPC-. In addition, Stock and Watson (1999) provide evidence that the Phillips curve is useful in forecasting inflation in the short-run. As a matter of fact, this function belongs now to the workhorse of Central Banks' toolkits to understand inflationary dynamics in most countries.

Using this theoretical foundation, I evidence an output-price trade off in Argentina during the analyzed years. According to my estimates, output in Argentina was below its potential level between 1994 and 2006. In those years, unemployment was running high and it even surpassed 20% mark right after the local crisis of 2001. However, the country experienced a fast recovery after the

FIGURE 1  
INFLATION IN ARGENTINA (—) AND LATAM AVERAGE (---)



Note: CPI yearly inflation. See the appendix for data sources.

crisis and, as a result, the output gap was closed around 2007 and has remained positive since then. The most important piece of evidence I present here is that there was a positive and increasing output gap between 2007 and 2015 which was highly related with the increasing inflation of that period.

After establishing the correlation between output gap and prices, I explore what was the policy reaction to this high inflation and whether its monetary authority can be held responsible for not curtailing it. In particular, I measure quantitatively to what extent monetary policy was biased towards passiveness during these inflationary years in Argentina. To address this question, I follow the methodology proposed by Orphanides (2002), who compares the actual interest rate with the one obtained by a Taylor-type monetary policy rule. The evidence presented here reveals that Latin American countries did follow a Taylor rule, but Argentina did not. Particularly, my estimates indicate that the interest rate in Argentina was at least 10% lower on average than a rate proposed by a standard monetary policy rule.

Although there are many papers that study high inflationary processes in Argentina, only a few of them deal specifically with the one of 2007-2015. Certainly because this is too a recent period to study<sup>1</sup>. In fact, there are only two closely related works: the one of Damill *et al.* (2015), who analyze the period 2002-2013 and state that stagflation observed in Argentina since 2011 was due to “a shortsighted strategy that sought to stimulate aggregate demand disregarding the impacts on inflation, the balance of payments and the fiscal deficit”. And the one by Gerchunoff and Rapetti (2016), who do a historical analysis of Argentina for the period 1930-2015 and find that, since 2008, “economic policy was based on fiscal and monetary expansion to satisfy social aspirations”. Although both of these works are implicitly assuming that the Argentine economy was growing above its potential level during those years, they do not provide formal evidence of the existence of a positive output gap. The present paper intends to fill this gap<sup>2</sup>.

This work also presents potential output and output gap estimates for the rest of Latin American countries. The intention of showing cross-country evidence is to see whether the estimates are substantially different and, consequently, can add robustness to the paper’s conclusions. Indeed, the results indicate that, in the rest of the region, there was no potential output stagnation, nor an output

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<sup>1</sup> Among the several works that study inflationary dynamics in Argentina, the interested reader can consult Heymann and Leijonhufvud (1995), Dabús (2000), Marcet & Nicolini (2005) and Basco *et al.* (2009).

<sup>2</sup> D’Amato and Garegnani (2009) study the short-run dynamics of inflation during the period 1993-2007 by estimating an hybrid New Keynesian Phillis Curve with GMM. The authors evaluate parameter’s stability before and after the exchange rate regime shift in 2002. They conclude that the output gap loses explanatory power after 2002, when inflation becomes more persistence. On the contrary, the evidence presented below shows that the output gap became positive around 2007, coinciding with a further increase in inflation. From a policy perspective, the results presented here can be interpreted as a deliberate intention of the government to exploit the short-run Phillips Curve trade-off.

gap as high and persistent as in Argentina, nor any significant deviation from a standard money rule.

The rest of the paper is structured as follows. Section 2 introduces the methodology used, which is based on the BQ decomposition to obtain the potential output and the output gap from the series of output growth and unemployment. In section 3, I present the evidence for Argentina and the rest of my case studies from where the main results of the article are derived. I also show how I do the counterfactual comparison between the actual interest rate and the one of the *ex-post* Taylor-type rule. This allows to see whether there was a strong deviation between them. In addition, the results of a structural break test are shown, as well as the estimates of an alternative specification of the model. Both of these results are reashuring of the evidence presented here. Section 4 concludes and briefly discusses the policy implications of the results obtained in this work.

## 2. METHODOLOGY

The estimation of the potential output and output gap can be performed in several ways. The most common strategy is to use statistical tools (like HP filters), to estimate a functional form of a production function (like a Cobb-Douglas function) or to apply the method by BQ. Every estimation has its pros and cons, but the one proposed by BQ has the benefit of being based on a minimal set of assumptions on which there is a wide consensus among economists: i.e., that supply shocks have permanent effects on output while demand shocks have only transitory effects. This attribute of the BQ method is an advantage when compared to a more restrictive production function estimation, and it has provided more complex dynamics than a statistical estimation (see Dupasquier *et al.* (1999)). In addition, cross-country comparison using the HP filter with a single smoothing parameter may be problematic because of potentially different domestic cycles lengths, as stated by Canova (2007)<sup>3</sup>.

As any identification scheme, the BQ method is not immune to critiques. In particular, Faust and Leeper (1998) pointed out the risk in the interpretation of supply and demand shocks in a low-dimensional model. However, the omitted variable problem is still present in any other identification scheme and even in the Dynamic Stochastic General Equilibrium (DSGE) modeling framework<sup>4</sup>.

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<sup>3</sup> The results shown in this paper are not robust to an estimation of the potential output and the output gap using the output's HP filtered trend and cyclical components, respectively. In particular, HP filter estimates do not indicate that Argentinean potential output was so stagnant, nor that its output gap was significant after 2009. This lack in robustness is the natural result of the HP filtering method, which tends to provide a smoother potential output and, consequently, a narrower output gap estimate than the BQ decomposition. This robustness check is not shown here but it is available upon request.

<sup>4</sup> Benati (2012) overcomes the low dimensionality problem by including real money growth and the long-short spread of sovereign bonds in the VAR model. Below, I show that the results do not change significantly under this alternative specification.

Another critique can come from the fact that we are assuming that the underlying economy has a specific structure where demand shocks have no long-run effects. As a matter of fact, Keating (2013) shows that the dynamics of demand shocks might be different under certain circumstances. Despite these warnings, the BQ method remains as a valid identification scheme in the structural VAR literature because of its minimal, and widely accepted, identifying restrictions.

In the BQ decomposition, potential output can be interpreted as the evolution of output when only supply shocks are active, while the output gap can be obtained by setting on demand shocks only. Many studies perform similar estimations of potential output and output gap: e.g., Elosegui *et al.* (2006) employed the BQ decomposition to determine potential output in Argentina from 1980 to 2004, and Benati (2012) to estimate the potential output drop in some developed economies after the 2008 financial crisis.

The starting point is the following structural VAR model:

$$Y_t = C(L)e_t$$

where

$$Y_t = \begin{bmatrix} \Delta y_t \\ U_t \end{bmatrix} \quad ; \quad e_t = \begin{bmatrix} e_t^s \\ e_t^d \end{bmatrix}$$

and  $\Delta y$  is output growth,  $U$  is the unemployment rate and  $e^s$  and  $e^d$  are supply and demand shocks, respectively. In addition,  $C(L)$  are structural coefficient matrices with  $L$  as lag operator. If  $C(L)$  is invertible, then:

$$\begin{aligned} C(L)^{-1}Y_t &= e_t \\ B(L)Y_t &= e_t \end{aligned}$$

where  $B(L) = C(L)^{-1}$ . Considering  $B(L) = B_0 - B_1L - B_2L^2 - \dots - B_pL^p$ , the process has the following structural VAR representation:

$$\begin{aligned} Y_t &= B_0^{-1}B_1Y_{t-1} + B_0^{-1}B_2Y_{t-2} + \dots + B_0^{-1}B_pY_{t-p} + B_0^{-1}e_t \\ (1) \quad Y_t &= A_1Y_{t-1} + A_2Y_{t-2} + \dots + A_pY_{t-p} + A_0e_t \end{aligned}$$

where  $A_i = B_0^{-1}B_i$  for  $i = 1, 2, \dots, p$  and  $A_0 = B_0^{-1}$  is the impact matrix. Although the  $A_0$  matrix is crucial to obtaining the structural shocks from the reduced-form disturbances, the BQ identification is performed instead considering the long-run effects of the structural innovations. These can be calculated from (1) by setting:

$$(I_K - A_1L - A_2L^2 - \dots - A_pL^p)Y_t = A_0e_t$$

where  $K$  is the VAR dimension. Then, we can easily obtain the long-run impact matrix by:

$$\begin{aligned}
 Y_t &= (I_K - A_1L - A_2L^2 - \dots - A_pL^p)^{-1} A_0 e_t \\
 Y_t &= [I_K - A(L)]^{-1} A_0 e_t \\
 Y_t &= [I_K - A(1)]^{-1} A_0 e_t \\
 Y_t &= \Xi_\infty e_t
 \end{aligned}$$

where:

$$(2) \quad \underbrace{\begin{bmatrix} \Delta y_t \\ U_t \end{bmatrix}}_{\hat{Y}_t} = \underbrace{\begin{bmatrix} \xi_{11} & \xi_{12} \\ \xi_{21} & \xi_{22} \end{bmatrix}}_{\Xi_\infty} \underbrace{\begin{bmatrix} e_t^s \\ e_t^d \end{bmatrix}}_{e_t}$$

Now, the BQ identification implies that in (2), the long-run multiplier  $\xi_{12} = 0$ ; i.e., there is no effect of demand shocks over output growth in the long-run.

Next, the following VAR( $p$ ) reduced-form model is estimated for each country:

$$(3) \quad Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + u_t$$

where  $u_t \sim \mathcal{N}(0, \Sigma_u)$  are the reduced-form residuals<sup>5</sup>. Following Stock & Watson (2002), whenever I detect the presence of outliers (identified as observations that differ from the sample median by more than the sample interquartile range), I replace these observations with interpolated values (using the median of the six adjacent observations). In addition, an augmented Dickey-Fuller test reveals that non-stationarity in unemployment is present for all countries and is removed *via* linear detrending<sup>6</sup>.

In order to select the lag order, I use a maximum lag of eight quarters and I follow Ivanov & Kilian (2005), who recommend the Hannan-Quinn criterion for quarterly VARs with sample sizes bigger than 120 observations and the Schwarz Information for smaller samples. The lag order is changed whenever residual autocorrelation is detected. I also verify non-normality to be present in most of the countries' VAR residuals. However, as noted by Berkowitz &

<sup>5</sup> The VAR model (3) is estimated using the longest data sample availability for each country at the time of writing the paper. See the appendix for details.

<sup>6</sup> The sampled period used here for Argentina (1980-2015) includes several regimes with potential structural breaks. Below, I show the results of a Chow test where the null of no structural break cannot be rejected.



Kilian (2000), bootstrapping techniques, used here to characterize uncertainty around the estimates, reduce the risk of working with non-normal residuals<sup>7</sup>.

Once the matrices of coefficients  $A_i$  and the reduced-form variance-covariance matrix  $\Sigma_u$  are estimated, I can obtain the impact matrix  $A_0$  as in Lutkepohl (2005). In particular, I use the following expression:

$$A_0 = [I_K - \hat{A}(1)] * chol \left\{ [I_K - \hat{A}(1)]^{-1} \Sigma_u [I_K - \hat{A}(1)]^{-1} \right\}$$

where *chol* is the ‘lower’ Cholesky operator. As it becomes clear comparing (1) with (3), the structural shocks are a linear combinations of the VAR’s reduced-form residuals. Hence, the former can be recovered from the latter using the estimated impact matrix  $A_0$ :

$$\underbrace{\begin{bmatrix} e_t^s \\ e_t^d \end{bmatrix}}_{e_t} = A_0^{-1} \underbrace{\begin{bmatrix} u_t^1 \\ u_t^2 \end{bmatrix}}_{u_t}$$

I then rerun history conditional only on the transitory shocks. That is, I set the supply shocks  $e_t^s = 0$ . By doing this, I am left with the cyclical component of output, i.e., the output gap ( $\tilde{y}$ ):

$$(4) \quad \begin{bmatrix} \tilde{y}_t \\ \tilde{u}_t \end{bmatrix} = \hat{A}_1 \begin{bmatrix} \tilde{y}_{t-1} \\ \tilde{u}_{t-1} \end{bmatrix} + \hat{A}_2 \begin{bmatrix} \tilde{y}_{t-2} \\ \tilde{u}_{t-2} \end{bmatrix} + \dots + \hat{A}_p \begin{bmatrix} \tilde{y}_{t-p} \\ \tilde{u}_{t-p} \end{bmatrix} + \underbrace{\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}}_{A_0} \underbrace{\begin{bmatrix} 0 \\ e_t^d \end{bmatrix}}_{e_t}$$

It is worth noting that the first  $p$  observations of the output gap will be 0 in my estimation, which is unrealistic. However, the effect of these misspecified initial conditions should not have a significant impact in the estimation as we move to the subsequent periods. In fact, the reader can verify in the following section that, as I am mainly concerned with the period 2004-15, the initial estimated values should not impact my overall conclusions.

Next, I can get an estimate of the logarithm of potential output by subtracting the cyclical component from the original log of output:

$$\bar{y}_t = y_t - \tilde{y}_t$$

Finally, I repeat this procedure 2,000 times by doing bootstrapping from the original VAR residuals estimates. Therefore, I can characterize uncertainty

<sup>7</sup> Residuals’ tests are not presented here but are available upon request.

around the estimates with the distributions of the potential output and output gap obtained for each country.

### 3. EVIDENCE

The results are splitted into two subsections: the first consists in some general results for Argentina from 1980 to 2015, and the second is a comparison between the countries analyzed from 2004 to 2015. The first subsection intends to introduce the phenomena being studied, i.e. the evolution of potential output and the output gap. While the second subsection shows evidence supporting the specificity of Argentinean performance and its relationship with the high inflation observed since 2007. In addition, a third subsection is devoted to a structural break test and to an alternative specification of the model. It is shown there that there is no evidence of structural change, neither of lack of robustness to an augmented version of the baseline model.

#### 3.1. General results for Argentina (1980-2015)

Figure 2 presents the median estimates of the logarithm of potential output and the output gap in Argentina together with the 68% confidence intervals for the whole sample period, from 1980:Q1 to 2015:Q4. These estimates can help us to interpret the country's economic outcome in the last decades.

As can be seen from the top panel, during the 1980's potential output was stagnant. In fact, this period has been called the *lost decade* because of the output stagnation –see Kydland and Zarazaga (2002)–. In addition, this was an hyperinflationary period with an average annual inflation rate of 200% and peaks of 4000% by the end of the 1980's. However, as the lower panel of Figure 2 shows, there is no evidence of any significant output gap during those years. In fact, hyperinflation of the 1980's was quite a different phenomenon from the moderately high inflation of the 2000's. While the former was not related to the output gap, the latter was, as will be shown below.

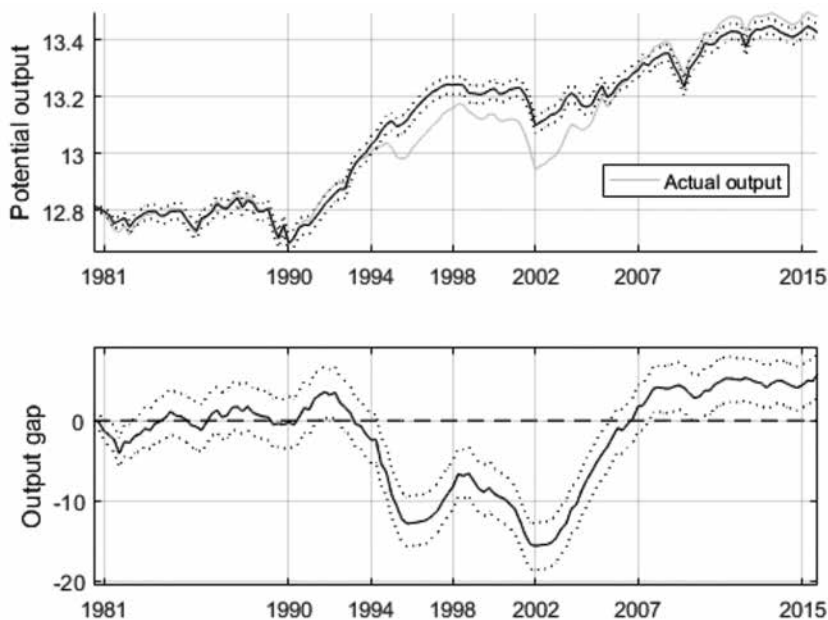
The top panel of Figure 2 also shows that potential output grew steadily during the 1990's<sup>8</sup>. During this decade, there was a strong boost in private investment while the country went from relative autarky to a fairly open economy. At the same time, policy makers successfully controlled inflation, which was brought down to an average of 1%, and even to disinflation, by the end of the decade.

One of the main features of the 1990's was the adoption of a hard peg known as the *convertibility plan*. While being successful in controlling inflation and in enhancing investment during the first part of the decade, the *convertibility plan* became unfitted to protect the country from external shocks in the second half. As a matter of fact, the fixed exchange rate might well have amplified the local

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<sup>8</sup> Similar estimates were obtained by Elosegui *et al.* (2006).

FIGURE 2  
ARGENTINA: MEDIAN (—) AND 68% CI (...)



Note: The potential output and the output gap are based on 2,000 bootstrap replications of estimated VAR model. As the estimates are only significant at a 68% level, no other confidence intervals are presented in the figures.

effects of external disturbances. My estimates indicate that actual output was below its potential level during most of that decade<sup>9</sup>. In particular, Argentina was strongly affected by the Mexican and Brazilian currency devaluations of 1994 and 1998, respectively. Actually, as shown in the first panel of Figure 2, the economy seemed unable to recover from the Brazilian devaluation as it experienced a *plateau* in its potential output from 1998 to 2002, the year in which Argentina suffered a strong contraction because of a financial crisis. The second panel of Figure 2 shows that the output gap became negative in 1994. Although this is not the main goal of this work, one interesting observation is that the output gap estimation in Argentina can be related to the low, even negative inflation of the late 1990's.

After the 2002 crash, the economy showed an impressive recovery that, with the exception of the worldwide financial crisis of 2009, lasted until 2011. An important driver of this recovery may have been the real exchange rate increase after the abandonment of the *convertibility plan* and the currency devaluation

<sup>9</sup> Estimates are in line with Meloni (2005).

in January 2002, together with the 2000's commodity boom. With favorable terms-of-trade, the country was able to rapidly close its output gap.

However, potential output started to grow weakly in 2007 and the output gap became positive from then on. Additionally, potential output stagnated in 2011 and experienced another *plateau* until the end of the sample in 2015. In fact, the increase in the output gap observed since 2007 can be viewed as a manifestation of the economy's overheating. In what follows, I claim that this positive output gap can explain the high inflation Argentina experienced from 2007 to 2015.

### 3.2. Main results for Argentina and the other Latin American countries (2004-2015)

While Figure 2 provides important insights into the relationship between potential output, the output gap and inflation, these are largely descriptive results. To study the main questions of this work, in Figures 3 to 6 I turn to a more detailed analysis comparing the results of Argentina with those of the other Latin American comparable countries: Brazil, Chile, Colombia, Mexico and Peru. This selection of countries is based on them being the most important economies in the region<sup>10</sup>. Because my intention is to explain the high inflation Argentina has experienced in the years 2004-2015, I will focus on the estimates obtained for that period. As explained in detail below, I find that there are some specific characteristics in Argentina that can explain the high inflation during those years.

Figure 3 shows logarithms of each country's real GDP together with the estimated median of potential output and the 68% confidence bands. As can be seen, all comparable countries show similar potential output paths: an important growth from 2004 until 2008, a contraction in 2009 during the international crisis and a recovery starting on 2010 with a sustained growth until the end of the data sample. However, Argentinean potential output became stagnant in 2011. In other words, once the effects of the 2009 crisis were overcome, the rest of the Latin American countries continued with their sustained growth in potential output, but Argentina did not.

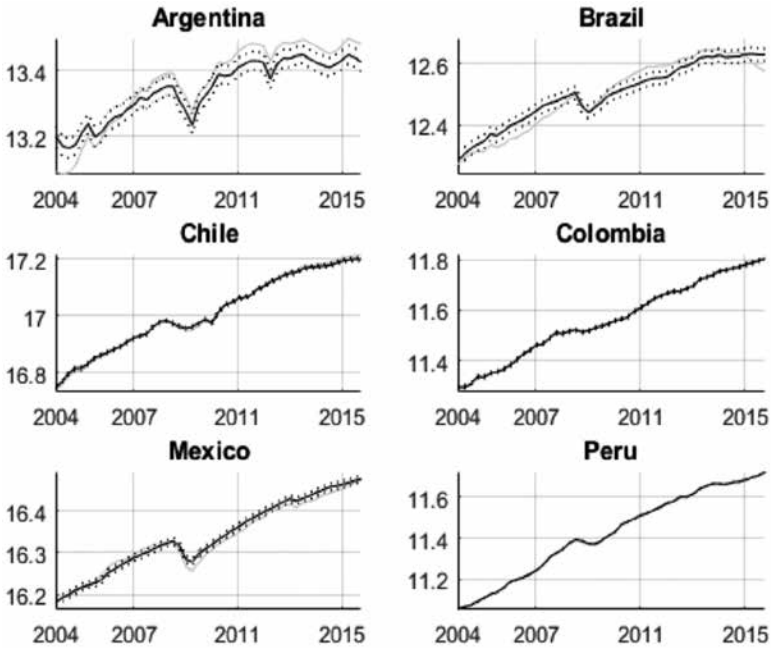
The fact that Argentinean potential output did not follow the same trend as the rest of the countries reflects a supply-side negative contribution to growth. Heymann & Ramos (2010) argue that supply-side contribution to growth became weak in 2010 because of a drop in the real exchange rate. These authors, as well as Frenkel (2008), claim that the high real exchange rate observed after 2002 acted as a positive productivity shock for Argentina, though its effects were fairly dissipated by 2005.

Another observation from Figure 3 is that actual output in Argentina was systematically above its potential level since 2007, while no such strong deviation

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<sup>10</sup> Venezuela is also among the major Latin American economies but it is excluded from the control group due to lack of recent data on inflation. Nevertheless, it is worth pointing out that Venezuela is the other exception in the region of a high inflationary country during the 2000's, besides Argentina.

FIGURE 3  
ACTUAL OUTPUT (—), POTENTIAL OUTPUT (—) AND 68% CI (…)



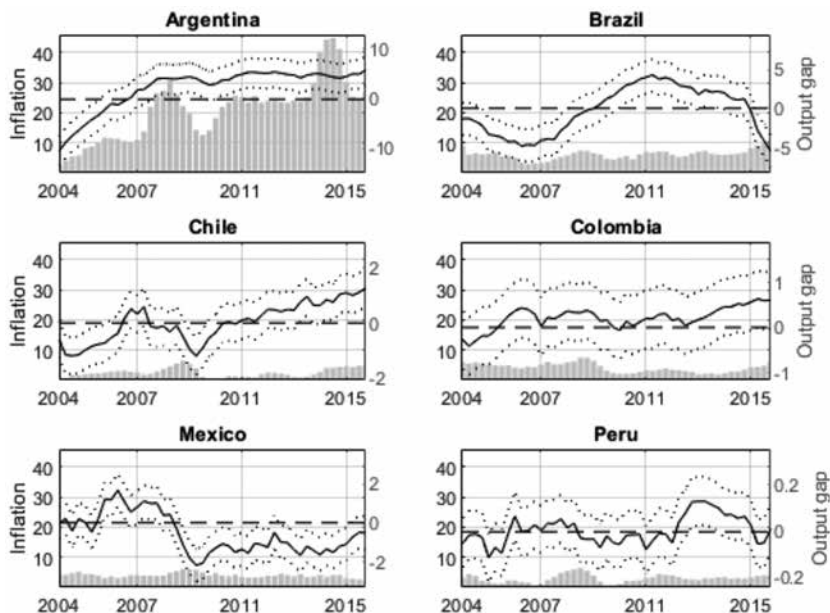
Note: The potential outputs are based on 2,000 bootstrap replications of estimated VAR models.

is observed for the rest of the countries. Brazil experienced a deviation of actual output from the potential level, but neither as significant nor as persistent as the one of Argentina. Chile also had an actual output slightly above its potential level from 2012, while Mexico's actual output has been below its potential level since 2008. As for Colombia and Peru, the estimations indicate that their actual outputs were fairly on their potential levels during the analyzed years. These results become clearer when looking at the output gap estimates below.

In Figure 4, I present the inflation rate and the output gap median estimate together with the 68% confidence bands. All countries' graphs are scaled for Argentinean values in inflation (left axis), although the output gap estimates (right axis) are in each country's idiosyncratic scale. This figure shows more clearly the deviations from potential output mentioned previously, i.e. the output gap.

Figure 4 shows the most important finding of the article, i.e., that Argentina was the only country which had both an output gap and inflation. The estimates indicate that the output gap turned positive in 2007 and remained significantly positive since then. During that year, inflation jumped from 10% to 20% and remained around 25% from 2008 on. In addition, the output gap and inflation were highly correlated in Argentina but not in the rest of the countries, as shown in Table 1 below. This suggests the existence of a Phillips curve trade off in

FIGURE 4  
INFLATION (●), OUTPUT GAP MEDIAN (—), 68 % CI (···) AND 0 OUTPUT GAP (— —)



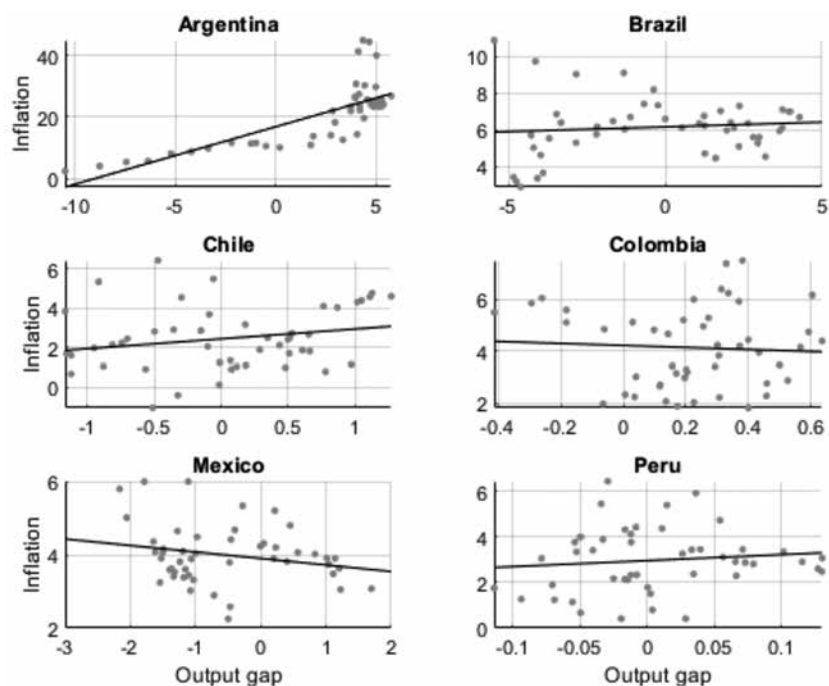
Note: The output gaps are based on 2,000 bootstrap replications of estimated VAR models.

Argentina during those years. Figure 5 shows a scatter plot and a linear fit of the inflation-output gap relation to support the evidence of a Phillips Curve only in Argentina.

The rest of the countries do not show a significantly positive output gap, with the exceptions of Brazil (between 2010 and 2013) and Chile since 2013. In the case of Brazil, the output gap looks more like a transitory phenomena and does not present the persistence observed in Argentina. In fact, the inflation rate remained fairly constant at a 6%, which was the standard rate for the country during those years. As for Chile, there does seem to be a positive comovement between output gap and inflation since 2013 (or probably before) which can be the explanation in its raising level of inflation. In any case, the allegedly macroeconomic misalignment in Chile is nothing compared to the Argentinean one during the analyzed years because both inflation and the output gap were much higher in the latter than in the former country. As plotted in Figure 4, the output gap point estimate has been around 5 for Argentina since 2007, while it barely surpassed 1 in Chile during 2015<sup>11</sup>.

<sup>11</sup> An estimation of a New Keynesian Phillips Curve can be done instead of relying on the output gap and inflation correlation. But, as one of the main goals of this study is to

FIGURE 5  
PHILLIPS CURVE AND LEAST SQUARES FIT (—)



Note: The output gaps are based on 2,000 bootstrap replications of estimated VAR models.

One possible reason for an output gap-inflation trade off being present in Argentina but not in the rest of the region could result from the different monetary policies these countries implemented. In order to compare the policy reactions among the countries of study, I plot the actual interest rates in each country along with those proposed by a standard monetary rule. This is a similar exercise as the one performed by Orphanides (2002), who investigated whether the Fed can be held responsible for the high inflation episodes in the US during

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provide evidence of an output-inflation trade-off in Argentina specifically for the period 2004-2015, this would consist in a too short sample to estimate. For longer data samples, linear regressions have been done to check for a significant output gap component in both a forward/backward-looking and backward-looking Phillips Curves for Argentina. In both cases the output gap coefficient was significant at the 95% confidence level. For the rest of the countries, a backward-looking Phillips Curve indicated no significant output gap component for the case of Brazil, Mexico and Peru, and a significant one for the case of Chile and Colombia. These estimates are not presented here, but are available upon request.

the 1970's. Here, I compare the actual interest rate with the one of an *ex-post* monetary rule<sup>12</sup>.

I use the following rule proposed by Lubik and Schorfheide (2007), which is a modified version of the one in Taylor (1993):

$$(5) \quad R_t^* = \pi^* + \rho_R R_{t-1} + (1 - \rho_R) \left[ \phi_\pi (\pi_t - \pi^*) + \phi_y \tilde{y}_t + \phi_e \Delta e_t \right]$$

where  $R^*$  is the monetary policy rule rate,  $R$  the actual interest rate,  $\rho_R$  is a smoothing parameter,  $\pi$  is the inflation rate,  $\pi^*$  is the inflation target,  $\phi_\pi$  is the inflation parameter,  $\tilde{y}$  is the median estimation of the output gap obtained in (4),  $\phi_y$  is the output gap parameter,  $\Delta e$  is the nominal exchange rate depreciation and  $\phi_e$  is the exchange rate parameter.

Equation (5) is a standard Taylor rule for a small open economy in which the nominal exchange rate is included as a relevant policy variable. Taylor (2001) used a similar rule to explain the role of the exchange rate in monetary policy rules, while Lubik & Schorfheide (2007) estimated (5) to verify if a selected group of developed small open economies considered their nominal exchange rates when setting their monetary policies.

The way the parametrization is done is particularly relevant to the counterfactual comparison between the monetary policy rule rate  $R^*$  and the actual one  $R$ , as I perform here. Instead of estimating this function for every country, the parameters in (5) are set as the benchmark prior values used by Lubik and Schorfheide (2007) in the Bayesian estimation of the monetary rule. This parametrization fulfils the conditions of determinacy typically implied in a monetary policy rule of this sort, as explained in detail by Woodford (2003). In particular, a too high output gap parameter might be “dangerous” for inflationary dynamics, whereas the inflation coefficient needs to be higher than 1 to meet the *Taylor principle*. Or as Orphanides (2002) put it, it is typically considered  $\phi_\pi > 1$  to be “a strong systematic response to inflationary developments in the economy”. Here, the baseline parameters are set to  $\phi_\pi = 1.5$  and  $\phi_y = 0.25$ . As for the rest of the rule's parameters, they are calibrated as  $\phi_e = 0.25$  and  $\rho_R = 0.5$ .

Next, a common inflation target is needed. Although it is questionable to set an equal inflation target in all countries, I find  $\pi^* = 5$  to be a reasonable target for these economies, keeping in mind that the average inflation was 4%

<sup>12</sup> The reader must be aware that it is questionable to perform such an exercise. In first place, there is a lot of controversy around the effectiveness of Taylor-type monetary rules. As a matter of fact, Woodford (2001) states that monetary policy cannot act alone against inflation and has to be coordinated with fiscal policy. Secondly, Orphanides & van Norden (2005) claim that the output gap might not be operationally useful to control present inflation because real time data at Central Bank's disposal is imperfectly estimated. And thirdly, it is debatable whether we can apply the same rule to different Latin American countries. However, this exercise is appealing because it is easily interpretable due to the popularity of the Taylor type monetary rules in the literature.

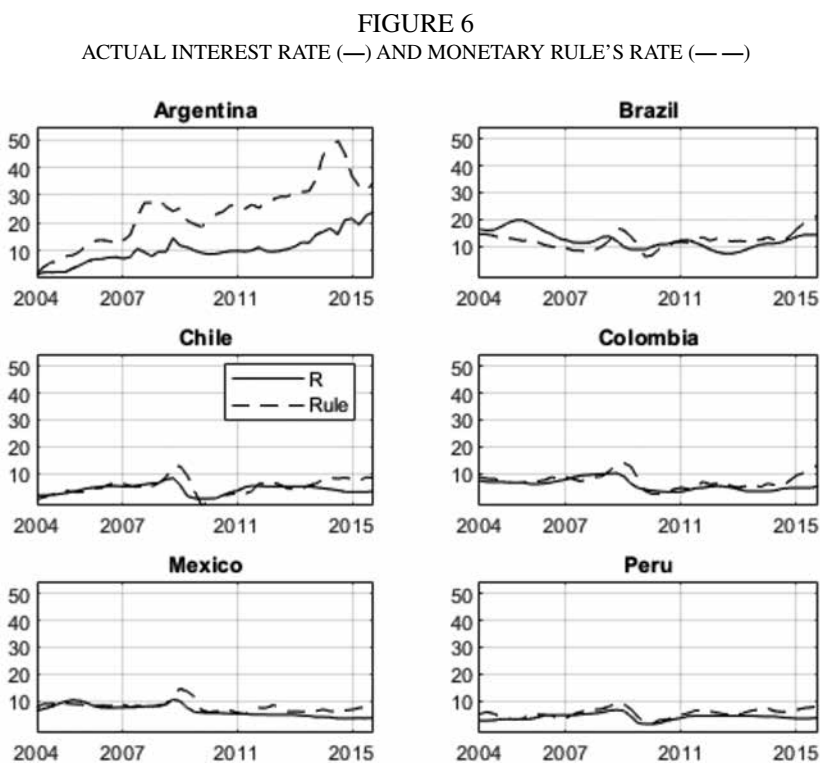


in most of the countries for the analyzed period. Alternatively, the results can be interpreted as the ones needed to reach at least a 5% inflation rate.

In Figure 6, I plot the actual interest rate in each country together with the one obtained with the monetary rule (5). By comparing their evolution, we can see that the monetary policy was extremely loose in Argentina. In particular, the rule indicates that the interest rate should have been 13.3% higher on average to meet a 5% inflation target, as described in Table 1. In turn, no significant deviation from the rule's rate can be observed in any of the other countries.

The plots shown in Figure 6 are sensitive to the values of the policy parameters to a limited extent only. Firstly, the results are mostly sensitive to the inflation parameter  $\phi_\pi$ : lower values of this coefficient deliver a lower deviation of the rule's rate from the actual interest rate in Argentina. If the parameter is set to  $\phi_\pi = 1.1$ , which still satisfies the *Taylor principle*, then the deviation from the rule's rate would be 10.2% on average for the country, which is still in line with the baseline results.

In addition, changes in the rule's rate output gap parameter  $\phi_y$  can deliver different results. A "countercyclical response to the business cycle", as proposed



Note: The monetary rule's rates were calculated using the output gaps median estimates based on 2,000 bootstrap replications of the VAR models.

TABLE 1  
OUTPUT GAP, INFLATION CORRELATION AND MEAN DEVIATION  
FROM MONETARY RULE

	$Corr(\tilde{y}, \pi)$	$Mean(R_t^* - R_t)$
Argentina	0.8	13.3
Brazil	0.1	-0.2
Chile	0.2	1.1
Colombia	-0.1	1.5
Mexico	-0.2	1.5
Peru	0.1	1.5

Note: Based on 2,000 bootstrap replications of the estimated VAR models using data from 2004:Q1 to 2015:Q4.

by Orphanides (2002), implies that  $\phi_y > 0$ . In an alternative specification, setting  $\phi_y = 0.1$  does not deliver a different deviation from the rule's rate. On the other hand, a greater policy activism compatible with a coefficient of  $\phi_y = 1.5$  would result in a deviation from the rule of 14.7%.

Last, the rule's rate is also sensitive to the exchange rate parameter  $\phi_e$ . In particular, Taylor (2001) discusses the implication of including this variable in a Central Bank's decision rule. He states that there is no clear evidence suggesting that including the exchange rate in the monetary policy rules stabilizes inflation and output. However, Lubik & Schorfheide (2007) find that the Bank of Canada and the Bank of England do respond to exchange rate movements (while the Central Banks of Australia and New Zealand do not). Setting the parameter to  $\phi_e = 0$ , as in the original closed economy monetary policy rule, results in a deviation of 11.7%; while setting it to  $\phi_e = 0.5$ , delivers a deviation from the rule of 15%. Both of these results are reassuring as to the stability of the main findings. The results of the mean deviation from a monetary rule in Argentina for different parameters' specifications are summarized in Table 2.

TABLE 2  
MEAN DEVIATION FROM MONETARY RULE, ARGENTINA

	$\phi_\pi$	$\phi_y$	$\phi_e$	$Mean(R_t^* - R_t)$
Baseline	1.5	0.25	0.25	13.3
Lower $\phi_\pi$	1.1	0.25	0.25	10.2
Higher $\phi_y$	1.5	1.5	0.25	14.7
Lower $\phi_e$	1.5	0.25	0	11.7
Higher $\phi_e$	1.5	0.25	0.5	15

Note: Based on 2,000 bootstrap replications of the estimated VAR models using data from 2004:Q1 to 2015:Q4.

In summary, the outcome shown in Table 2 indicate that Argentina deviated, on average, between 10% and 15% from the monetary rule (5), depending on the parameter specification. For the baseline specification that takes the prior values set by Lubik & Schorfheide (2007), the deviation was 13.3% on average for Argentina, while it was negligible for the rest of the countries, as shown in Table 1.

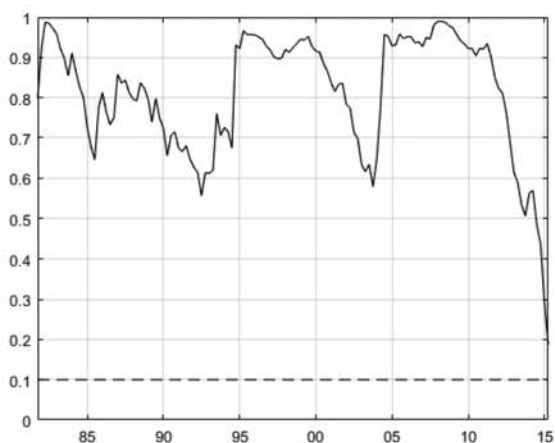
### 3.3. Structural break test and alternative specification

As the presence of a structural break would undermine the evidence shown above, this subsection presents the results of a test that verifies the stability of the estimated model's parameters. As explained below, there is no evidence of structural change. Additionally, it is shown that the results do not change significantly when estimating an alternative specification of the model.

#### 3.3.1. Structural break test

As noted by Fernald 2007, long-run restrictions are very sensitive to low frequency correlations. In particular, he shows that a small change in the long-run relationship between variables may have a significant effect on the higher frequency IRFs. The sampled period used here for Argentina (1980-2015) includes several regimes with potential structural breaks. In fact, a visual inspection of unemployment series suggest that there might have been a structural break in 1994 and another in 2006. However, a standard Chow test does not reject the null of no structural break for neither of these periods.

FIGURE 7  
CHOW TEST, P-VALUES



Note: Based on 2000 bootstrapped replications of estimated VAR model of Argentina.

In addition, a Chow forecast test based on 2,000 bootstrapped replications of the estimated VAR is done using JMulti software provided by Lutkepohl (2005). This test is based on comparing forecasts with actually observed values and provides p-values based on the bootstrapped replications for each point. The main advantage of this test when compared with a standard Chow test is that it allows to search for structural breaks over all data points instead of imposing a specific date. Whenever the p-value is below 10%, the null of no structural break is rejected at that particular period. As shown in Figure 7, there is no evidence of structural break either.

### 3.3.2. *Alternative specification*

In Benati (2012), a multivariate VAR is used to estimate potential output. In particular, Benati uses real money growth and the long-short spread to complement the series of unemployment and output originally used by BQ. The long-short spread is not easily available for Argentina, because long term bonds are rarely issued. However, a foreign-local spread can be built comparing the 3M-Tbill rate of US vs the local interest rate of comparable assets, as in Neumeyer & Perri (2005).

Next, I do a robustness check comparing the baseline results, which uses only unemployment and output growth (as in BQ), with the alternative setup including real money growth and the foreign-local spread (as in Benati). The results are displayed in Figures 8 and 9.

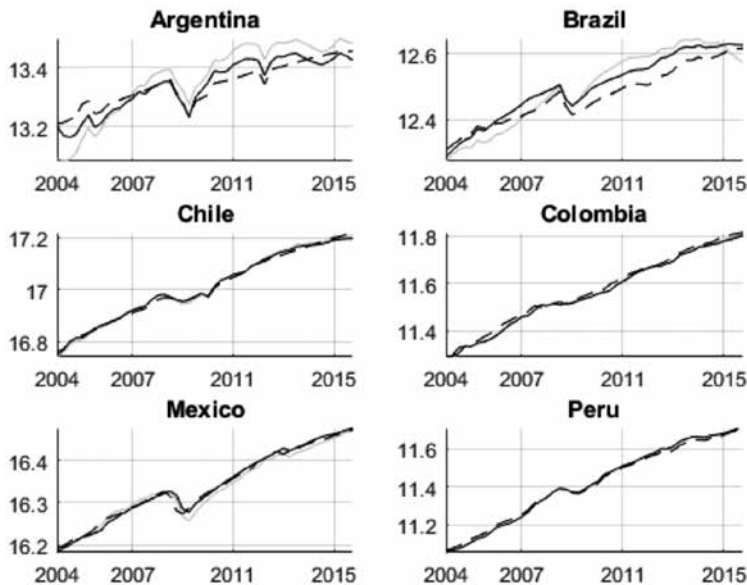
One of the findings of the manuscript is that Argentinean potential output becomes stagnant since 2011 while this did not happen in the rest of the countries. Figure 8 shows that this result moderates when using Benati's specification: while potential output becomes flatter in Argentina after 2009, the stagnation is not as clear as in BQ's specification. For the rest of the countries, results do not change significantly.

The second, and most important, finding of the article is that Argentina showed a positive output gap since 2007 which was highly correlated to its inflation, while this was not the case for the rest of the analyzed countries. In Figure 9, I compare the BQ output gap estimates with the Benati's ones. It can be seen that results are not significantly different, with the exception of Peru. In particular, Peru shows a stronger output gap in Benati's than in BQ's specification.

Regarding for the third piece of evidence presented in this work, that the monetary policy was too loose in Argentina when compared with the rest of the countries, there are barely any differences between both specifications. This result is omitted here, though it is available upon request.

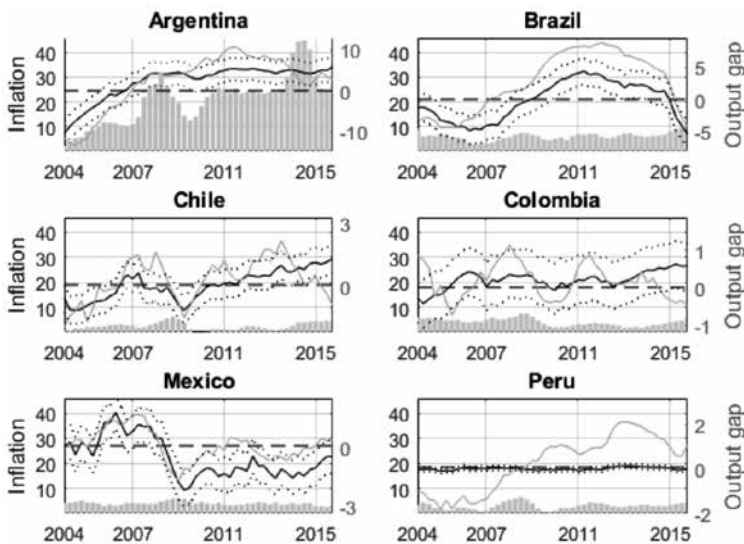
As the evidence derived from Benati's specification is not too different from the BQ one, some readers might wonder why is not the former setup used as baseline. The reason is that the null of no structural brake is rejected when the real interest rate and the spread are included in the VAR model. In particular, a Chow test similar to the one presented above indicates the presence of structural break in Argentina between 2001 and 2005. This is probably due to the big jump

FIGURE 8  
ACTUAL OUTPUT (—) AND POTENTIAL OUTPUT: BQ (---) AND BENATI (— —)



Based on 2000 bootstrapped replications of estimated VAR models.

FIGURE 9  
INFLATION (|) AND OUTPUT GAP: BQ (—) WITH 68% CI (····) AND BENATI (— —)



Note: Based on 2000 bootstrapped replications of estimated VAR models.

these variables experienced during the crisis and subsequent Argentinean sovereign debt default of 2002. Hence, BQ specification is kept as the baseline model.

#### 4. CONCLUSIONS

In this work I estimate the potential output and output gap in Argentina and the main other Latin American economies using a structural VAR model identified with long-run restrictions. My intention is to see whether this estimation can be useful to shed light on the causes of the high inflation Argentina suffered from 2007 to 2015. In fact, I find three main factors that can explain why inflation was around five times higher in this country than in the rest of the analyzed Latin American economies.

First, I find that potential output grew at a weaker pace since 2007 and was stagnant from 2011 to 2015. While in the rest of Latin America potential output also became weaker in 2007, there was no stagnation in the following years. Several reasons can explain this stagnant potential output. In particular, the previous literature states that the level of the real exchange rate had dropped in 2007 and this turned out to be a deterrent for investment in the country.

Whatever the reason for this weaker potential output was, the output gap was positive and increasing from 2007 in Argentina, which is my second finding. The rest of the Latin American countries did not show this feature, with the exception of Brazil, which did have a positive output gap from 2010 to 2015 though not as persistent as the one in Argentina. Also, I find a strong correlation between the median estimate of the output gap and inflation in Argentina. This leads to the main conclusion: that the high inflation experienced by the country from 2007 to 2015 was primarily due to the existence of a positive and increasing output gap.

Third, I verify that the monetary policy was loose during the inflationary period in Argentina. In particular, I compare the actual with an *ex-post* interest rate obtained with a standard monetary rule. I find that there was a strong deviation between them in Argentina and not in the comparable economies. According to my estimates, this deviation was between 10% and 15% on average, depending on different parameter specifications. For the baseline parameters' values, my estimates indicate that the interest rate in Argentina should have been 13% higher on average if the Central Bank had followed a standard monetary rule. Alternatively, no significant deviation is found in the rest of the countries under any parameter specifications.

In summary, my results can prove that Argentina had some country features including potential output stagnation from 2011, rising output gap since 2007 and a loose monetary policy since 2004 that can explain the high inflation of the country during the period 2007 to 2015. Furthermore, the rest of the Latin American countries analyzed here did not share these patterns and managed to keep inflation below 10% over the period. The policy implications of my results are straightforward: following a monetary policy rule can help to bring down

inflation in Argentina. However, as noted by Dabús *et al.* (2016), this might take a while because the Central Bank needs to restore its reputation after years of high inflation.

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## DATA APPENDIX

To estimate (3) I use quarterly series for real GDP and monthly series of unemployment. The data samples are: Argentina (1980:Q1-2015:Q4), Brazil (1991:Q1-2015:Q4), Chile (1986:Q2-2016:Q2), Colombia (1994:Q1-2016:Q2), Mexico (1996:Q1-2016:Q2) and Peru (2001:Q1-2016:Q2). To obtain the monetary rule interest rate in (5) I use monthly series of CPI, nominal interest rate and nominal exchange rate with a data sample from 2004:Q1 to 2015:Q4 for all countries.

The data sources are: Argentina (INDEC, BCRA), Brazil (IBGE and BCB), Chile (INE and Central Bank), Colombia (Central Bank), Mexico (INEGI and Central Bank) and Peru (Central Bank).

In the case of Argentina, the measurement of inflation done by the National Statistics Institute since 2007 has been lower than the actual inflation. For this reason, throughout this work I use the alternative estimates performed by CENDA (Centro de Estudios para el Desarrollo Argentino) from 2007 to 2010, and the ones done by the Statistical Institute of Province of San Luis from 2011 to 2015. These alternative estimates indicate that inflation was around twice as high as the official figures. Argentinian GDP was also affected by poor statistics during the analyzed period - see Camacho *et al.* (2015)-. However, this had been corrected by the time of the writing of this paper. The interest rate used for Argentina is the call rate. The results presented here about the deviation from a Taylor-type rule are not significantly altered if the fixed deposit interests rates are used instead.

Additionally, I take the free market nominal exchange rate starting on 2012 from the Argentinean newspaper *Ámbito financiero* because the official exchange rate was much lower. In any case, the official and free market exchange rates are highly correlated ( $\rho = 0.9$ ), so using one rather than the other does not alter significantly my results.

I adjust for seasonality using the X-13ARIMA-SEATS method when necessary and I convert data to quarterly frequency by taking averages within the quarter when the original frequency is higher. Finally, inflation and the depreciation rates are yearly changes in the CPI index and the nominal exchange rate, respectively.

