

## **Controlling Inflation: Applying Rational Expectations to Latin America**

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This paper examines the relationship between inflation and unemployment in three Latin American countries. Specifically, it seeks to determine if expectations regarding inflation allow for inflation and unemployment to move independently from each other. I will be studying this topic as it applies to the Latin American countries of Argentina, Brazil, and Chile, and I will be testing the usefulness of the Rational Expectations Hypothesis in understanding these relationships.

The Rational Expectations Hypothesis (REH) asserts that individuals will base expectations of future economic conditions on all information that is available to them, such as newspaper articles, statements from the Federal Reserve, and personal experience. REH assumes that people will search these sources of information because these resources will help them maximize their utility. Further, as they form their expectations, they will apply this information to a concept, model, or understanding of how the economy works, such as lessons learned in a Principles of Macroeconomics course, or an economic theory such as the Quantity Theory of Money.

The assumptions of REH have been incorporated into economic thinking, and one assertion that this has yielded is that inflation and unemployment are independent phenomena; there is no relationship between the two. This is because economic policies designed to control inflation will be expected and economic agents will adjust their behavior and negate the effects of the policy. In the absence of REH, it would seem that this would occur at the expense of a rise in unemployment. Conversely, REH asserts that a government should be able to control inflation without seeing a rise in unemployment, or a corresponding decline in economic activity. Sargent (1986) explains that when a country “changes the rules of the game” or embarks on a

new policy regime in an effort to control a rising price level, economic agents will expect inflation to fall. Therefore, it is only by completely changing policy regimes that a government will be able to reduce inflation without seeing a fall in output or a rise in unemployment.

This paper is a study of the ability of three Latin American countries, Argentina, Brazil, and Chile, to control inflation through the mechanism of a change in policy regime, without experiencing a rise in unemployment.

The success of REH in empirical studies is one of the reasons that it has become a prominent theory of macroeconomic thought. Another factor is the intellectual logic of the theory. REH asserts that people will maximize their utility by forming accurate expectations and will therefore obtain all information that is available to them at little or no cost. REH is firmly based on the simple economic principle of utility-maximization. These factors make REH an important topic in macroeconomic thought, and a worthwhile topic for this paper.

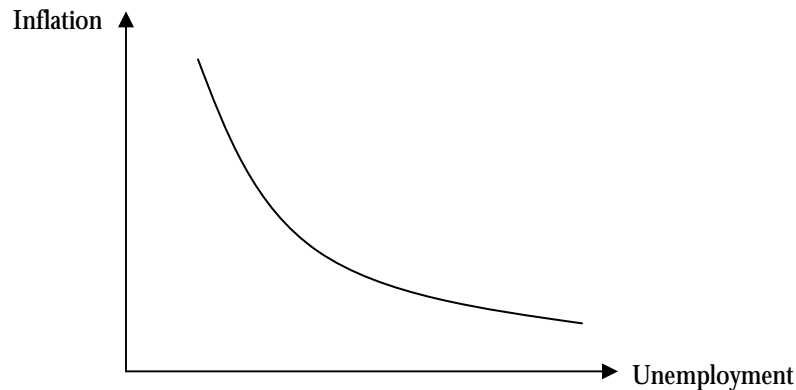
Testing REH is important because of the need to understand and accurately model the formation of expectations. This paper is an attempt to provide evidence to support the rational expectations hypothesis and consequently, increase our understanding of how expectations are formed. While this paper will not be conclusive, it will further our understanding and provide a basis for future work.

## **2. Theoretical Background**

The theoretical basis for this study rests on the expectations - augmented Phillips Curve. This is a variation of the Phillips Curve that takes into consideration the implications of REH. First, let me review the basic Phillips Curve, before proceeding into a discussion of the more complex expectations-augmented Phillips Curve.

The Phillips curve (Figure 1) represents an historical relationship between inflation and unemployment. It implies that there is a tradeoff between the two variables, so that a government may be able to reduce inflation, but only at the cost of higher unemployment (Sargent, 1986).

**Figure 1: THE PHILLIPS CURVE**

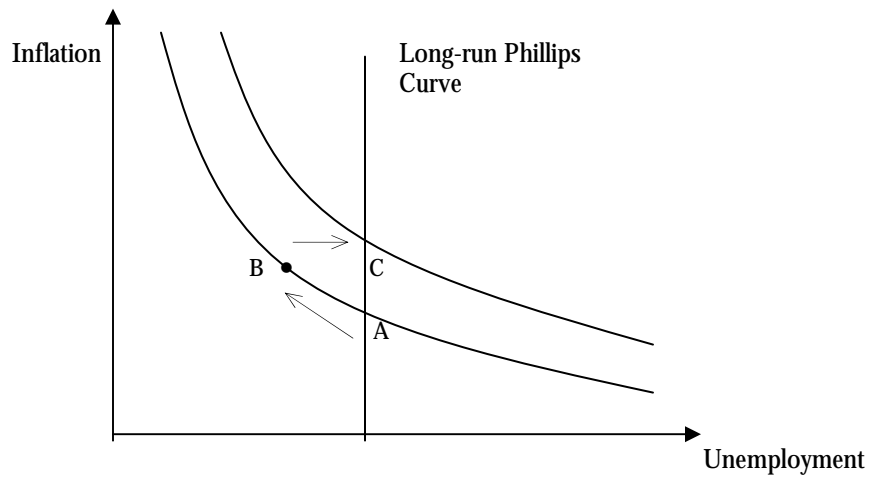


Shaw (1984) presents general information on the rational expectations hypothesis in his book. In chapter 4 on the expectations – augmented Phillips Curve, he explains the faults that proponents of Rational Expectations find in the Phillips curve augmented with adaptive expectations. The expectations-augmented Phillips curve affirms the existence of a similar relationship, but also claims that the Phillips curve may shift as well, and as a result, we will end up with a vertical, or near-vertical, long-run Phillips Curve (Shaw, 1984).

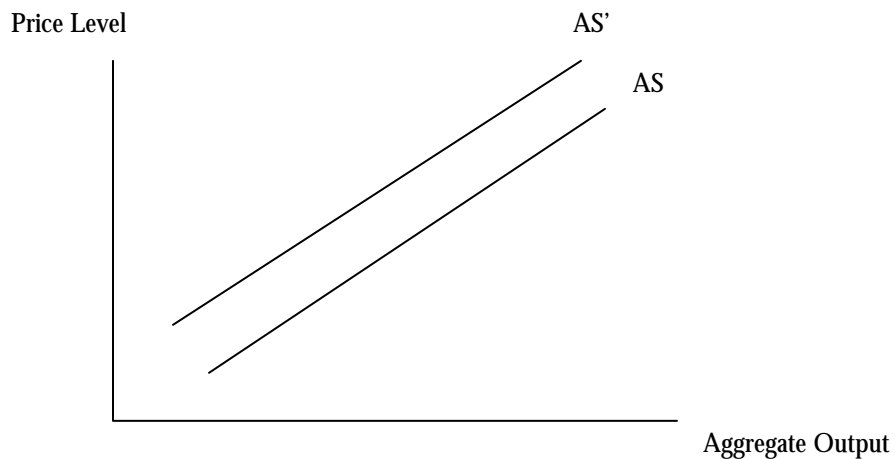
I will give the following example of what may occur in the absence of rational expectations so that we may better understand the assertions that this paper is testing. Suppose the government wants to reduce unemployment, perhaps for electoral reasons, or because it believes the country is currently above the natural rate of unemployment. It will start at the intersection near Point A in Figure 2. In order to reduce the unemployment rate, the government

may make an open market purchase of government bonds in order to increase the money supply. This expansionary policy will cause a movement along the Phillips Curve so that unemployment will fall and inflation will rise to Point B. This is a short-term position however, because in the absence of rational expectations, workers will see this decline in their real wage, and will bargain for higher nominal wages in the next contract cycle.

**Figure 2: THE EXPECTATIONS-AUGMENTED PHILLIPS CURVE**



**Figure 3: THE AGGREGATE SUPPLY CURVE**



When the government embarked on its expansionary policy, workers anticipated the accompanying increase in price level, and now factor this into their wage agreements as their contracts are up. This will raise the price of inputs to production, which will have the effect of shifting the Aggregate Supply curve inward, from AS to AS' in Figure 3. An inward shift in the aggregate supply curve causes a decline in output. This decline in output will cause an increase in the unemployment rate. Therefore, unemployment will rise again, to the level of the long-run Phillips curve. The economy however, is still at the new, higher price level. It has shifted to a new, higher Phillips Curve, where unemployment is roughly the same, but the inflation rate is higher.

I mentioned that the long-run Phillips curve is conceptualized as being vertical or near-vertical because of the forces explained above that will tend to push the economy toward this equilibrium. A consequence of this long-run Phillips Curve however, is the apparent independence of the inflation rate and the level of unemployment. In the long-run, unemployment will be constant at the long-run Phillips curve, which is positioned at the natural rate of unemployment. This level of employment will persist no matter what the inflation rate is.

Sargent (1986) argues that the Phillips Curve is vertical in the short run as well as the long run, which means that inflation and unemployment are always independent. He then advocates the effectiveness a change in regime can have in maintaining output while reducing inflation. In the third chapter of his book, Sargent analyzes four European countries and their efforts to control hyperinflation. He finds several characteristics that are common to each of the countries. The first characteristic is the enormous budget deficit that each of the countries was running at the beginning of the period. Second, each country undertook "deliberate and drastic" fiscal and monetary measures to end inflation. Third, in each country the price level

immediately stabilized after these measure were put into place. Sargent's (1986) work serves as the foundation for testing the success of changes in policy regimes in controlling inflation because of this independence between inflation and unemployment. Further, it is extremely relevant because his test was used in this research. This paper attempts to build on his work by applying his model to Latin America and demonstrating that output was not affected by the anti-inflation measures. This work tests the hypothesis that Argentina, Brazil, and Chile were able to reduce inflation without experiencing a rise in unemployment.

### **3. The Model**

The conclusions of the expectations-augmented Phillips curve can be stated in the following equation:

$$(1) \pi_t = \alpha + \beta(Q - Q_p)_t + \beta_0\pi_t^e$$

It states that inflation  $\pi$ , is a function of a constant ( $\alpha$ ), the output gap, which is real output ( $Q$ ) minus potential output ( $Q_p$ ), and the expected inflation rate ( $\pi^e$ ). This is the basis for the equation that will test the hypothesis that these countries were able to reduce inflation without seeing a rise in the unemployment rate. It is nearly impossible to get data for  $Q_p$  and  $\pi^e$ , however. Data for potential output does not exist for these countries, and it is impossible to exactly measure expectations. Both of these hard-to-measure variables were accounted for with substitutes.

The unemployment rate ( $U$ ) was substituted for the output gap ( $Q - Q_p$ ) because the two variables most closely move together and are accurate measures of the state of the economy. This yields the following equation:

$$(2) \pi = \alpha + \beta_1U + \beta_0\pi^e$$

A substitute was used for expected inflation ( $\pi^e$ ) also. REH asserts that people will base expectations on all available information and apply it to their understanding of how the economy works. One popular theory that affects people's understanding of the economy is the Quantity Theory of Money. It states that  $MV = PQ$ , where M is the money supply, V is the velocity of money, P is the price level, and Q is output.

For the purposes of this model, it can be assumed that velocity is constant because the institutions affecting velocity are very slow to change. Further, if the economy is at full output, then Q is constant as well and a change in the money supply will equal a change in the price level, or

$$(3) \Delta M = \Delta P$$

Because  $\Delta P$  is the inflation rate, change in money supply from the previous period can be used as a proxy for the expected inflation rate of this period. This yields the equation

$$(4) \pi_t = \alpha + \beta_1 U_t + \beta_2 \Delta M_{t-1}$$

#### **4. Empirical Testing**

The tested hypothesis was that the countries of Argentina, Brazil, and Chile were able to see a decline in inflation without experiencing a rise in the unemployment rate. This hypothesis was tested using Equation 4

$$\pi_t = \alpha + \beta_1 U_t + \beta_2 \Delta M_{t-1}$$

A coefficient estimate of zero for  $\beta_1$  and one for  $\beta_2$  would support the hypothesis. If  $\beta_1$  were zero, the independence of the unemployment rate and the inflation rate would be affirmed. In other words, unemployment could change even as inflation did not, and vice versa. A coefficient estimate of one for  $\beta_2$  would affirm the impact of expected inflation on the actual inflation rate.

This is because equation 3 indicates that the relationship between  $\Delta M$  and  $\Delta P$  (the inflation rate) should be one-to-one; that is, the coefficient should be one.

The variables involved in testing the hypothesis are inflation ( $\pi_t$ ), unemployment ( $U_t$ ), and change in the money supply lagged one period ( $\Delta M_{t-1}$ ). Economic theory suggests that money affects prices with a lag of up to two years. This work uses a lag of one year as a halfway approximation of the lag. Inflation is the dependent variable; unemployment and change in the money supply are both independent variables. Data was collected on consumer price levels from the International Monetary Fund's *International Financial Statistics Yearbook*. The percent change in price level was then calculated to determine the rate of inflation for each year. The percent change in money supply was obtained by using the broadest definition of money from the *International Financial Statistics Yearbook*, which is "Money plus Quasi-Money". Period two's money supply was then subtracted from period one's and then divided by period two's to obtain the percent change in money supply. For unemployment, the *International Financial Statistics Yearbook* was used back to 1984. For previous years, data provided by the International Labour Organization in its annual *Yearbook of Labour Statistics* was used. Unemployment is reported as a percentage of total workforce. In the test for Argentina, data from 1966 to 1996 was tested. For Brazil, data from 1976 to 1997 was tested. Chile was tested using data ranging from 1966 to 1998. These dates were determined by the availability of data for each country. These dates yielded 30, 18 and 32 data points each for Argentina, Brazil and Chile, respectively. The low number of observations for Brazil is frustrating and creates a need for this test to be redone when more data points are available.

Equation 4,  $\pi_t = \alpha + \beta_1 U_t + \beta_2 M_{t-1}$ , was estimated using Ordinary Least Squares. Recall that two results would support the hypothesis. The first is that  $\beta_1$  would be equal to zero; this



would indicate that there is little relationship between unemployment and inflation. The second favorable result is that  $\beta_2$  is positive and statistically different from zero. This would suggest that there is a connection between expected inflation (for which last period's money supply is a proxy) and actual inflation.

The following table summarizes the results of the test. T-statistics are in parentheses below the coefficient estimate.

	<b>Argentina</b>	<b>Brazil</b>	<b>Chile</b>
$\beta_1$	<b>8.281</b> <i>(0.28)</i>	<b>35.849</b> <i>(0.34)</i>	<b>-4.946</b> <i>(-1.33)</i>
$\beta_2$	<b>0.979*</b> <i>(4.23)</i>	<b>17.110*</b> <i>(2.96)</i>	<b>0.952*</b> <i>(-6.22)</i>
R-squared	0.402	0.369	0.585
F-statistic	9.077	4.383	20.476
Durbin-Watson	1.804	1.235	1.209

\* significant at the .05 level

## 5. Analysis

The coefficient estimates for  $\beta_1$  were positive for both Argentina and Brazil, but were negative for Chile. For all three countries however, the t-statistics indicated that the results are not statistically different from zero. This indicates that there is no connection between the unemployment rate and the inflation rate. This supports the hypothesis.

The results for  $\beta_2$  lend support to the hypothesis also. For both Argentina and Chile, the coefficient was positive and close to one, which was predicted by theory. For Brazil however, the coefficient estimate is much greater than one. This is a problem because an increase in the money supply is not expected to affect the inflation rate by a multiple greater than one; this would indicate an accelerator effect. Economic theory does not support this conclusion.

Therefore, the results for Brazil are less conclusive. This may be because only 18 data points were available for this test. For all three countries though, the t-statistic indicates that the coefficients are statistically different from zero. This supports the hypothesis with Argentina and Brazil, because it indicates that there is a connection because expected inflation, as it has been modeled, and actual inflation.

The R-squared value is low. This indicates that the model does not explain everything that affects the inflation rate. The model does, however, explain the relationship between expected inflation and inflation. The F-statistic draws a similar conclusion. Because it is low, it can be concluded that there are other factors affecting the inflation rate.

The Durbin-Watson test was used to determine if autocorrelation was a problem with the model. This test indicated that neither positive nor negative autocorrelation was a problem for Argentina or Brazil. Autocorrelation is a potential problem for Chile, however.

In order to correct for autocorrelation, an AR(1) term was added to the equation. The results are summarized in the following table.

	<b>Chile</b>
$\beta_1$	<b>0.203</b> (.96)
$\beta_2$	<b>0.427</b> (.102)
R-squared	0.713
F-statistic	22.367

The t-statistic indicates that the coefficient estimate for  $\beta_1$  is not statistically different from zero. This result indicates that there is no connection between the unemployment rate and inflation. This supports the hypothesis that Chile was able to reduce inflation without seeing a rise in unemployment.

For  $\beta_2$ , the t-statistic indicates that the coefficient estimate is not statistically different from zero. This indicates that expectations modeled as changes in the money supply last period had no impact on the inflation rate. This does not support the hypothesis of this paper.

The correlation between independent variables was inspected to determine if there was any potential for multicollinearity in the model. There was no significant correlation (greater than .6) in the model, which indicates that multicollinearity is not a problem in this model.

## **6. Conclusion**

This paper was an effort to prove the hypothesis that the Latin American countries of Argentina, Brazil and Chile were able to control inflation without experiencing a rise in unemployment. This hypothesis was tested using a model that incorporated the variables of inflation, unemployment and change in the money supply. The results indicate that inflation changes with expectations in inflation. Further, the results indicate that there is no significant relationship between inflation and unemployment, indicating that these countries were able to reduce inflation without seeing an increase in unemployment.

Further work in this area needs to focus on testing REH in other conditions. Although the test lends support to REH, further testing will need to be completed before all confidence can be put behind REH. These tests can be applied to other developing countries or developed countries in a time when they were developing, because this is when countries are most likely to experience inflation.

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