

## Box 2 THE PATACON MODEL

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### 1. Introduction

The Macroeconomic Models Department at *Banco de la República* has been working on medium- and long-term forecasts for inflation and economic growth during the last six years. In doing so, its main forecasting tool has been a dynamic stochastic general equilibrium model that is useful in designing monetary policy for a small and open economy such as that of Colombia. This has been dubbed as a policy analysis tool applied to Colombian needs (PATACON). Central banks such as those in Canada, Sweden, Norway and Chile, which are recognized for adopting the latest technological tools, currently use models similar to PATACON. This demonstrates the constant efforts of *Banco de la República* to include the very latest academic development in its economic analysis.

The intent of this section is to describe the model in a simple way and, for that reason, the technical specifics are omitted. A detailed description can be found in González et al. (2011) and in Bonaldi et al. (2010).

The PATACON is a neo-Keynesian model adjusted to a small and open economy that includes a set of nominal and real rigidities. In contrast to the model currently used by *Banco de la República*, the transmission mechanism model (TMM), PATACON does not imply a conceptual change in the way macroeconomic phenomena are interpreted or in the mechanisms for monetary policy transmission. Rather, it complements this vision. The model expands the range of possible exercises, simulations and analysis the technical staff can develop to provide information that is relevant to making decisions on economic policy.

There are two fundamental differences between the TMM and PATACON. To begin with, PATACON is a more disaggregated model than the TMM. The different components of GDP demand are modeled explicitly, making PATACON consistent with the national accounts and, therefore, allowing observable variables to be explained. The TMM, for its part, works on gaps or deviations of the variables with respect to

some potential or long-term level. Secondly, since PATACON is a model built on microeconomic principles, it is possible to carry out counterfactual economic-policy exercises to study the consequences of changes in policy rules. The results of these exercises are valid insofar as the model contemplates that economic agents react to changes in policy. This implies these exercises are not subject to Lucas's critique (Lucas, 1976).

It is important to note that both the TMM and PATACON are models of rational, dynamic, and stochastic expectations. Therefore, the solution of both models assumes the macroeconomic variables observed in a given period reflect both their most recent behavior and agents' expectations about what can happen in the future. The latter differentiates these models from traditional forecasts, which are constructed using time series methods.

PATACON can be used in at least four ways. The first is to summarize the information in a set of macroeconomic series in a coherent way that facilitates its interpretation. Secondly, PATACON can be used as a tool to design monetary policy. In this context, it is customary to construct counterfactual exercises to compare the effect of alternative monetary policies on the economy. The third type of exercise is the simulation of macroeconomic shocks and the quantification of their possible impact on the economy.<sup>1</sup> Finally, one of the most common uses for the model is to forecast. The main advantage with PATACON, and with models of this type in general, compared to others, is that the forecast can be fully explained in terms of the behavior of the exogenous variables. This is not conditioned and only reflects the structure of the model. Such information is useful when it comes to designing risk scenarios, since it is enough to divert the behavior of the exogenous variables in contrast with the central scenario. Accordingly, PATACON imposes discipline on these exercises, because it allows us to examine the consequences of these alternative assumptions within a coherent conceptual framework.

The forecast is conditioned in two ways using future paths of the exogenous variables, insofar as it is possible to consider the future behavior of the exogenous variables as being anticipated or not by the agents. In the first case, the agents in the model

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\* The opinions expressed in this section are solely those of the authors and imply no commitment on the part of *Banco de la República* or its Board of Directors.

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1 These usually are developed using computable general equilibrium models in which there is no active monetary policy, and the decisions of economic agents across different period of time are not optimal.

use this information to make their decisions at present and in the future; in the second case, they are surprised by the future shocks from the exogenous variables. Finally, given the structure of PATACON and the computational platform on which the exercises are done, it also is possible to condition endogenous variables. In this case, PATACON identifies the path of the exogenous variables, which would be equivalent to conditioning the endogenous variable.

## 2. The Structure of the Model

The PATACON is structured on a neoclassical growth model in which there are households and companies that optimize the use of their resources over time. The source of growth is exogenous and depends on technological change and the rate of population growth. In this sense, the long-term growth rate is exogenous and the quarterly growth forecast converges to the previous one (see Box 3). Following the work of Christiano et al. (2005), and Smets and Wouters (2007), this model is increased with nominal wage and price rigidities, and with real rigidities, such as consumption habits, adjustment costs in investment, and the variable use of capital and its endogenous depreciation.

PATACON, which is a standard neo-Keynesian model, is adjusted to include some of the characteristics of the Colombian economy. This is reflected in the productive structure and in the exogenous shocks that are assumed to affect the economic cycle. These shocks can be of internal and external origin. The main ways PATACON varies from the traditional model are described below.

Colombia is a net borrower in the international capital market and, therefore, the behavior of the external interest rate could be expected to affect the way its economic cycle evolves. In the model, this interest rate depends on an endogenous risk premium and an exogenous risk that approximates the country's perception on international markets. The endogenous risk component is determined by the development of the external debt relative to GDP. The way the external interest rate behaves directly affects the country's borrowing capacity and the cost of future debt payments. In addition, the difference between external and domestic interest rates largely determines how the nominal exchange rate will evolve in the short term and, hence, the evolution of inflation and the trade balance, among other variables.

Although Colombia is not an economy that is especially open to foreign trade,<sup>2</sup> international prices do affect

output and inflation. In fact, the baskets of final consumer goods and investment are composed of both locally produced and imported goods. Moreover, the economy needs imported input to produce. Therefore, the price of imported goods can affect inflation directly through the price of those that are for consumption and through production costs. It is worth noting that these goods must be marketed in pesos, which implies the use of local factors. Hence, their final price is a function of the external price, the nominal exchange rate, and the cost of marketing. Therefore, movement in the nominal exchange rate is not necessarily transmitted with the same intensity to the ultimate peso price of imported goods. The work of González et al. (2010) and Parra (2010) argue this result.

There are internal shocks that affect the economic cycle and their transmission channels are modeled explicitly in PATACON. The most important of these are exogenous cost shocks, which can be associated with weather phenomena or regulated goods, and shocks to demand, in terms of both consumption and investment, that can capture changes in fiscal policy or in consumer and investor confidence.

Finally, the model includes action taken by the monetary authority, which is modeled through a policy rule used to determine the value of the short-term nominal interest rate. This aspect takes into account the fact that *Banco de la República's* objective is to meet the inflation target and to ensure that output stays near its long-term sustainable level. This way of incorporating the monetary authority recognizes the fact that its policy cannot permanently influence the rate of economic growth.

## 3. Fan Chart

The fan chart is a tool that represents the possible future values of a variable based on available information. The further into the future the forecast goes, the more uncertain it becomes. In other words, the projection ranges are extended. The fan chart, created by the Bank of England staff in 1977, has been widely used in the price reports of various central banks in countries that use inflation targeting, such as England, Peru, Malaysia, Hungary, and Israel.

Since 1999, *Banco de la República* has made an effort to determine the factors that could affect macroeconomic variables in the medium term. Once they are identified, the Bank quantifies their impact on the probability distribution of the forecast for the variable; that is, the fan chart. Currently, the Bank uses the factors determined by the PATACON forecast model, namely; external demand, imported prices, commodity prices, transfers, consumer confidence, investment efficiency,

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2 In fact, the most important ratio of exports to GDP is around 45%.

monetary policy, external interest rate, supply shock, wage cost shock, inflation in regulated items, food inflation and long-term growth.

The fan chart is a flexible, simple, formal, and independent tool of specific models. Compared to other methodologies, it is not only easier to apply, but offers several advantages. First, it communicates the potential risks that exist in the main forecast for a variable. This allows us to make the public aware of the presence of short- and medium-term risks that are not contemplated in the forecast for that variable. Secondly, it reflects future asymmetric risks in which the variable may assume values above or below the most likely forecast. In other words, the probability of being above or below the mode (most likely value) may be different. This advantage is relevant, for example, in situations where the central bank's loss function is asymmetric. Third, the fan chart incorporates uncertainty multipliers about the future values of factors and the variable, allowing not only greater flexibility in application, but also greater adaptability. This makes it possible to broaden or reduce the breadth of the forecast error to different horizons, which is reflected graphically. And fourth, it allows for introducing a wide variety of factors that could affect the variable in the future. In other words, this tool quantifies the effect biases in the forecast for exogenous factors have on the forecast for the variable. For example, it is possible to calculate the risk of a positive bias in the forecast for the external interest rate on the degree of asymmetry of the central forecast for inflation.

Finally, with PATACON, monetary policy becomes more transparent and communication with the public is easier, which helps to reinforce the central bank's credibility.

## References

- Bonaldi, P.; González, A.; Prada, J. D.; Rodríguez, D.; Rojas, L. E. (2009). "Método numérico para la calibración de un modelo DSGE," *Borradores de Economía*, no. 548, *Banco de la República*.
- Bonaldi, P.; González, A.; Rodríguez, D. (2010). "Importancia de las rigideces nominales y reales en Colombia: un enfoque de equilibrio general dinámico y estocástico," *Borradores de Economía*, no. 591, *Banco de la República*.
- Bustamante, C. (2011). "Política monetaria contracíclica y encaje bancario," *Borradores de Economía*, no. 646, *Banco de la República*.
- Christiano, L.; Eichenbaum, M.; Evans, C. (2005). "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, vol. 97, no. 3, pp. 586-606.
- González, A.; Mahadeva, L.; Prada, J. D.; Rodríguez, D. (2011). "Policy Analysis Tool Applied to Colombian Needs: Patacon," *Borradores de Economía*, no. 656, *Banco de la República*.
- González, A.; Mahadeva, L.; Rodríguez, D.; Rojas, L. E. (2009). "Monetary Policy Forecasting in a DSGE Model with Data that is Uncertain, Unbalanced and About the Future," *Borradores de Economía*, no. 559, *Banco de la República*.
- González, A.; Rincón, H.; Rodríguez, N. (2010). "La transmisión de los choques a la tasa de cambio sobre la inflación de los bienes importados en presencia de asimetrías," in M. Jalil and L. Mahadeva (eds.), *Mecanismos de transmisión de la política monetaria en Colombia*, Bogotá: *Banco de la República* and *Universidad Externado de Colombia*.
- Lucas, R. (1976). "Econometric Policy Evaluation: A Critique," in K. Brunner and A. Meltzer (eds.), *The Phillips Curve and Labor Markets*, Carnegie-Rochester Conference Series on Public Policy, New York: American Elsevier.
- López, M.; Prada, J. D. (2009). "Optimal Monetary Policy and Asset Prices: The Case of Colombia," *Ensayos sobre Política Económica*, vol. 28, no. 61, pp. 134-167.
- López, M.; Prada, J. D.; Rodríguez, N. (2009). "Evidence for a Financial Accelerator in a Small Open Economy, and Implications for Monetary Policy," *Ensayos sobre Política Económica*, vol. 27, no. 60, pp. 12-45.
- Mahadeva, L.; Parra, J. C. (2008). "Testing a DSGE Model and its Partner Database," *Borradores de Economía*, no. 479, *Banco de la República*.
- Parra, J. C. (2008). "Hechos estilizados de la economía colombiana: fundamentos empíricos para la construcción y evaluación de un modelo DSGE," *Borradores de Economía*, no. 509, *Banco de la República*.
- Parra, J. C. (2010). "La sensibilidad de los precios del consumidor a la tasa de cambio en Colombia: una medición de largo plazo," in M. Jalil and L. Mahadeva (eds.), *Mecanismos de transmisión de la política monetaria en Colombia*, Bogotá: *Banco de la República* and *Universidad Externado de Colombia*.
- Prada, J. D.; Rojas, L. E. (2010). "La elasticidad de Frisch y la transmisión de la política monetaria en Colombia," in M. Jalil and L. Mahadeva (eds.), *Mecanismos de transmisión de la política monetaria en Colombia*, Bogotá: *Banco de la República* and *Universidad Externado de Colombia*.
- Smets, F.; Wouters, R. (2007). "Shocks and Frictions in US Business Cycles," *American Economic Review*, vol. 97, no. 3, pp. 586-606.