

Box 2 The 4G Model

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The objectives of the Central Bank include the development of new tools for macroeconomic forecasting and monetary policy analysis. For this process, the Bank assessed the structure and properties of its main models, specifically the Transmission Mechanism Model (MMT; Gómez et al., 2002) and the Policy Analysis Tool Applied to Colombian Needs (Patacon; González et al., 2011). This assessment determined the need for a new model to replace the MMT. In this context, the implementation of a 4G (four-goods) model was proposed.

The 4G model is a neo-Keynesian semi-structural model adapted for a small, open, oil exporting economy. It follows the overall structure of the International Monetary Fund's global projection model, and is similar to that used by other central banks. The adapted version for Colombia considers four sub-baskets of the consumer price index (CPI: food and regulated, tradable, and non-tradable items) and their corresponding relative prices.

This box is intended to describe the 4G model in a simple way. A full description of the model and its properties can be found at González et al. (2019).

1. Structure of the 4G Model

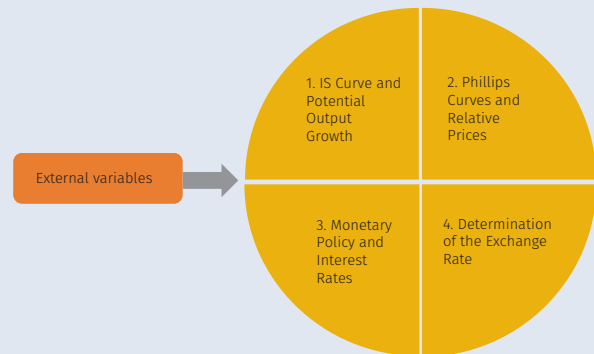
The model consists of four blocks of endogenous variables (Figure R2.1) and a set of exogenous variables. The latter incorporates the dynamics of external variables, specifically the United States interest rate and inflation, the output gap of Colombia's main trading partners, the external neutral real interest rate, the risk premia for Colombia, and the international price of oil, as well as its permanent and transitory components.

The first block of endogenous variables corresponds to the output gap, which is considered an as indicator of the economic cycle, and to potential output. Aggregate demand is modeled by an IS curve¹, where the output gap depends on the persistence of the economic cycle and of expected

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1 The IS curve represents the balance in an economy's goods and services market.

Diagram B2.1
Structure of the 4G Model



Source: González et al., 2019.

pressures from future income. This gap also reflects changes in consumption and investment resulting from the effects of the monetary policy stance and the deviation of the real exchange rate vis-à-vis its long-term trend. The IS curve also incorporates the pressures from the external demand of our trading partners and those caused by transitory variations in oil revenues. On the other hand, potential output is modeled as a trend whose long-term growth is determined by the technological development of the oil sector, resulting from permanent changes in the revenues from this activity.

The second block corresponds to the Phillips curves that characterize the dynamics of the variation in the prices of food and regulated, tradable and non-tradable items, besides establishing their relationship with the real costs in each sector. This breakdown of the CPI provides flexibility to the model by capturing the heterogeneity implicit in the inflation figure of each basket, its different long-term averages, and its different volatilities. It also improves the analysis of monetary policy by capturing the different sensitivities of each sector regarding the cyclical components of output and the real exchange rate gap, which represent the marginal costs of local producers and importers, respectively. The real exchange rate gap captures inflationary pressures coming from the exchange rate. Positive values in this gap imply upward pressures on inflation. This gap is calculated as the deviation of the real exchange rate versus a non-inflationary trend component estimated under the economic structure of the 4G model.

The Phillips curves in the 4G model also include relative price deviations versus their long-term trend. This gap is one of the price-adjustment mechanisms within the model and allows the inclusion of stances on their convergence in the forecasting scenarios. Finally, regarding regulated inflation, the impact that transitory variations in oil prices may have on their dynamics is acknowledged.

Monetary policy is characterized by a Taylor rule in the third block, in which the main instrument is the short-term

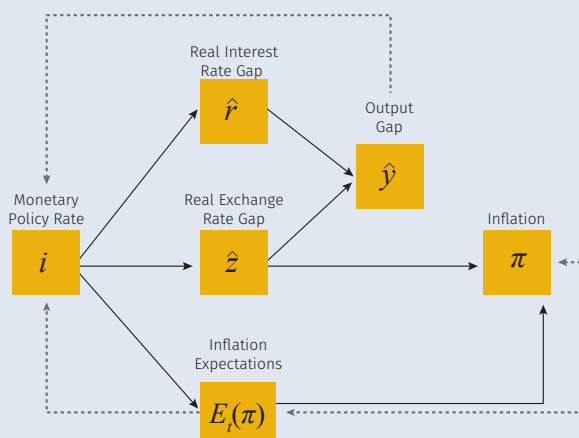
interest rate. As in the Patacon model, the 4G model takes into account that Banco de la República’s objective is to achieve the inflation target and to ensure that output remains around its long-term sustainable level. Particularly, the policy rule of the 4G model depends on the output gap and on the deviations from annual inflation expectations versus the target three quarters ahead, such that shocks in the current period are included in the Central Bank’s reaction function.

The fourth block determines the exchange rate by means of the uncovered interest rate parity, which collects the differentials between the internal interest rate and the risk-adjusted external rate, as well as the expected value of the exchange rate. The uncovered interest rate parity is a standard assumption for economies with an open capital and financial account such as Colombia and a high degree of floating exchange rate. This block also estimates the non-inflationary trend of the real exchange rate, whose growth fluctuates around a long-term value according to changes in productivity and technological factors in the oil sector as a result of permanent changes in this activity’s revenues.

2. Monetary policy transmission mechanism in the 4G model

An illustration of the monetary policy transmission mechanism in the model is shown in Figure R2.2. In this case, a monetary policy shock implies an increase in the market interest rate and a fall in inflation expectations. The latter lead to an increase in the real interest rate, and thus to a positive gap vis-à-vis the neutral real interest rate. This represents a contractive monetary policy stance. At the same time, the increase in the interest rate leads to an appreciation of the nominal exchange rate. The real exchange rate is also appreciated by opening a negative gap in the face of its long-term non-inflationary trend. A contractive monetary policy stance, along with a negative gap in the real exchange rate, causes downward pressures on

Diagram B2.2
Monetary Policy Shock



Source: González et al., 2019.

aggregate demand. In turn, negative product and real exchange-rate gaps reduce inflation. Inasmuch as the monetary policy shock recedes, the output gap closes, while price and nominal exchange rate levels stand lower than where they stood initially. The other variables converge to their corresponding long-term values (steady state).

3. Advantages of the 4G model as a forecasting and policy analysis tool

The nature of semi-structural models, particularly the 4G model, facilitates both the adjustment of the model to the data and the dissemination of its results. Its structure allows to incorporate the technical staff’s different judgments about the dynamics of the economy within the forecasting exercises. In addition, the model allows for an adequate understanding of the assumptions and risks included in the different scenarios. Thus, the 4G model is an additional tool for the technical staff at the Central Bank that allows to characterize the heterogeneity of the shocks that may affect inflation and economic activity, within a scheme that is consistent with the main characteristics of the Colombian economy. The main results concerning the historical decomposition of the shocks and the benefits of the adjustment of the model are presented in González et al.(2019).

References

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