Working papers economics - Neural Network Equilibrium Real Exchange Rate

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The combination of economic theory and neural networks makes it possible to capture complex relationships and enhance the understanding of real exchange rate misalignment in Colombia.

Publication Date: Thursday, 6 of August 2026 **Approach**
This paper estimates the degree of real exchange rate misalignment in Colombia, defined as the difference between the observed real exchange rate and the level implied by its short- and long-term economic fundamentals. To do so, the authors employ a neural network model that replaces the linear approaches traditionally used to estimate the equilibrium exchange rate.

The model groups the variables that explain exchange rate dynamics into five broad categories: relative prices of Colombia's exports and imports, government expenditure, Colombia's productivity relative to that of the United States, external debt, and a set of short-term factors including global uncertainty and interest rate differentials. Each category is incorporated separately, and the specification imposes theoretical restrictions to ensure that its effects are consistent with the relationships predicted by economic theory. As a result, the model gains the flexibility to capture complex relationships while preserving coherence with established economic principles.

Contribution
Estimating the equilibrium exchange rate is inherently challenging because it is not directly observable and must therefore be inferred. Traditional methods assume that economic variables are linearly related, an assumption that may oversimplify reality and obscure important interactions, particularly in small, open economies with significant exposure to international capital markets, such as Colombia.

Against this backdrop, the study makes three main contributions. First, it combines economic theory with neural networks: the model does not learn relationships freely but is constrained to respect relationships that have already been established in the literature. Second, it enables the estimation of the extent to which each group of variables contributes to exchange rate movements. Third, it employs a simpler and more interpretable complementary model to identify which specific variables within each group carry the greatest explanatory power.

Results

The study finds that the importance of the different determinants has changed over time. In the mid-2000s, when commodity prices were high, export and import prices, together with external debt, accounted for most of the appreciation of the Colombian peso. Following the pandemic, government expenditure gained greater relevance and became the main factor explaining the depreciation of the peso, consistent with the increase in fiscal spending observed during those years.

Regarding temporary deviations of the exchange rate from its equilibrium level, the study shows that the episodes of 2008-09 and the years following 2021 were largely driven by short-term factors, including global volatility, uncertainty, and changes in interest rate differentials between Colombia and the United States. When compared with a traditional statistical approach, the proposed model identifies the same broad periods of misalignment but provides an alternative explanation based on a different set of economic variables.

These findings provide a useful input for monitoring Colombia’s economic conditions and anticipating potential external risks.

Fuente: https://www.banrep.gov.co/en/publications-research/working-papers-economics/neural-network-equilibrium-real