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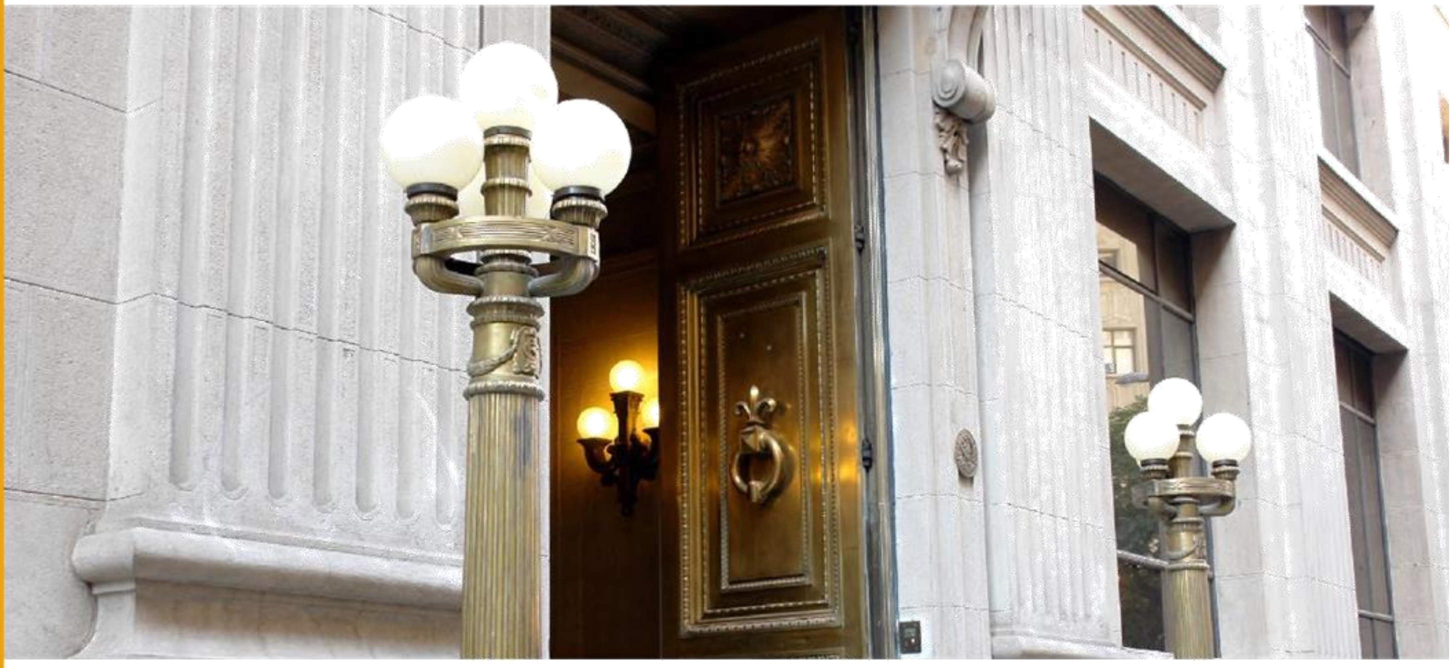

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Fiscal Consolidations in Commodity-Exporting Countries: A Small Open Economy DSGE Perspective*

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Abstract

Fiscal consolidation in commodity-exporting economies is inherently uncertain because fiscal revenues could depend heavily on volatile international commodity prices. This paper develops a small open economy Dynamic Stochastic General Equilibrium (SOE DSGE) model to quantify how deviations in commodity revenues affect consolidation outcomes, capturing key fiscal instruments such as distortionary taxes, public spending, and external borrowing. The model is calibrated and estimated using Ecuador's 2020–2025 IMF-supported program, an illustrative case of an oil-dependent economy pursuing fiscal adjustment under external assistance. Simulation results show that historically plausible fluctuations in oil revenues substantially alter fiscal and macroeconomic dynamics: higher-than-expected revenues improve the deficit and lower the risk premium, potentially weakening incentives to sustain consolidation, while revenue shortfalls worsen the fiscal balance, raise financing costs, and intensify the required adjustment effort. These asymmetries underscore the vulnerability of consolidation programs to exogenous shocks and the need for frameworks that explicitly incorporate revenue uncertainty. The analysis emphasizes the importance of incorporating revenue uncertainty into the design of fiscal programs and highlights the potential value of flexible targets or contingency clauses to improve their credibility and resilience. Although the calibration is specific to Ecuador, the model and findings are broadly relevant to other resource-rich economies facing similar challenges in balancing fiscal sustainability with exposure to volatile commodity markets.

Resumen

La consolidación fiscal en economías exportadoras de materias primas está sujeta a una alta incertidumbre, dado que los ingresos fiscales pueden depender fuertemente de los volátiles precios internacionales de los commodities. Este trabajo desarrolla un modelo de equilibrio general dinámico y estocástico (DSGE) para una economía pequeña y abierta, con el objetivo de cuantificar cómo las desviaciones en los ingresos por materias primas afectan los resultados de los planes de consolidación fiscal. El modelo incorpora instrumentos fiscales clave, como impuestos distorsionadores, gasto público y endeudamiento externo. La calibración y estimación se basan en el programa de consolidación fiscal para Ecuador durante el período 2020–2025, apoyado por el FMI, un caso ilustrativo de una economía dependiente del petróleo que busca ajustar sus cuentas fiscales bajo asistencia externa. Los resultados de simulación muestran que fluctuaciones históricamente plausibles en los ingresos petroleros alteran de manera significativa la dinámica fiscal y macroeconómica: ingresos mayores a los esperados mejoran el déficit y reducen la prima de riesgo, lo que podría debilitar los incentivos para sostener el esfuerzo de consolidación; mientras que ingresos menores deterioran el balance fiscal, elevan los costos de financiamiento y aumentan la magnitud del ajuste requerido. Estas asimetrías evidencian la vulnerabilidad de los programas de consolidación frente a shocks exógenos y la necesidad de marcos fiscales que incorporen explícitamente la incertidumbre sobre los ingresos. El análisis destaca la importancia de considerar dicha incertidumbre en el diseño de programas fiscales y subraya el valor potencial de metas flexibles o cláusulas de contingencia para mejorar su credibilidad y resiliencia. Aunque la calibración se basa en el caso de Ecuador, el modelo y los hallazgos son relevantes para otras economías ricas en recursos naturales que enfrentan desafíos similares al buscar sostenibilidad fiscal en contextos de alta volatilidad en los mercados de materias primas.

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*The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or the Central Bank of Chile.

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1 Introduction

When the boom in commodity prices ended around 2014, several commodity-exporting countries faced deteriorated fiscal sustainability prospects and higher risks of debt distress (see Richaud et al., 2019). The COVID-19 pandemic exacerbated these problems, with sovereign credit spreads such as the Emerging Market Bond Index Global (EMBIG) increasing by about 300 bps. Moreover, the turbulence caused by the global monetary tightening cycle that followed the post-pandemic rise in inflation, and the Russian invasion of Ukraine also sent spreads up by more than 100 bps. These tighter financial conditions affected the fiscal situation of many countries to the point that they needed to ask international organizations for extraordinary financing in order to face the challenges brought about by the global pandemic and its aftermath. Indeed, the IMF lists 90 countries currently receiving or having received about USD 170 billion in financial assistance and debt service relief from March 2020 to March 2022.[1] This type of funding is typically tied to the implementation of fiscal consolidation programs aimed at putting public finances on a sustainable trajectory.

In commodity-exporting countries, fiscal consolidation plans are particularly challenging to implement due to the high dependence of fiscal revenue on volatile international commodity prices. This volatility introduces significant uncertainty into revenue forecasts, complicating the design and implementation of credible consolidation strategies. To study these risks, we develop a small open economy Dynamic Stochastic General Equilibrium (DSGE) model tailored to the fiscal structure of commodity-exporting countries. The model serves as a laboratory to analyze how deviations in commodity revenue—calibrated to historical volatility—affect the fiscal deficit and broader macroeconomic outcomes during consolidation episodes.

Our contribution is twofold. First, we provide a quantitative framework to assess the vulnerability of fiscal consolidation plans to commodity price shocks. Second, we apply this framework to the case of Ecuador's 2020 IMF-supported program to provide insights into the macro-fiscal risks faced by oil-dependent economies under external financial assistance. In particular, the framework captures general equilibrium effects, such as how changes in foreign indebtedness influence domestic interest rates.

Our findings reveal that historically plausible deviations in commodity revenue from forecasts, calibrated to empirical volatility observed in oil revenue data, have substantial impacts on the fiscal deficit and the broader macroeconomy. In a scenario in which commodity revenue is one standard deviation higher than envisioned in the consolidation program, the deficit declines by more than twice the amount observed in the baseline scenario,

[1] See https://www.imf.org/en/Topics/imf-and-covid19/COVID-Lending-Tracker.

given paths of tax rates and government expenditure that follow the program. When the path of commodity revenue is one standard deviation lower, the deficit is substantially higher, by 2–3 percentage points of GDP. We observe similarly large effects on macro variables such as non-oil GDP, private consumption, private investment, and the country risk premium when we consider these alternative oil revenue paths.

Consequently, fiscal consolidation plans can be vulnerable to deviations in commodity revenue. Higher-than-expected revenue improves the deficit, potentially incentivizing abandonment of the program, whereas lower-than-expected revenue exacerbates the deficit, intensifying the fiscal effort required to meet the fiscal targets. These findings underscore the importance of incorporating revenue uncertainty into the design of fiscal programs and highlight the potential value of flexible targets or contingency clauses in consolidation plans.

While our simulations are grounded in Ecuador's IMF-supported program, the model is designed to capture the macro-fiscal dynamics common to commodity-exporting economies. As such, the insights are broadly relevant for countries facing similar external vulnerabilities and fiscal challenges.

This paper fits in a growing literature on fiscal policy in commodity-exporting countries, particularly in the context of fiscal consolidations under uncertainty. Previous studies have examined the procyclicality of fiscal policy in resource-rich economies and the role of fiscal rules and stabilization funds in mitigating revenue volatility (e.g., Venables, 2016, Villafuerte, López-Murphy and Ossowski, 2013). More recent work has incorporated commodity price shocks into DSGE frameworks to study the effects of alternative fiscal responses (e.g., Medina and Soto, 2016, Melina, Yang and Zanna, 2016). Our paper complements this literature by focusing on the interaction between commodity revenue volatility and fiscal consolidation programs, using a DSGE model calibrated to a real-world IMF-supported adjustment plan. In doing so, we highlight the macro-fiscal vulnerabilities that arise when consolidation targets are set without accounting for the stochastic nature of commodity revenues. Additionally, our DSGE framework could be useful to commodity-rich economies interested in fiscal consolidation analysis.

We structure the paper as follows: Section 2 reviews the related literature. In section 3, we present our SOE DSGE model for macro-fiscal analysis in a commodity-exporting country. Section 4 describes the parametrization strategy of the model, including its estimation. In turn, section 5 analyzes the dynamic behavior of the model under the chosen parametrization and discusses its performance in matching key moments of the data. Section 6 studies the behavior of the model economy under the consolidation program between Ecuador and the IMF, including when oil revenue deviates from its forecast. Finally, section 7 concludes.

2 Related Literature

Evaluating fiscal consolidations in economies that rely heavily on commodity revenues is inherently risky. The central challenge is that consolidation outcomes often depend less on the design of the adjustment itself than on the trajectory of volatile commodity-related revenue. In such settings, the success or failure of consolidation can be confounded by commodity price shocks, making ex ante assessments highly uncertain.

A large body of work documents how oil and other commodity revenues dominate macroeconomic dynamics in resource exporters. García-Albán, González-Astudillo and Vera-Avellán (2021) show that in Ecuador, oil revenue shocks have historically been the most important driver of output fluctuations, far outweighing standard fiscal shocks. Their simulations demonstrate that oil-financed investment booms produce strong short-run growth, whereas output contracts sharply when oil revenue declines and investment is cut. They also emphasize that a stabilization fund could substantially reduce output volatility. These results illustrate the broader risk: fiscal consolidation strategies are difficult to evaluate in commodity exporters because outcomes hinge on factors outside the direct control of policymakers.

Cross-country evidence reinforces this view. Villafuerte, López-Murphy and Ossowski (2013) document how fiscal policies in Latin American resource exporters follow a "roller-coaster" dynamic, expanding during booms and retrenching during busts, amplifying the cycle and complicating consolidation efforts. van der Ploeg and Venables (2011) and Venables (2016) stress that windfall revenues are often mismanaged, with governments failing to build buffers that would support adjustment in downturns. Forecasting studies confirm that commodity prices are hard to predict, with large errors even at short horizons (see Baumeister and Kilian, 2016), which means that baseline revenue projections used in consolidation programs are subject to high risk.

One response has been the development of fiscal frameworks that delink spending from current commodity revenue. Chile's structural balance rule is the most prominent example, where expert panels estimate long-run copper prices to set expenditure paths (see Frankel, 2011). Empirical evidence shows that resource exporters with fiscal rules are less procyclical and less vulnerable to revenue-driven retrenchments (see Bova, Carcenac and Guerguil, 2014; Eyraud et al., 2018). While these studies focus on improving fiscal stability more broadly, they do not directly assess how commodity revenue volatility interacts with fiscal consolidation plans. Our paper addresses this gap by explicitly modeling the vulnerability of consolidation strategies to commodity price shocks, using a structural framework that captures the dynamic interplay between fiscal instruments, external conditions, and macroeconomic outcomes.

From a modeling perspective, DSGE frameworks for commodity exporters have formalized key macro-fiscal dynamics. Medina and Soto (2016) and Melina, Yang and Zanna (2016) show how commodity price shocks interact with fiscal rules and debt dynamics, emphasizing the importance of institutional design in stabilizing resource-rich economies. Berg et al. (2012) embed public investment and debt sustainability in a DSGE model tailored to low-income, resource-rich countries, illustrating how the financing and composition of fiscal adjustment shape growth outcomes. While these studies focus on the broader macroeconomic implications of commodity shocks and fiscal policy, they do not explicitly examine how revenue volatility affects the credibility or effectiveness of fiscal consolidation plans.

Finally, the broader consolidation literature warns that composition and timing influence the real effects of adjustment. Spending-based consolidations are often less damaging in advanced economies (see Alesina, Favero and Giavazzi, 2015), but in commodity exporters, where capital spending is tightly linked to commodity receipts, cutting investment can be particularly contractionary (see Guajardo, Leigh and Pescatori, 2014). In Latin America, evidence suggests that consolidation through reduced public investment has especially large multipliers, making such strategies both painful and risky when driven by revenue shortfalls (see Carrière-Swallow, David and Leigh, 2018).

Taken together, this literature highlights the challenges of designing and evaluating fiscal consolidations in commodity-exporting economies. Our contribution is to formalize and quantify the vulnerability of consolidation plans to plausible deviations in commodity revenue forecasts, using a structural small open economy model with explicit fiscal and commodity blocks. While we ground our simulations in the case of Ecuador, the framework and insights are broadly applicable to other resource-dependent economies facing similar fiscal risks.

3 The DSGE Model

This section spells out a two-agent SOE model with real rigidities and a rich fiscal policy block. The economy is populated by optimizing households that have access to international financial assets and rule-of-thumb households that consume their disposable income every period. There are three categories of government expenditure: (i) consumption of final goods, which enters household utility as a proxy for publicly provided goods and services (e.g., health and education), (ii) investment in public capital, which enters the production function of the firms producing domestic goods, and (iii) transfers to households. The government finances its expenditures by levying three types of distortionary taxes—on consumption, labor income, and capital income—as well as by issuing foreign debt. Domestic goods, which are produced with private and public capital in addition to labor, are combined with imported goods to form final goods. Real rigidities include habit formation in private consumption and adjustment costs in private investment. The economy trades in domestic and foreign goods and exports an exogenous endowment of a commodity. Finally, the economy is subject to shocks to preferences, technology (neutral and investment-specific), commodity production, the components of government expenditure, tax rates, foreign GDP, foreign interest rates, a risk premium on external debt, and the international price of the commodity good.

3.1 Households

There is a continuum of infinitely lived households of unit mass. A fraction $\omega \in (0,1)$ of households are restricted and do not have access to saving instruments. They behave in a "hand-to-mouth" fashion whereby they consume their disposable income every period; we refer to this group as rule-of-thumb households and use the superscript r to denote variables that correspond to them. The remaining fraction $(1-\omega)$ of households have access to financial assets and can accumulate physical capital, which they rent to firms; we refer to this group as optimizing households and denote variables related to them with the superscript o. Both types of households have preferences defined over a composite consumption bundle, $\hat{C}_t^j$, that includes both private and public components and hours worked, h_t^j, for $j \in \{o,r\}$, that are paid a common hourly wage, W_t.[2]

Following Coenen, Straub and Trabandt (2013), the consumption bundle for households of type $j = \{o,r\}$ is a constant-elasticity-of-substitution (CES) aggregate of household purchases, denoted $\hat{C}_t^j$, of a final good, C_t^j, and government consumption, G_t^c, as follows:

$$\hat{C}_t^j \equiv \hat{C}^j(C_t^j, \breve{C}_{t-1}^j, G_t^c) = \left[(1-o_c)^{\frac{1}{\eta_c}} \left(C_t^j - \varsigma \breve{C}_{t-1}^j\right)^{\frac{\eta_c-1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} \left(G_t^c\right)^{\frac{\eta_c-1}{\eta_c}}\right]^{\frac{\eta_c}{\eta_c-1}},$$

where $\breve{C}_t^j$ denotes average consumption purchases across households of type j, which each household takes as given (in equilibrium, $C_t^j = \breve{C}_t^j$). The parameter $\varsigma \in (0,1)$ governs consumption habits, whereas $\eta_c > 0$ governs the elasticity of substitution between consumption purchases by the household and the government.[3]

[2] Throughout, uppercase letters denote variables containing a unit root in equilibrium (due to technological progress), whereas lowercase letters indicate variables with no unit root. The imported good is the numeraire. Appendix A describes how each variable is transformed to achieve stationarity in equilibrium. Variables without a time subscript denote non-stochastic steady state values.

[3] $\eta_c \to 0$ implies perfect complementarity, $\eta_c \to \infty$ gives perfect substitutability, and $\eta_c \to 1$ yields the Cobb–Douglas case.

Expected discounted utility of a representative household of type j is given by

$$E_t \sum_{s=0}^{\infty} \beta^s \upsilon_{t+s} \left[\frac{1}{1-\sigma} \left(\hat{C}^j_{t+s} \right)^{1-\sigma} - \Theta^j_{t+s} A^{1-\sigma}_{t+s-1} \kappa^j_{t+s} \frac{\left(h^j_{t+s} \right)^{1+\phi}}{1+\phi} \right], \tag{1}$$

where υ_t and κ_t are exogenous preference shocks, $\beta \in (0,1)$ is the intertemporal discount factor, $\sigma > 0$ and $\phi \geq 0$ are the inverse elasticity of intertemporal substitution and the inverse Frisch elasticity of hours worked, respectively, whereas A_t is a non-stationary technology index. Following Galí, Smets and Wouters (2012), Θ^j_t is an endogenous preference shifter that regulates the strength of the wealth effect on labor supply.[4]

Optimizing Households. Optimizing households save and borrow by trading non-state-contingent international bonds, F^{o*}_t, with foreign agents (foreign variables will be denoted with an asterisk). They also purchase an investment good, I^o_t, which determines next period's physical capital stock, K^o_t. Further, let r^*_t denote the gross return on F^{o*}_{t-1} and let r^k_t be the rental rate on capital K^o_{t-1}. Additionally, let Π^o_t denote the profits from the home good producing firm, which is owned by this type of household.

These households pay taxes on labor income, consumption expenditures, and capital income (after deducting depreciation costs) at rates, τ^n_t, τ^c_t, and τ^k_t, respectively. They also receive government transfers, TR^o_t. Hence, the period-by-period budget constraint of the representative optimizing household is given by

$$(1+\tau^c_t) p_t C^o_t + p_t I^o_t + r^*_t F^{o*}_{t-1} + T^o = (1-\tau^n_t) W_t h^o_t + F^{o*}_t + \left[(1-\tau^k_t) r^K_t + \tau^k_t \delta \right] K^o_{t-1} + TR^o_t + \Pi^o_t, \tag{2}$$

where p_t denotes the price of the final good relative to the price of the imported good, which is the numeraire.[5] T^o is a constant lump-sum tax introduced to ensure consistency between the model's steady-state budget constraint and observed fiscal aggregates, such as the share of government consumption and transfers in GDP.

[4] Θ^j_t satisfies

$$\Theta^j_t = \widetilde{\chi}^j_t A^{\sigma}_{t-1} \left[\hat{C}^j (C^j_t, \breve{C}^j_{t-1}, G^c) \right]^{-\sigma}, \qquad \widetilde{\chi}^j_t = \widetilde{\chi}^{j\,1-\nu}_{t-1} A^{-\sigma\nu}_{t-1} \left[\hat{C}^j (\breve{C}^j_t, \breve{C}^j_{t-1}, G^c) \right]^{\sigma\nu},$$

where $\nu \in [0,1]$ regulates the strength of the wealth effect: when $\nu = 1$, preferences are of the standard CRRA type; when $\nu = 0$, the wealth effect is shut down, as in the preferences by Greenwood, Hercowitz and Huffman (1988). Because the consumption bundle that determines household utility includes government consumption, the preference shifter Θ^j_t includes steady-state government consumption G^c, but this is a proxy. We acknowledge that the actual variable has a unit root and is transformed accordingly for stationarity.

[5] Note that consumption, C^o_t, and investment, I^o_t, are bundles of the final good, so to express them in terms of the foreign good, they must be multiplied by p_t; the other terms in the budget constraint are expressed in terms of the foreign good.

The physical capital stock evolves according to the following law of motion:

$$K_t^o = (1-\delta)K_{t-1}^o + [1-\Gamma\left(I_t^o/I_{t-1}^o\right)]u_t I_t^o, \qquad \delta \in [0,1], \tag{3}$$

where I_t^o denotes investment expenditures and

$$\Gamma\left(\frac{I_t^o}{I_{t-1}^o}\right) = \frac{\gamma_k}{2}\left(\frac{I_t^o}{I_{t-1}^o} - \bar{a}\right)^2, \qquad \gamma \geq 0, \qquad \bar{a} \geq 1,$$

are convex investment adjustment costs. The variable u_t is an investment shock that captures changes in the efficiency of the investment process (see Justiniano, Primiceri and Tambalotti, 2010) and $\bar{a}$ is the steady-state trend growth rate of the economy. The household chooses C_t^o, h_t^o, I_t^o, K_t^o, and F_t^{o*} to maximize (1) subject to (2)-(3), taking W_t, r_t^*, r_t^K, TR_t^o, G_t^c, Π_t^o, F_{t-1}^{o*}, K_{t-1}^o, and T^o as given.

The (gross) interest rate at which optimizing households save and borrow is given by:

$$r_t^* = R_{t-1}^* \xi_{t-1}, \tag{4}$$

where R_{t-1}^* is the gross foreign real interest rate, which evolves exogenously, and ξ_{t-1} denotes a country premium given by (see Schmitt-Grohe and Uribe, 2003; Adolfson et al., 2008):

$$\xi_t = \bar{\xi}\exp\left[\psi\frac{(F_t^* + B_t^*)/Y_t - (\bar{f}^* + \bar{b}^*)}{\bar{f}^* + \bar{b}^*} + \frac{\zeta_t - \bar{\zeta}}{\bar{\zeta}}\right], \qquad \psi > 0, \qquad \bar{\xi} \geq 1, \tag{5}$$

where F_t^* is the aggregate stock of private foreign debt, B_t^* is foreign government debt, Y_t is GDP (to be defined below), ζ_t is an exogenous idiosyncratic component of the country premium, and $(\bar{f}^* + \bar{b}^*)$ is an exogenous target for the ratio of foreign debt to GDP. The steady-state level of the country risk premium is determined by $\bar{\xi}$. The country premium increases with the economy's external debt burden and with exogenous risk shocks, capturing the idea that a higher indebtedness level and adverse global conditions raise the economy's borrowing costs.

Rule-of-Thumb Households. The subset of households that do not have access to financial assets or capital accumulation receive only labor income and government transfers, TR_t^r, which they use to consume and pay the consumption tax. We assume that rule-of-thumb households do not pay labor income taxes, reflecting either thresholds in the tax code or their representation of informal sector workers. Hence, they face the following simpler budget constraint:

$$(1+\tau_t^c)p_t C_t^r = W_t h_t^r + TR_t^r. \tag{6}$$

They solve a static optimization problem, choosing C_t^r and h_t^r, subject to (6).

3.2 Firms

The supply side of the economy is composed of four types of competitive firms, as follows: a set of firms that produce a home good using labor and capital, a set of firms that import a homogeneous foreign good, a set of firms that combine the domestic and foreign goods into a final good that is purchased by households and the government for consumption and investment, and a set of competitive firms producing a homogeneous commodity good that is exported. A proportion of those commodity-exporting firms is owned by the government and the remaining proportion is owned by foreign agents. The total mass of firms in each sector is normalized to one.

Home Goods. Home goods are produced according to the following technology:

$$Y_t^H = z_t \left(K_{t-1}^g\right)^\gamma K_{t-1}^\alpha [A_t h_t]^{1-\alpha-\gamma}, \qquad \alpha \in [0,1), \qquad \gamma \in [0,1), \tag{7}$$

where z_t is an exogenous stationary technology shock, A_t (with $a_t \equiv A_t/A_{t-1}$) is a non-stationary technology index, K_{t-1} is the aggregate stock of private capital available for production in period t, and K_{t-1}^g is the stock of public capital. The firm hires labor and rents private capital to maximize profits subject to the technology constraint (7), taking the stock of public capital as given.[6]

Foreign Goods. A representative importing firm buys an amount Y_t^F of a homogeneous foreign good to meet the demand of the final good producers, X_t^F. This representative importing firm makes zero profits.

Final Goods. A representative final-goods firm demands home and foreign goods in the amounts X_t^H and X_t^F, respectively, and combines them according to the following technology:

$$Y_t^C = \left[(1-o)^{\frac{1}{\eta}} \left(X_t^H\right)^{\frac{\eta-1}{\eta}} + o^{\frac{1}{\eta}} \left(X_t^F\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \qquad o \in (0,1), \qquad \eta > 0. \tag{8}$$

[6]The firm earns positive profits in equilibrium due to the inclusion of public capital, which introduces decreasing returns to scale in private inputs, thereby breaking the standard zero-profit condition under constant returns.

Let p_t and p_t^H denote the relative prices of Y_t^C and X_t^H, respectively, in terms of the imported good. Subject to the technology constraint (8), the firm maximizes its profits $\Pi_t^C = p_t Y_t^C - p_t^H X_t^H - X_t^F$ over the input demands X_t^H and X_t^F, taking p_t and p_t^H as given. This firm makes zero profits in equilibrium.

Commodities. A representative commodity-producing firm produces a quantity of a commodity good Y_t^P in each period, which evolves exogenously. The entire production is sold abroad at a given international price, p_t^{P*}, which also evolves exogenously. The income generated in the commodity sector is therefore equal to $p_t^{P*} Y_t^P$. The government receives a share $\chi \in [0, 1]$ of this income and the remaining share goes to foreign agents.

3.3 Fiscal Policy

The government demands the final good for consumption (G_t^c) and investment (G_t^i) purposes and makes transfers to households (TR_t). It levies taxes on consumption expenditures, labor and capital income, issues foreign debt, and receives a share $\chi \in (0, 1)$ of the income generated in the commodity sector. Hence, the government satisfies the following period-by-period constraint:[7]

$$p_t G_t^c + p_t G_t^i + TR_t + r_t^* B_{t-1}^* = B_t^* + \tau_t^c p_t C_t + (1-\omega)\tau_t^n W_t h_t^o + \tau_t^k (r_t^k - \delta) K_{t-1} + \chi p_t^{P*} Y_t^P + (1-\omega) T^o. \tag{10}$$

Government expenditure components respond endogenously to the output gap (deviations of output from steady state) and deviations of the government debt-to-GDP ratio from target, capturing both cyclical behavior and potential fiscal sustainability concerns, as follows:

$$G_t^c = (a_{t-1} G_{t-1}^c)^{\rho_{gc}} \left(G^c \left(\frac{Y_t}{Y} \right)^{\alpha_{gc}} \left(\frac{B_{t-1}^*/Y_{t-1}}{\bar{b}^*} \right)^{\gamma_{gc}} \right)^{1-\rho_{gc}} \exp(e_t^{gc}), \tag{11}$$

$$G_t^i = (a_{t-1} G_{t-1}^i)^{\rho_{gi}} \left(G^i \left(\frac{Y_t}{Y} \right)^{\alpha_{gi}} \left(\frac{B_{t-1}^*/Y_{t-1}}{\bar{b}^*} \right)^{\gamma_{gi}} \right)^{1-\rho_{gi}} \exp(e_t^{gi}), \tag{12}$$

[7] The tax rates τ_t^c, τ_t^n and τ_t^k are fixed at their steady state values when we estimate the model, but in the simulation of a fiscal consolidation, which includes increases in tax rates, we allow them to follow an exogenous AR(1) process, as follows:

$$\tau_t^x = \rho_{\tau x} \tau_{t-1}^x + (1 - \rho_{\tau x}) \tilde{\tau}^x + \varepsilon_t^{\tau x} \quad \rho_{\tau x} \in [0, 1), \tag{9}$$

where $x \in \{c, n, k\}$, $\varepsilon_t^{\tau x}$ are i.i.d. shocks to tax rates, and the parameters $\tilde{\tau}^x$ determine the value of tax rates at steady state.

$$TR_t = (a_{t-1}TR_{t-1})^{\rho_{TR}} \left(TR \left(\frac{Y_t}{Y} \right)^{\alpha_{TR}} \left(\frac{B^*_{t-1}/Y_{t-1}}{\bar{b}^*} \right)^{\gamma_{TR}} \right)^{1-\rho_{TR}} \exp(e^{TR}_t), \qquad (13)$$

where ρ_{gc}, ρ_{gi} and ρ_{TR} lie in the $[0, 1)$ interval and govern the persistence of the components of expenditure. The parameters α_{gc}, α_{gi}, and α_{TR} govern the strength of the response of each expenditure component to the business cycle, with positive values indicating procyclical behavior and negative values indicating countercyclical behavior. The parameters γ_{gc}, γ_{gi}, and γ_{TR} govern the strength of the response of each expenditure component to deviations of the government debt-to-GDP ratio from its target, $\bar{b}^*$, with negative values indicating a debt-stabilizing behavior. The components of government expenditure are also subject to exogenous white noise shocks, e^{gc}_t, e^{gi}_t, and e^{TR}_t.[8]

Government investment augments the stock of public capital, which is an input in the production of home goods, according to the following law of motion:

$$K^g_t = (1 - \delta_g)K^g_{t-1} + G^i_t, \quad \delta_g \in [0, 1], \qquad (14)$$

where δ_g is the depreciation rate of public capital.

The government distributes shares ω^G and $(1-\omega^G)$ of total transfers to rule-of-thumb and optimizing households, respectively. Total transfers received by rule-of-thumb households satisfy $\omega TR^r_t = \omega^G TR_t$, whereas transfers received by optimizing households satisfy $(1 - \omega)TR^o_t = (1 - \omega^G)TR_t$. This formulation allows the government to target transfers differently than the population share, for example focusing them on the financially restricted rule-of-thumb households.

3.4 The Rest of the World

Foreign demand for the home good, X^{H*}_t, is given by the schedule

$$X^{H*}_t = o^* \left(p^H_t\right)^{-\eta^*} Y^*_t, \qquad o^* \in (0, 1), \qquad \eta* > 0, \qquad (15)$$

where Y^*_t denotes foreign aggregate demand, proxied by foreign GDP, which evolves exogenously, and η^* is an elasticity that governs how exports demand responds to changes in the price of the home good.

[8]Once again, we are slightly abusing notation in the expenditure rules by denoting the steady state value of each component as G^c, G^i and TR. The components of expenditure have a unit root, so they do not have a steady state. It is the transformed variables, $\frac{G^c_t}{A_{t-1}}$, $\frac{G^i_t}{A_{t-1}}$, and $\frac{TR_t}{A_{t-1}}$ that have a steady state.

3.5 Aggregation and Market Clearing

To aggregate private consumption, hours worked, and transfers, consider that both types of households, optimizing and rule-of-thumb, consume and work, and receive transfers. Hence, the following conditions hold: $C_t = (1-\omega)C_t^o + \omega C_t^r$; $h_t = (1-\omega)h_t^o + \omega h_t^r$; and $TR_t = (1-\omega)TR_t^o + \omega TR_t^r$.

As only optimizing households own firms and hold financial assets and physical capital, we have the following conditions for aggregate profits, private asset holdings, the aggregate capital stock and aggregate investment, respectively: $\Pi_t = (1-\omega)\Pi_t^o$; $F_t^* = (1-\omega)F_t^{o*}$; $K_t = (1-\omega)K_t^o$; and $I_t = (1-\omega)I_t^o$.

In the market for final goods, the clearing condition is $Y_t^C = C_t + I_t + G_t^c + G_t^i$, while in the markets for home and foreign goods, we have $Y_t^H = X_t^H + X_t^{H*}$, and $Y_t^F = X_t^F$. Hence, aggregate demand is the sum of domestic absorption, Y_t^C, and the trade balance, TB_t, which in equilibrium equals real GDP, Y_t. Consequently, expressed in terms of foreign goods (the numeraire), real GDP is given by:

$$Y_t = p_t Y_t^C + TB_t = \underbrace{p_t(C_t + I_t + G_t^c + G_t^i)}_{\text{Domestic absorption}} + \underbrace{p_t^H X_t^{H*} + p_t^{P*} Y_t^P - Y_t^F}_{\text{Trade balance}}.$$

Alternatively, real GDP can be expressed as domestic supply: $Y_t = p_t^H Y_t^H + p_t^{P*} Y_t^P$.

The net foreign asset position of this economy results from combining the period-by-period budget constraints of the households and government. The aggregate household budget constraint is the weighted sum of the optimizing and rule-of-thumb households' budget constraints, where the weights are their shares in the population, $(1-\omega)$ and ω, respectively, which results in:

$$\begin{aligned}(1+\tau_t^c)p_t C_t + p_t I_t + r_t^* F_{t-1}^* + (1-\omega)T^o = &W_t h_t - (1-\omega)\tau_t^n W_t h_t^o + F_t^* + \\ &+ \left[(1-\tau_t^k) r_t^K + \tau_t^k \delta\right] K_{t-1} + TR_t + \Pi_t.\end{aligned}$$

Combining the previous expression with the period-by-period budget constraint of the government in (10) obtains the balance-of-payments identity:

$$F_t^* + B_t^* = r_t^*(F_{t-1}^* + B_{t-1}^*) - TB_t + (1-\chi)p_t^{P*} Y_t^P,$$

which states that the change in the net foreign asset position is equal to the current account balance (the trade balance plus net interest income).

3.6 Driving Forces

In addition to the previously described shocks to tax rates and government expenditures, several exogenous variables in the model follow an AR(1) process of the form

$$log(x_t/\bar{x}) = \rho_x log(x_{t-1}/\bar{x}) + \varepsilon_t^x, \qquad \rho_x \in [0,1),$$

where ε_t^x are white noise shocks and $\bar{x}$ is their steady-state counterpart, for $x = \{v, \kappa, u, z, a, \zeta, R^*, p^{P*}, y^P, y^*\}$. The economy is subject to a wide array of shocks, including those to consumption and labor supply preferences, investment efficiency, technology (both transitory and permanent), external financial conditions, and commodity market dynamics. These shocks reflect the key sources of macroeconomic volatility faced by commodity-exporting countries.[9]

In sum, the model integrates heterogeneous households, a detailed fiscal block, and a realistic external sector to capture the macroeconomic dynamics of a commodity-exporting small open economy. Its structure allows us to analyze how fiscal consolidation plans interact with commodity revenue volatility, providing a rich framework for policy evaluation.

4 Parametrization Strategy

Our strategy for taking the model to the data combines the estimation of most of the parameters and the calibration of the rest. While some parameters are directly assigned values based on external sources, particularly studies focused on Latin American economies, others are solved endogenously within the steady-state system to match empirical targets, such as ratios with respect to GDP of government consumption, transfers, external debt, and oil production, and the public-to-total investment ratio.[10]

Calibrated Parameters. In general, our calibrations for preferences and technology follow the strategies in Medina and Soto (2016), whose model is tailored to Latin American economies with similar structural features, and Coenen, Straub and Trabandt (2013). To obtain targets for some of the steady-state values, we use the 2022-2027 projections in the July 2022 IMF Staff Report for Ecuador (see Oner et al., 2022) and data counterparts over the estimation sample in other cases.[11]

[9]The full set of stationary equilibrium conditions appears in appendix A.

[10]See appendix B for details on the parameters that are solved endogenously.

[11]Table C.1 in appendix C presents the calibrated parameters and targeted steady state values, and their sources.

Estimation of Parameters. We estimate the parameters of the model with Bayesian techniques, solving the model with a linear approximation around the non-stochastic steady state. Priors are selected based on standard values in the literature and economic plausibility, ensuring convergence of the posterior distributions. We use quarterly information from Ecuador for the period 2004–2019 for the following 13 observable variables: Non-oil GDP, private aggregate consumption, aggregate investment, government consumption, government investment, government transfers, the trade balance, hours worked, the country risk premium as measured by the Emerging Markets Bond Index (EMBI) for Ecuador, the West Texas Intermediate (WTI) oil price, oil production, the foreign interest rate, and foreign GDP. The inclusion of oil prices and the EMBI spread helps identify parameters related to commodity shocks and the country risk premium. We exclude post-2019 data mainly to ignore pandemic-related distortions.[12]

We now turn to evaluating the model's ability to replicate key empirical moments and its dynamic behavior under the estimated parameters.

5 Model Dynamics and Performance

To assess how the model fits the data, we compute for nine selected variables the following model-implied moments, evaluated at the posterior mean of the parameters: their correlation with GDP, standard deviation, and first-order autocorrelation coefficient. Then, we compare these statistics with empirical moments. Overall, the model replicates key empirical features of the Ecuadorian economy, including the co-movement with GDP, volatility, and persistence of macroeconomic aggregates, with deviations generally within acceptable bounds for estimated DSGE models.[13]

To understand how the model interprets the data through its structural shocks, figure 1 shows the historical shock decomposition of the annual growth rate of non-oil GDP.[14] Shocks are grouped into six categories: i) commodity shocks, which include oil price (p^{P*}) and oil output (Y^P) shocks, ii) a risk shock that affects the country premium (ζ), iii) fiscal policy (FP) shocks, which include those to government consumption, government investment, and transfers (e^{gc}, e^{gi}, and e^{TR}), iv) technology shocks, which include transitory (z) and permanent (a) productivity shocks, and investment efficiency (u) shocks, v) foreign shocks, which include shocks to the foreign interest rate (R^*) and foreign demand (y^*), and vi)

[12] Table D.1 in appendix D shows the prior and posterior distributions of the estimated parameters. This appendix also discusses the parameter estimates in the interest of keeping the discussion in the main body of the paper fluid and concise.

[13] Table F.1 in appendix F reports the comparison between model-implied and empirical moments.

[14] Table F.2 in appendix F reports the unconditional variance decomposition of selected variables.

preference shocks, which include consumption (v) and labor supply (κ) shocks.[15] Ecuador displays a cycle marked by a substantial expansion since the mid 2000s, which, as in other Latin American countries, coincided with the boom in international commodity prices. This boom was briefly interrupted in 2008–2009 by the Global Financial Crisis (GFC), and later brought to a sudden halt in 2014, when international commodity prices collapsed. The last five years of the sample are marked by a seemingly permanent decline in the growth rate of non-oil GDP.

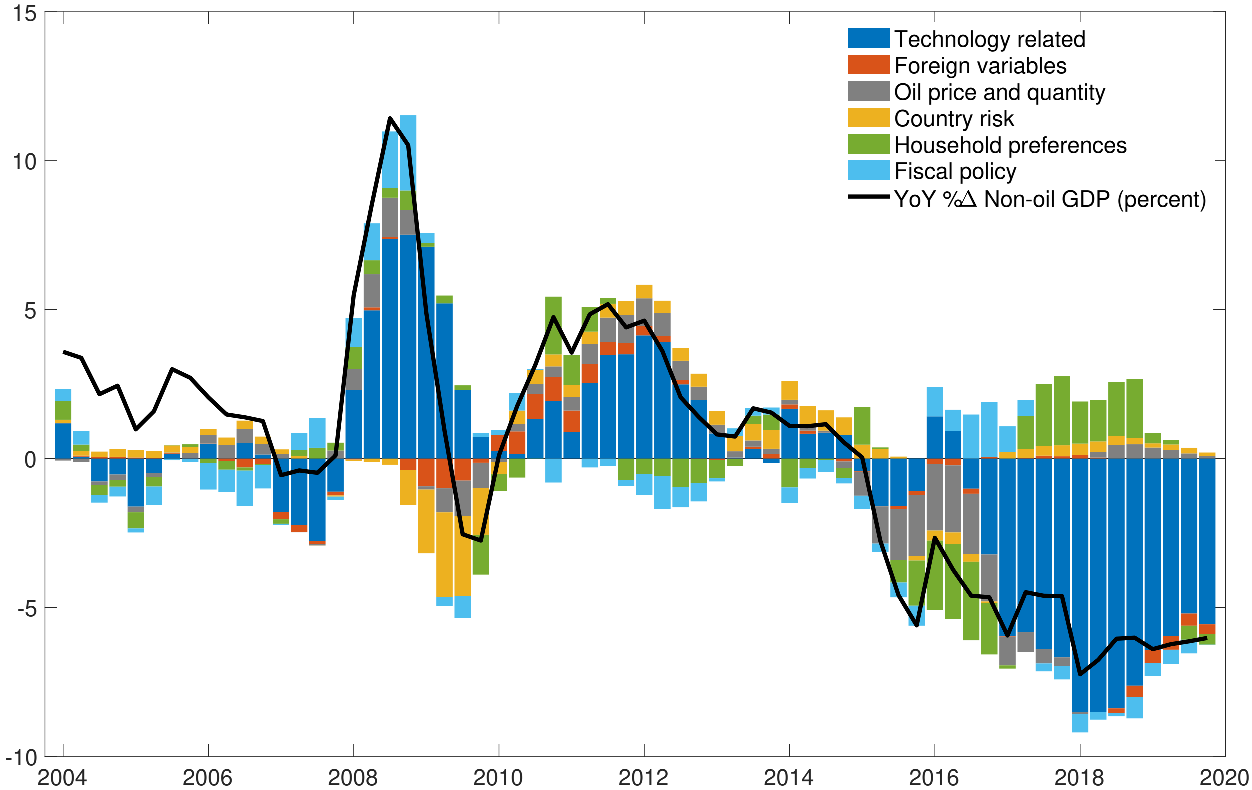
Looking at the cycle through the lens of the model points to technology shocks (dark blue bars) as the most important drivers. This is particularly relevant in the last part of the sample, in which permanent productivity shocks (a_t) are the only way for the model to rationalize the permanent decline in output growth. A deep understanding of this phenomenon is beyond the scope of this paper, but one possible explanation is that growth patterns featuring weak (strong) demand induce a slowdown (rise) in productivity, as argued by Stadler (1990), Anzoategui et al. (2019), Jordà, Singh and Taylor (2020), and Furlanetto et al. (2025), among others.

Oil shocks (gray bars) are relevant drivers of output growth during episodes of oil price swings, such as the high prices observed from the mid 2000s to 2013, which exert upward pressure, in general. Oil shocks contribute negatively during the GFC, when the oil price declined, and especially during 2014–2017, a period of low oil prices that exerted substantial negative pressure on output growth.

Country risk premium shocks (yellow bars) exert downward pressure on output growth around the GFC of 2008 for two reasons, one global and one idiosyncratic. First, the global turmoil increased international investors' risk perception of emerging markets. The second and surely more important reason is that Ecuador decided to default on its sovereign debt for political considerations in December of 2008. These forces sent the Ecuadorian EMBI spread above 4,000 points (a 40 percentage-point premium above the equivalent risk-free bond). As time progressed and Ecuador regained access to financial markets, the downward trend in the country risk premium generated a positive effect of these shocks on output growth through 2014. Between 2015 and 2016, risk shocks put downward pressure on growth, again due to global and idiosyncratic factors. In this period, country premiums increased in developing countries (especially in Latin America) due to the decline in commodity prices. The idiosyncratic factor was a severe earthquake that affected two coastal provinces in Ecuador. Towards the end of the sample, with the country risk premium mostly declining, the effect of these shocks on GDP growth is small but positive.

[15]We ignore the role of initial conditions and measurement error, so the bars do not add up exactly to the solid line. Appendix G contains the shock decomposition of the other observable variables of the model.

Figure 1: Historical Shock Decomposition of Annual Non-Oil GDP Growth



Note: The solid black line denotes the four-quarter moving sum of the observable variable—the demeaned quarter-on-quarter log difference of non-oil GDP, which approximates its annual growth rate. The bars are four-quarter moving sums of shocks obtained from the historical shock decomposition of the observable variable. For details on the shock groupings, see the text.

Fiscal policy shocks (light blue bars) contribute positively to output growth during 2007–2008, a period of highly expansionary fiscal policy. Fiscal policy shocks are also expansionary during 2016–2017, likely due to the severe earthquake and its effect on the Ecuadorian economy, which required a fiscal expansion in full force to restore physical infrastructure.[16] Additionally, the presidential elections of 2017 might have also played a role in the expansionary fiscal policy, as the sitting president was trying to promote a candidate of his own party.

To illustrate how two external shocks of interest for this paper—oil price and country risk

[16]Governmental and international institutions report the cost of reconstruction and economic recovery was close to $3 billion. See https://www.worldbank.org/en/news/feature/2021/04/27/a-cinco-a-os-del-terremoto-ecuador-sigue-trabajando-en-su-resiliencia-frente-a-desastres and https://ecuadorchequea.com/moreno-ley-de-solidaridad-1500-millones/.

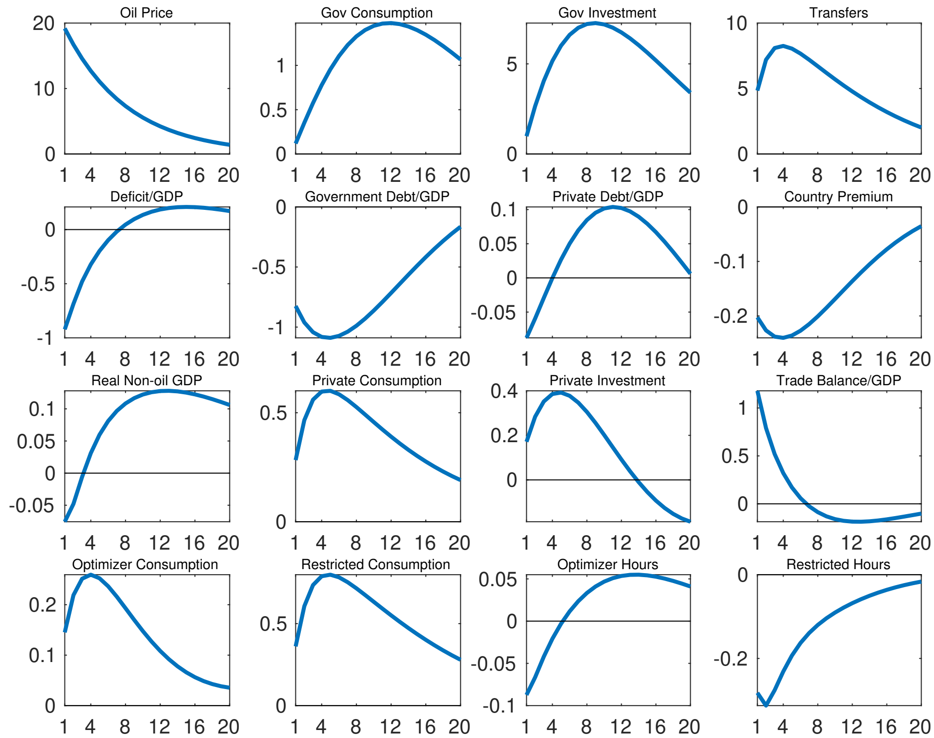
premium shocks—propagate through the model economy, we analyze their impulse-response functions. These shocks are interesting, because they may affect fiscal outcomes and macroeconomic dynamics during the implementation of fiscal consolidation plans, potentially generating deviations from baseline trajectories.

Effects of an oil price shock. A one-standard-deviation shock to the price of oil causes the price to increase by 19% on impact, as shown in figure 2 (top-left panel). The government receives an oil revenue windfall that reduces the deficit (panel 2-1) and, accordingly, public debt (panel 2-2). The decline in the model economy's debt-to-GDP ratio leads to a decline of more than 200 bps in the country premium (panel 2-4). Following the estimated reaction functions of government expenditure, all three components—government consumption, government investment, and transfers—increase gradually, reaching peaks four to twelve quarters after the shock hits the economy (panels 1-2, 1-3, and 1-4). The expansion in government expenditure reflects both improved fiscal space—via a lower debt-to-GDP ratio—and the endogenous estimated procyclical response of spending to a positive output gap, as encoded in the fiscal rules.

Because public and private consumption are complementary for household utility, both the optimizing and restricted rule-of-thumb households increase consumption on impact (panels 4-1, 4-2, and 3-2). The increase in transfers also contributes to the increase in consumption of rule-of-thumb households, who also reduce hours worked (panel 4-4) due to the income effect. The decline in the country premium increases the present value of investment—i.e., increases Tobin's q—so the optimizing households increase private investment (panel 3-3), such that the 200 bps decline in the country premium translates into a roughly 0.4% increase in investment a year after the shock hits the economy. The overall effect on non-oil GDP is slightly negative on impact (panel 3-1), because hours worked reach their trough almost immediately, whereas public and private demand for consumption and investment, as well as government transfers, take several quarters to reach their peak. Non-oil GDP begins expanding persistently about a year after the shock hits the economy.

Effects of a country premium shock. We now describe the response of the model economy to a shock to the country risk premium, which is shown in figure 3. A one-standard-deviation shock to the idiosyncratic component of the country premium (the top-left panel) drives up the premium by over 300 basis points (panel 2-4). This increase in the country premium drives down the present value of investment, which leads the optimizing households to decrease investment (panel 3-3). The higher country premium also exerts downward pressure on the consumption of optimizing households (panel 4-1) due to the

Figure 2: Impulse Responses to an Oil Price Shock



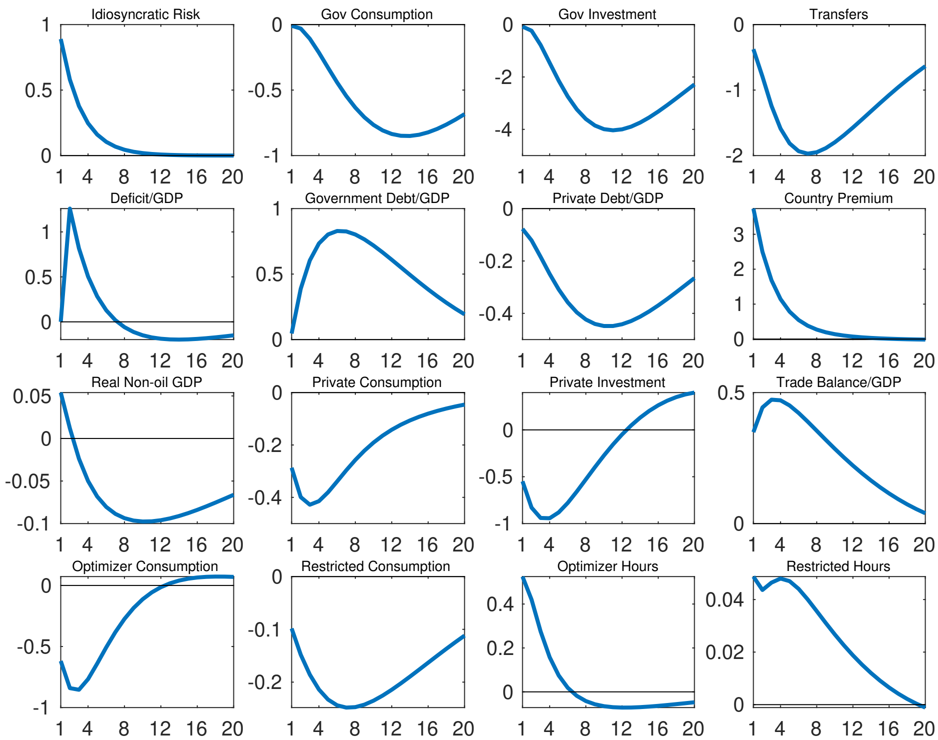
Note: Impulse responses to a one-standard-deviation shock to the international oil price. X axes denote quarters. Y axes denote percent deviations from steady state, except for variables expressed as ratios to GDP and the country premium, which are expressed as percentage point deviations from steady state. Public and private debt, and the country premium, are annualized.

intertemporal substitution effect. Furthermore, because optimizing households are debtors in steady state, the higher country premium makes them relatively poorer, which also drives down their consumption, as well as their leisure (panel 4-3), due to the negative income effect.

The higher country premium also increases the government's interest payments and, thus, the deficit (panel 2-1) and debt (panel 2-2). The components of government expenditure (panels 1-2, 1-3 and 1-4) decline for two reasons—to stabilize a rising public debt-to-GDP ratio and due to their procyclical response to a contractionary shock. The decline in government transfers depresses consumption of the rule-of-thumb households (panel 4-2) and leads them to work more (panel 4-4) due to the negative income effect. Overall, GDP rises slightly on impact due to the expansion of hours worked, but declines persistently shortly after the shock hits the economy.

Eventually, the decline in government expenditure pushes the deficit-to-GDP ratio below steady state (panel 2-1), containing the increase in public debt. Forward-looking, optimizing households anticipate that this fiscal contraction will induce the country premium to fall below steady state, which ultimately pushes their consumption and investment above steady state.

Figure 3: Impulse Responses to an Idiosyncratic Country Risk Shock



Note: Impulse responses to a one-standard-deviation shock to the idiosyncratic component of country risk. Y axes denote percent deviations from steady state, except for variables expressed as ratios to GDP and the country premium, which are expressed as percentage point deviations from steady state. Public and private debt, and the country premium, are annualized.

Building on these dynamics, we now examine how fiscal consolidation plans perform under alternative paths for commodity revenue, highlighting the vulnerabilities introduced by external shocks.

6 Fiscal Consolidations

This section discusses the macroeconomic effects of fiscal consolidations under historically plausible deviations in commodity revenue from forecasts. To ground our simulations, we use the fiscal consolidation agreement between the government of Ecuador and the IMF, which we used in section 4 to discipline our model (henceforth the agreement), for the 2020–2025 period. We analyze the model economy's performance when oil revenue is higher or lower than originally envisioned in the program.[17]

The agreement between Ecuador and the IMF consisted of a combination of increases in tax rates and a reduction in government expenditure. To simulate increases in tax rates, we depart from our assumption during estimation that all tax rates remain at their steady state, and instead allow them to evolve according to an AR(1) process with very high persistence, to capture the fact that agents understand tax changes to be long-lasting.[18] We feed our simulations with the projected paths of tax rates and government expenditure in the consolidation program, as well as the projected path for oil revenue.

To generate the simulations, we work with the linear state-space form of the solution to our model, as follows: We feed the state-space model with "observable" variables that are the six fiscal instruments and oil revenue trajectories in the agreement, and obtain the implied trajectories of the model's variables. Consequently, in our setup, a fiscal consolidation simulation is a conditional forecast that starts at the steady state of the DSGE model and uses the state-space system to back out the macroeconomic variables' trajectories. We set the change in the fiscal instruments to last 24 quarters (6 years).[19]

The trajectories of tax rates and government expenditures used to generate our simulation are shown in tables 1 and 2, respectively. Tax rate changes, which are expressed as percentage point (pp) changes from tax rates in the previous period, include a permanent 3 pp increase in the labor income tax rate in 2022, the third year of the program, and a transitory 0.5 pp increase in the capital income tax rate during the third year of the program. The agreement did not include changes to the value-added tax rate, which we would implement with shocks to the consumption tax rate.[20]

[17]Our simulation approximates the consolidation program, recognizing that the actual fiscal adjustments involve institutional and distributional complexities beyond the scope of our stylized DSGE framework.

[18]In the model, we assume that tax rates evolve as follows: $\tau_t^x = .999\tau_{t-1}^x + (1 - .999)\tilde{\tau}^x + \varepsilon_{\tau^x}$, for $x \in \{c, n, k\}$ where $\tilde{\tau}^x$ is the steady-state tax rate.

[19]We implement this conditional forecast with the Kalman smoother. In effect, we hit the model with a sequence of unexpected shocks to the fiscal instruments and oil revenue that deliver the desired paths. The macroeconomic effect of this simulation is then the expected value of the model variables given the sequence of shocks. Furthermore, in the simulation, we shut down all but the fiscal policy shocks and the oil price shock, so the Kalman smoother cannot infer other shocks to accommodate the given paths of the fiscal instruments and oil revenue. A limitation of our methodology is that, by using sequences of unexpected shocks to generate the simulations, anticipatory responses are limited, especially to adjustments in government expenditure. This implies that the model may understate the anticipatory effects of expenditure-based consolidations, which in reality could influence private sector behavior before implementation. Adjustments in tax rates do generate substantial anticipatory responses, because they are simulated as quasi-permanent changes.

[20]The personal income tax reform implied a more progressive scheme and a reduction of deductions for high-income earners. Because the model has a single labor income tax rate for all agents, we assume an average tax rate change across the board as a way to implement this reform, taking into

Regarding government expenditure, table 2 shows the evolution of its three components as percent changes from the previous year in real terms. Broadly speaking, the consolidation program contemplates a moderation of the growth rate of government consumption, a substantial decline in the level of government investment in the first year that is only partially recovered in the following years, and a trajectory for the level of transfers that consists of a decline in the first year, a substantial increase in the second and third years, and another decline for the final three years. The increase in transfers was designed to protect vulnerable households from adverse effects of the consolidation program.[21]

Table 1: Fiscal Consolidation: Tax Rate Changes

Year	Consumption Tax	Labor Income Tax	Capital Income Tax
2020	+0	+0	+0
2021	+0	+0	+0
2022	+0	+3	+0.5
2023	+0	+0	−0.5
2024	+0	+0	+0
2025	+0	+0	+0

Note: Entries denote percentage point changes from tax rates in the previous year.

Table 2: Fiscal Consolidation: Government Expenditure Trajectory

Year	Government Consumption	Government Investment	Transfers
2020	+0.9	−29.4	−25.7
2021	+1.8	+10.6	+57.9
2022	−3.9	−1.6	+11.1
2023	+0.8	+4.1	−14.2
2024	+0.5	+0.9	−14.8
2025	+1.9	+0.8	−15.0

Note: Entries denote percent changes from the previous year in real terms.

A final ingredient in the simulation is the trajectory of oil revenue. Table 3 shows the projected real growth rate of oil revenue in the consolidation agreement. Since the

account that the Ecuadorian government estimated that 3.4% of the labor force would have been affected by the reform (see the proposal of the Law for Economic Development and Fiscal Sustainability sent by the Executive branch to Congress: https://www.comunicacion.gob.ec/wp-content/uploads/2021/11/LeyParaElDesarrolloEconomico.pdf). Similarly, the consolidation program considered a temporary contribution in 2022 by persons whose net worth was above $1 million (a 1% to 1.5% tax rate) and firms whose net worth was above $5 million (0.8% tax rate). To include these measures in our model, we assume a transitory increase in the capital income tax rate. For more details, see IMF Country Report No. 22/225 (https://www.elibrary.imf.org/view/journals/002/2022/225/article-A000-en.xml).

[21] Again, see item 18 of IMF Country Report No. 22/225 (https://www.elibrary.imf.org/view/journals/002/2022/225/article-A000-en.xml).

program was approved on September 2020, about six months after the onset of the COVID-19 pandemic, it projected a substantial decline in the level of oil revenue in that year, a strong recovery in the following two years, and a moderation in the last three years of the program.

Table 3: Fiscal Consolidation: Oil Revenue Trajectory

2020	2021	2022	2023	2024	2025
-42.3	+63.9	+30.4	-9.5	-9.4	-8.6

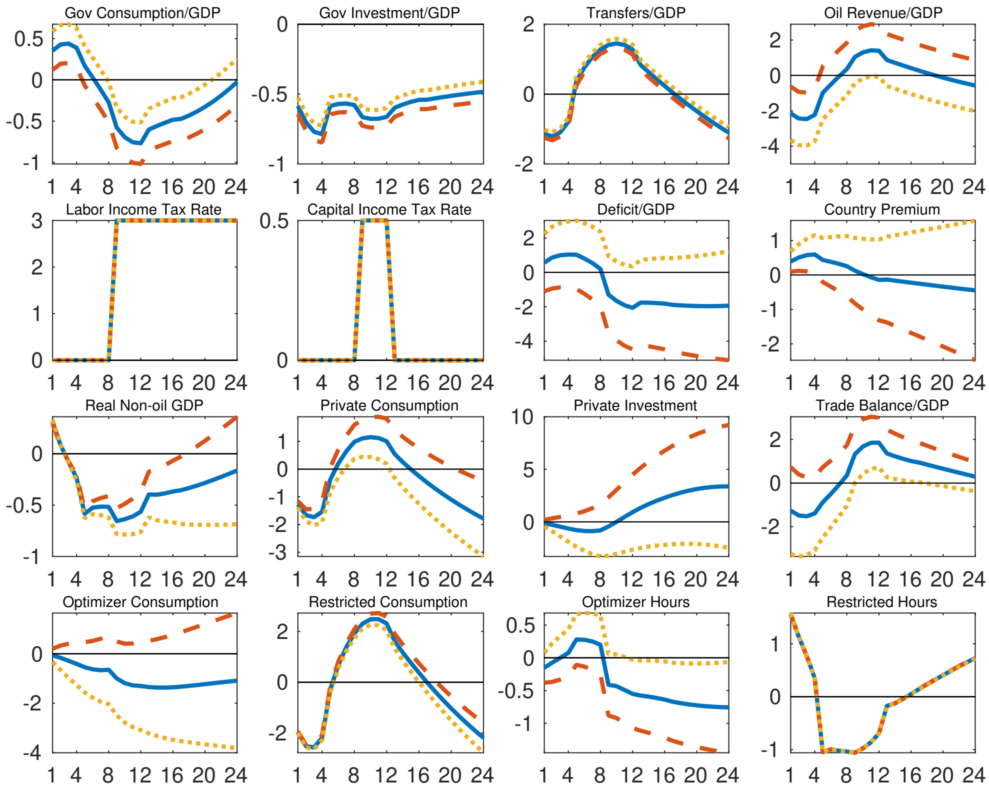
Note: Entries denote percent changes from the previous year in real terms.

Figure 4 shows the macroeconomic effects of this consolidation plan under the baseline oil revenue path and under scenarios with positive and negative deviations from the forecast. Solid blue lines display the baseline case, in which the real growth rate of oil revenue follows the projected path in the program. Dashed orange lines show an alternative case in which oil revenue is one standard deviation higher, whereas oil revenue is one standard deviation lower in the scenario in dotted yellow lines.[22] The trajectories of the six *fiscal instruments* is the same in all scenarios. This is obvious for the case of tax rates, shown in panels 2-1 and 2-2 of the figure. The level of each of the components of government expenditure follows the same trajectory in real terms across the three scenarios, but when expressed as ratios to GDP, as in panels 1-1, 1-2 and 1-3, they differ. This is due to differences in the denominator (GDP), which is an endogenous outcome of each simulation and is not immune to alternative paths for oil revenue.

We first comment on the baseline case, describing the trajectories of the fiscal instruments and their macroeconomic effects (the blue lines). Consistent with the values shown in table 1, the labor income tax rate permanently increases by 3 pp from the third year (quarter 9, panel 2-1), the capital income tax rate increases by 0.5 pp during the third year (panel 2-2), and the consumption tax rate (not shown) remains at steady state over the entire simulation. The annual paths of the components of government spending experience more variability, as shown in table 2. To get sequences of quarterly pp deviations of GDP ratios from steady state, we apply a quadratic interpolation to the annual sequences, ensuring that each year's four-quarter average is equal to the corresponding annual value. After the initial increase we described before, government consumption declines gradually, reaching a trough of about 0.8 pp of GDP below steady state in quarter 12 (top-left panel). Government investment declines immediately, with the government investment-to-GDP ratio falling 0.7 pp below steady state and then increasing slightly, reaching 0.5 pp below by the end of the 24-quarter

[22]The standard deviation is computed from the historical quarterly growth rate of real oil revenue over the estimation sample. We then add/subtract this value to/from the baseline growth rate in each quarter, preserving the original trajectory's shape but shifting its level.

Figure 4: Fiscal Consolidation Under Alternative Paths for Oil Revenue



Note: Simulations of a fiscal consolidation combining adjustments of multiple revenue and expenditure instruments designed to approximate the agreement between the government of Ecuador and the IMF for the 2020–2025 period, as shown in tables 1 and 2. X axes denote quarters. Y axes denote percent deviations from steady state, except for variables expressed as ratios to GDP and the country premium, which are expressed as percentage point deviation from steady state. The country premium is annualized. Solid blue lines depict the effects of the fiscal consolidation with oil revenues as forecast by the agreement. The dashed orange and dotted yellow lines display cases when oil revenue is one standard deviation higher and lower, respectively, than expected by the agreement.

horizon (panel 1-2). The transfers-to-GDP ratio displays an inverse u-shape, lying below steady state during the first year, rising above it during the second to fourth years, and dipping below for the final two years (panel 1-3). Finally, in line with the values in table 3, the path of the oil revenue-to-GDP ratio in panel 1-4 starts about 2 pp below steady state during the first year, then rises gradually for the next two years, reaching a peak of about 1 pp in quarter 12 of the simulation, and then declines in the remaining three years, reaching about -0.5 pp by the end of the horizon.

The fiscal consolidation reduces the deficit-to-GDP ratio (panel 2-3), which reaches 2 pp below steady state by quarter 12.[23] The decline in the deficit contains public debt, leading

[23]In our model, the effect of the consolidation on the fiscal balance is about half of that estimated by the

to a decline in the country risk premium (panel 2-4), which reaches about 50 bps below steady state, on an annual basis, by the end of the simulation. A 2 pp improvement in the deficit-to-GDP ratio and a 50 bps decline in the country premium are both substantial adjustments given Ecuador's fiscal vulnerabilities. The lower country risk premium leads to higher private investment (panel 3-3).

Higher taxes, especially on labor income, reduce the consumption of optimizing households (panel 4-1), whereas the consumption of restricted hand-to-mouth households (panel 4-2) follows the inverse u-shape pattern of government transfers, as this group of consumers receives the entirety of transfer. Aggregate private consumption (panel 3-2) also follows this u-shape trajectory because hand-to-mouth households' consumption outweighs their optimizing counterparts'. Hours worked of optimizing households (panel 4-3) decline below steady state in quarter 8, following the increase in the labor income tax. In the case of hand-to-mouth households (panel 4-4), hours worked follow an inverse pattern to that of transfers due to their income effect.

The
contraction in government demand—particularly consumption and investment—alongside reduced labor supply, leads to a decline in non-oil GDP of approximately 0.5% below trend during years 2 and 3 (panel 3-1). From the fourth year, the expansion in private investment due to the lower country risk premium and an improvement in the trade balance (panel 3-4) contribute to a partial recovery of GDP, which ends the six-year simulation horizon about 0.2% below trend.

We now turn to the alternative scenarios, where oil revenue deviates positively or negatively from the baseline projection, to assess how such shocks affect the consolidation's effectiveness. The alternative scenarios for oil revenue generate substantially different macroeconomic outcomes, holding the trajectories in tax rates and government expenditure fixed. The path of the oil revenue-to-GDP ratio (panel 1-4) is roughly 2 pp higher or lower under historically plausible deviations. When oil revenue is higher, as depicted by dashed orange lines, the deficit-to-GDP ratio (panel 2-3) declines more than twice as much as in the baseline case, reaching 5 pp below steady state by the end of the horizon. The lower deficit contains public debt such that the decline in the country risk premium reaches more than 200 bp (panel 2-4). In these conditions, private investment expands forcefully (panel 3-3). Real non-oil GDP (panel 3-1) reaches a similar trough, but recovers much faster, increasing above steady state by the fifth year.

When oil revenue is lower than anticipated, as depicted by dotted yellow lines, the

IMF, whose Country Report No. 22/225 shows that the primary balance of the non financial public sector would improve by 4.5% of GDP between 2020 and 2025 with the program.

deficit-to-GDP ratio (panel 1-4) does not manage to decline below steady state. Without further adjustment to tax rates or government expenditure, this situation generates an increase in the country risk premium, which reaches about 150 bp above steady state by the end of the horizon (panel 2-4). Private investment (panel 3-3) does not increase in these circumstances, while private consumption (panel 3-2) declines more than in the baseline. Real non-oil GDP (panel 3-1) reaches a similar trough across scenarios, but in the low oil revenue case, it fails to recover over the 24-quarter horizon, remaining persistently more than 0.5% below steady state.[24]

7 Conclusion

This paper explored the macroeconomic effects of fiscal consolidations in commodity-exporting countries using a DSGE model calibrated to Ecuador and its 2020–2025 IMF-supported adjustment program. Our simulations show that the outcomes of fiscal consolidation plans can be highly sensitive to deviations in commodity revenue from forecasts.

When oil revenue is higher than expected, the fiscal deficit improves more rapidly, public debt declines, and the country risk premium falls. These dynamics may reduce the perceived urgency of continued fiscal adjustment and could, in practice, create incentives to relax or abandon the consolidation effort. Conversely, when oil revenue falls short of projections, the fiscal deficit deteriorates compared with the original projection, the country risk premium rises, and private investment weakens. In such cases, achieving the original fiscal targets may require a more aggressive adjustment, which could be politically or socially difficult to implement.

While our model does not explicitly capture the political economy of fiscal policy, the results suggest that the design of consolidation programs should account for the risks posed by commodity price volatility. Incorporating mechanisms such as flexible fiscal targets or contingency clauses could help programs remain credible and sustainable in the face of external shocks, ensuring that temporary revenue windfalls or shortfalls do not derail the broader adjustment effort.

[24] To further illustrate the behavior of the model under fiscal consolidation scenarios, we analyze alternatives based either on tax rate increases only, whose results appear in figure H.7 of appendix H.7, or on expenditure reductions alone, whose results appear in figure H.8. As an additional sensitivity exercise, we explore how the baseline fiscal consolidation would change when the pass-through from a lower risk premium is not complete, as would be the case, for example, in a country that imposes capital controls. The results appear in appendix H.8.

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Appendix

A Stationary Equilibrium Conditions

The variables in uppercase contain a unit root in equilibrium due to the presence of the non-stationary productivity index A_t. We need to transform these variables to have a stationary version of the model. To do this, lowercase variables denote the uppercase variable divided by A_{t-1} (e.g. $c_t \equiv \frac{C_t}{A_{t-1}}$). The only exception is the Lagrange multiplier Λ_t, which is multiplied by A_{t-1}^{σ} (i.e. $\lambda_t \equiv \Lambda_t A_{t-1}^{\sigma}$), for it decreases along the balanced growth path.

The rational expectations equilibrium of the stationary version of the model model is the set of 45 sequences

$$\{\lambda_t^o, \hat{c}_t^o, c_t^o, h_t^o, i_t^o, k_t^o, f_t^{*o}, \Theta_t^o, \widetilde{\chi}_t^o, \lambda_t^r, \hat{c}_t^r, c_t^r, h_t^r, \Theta_t^r, \widetilde{\chi}_t^r, c_t, h_t, i_t, k_t, f_t^*, q_t, w_t, r_t^K, y_t, y_t^C, y_t^F\}$$

$$\{y_t^H, x_t^F, x_t^H, x_t^{H*}, \pi_t, p_t^H, p_t, tb_t, \xi_t, b_t^*, \tau_t^k, \tau_t^n, \tau_t^c, k_t^g, g_t^c, g_t^i, tr_t, tr_t^o, tr_t^r\},$$

such that for given initial values and 11 exogenous sequences

$$\{\upsilon_t, \kappa_t^o, \kappa_t^r, u_t, z_t, a_t, \zeta_t, R_t^*, p_t^{Co*}, y_t^{Co}, y_t^*\}$$

the following conditions are satisfied:
Optimizer consumption first order condition:

$$\lambda_t^o(1+\tau_t^c)p_t = \hat{c}_t^{o^{-\sigma}} \left(\frac{(1-o_c)\hat{c}_t^o}{c_t^o - \varsigma \frac{c_{t-1}^o}{a_{t-1}}} \right)^{\frac{1}{\eta_c}} \tag{E.1}$$

Restricted consumption first order condition:

$$\lambda_t^r(1+\tau_t^c)p_t = \hat{c}_t^{r^{-\sigma}} \left(\frac{(1-o_c)\hat{c}_t^r}{c_t^r - \varsigma \frac{c_{t-1}^r}{a_{t-1}}} \right)^{\frac{1}{\eta_c}} \tag{E.2}$$

Consumption aggregation:

$$c_t = (1-\omega)c_t^o + \omega c_t^r \tag{E.3}$$

Optimizer hours first order condition:

$$(1-\tau_t^n)w_t = \Theta_t^o \kappa_t^o \frac{h_t^{o^{\phi}}}{\lambda_t^o} \tag{E.4}$$

Restricted hours first order condition:

$$w_t = \Theta_t^r \kappa_t^r \frac{h_t^{r^{\phi}}}{\lambda_t^r} \tag{E.5}$$

Hours aggregation:

$$h_t = (1-\omega)h_t^o + \omega h_t^r \tag{E.6}$$

Optimizer debt first order condition:

$$\lambda_t^o = \frac{\beta}{a_t^\sigma} R_t^* \xi_t E_t \left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \lambda_{t+1}^o \right\}, \tag{E.7}$$

Final good production function:

$$y_t^C = \left[(1-o)^{\frac{1}{\eta}} \left(x_t^H\right)^{\frac{\eta-1}{\eta}} + o^{\frac{1}{\eta}} \left(x_t^F\right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \tag{E.8}$$

Foreign good first order condition:

$$x_t^F = o \left(\frac{1}{p_t} \right)^{-\eta} y_t^C, \tag{E.9}$$

Home good first order condition:

$$x_t^H = (1-o) \left(\frac{p_t^H}{p_t} \right)^{-\eta} y_t^C, \tag{E.10}$$

Foreign demand for home goods:

$$x_t^{H*} = o^* \left(p_t^H\right)^{-\eta^*} y_t^*, \tag{E.11}$$

Home good production function:

$$y_t^H = z_t \left(\frac{k_{gt-1}}{a_{t-1}} \right)^\gamma \left(\frac{k_{t-1}}{a_{t-1}} \right)^\alpha (a_t h_t)^{1-\alpha-\gamma}, \tag{E.12}$$

Home good market clearing:

$$y_t^H = x_t^H + x_t^{H*}, \tag{E.13}$$

Final good market clearing:

$$y_t^C = c_t + i_t + g_t^c + g_t^i, \tag{E.14}$$

Defenition of GDP:

$$y_t = p_t \left(c_t + i_t + g_t^c + g_t^i \right) + tb_t = p_t^H y_t^H + p_t^{Co*} y_t^{Co}, \tag{E.15}$$

Defenition of trade balance:

$$tb_t = p_t^H x_t^{H*} + p_t^{Co*} y_t^{Co} - y_t^F, \tag{E.16}$$

Private debt aggregation:

$$f_t^* = (1-\omega) f_t^{o*} \tag{E.17}$$

Balance of payments:

$$(f_t^* + b_t^*) = \frac{(f_{t-1}^* + b_{t-1}^*)}{a_{t-1}} R_{t-1}^* \xi_{t-1} - tb_t + (1-\chi) p_t^{Co*} y_t^{Co}, \tag{E.18}$$

Country premium:

$$\xi_t = \bar{\xi} \exp\left[\psi \frac{(f_t^* + b_t^*)/y - (\bar{f}^* + \bar{b}^*)}{\bar{f}^* + \bar{b}^*} + \frac{\zeta_t - \bar{\zeta}}{\bar{\zeta}} \right], \tag{E.19}$$

Evolution of private capital:

$$k_t^o = (1-\delta) \frac{k_{t-1}^o}{a_{t-1}} + \left[1 - \frac{\gamma_k}{2} \left(\frac{i_t^o}{i_{t-1}^o} a_{t-1} - \bar{a} \right)^2 \right] u_t i_t^o, \tag{E.20}$$

Private capital aggregation:

$$k_t = (1-\omega) k_t^o \tag{E.21}$$

Private investment aggregation:

$$i_t = (1-\omega) i_t^o \tag{E.22}$$

Optimizer capital first order condition:

$$q_t = \frac{\beta}{a_t^\sigma} E_t \left\{ \frac{v_{t+1}}{v_t} \frac{\lambda_{t+1}^o}{\lambda_t^o} \left[(1-\tau_{t+1}^k) r_{t+1}^K + \tau_{t+1}^k \delta + q_{t+1}(1-\delta) \right] \right\}, \tag{E.23}$$

Marginal product of capital:

$$r_t^K = p_t^H \alpha \frac{y_t^H}{k_{t-1}} a_{t-1}, \tag{E.24}$$

Marginal product of labor:

$$w_t = p_t^H (1-\alpha-\gamma) \frac{y_t^H}{h_t}, \tag{E.25}$$

Optimizer investment first order condition:

$$\begin{aligned} \frac{p_t}{q_t} &= \left[1 - \frac{\gamma_k}{2} \left(\frac{i_t^o}{i_{t-1}^o} a_{t-1} - \bar{a} \right)^2 - \gamma_k \left(\frac{i_t^o}{i_{t-1}^o} a_{t-1} - \bar{a} \right) \frac{i_t^o}{i_{t-1}^o} a_{t-1} \right] u_t \\ &\quad + \frac{\beta}{a_t^\sigma} \gamma_k E_t \left\{ \frac{v_{t+1}}{v_t} \frac{\lambda_{t+1}}{\lambda_t} \frac{q_{t+1}}{q_t} \left(\frac{i_{t+1}^o}{i_t^o} a_t - \bar{a} \right) \left(\frac{i_{t+1}^o}{i_t^o} a_t \right)^2 u_{t+1} \right\}, \end{aligned} \tag{E.26}$$

Foreign good market clearing:

$$y_t^F = x_t^F. \tag{E.27}$$

Defenition of optimizer consumption bundle:

$$\hat{c}_t^o = \left[(1-o_c)^{\frac{1}{\eta_c}} \left(c_t^o - \varsigma \frac{c_{t-1}^o}{a_{t-1}} \right)^{\frac{\eta_c - 1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} (g_t^c)^{\frac{\eta_c - 1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c - 1}} \tag{E.28}$$

Defenition of restricted consumption bundle:

$$\hat{c}_t^r = \left[(1-o_c)^{\frac{1}{\eta_c}} \left(c_t^r - \varsigma \frac{c_{t-1}^r}{a_{t-1}} \right)^{\frac{\eta_c - 1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} \left(g_t^c \right)^{\frac{\eta_c - 1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c - 1}} \tag{E.29}$$

Optimizer wealth effect parameter 1:

$$\Theta_t^o = \widetilde{\chi}_t^o \left(\left[(1-o_c)^{\frac{1}{\eta_c}} \left(c_t^o - \varsigma \frac{c_{t-1}^o}{a_{t-1}} \right)^{\frac{\eta_c - 1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} \left(\bar{g}^c \right)^{\frac{\eta_c - 1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c - 1}} \right)^{-\sigma}. \tag{E.30}$$

Optimizer wealth effect parameter 2:

$$\widetilde{\chi}_t^o = \widetilde{\chi}_{t-1}^{o\,1-\upsilon} \left(\left[(1-o_c)^{\frac{1}{\eta_c}} \left(c_t^o - \varsigma \frac{c_{t-1}^o}{a_{t-1}} \right)^{\frac{\eta_c - 1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} \left(\bar{g}^c \right)^{\frac{\eta_c - 1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c - 1}} \right)^{\sigma\upsilon} \tag{E.31}$$

Restricted wealth effect parameter 1:

$$\Theta_t^r = \widetilde{\chi}_t^o \left(\left[(1-o_c)^{\frac{1}{\eta_c}} \left(c_t^r - \varsigma \frac{c_{t-1}^r}{a_{t-1}} \right)^{\frac{\eta_c - 1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} \left(\bar{g}^c \right)^{\frac{\eta_c - 1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c - 1}} \right)^{-\sigma}. \tag{E.32}$$

Restricted wealth effect parameter 2:

$$\widetilde{\chi}_t^r = \widetilde{\chi}_{t-1}^{r\,1-\upsilon} \left(\left[(1-o_c)^{\frac{1}{\eta_c}} \left(c_t^r - \varsigma \frac{c_{t-1}^r}{a_{t-1}} \right)^{\frac{\eta_c - 1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} \left(\bar{g}^c \right)^{\frac{\eta_c - 1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c - 1}} \right)^{\sigma\upsilon} \tag{E.33}$$

Government budget constraint:

$$p_t g_t^c + p_t g_t^i + R_{t-1}^* \xi_{t-1} \frac{b_{t-1}^*}{a_{t-1}} + tr_t = \chi p_t^{Co*} y_t^{Co} + b_t^* + \tau_t^n w_t (1-\omega) h_t^o + \tau_t^k (r_t^k - \delta) \frac{k_{t-1}}{a_{t-1}} + \tau_t^c p_t c_t + (1-\omega) T \tag{E.34}$$

Transfers to optimizer households:

$$tr_t^o = \frac{1-\omega^G}{1-\omega} tr_t \tag{E.35}$$

Transfers to restricted households:

$$tr_t^r = \frac{\omega^G}{\omega} tr_t \tag{E.36}$$

Home good producer profits

$$\pi_t = \pi_t^H = p_t^H \gamma y_t^H \tag{E.37}$$

Government capital evolution:

$$k_t^g = (1-\delta_g)\frac{k_{t-1}^g}{a_{t-1}} + g_t^i \tag{E.38}$$

Consumption tax:

$$\tau_t^c = \tilde{\tau}^c \tag{E.39}$$

Labor income tax:

$$\tau_t^n = \tilde{\tau}^n \tag{E.40}$$

Capital income tax:

$$\tau_t^k = \tilde{\tau}^k \tag{E.41}$$

Government investment spending rule:

$$g_t^i = \left(g_{t-1}^i\right)^{\rho_{gA}} \left(\bar{g}^i \left(\frac{y_t}{y}\right)^{\alpha_{gi}} \left(\frac{b_{t-1}^*/y_{t-1}}{\bar{b}}\right)^{-\gamma_{gi}}\right)^{1-\rho_{gi}} \exp(e_t^{gi}) \tag{E.42}$$

Consumption spending investment rule:

$$g_t^c = \left(g_{t-1}^c\right)^{\rho_{gc}} \left(\bar{g}^c \left(\frac{y_t}{y}\right)^{\alpha_{gc}} \left(\frac{b_{t-1}^*/y_{t-1}}{\bar{b}}\right)^{-\gamma_{gc}}\right)^{1-\rho_{gc}} \exp(e_t^{gc}) \tag{E.43}$$

Transfers spending rule:

$$tr_t = \left(tr_{t-1}\right)^{\rho_{tr}} \left(\bar{tr} \left(\frac{y_t}{y}\right)^{\alpha_{tr}} \left(\frac{b_{t-1}^*/y_{t-1}}{\bar{b}}\right)^{-\gamma_{tr}}\right)^{1-\rho_{tr}} \exp(e_t^{tr}) \tag{E.44}$$

Restricted budget constraint:

$$(1+\tau_t^c)p_t c_t^r = w_t h_t^r + tr_t^r \tag{E.45}$$

The exogenous processes are

$$\log\left(x_t/\bar{x}\right) = \rho_x \log\left(x_{t-1}/\bar{x}\right) + \varepsilon_t^x, \qquad \rho_x \in [0,1), \qquad \bar{x} > 0,$$

for each exogenous sequence x_t, where the ε_t^x are i.i.d. shocks.

B Steady State

We show how to compute the steady state for given values of h^o, h^r, p, $i_r = g^i/i$, $s^f = f^*/y$, $s^g = pg^c/y$, $s^P = p^{Co*}y^{Co}/y$, $\bar{b} = b^*/y$,$s^{tr} = tr/y$, and $\xi = \bar{\xi}$. The parameters β, $\bar{\kappa}^o$,$\bar{\kappa}^r$, o^*, $\bar{g}^c$, $\bar{g}^A$, $(\bar{f}^* + \bar{b}^*)$,T, $\bar{tr}$, and $\bar{y}^{Co}$ are determined endogenously while the values of the remaining parameters are exogenous. All exogenous variables are equal to their "bar" values in steady state.

From (E.7),

$$\beta = \bar{a}^{\sigma}/(\bar{R}^{*}\bar{\xi}).$$

From (E.6)

$$h = (1-\omega)h^{o} + \omega h^{r}.$$

From (E.26) and the fact that we calibrate $\bar{u}$ to 1,

$$q = p.$$

From (E.39) - (E.41)

$$\tau^{k} = \bar{\tau}^{k}$$
$$\tau^{n} = \bar{\tau}^{n}$$
$$\tau^{c} = \bar{\tau}^{c}$$

From (E.23),

$$r^{K} = \frac{q\left(\frac{\bar{a}^{\sigma}}{\beta} - 1 + \delta\right) - \tau^{k}\delta}{1-\tau^{k}}.$$

Plugging (E.9) and (E.10) in (E.8),

$$p^{H} = p\left[\frac{1}{1-o}\left(1 - o\left(\frac{1}{p}\right)^{1-\eta}\right)\right]^{\frac{1}{1-\eta}}.$$

We now perform the following steps to derive $y^{H}, k, k^{g}, i, g^{i}, i^{o}$,and k^{o}.
From (E.38)

$$k^{g} = \frac{g^{i}}{1 - \frac{(1-\delta_{g})}{\bar{a}}}.$$

From (E.20) and $\bar{u} = 1$,

$$k^{o} = \frac{i^{o}}{1 - \frac{1-\delta}{\bar{a}}}.$$

From (E.21),

$$k = k^{o}(1-\omega).$$

From (E.22),

$$i^{o} = i/(1-\omega)$$

Combining these results yields

$$k_{r} \equiv \frac{k^{g}}{k} = i_{r}\frac{1 - \frac{1-\delta}{\bar{a}}}{1 - \frac{1-\delta_{g}}{\bar{a}}}.$$

This result along with equations (E.12) and (E.24) form a system in y^{H}, k, and k^{g} which gives

$$y^H = \left(\bar{z}\left(k_r \frac{p^H\alpha}{r^k}\right)^\gamma \left(\frac{p^H\alpha}{r^K}\right)^\alpha (\bar{a}h)^{1-\alpha-\gamma}\right)^{\frac{1}{1-\alpha-\gamma}}$$

$$k = p^H\alpha\frac{y^H}{r^K}\bar{a},$$

$$k^g = k_r k.$$

Then substituting in these results yields

$$g^i = \left(1 - \frac{1-\delta_g}{\bar{a}}\right)k^g$$

$$k^o = k/(1-\omega),$$

$$i^o = \left(1 - \frac{1-\delta}{a}\right)k^o,$$

$$i = (1-\omega)i^o.$$

From (E.25),

$$w = p^H(1-\alpha-\gamma)\frac{y^H}{h}.$$

Equations (E.15) and the definition of the share of commodity output in GDP, $s^P = (p^{Co*}y^{Co})/y$, form a system in y and $\bar{y}^{Co}$, which gives

$$y = \frac{p^H y^H}{1-s^{Co}}$$

$$\bar{y}^{Co} = \frac{s^{Co}y}{p^{Co*}}.$$

From $s^g = pg^c/y$,

$$g^c = s^g y/p.$$

From (E.42) and the assumption $\bar{b} = b^*/y$,

$$\bar{g}^i = g^i.$$

From (E.43) and the assumption $\bar{b} = b^*/y$,

$$\bar{g}^c = g^c.$$

From $\bar{b} = b^*/y$

$$b^* = \bar{b}y$$

From $\bar{f} = f^*/y$,

$$f^* = \bar{f}y.$$

From (E.17),

$$f^{o*} = \frac{f^*}{1-\omega}$$

From (E.18),

$$tb = (1-\chi) * p^{Co\star} y^{Co} - \left(1 - \frac{\bar{R}^* \bar{\xi}}{\bar{a}}\right)(f^* + b^*).$$

From (E.19) and $\xi = \bar{\xi}$,

$$(\bar{f^*} + \bar{b^*}) = \frac{f^* + b^*}{y}.$$

From the definition of GDP as the sum of domestic absorption and the trade balance (E.15),

$$c = \frac{y - tb}{p} - i - g^c - g^i.$$

From (E.14),

$$y^C = c + i + g^c + g^i$$

From (E.9),

$$x^F = o\left(\frac{1}{p}\right)^{-\eta} y^C.$$

From (E.10),

$$x^H = (1-o)\left(\frac{p^H}{p}\right)^{-\eta} y^C.$$

From (E.27),

$$y^F = x^F.$$

From (E.16),

$$x^{H*} = \frac{tb - \bar{p}^{Co*} y^{Co} + y^F}{p^H}.$$

From (E.11),

$$o^* = \frac{x^{H*}}{(p^H)^{-\eta*}\, \bar{y}^*}.$$

From (E.37),

$$\pi = p^H \gamma Y^H.$$

From the defenition of s^{tr},

$$tr = s^{tr} y$$

From (E.34),

$$T = \frac{\chi p^{Co*} y^{Co} - R^* \bar{\xi} \frac{b^*}{\bar{a}} + \tau^n W (1-\omega) h^0 + \tau^k (r^k - \delta) \frac{k}{\bar{a}} + \tau^c pc + \tau^\pi \pi - pg^c - pg^i + b^* - tr}{1-\omega}.$$

From (E.44),

$$\bar{tr} = tr.$$

From (E.35)-(E.36),

$$tr^o = \frac{1-\omega^G}{1-\omega} tr$$

$$tr^r = \frac{\omega^G}{\omega} tr.$$

From (E.45)

$$c^r = \frac{wh^r + tr^r}{(1+\tau^c)p}.$$

From (E.3),

$$c^o = \frac{c - \omega c^r}{1-\omega}.$$

From (E.28),

$$\hat{c}^o = \left[(1-o_c)^{\frac{1}{\eta_c}} \left(c^o - \varsigma \frac{c^o}{\bar{a}} \right)^{\frac{\eta_c - 1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} \left(g^c \right)^{\frac{\eta_c - 1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c - 1}}.$$

From (E.29),

$$\hat{c}^r = \left[(1-o_c)^{\frac{1}{\eta_c}} \left(c^r - \varsigma \frac{c^r}{\bar{a}} \right)^{\frac{\eta_c - 1}{\eta_c}} + o_c^{\frac{1}{\eta_c}} \left(g^c \right)^{\frac{\eta_c - 1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c - 1}}.$$

From (E.31),

$$\widetilde{\chi}^o = \hat{c}^{o^\sigma}.$$

From (E.33),

$$\widetilde{\chi}^r = \hat{c}^{r^\sigma}.$$

From (E.30),

$$\Theta^o = 1.$$

From (E.32),

$$\Theta^r = 1.$$

From (E.1),

$$\lambda^o = \frac{\hat{c}^{o^{-\sigma}}}{(1+\tau^c)p} \left(\frac{(1-o_c)\hat{c}^o}{c^o - \varsigma \frac{c^o}{\bar{a}}} \right)^{\frac{1}{\eta_c}}.$$

From (E.2),

$$\lambda^r = \frac{\hat{c}^{r^{-\sigma}}}{(1+\tau^c)p} \left(\frac{(1-o_c)\hat{c}^r}{c^r - \varsigma \frac{c^r}{\bar{a}}} \right)^{\frac{1}{\eta_c}}.$$

From (E.4)

$$\bar{\kappa}^o = \frac{\lambda^o (1-\tilde{\tau}^n) w}{h^{o^\phi}}.$$

From (E.5)

$$\bar{\kappa}^r = \frac{\lambda^r w}{h^{r^\phi}}.$$

C Calibrated Parameters

Following Medina and Soto (2016), we use logarithmic preferences, setting the inverse elasticity of intertemporal substitution, $\sigma = 1$. We follow Coenen, Straub and Trabandt (2013) and set the share of private consumption in the aggregate consumption bundle, $1 - o_c$, equal to 0.75. The depreciation rates of private and public capital, δ and δ_g, are set to 6% annually, following Medina and Soto (2016) for the former and Coenen, Straub and Trabandt (2013) for the latter. The parameter characterizing home bias in domestic demand, o, is set to 0.27, which is the average contribution of imports over domestic demand in the 2000–2019 period. In our Cobb-Douglas specification for the production of home goods, the output elasticity of labor, $1 - \alpha - \gamma$, is 0.66, following Medina and Soto (2016). The share of public capital is set to 0.034. This value corresponds to 10% of the share of total capital (private plus public, $\alpha + \gamma = 0.34$), and is motivated by Coenen, Straub and Trabandt (2013), who use a share of 0.1 for public capital in their CES aggregator of private and public capital.

We set the price elasticity of foreign demand for home goods, η^*, to 0.25 (see the estimates in Crespo and Gómez, 2004; Peláez et al., 2020). The government's share of the income generated in the commodity sector, χ, is set to 0.74, considering that the average share of total oil output produced by the public oil company during 2000–2019 is 60%, and a general tax on foreign firms is 35%.[25] The share of hand-to-mouth households, ω, is set to 0.7, following estimates by the Central Bank of Ecuador that suggest that about 30% of the population has an outstanding loan in the financial system (see Banco Central del Ecuador, 2023). We assume that all government transfers go to the hand-to-mouth households, setting $\omega_G = 1$. Finally, normalizing the time endowment of households to unity and using the historical average of hours worked per week adjusted by the average employment rate, we set $h^o = h^r = 0.3$.

Regarding the targeted first moments, most values are drawn from the 2022-2027 projections in the July 2022 IMF Staff Report for Ecuador (see Oner et al., 2022). This is the case for the ratios of government consumption and transfers to GDP, s^g and s^{tr}, the ratios of private and public external debt to GDP, $\bar{f}$ and $\bar{b}$, and the share of oil production in GDP, s^P. Other targeted moments are sample averages or drawn from other sources. This is the case for the ratio of public to total investment, i_r, the annualized quarterly growth rate of labor productivity, $\bar{a}$, the annualized quarterly gross real 3-month T-bill rate, R^*, the country risk premium, $\bar{\xi}$, and the consumption, corporate, and labor income tax rates, $\bar{\tau}_c$, $\bar{\tau}_k$, $\bar{\tau}_n$.

We also calibrate the parameters associated with the exogenous processes for which we have a data counterpart—oil production, the international interest rate, world GDP, and the price of oil. In all cases, we remove trends from these variables using the Hodrick and Prescott (1997) filter and estimate univariate AR(1) processes for the same sample period we use to estimate the rest of the parameters of the model.

[25] Note that $\chi = c + (1 - c) * t$, where c is the share of production owned by the government and t is the average tax rate on foreign oil producers.

Table C.1: Calibrated Parameters and Targeted Steady State Values

Parameter	Description	Value	Source
σ	Inverse elast. intert. subst.	1	Medina and Soto (2016)
$(1-o_c)$	Share of private consumption in $\hat{C}$	0.75	Coenen, Straub and Trabandt (2013)
δ	Annualized depreciation rate (K)	6%	Medina and Soto (2016)
δ_g	Annualized depreciation rate (K^g)	6%	Coenen, Straub and Trabandt (2013)
o	Home bias in domestic demand	0.27	Avg. share of imports (2000–2019)
$1-\alpha-\gamma$	Output elasticity of labor	0.66	Medina and Soto (2016)
γ	Output elasticity of public capital	0.034	Coenen, Straub and Trabandt (2013)
η^*	Price elasticity of foreign demand	0.25	Peláez et al. (2020)
χ	Government share in commodity sector	0.74	Average (2000–2019)
ω	Share of hand-to-mouth households	0.7	Central Bank of Ecuador estimates
h^o, h^r	Hours worked	0.3	Assumption and INEC statistics
s^g	Government consumption to GDP ratio	0.11	Oner et al. (2022)
s^{tr}	Government transfers to GDP ratio	0.05	Oner et al. (2022)
$\bar{f}$	Private external debt to quarterly GDP ratio	0.26	Oner et al. (2022)
$\bar{b}$	Total external debt to quarterly GDP ratio	1.42	Oner et al. (2022)
s^P	Oil production to total GDP ratio	0.08	Oner et al. (2022)
i_r	Public to total investment ratio	0.16	OECD average (2007-2020)
$\bar{a}$	Annualized balanced growth path	2%	González-Astudillo (2016)
R^*	Quarterly gross real foreign int. rate	1.001	Congressional Budget Office (2021)
$\bar{\xi}$	Quarterly gross country premium	1.013	Latin America avg. (1997-2020)
$\bar{\tau}_c$	Consumption tax rate	12%	Current rate
$\bar{\tau}_k$	Corporate tax rate	25%	Current rate
$\bar{\tau}_n$	Labor income tax rate	4%	Avg. labor income tax rate

D Estimated Parameters

The rest of the parameters of the model are estimated using Bayesian techniques, solving the model with a linear approximation around the non-stochastic steady state. For the observable variables, we use quarterly information from Ecuador for the period 2004–2019. Ecuador adopted the U.S. dollar as its official currency in January 2000. Our sample begins in 2004 because inflation took about 4 years to stabilize after a banking crisis in 1999 and the introduction of the U.S. dollar. We use the following 13 observable variables: Non-oil GDP, private aggregate consumption, aggregate investment, government consumption, government investment, government transfers, the trade balance, hours worked, the country risk premium as measured by the Emerging Markets Bond Index (EMBI) for Ecuador, the West Texas Intermediate (WTI) oil price, oil production, the foreign interest rate, and foreign GDP. Because the foreign good is the numeraire in the model, we deflate all the variables, which are expressed in current U.S. dollars, using the U.S. GDP deflator. In addition, we express all the flow variables as quarter-over-quarter growth rates, except hours worked and foreign output, which are expressed as percent deviations from a Hodrick and Prescott (1997) filtered trend. We do the same for the foreign interest rate, the (log real) oil price, and oil production. As we previously mentioned, we calibrate the parameters of the exogenous processes for which we have a data counterpart, but we also include these variables as observables in the Bayesian estimation.[26] Our estimation strategy also includes i.i.d. measurement errors for all observables. The variance of the measurement errors are set to 10% of the variance of the corresponding observables. Appendix E contains the sources of the data and offers details on the construction of the observable variables.

Table D.1 shows the prior and posterior distributions of the estimated parameters. The prior distributions are fairly loose. For the parameters of the fiscal expenditure rules ($\rho_x, \alpha_x, \gamma_x$ for $x = gc, gi, TR$), we center their prior distributions at the values we obtain from an external estimation in which the HP-filtered log deviation of each expenditure component is regressed on the log deviation of the government debt-to-GDP ratio and output, in addition to a lagged expenditure term. The prior distributions of the persistence coefficients of the structural shocks (ρ_x for $x = \upsilon, \kappa, u, z, a, \zeta$) are centered at 0.75, following the DSGE model estimated by Guerra-Salas, Kirchner and Tranamil-Vidal (2021) for Chile. We follow the same paper to inform the prior mean of the elasticity of the country risk premium to the aggregate debt-to-GDP ratio, ψ, which is centered at 0.005. The coefficient of investment adjustment costs, γ_k, is centered at the value obtained by Smets and Wouters (2007), close to 6. The rest of the parameters, including the variances of the shocks, were chosen to loosely match the sample standard deviation of the observed variables with their model counterparts under the prior means of the other coefficients, but the standard deviations of the prior distributions are wide enough to allow the data to inform the estimated posterior distributions.

We now discuss the results of the Bayesian estimation. The posterior mean estimates of the parameters associated with the fiscal expenditure rules suggest all three components (government consumption, investment, and transfers) are procyclical, because

[26] While the parameters of these exogenous processes were calibrated, including these variables in the data set is informative for the inference of the innovations associated with the other exogenous processes.

Table D.1: Estimated Parameters

Parameter	Description	Prior Distribution	Post. Mean	Post. SD
ϕ	Inv. Frisch elast. of h	$N^{(0,\infty)}(0.1,2)$	3.42	1.00
ς	Habit formation	$N^{(0,1)}(0.9,0.2)$	0.74	0.09
η_c	Elast. of subst. (C,G^c)	$N^{(0,\infty)}(1.5,2)$	0.79	0.71
ν	Wealth effect	$N^{(0,1)}(0.5,0.5)$	0.70	0.20
η	Elast. subst. home-foreign	$N^{(0,\infty)}(3,2)$	6.08	1.06
γ_k	Inv. adj. cost	$N^{(0,\infty)}(6,10)$	8.85	4.44
100ψ	Country prem. debt elast.	$N^{(0,\infty)}(0.5,10)$	2.21	1.40
ρ_{gc}	Gov. cons. persistence	$N^{(0,1)}(0.70,1)$	0.88	0.07
ρ_{gi}	Gov. inv. persistence	$N^{(0,1)}(0.48,1)$	0.77	0.08
ρ_{TR}	Transfers persistence	$N^{(0,1)}(0.37,1)$	0.47	0.12
α_{gc}	Gov. cons. cyclicality	$N(0.13,2)$	0.59	0.92
α_{gi}	Gov. inv. cyclicality	$N(1.77,2)$	2.58	1.57
α_{TR}	Transfers cyclicality	$N(3.52,2)$	5.46	0.96
γ_{gc}	Gov. cons. debt stabilization	$N^{(-\infty,0)}(-0.01,2)$	-0.50	0.41
γ_{gi}	Gov. inv. debt stabilization	$N^{(-\infty,0)}(-0.13,2)$	-1.82	0.67
γ_{TR}	Transfers debt stabilization	$N^{(-\infty,0)}(-0.35,2)$	-0.26	0.21
ρ_υ	AC cons. pref. sh.	Beta$(0.75,0.15)$	0.41	0.12
ρ_κ	AC labor pref. sh.	Beta$(0.75,0.15)$	0.74	0.10
ρ_u	AC invest. sh.	Beta$(0.75,0.15)$	0.35	0.11
ρ_z	AC stationary tech. sh.	Beta$(0.75,0.15)$	0.86	0.09
ρ_a	AC non-stationary tech. sh.	Beta$(0.75,0.15)$	0.79	0.13
ρ_ζ	AC country prem. sh.	Beta$(0.75,0.15)$	0.65	0.06
$\sigma_{e^{gc}}$	SD gov. cons. sh.	IG$(0.03,\infty)$	0.03	0.00
$\sigma_{e^{gi}}$	SD gov. inv. sh.	IG$(0.15,\infty)$	0.17	0.02
$\sigma_{e^{TR}}$	SD transfers sh.	IG$(0.10,\infty)$	0.11	0.01
$100\sigma_\upsilon$	SD cons. pref. sh.	IG$(1,\infty)$	10.23	2.63
$100\sigma_\kappa$	SD labor pref. sh.	IG$(4,\infty)$	7.56	1.91
$100\sigma_u$	SD invest. sh.	IG$(1,\infty)$	27.24	13.09
$100\sigma_z$	SD stationary tech. sh.	IG$(0.1,\infty)$	2.08	0.30
$100\sigma_a$	SD non-stationary tech. sh.	IG$(0.1,\infty)$	0.62	0.39
$100\sigma_\zeta$	SD country prem. sh.	IG$(0.9,\infty)$	0.89	0.08

Note: $N^{(l,u)}(a,b)$ denotes a normal distribution with mean a and standard deviation b that was restricted to take values between l and u during mode finding, but not during posterior distribution sampling. Beta(a,b) denotes a beta distribution with mean a and standard deviation b. $IG(a,b)$ denotes an inverse gamma distribution for the variance of the shocks where a is the mean of the standard deviation and b is its variance. Results are based on two Metropolis-Hastings chains of 500,000 draws each from the posterior distribution, after dropping 500,000 draws for each chain, using an acceptance rate of 0.3, and starting the chains around the posterior mode obtained with Dynare's Monte-Carlo–based optimization routine.

the parameters α_{gc}, α_{gi} and α_{TR} are all greater than zero. Fiscal transfers are the most procyclical component, whereas government investment is the least procyclical. Regarding the debt-stabilization parameters of the fiscal expenditure rules, we find that government investment is the most active expenditure instrument in debt stabilization. The negative values of these parameters indicate that when the public debt-to-GDP ratio deviates from target, expenditure moves in the opposite direction.[27]

The second set of results concerns preference parameters. The estimated value of ϕ, at 3.4, suggests a low elasticity of labor supply. The wealth effect on labor supply, ν, at 0.7, is estimated to be closer to CRRA formulations (the case when $\nu = 1$), than formulations that shut down the wealth effect (the case when $\nu = 0$). Additionally, the habit persistence parameter, ς, at 0.7, is estimated in the vicinity of the results in the literature. The parameter that governs the elasticity of substitution between private and government-provided goods, η_c, at 0.8, is estimated to be relatively low, pointing to complementarity between these two types of goods. Finally, the consumption preference shock, υ is estimated to be less persistent than the labor preference shock, κ, although it is also more volatile.

A third set of parameters is related to production and investment technologies. For instance, the estimation points to a high degree of substitutability between home and foreign goods, as indicated by the posterior mean of the parameter η. The investment adjustment cost parameter, γ_k, is in the upper bound of the results in the literature for developing economies (see, for example Sheen and Wang, 2016; Fornero and Kirchner, 2018; Guerra-Salas, Kirchner and Tranamil-Vidal, 2021), reflecting the higher investment adjustment costs faced by countries dependent on commodities with volatile prices, as argued by Devlin and Titman (2004). Among technology shocks, the investment efficiency shock, u_t, is estimated to have the lowest persistence and highest variance. The shock to the non-stationary technological index, a_t, is estimated to be highly persistent for a shock that generates permanent effects on the level of variables in the economy. As we explain below, this is a reasonable inference given the performance of the Ecuadorian economy in the sample period.

The last set of coefficients is related to the country risk premium, ξ. The posterior mean of parameter ψ suggests that a 1 percentage point increase in the total foreign debt-to-GDP ratio is estimated to increase the premium by about 23 basis points.[28] The idiosyncratic risk premium shock, ζ, displays moderate levels of persistence and volatility, relative to the other shocks.

[27]Note that the prior distributions of the debt-stabilization parameters are truncated to avoid de-stabilizing values.

[28]To gain intuition on this interpretation, note that linearizing the expression for the country premium, (5), around $\bar{f}^* + \bar{b}^*$, and ignoring the idiosyncratic risk shock, we get $\xi_t = \bar{\xi} + \frac{\psi}{\bar{f}^*+\bar{b}^*}((F_t^* + B_t^*)/Y_t - (\bar{f}^* + \bar{b}^*))$. Hence, the effect of a marginal increase in the quarterly debt-to-GDP ratio implies an increase in the quarterly risk premium equal to $\frac{\psi}{\bar{f}^*+\bar{b}^*}$. Consequently, a 1 pp increase in the annualized debt-to-GDP ratio is equivalent to an increase of 0.04 in $(F_t^* + B_t^*)/Y_t$, which is the quarterly counterpart. Then, the effect on the quarterly country premium is $0.04 \times \frac{\psi}{\bar{f}^*+\bar{b}^*}$, where $\bar{f}^* + \bar{b}^* = 1.55$. As a consequence, the effect is $0.04 \times 0.0221/1.55 = 0.00057$. Annualizing this effect results in $1.00057^4 - 1 = 0.0023$, i.e., 23 basis points. Interestingly, a linear regression of the EMBI spread against the total foreign debt-to-GDP ratio results in a coefficient equal to 19.

E Data Details

This section describes the data used, their sources, and the transformations we performed in order to estimate the model. The variables are as follows:

- Non oil GDP in current dollars: From the Central Bank of Ecuador's (CBE) national accounts bulletin. We deflate the data with the U.S. GDP price deflator and obtain quarter-over-quarter percent growth rates.
- Household consumption in current dollars: From the CBE's national accounts bulletin. We deflate the data with the U.S. GDP price deflator and obtain quarter-over-quarter percent growth rates.
- Total investment in current dollars: From the CBE's national accounts bulletin. We deflate the data with the U.S. GDP price deflator and obtain quarter-over-quarter percent growth rates.
- Oil production in current dollars: From the CBE's national accounts bulletin. We divide the oil GDP by the quarterly average oil price and apply the Hodrick and Prescott filter with $\lambda = 1600$ to obtain the cycle of that series in logs.
- Hours worked in current dollars: From the National Institute of Statistics and Censuses (NISC). We adjust the quarterly average weekly hours by the employment rate and divide by 120 hours, which is the total number of hours a week a person could work Monday through Friday. We then apply the Hodrick and Prescott filter with $\lambda = 1600$ to obtain the cycle of that series in logs.
- Government consumption spending in current dollars: From the CBE's national accounts bulletin. We deflate the data with the U.S. GDP price deflator and obtain quarter-over-quarter percent growth rates.
- Government investment spending in current dollars: From the CBE's monthly statistical information. We aggregate the monthly data to quarterly and then deflate the data with the U.S. GDP price deflator and obtain quarter-over-quarter percent growth rates.
- Government transfers in current dollars: From the CBE's monthly statistical information. We aggregate the monthly data to quarterly and then deflate the data with the U.S. GDP price deflator and obtain quarter-over-quarter percent growth rates.
- Trade balance in current dollars: From the CBE's national accounts bulletin. We divide by nominal GDP.
- 3-month Treasury bill rate: From the Federal Reserve Economic Database (FRED). We aggregate the monthly data to quarterly and obtain the equivalent quarterly gross rate. We then subtract the quarter-over-quarter U.S. inflation gross rate from the U.S. GDP price deflator.

Table F.1: Co-Movement, Volatility and Persistence

	Corr. with GDP		SD		1st order AC	
	Data	Model	Data	Model	Data	Model
Non-Oil GDP Growth	1	1	1.65	1.54	0.46	0.41
Private Consumption Growth	0.76	0.63	1.90	2.39	0.21	0.26
Total Investment Growth	0.64	0.51	3.45	5.18	0.53	0.27
Trade Balance to GDP	0.12	0.02	1.97	3.97	0.67	0.77
Hours Worked	−0.03	−0.15	1.97	0.81	0.36	0.74
Government Consumption Growth	0.67	0.29	3.30	3.66	0.15	0.15
Government Investment Growth	0.33	0.30	19.39	19.42	−0.08	−0.01
Government Transfers Growth	0.49	0.36	15.77	15.91	0.26	−0.01
Country Premium	−0.14	−0.16	1.30	1.26	0.73	0.70

Note: GDP is non-oil real GDP, SD denotes standard deviation, AC denotes autocorrelation.

- World GDP: From the OECD Statistics. We take the quarter-over-quarter growth rate of the G20 real GDP, compound the rate to obtain a level series, and then apply the Hodrick and Prescott filter with $\lambda = 1600$ to obtain the cycle of that series in logs.
- Oil price in current dollars: From the CBE's monthly statistical information. We aggregate the monthly data to quarterly, deflate the data with the U.S. GDP price deflator, and then apply the Hodrick and Prescott filter with $\lambda = 1600$ to obtain the cycle of that series in logs.
- EMBI: From the CBE's monthly statistical information. We aggregate the monthly data to quarterly, divide by 10,000 and add one to make it gross, and then obtain the equivalent quarterly gross rate.
- U.S. GDP price deflator: From the FRED database.

We demean all the series.

F Model-implied Moments against the Data

The model does a good job of matching the co-movement of most of these variables with GDP, both qualitatively and quantitatively. In terms of standard deviations, the model does a good job of matching the relative volatility of most variables. For example, investment is more volatile than consumption, which in turn is more volatile than output; government investment is the most volatile component of public expenditure, followed by transfers and government consumption. Quantitatively, however, the model overstates the volatility of consumption and investment. Finally, the model fits the persistence of the data very well, because the first-order autocorrelation coefficients are quantitatively close to their data counterparts.

We comment on the role of commodity, risk, and fiscal policy shocks, which are key aspects of our analysis. Commodity and risk premium shocks are not important drivers of fluctuations in output growth, but are important drivers of the trade balance-to-GDP

Table F.2: Variance Decomposition

	Commodity	Risk	FP	Technology	Foreign	Preferences
Non-Oil GDP Growth	3.1	1.4	6.3	73.8	0.6	14.8
Private Consumption Growth	10.7	5.0	14.4	19.7	0.8	49.3
Total Investment Growth	3.7	2.8	27.5	63.4	0.4	2.2
Trade Balance-to-GDP Ratio	33.8	11.8	6.4	31.1	1.7	15.3
Hours Worked	4.4	1.2	2.3	9.8	0.2	82.2
Government Consumption Growth	5.9	1.1	70.9	18.0	0.2	4.0
Government Investment Growth	4.9	0.8	91.5	2.3	0.1	0.4
Government Transfers Growth	25.7	0.4	66.8	5.5	0.1	1.5
Country Premium	2.8	92.7	0.3	3.2	0.0	0.3

Note: Fraction of the unconditional theoretical variances at the posterior mean (in percent) explained by the shocks, excluding measurement error. Commodity shocks include oil price (p^{P*}) and oil output (Y^P) shocks. The risk shock affects the country premium (ζ). Fiscal policy (FP) shocks include those to government consumption, government investment, and transfers (e^{gc}, e^{gi}, and e^{TR}). Technology shocks include transitory (z) and permanent (a) productivity shocks, and investment efficiency (u) shocks. Foreign shocks include shocks to the foreign interest rate (R^*) and foreign demand (y^*). Preference shocks include consumption (v) and labor supply (κ) shocks. Columns may not add to their exact percentages due to rounding.

ratio due to their direct influence on oil exports and the external cost of financing. Commodity shocks drive 25% of the fluctuations in government transfers, most likely due to the substantial gasoline subsidies offered to households in Ecuador. We now turn to fiscal policy shocks. These shocks explain a significant fraction of fluctuations in private consumption, likely due to the complementarity with private consumption goods in households' consumption basket. Fiscal policy shocks are also important drivers of investment growth, due to the role of public capital in the demand for private capital of the home goods-producing firm. Finally, as is usually the case in real business cycle models, the most important drivers of aggregate fluctuations are technology shocks, especially for output and investment growth, and preference shocks, especially or consumption growth and hours worked.

G Shock Decomposition for Observables

This appendix shows the historical shock decomposition of the observable variables in figures G.1-G.13 through the lens of the model.

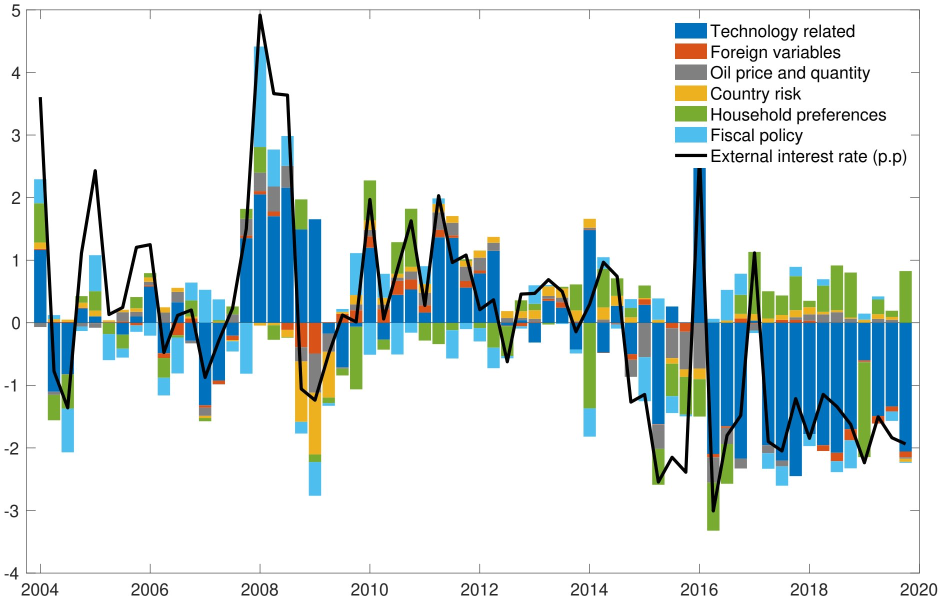
H Impulse-Response Analysis

The next six subsections present simulations in which each of the six fiscal instruments is adjusted to achieve a reduction in the fiscal deficit-to-GDP ratio of 1 percentage point on impact.

H.1 An Increase in the Consumption Tax Rate

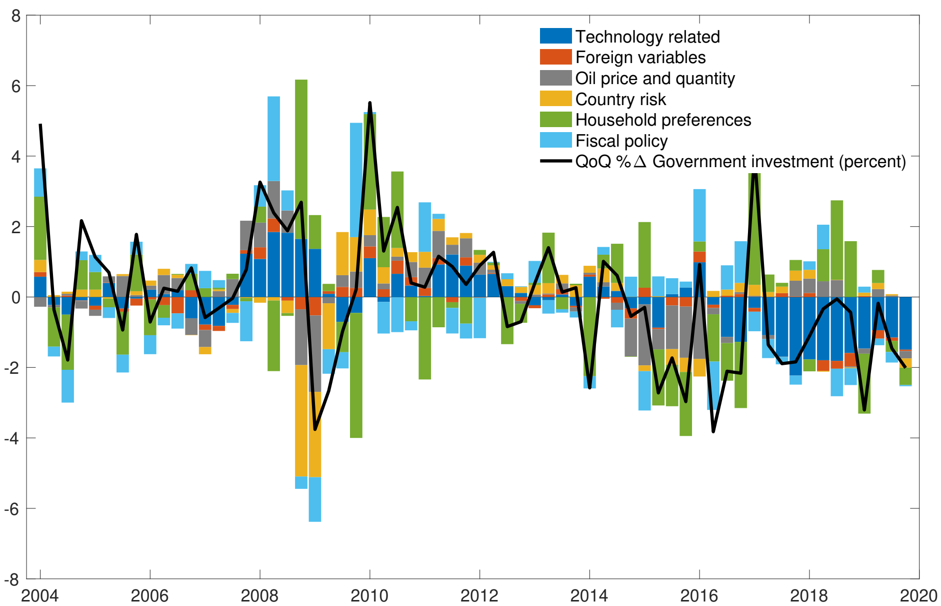
Figure H.1 presents a fiscal consolidation based on an increase in the consumption tax rate (plotted in the second row and first column of the figure; panel 2-1). The size of the tax rate

Figure G.1: Historical Shock Decomposition for Non-Oil GDP Growth Rate



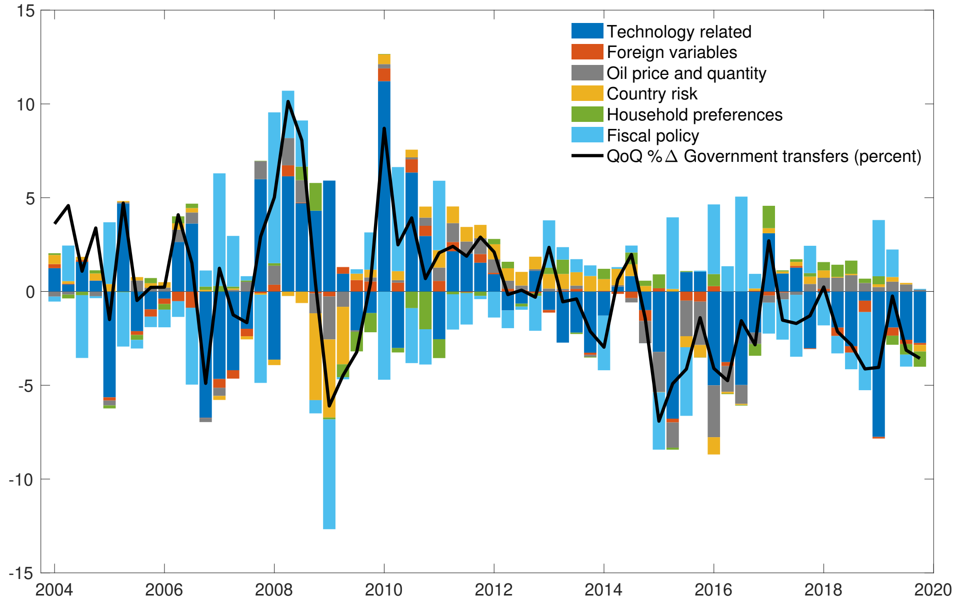
The black line is the observed variable. The y-axis is percentage point deviation from steady state and the x-axis is quarters.

Figure G.2: Historical Shock Decomposition for Private Consumtpion Growth Rate



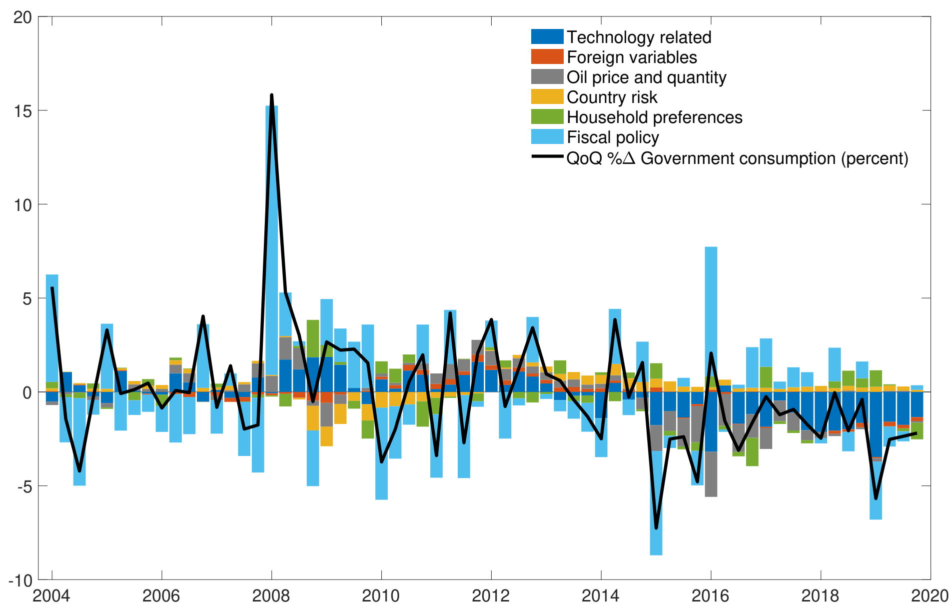
The black line is the observed variable. The y-axis is percentage point deviation from steady state and the x-axis is quarters.

Figure G.3: Historical Shock Decomposition for Total Investment Growth Rate



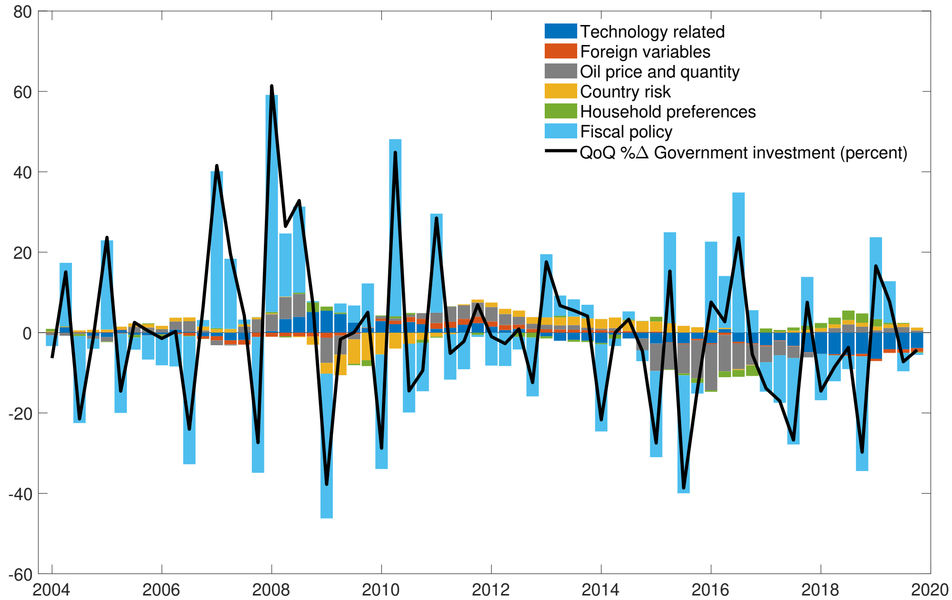
The black line is the observed variable. The y-axis is percentage point deviation from steady state and the x-axis is quarters.

Figure G.4: Historical Shock Decomposition for Government Consumption Growth Rate



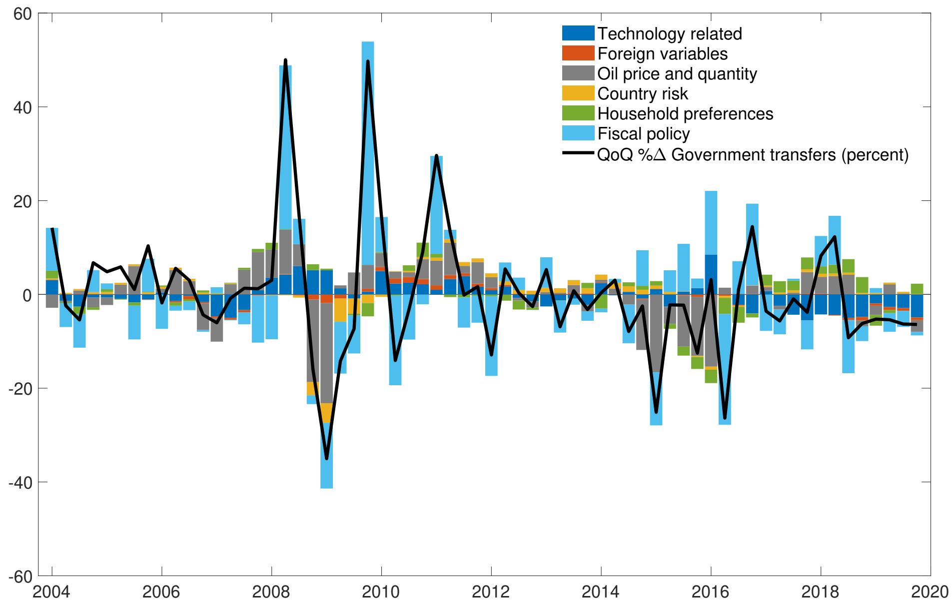
The black line is the observed variable. The y-axis is percentage point deviation from steady state and the x-axis is quarters.

Figure G.5: Historical Shock Decomposition for Government Investment Growth Rate



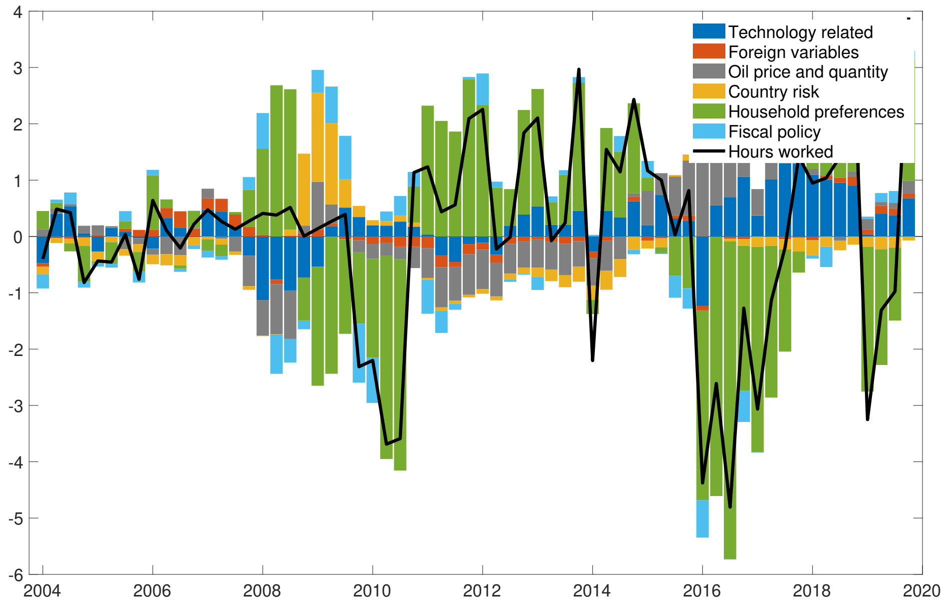
The black line is the observed variable.The y-axis is percentage point deviation from steady state and the x-axis is quarters.

Figure G.6: Historical Shock Decomposition for Transfers Growth Rate



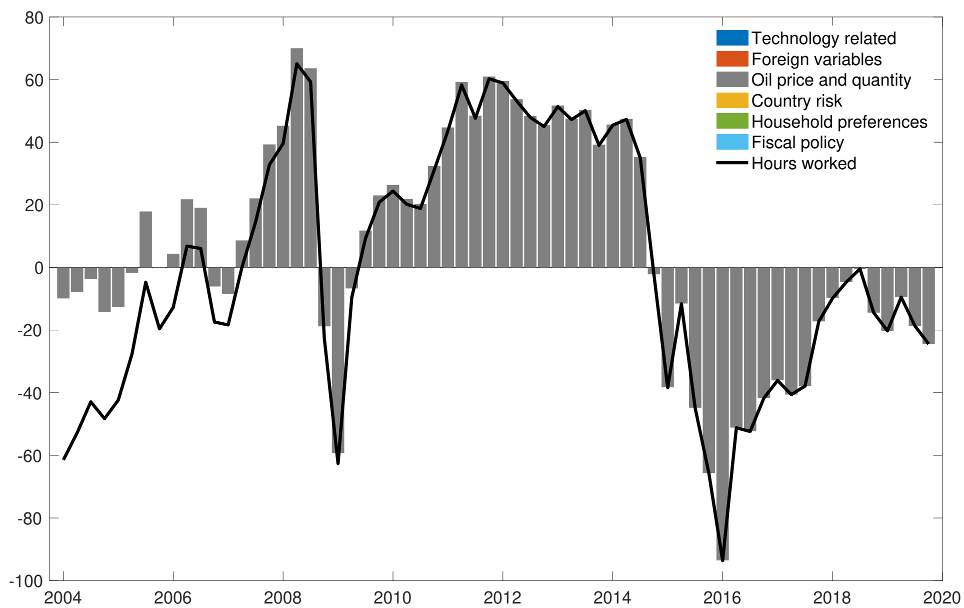
The black line is the observed variable. The y-axis is percentage point deviation from steady state and the x-axis is quarters.

Figure G.7: Historical Shock Decomposition for Hours



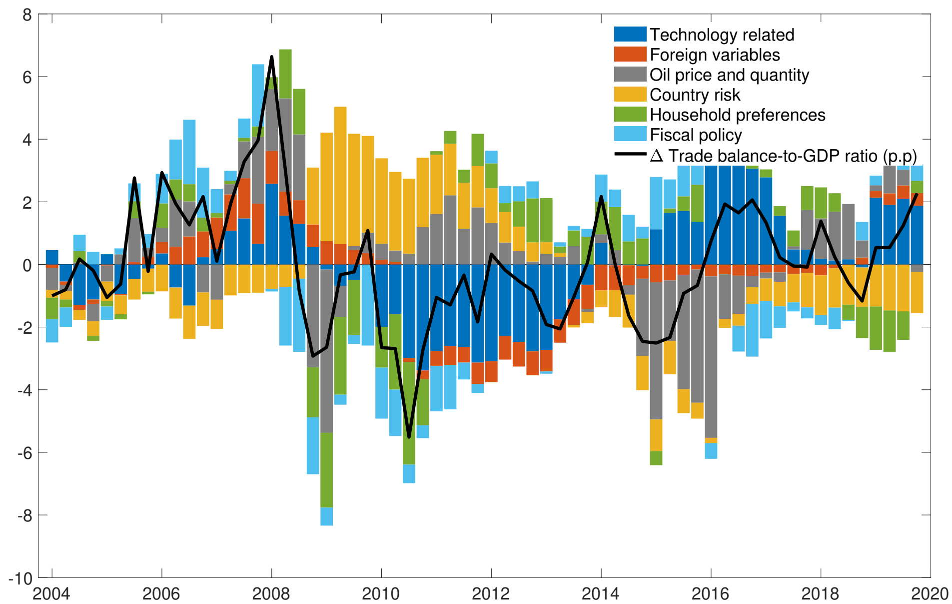
The black line is the observed variable. The y-axis is percent deviation from steady state and the x-axis is quarters.

Figure G.8: Historical Shock Decomposition for Oil Price



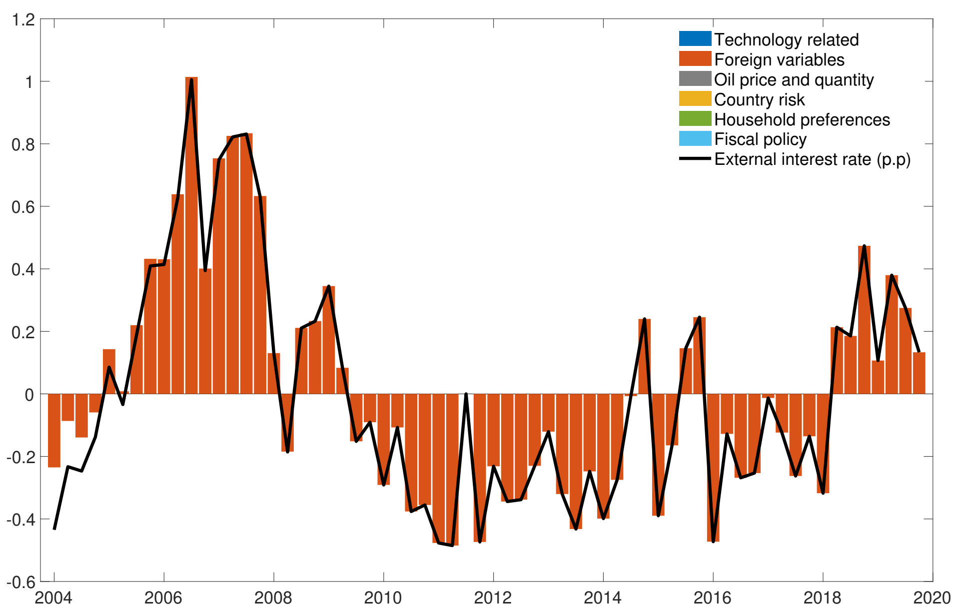
The black line is the observed variable.The y-axis is percent deviation from steady state and the x-axis is quarters.

Figure G.9: Historical Shock Decomposition for Trade Balance to GDP Ratio



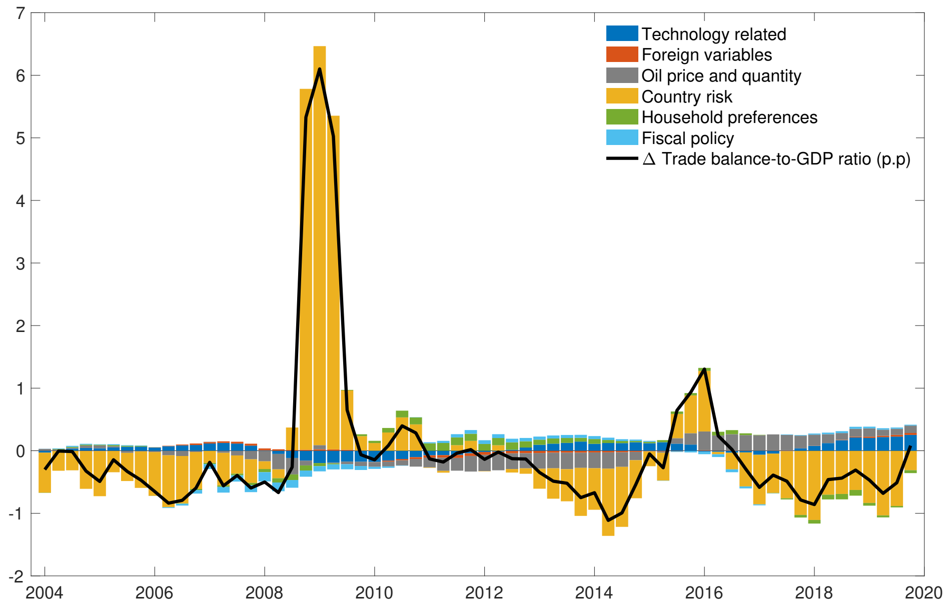
The black line is the observed variable. The y-axis is percentage point deviation from steady state and the x-axis is quarters.

Figure G.10: Historical Shock Decomposition for Foreign Interest Rate



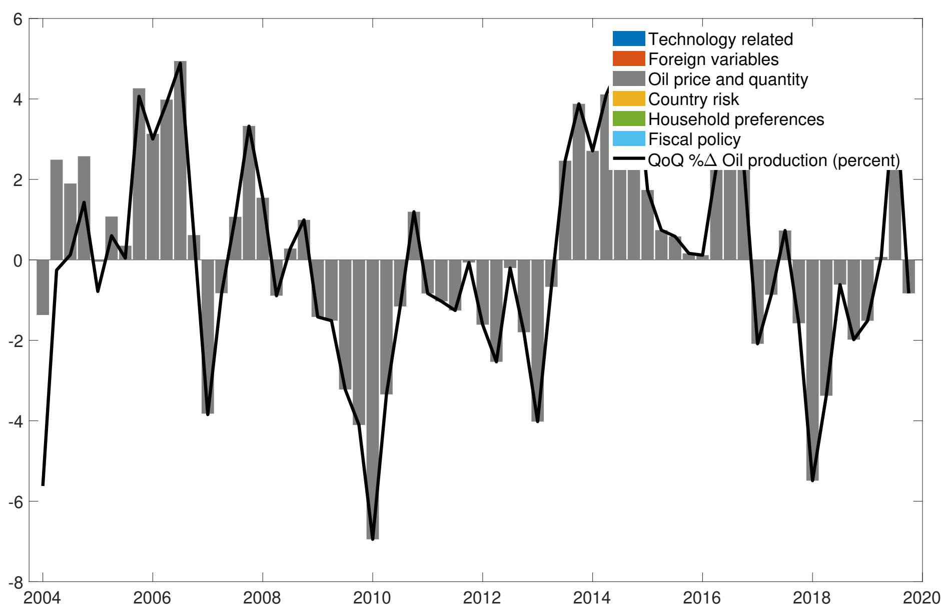
The black line is the observed variable. The y-axis is percent deviation from steady state and the x-axis is quarters.

Figure G.11: Historical Shock Decomposition for Country Premium



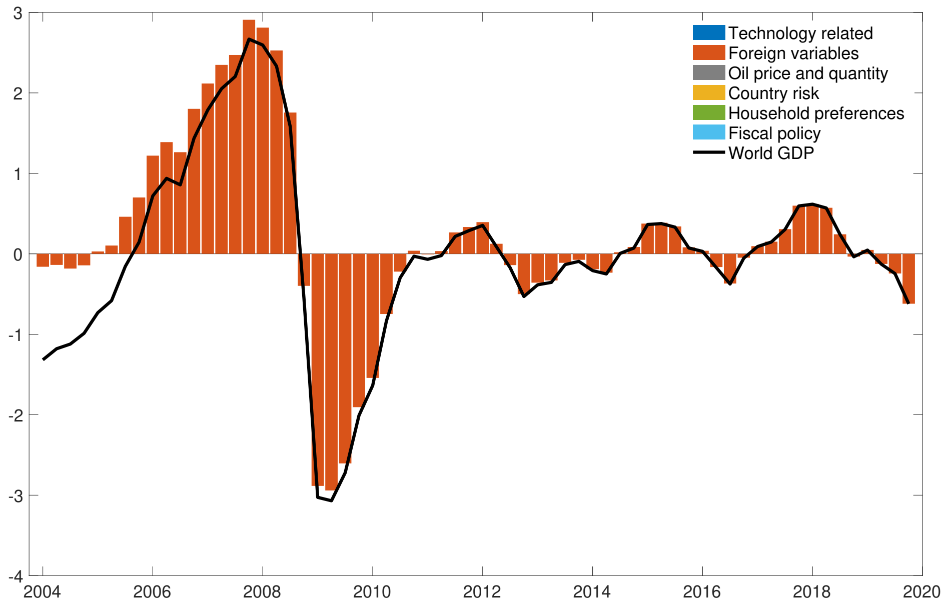
The black line is the observed variable. The y-axis is percent deviation from steady state and the x-axis is quarters.

Figure G.12: Historical Shock Decomposition for Oil Quantity



The black line is the observed variable. The y-axis is percent deviation from steady state and the x-axis is quarters.

Figure G.13: Historical Shock Decomposition for Foreign GDP



The black line is the observed variable. The y-axis is percent deviation from steady state and the x-axis is quarters.

increase, 1.6 pp above steady state, is designed to reduce the fiscal deficit-to-GDP ratio by 1 pp on impact (top-left panel).[29] Again, the simulation is a 5-year forecast, conditioning on the consumption tax rate lying 1.6 pp above its steady state and all other fiscal instruments remaining at their steady state for 20 quarters.

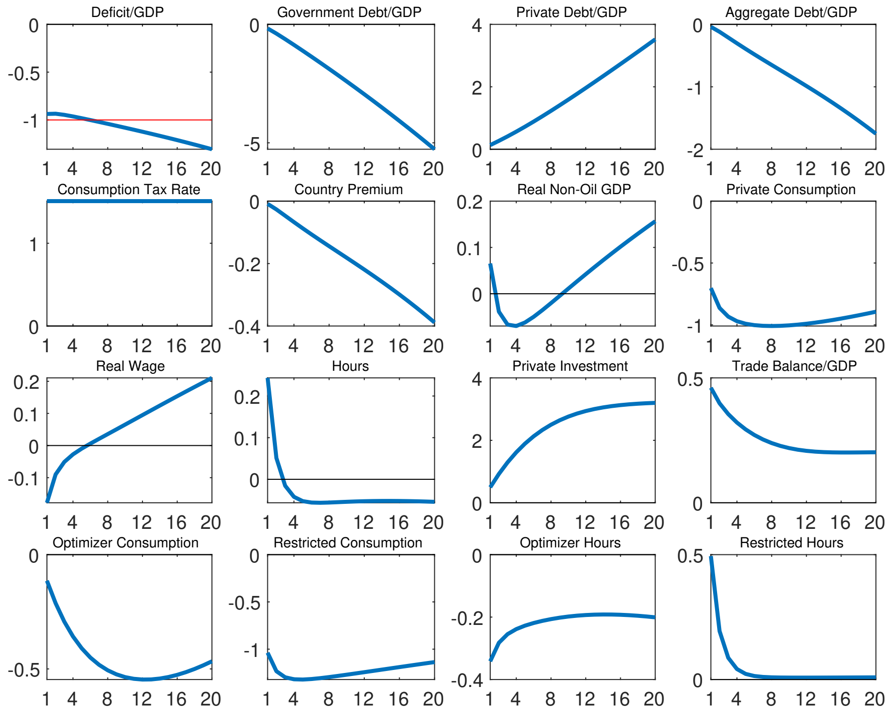
The decline in the fiscal deficit-to-GDP ratio generates a decline in the (annualized) government debt-to-GDP ratio (panel 1-2). Aggregate private consumption declines in response to the higher consumption tax rate (panel 2-4). The decline in consumption is more immediate for the hand-to-mouth households (panel 4-2) and more gradual for the optimizing households (panel 4-1), who can smooth consumption by increasing debt (panel 1-3). The increase in private debt is not sufficient to compensate the decline in public debt, so the aggregate foreign debt-to-GDP ratio declines (panel 1-4), generating downward pressure on the country risk premium (panel 2-2).

Forward-looking, optimizing households anticipate the decline in the country premium due to the fall in government debt, which increases the present value of investment (higher Tobin's q), leading to higher private investment throughout the simulation horizon (panel 3-3). During the first couple of years, as the model economy adjusts to the higher consumption tax rate, non-oil GDP declines (panel 2-3). However, as private investment gradually expands in response to the lower country risk premium, output eventually increases

[29]We calibrate the consumption tax rate change using the government budget constraint in steady state. Explicitly, we solve the following equation for x: $(pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega)h^o - \tau^k(r^k - \delta)\frac{k}{a} - (\tau^c + x)pc)/y = (pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega)h^o - \tau^k(r^k - \delta)\frac{k}{a} - \tau^c pc)/y - .01 \implies x = \frac{.01y}{pc}$. The deficit-to-GDP ratio does not fall by exactly 1 pp on impact because the calibration of the consumption tax rate assumed all other variables remained at steady state and thus did not account for the endogenous response of the economy to the tax change.

above trend.

Figure H.1: Consolidation: An Increase in the Consumption Tax Rate



Note: Fiscal consolidation designed to reduce the fiscal deficit-to-GDP ratio by approximately 1 percentage point on impact through an increase in the consumption tax rate, holding all other fiscal instruments constant. X axes denote quarters. Y axes denote percent deviations from steady state, except for variables expressed as ratios to GDP and the country premium, which are expressed as percentage point deviation from steady state. Public and private debt, and the country premium, are annualized.

H.2 An Increase in the Labor Income Tax Rate

Figure H.2 presents a fiscal consolidation based on an increase in the labor income tax rate (plotted in the second row and first column; panel 2-1). Again, the increase in the tax rate, of 5.6 pp above steady state, is calibrated to generate a decline in the fiscal deficit-to-GDP ratio of approximately 1 pp on impact (top-left panel).[30] The fall in the fiscal deficit leads to a decline in the (annualized) government debt-to-GDP ratio (panel 1-2).

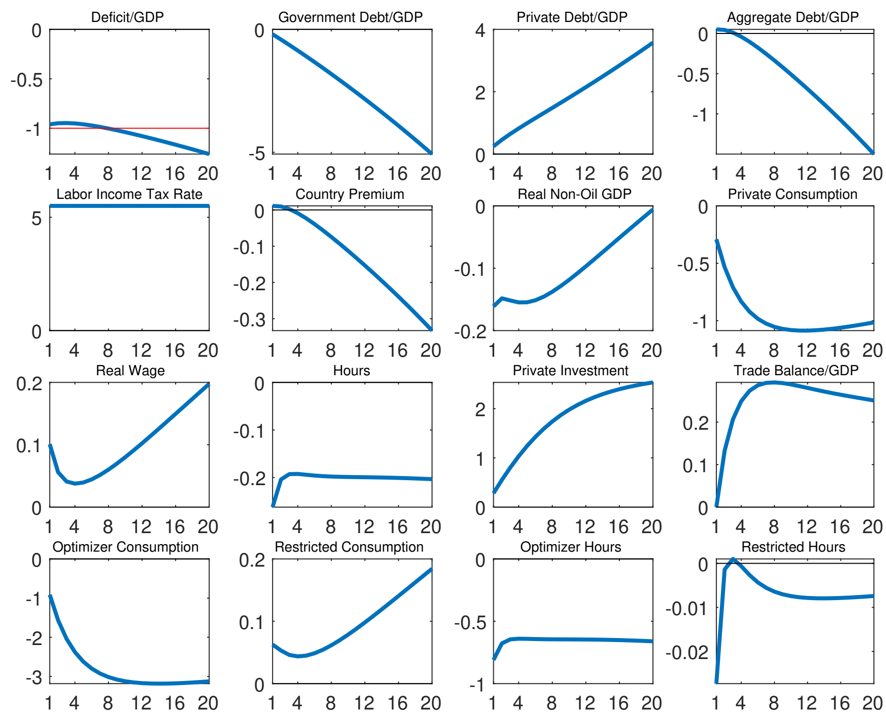
The higher labor income tax rate generates a decline in hours worked (panel 3-2) and an increase in the real wage due to its contractionary effect on labor supply (panel 3-1). The

[30] We calibrate the labor tax rate change using the government budget constraint in steady state. Explicitly, we solve the following equation for x: $(pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - (\tau^n + x) w (1-\omega) h^o - \tau^k (r^k - \delta) \frac{k}{a} - \tau^c pc)/y = (pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w (1-\omega) h^o - \tau^k (r^k - \delta) \frac{k}{a} - \tau^c pc)/y - .01 \implies x = \frac{.01y}{w(1-\omega)h^o}$.

labor income tax is only levied on optimizing households, so the decline in hours is driven by this group (panel 4-3). On the one hand, optimizing households also reduce consumption gradually but substantially in response to the intratemporal substitution effect induced by lower labor supply (panel 4-1). The group of hand-to-mouth households, on the other hand, increases consumption slightly in response to the rise in their disposable income due to the higher wage (panel 4-2).

Aggregate private consumption declines (panel 2-4), driven by the behavior of optimizing households, despite them issuing private foreign debt (panel 1-3) in order to reduce consumption gradually. The aggregate foreign debt-to-GDP ratio, however, declines (panel 1-4), driven by public debt, so the country risk premium also falls (panel 2-2). The lower premium induces an increase in private investment (panel 3-3). All in all, non-oil GDP falls below steady state (plot 2-3), driven by the decline in consumption demand and hours worked.

Figure H.2: Consolidation: An Increase in the Labor Income Tax Rate



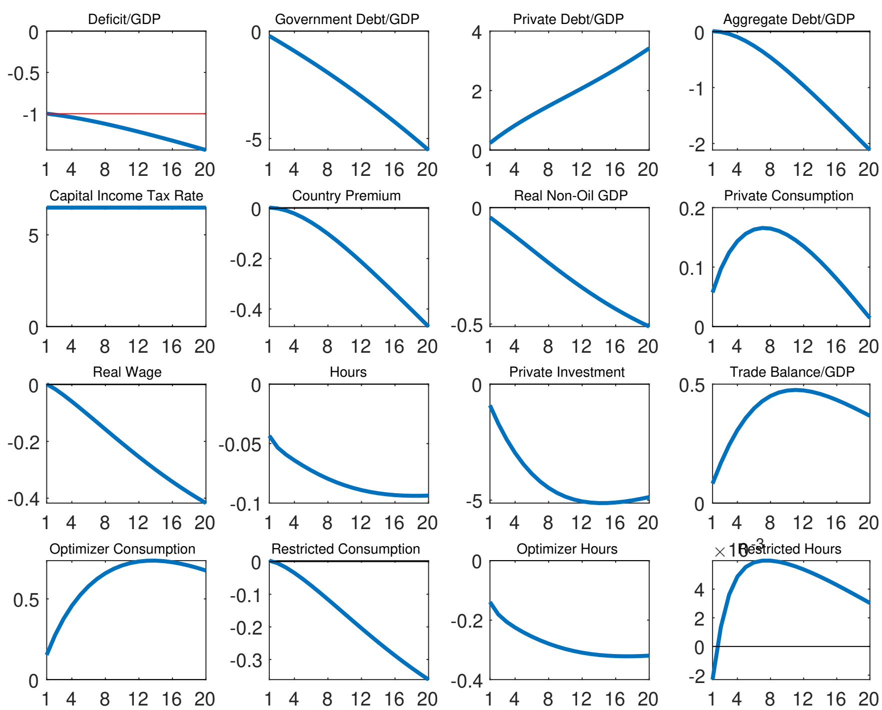
Note: Fiscal consolidation designed to reduce the fiscal deficit-to-GDP ratio by approximately 1 percentage point on impact through an increase in the labor income tax rate, holding all other fiscal instruments constant. For more details, see the note to figure H.1.

H.3 An Increase in the Capital Income Tax Rate

Figure H.3 presents a fiscal consolidation based on an increase in the capital income tax rate (panel 2-1) designed to reduce the fiscal deficit-to-GDP ratio by approximately 1 pp on impact (top-left panel). To achieve this, the capital income tax rate, which is levied only on the group of optimizing households, has to increase by 6.5 pp above steady state.[31] The decline in the fiscal deficit leads to a decline in the (annualized) government debt-to-GDP ratio (panel 1-2).

The country risk premium falls in response to lower aggregate debt (panel 2-2) which should lead to an increase in investment projects. However, private investment declines substantially (panel 3-3) because the force of the higher capital income tax dominates the decline in the premium. The lower risk premium generates an intertemporal substitution effect that leads optimizing households to increase consumption (panel 4-1), which drives a slight increase in aggregate private consumption (panel 2-4). The decline in investment affects the capital stock, which lowers the marginal product of labor and thus the real wage (panel 3-1), lowering consumption by hand-to-mouth households. Overall, the higher capital income tax generates a persistent decline in non-oil GDP (panel 2-3).

Figure H.3: Consolidation: An Increase in the Capital Income Tax Rate



Note: Fiscal consolidation designed to reduce the fiscal deficit-to-GDP ratio by approximately 1 percentage point on impact through an increase in the capital income tax rate, holding all other fiscal instruments constant. For more details, see the note to figure H.1.

[31] We calibrate the capital tax rate change using the government budget constraint in steady state. Explicitly, we solve the following equation for x: $(pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega) h^o - (\tau^k + x)(r^k - \delta)\frac{k}{a} - \tau^c pc)/y = (pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega) h^o - \tau^k (r^k - \delta)\frac{k}{a} - \tau^c pc)/y - .01 \implies x = \frac{.01y}{(r^k - \delta)\frac{k}{a}}$.

H.4 A Reduction in Government Consumption

We now turn to fiscal consolidation scenarios based on adjustments of the components of government expenditure. Figure H.4 presents a fiscal consolidation based on a reduction in government consumption. Again, we calibrate the size of the adjustment so that it generates a 1 pp decline, on impact, in the fiscal deficit-to-GDP ratio (top-left panel in the figure). We find that a 9% reduction in the level of government consumption generates the required adjustment (panel 2-1).[32]

The contraction in government consumption reduces the government debt-to-GDP ratio (panel 1-2), which in turn leads to a substantial decline in the country risk premium (more than 60 basis points after five years; panel 2-2). The intertemporal substitution effect induced by the lower country premium leads the optimizing households to increase consumption (panel 4-1). The decline in the country premium also induces an increase in investment (panel 3-3) due to the increase in its present value. The group of restricted, hand-to-mouth households reduces consumption initially (panel 4-2), because of the complementarity between public and private consumption and their inability to smooth the adjustment by issuing foreign debt, which is what the optimizing households do (panel 1-3). Eventually, however, the higher stock of private capital pushes the marginal product of labor and the real wage upwards (panel 3-1), which allows the hand-to-mouth households to increase consumption. Hours worked by both groups decline (panels 4-3 and 4-4). This is another consequence of the complementarity between public and private consumption—the decline in government consumption puts downward pressure on the marginal utility of private consumption, which leads to an intratemporal substitution towards leisure. Overall, the lower government consumption (panel 2-1) and hours worked (panel 3-2) generate an initial contraction in non-oil GDP (panel 2-3), but the subsequent expansion in aggregate demand eventually pulls it above trend.

H.5 A Reduction in Government Investment

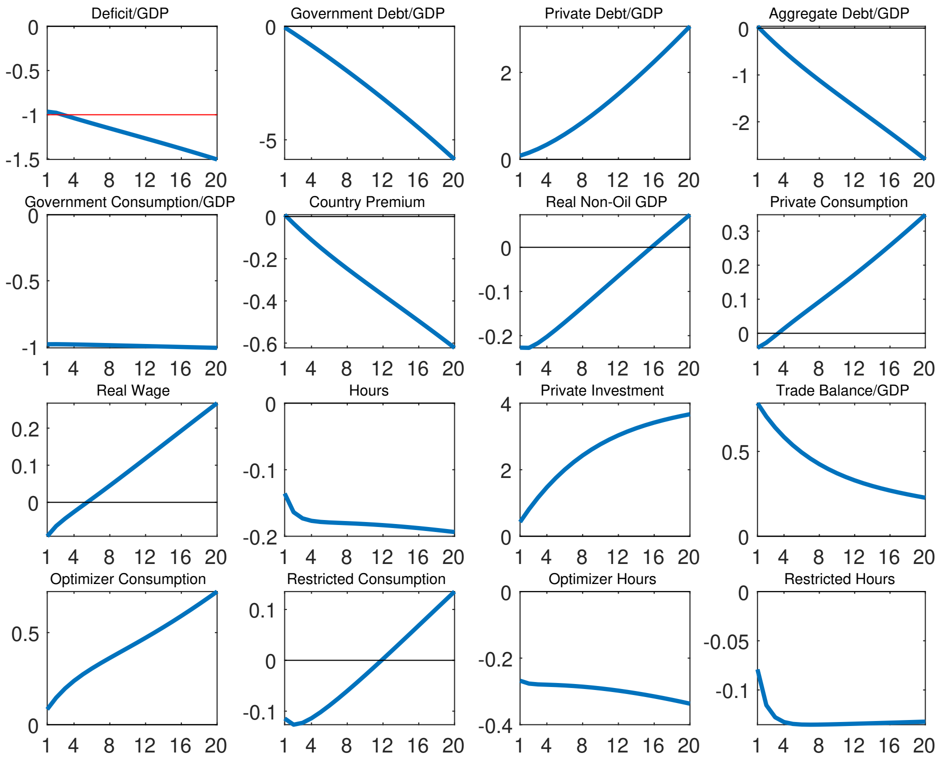
Figure H.5 presents a consolidation scenario based on a reduction in government investment. To generate a 1 pp decline in the fiscal deficit-to-GDP ratio (top-left panel), the level of government investment has to decline 37% (panel 2-1).[33]

The reduction in government investment leads to a substantial decline in the country risk premium (panel 2-2) through its effect on the government debt-to-GDP ratio (panel 1-2), which generates an intertemporal substitution effect for the households. The optimizing households increase consumption (panel 4-1) and leisure (panel 4-3). The decline in the premium also induces an increase in private investment (panel 3-3). The decline in the stock

[32] We calibrate the government consumption change using the government budget constraint in steady state. Explicitly, we solve the following equation for x: $(p(1-x)g^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega)h^o - \tau^k (r^k - \delta)\frac{k}{a} - \tau^c pc)/y = (pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega)h^o - \tau^k (r^k - \delta)\frac{k}{a} - \tau^c pc)/y - .01 \implies x = \frac{.01y}{pg^c}$.

[33] We calibrate the government investment change using the government budget constraint in steady state. Explicitly, we solve the following equation for x: $(pg^c + p(1-x)g^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega)h^o - \tau^k (r^k - \delta)\frac{k}{a} - \tau^c pc)/y = (pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega)h^o - \tau^k (r^k - \delta)\frac{k}{a} - \tau^c pc)/y - .01 \implies x = \frac{.01y}{pg^i}$.

Figure H.4: Consolidation: A Reduction in Government Consumption



Note: Fiscal consolidation designed to reduce the fiscal deficit-to-GDP ratio by approximately 1 percentage point on impact through a reduction in government consumption, holding all other fiscal instruments constant. For more details, see the note to figure H.1.

of public capital is larger, however, so the marginal product of labor and the real wage decline persistently (panel 3-1). Due to the reduction in the real wage, the restricted, hand-to-mouth households have no alternative but to reduce consumption.

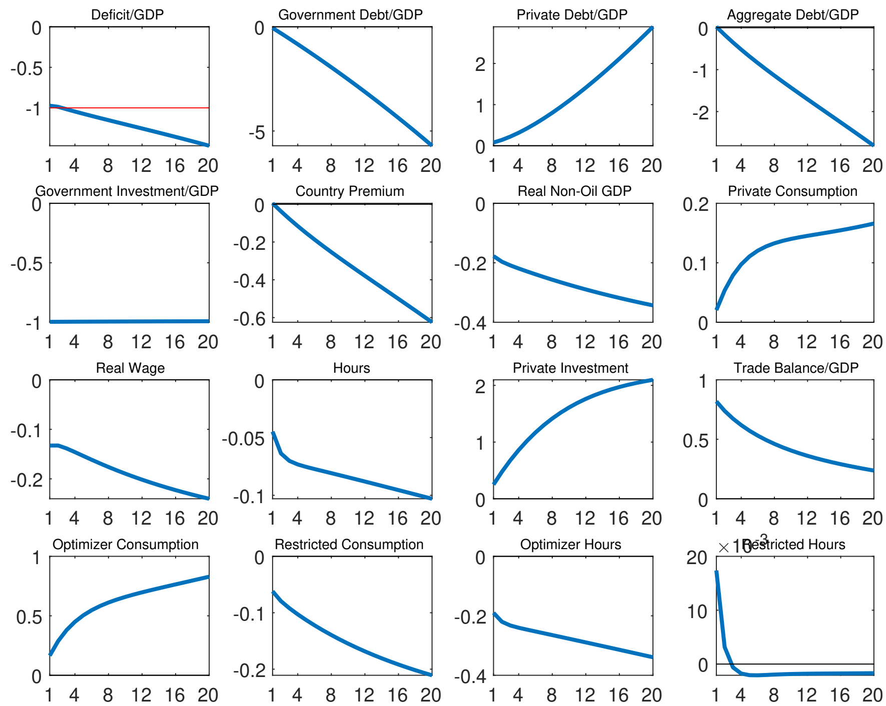
Despite the expansion in aggregate private demand, the decline in government investment (panel 2-1) and hours worked (panel 3-2) weigh on non-oil GDP, which remains below trend throughout the five-year horizon (panel 2-3).

H.6 A Reduction in Government Transfers

We now discuss a fiscal consolidation scenario based on a reduction of the final component of government expenditure, namely transfers, which we assume are only paid to the restricted, hand-to-mouth households. The results are shown in figure H.6. To generate a 1-pp reduction in the fiscal deficit-to-GDP ratio on impact (plot 1-1), the level of transfers must decline 20%, which is equivalent to 1 pp of GDP (plot 2-1).[34]

[34] We calibrate the transfer change using the government budget constraint in steady state. Explicitly, we solve the following equation for x: $(pg^c + pg^i + (1-x)tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega)h^o - \tau^k (r^k - \delta)\frac{k}{a} - \tau^c pc)/y = (pg^c + pg^i + tr + \xi R^* b^* - b^* - \chi p^{Co*} y^{Co*} - \tau^n w(1-\omega)h^o - \tau^k (r^k - \delta)\frac{k}{a} - \tau^c pc)/y - .01 \implies x = \frac{.01y}{tr}$.

Figure H.5: Consolidation: A Reduction in Government Investment



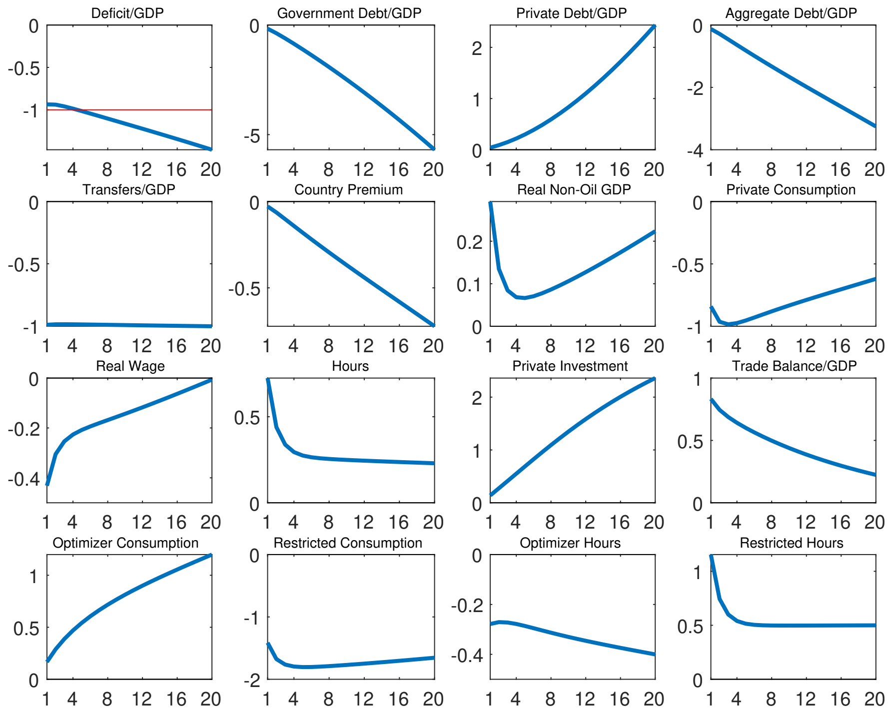
Note: Fiscal consolidation designed to reduce the fiscal deficit-to-GDP ratio by approximately 1 percentage point on impact through a reduction in government investment, holding all other fiscal instruments constant. For more details, see the note to figure H.1.

The reduction in transfers is a substantial income shock to the restricted households, who reduce consumption and leisure drastically in response (panels 4-2 and 4-4). The improvement in the fiscal deficit lowers the government debt-to-GDP ratio (panel 1-2), which generates a substantial decline in the country risk premium (panel 2-2). The optimizing households, who are not directly affected by the reduction in transfers, increase consumption and leisure because of the intertemporal substitution effect caused by the lower interest rate (panels 4-1 and 4-3). The decline in the premium also generates an increase in private investment (panel 3-3). The aggregate increase in labor supply (panel 3-2) puts downward pressure on the real wage (panel 3-1). The overall expansion in hours worked and private demand induce a modest expansion in non-oil GDP (panel 2-3).

H.7 Revenue- and Expenditure-Based Consolidations

The third step of our analysis compares a fiscal consolidation based on adjustments to tax rates (a revenue-based consolidation), with a consolidation based on adjustments to the components of government spending (expenditure-based). Specifically, we run counterfactual simulations that achieve the same level of deficit reduction as the full fiscal consolidation described in the previous subsection, but through adjustments in either tax rates or the

Figure H.6: Consolidation: A Reduction in Government Transfers



Note: Fiscal consolidation designed to reduce the fiscal deficit-to-GDP ratio by approximately 1 percentage point on impact through a reduction in government transfers, holding all other fiscal instruments constant. For more details, see the note to figure H.1.

components of government expenditure.

To implement the revenue-based consolidation, we assume that adjustments to each of the three tax rates in the model are responsible for achieving one third of the improvement in the primary balance-to-GDP ratio that is achieved under the full fiscal consolidation.[35] The revenue-based consolidation is a forecast conditioned on trajectories for the revenue from each tax as a share of GDP that deliver the desired improvement to the deficit, leaving the components of expenditure unchanged.[36] In every quarter of the six-year simulation horizon, the increase in each of the three tax revenue-to-GDP ratios equals one third of the improvement in the primary balance-to-GDP ratio in the corresponding quarter under the full fiscal consolidation. The adjustment is achieved by a sequence of shocks to the six fiscal instruments in the model.

Figure H.7 presents the results of the revenue-based consolidation in solid blue lines, and compares them to the results of the full consolidation (dashed red lines). To achieve the

[35]The primary fiscal balance is defined as revenue minus expenditure, excluding interest payments. We match changes in the primary balance rather than the overall balance because it affords more precision in reproducing the path of the fiscal deficit-to-GDP ratio.

[36]Although the levels of government spending are unchanged, they can fluctuate slightly when expressed as a share of GDP.

desired improvement in the fiscal deficit-to-GDP ratio (panel 2-3), the consumption tax rate must increase by up to 2.8 pp (panel 1-4), the labor income tax rate, by up to 8.9 pp (panel 2-1), and the capital income tax rate, by up to 10.7 pp (panel 2-2).

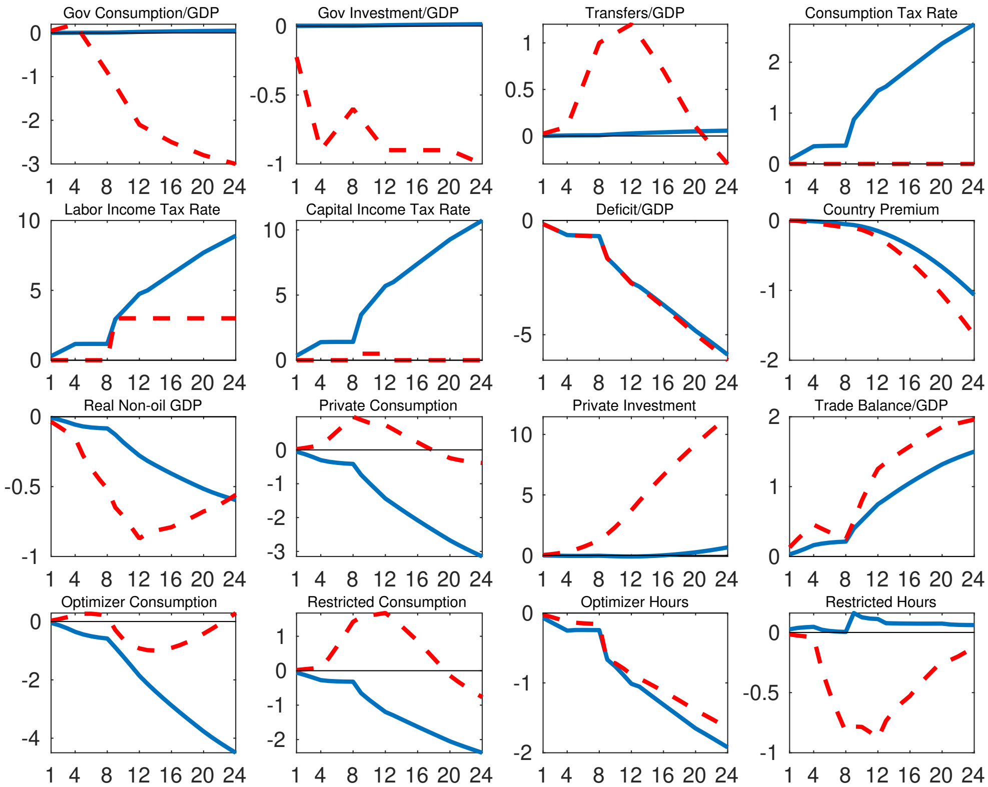
The revenue-based consolidation generates a more adverse effect on the consumption of both optimizing and hand-to-mouth households than the full fiscal consolidation (described in the previous subsection) due to the higher labor income and consumption tax rates, as well as the absence of support from transfers (panels 4-1 and 4-2). The country risk premium declines by up to 100 bps (panel 2-4), less than the 160 bps in the full simulation, because of a larger expansion in private foreign debt (not shown in the figure) that optimizing households use to smooth consumption. Private investment remains nearly unchanged for the first four years, and only increases slightly in fifth and sixth years (panel 3-3), due to the adverse effects of a higher capital income tax rate. However, hours worked decline less than in the full fiscal consolidation simulation because the restricted households do not reduce their hours (panel 4-4); they do so in the full simulation due to the income effect of higher transfers. The lower decline in aggregate labor and the fact that government purchases do not decline cushion the impact of the tax rate increases on non-oil GDP, which declines slightly less than in the full simulation (panel 3-1).

We now describe our final experiment—an expenditure-based fiscal consolidation. For this exercise, each of the three components of government expenditure declines by a magnitude that achieves one third of the improvement in the primary deficit-to-GDP ratio that occurs under the full fiscal consolidation. The expenditure-based consolidation is a forecast conditioned on trajectories for the three components of government spending, expressed as ratios to GDP, leaving tax rates unchanged. As in the previous simulations, the conditional forecast represents the response of the model economy to a sequence of structural shocks to the fiscal instruments that delivers the desired trajectories.

Figure H.8 depicts the results of the expenditure-based consolidation in solid blue lines, and compares them to the effects of the full consolidation, shown in dashed red lines. The plots in the first three columns of the first row show the evolution of the components of government spending (panels 1-1, 1-2, and 1-3). The decline in transfers generates a substantial negative income effect on the restricted, hand-to-mouth households, who reduce consumption (panel 4-2) and increase hours worked (panel 4-4) by more than in the revenue-based consolidation. In the full fiscal consolidation, transfers *increase* to cushion the impact on hand-to-mouth households, so the opposite occurs in that scenario.

The adjustment of government expenditure reduces foreign debt, which leads to a decline of up to 200 bps in the country risk premium (panel 2-4). The lower premium contributes to a substantial expansion in private investment (panel 3-3), which is slightly larger than that under the full consolidation. Such an expansion does not occur under the revenue-based consolidation due to the adverse effects of a higher capital income tax rate in that scenario. The lower country premium also generates an intertemporal substitution effect on optimizing households, who increase consumption (panel 4-1) and reduce hours worked (panel 4-3). However, aggregate private consumption declines (panel 3-2), driven by the behavior of hand-to-mouth households, in contrast to the expansion of aggregate private consumption under the full consolidation. The decline of private consumption under the expenditure-based consolidation is lower than that under the revenue-based consolidation due to the compensating force of higher consumption of optimizing households. Despite the

Figure H.7: Revenue-Based Fiscal Consolidation



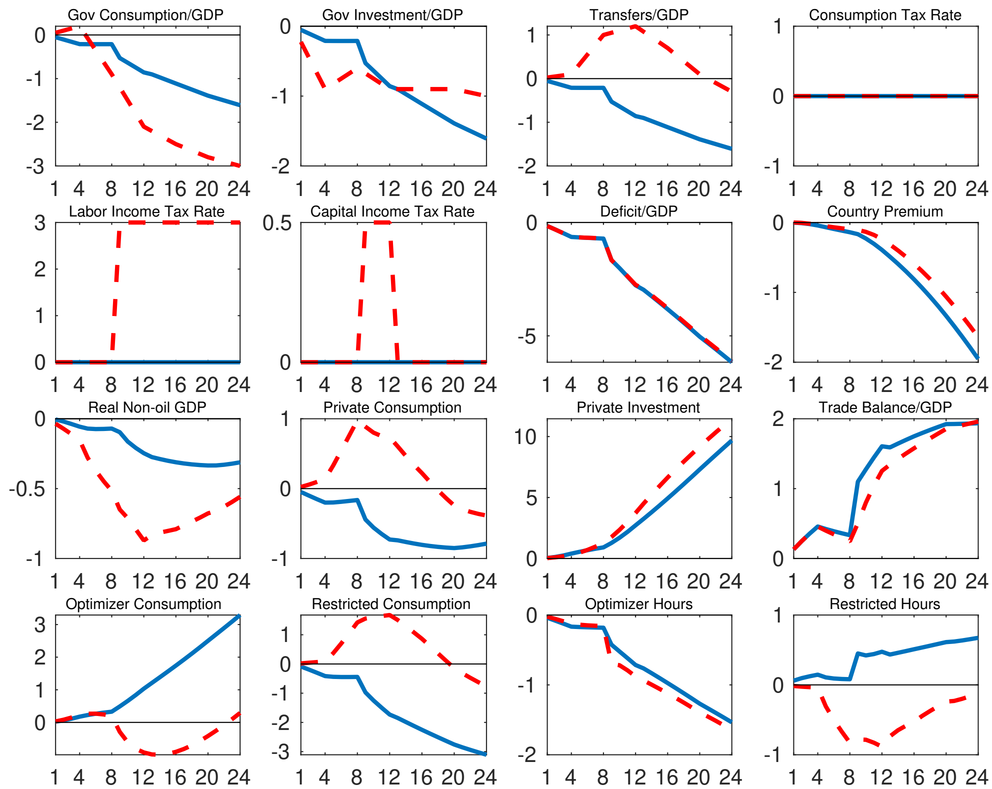
Note: Fiscal consolidation based on adjustments to labor income, capital income, and consumption tax rates (solid blue lines). The adjustment of each tax rate is designed to deliver one third of the improvement in the fiscal deficit achieved under the full fiscal consolidation, described in section 6, and shown in dashed red lines. X axes denote quarters. Y axes denote percent deviations from steady state, except for variables expressed as ratios to GDP and the country premium, which are expressed as percentage point deviation from steady state. The country premium is annualized.

differences with the revenue-based consolidation, the performance of non-oil GDP is similar (panel 3-1) because lower public demand is compensated by the better performance of private demand.

H.8 The Effect of Capital Controls

The final step evaluates the effect of the fiscal consolidation in a country in which the pass-through from external rates and the country premium is only partial, so that the benefits of lowering borrowing costs from reducing government debt are not as envisioned in the setup of our model. This feature could be common to certain commodity-exporting countries that have capital control measures in place, such as Ecuador. To that end, we assume that the return on foreign bonds that private agents receive or the interest rate they pay on borrowing is not $r_t^* = R_{t-1}^* \xi_{t-1}$, as specified in (4). To allow for only partial pass-through from either R_{t-1}^* or ξ_{t-1}, we specify the relevant interest rate that private agents face for consumption

Figure H.8: Expenditure-Based Fiscal Consolidation

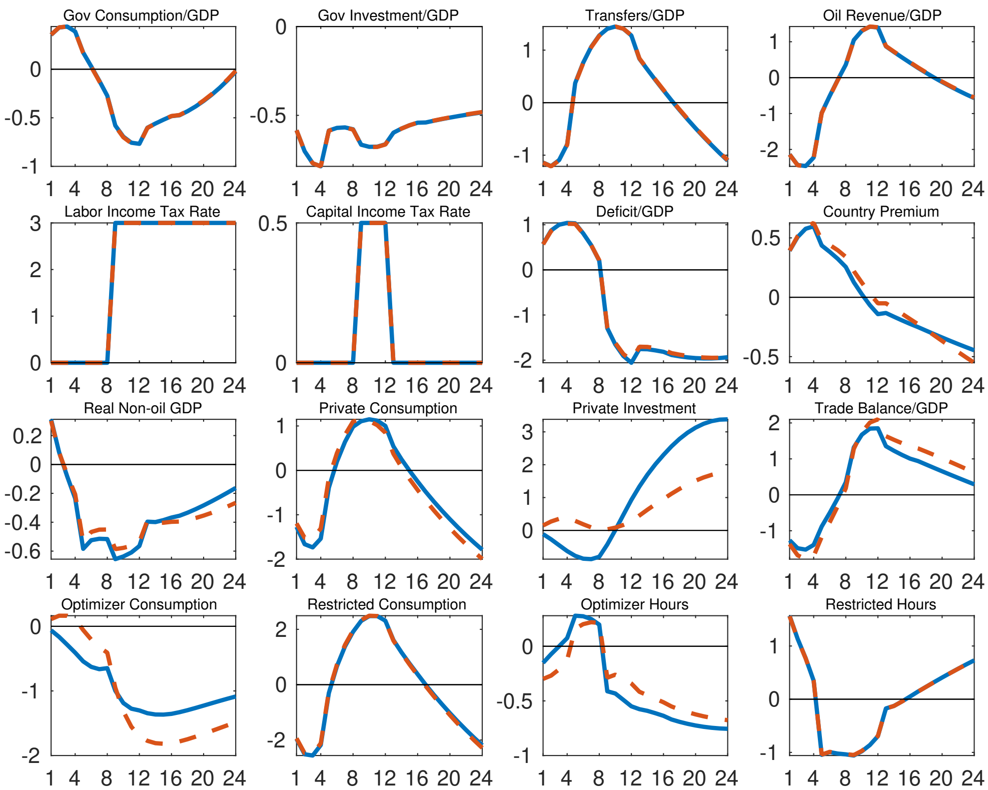


Fiscal consolidation based on adjustments to the components of government expenditure—consumption, investment and transfers (solid blue lines). The adjustment of each component is designed to deliver one third of the improvement in the fiscal deficit achieved under the full fiscal consolidation described in section 6, and shown in dashed red lines. For more details, see the note to figure H.7.

and investment decisions as $\tilde{r}_t^* = R^*\xi + \mu(R_{t-1}^*\xi_{t-1} - R^*\xi)$, with $\mu = 0.15$.[37]

[37]Notice that $\mu = 1$ implies complete pass-through and the absence of capital controls.

Figure H.9: Full Fiscal Consolidation with Capital Controls



Note: Fiscal consolidation combining adjustments of multiple revenue and expenditure instruments designed to approximate the agreement between the government of Ecuador and the IMF for the 2020–2025 period, as shown in tables 1 and 2. X axes denote quarters. Y axes denote percent deviations from steady state, except for variables expressed as ratios to GDP and the country premium, which are expressed as percentage point deviation from steady state. The country premium is annualized. We assume that that the interest rate that face private domestic agents is $\tilde{r}_t^* = R^*\xi + \mu(R^*_{t-1}\xi_{t-1} - R^*\xi)$, with $\mu = 0.15$. The continuous blue lines depict the effects of the fiscal consolidation absent capital controls while the dashed orange lines illustrate the effects under capital controls.

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