News Shocks and Inflation: Theory and Evidence from Large Oil Discoveries *

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Abstract

How does news about future fundamentals affect inflation today? We use large oil and gas discoveries worldwide with reserves exceeding 100 million barrels of oil equivalent and a production lag of at least five years as directly observable news about future output. Panel local projections show that a discovery worth 5 percent of initial GDP raises core consumer prices by 1.13 percent over the subsequent decade, while producer prices respond little. The consumer price response is driven by nontradables; tradable prices remain broadly stable, and the real exchange rate appreciates persistently. Real activity also rises before new oil production begins, while the current account initially deteriorates and later improves as new oil comes online. The core CPI response is concentrated under inflexible exchange-rate regimes and negligible under flexible ones. A three-sector New Keynesian small open economy model reproduces these patterns: a demand channel raises nontradable inflation while exchange-rate appreciation damps tradable inflation, and exchange-rate policy determines which force dominates.

Keywords: News shocks, inflation, oil discoveries, New Keynesian model, small open economy, exchange rate regimes

JEL: E31, E32, E52, F41, Q32

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1 Introduction

How does news about future fundamentals affect inflation today? In the canonical New Keynesian model, inflation is forward-looking: with sticky prices, firms set prices in response not only to current marginal costs, but also to expected future demand and cost conditions (Rotemberg, 1982; Calvo, 1983). News that shifts expectations about future fundamentals can therefore move inflation before those fundamentals are realized. Since Beaudry and Portier (2006), a large literature on news-driven business cycles has shown that news shocks can generate sizable movements in real activity—including output, consumption, investment, employment, and external balances (Jaimovich and Rebelo, 2009; Schmitt-Grohé and Uribe, 2012; Mertens and Ravn, 2012; Arezki et al., 2017). Much less is known about their inflationary effects. Existing theory gives ambiguous predictions, and empirical evidence remains mixed (Lorenzoni, 2009; Barsky et al., 2015). The key challenge in the literature is the identification problem: news shocks are rarely observed directly, and existing studies must infer them from identifying restrictions or structural models, so the results are inherently sensitive to those assumptions.

This paper provides theory and empirical evidence on how news shocks affect inflation in open economies. Our empirical strategy exploits plausibly exogenous variation in the timing of large oil and gas discoveries around the world as a directly observable measure of news about higher future output. A discovery reveals information about future resource income and output, but production usually begins only after a substantial development lag. Moreover, the timing of discoveries is shaped by geological uncertainty, making discoveries plausibly exogenous to contemporaneous macroeconomic conditions (Arezki et al., 2017). These features make oil and gas discoveries a useful laboratory for studying news shocks.

We construct a new dataset of 1,309 large oil and gas discoveries, defined as fields with reserves exceeding 100 million barrels of oil equivalent and a production lag of at least five years, covering 74 economies over 1980–2019. The data are drawn from the Rystad Energy upstream database and substantially expand the coverage of oil and gas discoveries used in the existing literature.[1] An important advantage of the Rystad data is that they report both

[1] Arezki et al. (2017) use the giant oil and gas discoveries compiled by Horn (2014), defined as discoveries with ultimate recoverable reserves of at least 500 million barrels of oil equivalent. Under this definition, there were 343 giant oil and gas discoveries during 1980–2012. Our dataset expands this coverage by including fields

the discovery year and the production-start year for each field. This allows us to observe field-specific production lags and to distinguish genuine news shocks from discoveries that quickly translate into current production. In our baseline analysis, we therefore exclude discoveries with production lags shorter than five years. This restriction helps ensure that the estimated inflation responses capture news about future resource income rather than contemporaneous increases in productive capacity.

We measure the economic size of each discovery by its net present value as a share of GDP, and aggregate to the country-year level. We combine these data with core consumer and producer price indexes (CPI and PPI) from the World Bank's Global Database of Inflation (GDI), sectoral price deflators and bilateral real exchange rates from the United Nations National Accounts Statistics (UNNAS), and macroeconomic aggregates from standard international sources. We estimate dynamic responses using panel local projections with country and year fixed effects (Jordà, 2005), which absorb time-invariant country characteristics and common global shocks.

The empirical analysis delivers three main findings. First, oil-discovery news raises consumer prices but has little effect on producer prices. A median-sized discovery, with an estimated net present value equal to 5 percent of GDP, raises core CPI by about 1.13 percent cumulatively over the decade following the discovery. The response of the PPI is small and statistically insignificant. This divergence reflects the sectoral composition of the two indexes. Consumer prices place substantial weight on nontradable goods and services, whose prices are determined largely by domestic demand and costs. Producer prices are more concentrated in tradable goods and intermediate inputs, whose prices are disciplined by world markets. Consistent with this interpretation, nontradable prices rise strongly after discoveries, while tradable prices remain broadly stable. The resulting increase in the relative price of nontradables is also mirrored in an appreciation of the bilateral real exchange rate, consistent with the wealth effect associated with an anticipated future resource windfall (Harding et al., 2020).

Second, the real-side responses indicate that discoveries initially operate as aggregate demand shocks. Output, consumption, and investment rise before production from newly discovered fields begins. Imports increase on impact, while exports rise only after several

above 100 million barrels of oil equivalent and extending the sample through 2019.

years, when new oil production comes online. The current account therefore deteriorates initially and improves later as resource exports expand. These dynamics are consistent with the intertemporal approach to the current account: in response to news of higher future income, economies increase absorption today by borrowing more or saving less (Obstfeld and Rogoff, 1995b).

Third, the inflation response depends systematically on the exchange-rate regime. Using the classification in Ilzetzki et al. (2019), we group pegs and narrow bands as inflexible regimes and wider bands and floating arrangements as flexible regimes. The increase in core CPI is concentrated in inflexible regimes. Under flexible exchange rates, the inflation response is small and statistically insignificant. This pattern points to the exchange rate as a central margin of adjustment to news about future resource income.

The results are robust to a wide range of alternative specifications. They are similar when we restrict the sample to countries with at least one large discovery, vary assumptions about oil prices and production lags in constructing discovery values, use alternative definitions of tradable and nontradable sectors, control for exploration expenditures, account for heterogeneous exposure to U.S. monetary policy shocks, select lags using the Bayesian Information Criterion, and correct for dynamic panel bias using the Split-Panel Jackknife procedure (Mei et al., 2026). These exercises indicate that the findings are not driven by sample composition, shock measurement, sectoral classification, global financial conditions, lag choices, or Nickell bias.

To interpret the evidence, we develop a small open-economy New Keynesian model with oil, tradable goods, and nontradable goods. Oil discoveries follow Arezki et al. (2017): a discovery reveals future oil production and export income, but new reserves become productive only after a time-to-connect delay. Households are forward-looking and consume and invest using both tradable and nontradable goods. Nontradable and home tradable producers set prices subject to nominal rigidities. Final tradable goods combine domestic tradable inputs and imported inputs, so tradable inflation depends partly on the exchange rate. Monetary policy follows a generalized Taylor rule that allows the central bank to respond to inflation, output, and nominal exchange-rate movements; the response to the exchange rate governs the degree of exchange-rate flexibility.

The model highlights two opposing forces. The first is an inflationary domestic-demand channel. A discovery raises expected future resource income, leading households to increase consumption and investment before production begins. Because part of this additional demand falls on nontradables, whose supply is domestically constrained and whose prices are sticky, marginal costs and nontradable inflation rise. This pushes up CPI inflation. The second is a disinflationary exchange-rate channel. Anticipated future oil exports generate an immediate nominal appreciation, which lowers the domestic-currency price of imported inputs and dampens tradable-goods inflation. This channel helps explain why producer prices respond weakly relative to consumer prices.

Exchange-rate policy determines which force dominates. Under an inflexible regime, nominal appreciation is limited, so the decline in imported-input prices is muted. The domestic-demand channel therefore dominates, making discovery news inflationary. Under a flexible regime, nominal appreciation absorbs part of the shock by reducing import prices and easing pressure on tradable-goods inflation. As a result, the same news shock generates a much weaker inflation response. The calibrated model generates cumulative impulse responses that are broadly consistent with the empirical results. Thus, the model rationalizes the main empirical findings: oil-discovery news raises absorption, appreciates the real exchange rate, worsens the current account initially, increases nontradable prices, and raises CPI inflation primarily under inflexible exchange-rate regimes.

The paper contributes first to the literature on news-driven business cycles. Existing work has focused mainly on real aggregates and has reached mixed conclusions about inflation. In standard New Keynesian models, favorable TFP news can be disinflationary because firms anticipate lower future marginal costs (Barsky et al., 2015). In contrast, noisy signals or optimism about future productivity can generate demand booms and raise inflation (Lorenzoni, 2009). Empirical studies based on structural VARs often find that positive TFP news lowers inflation (Barsky and Sims, 2011; Barsky et al., 2015; Kurmann and Sims, 2021; Miranda-Agrippino et al., 2026), while Cascaldi-Garcia and Vukotić (2022) find inflationary effects using patent-based innovation news. A central challenge is identification: latent news shocks are typically recovered using recursive orderings and max-share restrictions.[2]

[2]The VAR evidence relies on either the standard Cholesky triangularization or the max-share restrictions to recover TFP news shocks (Miranda-Agrippino et al., 2026; Francis et al., 2014; Kurmann and Sims, 2021). The first approach relies on an untested assumption about the ordering of VAR variables, while Dou et al.

Evidence from estimated DSGE models is also inherently model-dependent, as both the recovered news shocks and their transmission mechanisms depend on the assumed structure.[3] These approaches are informative but can be sensitive to identifying assumptions and model structure.

Taken together, the literature points to a fundamental empirical challenge: because news shocks are typically latent, existing estimates must infer them through identifying restrictions or structural models, making it difficult to directly measure their inflationary effects. We contribute by using observable oil-discovery news as a direct source of variation in expected future output, thereby providing new evidence on the inflationary consequences of news shocks.[4] This setting offers a unique advantage: oil discoveries are observed directly, so our estimates do not depend on VAR identifying restrictions or on the latent shock structure of an estimated DSGE model.

Second, this paper contributes to the New Open Economy Macroeconomics literature (Obstfeld and Rogoff, 1995a; Bergin, 2006; Itskhoki and Mukhin, 2021), and in particular to small open-economy New Keynesian frameworks (Galí and Monacelli, 2005; Schmitt-Grohé and Uribe, 2003). A defining feature of this literature, relative to the classic Mundell–Fleming framework, is its intertemporal structure: forward-looking agents respond today to anticipated changes in future fundamentals. Following large oil and gas discoveries, economies begin to adjust well before new oil production comes online. Domestic demand rises, nontradable prices and the core CPI increase, the real exchange rate appreciates, and the current account initially deteriorates. The evidence therefore shows that news about future fundamentals can trigger immediate nominal, real, and external adjustment. These responses are difficult to reconcile with a purely contemporaneous view of shocks, but they arise naturally in an intertemporal small open-economy New Keynesian model.

Finally, the paper identifies exchange-rate regimes as a key determinant of the inflation-

(2025) shows that the second approach—max-share identification—is valid only under restrictive necessary and sufficient conditions that are difficult to satisfy in practice, and that the identified TFP news shocks can be contaminated by other structural disturbances.

[3]For example, Görtz and Tsoukalas (2017) show that financial intermediation can amplify TFP news and turn it into a demand-like expansion that raises inflation, while Görtz et al. (2022) show that, even with financial frictions, the sign of the inflation response depends on the expected path of marginal costs and the horizon at which the news materializes.

[4]Our work is closely related to Arezki et al. (2017) and Sheng and Zhao (2024). Whereas they study the real effects of oil-discovery news in settings without a central role for nominal rigidities, we focus on its nominal and inflationary consequences and develop a New Keynesian framework in which monetary policy and exchange-rate regimes shape the transmission of news shocks.

ary effects of news in open economies. News about future output is not uniformly inflationary; its effect depends on the adjustment of the nominal exchange rate. When the exchange rate is constrained, higher expected income primarily raises domestic demand and nontradable prices. When the exchange rate is flexible, nominal appreciation lowers the domestic-currency cost of imports and attenuates the CPI response. Thus, the same news shock can have different nominal consequences depending on the monetary and exchange-rate regime. This open-economy dimension has received limited attention in the news-shock literature, which has focused primarily on closed-economy settings. We fill this gap by providing both empirical evidence and a theoretical rationale for the exchange-rate channel.

The rest of the paper is organized as follows. Section 2 describes the data and the empirical specification. Section 3 presents the empirical results and an extensive set of robustness checks. Section 4 develops the three-sector New Keynesian model of a small open economy with oil. Section 5 presents the calibration and the simulated impulse responses, which reproduce the main empirical patterns and illustrate the underlying mechanisms. Section 6 concludes.

2 Data and Empirical Specification

2.1 Empirical Strategy

We estimate the dynamic effects of oil-discovery news using panel local projections (Jordà, 2005). The baseline specification is

$$y_{i,t+h} - y_{i,t-1} = \beta^h Disc_{i,t} + \sum_{j=1}^{5} \delta_j^h Disc_{i,t-j} + \sum_{k=1}^{5} \zeta_k^h \Delta y_{i,t-k} + \alpha_i^h + \gamma_t^h + \epsilon_{i,t+h}, \tag{1}$$

for horizons $h = 0, 1, \ldots, 10$. The dependent variable is the cumulative change in outcome y from year $t-1$ to year $t+h$. The coefficient of interest, β^h, therefore measures the cumulative response of the outcome at horizon h to an oil-discovery news shock in year t. When y is the log of a price index, β^h corresponds to the cumulative change in the log price level, or equivalently cumulative inflation, over the same horizon.

The dependent variables include the log core CPI index, the log PPI index, log tradable

price index, log nontradable price index, and the logs of real GDP, consumption, investment, exports, and imports, measured in local currency units. We also examine the current-account-to-GDP ratio. The main explanatory variable, $Disc_{i,t}$, is the net present value of large oil and gas discoveries, scaled by GDP, as described in the next subsection.

The specification includes country fixed effects, α_i^h, which absorb time-invariant cross-country differences such as geography, long-run institutional characteristics, and resource endowments. Year fixed effects, γ_t^h, control for common global shocks, including movements in world oil prices, global financial conditions, and the global business cycle. We include five lags of discovery shocks and five lags of the first difference of the dependent variable to account for serial correlation, delayed effects of earlier discoveries, and persistence in macroeconomic dynamics. Standard errors are computed using the Driscoll and Kraay (1998) correction, which is robust to heteroskedasticity, serial correlation, and cross-sectional dependence in the error terms. We do not include country-specific time trends in the baseline specification, because large discoveries may themselves alter the long-run path of macroeconomic aggregates.

Our identification relies on the plausibly exogenous timing and size of discoveries, conditional on country and year fixed effects. As argued by Arezki et al. (2017), the timing and size of discoveries are largely determined by geological factors rather than contemporaneous macroeconomic conditions, so discoveries are unlikely to respond to current inflation, output or external accounts. Three threats to this assumption remain: discoveries may be partially anticipated by observable exploration activity; the NPV measure values discoveries at the contemporaneous world oil price, which could comove with country-specific price dynamics; and countries may respond heterogeneously to global financial conditions, which year fixed effects alone do not absorb. We address the first by controlling for exploration expenditures, the second by revaluing discoveries at the three-year moving average of oil prices, and the third by allowing exposure to U.S. monetary policy shocks to vary with capital-account openness, all in Section 3.2; the estimates are essentially unchanged. Moreover, we further exclude discoveries with production lags less than five years, to prevent our estimates from being confounded by the actual influx of revenues soon after the discovery.

The local-projection method is well suited to our setting for two reasons. First, it esti-

mates the cumulative impulse response directly at each horizon, rather than deriving it from the dynamic panel distributed-lag model of Arezki et al. (2017), in which responses and their confidence intervals must be iterated forward using the delta method. This maps directly into our object of interest—the total response of prices, quantities, and external balances over the years following a discovery—and smooths out short-run fluctuations. Second, lag-augmented local projections deliver more reliable inference in settings with persistent or potentially non-stationary variables, where standard autoregressive inference can perform poorly, especially at longer horizons (Montiel Olea and Plagborg-Møller, 2021).

To study the response of the real exchange rate, we do not apply the baseline specification (1) to the (unilateral) effective real exchange rate, as it is typically constructed as a geometric, trade-weighted average of bilateral exchange rates. Its movements may therefore reflect oil discoveries not only in the home country but also in all its trading partners. This aggregation can obscure the relative nature of the shock and complicate the interpretation of the estimated response.

We therefore follow Harding et al. (2020) and use bilateral real exchange rates. For each country pair (i, j), we define the bilateral discovery shock as

$$Disc_{ij,t} = \log\left(\frac{1 + NPV_{i,t}}{1 + NPV_{j,t}}\right),$$

where $NPV_{i,t}$ and $NPV_{j,t}$ denote the net present value of discoveries in countries i and j, respectively, scaled by GDP. This measure captures the size of discovery news in country i relative to country j. We then estimate the following bilateral local projection:

$$\log RER_{ij,t+h} - \log RER_{ij,t-1} = \beta^h Disc_{ij,t} + \sum_{m=1}^{5} \delta_m^h Disc_{ij,t-m} + \sum_{k=1}^{5} \zeta_k^h \Delta \log RER_{ij,t-k} + \alpha_{ij}^h + \gamma_t^h + \epsilon_{ij,t+h}, \tag{2}$$

for horizons $h = 0, 1, \ldots, 10$. The pair fixed effects, α_{ij}^h, absorb time-invariant bilateral characteristics such as distance, cultural similarity, and colonial ties, while year fixed effects, γ_t^h, control for global shocks common to all country pairs. The sequence of coefficients β^h traces the cumulative response of the bilateral real exchange rate to a relative oil-discovery news shock. For this specification, standard errors are computed using the Driscoll and Kraay (1998) correction, which ensures robustness to heteroskedasticity, serial correlation, and cross-sectional dependence.

2.2 World oil discovery data

We source our oil and gas discovery data from Rystad Energy (Rystad Energy, 2025), a leading energy consultancy based in Norway. This upstream database offers comprehensive global coverage of the petroleum sector from 1970 to 2024, encompassing both conventional and unconventional (shale/tight) fields worldwide. For each field, the dataset provides detailed information including ownership structure, operators, basin designations, and geographic coordinates. It also provides the life cycle information, such as the discovery year, the final investment decision time, the year of production start, the abolishing year, along with the annual production data broken down by different energy types. The data set also tracks the life-cycle economics of each asset within a standardized cash-flow framework. This framework disaggregates asset revenue into five key components: capital expenditures (Capex), exploration expenditures (Expex), operating expenditures (Opex), government take (royalties, taxes, and profit oil), and residual free cash flow to equity holders. This dataset has been widely used in the oil industry and academic studies regarding the oil market (Asker et al., 2019; Bornstein et al., 2023).

Our study focuses on conventional oil and gas discoveries spanning from 1980 to 2019. We exclude pre-1980 data due to the scarcity of macroeconomic variables for many countries, and we end the sample in 2019 to avoid the confounding effects of the Covid-19 pandemic. Following Arezki et al. (2017), we also exclude unconventional discoveries, such as shale resources. Shale reserves (e.g., in the US) have been known for decades; their recent exploitation is driven by technological advancements in extraction (such as horizontal drilling) rather than new discoveries, making them distinct from the discovery shocks we aim to capture.

The Rystad dataset covers oil and gas discoveries of all sizes, providing substantially broader coverage than Arezki et al. (2017), which restricts its focus to giant discoveries—defined as having at least 500 million barrels of oil equivalent in ultimate recoverable reserves. In this study, we utilize large oil and gas discoveries, defined as those with at least 100 million barrels of oil equivalent. To construct our shock series, we apply several strict filters. First, some oil fields report multiple discovered resources over time after the initial discovery; we exclude these subsequent discoveries for the same field, because most are appraisals of the initial discovery and are typically anticipated, so they do not qualify as exogenous news shocks. Second, we exclude small discoveries (below 100 million barrels), as their macroeconomic impacts are likely limited.

Finally, to ensure that we are isolating the pure anticipation effect, we explicitly exclude discoveries with a production lag of less than five years. While such rapid commercialization is relatively

uncommon, notable exceptions do exist. For example, Pemex's Quesqui field in Tabasco, Mexico, discovered in late 2019 with estimated reserves of 575 million barrels of oil equivalent, was brought online rapidly using Early Production Systems and nearby infrastructure. Production began almost immediately and peaked in 2022. Excluding these fast-developed oil fields prevents our estimates from being confounded by the actual influx of revenues and concurrent extraction activities.

Specifically, from an initial pool of 1,645 large discoveries, we drop 336 observations that transition into the production phase within five years, approximately 20.4% of the sample. Notably, Arezki et al. (2017) lacked data on production lags; thus, our ability to cleanly separate the anticipation effect from immediate production dynamics represents a significant empirical advantage. Consequently, our sample not only identifies a greater number of discovery news shocks than Arezki et al. (2017), but also provides a more rigorous measure of news shock.

Table 1 details the spatial and temporal distribution of 1,309 large discoveries between 1980 and 2019. Global discoveries peaked at 387 in the 1980s and averaged approximately 307 per decade thereafter, masking substantial regional heterogeneity. Discoveries declined sharply in mature producing regions, particularly Russia and Europe, while remaining relatively stable in the Middle East and North America. In contrast, exploration success shifted toward emerging frontiers: discoveries in Africa rose from 41 in the 1980s to 81 in the 2010s, and those in South America more than tripled over the same period. Asia recorded the largest cumulative total of 262 discoveries, although the number of discoveries in the region peaked during the 1990s.

The Rystad dataset provides both the discovery and production start years, enabling the calculation of the production lag for each field. In our full sample of large discoveries spanning 1980–2019, the median production lag is 7 years, with an interquartile range of 3 to 13 years.[5] While these lags are slightly longer than the 4–6 year average reported by Arezki et al. (2017) for giant oil discoveries, the difference is not qualitatively significant given the substantial heterogeneity across individual fields. Consequently, to maintain consistency with the established literature, we follow Arezki et al. (2017) and assume a standard expected production lag of 5 years. In the robustness check, we also set the expected production lag of 7 years, and the estimated IRFs are virtually the same.

Adopting the methodology of Arezki et al. (2017), we define the Net Present Value (NPV) of

[5]Note that we use the full sample of 1,645 large oil discoveries to compute the distribution of production lags, rather than the restricted sample that excludes discoveries with production lags shorter than five years. This is because agents do not know ex ante when production will begin, so their expected production lag should be unconditional and based on the full sample of large discoveries.

large oil discoveries for country i in year t, expressed as a percentage of GDP, as follows:

$$NPV_{i,t} = \frac{\sum_{d \in D_t} \sum_{j=5}^{J} \frac{q^d_{i,t+j} \cdot p^{\text{oil}}_t}{(1+r_i)^j}}{GDP_{i,t}} \times 100, \tag{3}$$

where $q^d_{i,t+j}$ represents the projected oil production profile for year $t+j$ associated with a specific large discovery d; p^{oil}_t denotes the prevailing oil price at the time of discovery; r_i is the country-specific discount rate; and J marks the exhaustion horizon of the oil resource, which we set to 20 years. The outer summation aggregates the discounted revenues over the set of discoveries D_t occurring in year t, accounting for the fact that a country may experience multiple discoveries in a single year. Finally, we incorporate risk-adjusted discount rates to account for variations in perceived political risk. Consistent with Arezki et al. (2017), the discount rate r_i is computed as the sum of a 5% risk-free rate and a country-specific risk premium.

Although Rystad reports annual production for each field, we do not use it to construct the NPV of discoveries, because actual production paths are endogenous outcomes of ex-post economic and political factors, including firms' strategic responses to oil price fluctuations and information unavailable to agents at the time of discovery. We instead follow Arezki et al. (2017) and construct a projected production profile $q^d_{i,t+j}$ as a reserve-specific plateau followed by an exponential decline.[6]

Figure 1 presents the histogram of the log Net Present Value ($NPV_{i,t}$) of worldwide large oil discoveries, expressed as a percentage of the respective country's GDP, between 1980 and 2019. As depicted, the distribution exhibits substantial heterogeneity and a pronounced right skew. Notably, the long right tail of the distribution highlights a subset of exceptionally large discoveries. As shown in the figure, a small number of log-NPV observations exceed 6.9 (equivalent to an NPV of over 1000% of the country's GDP), with the most extreme case approaching a log value of 10, i.e., the NPV of more than 300 times the country's GDP. These massive windfalls typically occur in smaller economies where a single giant oil discovery completely dwarfs the existing economic output.

We exclude these extreme right-tail observations from our baseline analysis for two primary reasons. First, the macroeconomic transmission of such extraordinarily large discoveries for small economies is fundamentally different from that of typical discoveries that we studied in our theoretical model, as those discoveries can turn a country into a petro-state, in which the resource sector dominates the whole economy and the non-oil sector is very small. Second, econometrically, retaining these extreme values would introduce severe high-leverage outliers. Including them would force

[6] See more details in Appendix B in Arezki et al. (2017).

the regression coefficients to reflect the idiosyncratic trajectories of a few hyper-endowed economies rather than the average macroeconomic effect across the broader sample.

Consequently, to ensure our estimates are representative and not distorted by these extreme outliers, we trim the sample by excluding countries where the NPV exceeds 10 times their GDP (1000% of GDP, or roughly 6.91 in log terms). This restriction drops five small economies: Equatorial Guinea, Guyana, Mozambique, Timor-Leste, and Turkmenistan. Following this exclusion, the sample encompasses 74 countries that experienced at least one large discovery during this period. Within this refined sample, the median NPV stands at 5% of GDP (1.65 in log terms), with an interquartile range equal to 18.49% of GDP.

2.3 Macro variables

Our inflation data come from the Global Database of Inflation (GDI, Ha et al., 2023, April 2025 version). We also use implicit price deflators from the United Nations National Accounts Statistics (UNNAS) to construct price indices for the tradable and nontradable sectors. Other annual macroeconomic variables are obtained from the World Development Indicators (WDI); GDP, consumption, investment, exports, and imports are measured in constant local currency units, while the current account balance is expressed as a percentage of GDP.[7] Because the coverage and quality of these series improve markedly after 1980, we restrict the analysis to the period 1980–2019. Table 2 reports the definitions and sources of the main variables.

The Global Database of Inflation (GDI) provides harmonized inflation rate series for a large set of countries over a long time span. It includes several measures of inflation rate, including headline CPI rate, core CPI rate, food CPI rate, energy CPI rate, and PPI inflation rate. Our analysis focuses on annual core CPI inflation rather than headline CPI inflation as the headline inflation is strongly affected by fluctuations in food and energy prices, especially in developing economies where these items account for a larger share of household expenditure. We complement it with PPI inflation,

[7] To ensure our estimates are not driven by extreme observations, which often reflect measurement errors, currency rebasing anomalies, or severe idiosyncratic disruptions in the WDI panel, we winsorize the macroeconomic aggregates at the 1st and 99th percentiles. The specific adjustment depends on how the variable enters our analysis. Because the current account balance is expressed directly as a percentage of GDP, we simply winsorize this ratio. For the remaining aggregates (consumption, investment, exports, and imports), which are measured in constant local currency units, cross-country percentiles of levels are uninformative due to vast scale differences and exponential growth over time. Therefore, we identify outliers for these variables based on their shares of GDP, which provide a standardized, scale-free metric of structural plausibility. If a variable's GDP share falls outside the 1st and 99th percentiles, we calculate the proportional scaling factor required to bind the share at the threshold and apply this exact scaling factor to the variable's level. This approach corrects extreme anomalies while preserving the internal scaling and accounting consistency of the national accounts data. Nevertheless, our empirical regression results remain robust if we do not trim those macro variables.

which places greater weight on tradable and producer prices and is therefore useful for distinguishing consumer-price responses from producer-price responses.

We convert annual core CPI and PPI inflation rates into price indices. This transformation is convenient for our local-projection design, because it allows us to construct cumulative log price changes over different horizons, which are the dependent variables in the empirical specification. The price indices are constructed as follows.

We first address gaps in the inflation series. For countries with breaks in the data, we isolate a single continuous segment of observations.[8] This initial adjustment affects 10 countries for core CPI and 14 countries for PPI. We then exclude observations with annual inflation rates outside the range of -50 to 50 percent, in order to prevent episodes of hyperinflation, severe deflation, other extreme macroeconomic disruptions, or statistical adjustments from driving the estimates. Because removing these extreme values may create additional breaks in the series, we once again isolate a continuous segment for the affected countries, applying the exact same selection criteria.

For each country, we normalize the first year of the resulting continuous series to 100 and recursively construct linked price indices using the annual inflation rates.[9] Finally, we exclude countries with fewer than five consecutive annual observations for both core CPI and PPI, since such limited coverage is likely to reflect poor data quality and provides insufficient time-series variation for the empirical analysis. After these steps, the final sample contains continuous core CPI and PPI price indices for approximately 102 countries.

A primary limitation of the GDI is the absence of sector-specific price indices. To construct price indices for the tradable and nontradable sectors, we obtain sectoral value-added data at the one-digit ISIC Rev. 3 level—in both current and constant national currency units—from the UNNAS. Following Harding et al. (2020), we calculate the price index $p^S_{i,t}$ for sector S in country i at time t as the ratio of sectoral value-added in current prices to its value in constant prices. The sectors denoted by S comprise agriculture, construction, manufacturing, and services. In our baseline specification, we define the tradable and nontradable sectors as manufacturing and services, respectively. To ensure methodological consistency with our treatment of the aggregate CPI and PPI data, we compute the

[8] Typically, we default to retaining the most recent continuous segment, since recent observations are generally more reliable and more comparable across countries. However, if this latest segment contains fewer than five consecutive observations, we instead retain a longer continuous period from earlier in the sample. This adjustment ensures we maximize data retention and avoid unnecessarily dropping countries in the subsequent filtering step, which requires a minimum of five consecutive observations.

[9] We use country-specific base years because no single year has non-missing observations for all countries. This normalization does not affect our estimates: since the dependent variables are cumulative log differences in price indices, any base-year scale factor cancels out mechanically. Thus, the estimated impulse responses are invariant to the choice of base year.

implied annual inflation rates from these sectoral price indices and apply the same data cleaning procedures. Specifically, to prevent extreme macroeconomic volatility from skewing our estimates, we exclude observations where the implied sectoral inflation rate falls outside the -50% to 50% range. Because these exclusions can create gaps in the data, we apply the exact same criteria used for the CPI and PPI series: we isolate a single continuous segment—defaulting to the most recent period unless it contains fewer than five consecutive observations—thereby avoiding the introduction of artificial structural breaks. Notably, our results are robust to alternative sectoral classifications, such as grouping manufacturing and agriculture as tradable against services and construction as nontradable, or treating manufacturing as the sole tradable sector against the other three sectors combined as nontradable.

We further follow Harding et al. (2020) to construct the bilateral real exchange rate. First, we construct an aggregate price index, $p_{i,t}$, for each country by aggregating across the four aforementioned sectors. We then convert these aggregate indices into a common currency using the IMF's national currency-to-US dollar exchange rates. Finally, we use these converted indices to calculate the bilateral real exchange rate, $RER_{ij,t}$, between country i and country j at time t, defined as $RER_{ij,t} = p_{j,t}^{USD} / p_{i,t}^{USD}$, where $p_{i,t}^{USD}$ and $p_{j,t}^{USD}$ represent the respective aggregate price indices expressed in US dollars. Thus, a decrease in $RER_{ij,t}$ implies the appreciation of the country i's currency relative to country j. Table 3 presents the descriptive statistics for the key variables used in the analysis.

3 Empirical results

3.1 Benchmark results

We now present the benchmark empirical results characterizing the dynamic macroeconomic transmission of a large oil discovery. The figures below plot the cumulative impulse responses to an oil-discovery news shock with NPV equal to 1% of GDP, estimated via panel local projections. Throughout, the shaded regions denote 90 percent confidence bands computed using Driscoll and Kraay (1998) standard errors. Unless stated otherwise, we report magnitudes for a median-sized discovery, whose NPV equals 5 percent of GDP. Because the local projection is linear in the discovery shock, the impulse responses in Figures 2, 3, 4, 5, and 7—estimated for a shock normalized to 1 percent of GDP—are simply rescaled by a factor of 5.

Figure 2 documents a striking dichotomy in aggregate price dynamics following the discovery

announcement. The estimates reveal that the core Consumer Price Index (CPI) rises significantly and persistently, whereas the Producer Price Index (PPI) exhibits no statistically significant response at any horizon. It suggests that the inflationary pressures triggered by the news shock are not uniformly distributed across the economy, but are instead highly dependent on the compositional weighting of the respective price indices. Quantitatively, a median-sized discovery—with an NPV equal to 5 percent of initial GDP—generates a cumulative increase of approximately 1.13 percent in the core CPI over the subsequent decade.

To unpack this aggregate divergence, Figure 3 examines the underlying sectoral price indices. The results confirm that the inflationary pressure is overwhelmingly concentrated in the nontradable sector, where prices rise sharply in response to the news. In contrast, tradable prices remain broadly stable. This sectoral asymmetry reflects the mechanics of domestic market clearing following a positive wealth shock. The discovery announcement stimulates an immediate expansion in domestic absorption. While the increased demand for tradables is readily accommodated by an influx of imports, the demand boom for nontradables must clear through domestic price adjustments, forcing nontradable prices upward. Because the core CPI basket places a substantial weight on domestically consumed nontradable goods and services, it captures these demand-driven inflationary pressures. Conversely, the PPI is heavily weighted toward tradable goods, leaving it largely insulated from the domestic demand boom. Quantitatively, a median-sized discovery generates a cumulative increase of approximately 0.49 percent in the nontradable price index over the subsequent decade. [10]

Figure 4 traces the responses of real activity to oil-discovery news. The evidence further supports that oil discovery initially acts as a demand shock. Real GDP, consumption, and investment all rise well before newly discovered fields typically begin production, indicating that the discovery affects the economy before the realization of additional oil output.

The consumption response is consistent with permanent-income behavior. A discovery raises expected future national income at the time the news arrives, even though the associated revenues are realized only after a development lag. Forward-looking households therefore smooth part of the anticipated windfall into current spending. Consumption increases during the anticipation phase, before any additional oil is extracted.

Investment responds through a complementary mechanism. Firms anticipate higher future de-

[10] The magnitudes of the core CPI and nontradable price index responses should not be compared directly as the two indices come from different sources and differ in coverage and construction. The core CPI from the GDI is usually a survey-based retail price index, whereas the nontradable price index is a value-added deflator constructed from the UNNAS. Aggregate price changes in CPI and PPI from GDI are therefore not a weighted sum of sectoral price changes from UNNAS.

mand and higher returns to capital, both in the resource sector and in nontradable industries that serve the domestic market. With adjustment costs in capital accumulation, the desired expansion in capacity is optimally spread over time. Investment therefore rises in advance of production, as firms begin to adjust capital stocks when the discovery is announced.

The GDP response is positive and persistent. Output increases steadily after the discovery, peaks around eight to nine years later, and remains elevated through the end of the ten-year horizon. This sustained expansion, together with its timing before new oil fields become productive, is consistent with a news-shock interpretation: agents revise upward their expectations of future fundamentals, and this revision generates contemporaneous increases in domestic demand and real activity.

Quantitatively, for a median-sized discovery, the cumulative expansions in GDP, consumption, and investment at peaks are approximately 0.31 percent, 0.8 percent, and 0.37 percent, respectively. While these magnitudes are roughly 20 to 50 percent of those reported in Arezki et al. (2017)—likely reflecting differences in the threshold size of the discoveries examined—the overall intertemporal patterns remain highly consistent.

Figure 5 reports the external-sector responses to oil-discovery news. Exports do not respond significantly in the first few years after a discovery. The response becomes positive and statistically significant only around the fourth year, after which exports rise sharply and remain elevated over the medium run. This delayed adjustment is consistent with the long development lag of newly discovered oil fields: export capacity expands only once discoveries begin to translate into production and foreign sales.

Imports, by contrast, rise immediately after the discovery. This response is consistent with the demand and investment boom documented above: households increase consumption, while firms import capital goods and intermediate inputs in anticipation of higher future oil income. In the medium run, the import response weakens as domestic supply gradually expands.

The current account reflects the net effect of these trade dynamics. It initially deteriorates slightly, consistent with front-loaded consumption and investment during the anticipation phase. From around year four onward, however, the current account improves as the export response strengthens and begins to dominate the import response. Overall, the evidence suggests that oil-discovery news first raises domestic absorption and import demand, but subsequently improves exports and the current account as production capacity comes online. This dynamic pattern is consistent with the intertemporal approach to the current account (Obstfeld and Rogoff, 1995b): countries borrow more and save less when they expect high future output.

Figure 6 documents the response of the bilateral real exchange rate. Driven by the anticipated wealth effect and the ensuing demand boom, the real exchange rate appreciates persistently. Six years after a median-sized discovery, the bilateral real exchange rate appreciates by 0.82 percent [11], confirming the presence of an exchange-rate channel that operates in tandem with the domestic demand expansion. This result supports the asset-pricing perspective of the exchange rate, i.e., exchange rates behave like asset prices and exchange rate movements are more linked to expected changes in future fundamentals rather than current fundamental changes, for instance, Engel and West (2005) and Chen et al. (2010), among others.

Our finding of a real exchange rate appreciation following a positive news shock aligns closely with the existing studies. For example, Harding et al. (2020) establish that a giant resource discovery equivalent to 10% of GDP causes the bilateral real exchange rate to appreciate by roughly 1.5% over the subsequent ten years. Crucially, this appreciation begins immediately upon discovery, driven by an increase in the prices of non-tradable goods, well before actual production commences. This anticipation effect mirrors the dynamics documented by Nam and Wang (2015), who find that favorable news about future productivity induces a strong, immediate real exchange rate appreciation. In their estimates, this appreciation peaks at roughly 2.1% around four quarters after the shock and remains highly persistent, lasting for up to 16 quarters.

The real exchange rate appreciation following oil discoveries can be accommodated through two distinct nominal margins: nominal exchange rate appreciation and domestic price inflation. Figure 7 examines these margins by estimating inflation responses separately across two different exchange-rate regimes, using the classification in Ilzetzki et al. (2019). We aggregate their coarse regime codes into two groups: inflexible regimes, which include pegs and narrow bands of at most ± 2 percent (Codes 1 and 2), and flexible regimes, which include wider bands and floating arrangements (Codes 3 and 4).[12] This classification separates economies in which nominal exchange rate movements are tightly constrained from those in which the exchange rate can adjust more freely to macroeconomic shocks. In our sample, exchange rate regime data is available for 100 countries; after applying our grouping criteria, 60 countries are classified under inflexible regimes and 22 countries under flexible regimes. 18 countries are unclassified and thus not included in either group.

This distinction is central to the transmission of the anticipated resource boom. In a standard

[11] From Figure 6, $\beta^{(6)} = -0.168$, implying that the real exchange rate will appreciate by $0.0082 \approx 0.168 \times \ln(\frac{1+0.05}{1})$ in the subsequent six years following a median discovery.

[12] The exchange rate regime code for a given country may change over times during 1980-2019. Thus, we classify countries as inflexible (flexible) regime for the whole sample period if the country's regime code is 1 or 2 (3 or 4) for more than half of years during sample period.

open-economy framework, a large oil discovery raises the expected future income, which generates pressure for real appreciation. When the nominal exchange rate is constrained, this adjustment must occur through domestic prices; when the exchange rate is flexible, nominal appreciation can absorb part of the adjustment. Figure 7 shows that the data conform closely to this prediction.

Under inflexible exchange-rate regimes, shown in the left panels, the nominal exchange rate cannot appreciate sufficiently in response to the discovery news. The real appreciation is therefore achieved primarily through higher domestic prices. Both core CPI and nontradable prices rise significantly and persistently, indicating that domestic inflation is the main margin of adjustment when the nominal exchange rate is constrained.

By contrast, under flexible exchange-rate regimes, shown in the right panels, the nominal exchange rate can appreciate following the discovery. This forward-looking nominal adjustment absorbs much of the pressure generated by the anticipated resource boom. As a result, the cumulative responses of core CPI and nontradable prices are small and statistically indistinguishable from zero. These findings underscore the exchange-rate regime as a key determinant of how anticipated wealth shocks are transmitted into domestic inflation.

3.2 Robustness check

To assess the robustness of our baseline findings, we consider alternative sample constructions, variable definitions, and econometric specifications. For each check, the online Appendix A reports the impulse responses for related macro variables. In all cases, the estimated responses remain quantitatively similar to the baseline, confirming that our main conclusions are not driven by any single specification choice.

Alternative sample A potential concern is that unobserved, time-invariant structural differences between oil-endowed nations and countries that never discover oil might confound the estimates. To mitigate this, we limit our estimation sample exclusively to countries that experienced at least one large oil discovery during the 1980–2019 period. As depicted in Figure A.1, the impulse responses of key variables including aggregate and sectoral price indices, real activity, external adjustment, and real exchange rates remain similar to the baseline results. This confirms the generalizability of the transmission mechanism and ensures the findings are not artifacts of structural heterogeneity between discovering and non-discovering economies.

Alternative oil price in the construction of NPV. In the baseline, NPV of discoveries is constructed using the prevailing spot oil price at the time of discovery. However, short-term price volatility might distort the measured size of the news shock, as current prices may not perfectly reflect the expected future value of the extracted oil. To address this, we reconstruct the NPV using the average of global oil prices in the discovery year and the two preceding years.[13] Figure A.2 demonstrates that this alternative valuation yields nearly identical macroeconomic dynamics, indicating that our results are robust to the assumptions underlying the valuation of the resource windfall.

Alternative production lag used in the construction of NPV. The baseline analysis follows the established literature by assuming a standard five-year delay. However, the empirical median production lag in our dataset is approximately seven years. To ensure our temporal assumptions do not artificially drive the results, we reconstruct the discovery NPVs assuming a seven-year production lag to better fit the actual data. Figure A.3 demonstrates that the impulse responses of both nominal and real variables are virtually unchanged, indicating that the macroeconomic adjustments are not sensitive to minor variations in the assumed development horizon.

Alternative definitions of tradable and nontradable sectors. To verify that the observed sectoral inflation divergence is not strictly an artifact of our baseline classification (which defines manufacturing as tradable and services as nontradable), we adopt a broader definition. We redefine the tradable sector to encompass both manufacturing and agriculture, and the nontradable sector to combine services and construction. Figure A.4 illustrates the impulse responses under these alternative groupings. The fundamental dichotomy persists: the nontradable composite experiences significant inflationary pressure, whereas the tradable composite remains insulated.

Alternative dependent-variable definitions. In our baseline analysis, the dependent variables for prices are expressed as cumulative log changes in price indices. Alternatively, we re-estimate using annual inflation rates as the dependent variables. Figure A.5 displays the impulse responses of oil discovery news on the inflation rates. The core CPI inflation rate and nontradable inflation rate continue to exhibit significant positive responses, while the PPI inflation rate and tradable inflation rate show no significant reaction. This reaffirms the core inflationary findings across alternative definitions of the dependent variables.

[13] We obtain similar results when we exclude the discovery year and value discoveries at the average oil price in the three years before the discovery.

Controlling for exploration capex and U.S. monetary policy. To ensure our discovery shocks are not confounded by pre-existing domestic investments or global financial cycles, we augment our baseline specification with two additional controls. First, because extensive exploration activities could independently stimulate demand or make discoveries partially anticipated, we control for log exploration capital expenditure (capex) in the current and previous five periods. Second, while year fixed effects absorb uniform global shocks, countries' heterogeneous responses to global financial conditions could potentially bias the results. To account for this, we introduce an interaction term between the country's lagged capital account openness-to-GDP ratio (measured as total foreign assets and liabilities over GDP) and U.S. monetary policy shocks, measured by the federal funds rate. Figure A.6 demonstrates that simultaneously including these controls does not materially alter the estimated impulse responses, confirming that our baseline dynamics are robust to both pre-discovery investments and U.S. monetary policy spillovers.

Lag selection using BIC. The baseline specification uniformly incorporates five lags of the dependent and independent variables to capture macroeconomic persistence. To avoid arbitrary lag selection and ensure an optimal balance between model fit and parsimony, we utilize the Bayesian Information Criterion (BIC) to determine the optimal lag structure. Figure A.7 demonstrates that optimizing the lag length does not alter the fundamental macroeconomic dynamics.

Nickell bias correction in panel local projections. Recently Mei et al. (2026) has pointed out the presence of the Nickell bias in the panel fixed-effect estimator of the panel local projection due to inherent dynamic structures of the predictive specifications, even if the regressors have no lagged dependent variables. We therefore re-estimate the model using the Split-Panel Jackknife (SPJ) bias correction proposed by Mei et al. (2026), combined with the BIC-selected lag structure from the previous exercise. Figure A.8 shows that the resulting responses for key macro variables closely track the baseline estimates, confirming that our findings are not driven by dynamic panel estimation bias.

4 Model

In this section, we develop a three-sector New Keynesian model of a small open economy with oil, nontradables, and tradables. The model is designed to account for the dynamic responses documented in the previous section, including the effects of oil-discovery news on inflation, real activity, and the real exchange rate. Moreover, we use the model to illustrate the key channels through which

news about future resource income affects inflation. The framework is closely related to the small open economy environment of Galí and Monacelli (2005), and the oil sector builds on Arezki et al. (2017).

The home economy is populated by a representative household, a set of firms operating in three production sectors, and a monetary authority. The production side consists of an oil sector, a nontradable sector, and a home tradable sector. Oil is exported in full and sold at an exogenous world price. Nontradable and home tradable firms are monopolistically competitive and face Rotemberg price adjustment costs. Final tradable goods are produced by combining domestically produced tradables with imported foreign tradables, while households consume and invest in final expenditure baskets that aggregate tradable and nontradable goods. This structure allows the model to distinguish between inflationary pressures arising from domestic demand for nontradables and the disinflationary effects of exchange-rate appreciation on imported tradable inputs. For simplicity, we assume Foreign country only produces tradable good, and Home economy is small relative to Foreign, so Home exogenous shocks do not affect the foreign country's aggregate price level.

The central disturbance is an oil-discovery news shock at Home. Upon announcement, agents learn that the economy's productive oil reserves will increase in the future. Current oil production is unaffected, however, because newly discovered reserves become productive only after a time-to-build, or time-to-connect, delay. Specifically, a discovery announced in period t enters the stock of producing reserves only in period $t + j$. The shock therefore changes expectations about future oil output, export revenues, and national income before any additional oil is extracted. This timing distinction is essential: it allows the model to isolate the macroeconomic effects of anticipated future resource income from the contemporaneous supply effects of realized oil production.

4.1 Household

The household chooses consumption, labor supply, domestic and foreign bond holdings, and sector-specific investment. International financial markets are incomplete: the household can trade one-period domestic nominal bonds and one-period foreign-currency bonds, but not a complete set of state-contingent claims. Preferences are given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{L_t^{1+\gamma}}{1+\gamma} \right], \tag{4}$$

where C_t is aggregate consumption, L_t is aggregate hours worked, $\beta \in (0,1)$ is the subjective discount factor, $\sigma > 0$ is the coefficient of relative risk aversion, $\gamma > 0$ is the inverse Frisch elasticity, and $\chi > 0$ governs the disutility of labor. Labor is perfectly mobile across sectors and is allocated to the nontradable, tradable, and oil sectors:

$$L_t = L_{N,t} + L_{T,t} + L_{O,t}. \tag{5}$$

The household owns the sector-specific capital stocks $K_{h,t-1}$, $h \in \{N, T, O\}$, and rents them to firms at nominal rental rates $R_{h,t}$. Capital is predetermined at the beginning of period t and is sector-specific in the short run. This assumption captures the limited short-run mobility of installed capital across sectors, which means once capital has been installed in a given sector, it cannot be immediately reallocated to another sector. For example, capital used in oil extraction is not readily transformed into capital used in nontradable production. Sectoral rental rates may therefore differ in the short run. New capital is accumulated through sector-specific investment $I_{h,t}$. The household also receives nominal wages W_t, firm profits Φ_t, and returns on domestic and foreign bonds. Its period budget constraint is

$$\begin{aligned} P_{C,t}C_t + P_{I,t}\sum_{h\in\{N,T,O\}} I_{h,t} + B_t + \mathcal{E}_t B_t^* = W_t L_t + \sum_{h\in\{N,T,O\}} R_{h,t}K_{h,t-1} + \Phi_t \\ + (1+i_{t-1})B_{t-1} + (1+i_{t-1}^*)\mathcal{E}_t B_{t-1}^*, \end{aligned} \tag{6}$$

where B_t denotes one-period nominal domestic bond holdings, B_t^* denotes foreign-currency bond holdings, i_t is the domestic nominal interest rate, and i_t^* is the interest rate paid on foreign bonds. The nominal exchange rate $\mathcal{E}_t$ is expressed as units of domestic currency per unit of foreign currency, so that $\mathcal{E}_t B_t^*$ is the domestic-currency value of foreign bond holdings. The household's budget constraint therefore incorporates both the standard intertemporal saving decision and the choice between domestic and foreign bond holdings, as in canonical small open economy models with incomplete international asset markets.

The aggregate consumption good is a CES composite of final nontradable and final tradable goods:

$$C_t = \left[\omega_C^{1/\xi} C_{N,t}^{\frac{\xi-1}{\xi}} + (1-\omega_C)^{1/\xi} C_{T,t}^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}}, \tag{7}$$

where $\omega_C \in (0,1)$ is the weight on nontradables in consumption and $\xi > 0$ is the elasticity of substitution between tradables and nontradables. This aggregator allows the model to distinguish move-

ments in the CPI from movements in producer prices, since the CPI places direct weight on nontradable consumption goods while final tradable prices are disciplined in part by world prices and the exchange rate. The corresponding consumer price index is

$$P_{C,t} = \left[\omega_C P_{N,t}^{1-\xi} + (1-\omega_C) P_{T,t}^{1-\xi}\right]^{\frac{1}{1-\xi}}. \tag{8}$$

Cost minimization implies the sectoral consumption demands

$$C_{N,t} = \omega_C \left(\frac{P_{N,t}}{P_{C,t}}\right)^{-\xi} C_t, \qquad C_{T,t} = (1-\omega_C)\left(\frac{P_{T,t}}{P_{C,t}}\right)^{-\xi} C_t. \tag{9}$$

Thus, relative prices determine the composition of consumption expenditure, while $P_{C,t}$ is the unit price of the aggregate consumption bundle.

The household purchases an aggregate investment good, also produced from nontradable and final tradable goods, and allocates it across sector-specific capital stocks. The aggregate investment good is

$$I_t = \left[\omega_I^{1/\xi} J_{N,t}^{\frac{\xi-1}{\xi}} + (1-\omega_I)^{1/\xi} J_{T,t}^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}}, \tag{10}$$

where $\omega_I \in (0,1)$ is the nontradable share in investment. The investment price index is

$$P_{I,t} = \left[\omega_I P_{N,t}^{1-\xi} + (1-\omega_I) P_{T,t}^{1-\xi}\right]^{\frac{1}{1-\xi}}, \tag{11}$$

and the associated demands for two goods are

$$J_{N,t} = \omega_I \left(\frac{P_{N,t}}{P_{I,t}}\right)^{-\xi} I_t, \qquad J_{T,t} = (1-\omega_I)\left(\frac{P_{T,t}}{P_{I,t}}\right)^{-\xi} I_t. \tag{12}$$

Total investment is allocated across sectors according to

$$I_t = I_{N,t} + I_{T,t} + I_{O,t}. \tag{13}$$

Capital accumulation in each sector is subject to investment adjustment costs:

$$K_{h,t} = (1-\delta)K_{h,t-1} + I_{h,t}\left[1 - \frac{\psi_h}{2}\left(\frac{I_{h,t}}{I_{h,t-1}} - 1\right)^2\right], \qquad h \in \{N,T,O\}, \tag{14}$$

where δ is the depreciation rate and $\psi_h \geq 0$ controls the size of sector-specific investment adjustment costs. These costs are specified in terms of changes in the investment flow. They prevent unrealis-

tically sharp reallocations of investment across sectors in response to the oil discovery news shock. They also imply that the shadow value of installed capital can differ across sectors after a shock, even though households own all capital stocks.

Optimality conditions.[14] Let λ_t denote the multiplier on the household budget constraint after normalizing nominal revenues and expenditures by the consumption price index $P_{C,t}$. Equivalently, λ_t is the shadow value of one additional unit of resources measured in units of the consumption good. The first-order condition for consumption is

$$\lambda_t = C_t^{-\sigma}. \tag{15}$$

The intratemporal labor-supply condition is

$$\chi L_t^{\gamma} = \lambda_t \frac{W_t}{P_{C,t}}. \tag{16}$$

This condition determines aggregate hours worked as a function of the real wage and the marginal utility of consumption. Because labor is perfectly mobile across sectors, all sectors face the same nominal wage. Sectoral labor allocations are then determined by firms' labor demand conditions together with aggregate labor supply.

The Euler equation for domestic bonds is

$$1 = \beta(1 + i_t)\mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{P_{C,t}}{P_{C,t+1}} \right]. \tag{17}$$

This equation equates the utility cost of giving up one unit of current consumption to the expected discounted utility value of the nominal payoff next period, deflated by CPI inflation. It is the standard intertemporal optimality condition for a nominal risk-free asset.

The Euler equation for foreign bonds is

$$1 = \beta(1 + i_t^*)\mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \frac{P_{C,t}}{P_{C,t+1}} \right]. \tag{18}$$

Relative to the domestic bond Euler equation, the payoff on the foreign bond is adjusted by the change of nominal exchange rate, $\mathcal{E}_{t+1}/\mathcal{E}_t$. Combining the two Euler equations yields the usual uncovered-interest-parity condition. Later we will introduce the debt-elastic risk premium to ensure stationarity of the equilibrium of a small open economy, following Schmitt-Grohé and Uribe (2003).

[14] See the detailed derivation in Appendix B.1.

Let $Q_{h,t}$ denote the real shadow value of installed capital in sector h (the real Tobin's Q), measured in units of the consumption good. The asset-pricing equation for installed capital in sector h is

$$Q_{h,t} = \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left(\frac{R_{h,t+1}}{P_{C,t+1}} + (1-\delta) Q_{h,t+1} \right) \right]. \tag{19}$$

The current value of installed capital equals the expected discounted value of its future real rental income plus the continuation value of the undepreciated capital stock. Because capital is sector specific, $Q_{h,t}$ may vary across h, reflecting sector-specific expected returns and adjustment costs.

The optimal investment condition is

$$\begin{aligned} \frac{P_{I,t}}{P_{C,t}} = Q_{h,t} \left[1 - \frac{\psi_h}{2} \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right)^2 - \psi_h \frac{I_{h,t}}{I_{h,t-1}} \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right) \right] \\ + \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} Q_{h,t+1} \psi_h \left(\frac{I_{h,t+1}}{I_{h,t}} \right)^2 \left(\frac{I_{h,t+1}}{I_{h,t}} - 1 \right) \right], \qquad h \in \{N, T, O\}. \end{aligned} \tag{20}$$

The condition equates the relative price of investment to the shadow value of installed capital, adjusted for the marginal effect of current investment on adjustment costs today and tomorrow. At the steady state, the adjustment-cost terms vanish and $P_{I,t}/P_{C,t} = Q_{h,t}$. Away from steady state, adjustment costs dampen the response of sectoral investment and generate gradual capital accumulation.

Lastly, the household's choices are also subject to standard no-Ponzi and transversality conditions for domestic bonds, foreign bonds, and sectoral capital stocks.

4.2 Production

The production side of the economy consists of three sectors. The nontradable sector produces nontradable goods for domestic absorption. The home tradable sector produces differentiated tradable goods that are used both domestically and abroad. The oil sector produces a homogeneous export good that is sold on world markets at the exogenous foreign-currency oil price.

4.2.1 Nontradable sector

The nontradable sector consists of a competitive final-good producer and a continuum of monopolistically competitive firms indexed by $i \in [0,1]$ that supply differentiated varieties and face Rotemberg price adjustment costs. The final good producer combines these varieties into a compos-

ite nontradable good through the CES form:

$$Y_{N,t} = \left(\int_0^1 Y_{N,t}(i)^{\frac{\varepsilon_N - 1}{\varepsilon_N}} di \right)^{\frac{\varepsilon_N}{\varepsilon_N - 1}}, \tag{21}$$

where $\varepsilon_N > 1$ denotes the elasticity of substitution across nontradable varieties. Cost minimization implies the nontradable sectoral price index

$$P_{N,t} = \left(\int_0^1 P_{N,t}(i)^{1-\varepsilon_N} di \right)^{\frac{1}{1-\varepsilon_N}}, \tag{22}$$

and the demand for variety i is:

$$Y_{N,t}(i) = \left(\frac{P_{N,t}(i)}{P_{N,t}} \right)^{-\varepsilon_N} Y_{N,t}. \tag{23}$$

Each nontradable variety producer produces one differentiated variety through a Cobb–Douglas technology using labor and sector-specific capital:

$$Y_{N,t}(i) = A_{N,t} K_{N,t-1}(i)^{\alpha_N} L_{N,t}(i)^{1-\alpha_N}, \tag{24}$$

where $A_{N,t}$ is sectoral productivity and $\alpha_N \in (0,1)$ is the capital share.[15] Given factor prices, cost minimization implies a common real marginal cost across firms producing different varieties. Expressed in units of the final nontradable good, the real marginal cost is

$$MC_{N,t} = \frac{1}{A_{N,t}} \left(\frac{R_{N,t}/P_{N,t}}{\alpha_N} \right)^{\alpha_N} \left(\frac{W_t/P_{N,t}}{1-\alpha_N} \right)^{1-\alpha_N}. \tag{25}$$

This expression is the unit cost of producing one additional unit of the nontradable intermediate good, normalized by the nontradable price level.

In a symmetric equilibrium, all firms choose the same factor inputs, and set the same price and produce the same quantity. Aggregate nontradable output is therefore

$$Y_{N,t} = A_{N,t} K_{N,t-1}^{\alpha_N} L_{N,t}^{1-\alpha_N}. \tag{26}$$

[15] We slightly abuse the notation of $K_{N,t-1}(i)$ here as it is chosen by each variety producer at period t. However, in the symmetric equilibrium, all atomic firms rent the same amount of capital, equal to aggregate sector-specific capital stock $K_{N,t-1}$, which is predetermined by household in the end of period $t-1$.

The associated factor demand conditions are

$$W_t = (1-\alpha_N)\frac{P_{N,t}MC_{N,t}Y_{N,t}}{L_{N,t}}, \qquad R_{N,t} = \alpha_N \frac{P_{N,t}MC_{N,t}Y_{N,t}}{K_{N,t-1}}. \tag{27}$$

These equations equate factor prices to the corresponding marginal revenue products, taking into account that the marginal unit of output is valued at $P_{N,t}MC_{N,t}$.

Nontradable variety producers face nominal price rigidity in the form of quadratic Rotemberg adjustment costs (Rotemberg, 1982).[16] A firm that changes its price from $P_{N,t-1}(i)$ to $P_{N,t}(i)$ incurs the real resource cost in units of the final nontradable good:

$$\frac{\phi_N}{2}\left(\frac{P_{N,t}(i)}{P_{N,t-1}(i)} - 1\right)^2 Y_{N,t},$$

where $\phi_N \geq 0$ governs the degree of price rigidity.

The firm chooses its price sequence to maximize the expected discounted value of profits, taking its demand curve as given and discounting nominal payoffs using the household's stochastic discount factor. The derivation details are presented in Appendix B.2. In symmetric equilibrium, the first-order condition for optimal price setting yields the nonlinear Phillips curve

$$(\Pi_{N,t}-1)\Pi_{N,t} = \frac{\varepsilon_N}{\phi_N}\left(MC_{N,t} - \frac{\varepsilon_N - 1}{\varepsilon_N}\right) + \beta \mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{P_{C,t}}{P_{C,t+1}}\frac{P_{N,t+1}}{P_{N,t}}\frac{Y_{N,t+1}}{Y_{N,t}}(\Pi_{N,t+1}-1)\Pi_{N,t+1}\right], \tag{28}$$

where $\Pi_{N,t} = P_{N,t}/P_{N,t-1}$ denotes gross inflation in the nontradable sector.

Log-linearizing around a zero-inflation steady state gives the New Keynesian Phillips curve for the nontradable sector:

$$\pi_{N,t} = \beta E_t \pi_{N,t+1} + \kappa_N \widehat{MC}_{N,t}, \qquad \kappa_N \equiv \frac{\varepsilon_N - 1}{\phi_N}. \tag{29}$$

where $\pi_{N,t} \equiv \log \Pi_{N,t}$ is the log-deviation of nontradable inflation from steady state and $\widehat{MC}_{N,t}$ is the log-deviation of real marginal cost from its flexible-price level. This equation links current nontradable inflation to real marginal cost and expected future inflation. The slope of the Phillips curve, κ_N, is decreasing in the adjustment-cost parameter ϕ_N. Thus, greater nominal price rigidity implies a flatter Phillips curve and a more gradual response of nontradable inflation to movements

[16] We use Rotemberg pricing rather than Calvo pricing for tractability. In symmetric equilibrium, Rotemberg pricing does not generate price dispersion across firms, which avoids introducing price dispersion as an additional state variable. Around a zero-inflation steady state, the resulting Phillips curve is closely related to that obtained under Calvo pricing.

in real marginal cost.

Nominal profits in the nontradable sector are

$$\Phi_{N,t} = P_{N,t} Y_{N,t} \left[1 - MC_{N,t} - \frac{\phi_N}{2} (\Pi_{N,t} - 1)^2 \right]. \tag{30}$$

These profits are rebated lump-sum to households.

The nontradable goods market clears according to

$$Y_{N,t} = C_{N,t} + J_{N,t} + \frac{\phi_N}{2} (\Pi_{N,t} - 1)^2 Y_{N,t}. \tag{31}$$

Thus, the output of the final nontradable good is absorbed by nontradable consumption demand, nontradable investment demand, and the real resources used in price adjustment.

4.2.2 Tradable sector

The tradable sector has two layers. First, a competitive final-good producer combines a domestically produced tradable input with an imported foreign input. Second, the domestic tradable input is produced by monopolistically competitive firms that supply differentiated varieties and face Rotemberg price adjustment costs. Since the pricing and production problem of home tradable firms is isomorphic to that of nontradable firms, we present the main equilibrium conditions and emphasize the additional open-economy setting.

The final tradable good is a CES composite of home and foreign tradable inputs:

$$Y_{T,t} = \left[\omega_H^{1/\eta} (Y_{H,t}^{dom})^{\frac{\eta-1}{\eta}} + (1 - \omega_H)^{1/\eta} Y_{F,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \tag{32}$$

where $\omega_H \in (0, 1)$ measures home bias in the tradable bundle and $\eta > 0$ is the elasticity of substitution between home and foreign tradable goods. The corresponding price index is

$$P_{T,t} = \left[\omega_H P_{H,t}^{1-\eta} + (1 - \omega_H)(\mathcal{E}_t P_{F,t}^*)^{1-\eta} \right]^{\frac{1}{1-\eta}}, \tag{33}$$

where $P_{F,t}^*$ is the price of foreign tradable goods in foreign currency and $\mathcal{E}_t$ denotes the nominal exchange rate, measured in domestic currency per unit of foreign currency.

In our model, we define the producer price index as the final tradable price index $P_{T,t}$. This mapping reflects the construction of our PPI data. First, PPIs typically cover goods-producing, tradable sectors and exclude services (International Monetary Fund, 2004). Second, the Global Database

of Inflation explicitly notes that its PPI series covers both domestic and imported products (Ha et al., 2023). Moreover, producer prices are exposed to trade policy shocks such as tariff changes through pervasive imported inputs (Brandt et al., 2017; Flaaen and Pierce, 2026; Gilchrist et al., 2026). Thus, the empirical PPI corresponds naturally to the final tradable price index in our model, which combines home-produced and imported tradable inputs. This mapping also captures the two features relevant to our analysis: producer prices are dominated by tradable goods, and they respond to exchange-rate movements through the imported-input channel.

The demand for the home and foreign inputs is

$$Y_{H,t}^{dom} = \omega_H \left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\eta} Y_{T,t}, \qquad M_t \equiv Y_{F,t} = (1-\omega_H)\left(\frac{\mathcal{E}_t P_{F,t}^*}{P_{T,t}}\right)^{-\eta} Y_{T,t}. \tag{34}$$

Thus, an appreciation of domestic currency (a decline in $\mathcal{E}_t$) shifts domestic tradable demand toward imports, and reduces the overall tradable sector price level $P_{T,t}$.

The market structure of home tradable firms is the same as the nontradable sector. First, the home tradable input is itself a CES aggregate of differentiated varieties:

$$Y_{H,t} = \left(\int_0^1 Y_{H,t}(i)^{\frac{\varepsilon_H - 1}{\varepsilon_H}} di\right)^{\frac{\varepsilon_H}{\varepsilon_H - 1}}, \tag{35}$$

with associated price index

$$P_{H,t} = \left(\int_0^1 P_{H,t}(i)^{1-\varepsilon_H} di\right)^{\frac{1}{1-\varepsilon_H}}, \tag{36}$$

where $\varepsilon_H > 1$. The demand for variety i is

$$Y_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\varepsilon_H} Y_{H,t}. \tag{37}$$

There is a continuum of monopolistically competitive firms that supply differentiated varieties and face quadratic Rotemberg price adjustment costs, by hiring labor and renting sector-specific capital. In a symmetric equilibrium, aggregate home tradable production is

$$Y_{H,t} = A_{T,t} K_{T,t-1}^{\alpha_T} L_{T,t}^{1-\alpha_T}. \tag{38}$$

Real marginal cost, expressed in units of the home tradable good, is

$$MC_{H,t} = \frac{1}{A_{T,t}} \left(\frac{R_{T,t}/P_{H,t}}{\alpha_T}\right)^{\alpha_T} \left(\frac{W_t/P_{H,t}}{1-\alpha_T}\right)^{1-\alpha_T}. \tag{39}$$

The associated factor demand conditions are

$$W_t = (1-\alpha_T)\frac{P_{H,t}MC_{H,t}Y_{H,t}}{L_{T,t}}, \qquad R_{T,t} = \alpha_T\frac{P_{H,t}MC_{H,t}Y_{H,t}}{K_{T,t-1}}. \tag{40}$$

As in the nontradable sector, home tradable producers set prices subject to Rotemberg adjustment costs with the quadratic parameter ϕ_T, which allows us to capture different price rigidities across sectors. The derivation details are presented in Appendix B.2. In symmetric equilibrium, optimal price setting implies

$$(\Pi_{H,t}-1)\Pi_{H,t} = \frac{\varepsilon_H}{\phi_T}\left(MC_{H,t} - \frac{\varepsilon_H - 1}{\varepsilon_H}\right) + \beta\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{P_{C,t}}{P_{C,t+1}}\frac{P_{H,t+1}}{P_{H,t}}\frac{Y_{H,t+1}}{Y_{H,t}}(\Pi_{H,t+1}-1)\Pi_{H,t+1}\right], \tag{41}$$

where $\Pi_{H,t} = P_{H,t}/P_{H,t-1}$ denotes the gross inflation of home tradable inputs. This equation is the home tradable counterpart of the nontradable Phillips curve. The key difference is that demand for home tradables depends not only on domestic absorption but also on import substitution and foreign export demand.

Similarly, we can obtain the log-linearized Phillips curve for home-produced tradable goods:

$$\pi_{H,t} = \beta E_t\pi_{H,t+1} + \kappa_H\widehat{MC}_{H,t}, \qquad \kappa_H \equiv \frac{\varepsilon_H - 1}{\phi_T}. \tag{42}$$

Note that in the calibration exercise, we set $\phi_N > \phi_T$ to capture the reality that the price rigidity in nontradable sector is typically higher than tradable sector.

Nominal profits in the home tradable sector are

$$\Phi_{H,t} = P_{H,t}Y_{H,t}\left[1 - MC_{H,t} - \frac{\phi_T}{2}(\Pi_{H,t}-1)^2\right]. \tag{43}$$

The home tradable goods market clears according to

$$Y_{H,t} = Y_{H,t}^{dom} + X_{H,t} + \frac{\phi_T}{2}(\Pi_{H,t}-1)^2Y_{H,t}, \tag{44}$$

where $X_{H,t}$ denotes exports of home tradables, which will be explained later. Hence, home tradable input production is absorbed by domestic use in the final tradable good, foreign demand, and Rotemberg adjustment costs.

4.2.3 Oil sector

The oil sector is modeled as an extractive sector in which current production depends not only on variable factor inputs, but also on the stock of producing reserves that has already been connected to extraction capacity. The production function is given by:

$$Y_{O,t} = A_{O,t} K_{O,t-1}^{\alpha_k} L_{O,t}^{\alpha_L} Res_{t-1}^{1-\alpha_k-\alpha_L}, \tag{45}$$

where $A_{O,t}$ is oil-sector productivity, $K_{O,t-1}$ is the stock of oil-sector capital predetermined at the end of the period $t-1$, $L_{O,t}$ is labor employed in oil production, and Res_{t-1} is the stock of producing reserves. The parameters satisfy $\alpha_k > 0$, $\alpha_L > 0$, and $\alpha_k + \alpha_L < 1$. The final restriction implies that producing reserves are an essential factor in extraction. A larger stock of producing reserves raises the productivity of capital and labor, capturing the idea that oil fields with greater available reserves are easier and less costly to operate.

The stock of producing reserves evolves according to

$$Res_t = Res_{t-1} + \varsigma - Y_{O,t} + \varepsilon_{t-j}^{Res}. \tag{46}$$

The constant term ς denotes an exogenous constant reserve inflow, which ensures that the economy admits a non-degenerate steady state with positive oil production and a positive stock of producing reserves. Current extraction $Y_{O,t}$ depletes the stock of producing reserves one-for-one. The term ε_{t-j}^{Res} denotes the oil discovery news shocks, and the time lag captures the time-to-connect nature of oil discoveries: news about an oil discovery arrives at period $t-j$, but the associated reserves become productive only at period t. Thus, the discovery affects agents' expectations and forward-looking decisions immediately upon announcement, while actual oil production capacity expands only after a delay of j periods.

Oil is fully exported and sold at the world price. The domestic-currency oil price is therefore

$$P_{O,t} = \mathcal{E}_t P_{O,t}^*, \tag{47}$$

where $P_{O,t}^*$ is the world oil price in foreign currency and $\mathcal{E}_t$ is the nominal exchange rate, expressed as units of domestic currency per unit of foreign currency. Since the home economy is small in world oil markets, $P_{O,t}^*$ is taken as exogenous.

The oil producer hires labor, rents the sector-specific capital from the households, and utilizes

the reserve stock to maximize the expected present value of profits, taking as given the oil price and the stochastic discount factor of the household and subject to the production technology and reserve accumulation constraint. The details of the oil producer's dynamic extraction problem are provided in Appendix B.3. Below we discuss the main intuitions and key results.

The oil producer is forward-looking because current extraction reduces the stock of reserves available for future production. Let ζ_t denote the nominal shadow value of one additional unit of producing reserves, i.e., the multiplier on the reserves law of motion. Equivalently, ζ_t is the scarcity value of leaving one unit of oil in the ground. The producer internalizes this opportunity cost when choosing current inputs. As a result, the effective price relevant for current production is not the spot price $P_{O,t}$, but the net price $P_{O,t} - \zeta_t$. Optimal labor and capital demand satisfy

$$W_t = \alpha_L \frac{(P_{O,t} - \zeta_t) Y_{O,t}}{L_{O,t}}, \qquad R_{O,t} = \alpha_k \frac{(P_{O,t} - \zeta_t) Y_{O,t}}{K_{O,t-1}}. \tag{48}$$

These conditions equate factor prices to the corresponding marginal revenue products, evaluated at the net-of-depletion price. They differ from static factor demand conditions because an additional unit of output today lowers tomorrow's reserve stock. When the shadow value of reserves is high, the net price $P_{O,t} - \zeta_t$ is low, and the producer has an incentive to restrain current extraction.

The shadow value of reserves satisfies the intertemporal condition

$$\zeta_t = \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{P_{C,t}}{P_{C,t+1}} \left\{ (P_{O,t+1} - \zeta_{t+1})(1 - \alpha_k - \alpha_L) \frac{Y_{O,t+1}}{Res_t} + \zeta_{t+1} \right\} \right]. \tag{49}$$

The stochastic discount factor is inherited from the household because oil firms are owned by households. Equation (49) states that the value of one unit of reserves today equals its expected discounted value tomorrow. This equation is the model's Hotelling-type condition, modified to allow reserves to enter production directly as a productive state variable.

Oil-sector profits are defined as revenues net of payments to labor and rented capital:

$$\Phi_{O,t} = P_{O,t} Y_{O,t} - W_t L_{O,t} - R_{O,t} K_{O,t-1}. \tag{50}$$

Using the optimal factor demand conditions, these profits can also be interpreted as the sum of an

operating surplus and a scarcity-rent component. In particular, substituting (48) into (50) gives

$$\begin{aligned}\Phi_{O,t} &= P_{O,t}Y_{O,t} - \alpha_L(P_{O,t} - \zeta_t)Y_{O,t} - \alpha_k(P_{O,t} - \zeta_t)Y_{O,t} \\ &= \left[(1 - \alpha_k - \alpha_L)P_{O,t} + (\alpha_k + \alpha_L)\zeta_t\right] Y_{O,t}. \end{aligned} \tag{51}$$

Equivalently,

$$\Phi_{O,t} = (1 - \alpha_k - \alpha_L)(P_{O,t} - \zeta_t)Y_{O,t} + \zeta_t Y_{O,t}. \tag{52}$$

Thus, oil-sector dividends reflect both the current operating surplus from extraction and the scarcity value associated with ownership of the reserve stock. These profits are rebated lump-sum to households. Total profits received by households are

$$\Phi_t = \Phi_{N,t} + \Phi_{H,t} + \Phi_{O,t}. \tag{53}$$

4.3 Aggregate output and external account

Aggregate output. Aggregate real GDP is measured as value added across the three sectors, evaluated at steady-state relative prices:

$$Y_t = \frac{\bar{P}_N Y_{N,t} + \bar{P}_H Y_{H,t} + \bar{\mathcal{E}}\bar{P}^*_O Y_{O,t}}{\bar{P}_C}. \tag{54}$$

This definition holds relative prices fixed at their steady-state values, isolating movements in real quantities from valuation effects driven by changes in the terms of trade or the real exchange rate.

External account. The open-economy block links the domestic production structure to the rest of the world. The home economy exports both home-produced tradable goods and oil, and imports foreign tradable inputs used in the production of the domestic final tradable composite. Foreign prices and foreign demand are taken as exogenous, consistent with the small open economy assumption.

Foreign demand for the home tradable good is downward sloping:

$$X_{H,t} = \left(\frac{P_{H,t}}{\mathcal{E}_t P^*_{T,t}}\right)^{-\eta^*} Y^*_t, \tag{55}$$

where $P^*_{T,t}$ is the foreign tradable price index, Y^*_t is an exogenous foreign demand shifter, and $\eta^* > 0$ is the price elasticity of foreign demand. The relevant price is the price of the home tradable good relative to the foreign tradable price, both expressed in the same currency. An appreciation of the

domestic currency, i.e., a decrease in $\mathcal{E}_t$, reduces the exports of the home tradable good, all else equal.

Oil exports equal oil production:

$$X_{O,t} = Y_{O,t}. \tag{56}$$

This assumption reflects the focus of the model on oil-exporting economies in which oil is sold on world markets and is not used as an intermediate input by domestic firms.

Import demand for foreign tradable input is given by equation (34), reproduced here for convenience: $M_t = (1-\omega_H)\left(\frac{\mathcal{E}_t P^*_{F,t}}{P_{T,t}}\right)^{-\eta} Y_{T,t}$. Imports rise with aggregate tradable absorption, $Y_{T,t}$, and fall with the relative price of imported inputs. Since the domestic-currency price of imports is $\mathcal{E}_t P^*_{F,t}$, an appreciation lowers this relative price and therefore raises import volumes, other things equal.

The nominal trade balance is

$$TB_t = P_{H,t}X_{H,t} + P_{O,t}Y_{O,t} - \mathcal{E}_t P^*_{F,t} M_t. \tag{57}$$

The first two terms denote non-oil and oil export revenues, respectively, while the last term is import expenditure. Net foreign assets evolve according to

$$\mathcal{E}_t B^*_t = (1 + i^*_{t-1})\mathcal{E}_t B^*_{t-1} + TB_t. \tag{58}$$

Hence, the current account, defined as the change in the domestic-currency value of net foreign assets, is

$$CA_t \equiv \mathcal{E}_t B^*_t - \mathcal{E}_t B^*_{t-1} = i^*_{t-1}\mathcal{E}_t B^*_{t-1} + TB_t. \tag{59}$$

These identities discipline the model's external adjustment. The impact of oil discovery news on the current account is consistent with the classic intertemporal approach to the current account, i.e., the current account reflects forward-looking saving and investment decisions in response to anticipated changes in future income (Obstfeld and Rogoff, 1995b). An oil-discovery news shock raises the present value of national income before oil revenues are realized. Households and firms therefore increase consumption and investment on impact, raising imports, while the associated appreciation may reduce non-oil exports. Since oil exports do not yet rise, the trade balance and the current account can deteriorate initially despite higher lifetime wealth.

Once the new reserves become productive, oil export revenues increase, improving trade balance and rebuilding net foreign assets. The model therefore delivers the current-account dynamics emphasized by Arezki et al. (2017): oil-discovery news can generate a short-run current-account

deficit before the associated resource revenues materialize.

4.4 Monetary Policy and Uncovered Interest Parity

To close the model, we specify the monetary policy rule and the conditions that determine the nominal exchange rate. Together, the Taylor rule, the uncovered interest parity (UIP) condition, and the debt-elastic risk premium form a three-equation system that jointly determines the domestic nominal interest rate i_t, the effective foreign interest rate i_t^*, and the nominal exchange rate $\mathcal{E}_t$. In the next subsection, we characterize the forward-looking nature of the nominal exchange rate and the role of exchange-rate flexibility ϕ_e, and we derive the response of the real exchange rate, which is the object examined in the empirical analysis of Section 3.

Monetary policy. The central bank follows a generalized Taylor-type rule with interest-rate smoothing (Bergin, 2006; Itskhoki and Mukhin, 2025). It adjusts the nominal interest rate in response to CPI inflation, aggregate output, and nominal exchange-rate depreciation:

$$\frac{1+i_t}{1+\bar{i}} = \left(\frac{1+i_{t-1}}{1+\bar{i}}\right)^{\rho_i} \left[\left(\frac{\Pi_{C,t}}{\bar{\Pi}_C}\right)^{\phi_\pi} \left(\frac{Y_t}{\bar{Y}}\right)^{\phi_y} \left(\frac{\mathcal{E}_t}{\mathcal{E}_{t-1}}\right)^{\phi_e}\right]^{1-\rho_i}, \tag{60}$$

where $\Pi_{C,t} = \frac{P_{C,t}}{P_{C,t-1}}$ denotes CPI inflation, $\rho_i \in [0,1)$ governs interest-rate smoothing, $\phi_\pi > 1$ ensures an active response to inflation, and $\phi_y, \phi_e \geq 0$ are the output and exchange-rate depreciation response coefficients. The variables with bars are steady-state values.

The rule responds to exchange rate changes rather than to the levels because this formulation captures a crawl-like policy in which the central bank resists exchange-rate movements without committing to a fixed parity, consistent with the fear-of-floating evidence that managed regimes stabilize the rate of change of the exchange rate rather than its level (Itskhoki and Mukhin, 2025). The coefficient ϕ_e governs the degree of exchange-rate flexibility. A higher value of ϕ_e means the central bank responds more aggressively to exchange-rate movements, corresponding to a tightly managed or inflexible exchange-rate regime. Conversely, a lower value of ϕ_e allows the exchange rate to adjust more freely, corresponding to a more flexible regime. This parameter is central to the paper's analysis of how the inflationary effects of oil-discovery news depend on the exchange-rate regime.

Exchange rate determination. The nominal exchange rate is determined by the uncovered interest parity (UIP) condition. Equating the household's Euler equations for domestic bonds (17) and foreign bonds (18) and dropping the covariance between exchange-rate changes and the household's

stochastic discount factor, which is of second order and vanishes in the log-linear approximation, yields

$$1 + i_t = (1 + i_t^*)\, \mathbb{E}_t \left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right]. \tag{61}$$

This condition states that the expected returns on domestic and foreign bonds must be equal in equilibrium. To ensure that the equilibrium dynamics of net foreign assets are stationary, following Schmitt-Grohé and Uribe (2003) we allow the effective foreign interest rate faced by domestic residents to depend on the economy's net foreign asset position:

$$1 + i_t^* = (1 + i_t^w)\, \exp\left[-\chi_B \left(\frac{\mathcal{E}_t B_t^*}{P_{C,t} Y_t} - \bar{b} \right) \right], \tag{62}$$

where i_t^w is the exogenous world interest rate, $\chi_B > 0$ controls the sensitivity of the borrowing rate to the external position, and $\bar{b} \equiv \bar{\mathcal{E}} \bar{B}^* / (\bar{P}_C \bar{Y})$ is the steady-state net foreign asset position relative to output. When net foreign assets fall below their steady-state level, the effective foreign rate rises above the world rate, making borrowing more expensive and encouraging a return to the steady state. Combining equations (61) and (62), we have the risk premium term in the traditional UIP condition:

$$1 + i_t = (1 + i_t^w)\, \mathbb{E}_t \left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right] \exp\left[-\chi_B \left(\frac{\mathcal{E}_t B_t^*}{P_{C,t} Y_t} - \bar{b} \right) \right], \tag{63}$$

To save space, the equilibrium conditions including the first-order conditions and market-clearing conditions are listed in Appendix B.4.

4.5 Exchange Rate Dynamics

Having laid out the model, we now log-linearize several key equations to develop intuition for the impact of an oil-discovery news shock on the exchange rate. Throughout this section, variables topped with a hat, such as $\hat{X}_t$, denote log-deviations from the deterministic steady state, defined as $\hat{X}_t \equiv \log(X_t / \bar{X})$, except for interest rates, which are defined as $\hat{i}_t \equiv \log[(1 + i_t)/(1 + \bar{i})]$, and similarly for i_t^* and i_t^w.

Log-linearizing the generalized Taylor rule in equation (60) and the risk-adjusted UIP condition in equation (63) around the steady state, after some algebra, yields the forward-looking difference equation for the nominal exchange rate stated in the following lemma.

Lemma 1 (Forward-looking nominal exchange rate)**.** *Let $\hat{\mathcal{E}}_t$ denote the log-deviation of the nominal exchange rate from its steady state, and define $\Gamma \equiv 1 + \chi_B \bar{b} + (1 - \rho_i)\phi_e$, where $\bar{b} \equiv \bar{\mathcal{E}} \bar{B}^* / (\bar{P}_C \bar{Y})$ is the steady-state net foreign asset position relative to output. The equilibrium nominal exchange rate satisfies the*

forward-looking difference equation

$$\hat{\mathcal{E}}_t = \frac{1}{\Gamma}\Big\{\mathbb{E}_t[\hat{\mathcal{E}}_{t+1}] + \underbrace{\hat{i}^w_t - \rho_i \hat{i}_{t-1} - (1-\rho_i)\big[\phi_\pi \pi_{C,t} + \phi_y \hat{Y}_t\big] + (1-\rho_i)\phi_e \hat{\mathcal{E}}_{t-1} + \chi_B \bar{b}\big(\hat{P}_{C,t} + \hat{Y}_t - \hat{B}^*_t\big)}_{=:\, D_t}\Big\}, \tag{64}$$

Lemma 1 makes explicit that the nominal exchange rate is a forward-looking asset price: the current exchange rate loads with weight $1/\Gamma$ on its expected future value and on the driving variables D_t, rather than on current fundamentals alone. Iterating (64) forward, the exchange rate equals a present value of the entire expected future path of the driving variables, geometrically discounted by $1/\Gamma$, as shown in Appendix B.5.1.[17] The signs of the underlying effects are standard. An increase in the world interest rate $\hat{i}^w_{t+k}$ depreciates the home currency, as capital flows out toward higher foreign yields. An increase in CPI inflation $\pi_{C,t+k}$ or output $\hat{Y}_{t+k}$ appreciates the home currency, because both trigger monetary policy tightening through the Taylor rule; higher output also lowers the risk premium by raising GDP in the denominator of the net foreign asset ratio. An increase in net foreign assets $\hat{B}^*_{t+k}$ appreciates the currency by lowering the risk premium and making domestic bonds relatively more attractive.

This forward-looking structure is central for understanding the effects of oil-discovery news. An oil discovery changes the expected future path of the driving variables even though current oil production is unchanged: agents anticipate stronger domestic demand and thus higher future inflation and output, and they anticipate an improvement in the external position once oil exports begin. Because the exchange rate loads on the entire expected future path of these fundamentals, it appreciates on impact—at the time of the announcement—well before the newly discovered oil enters production.

The coefficient ϕ_e plays a central role in shaping the exchange-rate response to news, through both the discount factor $\Gamma = 1 + \chi_B \bar{b} + (1-\rho_i)\phi_e$ and the persistence term $(1-\rho_i)\phi_e \hat{\mathcal{E}}_{t-1}$ embedded in D_t. A higher ϕ_e—corresponding to a more tightly managed or inflexible exchange-rate regime—raises Γ, thereby reducing the weight the exchange rate places on expected future fundamentals and anchoring it more firmly to its past level. Conversely, a lower ϕ_e—corresponding to a more flexible regime—implies a smaller Γ, so the exchange rate responds more aggressively to news about future inflation, output, and the external position. This mechanism is essential for understanding why oil-discovery news shocks are more inflationary under inflexible exchange-rate regimes: when ϕ_e is large, the exchange rate appreciates less on impact, so the disinflationary import-price channel is

[17] In our calibration, $\chi_B = 0.0001$ and $\bar{b}$ is small, so $\chi_B \bar{b}$ is close to zero, and with $\phi_e > 0$, we have $\Gamma > 1$.

weaker and the domestic demand channel dominates.

Next, we turn to the real exchange rate. We define the real exchange rate as

$$e_t = \frac{\mathcal{E}_t P^*_{F,t}}{P_{C,t}}, \tag{65}$$

where a decline in e_t denotes a real appreciation. We have the following proposition:

Proposition 2 (Real exchange rate decomposition). *Let $\hat{e}_t$ denote the log-deviation of the real exchange rate from its steady state. Assuming $\hat{P}^*_{F,t} = 0$, the real exchange rate can be decomposed as*

$$\hat{e}_t = -s_C \hat{p}_t^{N/T} - s_H \hat{p}_t^{H/F}, \tag{66}$$

where s_C is the steady-state expenditure share of nontradables in consumption, s_H is the steady-state expenditure share of home-produced goods in the tradable bundle, $\hat{p}_t^{N/T} \equiv \hat{P}_{N,t} - \hat{P}_{T,t}$ is the internal relative price of nontradables, and $\hat{p}_t^{H/F} \equiv \hat{P}_{H,t} - \hat{\mathcal{E}}_t$ is the relative price of home tradables against the foreign tradable good.

The functional forms of s_C and s_H, together with the derivation, are provided in Appendix B.5.2.

Proposition 2 shows that the real exchange rate moves through two channels. The first is the internal relative-price channel: a rise in the relative price of nontradables, $P_{N,t}/P_{T,t}$, appreciates the real exchange rate with elasticity s_C. The second is the home-tradable price channel: an increase in the price of home-produced tradables relative to the foreign tradable input, $P_{H,t}/(\mathcal{E}_t P^*_{F,t})$, appreciates the real exchange rate with elasticity s_H.

Following an oil-discovery news shock, both channels contribute to a real appreciation. The anticipated future resource windfall raises domestic absorption and increases demand for nontradable goods, driving up $\hat{p}_t^{N/T}$. At the same time, stronger domestic demand and tighter factor markets raise home tradable marginal costs and therefore $\hat{P}_{H,t}$, while the nominal exchange rate appreciates on impact through the forward-looking mechanism in Lemma 1, raising $\hat{p}_t^{H/F}$. Both forces push $\hat{e}_t$ downward, generating a real appreciation following the oil discovery news shock that is consistent with the empirical response of the bilateral real exchange rate documented in Section 3.

The decomposition also clarifies how the exchange-rate regime shapes the real appreciation, and thus the inflationary consequences of the news. Under a flexible regime, the appreciation operates primarily through the nominal exchange rate: the currency appreciates on impact, which raises $\hat{p}_t^{H/F}$ and lowers the domestic-currency price of imported goods, dampening tradable inflation. Under an inflexible regime, nominal appreciation is limited by the high value of ϕ_e, so the real appreciation is achieved instead through the internal relative-price channel: the demand boom raises nontradable

prices, increasing $\hat{p}_t^{N/T}$ and therefore CPI inflation. Hence, the same real appreciation has very different inflationary consequences across regimes—it operates through nominal adjustment with muted inflation under flexibility, but through higher nontradable inflation under an inflexible regime.

4.6 Aggregate Inflation Decomposition

Now we turn to the key question of the model: how oil discovery news shocks affect aggregated inflation dynamics? Note that the model distinguishes among several price indexes because oil-discovery news moves sectoral relative prices through different channels. Log-linearizing the CPI price index (8) around the steady state gives

$$\pi_{C,t} = s_C \pi_{N,t} + (1 - s_C)\pi_{T,t}, \tag{67}$$

where s_C denotes the steady-state expenditure share of nontradable goods in the consumption basket, $\pi_{N,t} \equiv \log(P_{N,t}/P_{N,t-1})$ is nontradable inflation, and $\pi_{T,t} \equiv \log(P_{T,t}/P_{T,t-1})$ is inflation in the final tradable composite.

The distinction between the final tradable price $P_{T,t}$ and the price of home-produced tradable goods $P_{H,t}$ is important. The final tradable composite includes both domestically produced tradable goods and imported goods, whereas $P_{H,t}$ refers only to home-produced tradable varieties. Log-linearizing the tradable price index (33) yields

$$\pi_{T,t} = s_H \pi_{H,t} + (1 - s_H)\left(\Delta\epsilon_t + \pi^*_{F,t}\right), \tag{68}$$

where s_H is the steady-state share of home-produced goods in the tradable bundle, $\pi_{H,t} \equiv \log(P_{H,t}/P_{H,t-1})$ denotes inflation in home-produced tradable goods, and $\Delta\epsilon_t \equiv \log \mathcal{E}_t - \log \mathcal{E}_{t-1}$ denotes nominal exchange-rate depreciation. Imported goods are priced in foreign currency at $P^*_{F,t}$, so their domestic-currency inflation rate is $\Delta\epsilon_t + \pi^*_{F,t}$. Assuming that foreign-currency import prices are constant, $\pi^*_{F,t} = 0$, equation (68) simplifies to

$$\pi_{T,t} = s_H \pi_{H,t} + (1 - s_H)\Delta\epsilon_t. \tag{69}$$

The following proposition summarizes the CPI inflation decomposition.

Proposition 3 (CPI inflation decomposition)**.** *Assume that foreign-currency import prices are constant,*

$\pi^*_{F,t} = 0$. *CPI inflation can be decomposed as*

$$\pi_{C,t} = s_C \pi_{N,t} + (1 - s_C) \left[s_H \pi_{H,t} + (1 - s_H) \Delta \epsilon_t \right], \tag{70}$$

where s_C is the steady-state expenditure share of nontradables in the consumption basket and s_H is the steady-state expenditure share of home-produced goods in the tradable bundle. Thus, CPI inflation can be decomposed into three components: nontradable inflation, inflation in home-produced tradable goods, and domestic-currency import-price inflation. Substituting the sectoral New Keynesian Phillips curves (29) and (42) yields

$$\pi_{C,t} = s_C \left(\beta E_t \pi_{N,t+1} + \kappa_N \widehat{MC}_{N,t} \right) + (1 - s_C) \left[s_H \left(\beta E_t \pi_{H,t+1} + \kappa_H \widehat{MC}_{H,t} \right) + (1 - s_H) \Delta \epsilon_t \right]. \tag{71}$$

Transmission of oil discovery news shocks. Equation (71) decomposes CPI inflation into two opposing channels. The first is a domestic demand channel that is inflationary. News of a future oil windfall generates a positive wealth effect. Households increase consumption and firms increase investment before the newly discovered reserves become productive. The resulting increase in domestic absorption raises demand for nontradable goods, which must be produced domestically. Higher nontradable demand increases labor demand and raises real marginal cost $\widehat{MC}_{N,t}$. Through the nontradable Phillips curve, this raises nontradable inflation $\pi_{N,t}$, which feeds into CPI inflation with weight s_C. Stronger domestic absorption and tighter factor markets may also raise marginal cost in the home tradable sector, $\widehat{MC}_{H,t}$, creating additional upward pressure on home-produced tradable inflation $\pi_{H,t}$.

The second is a disinflationary exchange-rate channel. As discussed in Lemma 1, we show that the nominal exchange rate tends to appreciate following oil discoveries, implying $\Delta \epsilon_t < 0$. This reduces the domestic-currency price of imported goods and dampens inflation in the final tradable composite $\pi_{T,t}$. Because tradable goods enter the CPI with weight $1 - s_C$, the exchange-rate channel offsets part of the inflationary pressure generated by stronger domestic demand.

Whether CPI inflation rises or falls on net depends on the relative strength of these two channels. CPI inflation is more likely to rise when the nontradable share s_C is large and monetary policy limits the nominal exchange-rate appreciation, thereby weakening the disinflationary import-price channel. It also responds more strongly when κ_N and κ_H are larger: these coefficients fall as price-adjustment costs rise, so greater price flexibility lets sectoral firms pass increases in marginal costs through to prices more rapidly, amplifying the domestic-demand channel.

Equation (71) also highlights the role of inflation expectations. The terms $E_t \pi_{N,t+1}$ and $E_t \pi_{H,t+1}$

imply that current inflation depends on expected future inflation in each sector. Oil-discovery news raises expected future nontradable inflation because agents anticipate sustained demand pressure on the nontradable sector. Through the forward-looking NKPC, these higher inflation expectations feed directly into current nontradable price-setting, amplifying the demand channel even before current marginal costs fully adjust. The inflationary effect of news shocks thus operates not only through current cost pressures but also through the expectations-driven propagation built into the Phillips curve.

Equation (69) and (70) also explains the divergent CPI and PPI responses. In the model, PPI corresponds to tradable inflation $\pi_{T,t}$. The oil discovery raises home tradable marginal cost $\widehat{MC}_{H,t}$, putting upward pressure on $\pi_{H,t}$, but the associated appreciation ($\Delta\epsilon_t < 0$) lowers import prices and dampens $\pi_{T,t}$. Because PPI excludes the nontradable component, it is less exposed to the inflationary demand channel and more exposed to the disinflationary exchange-rate channel. The model thus generates a positive CPI response alongside a muted PPI response following oil discovery news shocks.

Last, we discuss the role of exchange rate regime in shaping the inflation responses to oil discoveries. Recall that the coefficient ϕ_e in the Taylor rule (60) governs the degree of exchange-rate flexibility: a higher ϕ_e corresponds to a more tightly managed, or inflexible, exchange-rate regime, whereas a lower ϕ_e corresponds to a more flexible regime. The following proposition characterizes how this coefficient shapes the inflation response to oil-discovery news.

Proposition 4 (Exchange-rate flexibility and the inflation response)**.** *Consider the log-linearized equilibrium and an oil-discovery news shock. A higher exchange rate response coefficient ϕ_e in the Taylor rule* (60) *dampens the appreciation of the nominal exchange rate and raises the response of CPI inflation.*

As discussed in Lemma 1, a larger ϕ_e indicates tighter management of the nominal exchange rate: the impact appreciation is dampened, weakening the disinflationary $\Delta\epsilon_t$ term in equation (71). To resist the appreciation, the central bank must lower the nominal interest rate even as inflation and output rise, which further stimulates domestic demand and raises nontradable inflation through the Phillips curve. Both forces push CPI inflation upward, so the same oil-discovery news shock is more inflationary when ϕ_e is larger, consistent with the significantly larger CPI responses under inflexible exchange-rate regimes documented in Section 3.

Conversely, when ϕ_e is low, the central bank is under a flexible exchange-rate regime. The currency appreciates sharply on impact, amplifying the disinflationary $\Delta\epsilon_t$ term in equation (71). The central bank, primarily targeting inflation rather than the exchange rate, raises the nominal interest

rate in response to the demand-driven rise in inflation and output, which further supports the appreciation through uncovered interest parity. The exchange-rate channel therefore offsets a larger share of the demand-driven pressure, so CPI inflation responds only weakly to the same oil-discovery news shock, consistent with the small and statistically insignificant responses under flexible exchange-rate regimes documented in Section 3.

5 Calibration and simulation

Next, we calibrate the model to simulate the dynamic effects of oil-discovery news shocks on inflation and other macro variables. The calibration does not aim to match the empirical cumulative responses in Section 3 quantitatively, as the underlying model parameters may vary substantially across countries. We instead take parameters from the literature and ask whether the model reproduces the empirical patterns qualitatively.

The oil discovery shock is normalized so that the present discounted value of the future increase in oil production equals one percent of initial GDP. The defining feature of the experiment is that agents receive the news before oil production rises. In the benchmark calibration, newly discovered oil becomes part of producing reserves after $j = 5$ years, matching the production lag assumed in the empirical NPV construction.

5.1 Calibration

The model is calibrated at annual frequency. Parameter values are chosen from standard small open economy DSGE models, from the oil-discovery framework of Arezki et al. (2017), and from steady-state targets. Table 4 reports the benchmark calibration.

Most preference and technology parameters are standard. The discount factor is set to $\beta = 0.943$, implying a 6 percent annual steady-state real interest rate, which is relatively high as our sample covers many developing economies with relatively high returns to capital. The exogenous world interest rate i_t^w is calibrated to an annualized rate of six percent, sharing the same steady-state value as the domestic interest rate $\bar{i} = 1/\beta - 1$. Preferences are logarithmic in consumption, $\sigma = 1$. The inverse Frisch elasticity is set to $\gamma = 1$, and the labor disutility parameter is calibrated to $\chi = 5.78$ so that steady-state labor supply is $\bar{L} = 1/3$.

The annual depreciation rate is $\delta = 0.10$. The capital share is $\alpha_T = 0.40$ in the home tradable sector and $\alpha_N = 0.33$ in the nontradable sector. The oil-sector production parameters follow Arezki

et al. (2017): the capital share is $\alpha_k = 0.49$, the labor share is $\alpha_L = 0.13$, and the remaining share, $1 - \alpha_k - \alpha_L = 0.38$, is assigned to producing reserves. The steady-state reserve inflow is set to $\varsigma = 0.03$, which helps match an oil-output-to-GDP ratio of six percent.

The expenditure shares and elasticities govern our mechanism. Nontradables account for 70 percent of both consumption and investment ($\omega_C = \omega_I = 0.70$). Home goods account for 60 percent of the tradable bundle ($\omega_H = 0.60$); the 40 percent import share gives exchange-rate appreciation substantial scope to dampen tradable inflation. The open economy block features imperfect substitution between domestic and foreign goods. The elasticity between tradables and nontradables is $\xi = 0.44$, as in Stockman and Tesar (1995); the home-foreign tradable elasticity η and the foreign demand elasticity η^* are both 1.5. Foreign prices and the world oil price are normalized to one: $P_F^* = P_T^* = P_O^* = 1$. The foreign demand shifter is set to $Y^* = 0.044$, which helps match a steady-state trade-balance-to-GDP ratio of four percent. The steady-state nominal exchange rate is normalized to $\bar{\mathcal{E}} = 1$.

Nominal rigidities are asymmetric, and the asymmetry matters. Nontradable price adjustment is costlier than tradable ($\phi_N = 10$ versus $\phi_T = 5$), consistent with evidence that services prices are stickier than goods prices. The elasticity of substitution across varieties is set to $\varepsilon_N = \varepsilon_H = 6$, implying a steady-state markup of 1.2 in both sectors. The investment adjustment cost parameter is $\psi_h = 1.4$ for each sector, which prevents implausibly sharp reallocation of investment across sectors after the news.

For the Taylor rule, the interest-rate smoothing parameter is $\rho_i = 0.8^4$, the annual counterpart of the quarterly value 0.8 estimated by Smets and Wouters (2007). The responses to CPI inflation and output are $\phi_\pi = 1.50$ and $\phi_y = 0.125$, as in Schmitt-Grohé and Uribe (2022). For the exchange-rate response coefficient, Itskhoki and Mukhin (2025) set $\phi_e = 0$ under a fully floating exchange-rate regime and $\phi_e = 5$ under a pegged regime in their small open economy New Keynesian model (online appendix, Table A4). Their rule responds to the deviation of the exchange rate from its steady-state level, whereas our rule responds to exchange-rate movements and therefore admits greater exchange-rate volatility; we accordingly treat $\phi_e = 5$ as an upper bound. Because our empirical panel pools countries under different exchange-rate regimes, the benchmark calibration uses an intermediate $\phi_e = 2.4$. To characterize the role of exchange-rate flexibility, we compare a high value of $\phi_e = 4$, corresponding to an inflexible regime, against a low value of $\phi_e = 0.5$, corresponding to a flexible regime. Finally, the debt-elastic premium $\chi_B = 0.0001$ follows Schmitt-Grohé and Uribe (2003) and serves only to pin down a stationary net foreign asset position.

5.2 Simulation results

To be consistent with the empirical impulse responses, the simulated responses are cumulative and correspond to a single normalized oil-discovery news shock.

5.2.1 Inflation and Real Exchange Rate

Proposition 3 predicts that oil-discovery news raises CPI inflation through nontradable inflation, while the exchange-rate channel damps tradable inflation. Figure 8 confirms this prediction. Panel (a) shows the cumulative CPI response: the model generates a positive response on impact, the cumulative increase rises during the first two to three years after the announcement, and afterward the price level starts to gradually decline as domestic supply catches up. The increase is driven by the nontradable sector: panel (c) shows nontradable inflation rising sharply after the news shock, while panel (d) shows tradable inflation nearly flat throughout the simulation horizon. Panel (b) shows the cumulative impulse response of the real exchange rate, suggesting persistent appreciation, which partially offsets the inflation pressure.

The mechanism is the demand channel described in Proposition 3. The news shock raises expected lifetime wealth and stimulates domestic absorption before oil production begins. Since nontradable goods must be produced domestically and their supply is constrained by installed capital and nominal rigidities, the increase in demand pushes up nontradable marginal costs and nontradable prices through the nontradable Phillips curve (29).

Tradable inflation remains muted for two reasons, both visible in equation (69). First, the tradable price index $P_{T,t}$ is a composite of the price of domestically produced tradable goods $P_{H,t}$ and the domestic-currency price of imported foreign goods $\mathcal{E}_t P^*_{F,t}$. Even though stronger domestic demand puts some upward pressure on home tradable prices, this pressure is largely offset by the decline in the import price of foreign inputs as the home currency appreciates. Second, the weight of home-produced goods in the tradable composite, s_H, is less than one, so the pass-through of home tradable marginal cost increases to final tradable prices is incomplete.

The appreciation of the real exchange rate in Panel (b) follows Lemma 1 and Proposition 2. The anticipated future resource windfall raises demand for nontradables, driving up the relative price of nontradables, $\hat{p}_t^{N/T}$, while stronger demand and the nominal exchange rate appreciation raise the relative price of home tradable inputs to foreign tradable input, driving up $\hat{p}_t^{H/F}$. Both channels push the real exchange rate downward—an appreciation, given the convention in equation (65).

The simulated aggregate and sectoral price responses reproduce the empirical patterns in Fig-

ures 2 and 3: nontradable prices rise while tradable prices stay flat, and CPI rises while PPI—which corresponds to the tradable price index $P_{T,t}$ in the model—does not respond. The model thus rationalizes why the inflationary effect of oil discovery news is concentrated in consumer prices, which place substantial weight on nontradables, rather than in producer prices, which are dominated by tradable goods.

5.2.2 Real activity and trade flows

Panels (a)–(c) of Figure 9 report output, consumption, and investment, all of which increase following the oil discovery news shock. Consumption rises immediately on impact because households anticipate higher future income from oil production and exports. Investment also expands, reflecting both the wealth effect and the incentive to accumulate capital in anticipation of stronger future production. Output rises gradually during the anticipation phase and accelerates once the newly discovered oil becomes productive at $t = 5$. Because activity expands before oil production begins, oil-discovery news operates like an aggregate demand shock.

Panels (d)–(f) of Figure 9 report the cumulative responses of exports, imports, and the current account-to-GDP ratio. These patterns are largely consistent with the empirical responses in Figure 5. In the short run, imports increase because the news shock raises expected lifetime wealth and stimulates domestic absorption before oil exports expand, and the real appreciation makes foreign goods relatively cheaper. By contrast, non-oil exports decline slightly at first. This decline reflects a Dutch disease mechanism: the real appreciation raises the relative price of domestically produced tradable goods in foreign markets, weakening the competitiveness of the home tradable sector. As a result, the current account deteriorates before oil production begins.

However, once the new reserves become productive, oil output and export revenues increase. Total exports then rise sharply, and the current account turns positive, consistent with the data. The model thus captures the intertemporal pattern of the current account emphasized by Arezki et al. (2017): oil discoveries initially worsen the current account because the economy borrows more and saves less before production from the new fields begins, but the external position improves once oil exports commence.

5.2.3 Exchange-rate regime and inflation

Proposition 4 predicts that a higher ϕ_e damps the impact appreciation of the nominal exchange rate and raises the CPI inflation response. Figure 10 tests this prediction by comparing an inflexible

exchange rate regime with a high $\phi_e = 4$ against a flexible regime with a low $\phi_e = 0.5$. The results confirm the prediction: the cumulative CPI response is substantially larger under the inflexible regime and remains positive throughout the simulation horizon. When monetary policy places a larger weight on exchange-rate stabilization, nominal exchange-rate adjustment is limited, and the central bank leans against the appreciation rather than responding fully to the rise in inflation and output. The economy therefore cannot absorb the oil-discovery news shock through nominal appreciation and lower imported goods prices. The wealth effect instead translates more directly into stronger domestic absorption and higher demand for nontradable goods, pushing up nontradable prices and aggregate CPI inflation. By contrast, under the flexible exchange-rate regime, the nominal exchange rate adjusts freely and appreciates on impact. The resulting decline in the domestic-currency price of imported goods dampens tradable inflation and offsets part of the increase in nontradable inflation, so the aggregate CPI response is weaker and eventually turns slightly negative.

This simulated ordering reproduces the empirical split documented in the regime analysis: the response of core CPI is significantly larger under inflexible exchange-rate regimes and small and statistically insignificant under flexible regimes (Figure 7).

Moreover, Figure 10 also presents the cumulative CPI responses to an oil-discovery news shock under two additional calibrations of inflexible exchange-rate regimes, with $\phi_e = 3$ and $\phi_e = 5$. A higher value of ϕ_e corresponds to a more tightly managed nominal exchange rate. The figure shows that the qualitative pattern of the CPI response is similar across $\phi_e \in \{3, 4, 5\}$. However, the magnitude of the response increases with ϕ_e: cumulative CPI inflation becomes larger and more persistent as the exchange rate is managed more tightly. Intuitively, stronger intervention limits nominal appreciation and weakens the disinflationary import-price channel, allowing demand-driven pressures in the nontradable sector to play a larger role in aggregate consumer prices. This sensitivity exercise therefore reinforces the paper's main mechanism: exchange-rate management amplifies the inflationary effects of oil-discovery news.

5.2.4 Summary

In summary, our calibrated model reproduces the main qualitative patterns of the empirical impulse responses, although our model abstracts from many additional frictions or institutional features, such as sticky wages, financial frictions, information frictions, and fiscal policies. Oil-discovery news shocks raise CPI inflation through the domestic demand channel operating on the nontradable sector, while tradable and PPI inflation remain muted because exchange-rate appreciation offsets the

increase in home tradable costs. Real activity expands during the anticipation phase, and the current account follows an intertemporal path of initial deterioration followed by improvement once oil production begins. The inflationary effect is amplified under less flexible exchange-rate regimes, consistent with the empirical evidence.

6 Conclusion

Whether news shocks are inflationary is a central question not only for canonical New Keynesian models but also for central banks seeking to formulate appropriate monetary policy. This paper shows that news about future output can be inflationary in open economies. Large oil discoveries with at least five-year production lag provide a useful setting because they reveal information about higher future output while leaving current productive capacity essentially unchanged.

The evidence indicates that oil-discovery news sets in motion a broad macroeconomic adjustment before new oil is produced. Domestic absorption rises, the current account initially weakens, and the real exchange rate appreciates on impact. The price response, however, is highly uneven across sectors and exchange-rate regimes. Consumer prices rise because nontradable prices increase, whereas producer prices and tradable prices respond little. Moreover, the inflationary effect is concentrated in economies with inflexible exchange-rate regimes, where nominal appreciation is limited and the required real appreciation is instead achieved through higher domestic prices.

These findings contribute to the literature on news shocks by emphasizing that the inflationary consequences of news depend on both the nature of the news and the openness of the economy. In closed-economy settings, news about future productivity is often disinflationary because it signals lower future marginal costs. By contrast, oil-discovery news raises expected wealth without expanding current supply, generating an immediate increase in demand. In an open economy, the exchange rate then determines how this pressure is allocated between nominal appreciation and domestic inflation. For policymakers in resource-rich economies, the exchange-rate regime is therefore not a background feature but a central determinant of how anticipated resource windfalls pass through to consumer inflation.

Finally, the canonical shock analyzed in the news-driven business cycle literature is a shock to future aggregate TFP. Oil-discovery news differs from TFP news along two margins. The first is the nature of the shock: productivity news raises future supply and lowers expected future marginal costs, whereas an oil discovery raises expected future income without expanding current supply, so its inflationary impulse operates through demand. The second is that oil-discovery news is a

sectoral shock. It announces higher future output in a specific, export-oriented resource sector rather than an economy-wide productivity gain, and the resulting wealth effect falls disproportionately on nontradable goods, whose supply cannot be expanded through imports and whose prices are sticky. The implication for the TFP-news literature is that the inflation response to news is not a property of news per se, but depends on what the news is about and on the sectoral and open-economy structure through which expectations reach prices.

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Table 1: The Spatial and Temporal Distribution of Large Discoveries (1980-2019)

	Decade				
Regions	1980s	1990s	2000s	2010s	Total
Africa	41	60	69	81	251
Asia	67	81	58	56	262
Europe	45	20	10	12	87
Middle East	71	46	58	56	231
North America	25	14	20	19	78
Oceania	9	11	22	15	57
Russia	110	32	43	32	217
South America	19	10	37	60	126
World	**387**	**274**	**317**	**331**	**1,309**

Notes: This table aggregates the number of large oil and gas discoveries by regions and decade. The data covers the period from 1980 to 2019. Regions are classified by Rystad. One country can have multiple large discoveries for a given year.

Table 2: Data Definition and Sources

Variable	Definition	Source
Core CPI	Core consumer price index (first year in data = 100)	Global database of inflation (2025)
PPI	Producer price index (first year in data = 100)	Global database of inflation (2025)
Tradable price	Price index in tradable sector (2015 = 100), local currency unit	UN Stats (2025)
Nontradable price	Price index in nontradable sector (2015 = 100), local currency unit	UN Stats (2025)
Real GDP	GDP in constant prices, local currency unit	World Bank (2025)
Real final consumption	Final consumption expenditure in constant local currency unit	World Bank (2025)
Real gross capital formation	Gross capital formation in constant local currency unit	World Bank (2025)
Real import	Import in constant local currency unit	World Bank (2025)
Real export	Export in constant local currency unit	World Bank (2025)
Current account/GDP	—	World Bank (2025)

Table 3: Summary Statistics of Macro Variables

Variable	Countries	Obs.	Mean	Std. Dev.	Min	Max
Log core CPI	89	2,029	526.930	57.606	452.453	744.481
Log PPI	92	2,181	534.313	77.335	387.324	912.921
Log tradable price	97	3,099	580.432	108.011	362.897	1182.689
Log nontradable price	97	3,022	555.327	96.428	403.913	1037.169
Log real GDP	101	3,772	2778.752	308.249	2111.892	3723.383
Log real final consumption	96	3,451	2468.717	192.547	1966.330	3049.034
Log real gross capital formation	99	3,542	2345.136	203.595	1613.249	2945.173
Log real import	96	3,470	2383.324	184.702	1853.932	2877.243
Log real export	98	3,540	2372.994	199.438	1344.919	2860.770
Current account/GDP	96	3,216	-1.784	7.302	-32.096	25.758
Log real exchange rate	88	181,204	0.043	0.506	-10.660	11.513

Notes: The sample covers the period from 1980 to 2019. As detailed in Table 2, all real variables are expressed in constant local currency units, with the exception of the real exchange rate. Variables prefixed with Log are constructed by taking the natural logarithm of the original series and multiplying by 100; however, the logarithmic transformation of the real exchange rate is not scaled by 100 due to different specification. Finally, the current account-to-GDP ratio is not log-transformed and is expressed directly as a percentage.

Table 4: Baseline Calibration

Parameter	Value	Description	Source / Rationale
Preferences			
β	0.943	Subjective discount factor	Arezki et al. (2017)
σ	1	Relative risk aversion	Log utility
γ	1	Inverse Frisch elasticity	Arezki et al. (2017)
χ	5.78	Labor disutility scale	Match $\bar{L} = 1/3$
Technology and production			
δ	0.10	Annual depreciation rate	Arezki et al. (2017)
α_T	0.40	Capital share in home tradables	Benchmark calibration
α_N	0.33	Capital share in nontradables	Benchmark calibration
α_L	0.13	Labor share in oil production	Arezki et al. (2017)
α_k	0.49	Capital share in oil production	Arezki et al. (2017)
ς	0.03	Steady-state reserve inflow	Match $\bar{Y}_O/\bar{Y} = 0.06$
Open economy and trade			
ω_H	0.60	Home share in tradable bundle	Galí and Monacelli (2005)
ω_C	0.70	Nontradable share in consumption	Benchmark calibration
ω_I	0.70	Nontradable share in investment	Benchmark calibration
ξ	0.44	Elasticity between tradables and nontradables	Stockman and Tesar (1995)
η	1.50	Elasticity between home and foreign tradables	Schmitt-Grohé and Uribe (2022)
η^*	1.50	Foreign demand elasticity	Benchmark calibration
P_F^*	1	Foreign input price	Normalization
P_T^*	1	Foreign tradable price index	Normalization
P_O^*	1	World oil price	Normalization
i_t^w	0.06	World interest rate	Normalization
Y^*	0.044	Foreign demand shifter	Match $\overline{TB}/\bar{Y} = 0.04$
$\bar{\mathcal{E}}$	1	Steady-state exchange rate	Normalization
χ_B	0.0001	Debt-elastic premium	Schmitt-Grohé and Uribe (2003)
Nominal and investment rigidities			
ϕ_N	10	Nontradable price adjustment cost	Moderate price stickiness
ϕ_T	5	Home tradable price adjustment cost	Moderate price stickiness
ψ_h	1.4	Investment adjustment cost	Christiano et al. (2005)
$\varepsilon_N, \varepsilon_H$	6	Elasticity across differentiated varieties	Markup of 1.2
Monetary policy			
ρ_i	0.8^4	Interest-rate smoothing	Smets and Wouters (2007)
ϕ_π	1.50	Inflation response	Schmitt-Grohé and Uribe (2022)
ϕ_y	0.125	Output response	Schmitt-Grohé and Uribe (2022)
ϕ_e	2.4	Exchange-rate response	Itskhoki and Mukhin (2025)

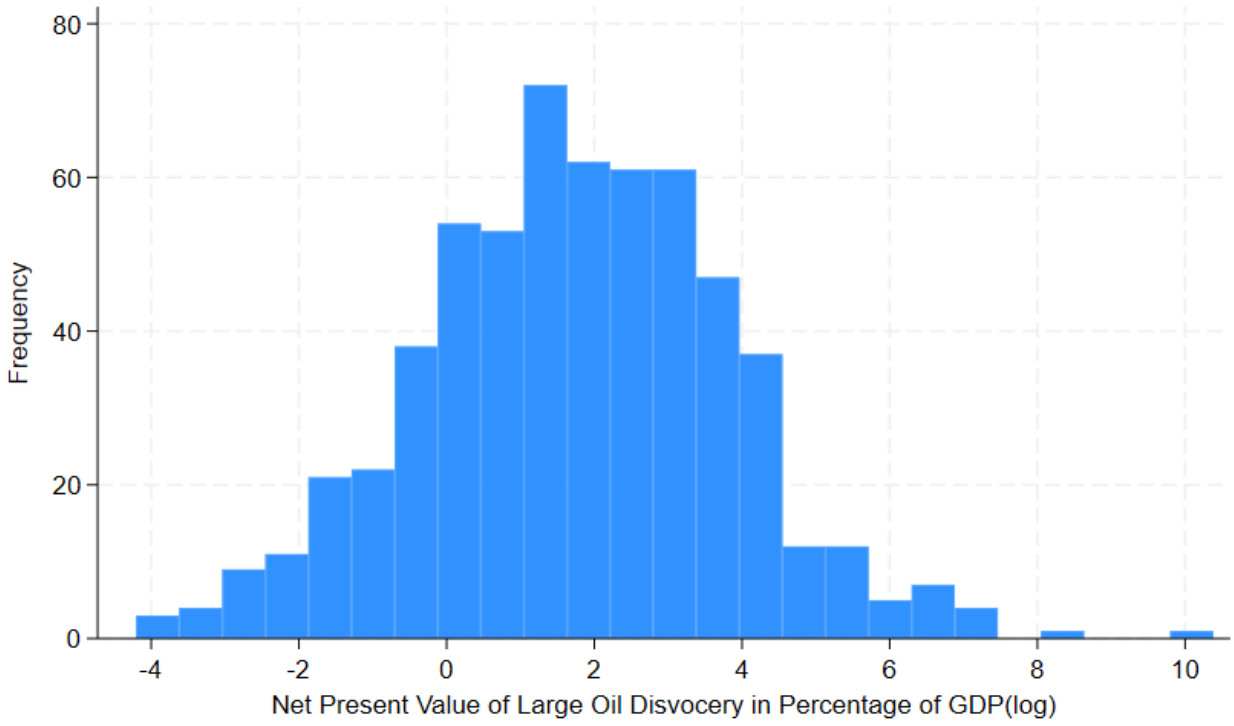
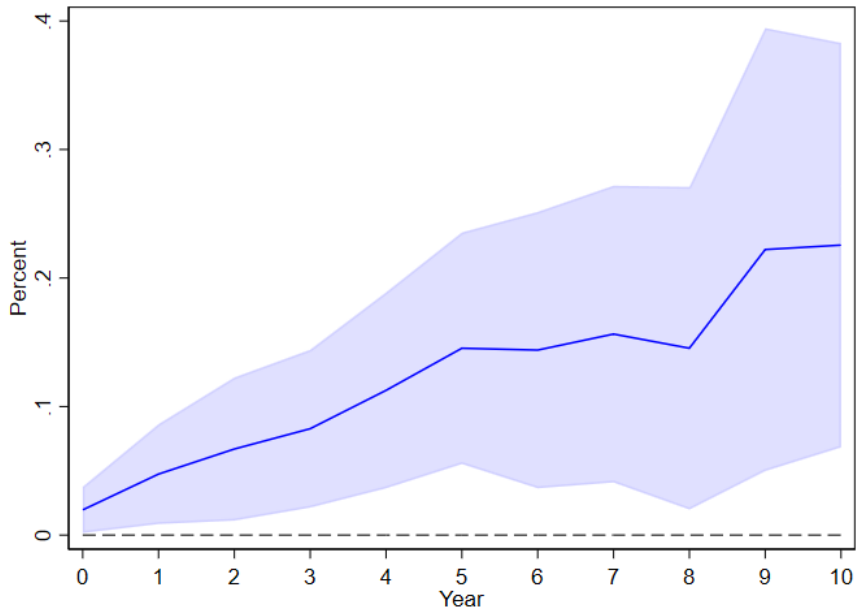
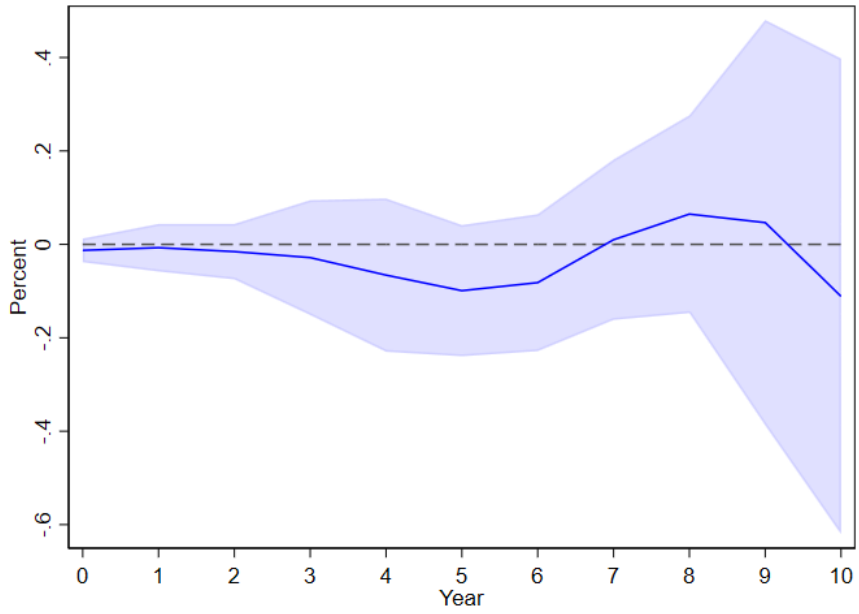


Figure 1: The Distribution of Net Present Value of Large Oil Discoveries: 1980-2019

Notes: The figure presents the distribution of the logarithm of the net present value of large oil discoveries in Table 1. While the large discoveries in Table 1 are at the field level, the NPVs of those large discoveries are aggregated to the country-year level as shown in equation (3).



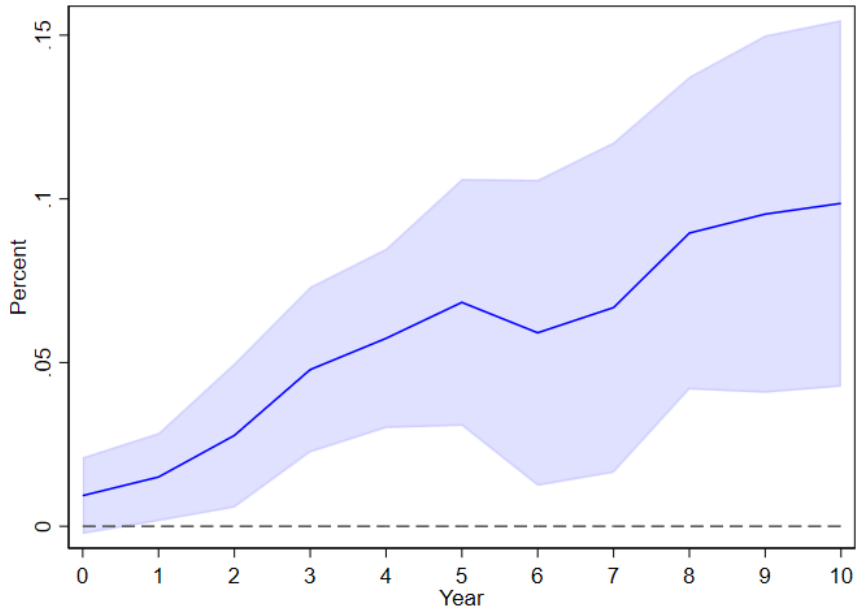
(a) Core CPI



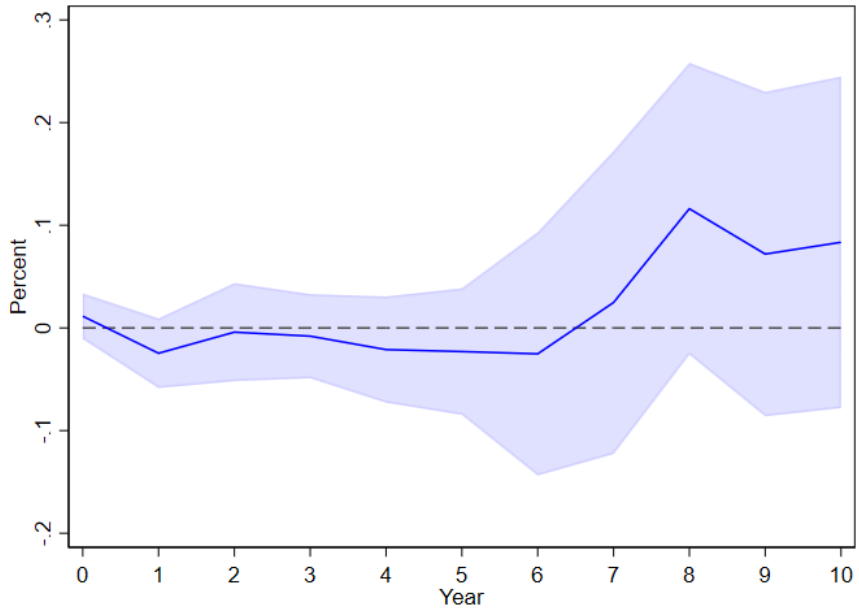
(b) PPI

Figure 2: The Impact of Large Oil Discoveries on Core CPI and PPI price index

Notes: The figure presents the cumulative impulse response for Core CPI, and PPI following large oil discoveries with NPV equal to 1% of GDP. The line indicates point estimates, and shaded areas represent 90% confidence intervals. The vertical axis shows percentage change.



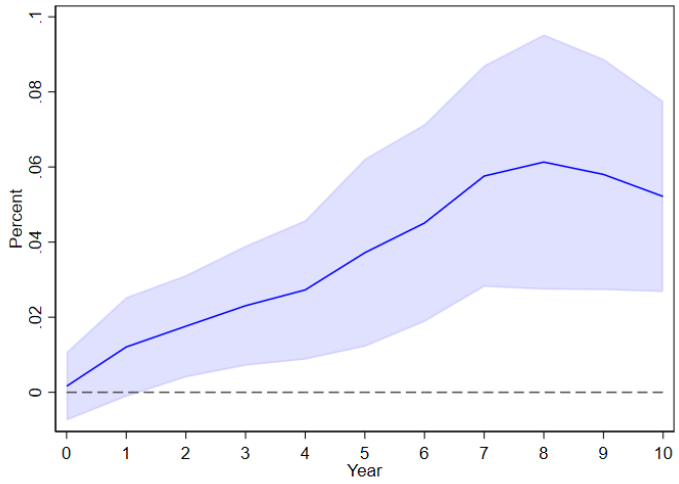
(a) Nontradable



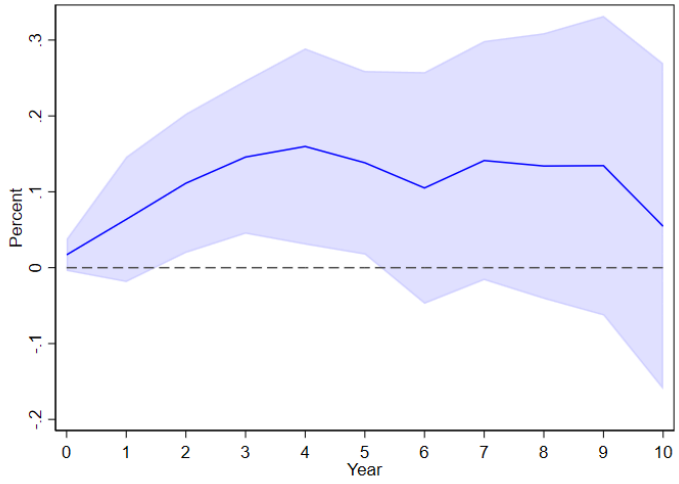
(b) Tradable

Figure 3: The Impact of Large Oil Discoveries on Tradable and Nontradable Price Indices

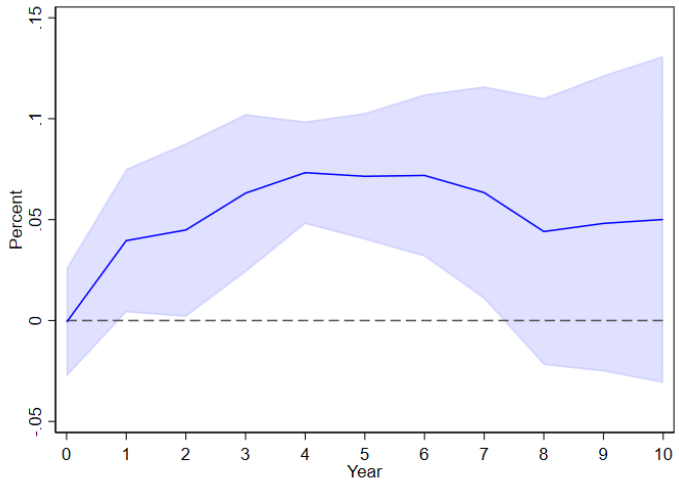
Notes: The figure presents the cumulative impulse responses for the price indices in the tradable sector and the nontradable sector following large oil discoveries with NPV equal to 1% of GDP. The tradable sector and the nontradable sector refer to the manufacturing sector and the service sector, respectively. The line indicates point estimates, and shaded areas represent 90% confidence intervals. The vertical axis shows percentage change.



(a) GDP



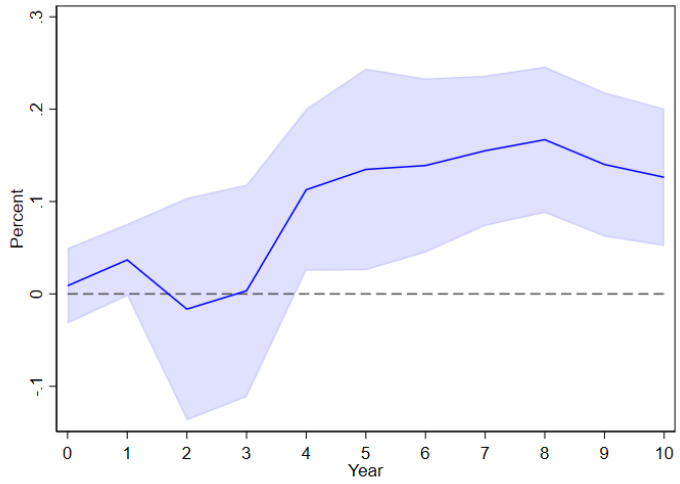
(b) Consumption



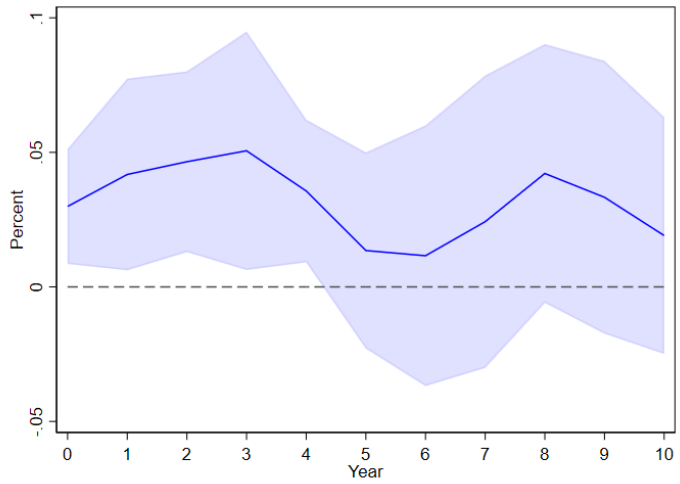
(c) Investment

Figure 4: The Impact of Large Oil Discoveries on GDP, Consumption, and Investment

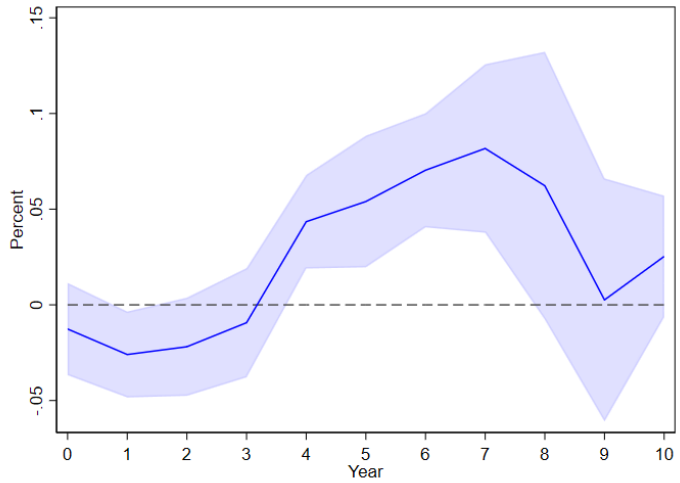
Notes: The figure presents the cumulative impulse response for GDP, consumption, and investment following large oil discoveries with NPV equal to 1% of GDP. The line indicates point estimates, and shaded areas represent 90% confidence intervals. The vertical axis shows percentage change.



(a) Export



(b) Import



(c) Current Account/GDP

Figure 5: The Impact of Large Oil Discoveries on Current Account, Exports, and Imports

Notes: The figure presents the cumulative impulse response for the real export, the real import, the current account/GDP ratio following large oil discoveries with NPV equal to 1% of GDP. The line indicates point estimates, and shaded areas represent 90% confidence intervals. The vertical axis shows percentage change.

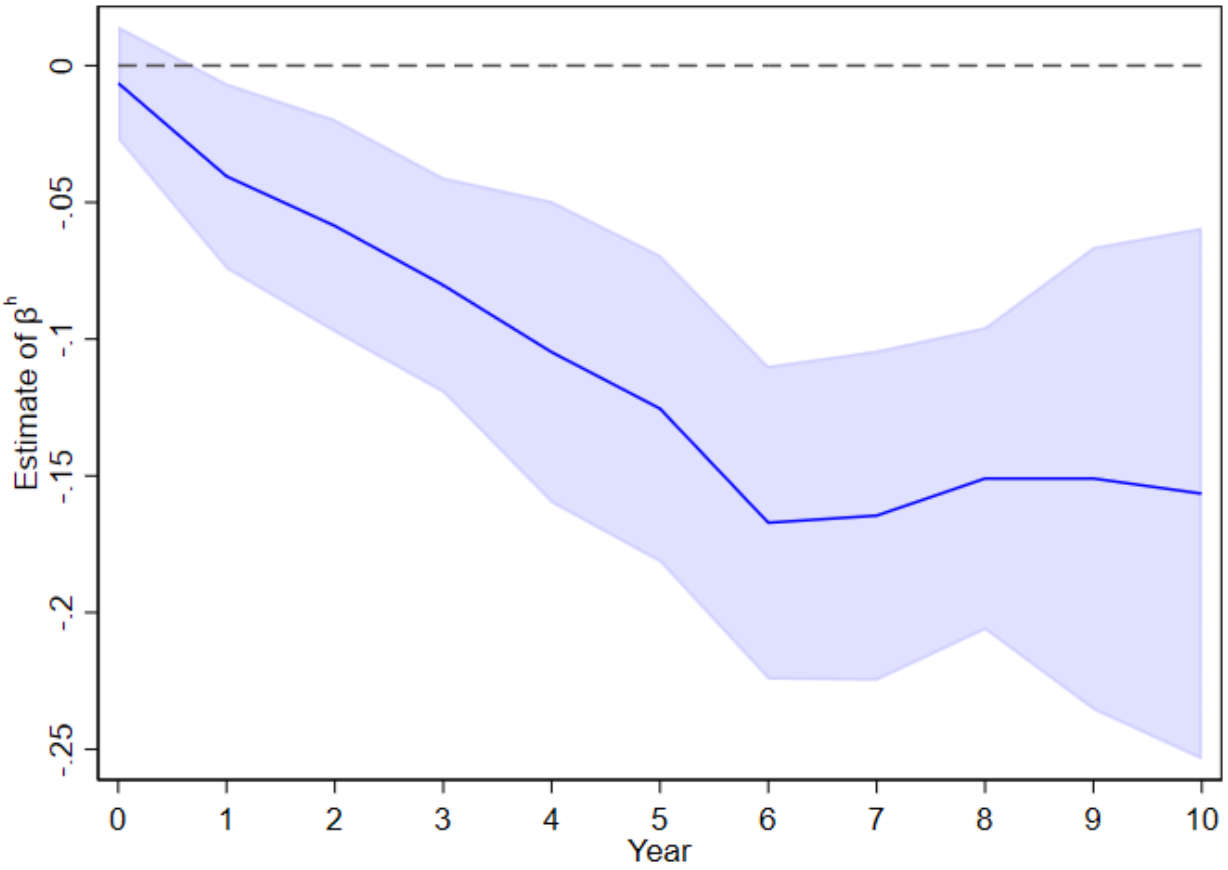


Figure 6: The Impact of Large Oil Discoveries on the Bilateral Real Exchange Rate

Notes: The figure presents the cumulative impulse response for the bilateral real exchange rate between two countries following a large oil discovery with NPV equal to 1% of GDP at home but no discovery at the foreign country. The line indicates point estimates, and shaded areas represent 90% confidence intervals. The vertical axis shows percentage change.

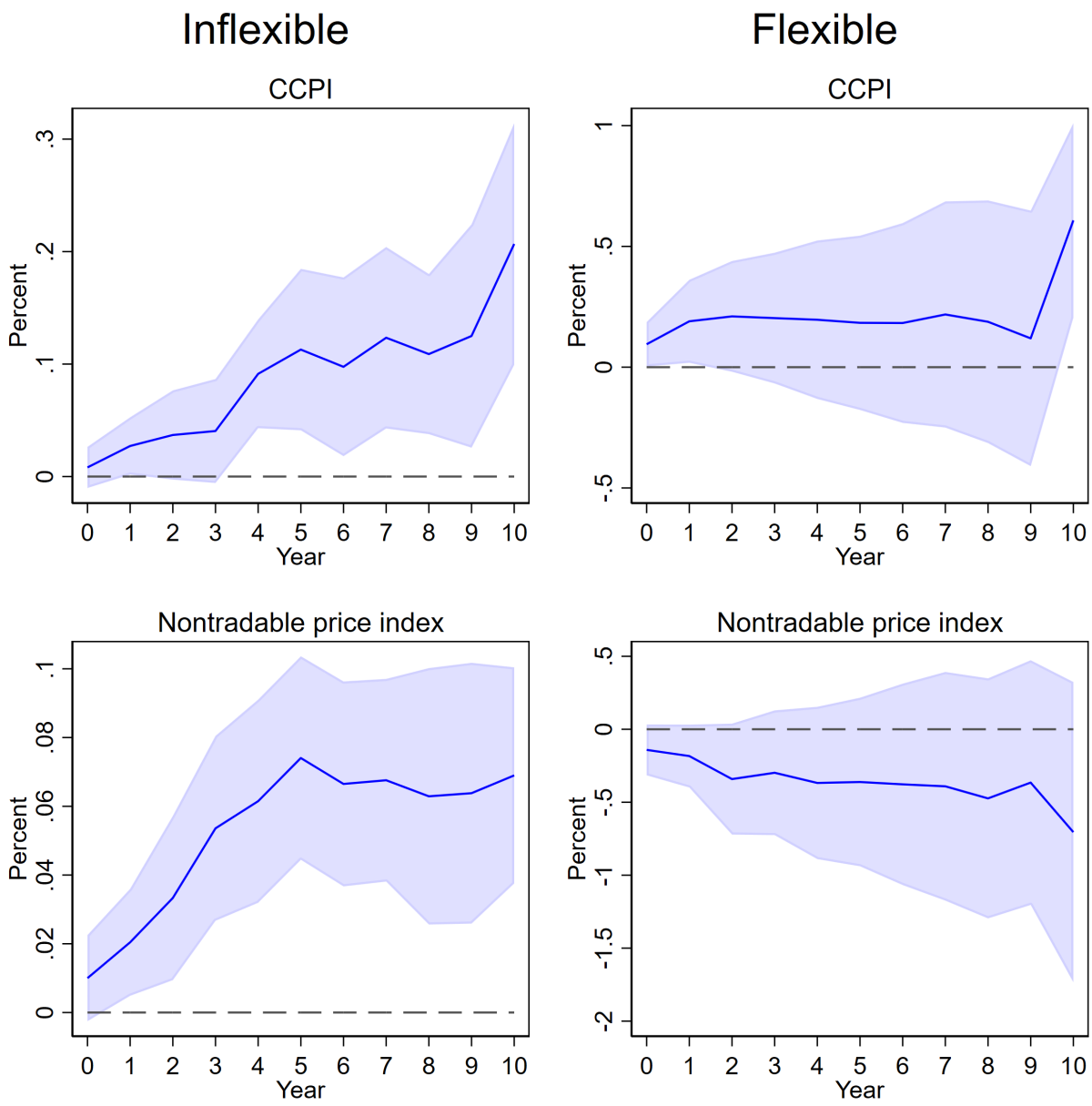


Figure 7: Cumulative Response of Inflation under Different Exchange Rate Regimes

Notes: The figure presents the cumulative impulse responses of the core CPI and the nontradable price index following a large oil discovery with NPV equal to 1% of GDP, partitioned by the exchange rate regime classification (inflexible versus flexible) based on Ilzetzki et al. (2019). The line indicates point estimates, and shaded areas represent 90% confidence intervals. The vertical axis shows percentage change.

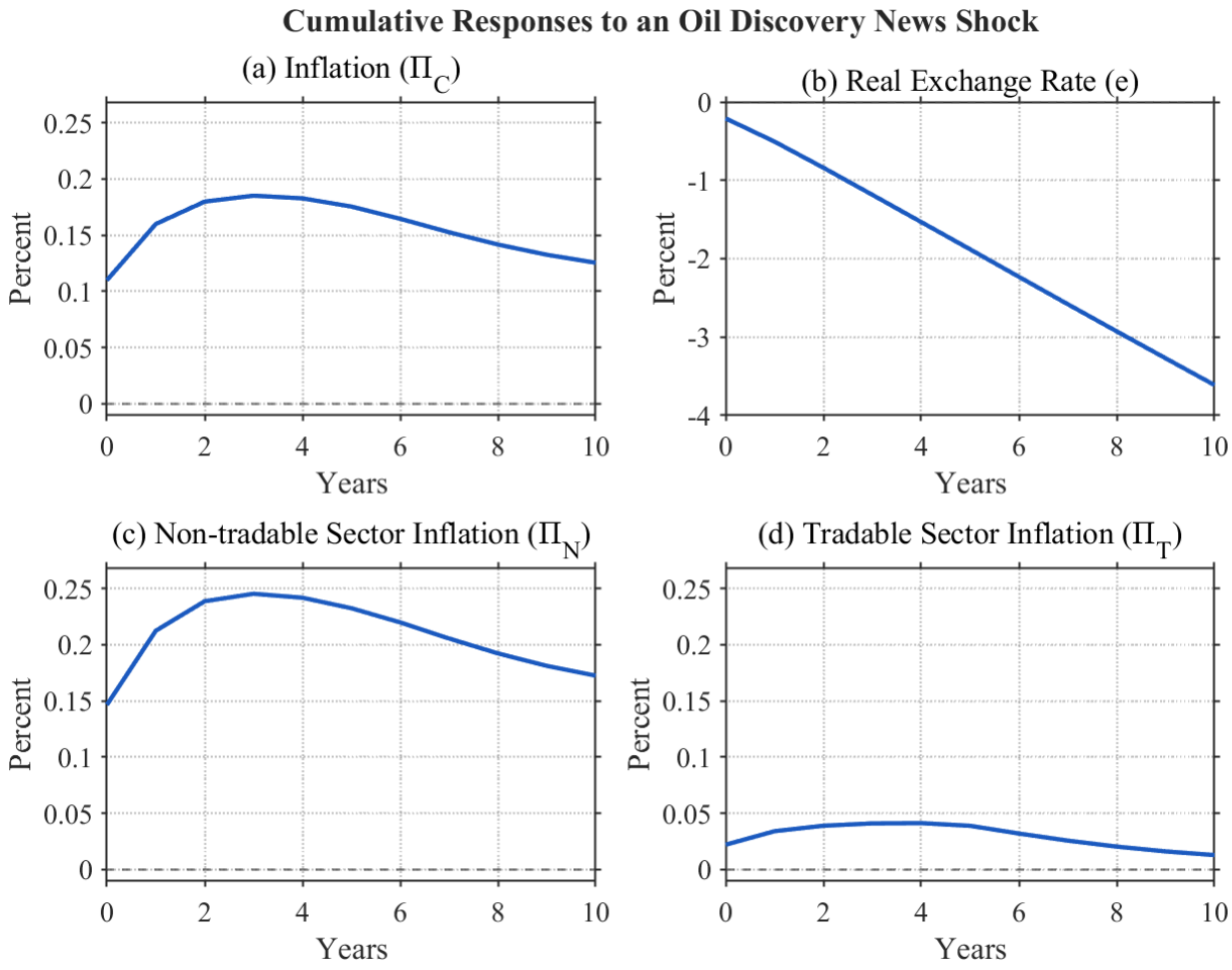


Figure 8: Cumulative Responses of Inflation and Real Exchange Rate to an Oil Discovery News Shock

Notes: The figure reports cumulative responses to an oil-discovery news shock whose present discounted value equals one percent of initial GDP. The panels show (a) CPI inflation, (b) the real exchange rate, (c) nontradable inflation, and (d) tradable inflation. The shock is announced in year 0, while newly discovered oil becomes productive after $j = 5$ years. The vertical axis is in percent.

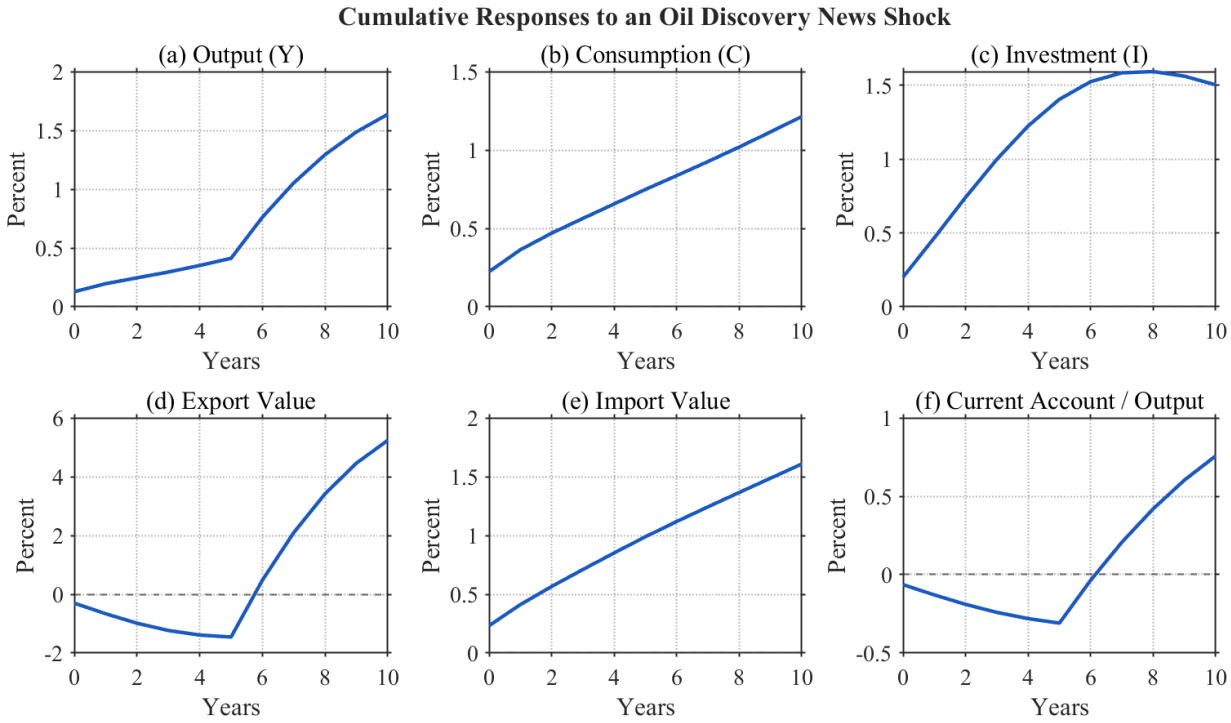


Figure 9: Cumulative Responses of Macroeconomic Variables to an Oil Discovery News Shock

Notes: The figure reports cumulative responses to an oil-discovery news shock whose present discounted value equals one percent of initial GDP. The panels show (a) GDP, (b) consumption, (c) investment, (d) current account-to-GDP ratio, (e) exports, and (f) imports. The shock is announced in year 0, while newly discovered oil becomes productive after $j = 5$ years. The vertical axis is in percent.

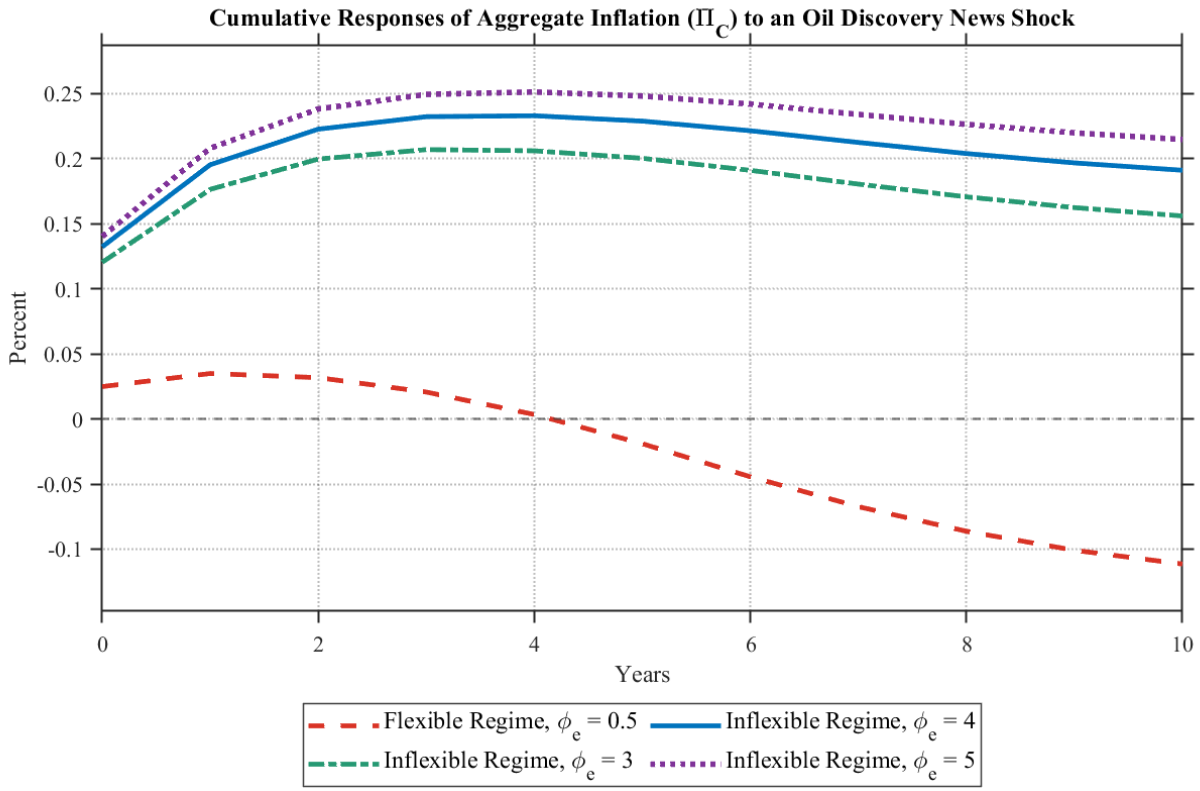


Figure 10: Cumulative Response of CPI Inflation under Different Exchange Rate Regimes

Notes: The figure reports cumulative responses of CPI inflation to an oil-discovery news shock under different exchange rate regimes. The dashed red line denotes the flexible exchange rate regime ($\phi_e = 0.5$). The solid blue line, dash-dotted green line, and dotted purple line denote inflexible exchange rate regimes with $\phi_e = 4$, $\phi_e = 3$, and $\phi_e = 5$, respectively.

Online Appendix for "News Shocks and Inflation: Theory and Evidence from Large Oil Discoveries"

Bohou Cai, Liugang Sheng, and Hongyan Zhao

Not for Publication

Contents of the Online Appendix

The online appendix has two parts. **Part A** presents all robustness checks, and **Part B** collects the model derivations.

- **Part A: Robustness Checks**
  - A.1 Alternative sample
  - A.2 Alternative oil price in the construction of NPV
  - A.3 Alternative production lag used in the construction of NPV
  - A.4 Alternative definitions of tradable and nontradable sectors
  - A.5 Alternative dependent-variable definitions
  - A.6 Controlling for exploration capex and U.S. monetary policy
  - A.7 Lag selection using BIC
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- **Part B: Model**
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  - B.3 Derivation of Oil-Sector Optimality Conditions
  - B.4 Equilibrium Conditions
  - B.5 Log-linearized Equilibrium Conditions

A Robustness Check

A.1 Alternative sample

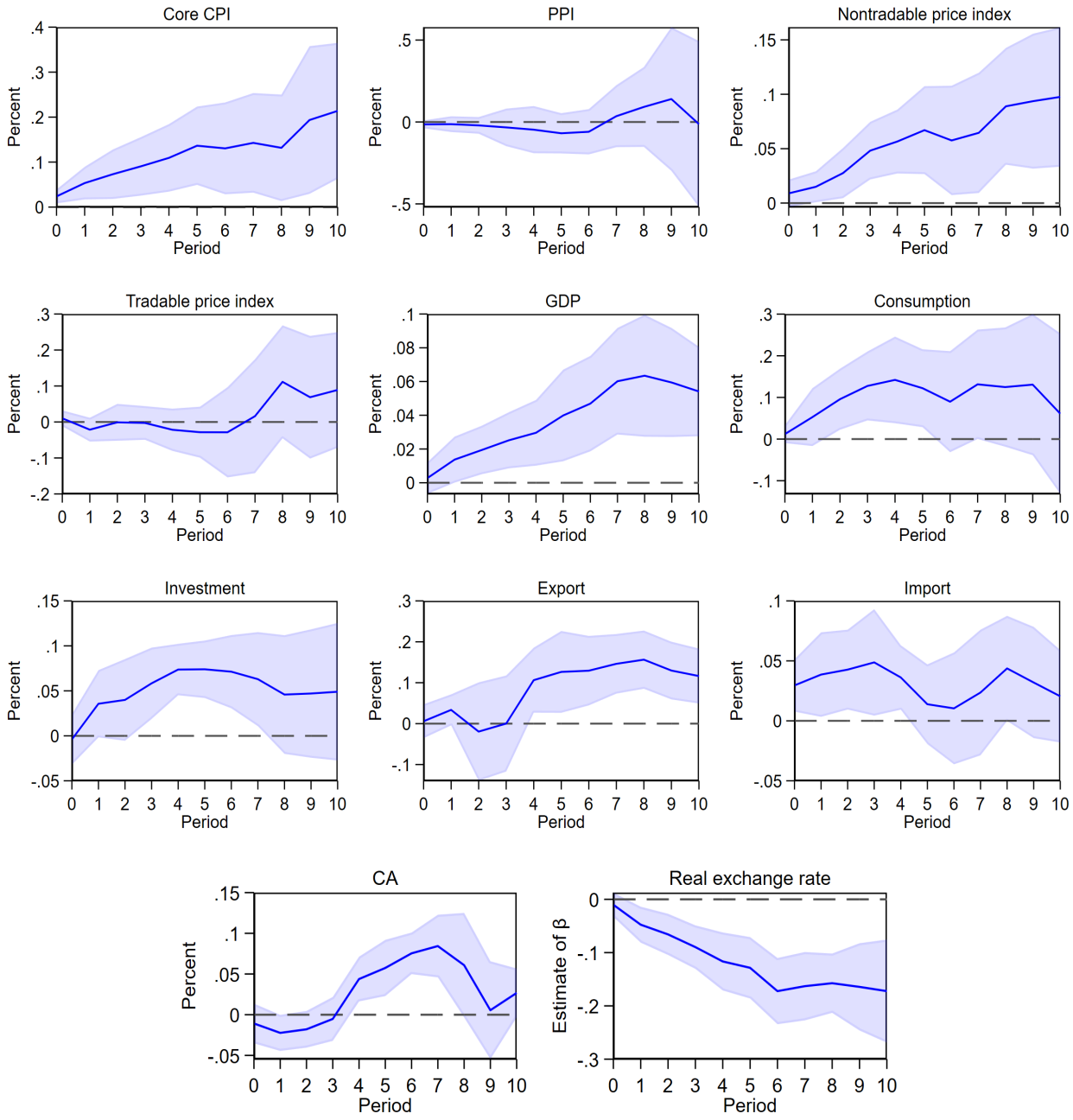


Figure A.1: Alternative sample: countries with at least one large oil discovery.

Notes: The figure presents the cumulative impulse responses of key macroeconomic variables (Core CPI, PPI, Nontradable and Tradable price indices, GDP, Consumption, Investment, Exports, Imports, Current Account, and Real exchange rate) following a large oil discovery with NPV equal to 1% of GDP. Unlike the baseline specification, this robustness check restricts the sample exclusively to countries that have experienced at least one large oil discovery during the sample period. The solid lines indicate point estimates, and the shaded areas represent 90% confidence intervals. The vertical axis denotes the cumulative percentage change.

A.2 Alternative oil price in the construction of NPV

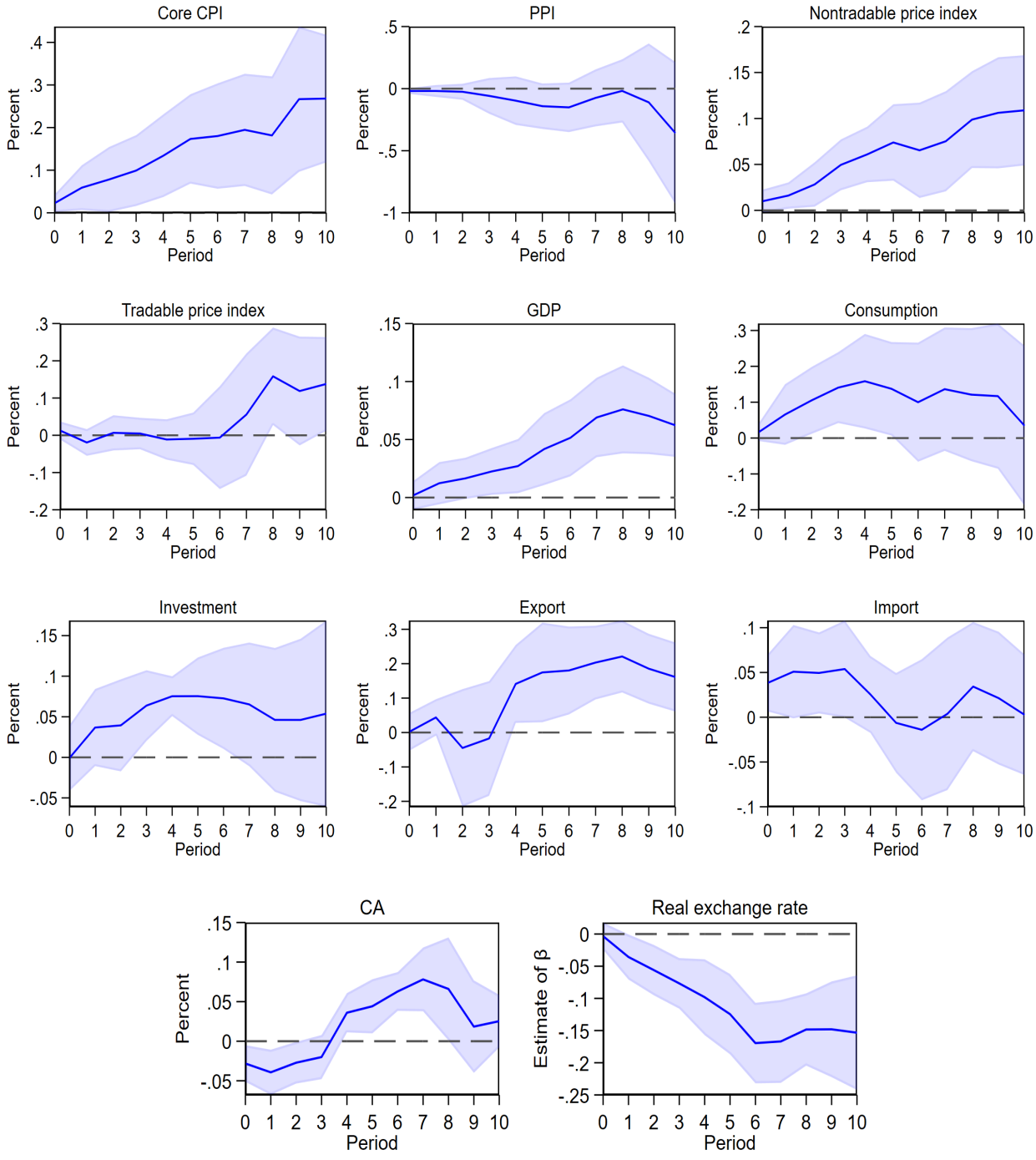


Figure A.2: Construction of NPV using the three-year average of world oil prices before the discovery.

Notes: The figure presents the cumulative impulse responses of key macroeconomic variables (Core CPI, PPI, Nontradable and Tradable price indices, GDP, Consumption, Investment, Exports, Imports, Current Account, and Real exchange rate) following a large oil discovery with NPV equal to 1% of GDP. Unlike the baseline specification, which uses current oil price to value the discoveries, this robustness check reconstructs the NPV using the average of global oil prices in the discovery year and the two preceding years. The solid lines indicate point estimates, and the shaded areas represent 90% confidence intervals. The vertical axis denotes the cumulative percentage change.

A.3 Alternative production lag used in the construction of NPV

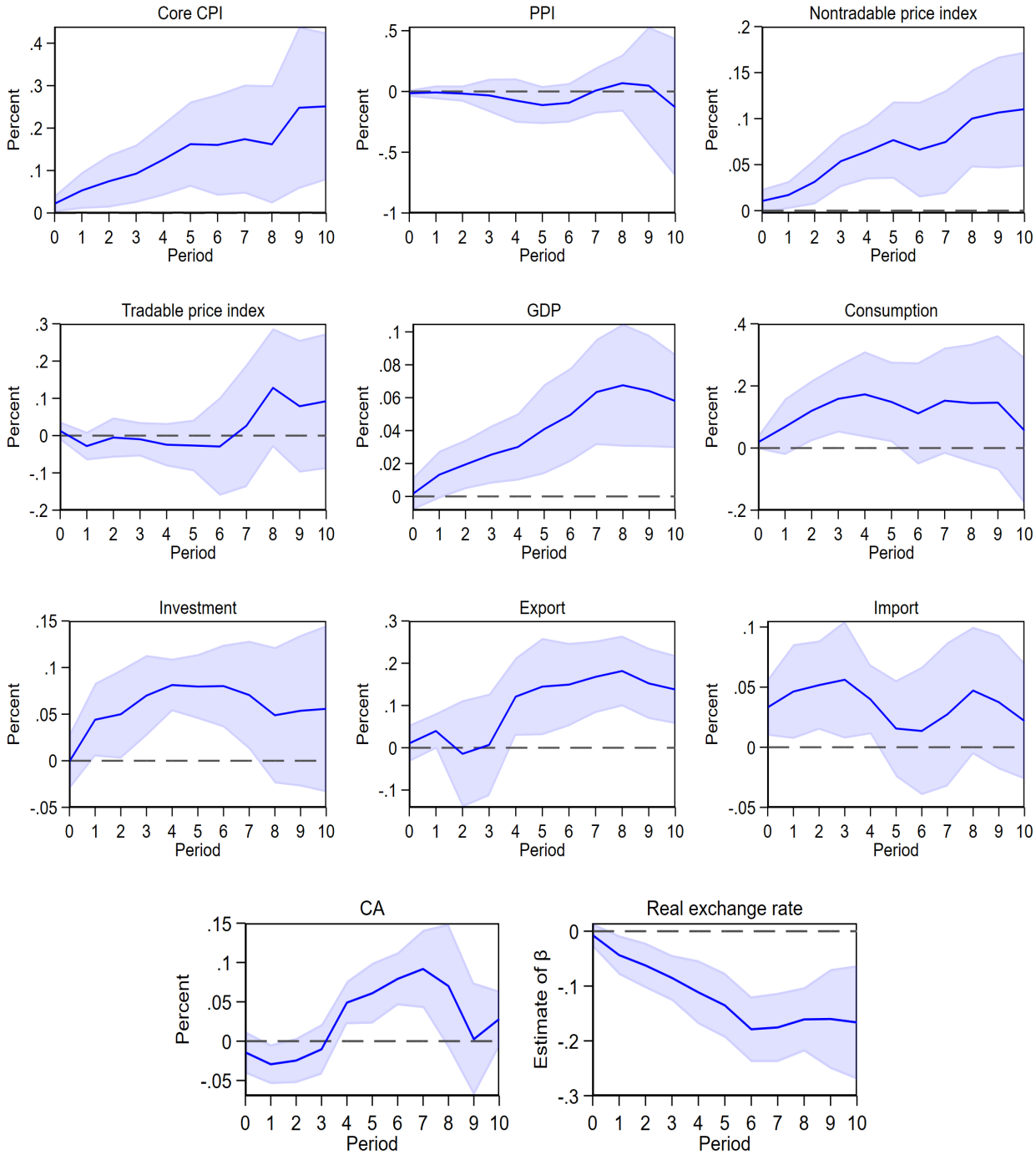


Figure A.3: Construction of NPV using 7-year production lags.

Notes: The figure presents the cumulative impulse responses of key macroeconomic variables (Core CPI, PPI, Nontradable and Tradable price indices, GDP, Consumption, Investment, Exports, Imports, Current Account, and Real exchange rate) following a large oil discovery with NPV equal to 1% of GDP. In contrast to the baseline model, which assumes a standard five-year delay between discovery and actual production, this exercise utilizes a seven-year production lag to construct the discovery's NPV. The solid lines indicate point estimates, and the shaded areas represent 90% confidence intervals. The vertical axis denotes the cumulative percentage change.

A.4 Alternative definitions of tradable and nontradable sectors

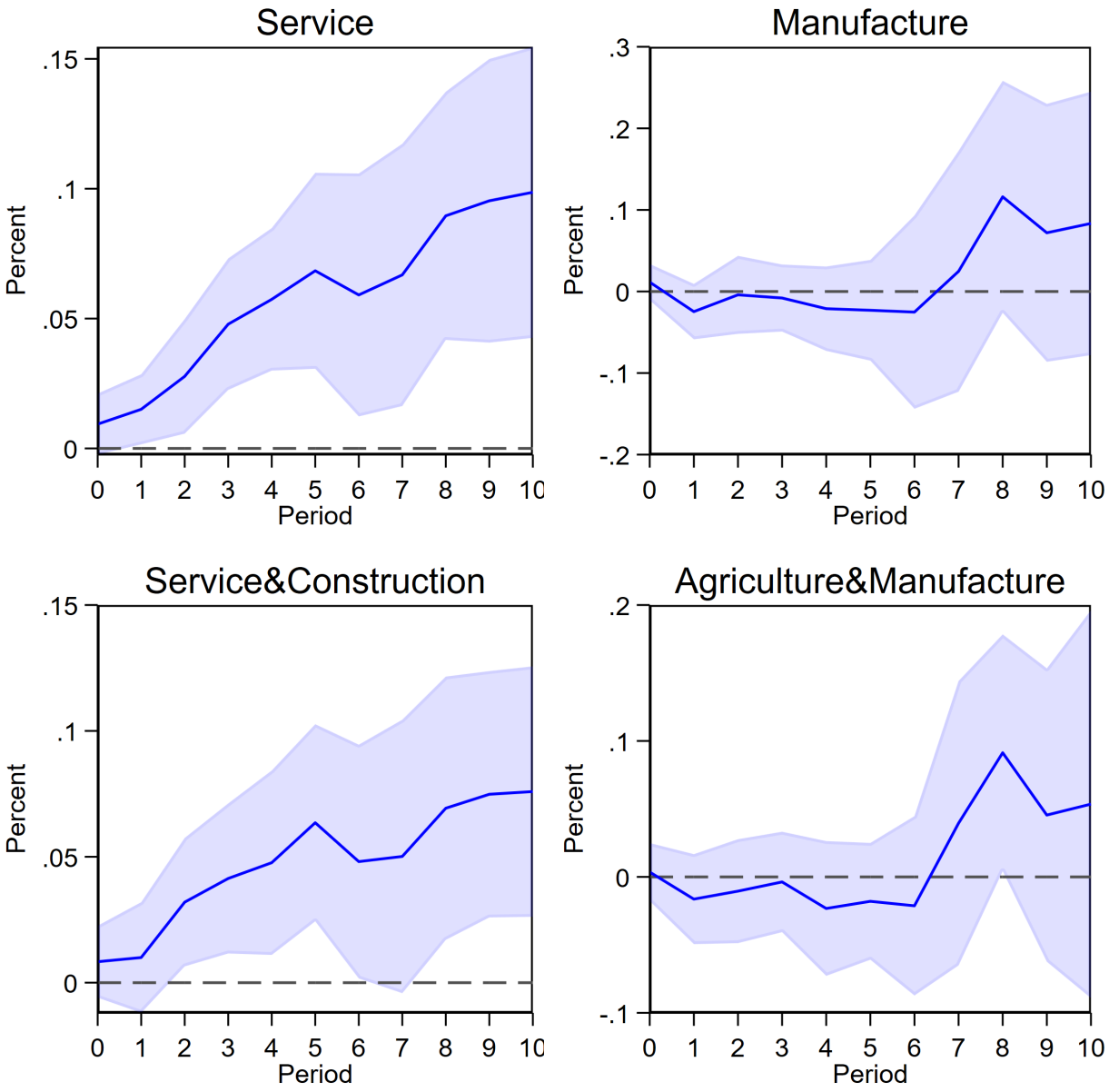


Figure A.4: Alternative definitions of tradable and nontradable sectors.

Notes: The figure presents the cumulative impulse responses of prices in specific sectors following a large oil discovery with NPV equal to 1% of GDP. This robustness check explores alternative definitions of tradable and nontradable sectors compared to the baseline analysis. Specifically, it examines the responses of the Service, Manufacturing, a combined Service & Construction (proxying alternative nontradables), and a combined Agriculture & Manufacturing (proxying alternative tradables) price index. The solid lines indicate point estimates, and the shaded areas represent 90% confidence intervals. The vertical axis denotes the cumulative percentage change.

A.5 Alternative dependent-variable definitions

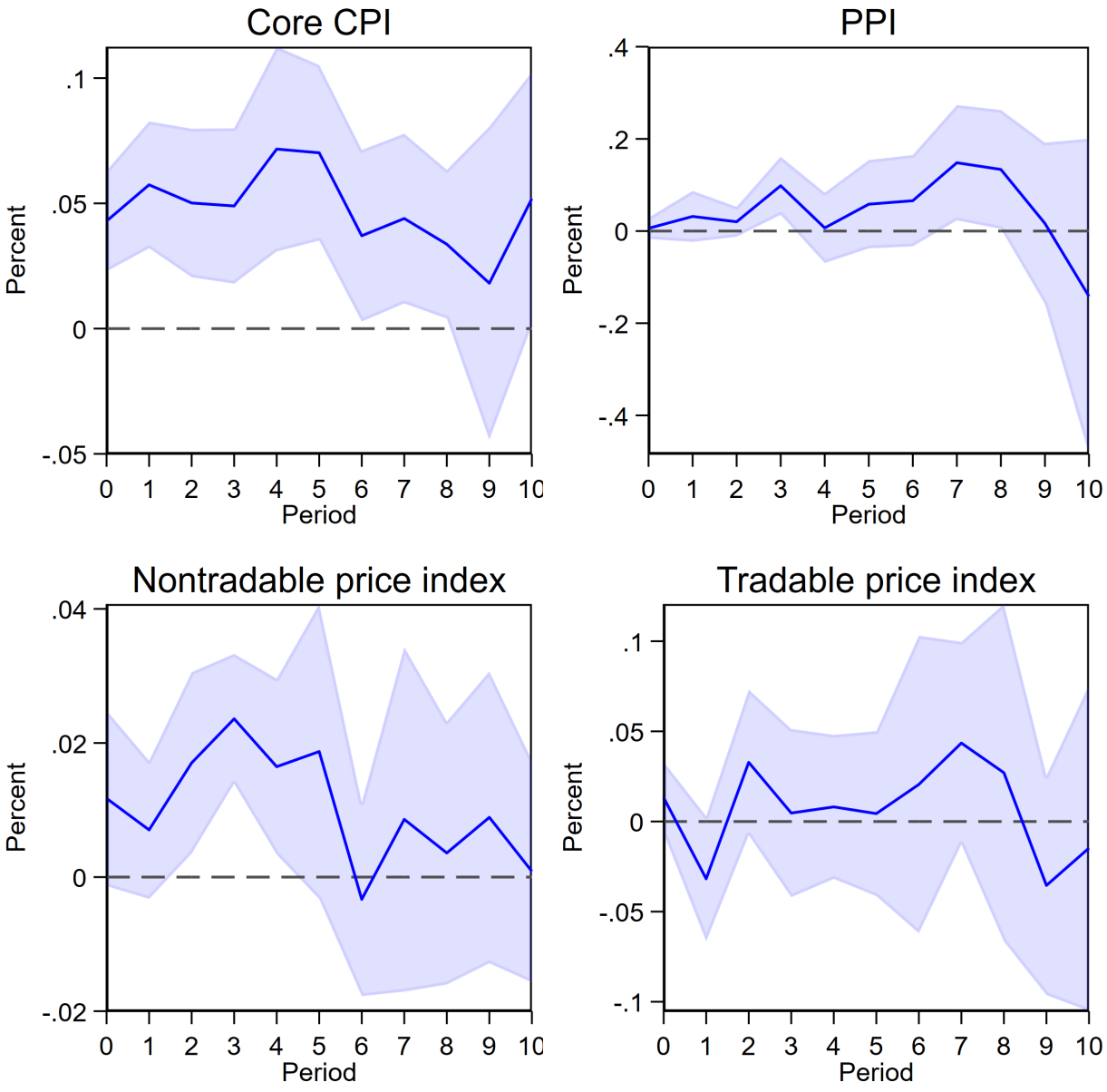


Figure A.5: Alternative dependent-variable definitions: inflation rate instead of price index.

Notes: The figure presents the impulse responses of key macroeconomic variables (Core CPI, PPI, Nontradable and Tradable price indices) following a large oil discovery with NPV equal to 1% of GDP. Departing from the baseline approach, which evaluates prices as cumulative log deviations of base-year indices, this alternative specification directly employs annual inflation rates as the dependent variables. The solid lines indicate point estimates, and the shaded areas represent 90% confidence intervals. The vertical axis denotes the percentage change.

A.6 Additional Controls

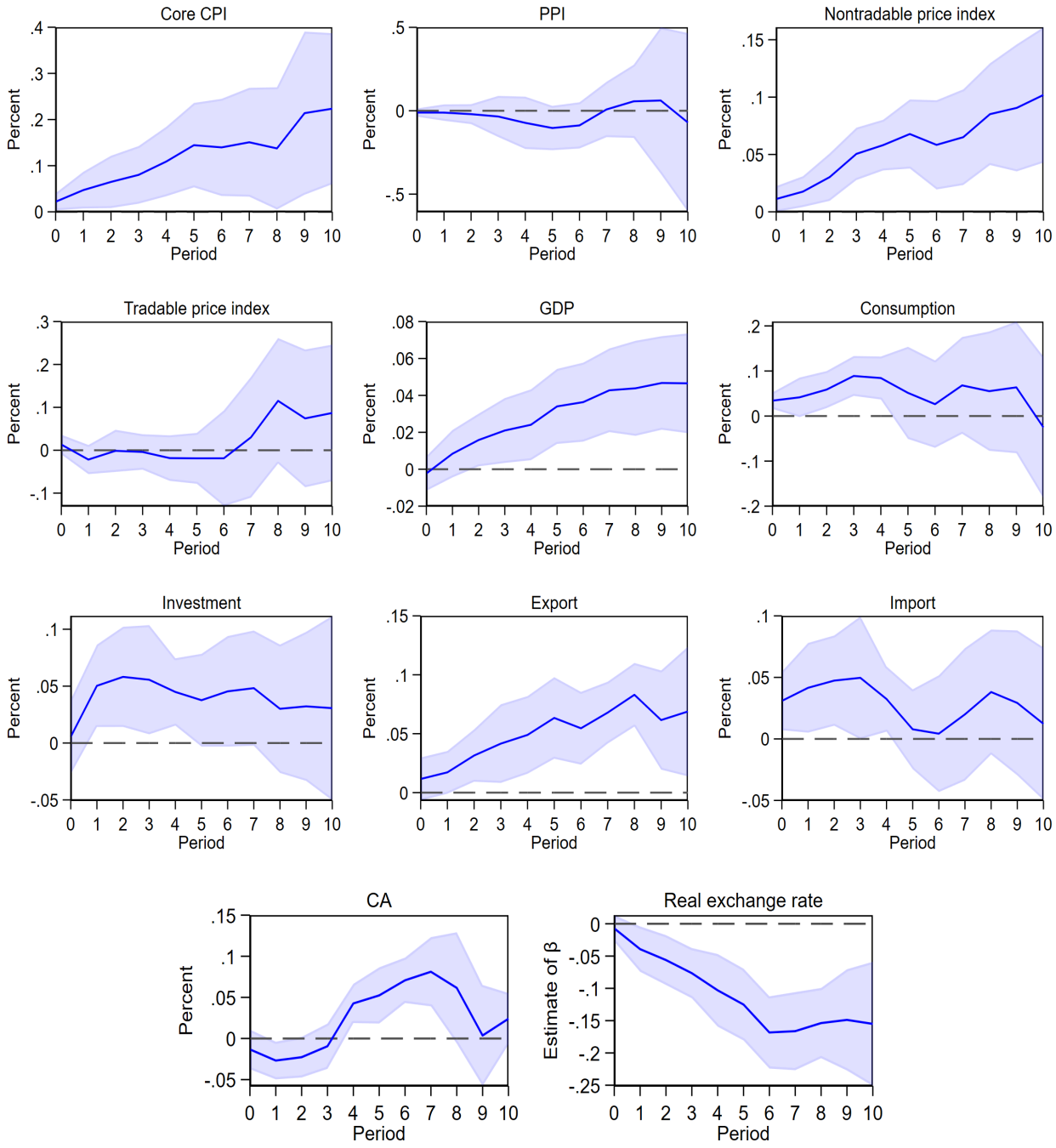


Figure A.6: Controlling for exploration capex and U.S. monetary policy.

Notes: The figure presents the cumulative impulse responses of key macroeconomic variables (Core CPI, PPI, Nontradable and Tradable price indices, GDP, Consumption, Investment, Exports, Imports, Current Account, and Real exchange rate) following a large oil discovery with NPV equal to 1% of GDP. This specification augments the baseline regression with two additional controls: exploration capital expenditures (capex) in the current and previous five periods and an interaction term between the country's lagged capital account openness-to-GDP ratio and U.S. monetary policy shocks measured by the federal funds rate. The solid lines indicate point estimates, and the shaded areas represent 90% confidence intervals. The vertical axis denotes the cumulative percentage change.

A.7 Lag selection using BIC

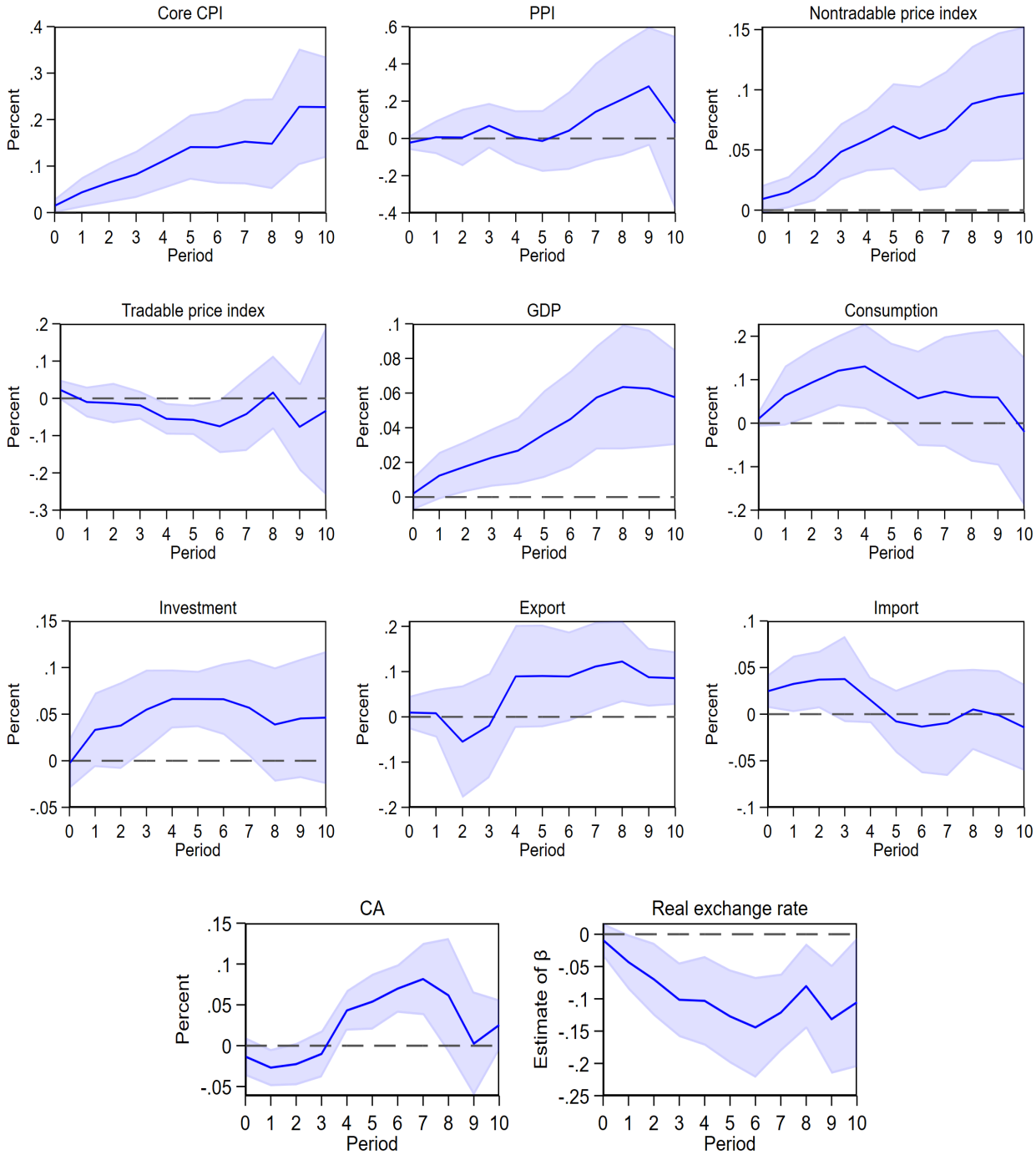


Figure A.7: Lag selection using BIC.

Notes: The figure presents the cumulative impulse responses of key macroeconomic variables (Core CPI, PPI, Nontradable and Tradable price indices, GDP, Consumption, Investment, Exports, Imports, Current Account, and Real exchange rate) following a large oil discovery with NPV equal to 1% of GDP. Rather than imposing a uniform five-lag structure as in the baseline analysis, this robustness check utilizes the Bayesian Information Criterion (BIC) to select the optimal lag length for the model. The solid lines indicate point estimates, and the shaded areas represent 90% confidence intervals. The vertical axis denotes the cumulative percentage change.

A.8 Nickell bias correction in panel local projections

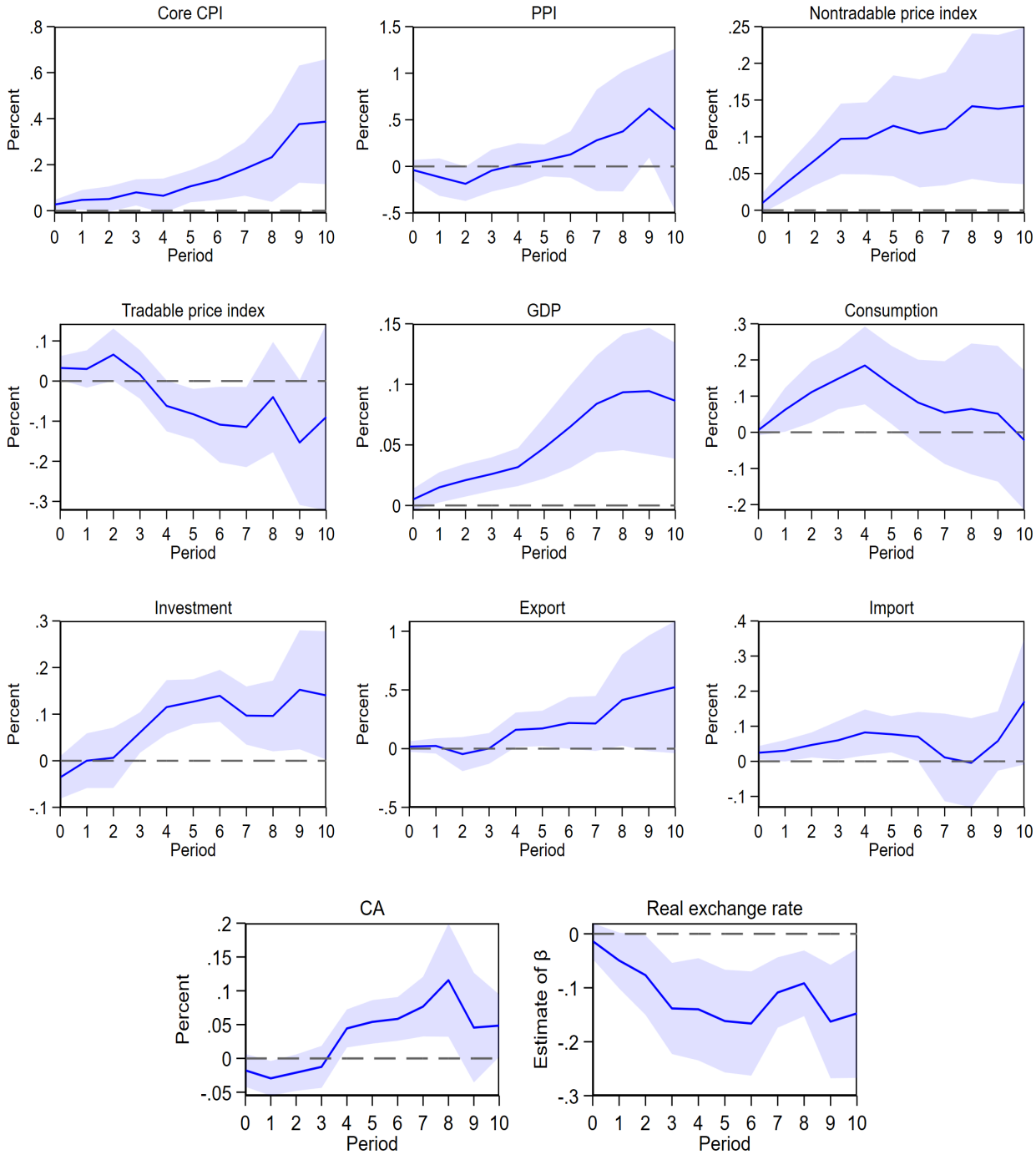


Figure A.8: Nickell bias correction in panel local projections.

Notes: The figure presents the cumulative impulse responses of key macroeconomic variables (Core CPI, PPI, Nontradable and Tradable price indices, GDP, Consumption, Investment, Exports, Imports, Current Account, and Real exchange rate) following a large oil discovery with NPV equal to 1% of GDP. This regression adopts the Split-Panel Jackknife (SPJ) estimator to correct for Nickell bias, implemented alongside the BIC-determined lag selection. The solid lines indicate point estimates, and the shaded areas represent 90% confidence intervals. The vertical axis denotes the cumulative percentage change.

B Model

This part of the appendix collects the derivations of the model developed in Section 4.

B.1 Derivation of Household Optimality Conditions

This appendix derives the household first-order conditions used in the model. The representative household maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{L_t^{1+\gamma}}{1+\gamma} \right], \tag{72}$$

where C_t is composite consumption, L_t is total labor supply, $\beta \in (0,1)$, $\sigma > 0$, $\gamma > 0$, and $\chi > 0$.

The household owns sector-specific capital in the nontradable, home tradable, and oil sectors, indexed by $h \in \{N, T, O\}$. Capital is predetermined at the beginning of period t, rented to firms within the period, and augmented through sector-specific investment. The household also trades a domestic nominal bond B_t and a foreign-currency bond B_t^*. The nominal exchange rate $\mathcal{E}_t$ is expressed as domestic currency per unit of foreign currency.

The period-t nominal budget constraint is

$$\begin{aligned} P_{C,t} C_t + P_{I,t} \sum_{h \in \{N,T,O\}} I_{h,t} + B_t + \mathcal{E}_t B_t^* = (1 + i_{t-1}) B_{t-1} + (1 + i_{t-1}^*) \mathcal{E}_t B_{t-1}^* \\ + W_t L_t + \sum_{h \in \{N,T,O\}} R_{h,t} K_{h,t-1} + \Phi_t. \end{aligned} \tag{73}$$

Total profits are rebated lump-sum to the household:

$$\Phi_t = \Phi_{N,t} + \Phi_{H,t} + \Phi_{O,t}. \tag{74}$$

For each sector $h \in \{N, T, O\}$, capital evolves according to

$$K_{h,t} = (1 - \delta) K_{h,t-1} + I_{h,t} \left[1 - \frac{\psi_h}{2} \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right)^2 \right], \tag{75}$$

where $\delta \in (0,1)$ is the depreciation rate and $\psi_h \geq 0$ governs investment adjustment costs. The aggregate investment good satisfies

$$I_t = \sum_{h \in \{N,T,O\}} I_{h,t}. \tag{76}$$

B.1.1 The Lagrangian

Let λ_t denote the multiplier on the real budget constraint, obtained by dividing (73) by $P_{C,t}$. Thus, λ_t is the real marginal utility value of wealth. Let $\mu_{h,t}$ denote the multiplier on the capital accumulation constraint for sector h. The household Lagrangian is

$$\begin{aligned}\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Bigg\{ & \frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{L_t^{1+\gamma}}{1+\gamma} + \lambda_t \Bigg[\frac{(1+i_{t-1})B_{t-1} + (1+i_{t-1}^*)\mathcal{E}_t B_{t-1}^* + W_t L_t}{P_{C,t}} \\ & - C_t - \frac{\sum_{h\in\{N,T,O\}} R_{h,t} K_{h,t-1} P_{I,t} \sum_{h\in\{N,T,O\}} I_{h,t} + B_t + \mathcal{E}_t B_t^* + \Phi_t}{P_{C,t}} \Bigg] \\ & + \sum_{h\in\{N,T,O\}} \mu_{h,t} \left[(1-\delta) K_{h,t-1} + I_{h,t} \left[1 - \frac{\psi_h}{2} \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right)^2 \right] - K_{h,t} \right] \Bigg\}. \end{aligned} \tag{77}$$

Define real Tobin's Q for sector h as

$$Q_{h,t} \equiv \frac{\mu_{h,t}}{\lambda_t}. \tag{78}$$

Since λ_t is the real marginal utility value of wealth, $Q_{h,t}$ is measured in units of the consumption good per unit of installed capital.

B.1.2 Marginal Utility of Wealth

Differentiating (77) with respect to C_t gives

$$\frac{\partial \mathcal{L}}{\partial C_t} = C_t^{-\sigma} - \lambda_t = 0. \tag{79}$$

Therefore,

$$\lambda_t = C_t^{-\sigma}. \tag{80}$$

B.1.3 Labor Supply

Differentiating with respect to L_t gives

$$\frac{\partial \mathcal{L}}{\partial L_t} = -\chi L_t^{\gamma} + \lambda_t \frac{W_t}{P_{C,t}} = 0. \tag{81}$$

Hence,

$$\chi L_t^{\gamma} = \lambda_t \frac{W_t}{P_{C,t}}. \tag{82}$$

This condition equates the marginal disutility of labor to the marginal utility value of the real wage.

B.1.4 Euler Equation for Domestic Bonds

The domestic bond B_t appears as an outflow in the period-t budget constraint and as an inflow in period $t+1$. Differentiating with respect to B_t yields

$$-\lambda_t \frac{1}{P_{C,t}} + \beta \mathbb{E}_t \left[\lambda_{t+1} \frac{1+i_t}{P_{C,t+1}} \right] = 0. \tag{83}$$

Therefore,

$$\frac{\lambda_t}{P_{C,t}} = \beta(1+i_t)\mathbb{E}_t \left[\frac{\lambda_{t+1}}{P_{C,t+1}} \right]. \tag{84}$$

Multiplying both sides by $P_{C,t}/\lambda_t$ gives

$$1 = \beta(1+i_t)\mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{P_{C,t}}{P_{C,t+1}} \right]. \tag{85}$$

Equivalently, using $\Pi_{C,t+1} \equiv P_{C,t+1}/P_{C,t}$,

$$1 = \beta(1+i_t)\mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{1}{\Pi_{C,t+1}} \right]. \tag{86}$$

B.1.5 Euler Equation for Foreign Bonds

The foreign bond B_t^* is denominated in foreign currency. Its domestic currency value at time t is $\mathcal{E}_t B_t^*$. Differentiating the Lagrangian with respect to B_t^* gives

$$-\lambda_t \frac{\mathcal{E}_t}{P_{C,t}} + \beta \mathbb{E}_t \left[\lambda_{t+1} \frac{(1+i_t^*)\mathcal{E}_{t+1}}{P_{C,t+1}} \right] = 0. \tag{87}$$

Thus,

$$1 = \beta(1+i_t^*)\mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \frac{P_{C,t}}{P_{C,t+1}} \right]. \tag{88}$$

Combining (85) and (88) delivers the model's uncovered interest parity condition. In the main text, the effective foreign interest rate i_t^* also contains a debt-elastic premium that ensures stationarity of the net foreign asset position.

B.1.6 Capital Pricing

For each sector $h \in \{N, T, O\}$, differentiating the Lagrangian with respect to $K_{h,t}$ gives

$$-\mu_{h,t} + \beta \mathbb{E}_t \left[\lambda_{t+1} \frac{R_{h,t+1}}{P_{C,t+1}} + \mu_{h,t+1}(1-\delta) \right] = 0. \tag{89}$$

Dividing by λ_t and using $Q_{h,t} \equiv \mu_{h,t}/\lambda_t$ yields

$$Q_{h,t} = \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{R_{h,t+1}}{P_{C,t+1}} + \frac{\lambda_{t+1}}{\lambda_t} Q_{h,t+1}(1-\delta) \right]. \tag{90}$$

Therefore,

$$Q_{h,t} = \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left(\frac{R_{h,t+1}}{P_{C,t+1}} + (1-\delta) Q_{h,t+1} \right) \right], \qquad h \in \{N, T, O\}. \tag{91}$$

B.1.7 Investment Decision

For compactness, define the gross investment growth rate

$$g_{h,t} \equiv \frac{I_{h,t}}{I_{h,t-1}}, \qquad h \in \{N, T, O\}. \tag{92}$$

The investment term entering capital accumulation is

$$\mathcal{S}_{h,t} \equiv I_{h,t} \left[1 - \frac{\psi_h}{2} (g_{h,t} - 1)^2 \right]. \tag{93}$$

Differentiating the Lagrangian with respect to $I_{h,t}$ gives

$$0 = -\lambda_t \frac{P_{I,t}}{P_{C,t}} + \mu_{h,t} \frac{\partial \mathcal{S}_{h,t}}{\partial I_{h,t}} + \beta \mathbb{E}_t \left[\mu_{h,t+1} \frac{\partial \mathcal{S}_{h,t+1}}{\partial I_{h,t}} \right]. \tag{94}$$

The relevant derivatives are

$$\frac{\partial \mathcal{S}_{h,t}}{\partial I_{h,t}} = 1 - \frac{\psi_h}{2} \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right)^2 - \psi_h \frac{I_{h,t}}{I_{h,t-1}} \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right), \tag{95}$$

$$\frac{\partial \mathcal{S}_{h,t+1}}{\partial I_{h,t}} = \psi_h \left(\frac{I_{h,t+1}}{I_{h,t}} \right)^2 \left(\frac{I_{h,t+1}}{I_{h,t}} - 1 \right). \tag{96}$$

Substituting these expressions into (94), dividing by λ_t, and using $Q_{h,t} = \mu_{h,t}/\lambda_t$, we obtain

$$\frac{P_{I,t}}{P_{C,t}} = Q_{h,t}\left[1 - \frac{\psi_h}{2}\left(\frac{I_{h,t}}{I_{h,t-1}} - 1\right)^2 - \psi_h \frac{I_{h,t}}{I_{h,t-1}}\left(\frac{I_{h,t}}{I_{h,t-1}} - 1\right)\right] + \beta \mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t} Q_{h,t+1}\psi_h\left(\frac{I_{h,t+1}}{I_{h,t}}\right)^2\left(\frac{I_{h,t+1}}{I_{h,t}} - 1\right)\right], \qquad h \in \{N, T, O\}. \tag{97}$$

B.2 Derivation of Sectoral Rotemberg Phillips Curves

This section derives the nonlinear Phillips curves for the sectors with monopolistic competition and Rotemberg price adjustment costs. The derivation is identical for the nontradable and home tradable sectors, up to notation.

B.2.1 Nontradable Sector

A nontradable intermediate firm i faces demand

$$Y_{N,t}(i) = \left(\frac{P_{N,t}(i)}{P_{N,t}}\right)^{-\varepsilon_N} Y_{N,t}, \tag{98}$$

where $\varepsilon_N > 1$. The firm chooses $\{P_{N,t}(i)\}_{t=0}^{\infty}$ to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}\left[P_{N,t}(i)Y_{N,t}(i) - P_{N,t}MC_{N,t}Y_{N,t}(i) - P_{N,t}\frac{\phi_N}{2}\left(\frac{P_{N,t}(i)}{P_{N,t-1}(i)} - 1\right)^2 Y_{N,t}\right], \tag{99}$$

where $MC_{N,t}$ is real marginal cost in units of the nontradable good and $\Lambda_{t,t+k}$ is the household's nominal stochastic discount factor:

$$\Lambda_{t,t+k} \equiv \beta^k \frac{\lambda_{t+k}/P_{C,t+k}}{\lambda_t/P_{C,t}}. \tag{100}$$

After substituting demand, the first-order condition with respect to $P_{N,t}(i)$, evaluated in a symmetric equilibrium with $P_{N,t}(i) = P_{N,t}$, is

$$0 = (1 - \varepsilon_N)Y_{N,t} + \varepsilon_N MC_{N,t}Y_{N,t} - \phi_N(\Pi_{N,t} - 1)\Pi_{N,t}Y_{N,t} + \mathbb{E}_t\left[\Lambda_{t,t+1}\phi_N(\Pi_{N,t+1} - 1)\Pi_{N,t+1}\frac{P_{N,t+1}}{P_{N,t}}Y_{N,t+1}\right], \tag{101}$$

where

$$\Pi_{N,t} \equiv \frac{P_{N,t}}{P_{N,t-1}}. \tag{102}$$

Dividing by $Y_{N,t}\phi_N$ and rearranging gives

$$(\Pi_{N,t}-1)\Pi_{N,t}=\frac{\varepsilon_N}{\phi_N}\left(MC_{N,t}-\frac{\varepsilon_N-1}{\varepsilon_N}\right)+\mathbb{E}_t\left[\Lambda_{t,t+1}\frac{P_{N,t+1}}{P_{N,t}}\frac{Y_{N,t+1}}{Y_{N,t}}(\Pi_{N,t+1}-1)\Pi_{N,t+1}\right]. \tag{103}$$

Using

$$\Lambda_{t,t+1}=\beta\frac{\lambda_{t+1}}{\lambda_t}\frac{P_{C,t}}{P_{C,t+1}}, \tag{104}$$

the nontradable Phillips curve becomes

$$(\Pi_{N,t}-1)\Pi_{N,t}=\frac{\varepsilon_N}{\phi_N}\left(MC_{N,t}-\frac{\varepsilon_N-1}{\varepsilon_N}\right)+\beta\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{P_{C,t}}{P_{C,t+1}}\frac{P_{N,t+1}}{P_{N,t}}\frac{Y_{N,t+1}}{Y_{N,t}}(\Pi_{N,t+1}-1)\Pi_{N,t+1}\right]. \tag{105}$$

B.2.2 Home Tradable Sector

The home tradable sector has the same monopolistic-competition and Rotemberg pricing structure. A firm i faces demand

$$Y_{H,t}(i)=\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\varepsilon_H}Y_{H,t}, \tag{106}$$

where $\varepsilon_H>1$, and adjusts prices subject to the cost

$$P_{H,t}\frac{\phi_T}{2}\left(\frac{P_{H,t}(i)}{P_{H,t-1}(i)}-1\right)^2Y_{H,t}. \tag{107}$$

By the same steps as above, the symmetric-equilibrium price-setting condition is

$$(\Pi_{H,t}-1)\Pi_{H,t}=\frac{\varepsilon_H}{\phi_T}\left(MC_{H,t}-\frac{\varepsilon_H-1}{\varepsilon_H}\right)+\beta\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{P_{C,t}}{P_{C,t+1}}\frac{P_{H,t+1}}{P_{H,t}}\frac{Y_{H,t+1}}{Y_{H,t}}(\Pi_{H,t+1}-1)\Pi_{H,t+1}\right], \tag{108}$$

where

$$\Pi_{H,t}\equiv\frac{P_{H,t}}{P_{H,t-1}}. \tag{109}$$

B.3 Derivation of Oil-Sector Optimality Conditions

The oil sector is perfectly competitive in the product market and takes the domestic-currency oil price

$$P_{O,t}=\mathcal{E}_tP^*_{O,t} \tag{110}$$

as given. Oil output is produced using capital, labor, and producing reserves:

$$Y_{O,t} = A_{O,t} K_{O,t-1}^{\alpha_k} L_{O,t}^{\alpha_L} Res_{t-1}^{1-\alpha_k-\alpha_L}, \qquad \alpha_k > 0, \quad \alpha_L > 0, \quad \alpha_k + \alpha_L < 1. \tag{111}$$

Producing reserves evolve according to

$$Res_t = Res_{t-1} + \varsigma - Y_{O,t} + \varepsilon_{t-j}^{Res}. \tag{112}$$

B.3.1 Oil Producer's Lagrangian

The oil producer maximizes the expected discounted value of nominal profits, using the household's nominal stochastic discount factor. Let ζ_t denote the nominal shadow value of one unit of producing reserves. The Lagrangian is

$$\mathcal{L}^O = \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left\{ P_{O,t} Y_{O,t} - W_t L_{O,t} - R_{O,t} K_{O,t-1} + \zeta_t \left[Res_{t-1} + \varsigma - Y_{O,t} + \varepsilon_{t-j}^{Res} - Res_t \right] \right\}, \tag{113}$$

subject to (111). This formulation makes clear that current extraction yields revenue $P_{O,t}$ but also reduces reserves, whose shadow value is ζ_t.

B.3.2 Oil Labor Demand

Differentiating (113) with respect to $L_{O,t}$ gives

$$(P_{O,t} - \zeta_t) \frac{\partial Y_{O,t}}{\partial L_{O,t}} - W_t = 0. \tag{114}$$

Using the Cobb–Douglas production function,

$$\frac{\partial Y_{O,t}}{\partial L_{O,t}} = \alpha_L \frac{Y_{O,t}}{L_{O,t}}, \tag{115}$$

so

$$W_t = \alpha_L \frac{(P_{O,t} - \zeta_t) Y_{O,t}}{L_{O,t}}. \tag{116}$$

B.3.3 Oil Capital Demand

Differentiating with respect to $K_{O,t-1}$ yields

$$(P_{O,t} - \zeta_t)\frac{\partial Y_{O,t}}{\partial K_{O,t-1}} - R_{O,t} = 0. \tag{117}$$

Since

$$\frac{\partial Y_{O,t}}{\partial K_{O,t-1}} = \alpha_k \frac{Y_{O,t}}{K_{O,t-1}}, \tag{118}$$

we obtain

$$R_{O,t} = \alpha_k \frac{(P_{O,t} - \zeta_t)Y_{O,t}}{K_{O,t-1}}. \tag{119}$$

B.3.4 Euler Equation for Producing Reserves

Differentiating the oil producer's Lagrangian with respect to Res_t gives

$$-\zeta_t + \mathbb{E}_t\left[\Lambda_{t,t+1}\left\{(P_{O,t+1} - \zeta_{t+1})\frac{\partial Y_{O,t+1}}{\partial Res_t} + \zeta_{t+1}\right\}\right] = 0. \tag{120}$$

The marginal product of reserves in the next period is

$$\frac{\partial Y_{O,t+1}}{\partial Res_t} = (1 - \alpha_k - \alpha_L)\frac{Y_{O,t+1}}{Res_t}. \tag{121}$$

Therefore,

$$\zeta_t = \mathbb{E}_t\left[\Lambda_{t,t+1}\left\{(P_{O,t+1} - \zeta_{t+1})(1 - \alpha_k - \alpha_L)\frac{Y_{O,t+1}}{Res_t} + \zeta_{t+1}\right\}\right]. \tag{122}$$

Substituting the one-period stochastic discount factor gives

$$\zeta_t = \beta\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{P_{C,t}}{P_{C,t+1}}\left\{(P_{O,t+1} - \zeta_{t+1})(1 - \alpha_k - \alpha_L)\frac{Y_{O,t+1}}{Res_t} + \zeta_{t+1}\right\}\right]. \tag{123}$$

B.4 Equilibrium Conditions

We choose the consumption price index $P_{C,t}$ as the numeraire. A general equilibrium is defined as a sequence of endogenous prices and quantities such that, given the initial state variables and the sequence of exogenous processes, the following conditions hold: (i) the representative household maximizes expected utility subject to its budget and capital accumulation constraints; (ii) firms in the nontradable, home tradable, and oil sectors maximize expected profits subject to their respective

technological, resource, and pricing constraints; (iii) the monetary authority follows its specified interest rate rule; and (iv) all goods, factor, and financial markets clear. In particular, the domestic bond market clears in zero net supply, implying $B_t = 0$ for all t.

The endogenous variables are

$$C_t,\ L_t,\ I_t,\ K_t,\ Y_t,\ Y_{T,t},\ Y_{H,t},\ Y_{H,t}^{dom},\ X_{H,t},\ M_t,\ Y_{N,t},\ Y_{O,t}, C_{N,t},\ C_{T,t},\ J_{N,t},\ J_{T,t},\ K_{N,t},\ K_{T,t},\ K_{O,t}, I_{N,t},$$
$$I_{T,t},\ I_{O,t}, L_{N,t},\ L_{T,t},\ L_{O,t},\ W_t,\ \lambda_t,\ B_t^*,\ TB_t,\ P_{C,t},\ P_{N,t},\ P_{T,t},\ P_{H,t},\ P_{I,t}, \Pi_{C,t},\ \Pi_{N,t},\ \Pi_{T,t},\ \Pi_{H,t},\ MC_{N,t},$$
$$MC_{H,t},\ \mathcal{E}_t,\ i_t,\ i_t^*, Res_t,\ \zeta_t,\ R_{N,t},\ R_{T,t},\ R_{O,t},\ Q_{N,t},\ Q_{T,t},\ Q_{O,t}.$$

The exogenous shocks are ε_{t-j}^{Res}. The exogenous foreign prices and foreign demand shifter are $P_{O,t}^*, P_{F,t}^*, Y_t^*$.

B.4.1 Household Optimality Conditions

$$\lambda_t = C_t^{-\sigma}. \tag{124}$$

$$\lambda_t \frac{W_t}{P_{C,t}} = \chi L_t^{\gamma}. \tag{125}$$

$$\lambda_t = \beta \mathbb{E}_t \left[\lambda_{t+1} \frac{1 + i_t}{\Pi_{C,t+1}} \right]. \tag{126}$$

$$\lambda_t = \beta \mathbb{E}_t \left[\lambda_{t+1} (1 + i_t^*) \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right]. \tag{127}$$

$$Q_{h,t} = \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left(\frac{R_{h,t+1}}{P_{C,t+1}} + (1-\delta) Q_{h,t+1} \right) \right], h \in \{N, T, O\}. \tag{128}$$

$$K_{h,t} = (1-\delta) K_{h,t-1} + I_{h,t} \left[1 - \frac{\psi_h}{2} \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right)^2 \right], \qquad h \in \{N, T, O\}. \tag{129}$$

$$\begin{aligned} \frac{P_{I,t}}{P_{C,t}} = Q_{h,t} & \left[1 - \frac{\psi_h}{2} \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right)^2 - \psi_h \left(\frac{I_{h,t}}{I_{h,t-1}} - 1 \right) \frac{I_{h,t}}{I_{h,t-1}} \right] \\ & + \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} Q_{h,t+1} \psi_h \left(\frac{I_{h,t+1}}{I_{h,t}} - 1 \right) \left(\frac{I_{h,t+1}}{I_{h,t}} \right)^2 \right], \qquad h \in \{N, T, O\}. \end{aligned} \tag{130}$$

B.4.2 Production and Factor Demand

$$Y_{H,t} = A_{T,t} K_{T,t-1}^{\alpha_T} L_{T,t}^{1-\alpha_T}. \tag{131}$$

$$R_{T,t} K_{T,t-1} = \alpha_T P_{H,t} MC_{H,t} Y_{H,t}. \tag{132}$$

$$W_t L_{T,t} = (1-\alpha_T) P_{H,t} MC_{H,t} Y_{H,t}. \tag{133}$$

$$Y_{N,t} = A_{N,t} K_{N,t-1}^{\alpha_N} L_{N,t}^{1-\alpha_N}. \tag{134}$$

$$R_{N,t} K_{N,t-1} = \alpha_N P_{N,t} MC_{N,t} Y_{N,t}. \tag{135}$$

$$W_t L_{N,t} = (1-\alpha_N) P_{N,t} MC_{N,t} Y_{N,t}. \tag{136}$$

$$Y_{O,t} = A_{O,t} K_{O,t-1}^{\alpha_K} L_{O,t}^{\alpha_L} Res_{t-1}^{1-\alpha_K-\alpha_L}. \tag{137}$$

$$W_t = \alpha_L \frac{(P_{O,t} - \zeta_t) Y_{O,t}}{L_{O,t}}. \tag{138}$$

$$R_{O,t} = \alpha_k \frac{(P_{O,t} - \zeta_t) Y_{O,t}}{K_{O,t-1}}. \tag{139}$$

$$\zeta_t = \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{P_{C,t}}{P_{C,t+1}} \left\{ (P_{O,t+1} - \zeta_{t+1}) (1-\alpha_K-\alpha_L) \frac{Y_{O,t+1}}{Res_t} + \zeta_{t+1} \right\} \right]. \tag{140}$$

$$Res_t = Res_{t-1} + \varsigma - Y_{O,t} + \varepsilon_{t-j}^{Res}. \tag{141}$$

B.4.3 Aggregation, Demand, and Market Clearing

$$L_t = L_{N,t} + L_{T,t} + L_{O,t}. \tag{142}$$

$$K_t = K_{N,t} + K_{T,t} + K_{O,t}. \tag{143}$$

$$I_t = I_{N,t} + I_{T,t} + I_{O,t}. \tag{144}$$

$$C_{N,t} = \omega_C \left(\frac{P_{N,t}}{P_{C,t}} \right)^{-\xi} C_t. \tag{145}$$

$$C_{T,t} = (1 - \omega_C) \left(\frac{P_{T,t}}{P_{C,t}} \right)^{-\xi} C_t. \tag{146}$$

$$J_{N,t} = \omega_I \left(\frac{P_{N,t}}{P_{I,t}} \right)^{-\xi} I_t. \tag{147}$$

$$J_{T,t} = (1 - \omega_I) \left(\frac{P_{T,t}}{P_{I,t}} \right)^{-\xi} I_t. \tag{148}$$

$$Y_{N,t} = C_{N,t} + J_{N,t} + \frac{\phi_N}{2} (\Pi_{N,t} - 1)^2 Y_{N,t}. \tag{149}$$

$$Y_{T,t} = C_{T,t} + J_{T,t}. \tag{150}$$

$$Y_{H,t} = Y_{H,t}^{dom} + X_{H,t} + \frac{\phi_T}{2} (\Pi_{H,t} - 1)^2 Y_{H,t}. \tag{151}$$

$$P_{I,t}^{1-\xi} = \omega_I P_{N,t}^{1-\xi} + (1 - \omega_I) P_{T,t}^{1-\xi}. \tag{152}$$

$$P_{C,t}^{1-\xi} = \omega_C P_{N,t}^{1-\xi} + (1 - \omega_C) P_{T,t}^{1-\xi}. \tag{153}$$

$$P_{T,t} = \left[\omega_H P_{H,t}^{1-\eta} + (1-\omega_H)(\mathcal{E}_t P_{F,t}^*)^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{154}$$

$$Y_{H,t}^{dom} = \omega_H \left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\eta} Y_{T,t}. \tag{155}$$

$$M_t = (1-\omega_H)\left(\frac{\mathcal{E}_t P_{F,t}^*}{P_{T,t}}\right)^{-\eta} Y_{T,t}. \tag{156}$$

$$X_{H,t} = \left(\frac{P_{H,t}}{\mathcal{E}_t P_{T,t}^*}\right)^{-\eta^*} Y_t^*. \tag{157}$$

B.4.4 Trade Balance and Net Foreign Assets

$$TB_t = P_{H,t}X_{H,t} + \mathcal{E}_t P_{O,t}^* Y_{O,t} - \mathcal{E}_t P_{F,t}^* M_t. \tag{158}$$

$$\mathcal{E}_t B_t^* = (1+i_{t-1}^*)\mathcal{E}_t B_{t-1}^* + TB_t. \tag{159}$$

$$1 + i_t^* = (1+i_t^w)\exp\left[-\chi_B\left(\frac{\mathcal{E}_t B_t^*}{P_{C,t}Y_t} - \bar{b}\right)\right]. \tag{160}$$

B.4.5 Price Setting and Inflation Definitions

$$\begin{aligned} 0 = {} & (1-\varepsilon_N + \varepsilon_N MC_{N,t})\, Y_{N,t} - \phi_N(\Pi_{N,t}-1)\Pi_{N,t} \\ & + \beta \mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{\Pi_{N,t+1}}{\Pi_{C,t+1}}\frac{Y_{N,t+1}}{Y_{N,t}}\phi_N(\Pi_{N,t+1}-1)\Pi_{N,t+1}\right]. \end{aligned} \tag{161}$$

$$\begin{aligned} 0 = {} & (1-\varepsilon_H + \varepsilon_H MC_{H,t})\, Y_{H,t} - \phi_T(\Pi_{H,t}-1)\Pi_{H,t} \\ & + \beta \mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{\Pi_{H,t+1}}{\Pi_{C,t+1}}\frac{Y_{H,t+1}}{Y_{H,t}}\phi_T(\Pi_{H,t+1}-1)\Pi_{H,t+1}\right]. \end{aligned} \tag{162}$$

$$\Pi_{N,t} = \frac{P_{N,t}}{P_{N,t-1}}. \tag{163}$$

$$\Pi_{T,t} = \frac{P_{T,t}}{P_{T,t-1}}. \tag{164}$$

$$\Pi_{H,t} = \frac{P_{H,t}}{P_{H,t-1}}. \tag{165}$$

B.4.6 Monetary Policy and Exchange Rate

$$\frac{1+i_t}{1+\bar{i}} = \left(\frac{1+i_{t-1}}{1+\bar{i}}\right)^{\rho_i} \left[\left(\frac{Y_t}{\bar{Y}}\right)^{\phi_y} \left(\frac{\Pi_{C,t}}{\bar{\Pi}_C}\right)^{\phi_\pi} \left(\frac{\mathcal{E}_t}{\mathcal{E}_{t-1}}\right)^{\phi_e}\right]^{1-\rho_i}. \tag{166}$$

B.4.7 Aggregate Output and Exogenous Processes

$$Y_t = \frac{\bar{P}_H Y_{H,t} + \bar{P}_N Y_{N,t} + \bar{\mathcal{E}} \bar{P}^*_O Y_{O,t}}{\bar{P}_C}. \tag{167}$$

B.5 Log-linearized Equilibrium Conditions

Variables topped with a hat, such as $\hat{X}_t$, denote log-deviations from the deterministic steady state, defined as $\hat{X}_t \equiv \log(X_t/\bar{X})$, except for the interest rates, which is defined as $\hat{i}_t \equiv \log[(1+i_t)/(1+\bar{i})]$, and similarly for the foreign interest rate i^*_t. For gross inflation, we define $\pi_{j,t} \equiv \log(\Pi_{j,t})$. Variables without time variation in steady state are denoted with bars.

Household optimality conditions.

$$\hat{\lambda}_t = -\sigma \hat{C}_t. \tag{168}$$

$$\hat{\lambda}_t + \hat{W}_t - \hat{P}_{C,t} = \gamma \hat{L}_t. \tag{169}$$

$$\hat{\lambda}_t = \mathbb{E}_t\left[\hat{\lambda}_{t+1} + \hat{i}_t - \pi_{C,t+1}\right]. \tag{170}$$

$$\hat{\lambda}_t = \mathbb{E}_t\left[\hat{\lambda}_{t+1} + \hat{i}^*_t + \hat{\mathcal{E}}_{t+1} - \hat{\mathcal{E}}_t\right]. \tag{171}$$

$$\hat{Q}_{h,t} = \beta \frac{\bar{R}_h}{\bar{P}_C} \mathbb{E}_t \left[\hat{\lambda}_{t+1} - \hat{\lambda}_t + \hat{R}_{h,t+1} - \hat{P}_{C,t+1} \right] + \beta(1-\delta) \mathbb{E}_t \left[\hat{\lambda}_{t+1} - \hat{\lambda}_t + \hat{Q}_{h,t+1} \right], \quad h \in \{N, T, O\}. \tag{172}$$

$$\hat{K}_{h,t} = (1-\delta)\hat{K}_{h,t-1} + \delta \hat{I}_{h,t}, \quad h \in \{N, T, O\}. \tag{173}$$

$$\hat{P}_{I,t} - \hat{P}_{C,t} = \hat{Q}_{h,t} - \psi_h \left(\hat{I}_{h,t} - \hat{I}_{h,t-1} \right) + \beta \psi_h \mathbb{E}_t \left[\hat{I}_{h,t+1} - \hat{I}_{h,t} \right], \quad h \in \{N, T, O\}. \tag{174}$$

Production and factor demand.

$$\hat{Y}_{H,t} = \hat{A}_{T,t} + \alpha_T \hat{K}_{T,t-1} + (1-\alpha_T)\hat{L}_{T,t}. \tag{175}$$

$$\hat{R}_{T,t} + \hat{K}_{T,t-1} = \hat{P}_{H,t} + \hat{MC}_{H,t} + \hat{Y}_{H,t}. \tag{176}$$

$$\hat{W}_t + \hat{L}_{T,t} = \hat{P}_{H,t} + \hat{MC}_{H,t} + \hat{Y}_{H,t}. \tag{177}$$

$$\hat{Y}_{N,t} = \hat{A}_{N,t} + \alpha_N \hat{K}_{N,t-1} + (1-\alpha_N)\hat{L}_{N,t}. \tag{178}$$

$$\hat{R}_{N,t} + \hat{K}_{N,t-1} = \hat{P}_{N,t} + \hat{MC}_{N,t} + \hat{Y}_{N,t}. \tag{179}$$

$$\hat{W}_t + \hat{L}_{N,t} = \hat{P}_{N,t} + \hat{MC}_{N,t} + \hat{Y}_{N,t}. \tag{180}$$

$$\hat{Y}_{O,t} = \hat{A}_{O,t} + \alpha_K \hat{K}_{O,t-1} + \alpha_L \hat{L}_{O,t} + (1-\alpha_K-\alpha_L)\hat{Res}_{t-1}. \tag{181}$$

$$\hat{W}_t + \hat{L}_{O,t} = \frac{\bar{P}_O}{\bar{P}_O - \bar{\zeta}} \hat{P}_{O,t} - \frac{\bar{\zeta}}{\bar{P}_O - \bar{\zeta}} \hat{\zeta}_t + \hat{Y}_{O,t}. \tag{182}$$

$$\hat{R}_{O,t} + \hat{K}_{O,t-1} = \frac{\bar{P}_O}{\bar{P}_O - \bar{\zeta}} \hat{P}_{O,t} - \frac{\bar{\zeta}}{\bar{P}_O - \bar{\zeta}} \hat{\zeta}_t + \hat{Y}_{O,t}. \tag{183}$$

$$\hat{\zeta}_t = \mathbb{E}_t\left[\hat{\lambda}_{t+1} - \hat{\lambda}_t + \hat{P}_{C,t} - \hat{P}_{C,t+1}\right] + \beta\mathbb{E}_t\left[\hat{\zeta}_{t+1}\right]$$
$$+ \beta\frac{(1-\alpha_K-\alpha_L)(\bar{P}_O-\bar{\zeta})\bar{Y}_O/\overline{Res}}{\bar{\zeta}}\mathbb{E}_t\left[\frac{\bar{P}_O}{\bar{P}_O-\bar{\zeta}}\hat{P}_{O,t+1} - \frac{\bar{\zeta}}{\bar{P}_O-\bar{\zeta}}\hat{\zeta}_{t+1} + \hat{Y}_{O,t+1} - \widehat{Res}_t\right].$$

$$\overline{Res}\,\widehat{Res}_t = \overline{Res}\,\widehat{Res}_{t-1} - \bar{Y}_O\hat{Y}_{O,t} + \varepsilon^{Res}_{t-j}. \tag{184}$$

Aggregation, demand, and market clearing.

$$\bar{L}\hat{L}_t = \bar{L}_N\hat{L}_{N,t} + \bar{L}_T\hat{L}_{T,t} + \bar{L}_O\hat{L}_{O,t}. \tag{185}$$

$$\bar{K}\hat{K}_t = \bar{K}_N\hat{K}_{N,t} + \bar{K}_T\hat{K}_{T,t} + \bar{K}_O\hat{K}_{O,t}. \tag{186}$$

$$\bar{I}\hat{I}_t = \bar{I}_N\hat{I}_{N,t} + \bar{I}_T\hat{I}_{T,t} + \bar{I}_O\hat{I}_{O,t}. \tag{187}$$

$$\hat{C}_{N,t} = -\xi\left(\hat{P}_{N,t} - \hat{P}_{C,t}\right) + \hat{C}_t. \tag{188}$$

$$\hat{C}_{T,t} = -\xi\left(\hat{P}_{T,t} - \hat{P}_{C,t}\right) + \hat{C}_t. \tag{189}$$

$$\hat{J}_{N,t} = -\xi\left(\hat{P}_{N,t} - \hat{P}_{I,t}\right) + \hat{I}_t. \tag{190}$$

$$\hat{J}_{T,t} = -\xi\left(\hat{P}_{T,t} - \hat{P}_{I,t}\right) + \hat{I}_t. \tag{191}$$

$$\hat{Y}_{N,t} = \frac{\bar{C}_N}{\bar{Y}_N}\hat{C}_{N,t} + \frac{\bar{J}_N}{\bar{Y}_N}\hat{J}_{N,t}. \tag{192}$$

$$\hat{Y}_{T,t} = \frac{\bar{C}_T}{\bar{Y}_T}\hat{C}_{T,t} + \frac{\bar{J}_T}{\bar{Y}_T}\hat{J}_{T,t}. \tag{193}$$

$$\hat{Y}_{H,t} = \frac{\bar{Y}_H^{dom}}{\bar{Y}_H}\hat{Y}_{H,t}^{dom} + \frac{\bar{X}_T}{\bar{Y}_H}\hat{X}_{T,t}. \tag{194}$$

$$\hat{P}_{I,t} = \omega_I \left(\frac{\bar{P}_N}{\bar{P}_I}\right)^{1-\xi} \hat{P}_{N,t} + (1-\omega_I)\left(\frac{\bar{P}_T}{\bar{P}_I}\right)^{1-\xi} \hat{P}_{T,t}. \tag{195}$$

$$\hat{P}_{C,t} = \omega_C \left(\frac{\bar{P}_N}{\bar{P}_C}\right)^{1-\xi} \hat{P}_{N,t} + (1-\omega_C)\left(\frac{\bar{P}_T}{\bar{P}_C}\right)^{1-\xi} \hat{P}_{T,t}. \tag{196}$$

$$\hat{P}_{T,t} = \omega_H \left(\frac{\bar{P}_H}{\bar{P}_T}\right)^{1-\eta} \hat{P}_{H,t} + (1-\omega_H)\left(\frac{\bar{\mathcal{E}}\bar{P}_F^*}{\bar{P}_T}\right)^{1-\eta} \left(\hat{\mathcal{E}}_t + \hat{P}_{F,t}^*\right). \tag{197}$$

$$\hat{Y}_{H,t}^{dom} = -\eta\left(\hat{P}_{H,t} - \hat{P}_{T,t}\right) + \hat{Y}_{T,t}. \tag{198}$$

$$\hat{M}_t = -\eta\left(\hat{\mathcal{E}}_t + \hat{P}_{F,t}^* - \hat{P}_{T,t}\right) + \hat{Y}_{T,t}. \tag{199}$$

$$\hat{X}_{T,t} = -\eta^*\left(\hat{P}_{H,t} - \hat{\mathcal{E}}_t - \hat{P}_{F,t}^*\right) + \hat{Y}_t^*. \tag{200}$$

Trade balance and net foreign assets.

$$\begin{aligned}\widehat{\overline{TB}TB}_t = {} & \bar{P}_H\bar{X}_T\left(\hat{P}_{H,t} + \hat{X}_{T,t}\right) + \bar{\mathcal{E}}\bar{P}_O^*\bar{Y}_O\left(\hat{\mathcal{E}}_t + \hat{P}_{O,t}^* + \hat{Y}_{O,t}\right) \\ & - \bar{\mathcal{E}}\bar{P}_F^*\bar{M}\left(\hat{\mathcal{E}}_t + \hat{P}_{F,t}^* + \hat{M}_t\right).\end{aligned} \tag{201}$$

$$\bar{\mathcal{E}}\bar{B}^*\left(\hat{\mathcal{E}}_t + \hat{B}_t^*\right) = (1+\bar{i}^*)\bar{\mathcal{E}}\bar{B}^*\left(\hat{\mathcal{E}}_t + \hat{B}_{t-1}^* + \hat{i}_{t-1}^*\right) + \widehat{\overline{TB}TB}_t. \tag{202}$$

$$\hat{i}_t^* = -\chi_B\bar{b}\left(\hat{\mathcal{E}}_t + \hat{B}_t^* - \hat{P}_{C,t} - \hat{Y}_t\right). \tag{203}$$

Price setting and inflation definitions.

$$\pi_{N,t} = \beta\mathbb{E}_t\pi_{N,t+1} + \kappa_N\widehat{MC}_{N,t}, \qquad \kappa_N \equiv \frac{\varepsilon_N - 1}{\phi_N}. \tag{204}$$

$$\pi_{H,t} = \beta \mathbb{E}_t \pi_{H,t+1} + \kappa_H \widehat{MC}_{H,t}, \qquad \kappa_H \equiv \frac{\varepsilon_H - 1}{\phi_T}. \tag{205}$$

Sectoral inflation rates are defined as first differences of log price deviations:

$$\pi_{N,t} \equiv \widehat{p}_{N,t} - \widehat{p}_{N,t-1}, \tag{206}$$

$$\pi_{H,t} \equiv \widehat{p}_{H,t} - \widehat{p}_{H,t-1}, \tag{207}$$

The tradable price index is

$$P_{T,t} = \left[\omega_H P_{H,t}^{1-\eta} + (1-\omega_H)(\mathcal{E}_t P_{F,t}^*)^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{208}$$

Log-linearizing this index around the steady state gives

$$\widehat{p}_{T,t} = s_H \widehat{p}_{H,t} + (1 - s_H)\left(\widehat{\epsilon}_t + \widehat{p}_{F,t}^*\right), \tag{209}$$

where the steady-state expenditure share of home-produced goods in the tradable bundle is

$$s_H \equiv \frac{\omega_H \bar{P}_H^{1-\eta}}{\omega_H \bar{P}_H^{1-\eta} + (1-\omega_H)(\bar{\mathcal{E}}\bar{P}_F^*)^{1-\eta}} = \omega_H \left(\frac{\bar{P}_H}{\bar{P}_T}\right)^{1-\eta}. \tag{210}$$

Taking first differences yields tradable inflation:

$$\begin{aligned}
\pi_{T,t} &\equiv \widehat{p}_{T,t} - \widehat{p}_{T,t-1} \\
&= s_H\left(\widehat{p}_{H,t} - \widehat{p}_{H,t-1}\right) + (1 - s_H)\left[\left(\widehat{\epsilon}_t - \widehat{\epsilon}_{t-1}\right) + \left(\widehat{p}_{F,t}^* - \widehat{p}_{F,t-1}^*\right)\right] \\
&= s_H \pi_{H,t} + (1 - s_H)\left(\Delta\epsilon_t + \pi_{F,t}^*\right),
\end{aligned} \tag{211}$$

where

$$\Delta\epsilon_t \equiv \widehat{\epsilon}_t - \widehat{\epsilon}_{t-1} = \log \mathcal{E}_t - \log \mathcal{E}_{t-1}, \qquad \pi_{F,t}^* \equiv \widehat{p}_{F,t}^* - \widehat{p}_{F,t-1}^* = \log P_{F,t}^* - \log P_{F,t-1}^*. \tag{212}$$

If foreign prices are constant, $\pi_{F,t}^* = 0$, and therefore

$$\pi_{T,t} = s_H \pi_{H,t} + (1 - s_H)\Delta\epsilon_t. \tag{213}$$

The CPI price index is

$$P_{C,t} = \left[\omega_C P_{N,t}^{1-\xi} + (1-\omega_C) P_{T,t}^{1-\xi}\right]^{\frac{1}{1-\xi}}. \tag{214}$$

Log-linearizing this index around the steady state gives

$$\widehat{p}_{C,t} = s_C \widehat{p}_{N,t} + (1-s_C)\widehat{p}_{T,t}, \tag{215}$$

where the steady-state expenditure share of nontradables in the consumption basket is

$$s_C \equiv \frac{\omega_C \bar{P}_N^{1-\xi}}{\omega_C \bar{P}_N^{1-\xi} + (1-\omega_C)\bar{P}_T^{1-\xi}} = \omega_C \left(\frac{\bar{P}_N}{\bar{P}_C}\right)^{1-\xi}. \tag{216}$$

Taking first differences yields CPI inflation:

$$\begin{aligned} \pi_{C,t} &\equiv \widehat{p}_{C,t} - \widehat{p}_{C,t-1} \\ &= s_C\left(\widehat{p}_{N,t} - \widehat{p}_{N,t-1}\right) + (1-s_C)\left(\widehat{p}_{T,t} - \widehat{p}_{T,t-1}\right) \\ &= s_C \pi_{N,t} + (1-s_C)\pi_{T,t}. \end{aligned} \tag{217}$$

Combining (204), (205), (213), and (217) gives

$$\pi_{C,t} = s_C\left(\beta \mathbb{E}_t \pi_{N,t+1} + \kappa_N \widehat{MC}_{N,t}\right) + (1-s_C)\left[s_H\left(\beta \mathbb{E}_t \pi_{H,t+1} + \kappa_H \widehat{MC}_{H,t}\right) + (1-s_H)\Delta\epsilon_t\right]. \tag{218}$$

Aggregate output and exogenous processes.

$$\bar{Y}\hat{Y}_t = \frac{\bar{P}_H \bar{Y}_H}{\bar{P}_C}\hat{Y}_{H,t} + \frac{\bar{P}_N \bar{Y}_N}{\bar{P}_C}\hat{Y}_{N,t} + \frac{\bar{\mathcal{E}}\bar{P}_O^* \bar{Y}_O}{\bar{P}_C}\hat{Y}_{O,t}. \tag{219}$$

Monetary policy and exchange rate. The log-linearized Taylor rule and the forward-looking solution for the nominal exchange rate are derived in Appendix B.5.1.

B.5.1 Derivation of the Forward-Looking Nominal Exchange Rate

This appendix derives the solution for the nominal exchange rate stated in Lemma 1. The log-linearized Taylor rule (60) is

$$\hat{i}_t = \rho_i \hat{i}_{t-1} + (1-\rho_i)\left[\phi_\pi\, \pi_{C,t} + \phi_y\, \hat{Y}_t + \phi_e\left(\hat{\mathcal{E}}_t - \hat{\mathcal{E}}_{t-1}\right)\right]. \tag{220}$$

Define $\bar{b} \equiv \bar{\mathcal{E}}\bar{B}^*/(\bar{P}_C\bar{Y})$ as the steady-state net foreign asset position relative to output and let $\hat{i}_t^w \equiv \log[(1+i_t^w)/(1+\bar{i}^w)]$. Log-linearizing equation (63) yields

$$\hat{i}_t = \hat{i}_t^w + \mathbb{E}_t[\hat{\mathcal{E}}_{t+1}] - \hat{\mathcal{E}}_t - \chi_B\bar{b}\big(\hat{\mathcal{E}}_t + \hat{B}_t^* - \hat{P}_{C,t} - \hat{Y}_t\big). \tag{221}$$

Equating (220) and (221) and collecting terms involving $\hat{\mathcal{E}}_t$ gives

$$\big[1 + \chi_B\bar{b} + (1-\rho_i)\phi_e\big]\,\hat{\mathcal{E}}_t = \mathbb{E}_t[\hat{\mathcal{E}}_{t+1}] + D_t, \tag{222}$$

where the driving process D_t is

$$\begin{aligned} D_t \equiv\ & \hat{i}_t^w - \rho_i\hat{i}_{t-1} - (1-\rho_i)\big[\phi_\pi\pi_{C,t} + \phi_y\hat{Y}_t\big] \\ & + (1-\rho_i)\phi_e\hat{\mathcal{E}}_{t-1} + \chi_B\bar{b}\big(\hat{P}_{C,t} + \hat{Y}_t - \hat{B}_t^*\big). \end{aligned} \tag{223}$$

As $\Gamma = 1 + \chi_B\bar{b} + (1-\rho_i)\phi_e > 1$ in our calibration, solving equation (222) for $\hat{\mathcal{E}}_t$ yields equation (64) in Lemma 1. Since $1/\Gamma < 1$, iterating (64) forward yields the unique bounded solution

$$\hat{\mathcal{E}}_t = \frac{1}{\Gamma}\sum_{k=0}^{\infty}\left(\frac{1}{\Gamma}\right)^k \mathbb{E}_t\big[D_{t+k}\big], \tag{224}$$

which expresses the nominal exchange rate as a present value of expected future fundamentals.

B.5.2 Real Exchange Rate Decomposition

This appendix derives the log-linear relationship between the real exchange rate and relative prices in the model. Unlike the standard Balassa-Samuelson framework, the model's tradable price index is a CES composite of home-produced and imported goods, so the law of one price need not hold for the tradable bundle as a whole.

The real exchange rate is defined as

$$e_t \equiv \frac{\mathcal{E}_t P_{F,t}^*}{P_{C,t}}. \tag{225}$$

Log-linearizing around the steady state and setting foreign prices constant, $\hat{P}_{F,t}^* = 0$, gives

$$\hat{e}_t = \hat{\mathcal{E}}_t - \hat{P}_{C,t}. \tag{226}$$

From the log-linearized CPI index, equation (215), we have

$$\hat{P}_{C,t} = s_C \hat{P}_{N,t} + (1 - s_C)\hat{P}_{T,t}, \tag{227}$$

where $s_C \equiv \omega_C (\bar{P}_N / \bar{P}_C)^{1-\xi}$ is the steady-state nontradable expenditure share. From the log-linearized tradable price index, equation (209),

$$\hat{P}_{T,t} = s_H \hat{P}_{H,t} + (1 - s_H)\hat{\mathcal{E}}_t, \tag{228}$$

where $s_H \equiv \omega_H (\bar{P}_H / \bar{P}_T)^{1-\eta}$ is the steady-state home share in the tradable bundle and we have used $\hat{P}^*_{F,t} = 0$.

Substituting (228) into (227) and then into (226) yields

$$\begin{aligned} \hat{e}_t &= \hat{\mathcal{E}}_t - s_C \hat{P}_{N,t} - (1 - s_C)\left[s_H \hat{P}_{H,t} + (1 - s_H)\hat{\mathcal{E}}_t\right] \\ &= \left[1 - (1 - s_C)(1 - s_H)\right]\hat{\mathcal{E}}_t - s_C \hat{P}_{N,t} - (1 - s_C) s_H \hat{P}_{H,t}. \end{aligned} \tag{229}$$

To express the real exchange rate in terms of relative prices, define the internal relative price of nontradables and the relative price of home tradables:

$$\hat{p}^{N/T}_t \equiv \hat{P}_{N,t} - \hat{P}_{T,t}, \qquad \hat{p}^{H/F}_t \equiv \hat{P}_{H,t} - \hat{\mathcal{E}}_t. \tag{230}$$

Using $\hat{P}_{N,t} = \hat{p}^{N/T}_t + \hat{P}_{T,t}$ and substituting (228), we obtain $\hat{P}_{N,t} = \hat{p}^{N/T}_t + s_H \hat{P}_{H,t} + (1 - s_H)\hat{\mathcal{E}}_t$. Inserting this into (229) and collecting terms:

$$\begin{aligned} \hat{e}_t &= \left[1 - (1 - s_C)(1 - s_H)\right]\hat{\mathcal{E}}_t - s_C\left[\hat{p}^{N/T}_t + s_H \hat{P}_{H,t} + (1 - s_H)\hat{\mathcal{E}}_t\right] - (1 - s_C) s_H \hat{P}_{H,t} \\ &= \left[1 - (1 - s_C)(1 - s_H) - s_C(1 - s_H)\right]\hat{\mathcal{E}}_t - s_C \hat{p}^{N/T}_t - \left[s_C s_H + (1 - s_C) s_H\right]\hat{P}_{H,t} \\ &= s_H \hat{\mathcal{E}}_t - s_C \hat{p}^{N/T}_t - s_H \hat{P}_{H,t} \\ &= -s_C \hat{p}^{N/T}_t - s_H (\hat{P}_{H,t} - \hat{\mathcal{E}}_t) \\ &= -s_C \hat{p}^{N/T}_t - s_H \hat{p}^{H/F}_t. \end{aligned} \tag{231}$$

Equation (231) decomposes the real exchange rate into two components. The first term, $-s_C \hat{p}^{N/T}_t$, captures the contribution of the internal relative price of nontradables: a rise in $P_{N,t}/P_{T,t}$ appreciates the real exchange rate with elasticity s_C. The second term, $-s_H \hat{p}^{H/F}_t$, captures deviations from the law of one price in home-produced tradables: an increase in the domestic-currency price of home

tradables relative to the exchange rate also appreciates the real exchange rate, with elasticity s_H.

Following an oil-discovery news shock, both channels contribute to real appreciation. The anticipated future resource windfall raises domestic absorption and increases demand for nontradable goods, driving up $\hat{p}_t^{N/T}$. At the same time, stronger domestic demand and tighter factor markets raise home tradable marginal costs and therefore $\hat{P}_{H,t}$, while the nominal exchange rate appreciates ($\hat{\mathcal{E}}_t < 0$) in response to the expected improvement in the external position. Both forces push $\hat{e}_t$ downward, generating a real appreciation. Through the tradable price index (228), the nominal appreciation also lowers the domestic-currency price of imported goods, which is the mechanism through which the exchange-rate channel dampens tradable inflation.