Inflation and Exchange Rate Shocks in the Presence of Parallel Markets*

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Abstract

We study exchange-rate pass-through to consumer prices in dual-rate economies, where an official rate coexists with a parallel-market rate at a substantial premium, using monthly Nigerian data from 2014 to 2023. Prices respond strongly to the parallel rate but weakly to the administered official rate. In a structural VAR, a one-standard-deviation parallel-rate depreciation raises cumulative CPI by about 0.5% over the following year, implying a twelve-month structural pass-through of about 0.29. By contrast, a shock that raises the official rate does not raise prices; the central estimate is weakly negative. The asymmetry holds across major CPI sub-indices, widens with the parallel premium, and is corroborated by a joint OLS local projection. We interpret these findings through a framework of foreign-exchange rationing and repressed goods markets, in which the parallel rate is the marginal price of imports and the official rate acts only through fiscal financing and money creation, consistent with its weakly negative response. Central banks that track only the official rate may thus underestimate the sensitivity of inflation to exchange-rate movements in dual-rate regimes.

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1 Introduction

Exchange rate pass-through to retail prices shapes the real effects of nominal exchange rate movements, the welfare consequences of devaluation, and the transmission of monetary policy in open economies. A literature beginning with Mussa (1986) studies the channels linking exchange rates to domestic prices, including dollar invoicing, distribution margins, and pricing-to-market (Burstein et al., 2005; Atkeson and Burstein, 2008; Burstein and Gopinath, 2014; Gopinath et al., 2020).

This literature has largely abstracted from parallel foreign exchange markets.[1] Parallel markets are secondary markets in which foreign exchange trades outside official channels, typically at a premium over the central bank rate. They arise under managed regimes when official supply is rationed. They are common: in 2021, 23% of countries operated some form of multiple currency practice or exchange restriction conducive to parallel-market activity (IMF, 2022). When an official rate coexists with a parallel rate at a meaningful premium, two questions follow. Which rate is the relevant price of foreign exchange for the transactions that drive retail prices? And how should pass-through be measured when parallel-rate movements may already have transmitted to inflation before the official rate adjusts?

We answer these questions for Nigeria, where the gap between the parallel and official rates has been persistent. We assemble a daily dataset of parallel-market quotes covering 2014 to 2023 and combine it with official rates, central-bank external reserves, money, and consumer prices from the Central Bank of Nigeria and the National Bureau of Statistics. Over the pre-unification estimation sample (November 2014 to May 2023), the parallel premium averages 30% and peaks above 77%.

We organize the analysis around the general-equilibrium framework of inflation under foreign exchange rationing and repressed goods markets developed by Cerra (2016). When dollars are rationed at an overvalued official rate, the marginal price of foreign exchange is set in the parallel market. A binding cash-in-advance constraint pins down contemporaneous prices through money chasing the available quantity of imports. Because importers obtain incremental dollars at the parallel rate, marginal import pricing reflects the parallel market even when inframarginal dollars are allocated at the official rate (i.e., the parallel rate equals the scarcity price of those imports). The official rate enters only through future money creation: a higher official rate raises the naira value of dollar revenues sold by the central bank, narrows the fiscal deficit, and reduces subse-

[1] Some prior work considers parallel markets in the context of real exchange rate misalignment and deviations from purchasing power parity (e.g., Edwards, 1988; Sekkat and Varoudakis, 2000; Cavallo and Rigobon, 2016); our focus is the dynamics of pass-through to consumer prices.

quent monetary financing. Reserves operate the same way: when the central bank accumulates reserves, fewer dollars are absorbed from the private sector and money creation rises. The framework predicts distinct qualitative responses of the parallel rate, official rate, money, prices, and reserves to structural shocks, which we exploit for identification.

A sign-restricted structural VAR recovers the response to each shock from the qualitative restrictions the framework implies, and an OLS local projection that conditions consumer prices on both rates delivers the same asymmetry without the sign restrictions. A shock that depreciates the parallel rate raises cumulative CPI by about 0.5% over the following year, a structural pass-through of about 0.29 at twelve months. A shock that raises the official rate produces zero or weakly negative inflation, its central estimate consistent with the fiscal-financing channel in the framework. An adverse oil-revenue shock raises both rates, expands money, drains reserves by roughly 3.6% at twelve months, and raises prices through both channels. The asymmetry survives at the food sub-index, holds across the divisional CPI sub-indices, and is sharper in months when the parallel premium is wide.

Additional evidence supports this reading. A cross-sectional experiment recovers the mechanism from variation across goods rather than over time: when the CBN barred forty-one import categories from the official window in June 2015, forcing those goods alone onto the parallel market, prices in the more exposed CPI divisions rose about four percentage points faster over the following year. The asymmetry between the parallel and official rates is not an artifact of the currency in which imports are invoiced: despite China's standing as Nigeria's largest supplier and a bilateral swap line since 2018, Chinese imports are priced in dollars, and pass-through is not strongly related to a division's Chinese import share.

The paper contributes to two literatures. To the literature on exchange-rate pass-through in emerging markets, it shows that estimates relying on a single official rate can mismeasure pass-through in dual-rate regimes, where the relevant transaction price of foreign exchange is set in the parallel market, and that the shock-dependence documented for single-rate economies (Forbes et al., 2018, 2020) extends to the question of which of two rates a given shock moves. To the literature on parallel currency markets, it provides a quantitative reading of the fiscal-channel mechanism in a dual-rate economy, including its dependence on the size of the parallel premium and on the sign of the government's net foreign-exchange position.

The findings speak to a recurring policy question in emerging markets: whether central banks should delay an official devaluation to protect against inflation. When a meaningful parallel premium exists, much of the inflation has already passed through by the

time the official rate moves, blunting the protective effect of waiting. The structural results sharpen this conclusion. An official-rate movement driven by CBN policy does not raise prices on net at intermediate horizons; the central estimate is weakly contractionary. An official-rate movement that arrives through oil-revenue pressure raises prices through both the direct and money channels. The two events look similar in the data—in both cases the CBN devalues, but their consequences for inflation differ sharply.

Although the empirical analysis focuses on Nigeria, the mechanism is potentially relevant to a much broader class of economies characterized by foreign-exchange rationing, segmented currency markets, and administered exchange rates. Parallel-market premia emerged repeatedly in economies such as Argentina, Egypt, Lebanon, Iran, and Venezuela during periods of reserve scarcity and capital controls. The Nigerian case therefore provides a tractable setting in which to study a broader question: which exchange rate matters for inflation when official and market exchange rates diverge persistently?

Related Literature. An empirical literature studies exchange rate pass-through to consumer prices in economies without a parallel foreign exchange market. Goldberg and Knetter (1997) survey the early evidence, and Campa and Goldberg (2005, 2010) provide cross-country estimates of pass-through into import and consumer prices. Burstein et al. (2005) show that large nominal devaluations in emerging markets produce limited consumer-price inflation, attributing the gap to local distribution margins and substitution toward lower-quality goods. A complementary theoretical literature studies pricing-to-market, currency choice, and dollar invoicing as drivers of pass-through (Engel, 2006; Atkeson and Burstein, 2008; Gopinath et al., 2010). Boz et al. (2019) and Gopinath et al. (2020) document the empirical centrality of the dollar in international price-setting. Itskhoki and Mukhin (2021b) revisit the joint behavior of nominal and real exchange rates and rationalize key pass-through puzzles in a unified framework. Auer et al. (2021) report low retail pass-through in Switzerland after the 2015 franc appreciation. Cravino and Levchenko (2017) find that pass-through is heterogeneous across income deciles, with poorer households facing larger price increases. Forbes et al. (2018, 2020) show that the extent of pass-through depends on the shock driving the exchange rate, decomposing currency movements into underlying shocks that transmit to prices at systematically different rates.

A second literature, on currency misalignment and purchasing power parity, treats the parallel rate as the relevant price of foreign exchange. Dornbusch et al. (1983) provides an early case study of the Brazilian black market; Greenwood and Kimbrough (1987) and

Edwards (1988) model the determinants of the parallel rate under foreign exchange controls. Ghura and Grennes (1993), Sekkat and Varoudakis (2000), and Luintel (2000) link parallel premia to real exchange rate misalignment and to deviations from PPP. Cavallo and Rigobon (2016) use Argentine online prices to document persistent failures of the law of one price when the official rate is overvalued. Our contribution differs in focusing on dynamic CPI pass-through and on distinguishing the inflationary effects of parallel- and official-rate movements.

A third literature addresses the macroeconomic and fiscal consequences of parallel currency markets. Agénor (1992), Kiguel and O'Connell (1995), and Reinhart and Rogoff (2004) survey the historical prevalence of dual-rate regimes. Pinto (1988, 1991) and Morris (1995) build models in which the parallel rate is the marginal price of foreign exchange and an official devaluation has no direct effect on inflation, operating instead as an implicit tax that links the equilibrium premium to the fiscal deficit; Pinto (1991) argues that exchange-rate reform is therefore first a fiscal problem. Kaufmann and O'Connell (1991, 1997) document the fiscal and monetary correlates of the parallel premium in Tanzania. Schmitt-Grohé and Uribe (2024) solve for the optimal mix of exchange controls and inflation finance in a general-equilibrium economy with chronic fiscal deficits. Cerra (2016), on whose framework we build, develops a general-equilibrium model of inflation under foreign exchange rationing in Venezuela. Most directly related, Lariau et al. (2016) estimate pass-through in Angola and Nigeria using official and interbank rates and find no significant pass-through to Nigerian headline inflation; we revisit this finding by adding the parallel rate.

We also build on a methodological literature on identifying structural shocks in macroeconomic time series. We trace impulse responses using local projections following Jordà (2005). The sign-restricted SVAR adapts Uhlig (2005) and Rubio-Ramírez et al. (2010): structural shocks are recovered up to a set of rotations consistent with qualitative restrictions, and the restrictions in our case are read directly off the model in Section 3. The instrumental-variable local projection uses an external shifter to identify a single structural shock, as in Stock and Watson (2018) and Mertens and Ravn (2013). Our use of Nigeria-specific oil-supply disruptions is closest in spirit to Känzig (2021), who isolates global oil supply news from high-frequency surprises around OPEC announcements; we instead exploit physical disruption events documented in Rexer and Hvinden (2026).

Roadmap. The rest of the paper proceeds as follows. Section 2 provides background on parallel foreign exchange markets in Nigeria. Section 3 sets out the conceptual framework. Section 4 describes the data and the empirical strategy. Section 5 presents the main

results. Section 6 concludes.

2 Parallel Markets for Foreign Exchange

Parallel markets arise when a managed exchange rate coexists with restrictions on foreign exchange access. Agénor (1992) traces their emergence in developing countries to trade-flow restrictions in low-income economies and to capital controls in middle-income ones. The parallel market fills the residual demand left unmet by the official window.

Such restrictions are common across the developing world. According to the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* (IMF, 2022), 69% of countries operated some form of managed exchange arrangement in 2021. Of these, 11% maintain multiple currency practices and a further 12% apply foreign exchange restrictions that can give rise to parallel-market activity during periods of distress. All countries in the latter two groups are emerging-market and developing economies. Given the unofficial nature of many parallel markets, these counts likely understate prevalence.

Where parallel markets exist, the premium over the official rate is often substantial. Appendix Table A1 reports official and parallel rates as of March 2023 for the 25 countries with documented multiple currency practices, compiled by the World Bank (Malpass, 2023). Premiums vary widely. Crisis and conflict economies such as Lebanon, Yemen, Syria, and Iran show premiums above 100%. A second group of managed-regime economies—Argentina, Ethiopia, Zimbabwe, Burundi, Nigeria, and Algeria—operates with persistent premiums of 40% to 90%. Nigeria, the focus of this paper, sits in this group at 62% on the reference date. A third group maintains parallel markets with premiums under 15%.

2.1 Nigeria's Foreign Exchange Market

Nigeria has operated a parallel foreign exchange market continuously since the 1986 Structural Adjustment Programme replaced a fixed-rate regime with an auction-based one. Through the 1990s and 2000s, the Central Bank of Nigeria (CBN) cycled through a series of managed-rate arrangements. A parallel market filled residual demand whenever official supply was rationed.

Our sample covers an active phase of this regime. The 2014–2016 oil price collapse prompted the CBN to impose administrative rationing on a managed official rate. In June 2015 it issued a list of imports (the "41-item list," later expanded to 43 items) that could not be funded through any official window. These restrictions effectively forced importers in

excluded categories to source incremental foreign exchange through the parallel market. The key economic intuition is simple. Even when some firms receive foreign exchange at the official rate, the relevant price for retail pricing is often the cost of obtaining the next dollar rather than the average historical acquisition cost of existing inventories. Firms unable to secure sufficient official allocations must source incremental foreign exchange in the parallel market, and retail prices adjust accordingly. In this sense, the parallel rate functions as the marginal exchange rate for import pricing under rationing, while the official rate primarily determines the distribution of rents across firms with privileged access to the official window.

In June 2016 the CBN devalued the official rate from N197 to N305 per dollar and announced a transition to a flexible interbank market, but re-pegged shortly afterward. From the April 2017 launch of the Investors and Exporters (I&E) window onward, the CBN operated several official windows with distinct access criteria. In June 2023, the CBN collapsed its multiple windows into a single willing-buyer-willing-seller market, and the naira moved from N461 per dollar to N750 over the following weeks. Our estimation sample ends in May 2023, immediately before this break, to isolate the dual-rate regime. This institutional setting makes Nigeria a natural environment in which to distinguish between the administered official exchange rate and the marginal market-clearing exchange rate relevant for retail pricing.

3 Conceptual Framework

This section sets out the framework we use to interpret the empirical results. The framework follows Cerra (2016), drawing on her nontraded-good extension. We write out the two-good case in a form that aligns with the empirical specifications and make explicit the role of central-bank foreign exchange reserves. The mechanism is Cerra's: under foreign exchange rationing, current prices are pinned down by money and goods availability rather than by the official exchange rate, while the official rate operates indirectly through fiscal financing. Relative to Cerra (2016), we give the parallel market explicit structure: alongside importers, it is attended by noise traders whose demand for dollars is unrelated to current imports. Shocks to this demand are financial shocks in the sense of the segmented-markets exchange-rate literature (Gabaix and Maggiori, 2015; Itskhoki and Mukhin, 2021a), the structural counterpart of the financial shock in our empirical analysis. The framework is a set of within-period equilibrium conditions and flow identities. We use it to sign impact and short-horizon responses, not as a closed dynamic model.

3.1 Environment

Consider a small open economy that exports oil and imports one consumption good, indexed by T. Oil export receipts X_t are exogenous and accrue to the government. The government sells these receipts to the central bank at the official exchange rate s_t (domestic currency per dollar) and makes exogenous transfers T_t to households in domestic currency. The central bank allocates foreign exchange through rationing. A fraction $(1-\phi)X_t$ is sold directly to importers at the official rate, while the remaining ϕX_t is allocated to arbitrageurs (in Nigeria, the licensed bureaux de change), who resell those dollars on the parallel market at rate b_t. The parallel market has a second set of participants, noise traders, whom we introduce below.

Central bank balance sheet. The central bank's assets are international reserves R_t, a dollar stock valued at the official rate,[2] and net domestic assets N_t, which include the valuation account. Its liability is base money M_t:

$$s_t R_t + N_t = M_t. \tag{1}$$

The central bank need not distribute its dollar receipts in full each period. It retains a fixed share $\rho \in [0, 1)$ of X_t as reserves, an exogenous parameter of reserve policy. The reserve stock evolves as

$$R_{t+1} = R_t + \rho X_t. \tag{2}$$

The volume of dollars sold to importers and arbitrageurs is then $(1 - \rho)X_t$.

Money creation. Combining the consolidated government budget with the central-bank balance sheet (1) yields the money-supply equation

$$M_{t+1} = M_t + T_t - s_t(1 - \rho)X_t. \tag{3}$$

When $\rho = 0$ this is the Cerra (2016) baseline, money growth equal to the fiscal deficit. A positive ρ adds $s_t \rho X_t$, so that money creation in excess of the deficit equals the naira value of reserve accumulation, $\Delta M_{t+1} = T_t - s_t X_t + s_t \Delta R_{t+1}$.

Two implications guide the shock identification below. A higher official rate raises the naira value of every dollar the central bank sells, narrowing the deficit and slowing money creation while leaving the reserve stock unchanged. An adverse oil shock instead

[2]The identity holds at the prevailing s_t; revaluation of the stock when the official rate changes is absorbed in N_t. Measuring reserves in dollars matches the empirical series used in Section 4.

works on both margins: money creation rises as fewer dollars are sold, and, for the empirically relevant $\rho > 0$, reserves fall below their path as fewer are retained. The two shocks separate in the data, which Section 4 exploits.

3.2 Production, preferences, and pricing

There are two consumption goods. The first, T, is the imported good, purchased at the exogenous world price P_t^* and sold domestically at price P_t^T. The second, N, is locally produced with inelastic labor and productivity A_t:

$$Y_t^N = A_t L_t, \tag{4}$$

with $L_t = 1$ for all t and A_t an exogenous process capturing shocks to local productivity. A representative competitive producer chooses labor to maximize $P_t^N A_t L_t - w_t L_t$, implying the zero-profit condition

$$w_t = A_t P_t^N. \tag{5}$$

The representative household has preferences

$$U(C_t^T, C_t^N) = \omega \log C_t^T + (1-\omega) \log C_t^N, \qquad \omega \in (0,1), \tag{6}$$

and faces the budget constraint

$$M_{t+1} + P_t^T C_t^T + P_t^N C_t^N + b_t \psi_t = M_t + T_t + \Pi_t + w_t, \tag{7}$$

where Π_t denotes gross profits from import and arbitrage firms and $b_t \psi_t$ settles the dollar purchases of the household's noise-trader members, described below. Purchases of goods require cash in advance,

$$M_t \geq P_t^T C_t^T + P_t^N C_t^N. \tag{8}$$

We focus on the regime in which the constraint binds, $M_t = P_t^T C_t^T + P_t^N C_t^N$, the relevant case under positive expected inflation.

3.3 Noise traders

Alongside import firms, the parallel market is attended by noise traders, agents who purchase dollars for purposes unrelated to current imports: capital flight, precautionary hoarding of foreign currency, speculation against the peg. Their demand is a quantity ψ_t, which we treat as an exogenous, persistent process. Dis-hoarding and informal re-

mittance inflows sold on the parallel market enter as negative realizations. We refer to innovations to ψ_t as *financial shocks*.[3]

Noise traders hold no naira balances of their own. A purchase of ψ_t dollars is a zero-capital position: ψ_t dollars long against $b_t\psi_t$ naira owed to the arbitrageurs on trade credit, due at the period's close. Goods purchases require cash on the spot, constraint (8). Financial positions are credit transactions in the sense of Lucas and Stokey (1987): they settle at the close, when the household's members, noise traders included, pool receipts and obligations. The naira leg is the $b_t\psi_t$ settlement term in (7), and it nets against the same amount arriving inside Π_t. Two properties follow. No naira changes hands in the parallel market until the close, and the close nets within the household, so the money-supply equation (3) does not involve ψ_t: a financial shock leaves the money stock unchanged. The dollars, by contrast, leave the import circuit at once, so the same money chases fewer imported goods.[4]

3.4 Imported and local goods under rationing

Let Q_t denote the quantity of the imported good available for sale in period t. Under a binding cash-in-advance constraint and Cobb-Douglas preferences, the household allocates constant expenditure shares across the two goods:

$$P_t^T C_t^T = \omega M_t, \qquad P_t^N C_t^N = (1-\omega) M_t. \tag{9}$$

Imposing goods-market clearing, $C_t^T = Q_t$ and $C_t^N = Y_t^N$, yields

$$P_t^T = \omega \frac{M_t}{Q_t}, \tag{10}$$

and

$$P_t^N = (1-\omega) \frac{M_t}{Y_t^N}. \tag{11}$$

Equations (10)–(11) are the key departure from a standard cost-push view of inflation. Current prices depend on money and on the quantities of goods available for sale, not

[3]One microfoundation is the segmented-markets model of Gabaix and Maggiori (2015) and Itskhoki and Mukhin (2021a), in which noise-trader currency demand is absorbed by intermediaries with limited risk-bearing capacity; our ψ_t is the flow counterpart of their zero-capital noise-trader positions. In the older parallel-market literature the same object appears as portfolio demand for foreign currency (Dornbusch et al., 1983; Agénor, 1992; Kaufmann and O'Connell, 1997).

[4]The settlement convention matters for one result: if foreign-exchange purchases were instead financed one-for-one out of goods cash, the impact effect of a financial shock on the aggregate price level would be partly offset by lower nontradable spending; the responses of the tradable price and of both exchange rates are unchanged. Appendix H assesses identification schemes that leave the price response unrestricted.

directly on the official exchange rate. An official devaluation changes firms' rents but not the contemporaneous pricing equations.

Import availability is the released dollar flow net of noise traders' financial demand:[5]

$$Q_t = \frac{(1-\rho)X_t - \psi_t}{P_t^*}. \tag{12}$$

A higher retained share ρ tightens the import supply for given oil receipts; financial demand tightens it dollar for dollar. Reserve policy thus operates on prices through quantities as well as through money creation (Cerra, 2016): an adverse oil shock lowers both the released flow $(1-\rho)X_t$, tightening Q_t, and the naira absorbed $s_t(1-\rho)X_t$, raising money creation (3).

Import firms obtain dollars from two sources: the central bank, at rate s_t, and the parallel market, at rate b_t. With Q_t units imported at unit world price P_t^*, total dollar needs are $P_t^* Q_t$; the official window supplies $(1-\phi)(1-\rho)X_t$ and the parallel market the remainder. The import firm's profit is

$$\Pi_t^{\text{imp}} = P_t^T Q_t - s_t\,(1-\phi)(1-\rho)X_t - b_t\,[P_t^* Q_t - (1-\phi)(1-\rho)X_t]\,. \tag{13}$$

The middle term is the firm's inframarginal purchases at the official rate and the last its purchases at the parallel rate, so its average acquisition cost of foreign exchange lies between s_t and b_t. The parallel rate, however, is determined by the value of one additional dollar acquired at the margin. An extra dollar purchased on the parallel market allows the firm to import $1/P_t^*$ additional units of the good, which can be sold domestically at revenue P_t^T/P_t^*. As long as $b_t < P_t^T/P_t^*$, importers bid more for parallel-market dollars. Noise traders are never outbid: their demand is inelastic, so they take ψ_t at the going rate and supply no margin on which the price could settle. Competition among importers, with arbitrageurs supplying the parallel market, therefore implies

$$b_t = \frac{P_t^T}{P_t^*}. \tag{14}$$

[5]Explicitly, arbitrageurs' sales $\phi(1-\rho)X_t$ equal import firms' residual purchases $P_t^* Q_t - (1-\phi)(1-\rho)X_t$ plus ψ_t; rearranging gives (12). The allocation share ϕ cancels: a dollar rerouted from the window to the arbitrageurs adds one dollar to parallel-market supply and, by shrinking window allocations, one dollar to importers' residual demand. Reallocation across windows redistributes rents, equation (16), and moves no price; allocation policy matters only through the total release, the leakage ψ_t, or eligibility for the window (the margin the June 2015 exclusion list changed). We restrict attention to $\psi_t < \phi(1-\rho)X_t$, so that import firms remain active parallel-market buyers.

Combining (10), (12), and (14) gives

$$b_t = \frac{\omega M_t}{(1-\rho)X_t - \psi_t}. \tag{15}$$

The parallel rate is the scarcity price of imported consumption goods. It rises when money rises relative to import availability, when imported supply tightens (because X_t falls, ρ rises, or both), and when financial demand ψ_t strengthens. A given financial shock also moves the parallel rate by more when the market is thin, that is, when $(1-\rho)X_t - \psi_t$ is small and the premium is wide.

3.5 The role of the official exchange rate

The official exchange rate does not appear in the pricing equations (10), (11), or (15). Its role is instead fiscal. Appendix Figure A1 draws the resulting market for the imported good: vertical supply at the rationed quantity Q_t, cash-in-advance demand $P_t^T = \omega M_t/Q_t$, and a per-dollar rent $b_t - s_t$ on the dollars the central bank sells below the parallel rate.

A higher s_t raises the domestic-currency value of the dollars the central bank sells, reducing the need for monetary financing in (3) and compressing rents. Summing over import firms and arbitrageurs, total rents on the released dollar flow are

$$\Pi_t = (b_t - s_t)(1-\rho)X_t, \tag{16}$$

the premium earned on every dollar sold below the parallel rate, independent of the allocation ϕ and of ψ_t (noise traders pay the market rate). An official devaluation compresses these rents one-for-one with the dollar volume sold through the window.

The contractionary direction of this fiscal channel is not general: it rests on the government being a net seller of foreign exchange. Suppose the government also uses dollars directly, for its own imports G_t^* (in Nigeria, chiefly refined fuel) and external debt service D_t^*, and define its net foreign-exchange position $Z_t \equiv X_t - G_t^* - D_t^*$, the dollars it sells on net to the private sector. The money-supply equation (3) becomes

$$M_{t+1} = M_t + T_t - s_t(1-\rho)Z_t, \tag{17}$$

of which (3) is the case $Z_t = X_t$. We retain gross receipts in the availability and rent expressions; carrying the government's dollar use through them rescales $(1-\rho)X_t$ to $(1-\rho)Z_t$ without changing any qualitative implication. We use the extension only to sign the fiscal channel. The derivative $\partial \Delta M_{t+1}/\partial s_t = -(1-\rho)Z_t$ signs the channel: an official devalu-

ation reduces money creation if and only if the government is a net seller of foreign exchange ($Z_t > 0$). For a net buyer, the same devaluation raises the domestic-currency cost of the government's own dollar needs, widens the deficit, and is expansionary. The sign of the fiscal effect of a devaluation is therefore an empirical question about the public sector's foreign-exchange accounts, a point long recognized in the parallel-market literature (Pinto, 1988; Morris, 1995; Kaufmann and O'Connell, 1997) and studied in the exchange-controls setting by Schmitt-Grohé and Uribe (2024). For Nigeria over our sample the empirically relevant case is $Z_t > 0$, with oil receipts exceeding the government's dollar spending, though the margin narrowed late in the sample as fuel-subsidy costs grew.[6] The narrowing is consistent with the weakly rather than strongly negative estimates we report below.

The rent per dollar, $b_t - s_t$, is the shadow price of the window's rationing constraint: a persistent premium reveals that importers demand more dollars at s_t than they receive, so imports are supply-determined, the regime the framework describes. Binding rationing also makes s_t a policy instrument. Under binding rationing the official rate is administered and can be held anywhere below b_t; absent rationing it is not a free choice but is pinned down by goods-market clearing, $s_t = b_t = P_t^T / P_t^*$. The premium is strictly positive in every month of our estimation sample and closes only at the June 2023 unification, at which point s_t becomes the marginal price and the framework's mechanism switches off (Section 5.9). Maintaining an overvalued rate requires no reserves: because the window rations quantities, excess demand is turned away rather than served, so pressure appears as a widening premium, not as reserve losses.

The framework abstracts from two channels. Official-rate announcements may shift inflation expectations, a forward-looking response outside the static cash-in-advance setup. Within the model, an anticipated devaluation appears beforehand as financial demand rather than as a distinct shock. And ψ_t is a flow: we do not model the stock of foreign currency that noise traders accumulate or its expected return—the margin the segmented-markets literature emphasizes—because the identification uses only each disturbance's within-month footprint.

3.6 Structural shocks

The framework's disturbances are innovations to four exogenous processes: financial demand ψ_t, the official rate s_t, oil receipts X_t, and productivity or world import prices

[6] Appendix C decomposes Z_t year by year from IMF and World Bank data: consolidated oil revenue exceeds the government's fuel-subsidy imports and external debt service in every year, with the margin narrowest in 2021–22, when the subsidy peaked at 2.2% of GDP.

(A_t, P_t^*). Each produces a distinct qualitative signature across the variables $(b_t, s_t, M_t, P_t, R_t)$, where $P_t = (P_t^T/\omega)^\omega (P_t^N/(1-\omega))^{1-\omega}$ is the ideal consumer price index for (6), and each signature is read off the equations above.

1. A *financial shock* ε^{par}: an innovation to noise-trader demand ψ_t. Import availability tightens, (12), and the parallel rate and the tradable price rise together, since they are the same scarcity price, (14). The official rate is administered and unmoved. Money is unmoved, since ψ_t does not enter (3). Reserves are unmoved, since noise traders absorb dollars after release, (2). The responses of s_t, M_t, and R_t are exact zeros: predictions the identification leaves unrestricted and the estimates bear out.

2. A *CBN devaluation shock* ε^{cbn}: an innovation to the official rate. We treat s_t, like X_t, as an exogenous process, chosen by the government and adjusted infrequently. An innovation is a discretionary adjustment. The systematic component of official-rate policy, such as its response to oil pressure, is absorbed in the oil shock's signature and in the estimation's conditioning; ε^{cbn} is the residual discretionary component (Section 4). From (17), with $Z_t > 0$, money creation falls over subsequent months. From (15), the parallel rate is unaffected at impact, since M_t, X_t, and ψ_t are unchanged; the dollar reserve stock is likewise unaffected, (2). The price level has no contemporaneous response, (10)–(11), and a negative cumulative response through the money channel.

3. An *oil-revenue shock* ε^{oil}: a fall in X_t. Fewer dollars are sold to the private sector, so money creation rises, (17). For $\rho > 0$, fewer are retained, so reserves fall below their path, (2). Import availability tightens and the parallel rate rises, (15). The official-rate response is weakly positive: under oil pressure the CBN devalued or held, never revalued, so the restriction rules out only a perverse response. Prices rise through both the quantity and money channels.

4. A *productivity/terms-of-trade shock* ε^P: a fall in productivity A_t or a rise in the world import price P_t^* (the import-price side of the terms of trade; the export side operates through oil receipts X_t). The first raises the nontradable price, (11). The second raises the tradable price while leaving the parallel rate unchanged: the dollar flow pins $P_t^* Q_t$ in (12), so b_t in (15) does not involve P_t^*, and imported cost inflation raises prices without depreciating the parallel market. Both members leave the rates, money, and reserves unmoved. The shock exists so that the foreign-exchange shocks are not forced to explain inflation that originates elsewhere.

Not every input to these signatures is derived: the direction of the official-rate response under oil pressure and the sign of Z_t are institutional features of Nigerian policy

over the sample, documented rather than modeled. Section 4 formalizes the signatures as sign restrictions in a structural VAR, distinguishing those implied by the equations from those grounded in these facts.

Two implications for the empirical work. We take two implications to the data. First, the parallel rate should contain more information about contemporaneous inflation than the official rate: it is the market-clearing scarcity price of imported goods, while the official rate affects current prices only through future money creation. Second, official-rate movements should be followed by changes in money creation, in Nigeria's net-seller case a decline: a higher official rate raises the domestic-currency value of dollar sales, narrows the fiscal deficit, and reduces monetary financing. Both are borne out in the Nigerian data, as documented in Section 5.

4 Data and Empirical Strategy

4.1 Data

Central Bank of Nigeria. Three CBN-published series anchor the analysis. The official rate s_t is the CBN reference rate reported in the IMF *International Financial Statistics*, at which the government's oil-dollar revenues are converted to naira. This is the rate that the framework in Section 3 predicts should affect prices through the fiscal channel, because it determines the naira value of government FX inflows; it is not the rate at which most retail import transactions actually clear. The relevant transaction prices show up in the interbank rate (NAFEX/I&E) and, where rationing binds, in the parallel rate. We use the CBN reference rate as s_t for this reason. External reserves R_t are the CBN's liquid foreign-currency holdings in US dollars, drawn from the CBN's daily published series and aggregated to end-of-month values. Money supply M_t is M2 from the CBN's *Money and Credit Statistics*. We aggregate daily rate quotes to monthly averages throughout.

Parallel rate. The parallel rate b_t is from AbokiFX, a Nigerian website that publishes a daily parallel-market rate based on surveys of foreign exchange dealers. These data are widely used by market participants and in the applied literature on Nigeria. We supplement the series after its September 2021 suspension with an alternative daily dealer-survey series from a financial institution.

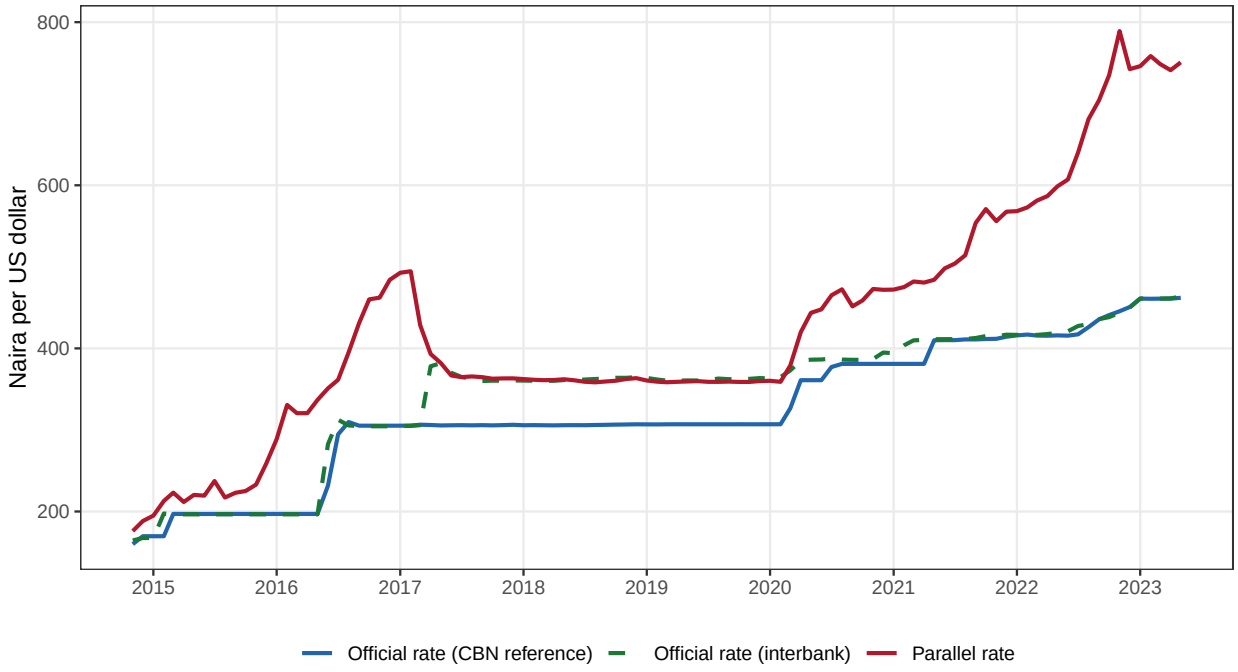
Consumer prices. Headline and food CPI from the World Bank, originally compiled by Nigeria's National Bureau of Statistics (NBS), together with the full panel of NBS divisional sub-indices.

Macroeconomic controls. Brent crude oil prices, the FAO food price index, and the U.S. Federal Funds rate from FRED.

Niger Delta militancy. Monthly counts of militant attacks against Nigerian oil infrastructure—pipelines, terminals, and offshore platforms compiled by Rexer and Hvinden (2026) from ACLED event records. The series runs through December 2019.

The estimation sample spans November 2014 to May 2023, ending immediately before the unification of Nigeria's exchange rate windows in June 2023. Figure 1 plots the rate series. The CBN reference rate adjusts in discrete devaluations with long flat plateaus, the interbank rate moves continuously, and the parallel rate sits persistently above both. The premium widens during major depreciation episodes, exceeding 70% in 2016–2017 and again in 2022–2023, and narrows in the intervening period of relative stability.

Figure 1: Nigerian Official and Parallel Exchange Rates, November 2014 to May 2023



Notes: Monthly averages of daily naira-per-dollar quotes. The CBN reference rate is reported in the IMF *International Financial Statistics*. The interbank rate is the NAFEX/I&E rate. The parallel rate is from AbokiFX through September 2021 and from an alternative dealer-survey dataset thereafter.

4.2 From Model to Identification

The framework in Section 3 predicts that distinct structural shocks produce distinct qualitative responses across the parallel rate, the official rate, money, prices, and reserves.

A financial shock raises the parallel rate and prices but leaves the administered official rate and reserves unmoved. A CBN devaluation shock raises the official rate and lowers money creation through the fiscal channel. An adverse oil-revenue shock raises both rates, expands money creation, drains reserves, and raises prices. A productivity/terms-of-trade shock raises prices alone. We use these patterns to identify the shocks in two ways.

A structural VAR with model-implied sign restrictions. We estimate a reduced-form VAR with two lags on $y_t = \left(\Delta \log b_t,\ \Delta \log s_t,\ \Delta \log M_t,\ \Delta \log P_t,\ \Delta \log R_t\right)'$ and impose the model-implied sign patterns on the structural impact matrix.[7] Table 1 lists the restrictions. Impact restrictions ($h = 0$) apply to the parallel rate, official rate, and CPI; the slower fiscal-channel restrictions on money and reserves apply to the cumulative response at $h = 6$ months. The unidentified fifth column of the structural matrix absorbs residual variation that does not match any of the four labeled shock patterns. Of 30,000 candidate rotations, 10,596 satisfy the restrictions (a 35.3% acceptance rate); the cumulative impulse responses below are summarized over these accepted draws.

Table 1: Identifying Sign Restrictions

	$\Delta \log b$ (parallel)	$\Delta \log s$ (official)	$\Delta \log M$ (M2)	$\Delta \log P$ (CPI)	$\Delta \log R$ (reserves)
ε^{par}: financial	> 0	~ 0	—	> 0	—
ε^{cbn}: CBN devaluation	—	> 0	< 0 at h=6	—	—
ε^{oil}: adverse oil-revenue	> 0	≥ 0	> 0 at h=6	> 0	< 0 at h=6
ε^{P}: productivity/terms-of-trade	—	—	—	> 0	—

Notes: Sign restrictions used to identify the four labeled structural shocks. "~ 0" for ε^{par} on $\Delta \log s$ is implemented as $|\Delta \log b| > |\Delta \log s|$ at impact. "—" means no restriction. Restrictions on $\Delta \log M$ and $\Delta \log R$ for ε^{cbn} and ε^{oil} are imposed on the cumulative response at horizon six months; all other restrictions are imposed at impact ($h = 0$). A fifth, unlabeled column of the structural impact matrix absorbs residual unidentified shocks.

Local projections. As alternate evidence of the parallel-market channel independent of sign restrictions, we estimate a horizon-by-horizon local projection of cumulative CPI on the two rates,

$$\Delta \log P_{t+h} - \Delta \log P_{t-1} = \alpha_h + \beta_h \Delta \log b_t + \gamma_h \Delta \log s_t + \boldsymbol{\delta_h'} X_t + \nu_{t+h}, \tag{18}$$

[7] The framework leaves the structural matrix identified up to an orthogonal rotation. Following Rubio-Ramírez et al. (2010), we draw random orthogonal rotations and retain those that satisfy the sign restrictions, reporting posterior medians and credible bands across accepted draws. Implementation details are in Appendix H.

principally by OLS, where β_h and γ_h are conditional correlations—the partial association of each rate with CPI holding the other fixed (Section 5.5). The CBN rate, Brent, FAO food prices, and the U.S. Federal Funds rate enter as exogenous controls, and Newey-West standard errors are computed at lag four. Appendix I reports a variant that instruments $\Delta \log b_t$ with the monthly count of Niger Delta militant attacks, isolating variation in the parallel rate plausibly exogenous to inflation, on a shorter sample ($N = 61$ months ending in December 2019).

These strategies target complementary objects. The SVAR identifies each structural shock up to a posterior over admissible rotations and traces the cumulative CPI response for each. The joint local projection instead conditions on the two rates directly, measuring the conditional correlation of each rate with prices; the external-instrument variant in Appendix I isolates one shock—a Nigeria-specific dollar-inflow shock acting through the parallel rate—and delivers a point estimate of the structural pass-through coefficient. All recover the inflation response to underlying shocks that move the two rates, in a setting where the rates are jointly determined.

What the CBN devaluation shock identifies. CBN devaluations in Nigeria are not random; they are responses to reserves pressure, inflation expectations, IMF program timing, or political circumstances. What the sign restrictions identify is the residual component of official-rate variation orthogonal to the three other shocks: the financial shock, which would push the parallel rate up by more than the official rate; the oil-revenue shock, which would deplete reserves; and the productivity/terms-of-trade shock, which would move CPI but not the rates. What remains for ε^{cbn} is the component of official-rate variation that is not explained by parallel-market pressure, oil revenue, or other inflation drivers. We are not claiming that the CBN devalues at random, but rather that the data identify a part of official-rate variation whose responses are consistent with the model's fiscal channel.

5 Results

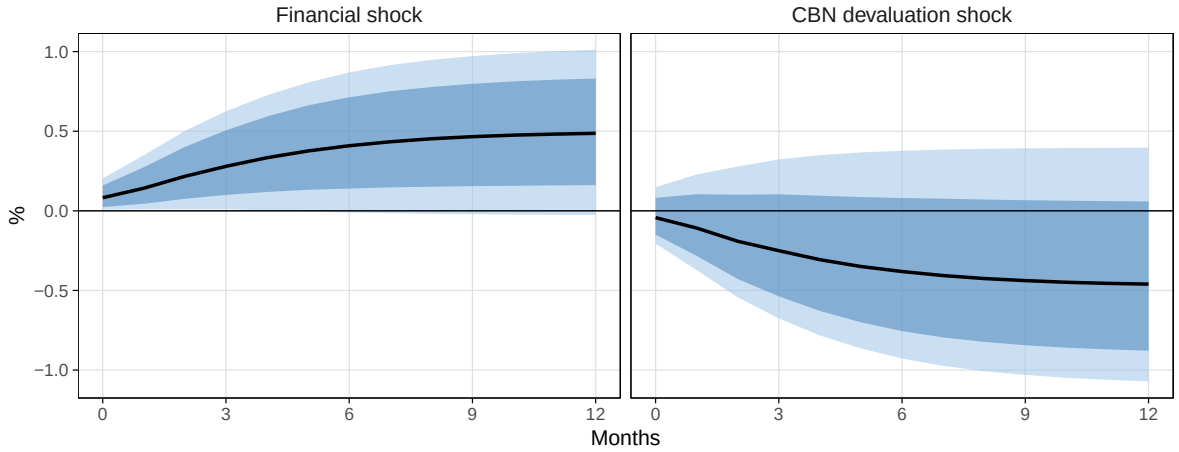
5.1 Aggregate Pass-Through to Headline CPI

A central distinction in the paper is between movements in the official exchange rate and movements in the scarcity value of foreign exchange. In a dual-rate regime, these need not coincide. A policy-driven adjustment in the official rate may leave the marginal availability of foreign exchange largely unchanged if rationing persists, while a parallel-market

depreciation directly reflects tighter dollar scarcity facing importers and households. The empirical analysis therefore distinguishes between shocks that primarily move the parallel market and shocks that primarily move the administered official rate, even though the two exchange rates remain jointly endogenous in equilibrium.

The headline finding is an asymmetry between two structural shocks. A financial shock, i.e., an innovation to dollar demand in the parallel market, raises cumulative CPI. A CBN devaluation shock does not; the central estimate is weakly contractionary, consistent with the model's fiscal channel. Figure 2 plots the two cumulative responses.

Figure 2: Cumulative CPI Response to a Financial vs. CBN Devaluation Shock



Notes: Posterior median (black line) and 68%/90% credible bands (shaded darker/lighter) of the cumulative log-CPI response to one-standard-deviation realizations of the financial shock and the CBN devaluation shock. Estimated from the sign-restricted SVAR described in Section 4 on five Nigerian monthly variables, November 2014 to May 2023.

Table 2 reports the cumulative responses at impact and at three-month intervals through one year. The financial-shock response grows steadily. It is near zero on impact ($+0.001$), turns positive by $h = 3$ ($+0.003$), reaches $+0.004$ at $h = 6$, and stabilizes near $+0.005$ for horizons of nine to twelve months. At twelve months the median cumulative response is $+0.005$ with a 68% credible band of $[+0.002, +0.008]$ that lies entirely above zero. A one-standard-deviation financial shock raises consumer prices by about half a percent over the year following the shock.

The official-rate response runs the other way. It is small at impact, drifts negative through the first quarter, and reaches its trough at intermediate horizons. The median cumulative response is -0.003 at $h = 3$, -0.004 at $h = 6$, and -0.005 at $h = 12$, with a 68% credible band of $[-0.009, +0.001]$ at twelve months. A majority of the posterior mass lies below zero at every horizon past impact, and the 68% upper bound is at most $+0.001$.

Table 2: Cumulative CPI Response by Structural Shock, Sign-Restricted SVAR

Horizon	ε^{par} (financial)	ε^{cbn} (CBN deval.)	ε^{oil} (oil revenue)	ε^{P} (productivity)
$h = 0$	0.001	-0.000	0.001	0.001
	[0.000, 0.002]	[-0.001, 0.001]	[0.000, 0.002]	[0.000, 0.002]
$h = 3$	0.003	-0.003	0.002	0.003
	[0.001, 0.005]	[-0.005, 0.001]	[0.001, 0.005]	[0.001, 0.005]
$h = 6$	0.004	-0.004	0.003	0.004
	[0.001, 0.007]	[-0.008, 0.001]	[0.001, 0.007]	[0.001, 0.007]
$h = 9$	0.005	-0.004	0.004	0.004
	[0.002, 0.008]	[-0.008, 0.001]	[0.001, 0.007]	[0.001, 0.008]
$h = 12$	0.005	-0.005	0.004	0.004
	[0.002, 0.008]	[-0.009, 0.001]	[0.001, 0.008]	[0.001, 0.008]

Notes: Posterior median and 68% credible bands of the cumulative log-CPI response to a one-standard-deviation realization of each structural shock, from the sign-restricted SVAR described in Section 4. Bracketed numbers are the 16th and 84th percentiles across 10596 accepted rotation draws (30000 proposals, 35.3% acceptance rate). The SVAR is estimated on monthly Nigerian data, November 2014 to May 2023.

A CBN devaluation shock does not raise prices; the central estimate is weakly contractionary. The weakly negative central estimate is consistent with the model's fiscal channel: a higher official rate raises the naira value of dollar receipts sold by the central bank, narrows the fiscal deficit, and reduces subsequent money creation. Section 5.6 shows that the weakly negative response sharpens in months with a wide parallel premium, where the rent in the official window is largest.

The two remaining shocks raise prices monotonically. The oil-revenue shock and the residual productivity/terms-of-trade shock each deliver cumulative twelve-month CPI responses near $+0.004$ with bands that exclude zero. We return to the oil-revenue shock in Section 5.2.

Implied structural pass-through. Structural pass-through from the parallel rate is the ratio of the CPI to the parallel-rate response under the financial shock. At twelve months the median ratio is $0.005/0.017 \approx 0.29$. The OLS-LP estimate of the same coefficient on the full sample is $\widehat{\beta}_{12} = 0.176$ (Section 5.5). The structural identification recovers a pass-through estimate roughly 60% larger than the conditional correlation. An external-instrument local projection (Appendix I) delivers a third, point-identified estimate that also exceeds the OLS conditional correlation, consistent with attenuation in OLS from measurement error in the dealer-survey parallel-rate quotes.

The estimate of 0.29 falls between the industrial-economy benchmarks compiled by Campa and Goldberg (2005); Burstein and Gopinath (2014) and Auer et al. (2021)—one- to two-year pass-through to tradable consumer prices in the range of 0.10 to 0.36, with an OECD average closer to 0.20—and the larger pass-through documented in high-inflation emerging-market devaluations (Burstein et al., 2005; Cravino and Levchenko, 2017). The natural reference set for Nigeria is the latter: dollar-invoicing-heavy economies with episodic large devaluations, where Gopinath et al. (2020) predicts above-OECD pass-through. The OLS conditional correlation of 0.18 understates the structural elasticity.

The asymmetry is not an artifact of aggregation. We re-estimate the SVAR sub-index by sub-index, substituting each NBS sub-index for headline CPI and leaving the sign restrictions unchanged: the financial shock raises prices in every one of the fifteen NBS sub-indices and the CBN devaluation shock lowers them, with the food response ($+0.6\%$ at twelve months) close to the headline. The credible bands exclude zero more often for tradable-content sub-indices than for services and administered prices, which is where an import channel should bite. Appendix K reports the full set, together with the OLS-LP conditional-correlation analogue.

5.2 The Fiscal Channel and Reserves

A weakly negative inflation response to an official devaluation may appear counterintuitive. In the framework developed above, however, the sign of that response depends on the channel through which the devaluation operates. The model splits transmission from the official rate to prices into two channels: a contemporaneous direct pass-through muted by foreign-exchange rationing, and a slower money-creation channel governed by the consolidated government budget. The CPI and M2 responses to the CBN devaluation shock together trace the model's predicted footprint of the second channel.

Table 3 reports the twelve-month cumulative response of each variable to each structural shock. Three patterns stand out. The financial shock raises the parallel rate by 1.7% at twelve months but leaves the official rate, money, and reserves unmoved within sampling uncertainty. The CBN devaluation shock raises the official rate by 0.5%, lowers money by 0.7%, and yields the weakly negative CPI response in Table 2. The oil-revenue shock moves both rates up together (4.3% on parallel, 3.7% on official), expands money by 1.0%, drains reserves by 3.6%, and raises prices through both channels.

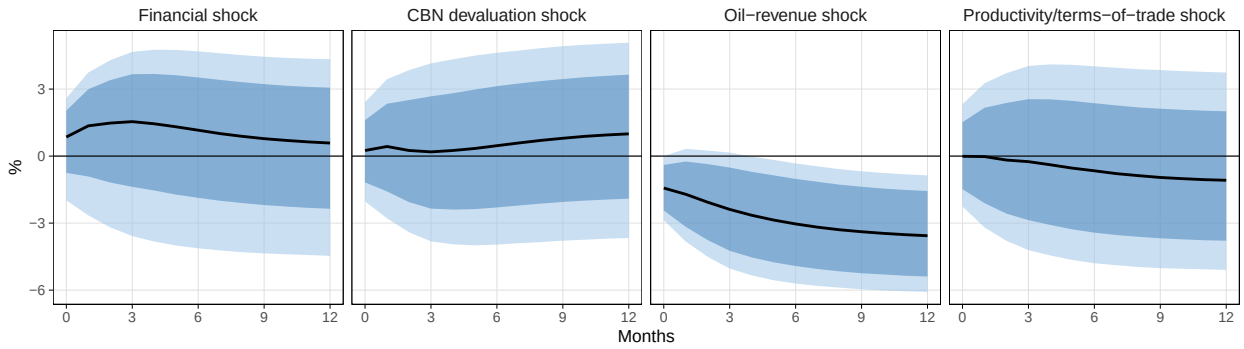
Reserves separate the oil-revenue shock from the rest. In Figure 3, only the oil-revenue shock produces a robust reserves drain: -0.036 at twelve months, with a 68% band of $[-0.054, -0.016]$ well below zero. The reserves responses to the financial shock, the CBN

Table 3: Cumulative Twelve-Month Response by Structural Shock, All Variables

Variable	ε^{par}	ε^{cbn}	ε^{oil}	ε^{P}
Parallel rate	0.017	-0.007	0.043	-0.019
	[-0.006, 0.038]	[-0.032, 0.019]	[0.027, 0.057]	[-0.042, 0.006]
Official rate	0.011	0.005	0.037	-0.004
	[-0.001, 0.021]	[-0.007, 0.018]	[0.030, 0.042]	[-0.019, 0.014]
M2	-0.001	-0.007	0.010	-0.003
	[-0.009, 0.009]	[-0.013, -0.002]	[0.004, 0.016]	[-0.011, 0.005]
CPI	0.005	-0.005	0.004	0.004
	[0.002, 0.008]	[-0.009, 0.001]	[0.001, 0.008]	[0.001, 0.008]
USD reserves	0.006	0.010	-0.036	-0.011
	[-0.024, 0.031]	[-0.019, 0.036]	[-0.054, -0.016]	[-0.038, 0.020]

Notes: Cumulative response at horizon $h = 12$ months of each variable to a one-standard-deviation realization of each structural shock. Bracketed numbers are 68% credible bands. Sample: November 2014 to May 2023. See Section 4 for the SVAR specification and identifying sign restrictions.

Figure 3: Cumulative Reserves Response to Each Structural Shock



Notes: Cumulative log USD-reserves response to each of the four structural shocks. Only the oil-revenue shock produces a robust reserves drain.

devaluation shock, and the productivity/terms-of-trade shock are centered near zero throughout. That contrast is what allows the identification scheme to separate the oil-revenue shock from the CBN devaluation shock, even though both raise the official rate.

A potential issue is that the SVAR assumes the fiscal channel rather than finding it: the identification imposes that a CBN devaluation shock lowers cumulative money growth at six months. Two pieces of evidence address this issue. First, the restriction is not critical for our headline results. Appendix Table A10 reports a variant that drops the M2 and reserves restrictions for all four shocks; the CPI response to the CBN devaluation shock is essentially unchanged at -0.005. Second, and more directly, the money response can be

estimated without the sign restrictions.

Table 4: Cumulative Response of M2 to an Official-Rate Movement, by Horizon

Horizon	Official rate	N
$h = 0$	0.096***	102
	(0.031)	
$h = 3$	-0.078	99
	(0.083)	
$h = 6$	-0.070	96
	(0.114)	
$h = 9$	-0.380***	93
	(0.127)	
$h = 12$	-0.543***	90
	(0.126)	

Notes: Cumulative response of log M2 to a contemporaneous log change in the official rate at horizon h, by local projection; controls are log changes in Brent, FAO food prices, and the U.S. Federal Funds rate. No sign restrictions are imposed. Sample: November 2014 to May 2023. Newey-West standard errors (lag 4) in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels.

Table 4 reports a local projection of cumulative log M2 on the official rate, a specification that imposes no sign restrictions.[8] Money falls after an official devaluation, and the effect grows with the horizon: the official-rate coefficient is -0.070 at six months, -0.380 at nine, and -0.543 at twelve, the last two significant at the 1% level. The projection measures the model's fiscal channel directly rather than assuming it, and is the empirical counterpart of the sign condition in Section 3: over our sample Nigeria is in the net-seller case, so an official devaluation narrows the deficit and slows money creation. The net-seller margin is not large, and it narrowed late in the sample as fuel-subsidy costs grew, consistent with an official-rate CPI response that is weakly rather than strongly negative.

Robustness. Appendix H reports four robustness exercises. The cumulative twelve-month CPI responses to ε^{par} and ε^{cbn} are stable across VAR lag lengths from one to three, across cumulative-restriction horizons from three to twelve months, and across alternative restriction sets—including the most aggressive variant, which drops the M2 and reserves restrictions entirely. A fourth exercise leaves the financial shock's price response unrestricted; these schemes are uninformative about that response, for timing reasons discussed in the appendix, while the CBN devaluation shock's non-inflationary response

[8] Equation (15) makes the parallel rate a function of the money stock, so we do not condition on it; including it leaves the estimates essentially unchanged.

survives every variant. Additional evidence that parallel-rate movements pass through to prices comes from the joint OLS local projection in Section 5.5, with an external-instrument variant in Appendix I. The estimation sample is short by macroeconometric standards (103 monthly observations for the SVAR and 61 for the LP-IV), so the credible bands and confidence sets reported throughout likely understate the full uncertainty. The asymmetry nevertheless survives on the December 2014 – December 2019 subsample—the window of the LP-IV, so the two designs are estimated on comparable samples—reported in Appendix H.

5.3 What Moves the Two Rates

A recent literature argues that pass-through is not a fixed structural constant but depends on the shock driving the exchange rate (Forbes et al., 2018, 2020). Our framework makes the same point in our setting with two exchange rates. The question is not only which shock moves the exchange rate but which of the two rates a given shock moves. This subsection reports the forecast-error variance decomposition that makes the shock-dependence concrete.

Table 5: Forecast-Error Variance Decomposition of the Exchange Rates and CPI (12-Month Horizon)

	Proportion of variance explained by:				
Variable	Financial	CBN devaluation	Oil-revenue	Productivity/ terms-of-trade	Residual
Parallel rate	25	15	22	19	19
Official rate	9	24	25	22	21
Headline CPI	20	22	17	21	21

Notes: Posterior-mean share (percent) of each row variable's forecast-error variance attributable to each structural shock, over the accepted rotations of the sign-restricted SVAR; rows sum to 100.

Table 5 decomposes the twelve-month forecast-error variance of each rate. Two features stand out. First, the two rates are driven by different shocks. The financial shock accounts for 25% of parallel-rate variance but only 9% of official-rate variance, while the CBN devaluation and oil-revenue shocks together account for roughly half of the official rate's variance. Second, and more important for the pass-through question, no single shock explains more than a quarter of either rate; most of each rate's variance comes from shocks other than its own. A researcher who treats an observed depreciation as a homogeneous event is averaging over sources with materially different inflation consequences—

the dual-rate analogue of the shock-dependence in Forbes et al. (2018).

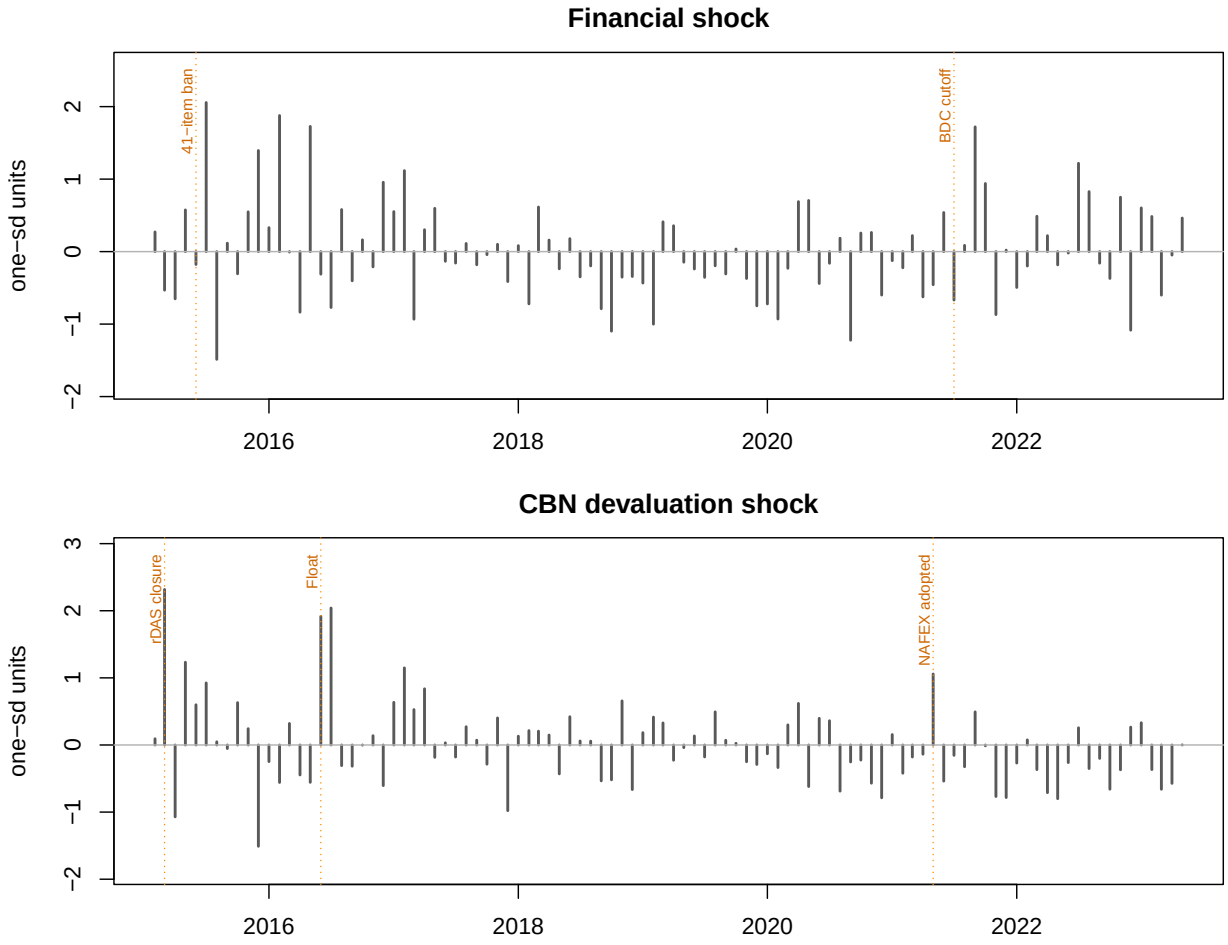
Two further decompositions, reported in Appendix J, make the same point from the pass-through side. Computing an implied pass-through shock by shock shows that a parallel-rate depreciation driven by a financial shock passes through to prices more than one driven by an oil-revenue shock, while the CBN devaluation shock carries no positive pass-through—the headline asymmetry, now conditioned on the shock rather than the rate. A historical decomposition of the three largest depreciation episodes shows that similar-sized moves had different causes: the 2016 and 2020 depreciations were oil-driven, whereas the 2021–22 premium widening was driven by CBN policy and domestic inflation, with oil pushing the other way.

5.4 Recovered Structural Shock Series

The accepted rotations also deliver the structural shocks themselves, which we summarize by their posterior medians. Figure 4 plots the financial and CBN devaluation shocks. Because none of the dated events below enters the estimation, the recovered series provide an external check on the labels. The largest financial-shock realization is July 2015, at 2.1 standard deviations, the month after the CBN excluded forty-one import categories from the official foreign-exchange window, pushing their dollar demand into the parallel market. The identification does not confound this with oil, since the oil-revenue shock recovered for the same month is favorable. A second cluster sits in the second half of 2021, when the CBN halted dollar sales to the bureaux de change and moved against the main publisher of parallel-rate quotes (Premium Times, 2021a,b)—administrative actions rather than responses to macroeconomic conditions. The period's rising reserves confirm the assignment to financial demand: an adverse oil shock would require a reserves drain.

The CBN devaluation series reads as a chronology of discretionary regime moves: its largest realizations are the closure of the rDAS window in February 2015, the float of June 2016, and the adoption of the NAFEX rate as the official rate in May 2021. Equally informative is an absence—the March 2020 devaluation barely registers, because the identification attributes that month's official-rate movement to the oil collapse it accompanied. These are qualitative checks, since structural shocks are one-step-ahead innovations that cannot be correlated directly with slow-moving observables, and anticipated events load onto the lags. But the pattern is reassuring for so parsimonious a framework: the largest realizations of each labeled shock line up with dated events of exactly the type its label implies, and the shocks take turns rather than firing together.

Figure 4: Recovered Structural Shock Series and Dated Events



Notes: Posterior-median structural shock series over the accepted rotations, in one-standard-deviation units. Top panel: financial shock; bottom panel: CBN devaluation shock. Dashed orange lines mark dated events: for the financial shock, the June 2015 exclusion list and the July 2021 halt of dollar sales to bureaux de change; for the CBN devaluation shock, the February 2015 rDAS closure, the June 2016 float, and the May 2021 adoption of the NAFEX rate as the official rate.

5.5 The Joint Local Projection

The SVAR results so far rest on sign restrictions read from the model. We now show that the central asymmetry survives without them, in a specification that simply conditions consumer prices on both rates. We estimate a horizon-by-horizon local projection of cumulative log CPI on contemporaneous changes in the parallel and official rates, with macro controls:

$$\Delta \log P_{t+h} - \Delta \log P_{t-1} = \alpha_h + \beta_h \Delta \log b_t + \gamma_h \Delta \log s_t + \boldsymbol{\delta}_{\boldsymbol{h}}' X_t + \varepsilon_{t+h}. \tag{19}$$

Newey-West standard errors are computed at lag four. The coefficients β_h and γ_h are conditional correlations rather than structural objects: they measure the partial association between each rate and CPI holding the other rate fixed. Both the SVAR above and the external-instrument LP in Appendix I indicate that they understate the structural pass-through. Their value is that they involve no rotation, no instrument, and no restriction beyond the choice of controls.

Table 6: Cumulative Pass-Through to Headline CPI, by Horizon

Horizon	Parallel rate (β_h)	Official rate (γ_h)	N
$h = 0$	-0.005	0.011*	102
	(0.013)	(0.007)	
$h = 3$	0.032	-0.018	99
	(0.056)	(0.028)	
$h = 6$	0.147**	-0.087**	96
	(0.073)	(0.035)	
$h = 9$	0.195***	-0.068	93
	(0.071)	(0.049)	
$h = 12$	0.176**	-0.011	90
	(0.076)	(0.048)	

Notes: Cumulative pass-through coefficients from the local-projection specification in Equation (19), estimated on Nigerian data from November 2014 to May 2023. Each row reports the joint regression of the log change in the consumer price index between $t-1$ and $t+h$ on contemporaneous log changes in the parallel and official naira-dollar rates. Newey-West standard errors with a lag of 4 in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels.

Table 6 reports the coefficients at impact and at three-month intervals through one year. The asymmetry is immediate. The parallel-rate coefficient at twelve months is $\widehat{\beta}_{12} = 0.176$, significant at the 5% level; the official-rate coefficient $\widehat{\gamma}_{12} = -0.011$ is indistinguishable from zero and dips to $\widehat{\gamma}_6 = -0.087$ at six months—the same weakly negative official-rate response the SVAR recovers. The pattern holds at the food sub-index and across the divisional sub-indices, reported in Appendix E.

5.6 State-Dependence and Nonlinearity

The joint local projection also affords the fiscal channel of Section 5.2 its sharpest test. If that channel drives the negative CBN-devaluation response, the effect should be larger when the rent in the official window is larger, since the fiscal correction a devaluation triggers scales with the gap between the official rate and the scarcity price of foreign

exchange. The log premium $\log(b_t/s_t)$ proxies for that gap directly. We augment the specification with interactions between each rate and an indicator that the lagged log premium exceeded its sample median, a gap of 22%.[9]

Table 7: State-Dependent Pass-Through to Headline CPI by Premium Regime

	Parallel rate			Official rate			
h	Low prem.	High prem.	Diff.	Low prem.	High prem.	Diff.	N
0	0.005	-0.019	-0.024	0.029	-0.011	-0.041*	102
	(0.010)	(0.012)	(0.016)	(0.023)	(0.010)	(0.022)	
3	0.091*	-0.036	-0.127**	0.034	-0.104***	-0.138	99
	(0.047)	(0.052)	(0.058)	(0.111)	(0.032)	(0.100)	
6	0.191*	0.061	-0.130	-0.060	-0.204***	-0.144	96
	(0.108)	(0.055)	(0.106)	(0.201)	(0.046)	(0.197)	
9	0.183	0.130**	-0.052	-0.048	-0.203***	-0.155	93
	(0.127)	(0.059)	(0.141)	(0.252)	(0.076)	(0.263)	
12	0.204	0.128*	-0.076	-0.292	-0.136*	0.156	90
	(0.130)	(0.072)	(0.149)	(0.286)	(0.071)	(0.302)	

Notes: Cumulative pass-through coefficients from a joint local projection of the cumulative log change in headline CPI on contemporaneous changes in the parallel and official rates, both interacted with an indicator that the lagged log parallel premium $\log(b_{t-1}/s_{t-1})$ was above its sample median (median premium $\approx 22\%$). "Low prem." reports the coefficient at $\mathbb{1}\{\text{high}\} = 0$; "High prem." is the sum of the level coefficient and the interaction; "Diff." is the interaction coefficient. Sample: monthly Nigerian data, November 2014 to May 2023. Newey-West standard errors with lag 4. *, **, *** denote significance at the 10%, 5%, and 1% levels.

Table 7 bears this out. The official-rate correlation with CPI is near zero in low-premium months. The point estimates oscillate between -0.05 and -0.10 at intermediate horizons and are insignificant, but the coefficient reaches $\widehat{\gamma}_6^{\text{hi}} = -0.20$ in high-premium months. These high-premium coefficients are large for a pass-through interpretation and partly reflect sharp episodes such as the June 2016 devaluation, so we read them as directionally consistent with the fiscal channel rather than as cleanly identified elasticities: closing a wider official-window gap through devaluation produces a larger cut in the financing need and in subsequent money creation. Those same episodes make the split as much a regime contrast as a premium contrast: the low-premium months are dominated by the comparatively pegged 2017–19 window, when the official rate barely moved, so the near-zero low-premium coefficient partly reflects a pegged rate with little variation to estimate from. We therefore rest the fiscal channel itself on the direct money-growth evidence of Section 5.2, which uses no premium split, and treat the state-dependence as corroboration. A continuous-premium specification (Appendix F) traces the same

[9] We do not estimate the state-dependent specification with the militancy IV: the LP-IV sample is short ($N = 61$), and splitting further by premium regime weakens the first stage below acceptable thresholds.

deepening of the response with the premium level—significantly so over the first two quarters—without resting on the discrete cut. The parallel-rate coefficient, by contrast, is similar across regimes, as the framework predicts—rationing binds throughout the pre-unification sample, so the parallel rate carries comparable pricing information whether the premium is wide or narrow.

Asymmetry and nonlinearity. Pass-through models often distinguish the response to a depreciation from that to an appreciation, and large moves from small. Neither margin is strongly identifiable here. Over the pre-unification sample the naira essentially never appreciates; the parallel rate is flat or depreciating in almost every month, leaving too few appreciation episodes to identify an appreciation response with any precision. The premium state-dependence above is the one nonlinearity this sample supports: a nonlinearity in the level of the gap rather than the sign of the move. We also interact the parallel-rate change with large-move indicators and with its own square. These specifications are statistically significant but mutually contradictory: threshold splits imply large moves pass through *less*, the quadratic implies the opposite. With a median absolute monthly move of only 1.4% and a small sample size, the data cannot pin down the shape.

5.7 A Quasi-Experiment: The June 2015 Exclusion List

The designs so far identify the parallel-rate channel from time-series variation. Nigeria also offers a cross-sectional experiment. In June 2015 the CBN excluded forty-one import categories from the official foreign-exchange window, forcing importers of those goods (and only those goods) to source dollars in the parallel market. The framework makes a sharp prediction: prices of the excluded goods should rise relative to those retaining official-window access, because their marginal price of foreign exchange jumped from the official rate to the parallel rate—a gap that averaged 30% over our sample.

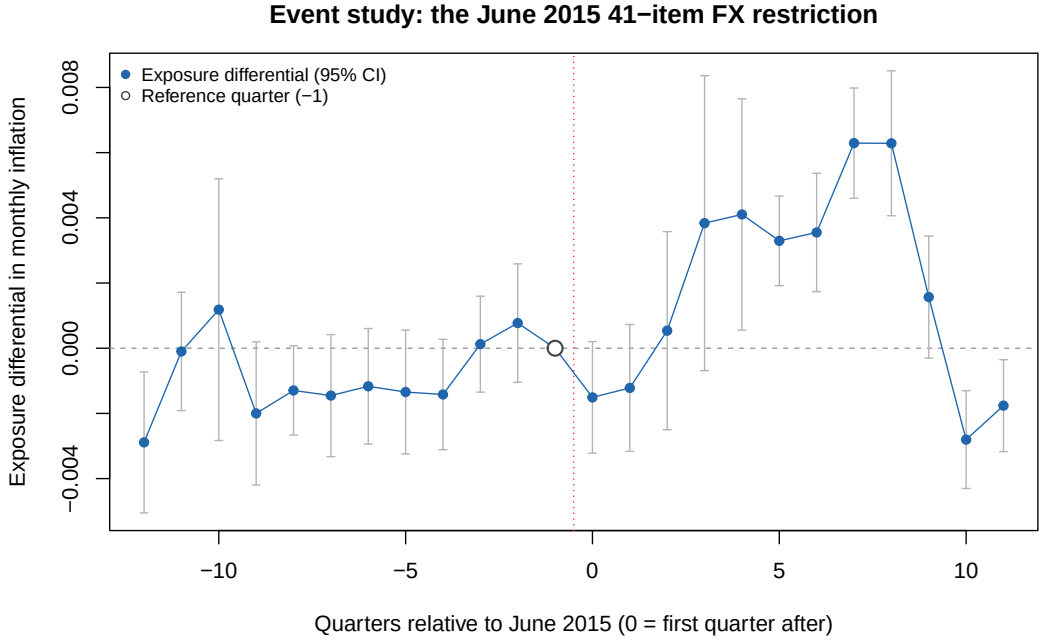
Testing this prediction requires measuring how much of each CPI division's consumption basket the exclusion list covered. We match the 41 categories to NBS CPI item codes (223 of 723 items) and weight them by household expenditure from the Nigeria Living Standards Survey 2018/19. Table 8 reports the resulting treatment intensity. Exposure is strongly graded: Clothing and Footwear is 79.6% exposed by expenditure, Furnishings 55.4%, and Food 45.3%, while Health, Transport, and Communication & Recreation contain no restricted items and serve as clean controls. We drop Housing as unmeasurable: its restricted items are construction materials collected in a different survey module, with no expenditure weight we can assign.

Table 8: Treatment Intensity: Exposure of CPI Divisions to the 41-Item Exclusion List

CPI division	Items	Total (N bn)	Restricted (N bn)	Exposure (%)
Clothing and Footwear	22	1,575	1,253	79.6
Furnishings & Household Equip.	18	1,059	587	55.4
Food & Non Alcoholic Bev.	88	19,416	8,802	45.3
Miscellaneous Goods & Services	9	609	42	6.9
Health	3	113	0	0.0
Transport	10	2,515	0	0.0
Communication & Recreation	7	1,147	0	0.0
Housing, Water & Utilities	12	2,060	—	—

Notes: Exposure is the share of a CPI division's total consumption expenditure in items on the CBN's June 2015 41-item exclusion list, weighted by Nigeria Living Standards Survey 2018/19 household consumption. Housing is dropped: its restricted items (construction materials) sit in a separate survey module with no assignable weight.

Figure 5: Event Study: Prices in Exposed CPI Divisions Around June 2015



Notes: Coefficients on exposure intensity interacted with quarterly bins of event time relative to June 2015, from a difference-in-differences on monthly sub-index inflation with division and month fixed effects. The quarter before June 2015 is the omitted reference, normalized to zero, so each point is the exposure differential relative to it; the vertical line marks the event. Bars are 95% confidence intervals, clustered by month.

The results line up with the predicted effect. Table 9 reports the event study in yearly bins around June 2015, and Figure 5 plots it in finer quarterly bins. The effect is con-

Table 9: The June 2015 Exclusion List: Difference-in-Differences Estimates

	Estimate	Std. error	N
Event study, yearly bins (reference: year -1)			
Year -4	-0.0015	(0.0056)	768
Year -3	-0.0008	(0.0008)	768
Year -2	-0.0012***	(0.0005)	768
Year 0	0.0005	(0.0010)	768
Year $+1$	0.0044***	(0.0007)	768
Year $+2$	0.0010	(0.0011)	768
Year $+3$	-0.0005	(0.0005)	768
Placebo (within pre-period)	0.0006	(0.0028)	384

Notes: Difference-in-differences on monthly COICOP sub-index inflation, comparing CPI divisions by their exposure to the June 2015 41-item exclusion list (Table 8). The dependent variable is the monthly log change in the sub-index; specifications include division and month fixed effects, and treatment enters as continuous exposure intensity. The event study bins time into years relative to June 2015, omitting year -1; the placebo row re-runs the design on a split entirely inside the pre-period. Standard errors clustered by month. *, **, *** denote significance at the 10%, 5%, and 1% levels.

centrated in the twelve months following the announcement: the year $+1$ coefficient is 0.0044, significant at the 1% level, implying that a fully exposed division saw monthly inflation about 0.44 percentage points higher than an unexposed one, or roughly 4 percentage points of additional inflation over the year for a division like Clothing. The quarterly figure traces the shape. The differential is flat for the first two quarters after the announcement, as pre-existing dollar allocations and inventories ran down; it then builds through 2016, peaks in early 2017 above the year-$+1$ average, and fades back toward zero over the rest of that year, leaving years $+2$ and $+3$ indistinguishable from zero. That fade is economically sensible rather than a sign of fragility: by 2016–17 the broader foreign-exchange crisis was rationing dollars for exposed and unexposed divisions alike, collapsing the very contrast the design exploits.

Pre-trends are largely flat. A placebo that re-runs the design entirely inside the pre-period returns essentially zero. One pre-period bin is an exception: year -2 is small but statistically negative at the 1% level (-0.0012). A sharper triple-difference interacting exposure with the parallel premium is not estimable here, because our parallel rate series begins in November 2014, leaving a pre-period of roughly eight months—too short to identify a pre-trend in the premium interaction. We rely instead on the division-level design, which averages over many restricted and unrestricted items.

5.8 Chinese Import Exposure and the Currency of Invoicing

The analysis so far treats the naira-dollar rates as the relevant prices of foreign exchange. China is Nigeria's largest single source of imports, and the two countries have operated a bilateral local-currency swap facility since 2018. If a material share of Nigerian imports were invoiced and settled in renminbi, the dollar rates would be the wrong prices for those goods, and measured pass-through should be weaker precisely in the CPI divisions most exposed to China. We test that implication three ways. All three point the same way: over our sample the dollar remains the invoicing currency, and the renminbi channel is too small and too late to show up in consumer prices.

Table 10: Chinese Share of Nigerian Imports by CPI Division

CPI division	Imports from China (US$ bn)	Total imports (US$ bn)	China share (%)
Education	0.58	0.78	74.8
Clothing and footwear	0.67	0.92	72.6
Communication	3.17	4.74	66.9
Furnishings and household equipment	6.54	10.27	63.6
Recreation and culture	4.04	7.72	52.4
Miscellaneous goods and services	1.17	3.06	38.4
Housing, water, electricity and gas	1.77	5.46	32.4
Health	1.88	14.10	13.3
Food and non-alcoholic beverages	3.91	57.50	6.8
Alcoholic beverages and tobacco	0.09	2.01	4.2
Transport	3.84	124.22	3.1

Notes: Cumulative Nigerian merchandise imports over 2014–2023 from UN Comtrade at the HS-6 level, mapped to COICOP divisions through an HS-6-to-COICOP concordance covering 5,590 HS-6 codes. "China share" is imports from China divided by imports from the world within each division. Transport is dominated by refined petroleum, which Nigeria sources overwhelmingly outside China; the communication division rests on a comparatively thin set of HS-6 lines. Divisions are ordered by China share.

We first measure exposure. Table 10 reports China's share of Nigerian imports by CPI division, built by mapping UN Comtrade HS-6 import flows into COICOP divisions. The variation is wide and economically sensible: China supplies roughly three-quarters of imports in education materials (74.8%) and clothing and footwear (72.6%), around two-thirds in communication (66.9%) and furnishings (63.6%), and about half in recreation (52.4%), but only 6.8% in food and 3.1% in transport, the latter dominated by refined petroleum that Nigeria sources elsewhere. If invoicing currency mattered for pass-through, this cross-section is where it should be visible.

We then ask whether pass-through varies with that exposure. On a monthly panel

of the eight tradable divisions, with division fixed effects, we interact each rate with the division's time-varying China import share; all variables are at the division level:

$$\Delta \log P_{t+h} - \Delta \log P_{t-1} = \alpha + \beta_h \Delta \log b_t + \delta_h \, \omega_\tau \Delta \log b_t + \gamma_h \Delta \log s_t + \kappa_h \, \omega_\tau \Delta \log s_t + \boldsymbol{\phi}_{\boldsymbol{h}}' X_t + \varepsilon_{t+h}, \tag{20}$$

where P_t is a division's sub-index CPI, ω_τ its China import share in year τ, and X_t the baseline macro controls. The coefficient of interest is δ_h: if a division's Chinese goods were priced in renminbi, the naira-dollar parallel rate would pass through less where the China share is higher, making δ_h negative.

Table 11: Pass-Through and Chinese Import Exposure

	$h = 6$	$h = 12$
Panel A. Naira rates interacted with the China import share		
Parallel rate	0.088	0.086
	(0.060)	(0.054)
Parallel rate × China share	-0.060	-0.053
	(0.055)	(0.082)
Official rate × China share	0.006	0.001
	(0.024)	(0.052)
Panel B. USD/CNY cross-rate		
USD/CNY	-0.092	-0.010
	(0.166)	(0.252)
USD/CNY × China share	0.066	-0.076
	(0.161)	(0.141)

Notes: Pooled panel of the eight tradable COICOP divisions, November 2014 to May 2023 ($N = 696$ at $h = 6$, 648 at $h = 12$), estimating equation 20; "China share" is a division's time-varying share of imports sourced from China. Driscoll-Kraay standard errors in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels.

We do not find strong empirical support for this. Table 11 reports the estimates. The parallel-rate interaction $\widehat{\delta}_h$ is -0.060 at six months and -0.053 at twelve, neither distinguishable from zero. The point estimates do carry the hypothesized negative sign, in that pass-through is nominally weaker where Chinese exposure is higher, but the effect is statistically weak, and the official-rate interaction is essentially zero at both horizons. Panel B repeats the exercise with the USD/CNY cross-rate in place of the naira rates and we find nulls there as well.

The second test asks whether the naira-yuan cross-rate carries independent pricing in-

formation. Augmenting the baseline local projection of equation (19) with the USD/CNY rate yields a twelve-month coefficient of 0.494 that is statistically indistinguishable from zero: the yuan cross-rate adds no measurable pass-through once the naira-dollar rates are included. Replacing the naira-dollar rates with naira-yuan rates altogether leaves pass-through no larger. The twelve-month parallel-rate coefficient is 0.145, against 0.176 for the dollar rate implying that the yuan rate does not price imports better than the dollar. Appendix L reports all three specifications.

The institutional record rationalizes the observed nulls. The Nigeria-China swap line was signed only in April 2018, so it is absent from the first three and a half years of the estimation sample. Its size is small relative to the trade it could plausibly settle: a RMB 15 billion facility, roughly $2.5 billion, against bilateral trade running between $8 and $22 billion a year. Take-up was slower still—only 11.6% of the earmarked amount had been drawn by June 2020, reaching roughly 60% only by June 2023, at the very end of our sample (Liu, 2025). Nigeria also had no renminbi clearing bank over this period, while the renminbi accounted for roughly 2% of global cross-border payments (Perez-Saiz and Zhang, 2023). A settlement channel this small, arriving this late, should not move consumer prices, and we do not find that it does. Chinese goods entering Nigeria over our sample were priced in dollars, which is why the dollar rates, and specifically the parallel rate, remained the relevant price.

5.9 Post-Unification Check

The framework predicts that once the official rate becomes the marginal price of foreign exchange, it should carry the pass-through that the parallel rate carried under the dual-rate regime. We examine this directly. We re-estimate the local projection in equation (19) with only the official rate on the right-hand side, separately on the pre-unification sample (November 2014 – May 2023, $N = 103$) and the post-unification sample (June 2023 – December 2024, $N = 17$ at impact). We drop the parallel rate from the specification because the two rates are nearly collinear once the premium has collapsed. Appendix Table A7 reports the results. The pre-unification official-rate coefficient is small and drifts negative through intermediate horizons ($\widehat{\gamma}_3 = -0.003$, $\widehat{\gamma}_6 = -0.036$). The post-unification official-rate coefficient is positive throughout ($\widehat{\gamma}_3 = 0.023$, $\widehat{\gamma}_6 = 0.010$), and the post-unification three-month coefficient is of a similar magnitude to the pre-unification parallel-rate coefficient at the same horizon in the single-rate specification ($\widehat{\beta}_3 = 0.034$). We have only nineteen months of post-unification parallel-rate and CPI data and cannot draw definitive conclusions, but this is suggestive evidence that the role of the marginal price of foreign

exchange has transferred from the parallel rate to the official rate.

Where the official rate landed. The June 2023 reform is worth characterizing precisely, because its form matters for how the framework reads it. On 14 June 2023 the CBN removed the cap on the Investors' and Exporters' window, collapsed its multiple windows into a single market, restored willing-buyer-willing-seller pricing, and reopened access for the previously excluded import categories (Central Bank of Nigeria, nd). This was a regulatory change—a removal of exchange controls and of the segmentation itself—rather than an administered devaluation of a peg to a new announced number, and the distinction is the one the model turns on. The framework predicts that a unified rate should settle at the parallel rate, because that is where the marginal dollar was already priced. That is what happened: the official rate moved from about N461 in May 2023 to roughly N700 within a day of the announcement and N757 by 20 June, converging toward a parallel rate that had already been trading near N750 before the policy changed (International Monetary Fund, 2024). The official rate caught up to the parallel rate; the parallel rate did not jump to meet it.

The premium then stayed closed, which is the fact most relevant to our reading. The IMF records the parallel premium narrowing sharply to an average of about 9% after unification. Following further pricing-transparency reforms in January and February 2024, it narrowed to -5% at end-February 2024 with the official rate briefly trading marginally weaker than the parallel rate (International Monetary Fund, 2024). The naira did continue to depreciate, and substantially: to roughly N900 by the end of 2023, past N1,400 in early February 2024 and a peak near N1,600 later that month, before recovering toward N1,300 by the end of March. But that is movement in the level of a single unified rate, not a reopening of the dual-rate wedge. The framework's shadow-rate logic predicts where unification lands, period by period; it does not pin down the subsequent path of the unified rate, which depends on the fiscal and monetary dynamics the model treats as exogenous. We therefore read the post-2023 experience as consistent with the mechanism without treating it as a test of it.

6 Implications and Conclusion

This paper documents an asymmetry in exchange-rate pass-through in a dual-rate economy: consumer prices respond to the parallel rate, the marginal price of foreign exchange, but not to the administered official rate. Using monthly data for Nigeria from 2014 to 2023, we identify the asymmetry through a sign-restricted SVAR whose restrictions are

read off a model of foreign-exchange rationing and repressed goods markets. We corroborate the parallel-rate channel with a joint OLS local projection, and with an external-instrument local projection.

The headline finding is the asymmetry. A financial shock to the parallel market raises cumulative CPI by about 0.5% over the following year, with the credible band excluding zero. A CBN devaluation shock does not raise prices; the central estimate is weakly contractionary. The negative sign is consistent with the model's fiscal channel: a higher official rate raises the naira value of dollar receipts sold by the central bank, narrows the fiscal deficit, and reduces subsequent money creation. The contraction sharpens in months with a wide parallel premium, where the rent in the official window is largest. An oil-revenue shock raises both rates, expands M2, drains reserves by 3.6%, and raises prices through both channels. A productivity/terms-of-trade shock raises prices alone.

The asymmetry is the paper's main fact. The structural identification narrows its interpretation: the parallel rate carries the pass-through, and the official rate, taken on its own, does not. We read the weakly negative response to a CBN devaluation shock as suggestive rather than as a sharply identified causal effect. The militancy IV-LP complements the SVAR rather than substituting for it, and is subject to exclusion-restriction concerns that the controls only partially address. The framework also abstracts from a channel that could shape the empirical responses: official-rate announcements may shift inflation expectations, which the model does not incorporate. Relatedly, the credibility of monetary policy may shape how a devaluation transmits to prices, though a time-varying proxy for it at monthly frequency within a single country is beyond what our design can support; we leave this to future work.

Two implications follow for central banks in dual-rate regimes. First, a monetary authority that tracks only the official rate understates the inflation pressure embedded in a depreciation. By the time an official adjustment is announced, much of the pass-through has already occurred through the parallel market. Second, an official-rate movement driven by CBN policy is not inflationary on impact; the central estimate is weakly contractionary at intermediate horizons. An official-rate movement that arrives through oil-revenue pressure is inflationary, because the same underlying shock that drives the central bank to devalue also expands money creation through reduced dollar sales. Treating all devaluations symmetrically misses both the underlying mechanism and the implications for inflation.

Two extensions are natural. The first is a sharper test of the rationing mechanism using direct data on central-bank allocations across the official window. The second is comparative analysis across other dual-rate economies such as Argentina, Egypt, Iran,

Lebanon, and Venezuela, to expand our understanding of pass-through dynamics in these settings.

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Appendices

A Cross-Country Parallel-Market Premiums

Table A1 lists the 25 countries with documented multiple currency practices as of March 2023, together with their official and parallel exchange rates and the implied premium, referenced in Section 2.

Table A1: Countries with Multiple Currency Practices, March 2023

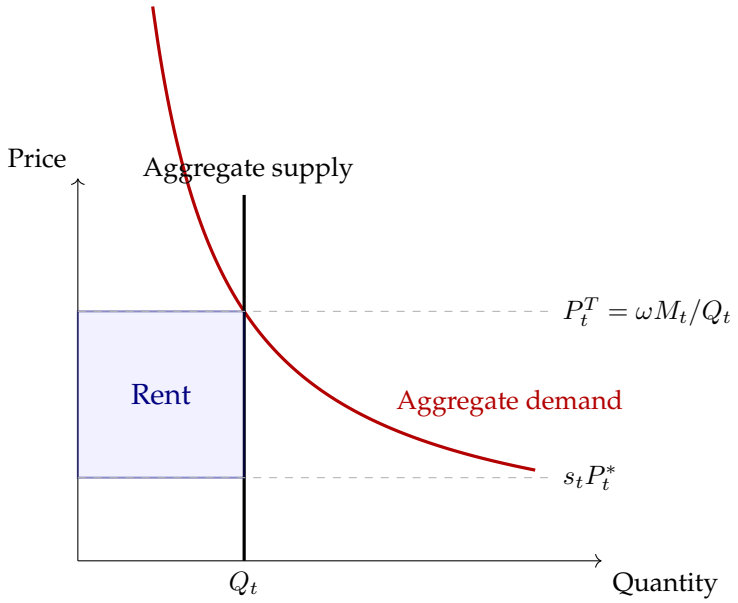
Country	Official	Parallel	Premium (%)
Iran (IFS rate)[a]	42,000	544,000	1,195.2
Lebanon	15,000	107,500	616.7
Yemen (Sana'a vs. Aden)	250	1,230	392.0
Syria	3,015	7,550	150.4
Iran (NIMA rate)[a]	285,000	544,000	90.9
Argentina	209	391	87.1
Ethiopia	54.4	100.2	84.1
Zimbabwe	930	1,600	72.1
Burundi[b]	2,061	3,359	63.0
Nigeria	461	745	61.7
Algeria	136	209	53.5
Malawi	1,028	1,495	45.4
Myanmar	2,100	2,857	36.0
Congo, Democratic Republic	2,036	2,323	14.1
Angola[c]	504	560	11.1
Bangladesh	106	113.3	6.9
Lao PDR[d]	16,221	17,327	6.8
Ghana	11.01	11.75	6.7
Libya	4.79	5.09	6.2
Mozambique	64.5	67.4	4.4
Ukraine	36.6	37.7	3.2
Sri Lanka	327	337	2.8
Sudan	590	605	2.6
Venezuela	24.5	24.7	0.9
South Sudan	851	850	-0.2

Notes: Official and parallel exchange rates in local currency per US dollar on March 31, 2023, unless otherwise noted. The premium is the percentage gap of the parallel rate over the official rate.
[a] Iran reports two official rates: the baseline IMF IFS rate and the NIMA rate.
[b] Burundi as of December 31, 2022.
[c] Angola as of January 27, 2023.
[d] Lao PDR as of February 28, 2023.
Sources: World Bank compilation (Malpass, 2023).

B The Market for the Imported Good Under Rationing

Figure A1 draws the market for the imported good described in Section 3. The official rate sets the unit cost of a dollar but not the market-clearing price, so an official devaluation shrinks the rent without moving P_t^T on impact.

Figure A1: The Market for the Imported Good Under Rationing



Notes: The market for the imported good in any period t. Aggregate supply is vertical at the quantity $Q_t = [(1-\rho)X_t - \psi_t]/P_t^*$ that import firms can finance with the dollars the central bank releases, net of noise-trader absorption. Aggregate demand is the cash-in-advance schedule $P_t^T = \omega M_t/Q_t$ that household spending traces out as Q_t varies. The intersection pins down the retail price P_t^T. The unit cost of importing one unit at the official rate is $s_t P_t^*$; the shaded area is schematic, illustrating the per-dollar wedge $b_t - s_t$ earned on dollars sold below the parallel rate. Total rents and their division between import firms and arbitrageurs are given by equation (16). A rise in M_t or in ψ_t shifts demand outward or supply inward and raises P_t^T; a devaluation of the official rate raises unit cost without affecting demand or supply: it leaves P_t^T unchanged on impact and shrinks the rent, leading to a fiscal correction that operates through future money creation, equation (3).

C The Government's Net Foreign-Exchange Position

Section 3 signs the fiscal channel by the government's net foreign-exchange position, $Z_t = X_t - G_t^* - D_t^*$: an official devaluation is contractionary when the government is a net seller ($Z_t > 0$). Table A2 decomposes that position for the years the IMF reports it, taking oil revenue and the fuel subsidy from the 2024 Article IV consultation and external debt service from the World Bank.

Table A2: The Government's Net Foreign-Exchange Position

(Percent of GDP)	2020	2021	2022	2023
Oil revenue, X	2.4	2.6	3.8	4.3
Fuel subsidy, G^*	0.1	1.1	2.2	0.9
External debt service, D^*	0.3	0.4	0.5	0.7
Net FX position, $Z = X - G^* - D^*$	$+2.0$	$+1.1$	$+1.1$	$+2.7$

Notes: Government foreign-currency flows, percent of GDP. Oil revenue (X) and the fuel subsidy (G^*) are consolidated-government figures from the IMF 2024 Article IV consultation for Nigeria, Table 3 (Government Operations); external debt service (D^*) is public and publicly-guaranteed external debt service from the World Bank's World Development Indicators.

The consolidated government is a net seller in every year—oil revenue exceeds its dollar spending on subsidized-fuel imports and external debt service throughout—and the margin is narrowest in 2021–22, when the fuel subsidy reached 2.2% of GDP, before widening again once the subsidy was removed in mid-2023. That narrowing is the empirical counterpart of the weakly, rather than strongly, negative CBN-devaluation response in the main text. The earlier sample years, with a smaller subsidy against comparable oil revenue, sit further inside net-seller territory.

D Time-Series Diagnostics

This appendix reports time-series diagnostics that support OLS-LP and reduced-form VAR estimation on the pre-unification sample.

Unit roots and stationarity. Table A3 reports augmented Dickey-Fuller, Phillips-Perron, and KPSS tests on the levels and first differences of log CPI, the log parallel rate, and the log CBN rate. The three levels are non-stationary; the three first differences are stationary at the 1% or 5% level.

Granger causality. Table A4 reports pairwise Granger-causality tests at six monthly lags. The parallel rate Granger-causes consumer prices ($F = 2.45$, significant at the 5% level), while the official rate does not—consistent with the structural asymmetry recovered in the main text.

Multicollinearity. Variance inflation factors on the joint specification regressors at $h = 12$ range from 1.11 for the parallel rate to 1.67 for Brent crude, well below the conventional

Table A3: Unit-Root and Stationarity Tests

Series	Form	ADF (p)	PP (p)	KPSS (p)	N
log CPI	level	0.990	0.990	0.010	103
log CPI	first difference	0.010	0.010	0.031	102
log Parallel rate	level	0.546	0.670	0.010	103
log Parallel rate	first difference	0.014	0.010	0.100	102
log Official rate	level	0.562	0.465	0.010	103
log Official rate	first difference	0.010	0.010	0.100	102

Notes: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests of the null of a unit root; Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test of the null of level stationarity. Sample: November 2014 to May 2023. The KPSS p-values for the first-difference series are reported as the smallest p for which the test statistic falls in the right tail; a value of 0.10 in the table means the test fails to reject stationarity at conventional levels.

Table A4: Granger Causality Tests

Direction	Lags	F	p-value	N
Panel A: Main spec (s = CBN reference rate)				
$\Delta \log b \to \Delta \log s$	6	3.03	0.010	103
$\Delta \log s \to \Delta \log b$	6	3.37	0.005	103
$\Delta \log b \to \Delta \log P$	6	2.45	0.031	103
$\Delta \log P \to \Delta \log b$	6	1.63	0.149	103
$\Delta \log s \to \Delta \log P$	6	1.11	0.365	103
$\Delta \log P \to \Delta \log s$	6	4.96	< 0.001	103
Panel B: Alternative spec (s^{NAFEX} = interbank rate)				
$\Delta \log b \to \Delta \log s^{\mathrm{NAFEX}}$	6	3.60	0.003	103
$\Delta \log s^{\mathrm{NAFEX}} \to \Delta \log b$	6	1.15	0.343	103
$\Delta \log s^{\mathrm{NAFEX}} \to \Delta \log P$	6	1.96	0.080	103
$\Delta \log P \to \Delta \log s^{\mathrm{NAFEX}}$	6	7.33	< 0.001	103

Notes: Each row reports a Granger causality test of the null that lags of the variable on the left do not predict the variable on the right, conditional on the right-hand variable's own lags. Variables are first differences of log CPI, the log parallel rate, and the indicated official rate. The conditional rows in Panel A also include lags of the third variable on the right-hand side. The lag length of six matches the intermediate horizon at which the main asymmetry in Section 5.5 becomes statistically significant. Sample: November 2014 to May 2023.

threshold of 5.

E OLS-LP: Sub-Index Heterogeneity

This appendix reports the food and divisional sub-index estimates from the joint local projection of Section 5.5, equation (19). The specification and Newey-West standard errors are unchanged; only the outcome sub-index varies.

Food CPI. Table A5 reports the OLS-LP coefficients with the food sub-index as the outcome. The parallel-rate response builds through $\widehat{\beta}_6 = 0.09$ and $\widehat{\beta}_7 = 0.11$, peaks at $\widehat{\beta}_{10} = 0.15$, and settles at $\widehat{\beta}_{12} = 0.114$. A one-percent depreciation of the parallel rate is associated with cumulative food inflation of about 0.11% over the following year, about two-thirds of the headline estimate. The official-rate coefficient drifts negative through the first half-year, reaches $\widehat{\gamma}_6 = -0.085$ (significant at the 5% level), and fades to zero by twelve months.

Table A5: Cumulative Pass-Through to Food CPI, by Horizon

Horizon	Parallel rate (β_h)	Official rate (γ_h)	N
$h = 0$	-0.023*	0.006	102
	(0.014)	(0.008)	
$h = 3$	-0.028	-0.024	99
	(0.056)	(0.035)	
$h = 6$	0.090	-0.085**	96
	(0.074)	(0.043)	
$h = 9$	0.140	-0.032	93
	(0.086)	(0.061)	
$h = 12$	0.114	0.038	90
	(0.083)	(0.067)	

Notes: Cumulative pass-through coefficients from the joint local-projection specification in Equation (19), with the food sub-index of the consumer price index as the outcome variable. Sample: Nigerian data from November 2014 to May 2023. Newey-West standard errors with a lag of 4 in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels.

Divisional sub-indices. Table A17 reports the joint OLS-LP estimates for the full set of NBS sub-indices. The parallel-rate coefficient is positive in twelve of the fifteen non-headline sub-indices. The two largest are administered or rebased-component categories: housing and utilities ($\widehat{\beta}_{12} = 0.43$) and education ($0.29$). The three sub-indices with negative point estimates are predominantly services or administered prices. The official-rate intermediate-horizon dip is more pronounced in the cross-section than at the headline

level; at $h = 6$, ten of fifteen non-headline sub-indices carry official-rate coefficients significant at the 5% level or better.

F State-Dependence: Continuous-Premium Specification

Because Nigeria's comparatively pegged 2017–2019 window carried a premium near the sample median, the median split of Section 5.6 partly separates a devaluing regime from a pegged one rather than a wide premium from a narrow one. We therefore re-estimate the specification with the *continuous* standardized lagged log premium in place of the dummy—a dose-response that cannot isolate a single episode. Table A6 reports the official-rate response. The premium slope is negative at every horizon and significant from one to six months, most sharply at three months. The response is significantly negative through the year at a wide premium (the 75th percentile, a 40% gap) but small and insignificant at a narrow one (25th percentile, 17%). The fiscal channel thus deepens smoothly with the premium, not discretely across a regime cut. The gradient is front-loaded and fades by $h = 8$. Because large premia still coincide with the crisis episodes, the continuous interaction narrows but does not eliminate the premium/regime correlation, so we read it and the median split together as suggestive rather than decisive.

G Post-Unification Pass-Through

This appendix reports the single-rate variant of the OLS local projection in equation (19), estimated separately on the pre-unification sample (November 2014 – May 2023) and the post-unification sample (June 2023 – December 2024). The specification keeps only one of the two rates on the right-hand side; otherwise it matches the joint OLS-LP. The exercise supports the post-unification check in Section 5.9.

H SVAR Robustness

This appendix reports four robustness exercises for the sign-restricted SVAR: varying the reduced-form VAR lag length, varying the horizon at which the cumulative M2 and reserves restrictions are imposed, varying the restriction set itself, and identifying the financial shock without its price restriction. Each table reports the cumulative twelve-month log-CPI response to each structural shock under the alternative specification.

Table A6: State-Dependence in the Fiscal Channel: Continuous-Premium Specification

	Official-rate response to $\Delta \log s_t$			
h	Narrow premium ($\approx 17\%$, p25)	Wide premium ($\approx 40\%$, p75)	Premium slope (per $+1$ SD)	N
0	0.002	-0.010	-0.008	102
1	-0.000	-0.032*	-0.024**	101
2	-0.002	-0.059**	-0.042***	100
3	-0.017	-0.096***	-0.058***	99
4	-0.047	-0.133***	-0.064**	98
5	-0.079	-0.166***	-0.064*	97
6	-0.101	-0.190***	-0.066*	96
7	-0.109	-0.197***	-0.065	95
8	-0.126	-0.195***	-0.051	94
9	-0.122	-0.181**	-0.044	93
10	-0.135	-0.171**	-0.026	92
11	-0.097	-0.132*	-0.026	91
12	-0.100	-0.117*	-0.012	90

Notes: Cumulative official-rate pass-through to headline CPI from the joint local projection of Section 5.5, with both rates interacted with the *standardized* lagged log parallel premium $z_t = (\log(b_{t-1}/s_{t-1}) - \bar{p})/\sigma_p$ (mean premium 28.9%, SD 13 log points) in place of the median split of Table 7. "Narrow" and "Wide" evaluate the official-rate response at the 25th and 75th percentiles of the premium (17% and 40% gaps); "Premium slope" is the interaction coefficient, the change in the response per one-standard-deviation increase in the premium (centering-invariant, the formal dose-response test). Delta-method standard errors for the narrow/wide responses. Sample: November 2014 to May 2023, Newey-West standard errors with lag 4. *, **, *** denote significance at the 10%, 5%, and 1% levels.

Table A7: Single-Rate OLS-LP, Pre- and Post-Unification

	$h = 0$	$h = 3$	$h = 6$	N
Panel A: Pre-unification (November 2014 – May 2023)				
Official rate	0.011*	-0.003	-0.036	103
	(0.007)	(0.029)	(0.046)	
Parallel rate	-0.003	0.034	0.143*	103
	(0.014)	(0.057)	(0.075)	
Panel B: Post-unification (June 2023 – December 2024)				
Official rate	0.010*	0.023	0.010	17
	(0.006)	(0.017)	(0.010)	
Parallel rate	0.005	0.005	0.017	17
	(0.010)	(0.029)	(0.015)	

Notes: Cumulative log-CPI response from a single-rate version of equation (19), with only the indicated rate on the right-hand side together with the macro controls (Brent, FAO food prices, U.S. Federal Funds rate). Each row reports a separate regression. Standard errors in parentheses are Newey-West with a lag of four for the pre-unification panel, as elsewhere in the paper; the post-unification panel reports OLS standard errors, as its short sample is unsuited to reliable HAC adjustment. *, **, *** denote significance at the 10%, 5%, and 1% levels. N at $h = 0$; longer horizons drop observations at the end of the post-unification sample.

Lag length. Table A8 reports the SVAR with VAR(1) and VAR(3) reduced forms alongside the VAR(2) main specification. The qualitative asymmetry between ε^{par} and ε^{cbn} survives in every case. VAR(3) yields the sharpest result, with the 68% credible band for ε^{cbn} lying entirely below zero.

Table A8: SVAR Robustness: VAR Lag Length

Specification	ε^{par}	ε^{cbn}	ε^{oil}	ε^{P}	Accept rate	N_{acc}
VAR(1)	0.004	-0.003	0.003	0.005	39.8%	11941
	[0.001, 0.008]	[-0.008, 0.002]	[0.000, 0.007]	[0.001, 0.008]		
VAR(2) (main)	0.005	-0.005	0.004	0.004	35.3%	10596
	[0.002, 0.008]	[-0.009, 0.001]	[0.001, 0.008]	[0.001, 0.008]		
VAR(3)	0.005	-0.006	0.005	0.003	35.9%	10773
	[0.000, 0.008]	[-0.010, -0.002]	[0.001, 0.008]	[-0.001, 0.007]		

Notes: Posterior median (top row) and 68% credible band (bottom row) of the cumulative twelve-month log-CPI response to each structural shock, under three lag specifications for the reduced-form VAR. All other identification choices match the main spec. Acceptance rate is the share of 30,000 rotation draws that satisfy the sign restrictions.

Restriction horizon. The main specification imposes the M2 fiscal-channel restriction (for ε^{cbn}) and the M2 and reserves restrictions (for ε^{oil}) on cumulative responses at $h = 6$ months. The choice of horizon is reasonable but not pinned down by the model. Table A9 reports the SVAR with the cumulative restrictions imposed at $h \in \{3, 6, 9, 12\}$. The cumulative twelve-month CPI responses are essentially unchanged across all four horizons; the acceptance rate rises from 31% at $h = 3$ to 38% at $h = 12$ because longer-horizon cumulative responses are less restrictive in finite samples.

Table A9: SVAR Robustness: Cumulative Restriction Horizon

Specification	ε^{par}	ε^{cbn}	ε^{oil}	ε^{P}	Accept rate	N_{acc}
$h_{\text{restr}} = 3$	0.005	-0.005	0.004	0.004	31.6%	9484
	[0.002, 0.008]	[-0.009, 0.000]	[0.001, 0.008]	[0.001, 0.008]		
$h_{\text{restr}} = 6$ (main)	0.005	-0.005	0.004	0.004	35.3%	10596
	[0.002, 0.008]	[-0.009, 0.001]	[0.001, 0.008]	[0.001, 0.008]		
$h_{\text{restr}} = 9$	0.005	-0.005	0.004	0.004	37.1%	11145
	[0.002, 0.008]	[-0.009, 0.001]	[0.001, 0.008]	[0.001, 0.008]		
$h_{\text{restr}} = 12$	0.005	-0.005	0.004	0.004	38.1%	11436
	[0.002, 0.008]	[-0.009, 0.001]	[0.001, 0.008]	[0.001, 0.008]		

Notes: Posterior median (top row) and 68% credible band (bottom row) of the cumulative twelve-month log-CPI response to each structural shock, under four choices of the horizon h_{restr} at which the cumulative M2 and reserves restrictions are imposed. All other identification choices match the main spec. The reduced-form VAR has two lags.

Restriction set. The most aggressive test drops the M2 and reserves restrictions and identifies the four shocks only from the impact responses of the parallel rate, the official rate, and CPI. To distinguish ε^{cbn} from ε^{oil} without the M2 discriminator, we add the dominance restriction $|\Delta \log s| > |\Delta \log b|$ at impact for ε^{cbn}, the policy analogue of the parallel-dominance restriction on ε^{par}. Table A10 also reports an intermediate specification that imposes the M2 and reserves restrictions at impact only (rather than cumulatively at $h = 6$). The headline twelve-month CPI responses are within sampling uncertainty of the main specification under both alternatives. When the M2 and reserves restrictions are dropped, the M2 and reserves IRFs are centered near zero with wide bands across all four shocks—as expected, since the disciplining restrictions have been removed—but the CPI asymmetry survives.

Pre-2020 sub-sample. Re-estimating the SVAR on the December 2014 – December 2019 window used by the LP-IV (61 monthly observations) yields a cumulative twelve-month

Table A10: SVAR Robustness: Restriction Set

Specification	ε^{par}	ε^{cbn}	ε^{oil}	ε^{P}	Accept rate	N_{acc}
Main spec ($h_{\text{restr}} = 6$)	0.005	-0.005	0.004	0.004	35.3%	10596
	[0.002, 0.008]	[-0.009, 0.001]	[0.001, 0.008]	[0.001, 0.008]		
Impact-only M2 & reserves	0.005	-0.005	0.004	0.004	31.0%	9286
	[0.002, 0.008]	[-0.009, -0.000]	[0.001, 0.008]	[0.001, 0.008]		
Drop M2 & reserves entirely	0.006	-0.005	0.003	0.004	66.4%	19917
	[0.002, 0.009]	[-0.009, 0.000]	[0.000, 0.007]	[0.000, 0.008]		

Notes: Posterior median (top row) and 68% credible band (bottom row) of the cumulative twelve-month log-CPI response to each structural shock under three identification schemes. The main spec imposes cumulative M2 and reserves restrictions at $h = 6$. The impact-only spec imposes the same sign patterns at $h = 0$ rather than cumulative. The drop-M2-and-reserves spec drops the M2 and reserves restrictions entirely and adds an impact dominance restriction $|\Delta \log s| > |\Delta \log b|$ for ε^{cbn} to distinguish it from ε^{oil}.

CPI response of $+0.005$ to ε^{par} and -0.003 to ε^{cbn}, close to the full-sample estimates. The asymmetry is not a post-2020 artifact.

Are ε^{cbn} and ε^{oil} the same shock? A reasonable concern is that major CBN devaluations in Nigeria were triggered by oil-revenue pressure, so the SVAR may not actually separate the two shocks. We address this with a historical decomposition: at each accepted rotation we extract the implied structural-shock time series $\varepsilon_t = (B_0' B_0)^{-1} B_0' u_t$ and summarize across rotations. The cross-rotation median correlation between ε_t^{cbn} and ε_t^{oil} is 0.03—essentially zero. Three of the ten largest-magnitude months are shared between the two shocks (Table A11); the remaining seven are distinct. The June 2016 devaluation and the December 2015 reserves crisis register as both kinds of shock, as one would expect for episodes in which oil pressure and policy response coincided. But the SVAR pulls them apart over most of the sample.

Identification uncertainty. Posterior credible bands reflect only rotation uncertainty given the reduced-form point estimates. A fully Bayesian implementation would also sample over the reduced-form parameters; this would widen the bands modestly but not change the qualitative pattern.

Identification without the financial shock's price restriction. The financial shock's CPI impact restriction is the one cell of Table 1 that overlaps with a headline result, so we assess identification schemes that leave the price response unrestricted. The first identifies the shock from the exchange-rate cells alone. The second replaces the price cell with

Table A11: Largest-Magnitude Months for the CBN Devaluation (ε^{cbn}) and Oil-Revenue (ε^{oil}) Shocks

	ε^{cbn}		ε^{oil}	
Rank	Date	Shock	Date	Shock
1	2015-03	3.08	2015-12	3.07
2	2016-07	2.90	2016-06	3.00
3	2016-06	2.69	2020-04	2.53
4	2015-12	-1.85	2020-05	-2.08
5	2015-05	1.46	2015-02	1.80
6	2021-05	1.45	2020-03	1.67
7	2015-04	-1.44	2018-11	-1.59
8	2017-02	1.41	2015-04	-1.54
9	2015-07	1.26	2022-12	-1.44
10	2017-12	-1.20	2016-11	-1.43

Notes: Months ranked by $|\varepsilon_t^{cbn}|$ and $|\varepsilon_t^{oil}|$ at the posterior-median rotation. Shocks are extracted from the sign-restricted SVAR by computing $\varepsilon_t = (B_0'B_0)^{-1}B_0'u_t$ for each accepted rotation and taking the cross-rotation median in each month. Of the ten largest-magnitude months in each column, 3 are shared between the two lists; the remainder are distinct. The pairwise correlation between ε_t^{cbn} and ε_t^{oil} at the median rotation is 0.03.

bound restrictions in the spirit of Kilian and Murphy (2012): the impact responses of the official rate, M2, and reserves are bounded near zero, which is the shock's silence signature in the framework, and the CPI response is left free. Table A12 reports the results. The CBN shock's non-inflationary response and the oil and productivity/terms-of-trade rows are essentially unchanged in every scheme. For the financial shock, the unrestricted CPI response is centered on zero with a band that includes the baseline estimate: the schemes are uninformative about the response rather than contradictory. The reason is timing. Pass-through at monthly frequency is delayed, so the impact comovement between the parallel rate and prices is weak, and without the model's restriction the labeling admits columns of either price sign, which average out. Within the SVAR, the price restriction does exactly the work the framework assigns it; the evidence that parallel-rate movements pass through to prices without the sign restrictions comes from the OLS local projection in Section 5.5 and the external-instrument LP in Appendix I.

Table A12: SVAR Robustness: Identification Without the Financial Shock's Price Restriction

Specification	ε^{par}	ε^{cbn}	ε^{oil}	ε^{P}	Accept rate	N_{acc}
Baseline restriction set	0.005	-0.005	0.004	0.004	35.3%	10596
	[0.002, 0.008]	[-0.009, 0.001]	[0.001, 0.008]	[0.001, 0.008]		
Rate cells only	0.000	-0.005	0.005	0.005	50.3%	15101
	[-0.005, 0.005]	[-0.009, 0.000]	[0.002, 0.008]	[0.001, 0.008]		
Bounded s, M, R ($\delta = 0.50$)	-0.000	-0.005	0.005	0.004	33.1%	9924
	[-0.006, 0.006]	[-0.009, -0.000]	[0.001, 0.008]	[0.001, 0.008]		
Bounded s, M, R ($\delta = 0.25$)	-0.001	-0.005	0.004	0.004	5.4%	1607
	[-0.006, 0.006]	[-0.009, -0.000]	[0.001, 0.007]	[0.001, 0.008]		

Notes: Posterior median (top row) and 68% credible band (bottom row) of the cumulative twelve-month log-CPI response to each structural shock; same data, reduced-form VAR, and rotation draws as the baseline. "Rate cells only" drops the financial shock's CPI impact restriction, identifying it from $\Delta \log b > 0$ and $|\Delta \log b| > |\Delta \log s|$ at impact. The bounded specifications instead identify the financial shock from its silence signature: impact responses of the official rate, M2, and reserves bounded by δ times the corresponding innovation standard deviation, with a relevance floor of 0.25 standard deviations on the parallel-rate impact and the dominance restriction retained; the CPI response is unrestricted. All other shock rows are unchanged throughout. Under every price-unrestricted scheme the financial shock's CPI band spans zero and includes the baseline estimate: the schemes are uninformative about the response rather than contradictory.

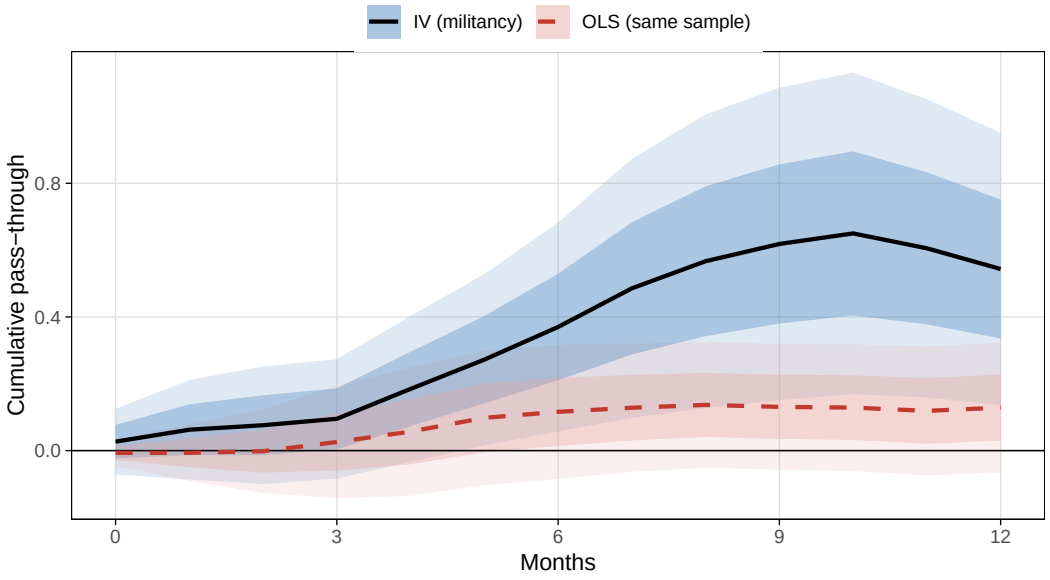
I External-Instrument Local Projection: The Militancy Instrument

The SVAR identifies the financial shock only up to a set of admissible rotations, and the joint OLS local projection (Section 5.5) recovers a conditional correlation. We point-identify the effect of the parallel rate using Niger Delta militant attacks on Nigerian oil infrastructure as an external instrument, following the local-projection IV in equation (18). The first stage is economically meaningful—an additional militant attack per month depreciates the parallel rate by 0.9%, significant at the 1% level—but its robust F-statistic of 7.7 falls below the Stock-Yogo threshold advocated by Lee et al. (2022), so we report a weak-instrument-robust Anderson-Rubin confidence set alongside the conventional Newey-West interval.[10] A placebo regression of the contemporaneous Brent log change on the same instrument returns $R^2 = 0.002$, indicating that it captures a Nigeria-specific dollar-inflow shock rather than a global oil-price movement. Figure A2 and Table A13 report the estimates: cumulative pass-through builds from near zero at impact to $\widehat{\beta}_{12}^{IV} = 0.54$, and the Anderson-Rubin 90% set excludes zero from six months onward

[10]We do not condition on M2 in the LP-IV. The model in Section 3 attributes part of the parallel-rate channel to money creation, so including M2 as a regressor would partial out a piece of the mechanism we are trying to estimate.

([0.19, 0.95] at $h = 6$ and [0.30, 1.27] at $h = 12$), lying entirely above the OLS conditional correlation on the same $N = 61$ subsample ($\widehat{\beta}_{12}^{OLS} = 0.13$) at every horizon past $h = 4$. The IV magnitude (0.54) brackets the SVAR (0.29) from above; both exceed OLS, consistent with attenuation from measurement error in the dealer-survey quotes. The two designs identify related but distinct objects on different samples—the SVAR averages over rotations through May 2023, the LP-IV isolates a dollar-inflow shock through December 2019—so the gap in magnitude is expected.

Figure A2: LP-IV vs. OLS-LP, Cumulative Pass-Through to Headline CPI



Notes: Cumulative pass-through to headline CPI from a one-percent depreciation of the parallel rate. The IV line instruments the parallel rate with the monthly count of Niger Delta militant attacks; the OLS line is the conditional correlation on the same subsample. Darker shading is the 68% confidence band; lighter shading is the 95% confidence band. Sample: December 2014 to December 2019.

Threats to exclusion. The identifying assumption is that militant attacks reach Nigerian retail prices only through the parallel rate. The most plausible alternative channels are muted here. Pipeline attacks could disrupt domestic refined-fuel distribution, but Nigerian refineries were largely non-functional over the sample and Brent enters as a control. Niger Delta unrest could disrupt agricultural supply chains running through Port Harcourt and Onne, but Nigerian food production is concentrated in the geographically separate north. Reverse causality is unlikely because the monthly attack pattern is dominated by discrete pipeline bombings and terminal blockades whose timing is strategic rather than a smooth function of inflation. None of these is fully shut down by the

Table A13: Cumulative Pass-Through to Headline CPI: LP-IV vs. OLS-LP

	LP-IV (Niger Delta militant attacks)				OLS-LP, same sample		
Horizon	$\widehat{\beta}_h^{IV}$	SE	AR 90% CI	First-stage F	$\widehat{\beta}_h^{OLS}$	SE	N
$h = 0$	0.027	0.050	[-0.07, 0.13]	7.67	-0.007	0.021	61
$h = 3$	0.095	0.091	[-0.05, 0.32]	7.67	0.026	0.086	61
$h = 6$	0.370**	0.159	[0.19, 0.95]	7.67	0.116	0.102	61
$h = 9$	0.618***	0.238	[0.36, 1.51]	7.67	0.131	0.096	61
$h = 12$	0.543***	0.208	[0.30, 1.27]	7.67	0.129	0.099	61

Notes: Cumulative local-projection coefficient on the parallel rate. LP-IV columns instrument $\Delta \log b_t$ with the monthly militant-attack count (Rexer and Hvinden, 2026); OLS columns report the conditional correlation on the same sub-sample. The Anderson-Rubin 90% confidence set is robust to weak instruments. Newey-West standard errors, lag four. Sample: December 2014 to December 2019. *, **, *** denote significance at the 10%, 5%, and 1% levels.

controls, so we read the LP-IV as informative about an upper-end magnitude rather than a clean LATE, and rely on the SVAR for the headline asymmetry.

J Shock-Dependence: Pass-Through and Episode Decompositions

Section 5.3 uses the forecast-error variance decomposition to show that the two rates are driven by different shocks. This appendix reports the two further decompositions referenced there.

Table A14: Implied Pass-Through to Consumer Prices by Structural Shock (12-Month Horizon)

Shock	Rate	$\Delta \log$ rate	$\Delta \log$ CPI	Pass-through
Financial	Parallel	0.017	0.005	0.29
Oil-revenue	Parallel	0.043	0.004	0.09
CBN devaluation	Official	0.005	-0.005	—

Notes: Implied pass-through is the cumulative twelve-month CPI response divided by the cumulative response of the rate the shock moves; responses are posterior medians from the sign-restricted SVAR and reproduce Table 3. The CBN devaluation shock moves the official rate, and its CPI response is the weakly negative fiscal channel of Section 5.2 rather than pass-through, so no ratio is reported. The productivity/terms-of-trade shock is omitted: it raises CPI with essentially no exchange-rate movement (imported cost-push inflation), so a pass-through ratio is undefined.

Table A14 computes an implied pass-through for each shock: the cumulative twelve-month CPI response divided by the response of the rate the shock moves. The contrast is large. A parallel-rate depreciation driven by a financial shock passes through to consumer prices at 0.29, one driven by an oil-revenue shock at only 0.09, even though both raise the same rate. One caveat governs how much weight to place on the financial figure: the parallel-rate response to a financial shock is imprecisely estimated—its 68% band includes zero, and it is positive in only 77% of accepted rotations—so the ratio is unstable; we therefore read the pass-through magnitude off the OLS local projection (Section 5.5) and the point-identified external-instrument LP (Appendix I) rather than off this ratio. The oil-revenue ratio, by contrast, is stably estimated, its denominator positive in every accepted draw. The CBN devaluation shock is the third case: it carries no positive pass-through, its price effect being the fiscal channel of Section 5.2.

Table A15: Historical Decomposition of the Parallel Rate by Episode

		Contribution of each shock (pp)				
Episode	Total $\Delta \log b$	Financial	CBN deval.	Oil-revenue	Prod./ ToT	Residual
2016 float (Jun–Sep)	29.6	-0.8	-3.7	13.9	11.0	2.6
COVID (Mar–Aug 2020)	27.5	4.5	2.6	8.8	3.7	-0.3
Premium widening (2021–22)	42.8	1.7	12.8	-9.4	6.9	5.1

Notes: Cumulative contribution (percent log change) of each structural shock to the parallel rate over each episode window, from the historical decomposition of the sign-restricted SVAR at the median-target rotation. 'Total' is the realized cumulative change; the four labeled shocks plus the unlabeled residual and a deterministic-trend component sum to the total.

Table A15 makes the point from the other side, decomposing the three largest depreciation episodes into the shocks that drove them. The 2016 float and the COVID episode of 2020 are both dominated by the oil-revenue shock, which contributes 13.9 and 8.8 percentage points of the 29.6% and 27.5% cumulative depreciations, respectively. The premium widening of June 2021 to December 2022 is different in kind: the largest single contributor is the CBN devaluation shock at 12.8 points, with the productivity/terms-of-trade shock adding 6.9, while the oil-revenue shock pushes the other way (-9.4 points) as oil prices recovered. Similar-sized moves, then, with different causes—pass-through estimated without regard to the source averages across different events.

K Heterogeneity Across Sub-Indices

The asymmetry reported in Section 5.1 holds category by category. We re-estimate the SVAR sub-index by sub-index, substituting each NBS sub-index for headline CPI in the five-variable system and leaving the sign restrictions unchanged.

Food CPI. Food is the natural place to start. It accounts for a large share of the Nigerian consumption basket, has the cleanest import-share data, and is the category in which the framework's tradable-versus-non-tradable distinction has the sharpest content. The cumulative twelve-month food-CPI response is $+0.006$ to the financial shock, with 68% credible band $[+0.002, +0.010]$ lying entirely above zero, and -0.003 to the CBN devaluation, with band $[-0.009, +0.003]$ that places most posterior mass below zero. The headline asymmetry reappears at the food level, with magnitudes in the same range and a slightly noisier CBN response.

Divisional sub-indices. The financial shock raises consumer prices across categories, building from impact through $h = 6$ and stabilizing at cumulative twelve-month responses of $+0.6\%$ for food, $+0.4\%$ for core ex-farm, and $+0.4\%$ for transport, with 68% bands above zero in each case. The CBN devaluation shock lowers prices across these categories, with central estimates between -0.3% and -0.5%, less precisely estimated than the parallel-rate response.

Table A16 reports cumulative CPI responses across all fifteen sub-indices to the financial and CBN devaluation shocks: the financial shock raises prices in every category, the CBN devaluation shock lowers them in every category, and the credible bands exclude zero for tradable-content sub-indices more often than for services and administered prices. Table A17 reports the corresponding OLS-LP joint specification.

L Naira-Yuan Pass-Through

Section 5.8 reports that the naira-yuan cross-rate carries limited independent pricing information. This appendix gives the three local projections behind that claim, all built on the baseline joint projection of equation (19) with Newey-West standard errors at lag four.

Spec A is the baseline in naira-dollar rates: the parallel rate carries a twelve-month pass-through of 0.176. Spec C replaces the naira-dollar rates with naira-yuan rates and returns a parallel-rate coefficient of 0.145, no larger than the dollar-rate figure—so pricing Nigerian imports off the yuan does not fit the data better than pricing them off the dollar.

Table A16: Sign-Restricted SVAR by CPI Sub-Index, Full Set

	$h = 6$		$h = 12$		
Sub-index	$\widehat{\mathsf{IRF}}^{par}$	$\widehat{\mathsf{IRF}}^{cbn}$	$\widehat{\mathsf{IRF}}^{par}$	$\widehat{\mathsf{IRF}}^{cbn}$	N_{accepted}
Food	**0.005**	-0.003	**0.006**	-0.003	3430
	[0.002, 0.008]	[-0.007, 0.003]	[0.002, 0.010]	[-0.009, 0.003]	
Imported food	**0.003**	**-0.003**	**0.003**	**-0.003**	4232
	[0.001, 0.005]	[-0.005, -0.000]	[0.001, 0.005]	[-0.006, -0.001]	
Core (ex-farm)	**0.003**	-0.003	**0.004**	-0.004	4193
	[0.001, 0.006]	[-0.006, 0.001]	[0.001, 0.007]	[-0.007, 0.000]	
Core (ex-farm, ex-energy)	**0.003**	-0.002	**0.003**	-0.003	3630
	[0.001, 0.005]	[-0.005, 0.001]	[0.001, 0.005]	[-0.006, 0.001]	
Alcohol & tobacco	**0.003**	**-0.004**	**0.004**	**-0.006**	4103
	[0.001, 0.005]	[-0.007, -0.000]	[0.001, 0.007]	[-0.009, -0.001]	
Clothing	**0.003**	-0.002	**0.004**	-0.003	3523
	[0.001, 0.005]	[-0.006, 0.002]	[0.002, 0.007]	[-0.008, 0.002]	
Housing & utilities	**0.006**	-0.005	**0.007**	-0.006	5159
	[0.002, 0.011]	[-0.010, 0.001]	[0.002, 0.011]	[-0.011, 0.001]	
Furnishings	**0.003**	-0.003	**0.003**	-0.004	3121
	[0.001, 0.005]	[-0.006, 0.000]	[0.001, 0.005]	[-0.006, 0.000]	
Health	**0.002**	-0.003	**0.003**	-0.004	4440
	[0.001, 0.004]	[-0.006, 0.000]	[0.001, 0.005]	[-0.007, 0.000]	
Transport	**0.003**	**-0.004**	**0.004**	**-0.005**	3214
	[0.001, 0.006]	[-0.007, -0.000]	[0.001, 0.007]	[-0.009, -0.000]	
Communication	**0.001**	**-0.002**	**0.002**	**-0.004**	4842
	[0.000, 0.003]	[-0.003, -0.001]	[0.001, 0.004]	[-0.006, -0.001]	
Recreation	**0.003**	-0.003	**0.003**	-0.003	3281
	[0.001, 0.005]	[-0.006, 0.001]	[0.001, 0.006]	[-0.006, 0.001]	
Education	**0.003**	-0.001	**0.004**	-0.002	5011
	[0.001, 0.006]	[-0.005, 0.002]	[0.001, 0.007]	[-0.006, 0.002]	
Restaurants	0.001	-0.002	0.001	-0.002	4744
	[-0.000, 0.003]	[-0.004, 0.001]	[-0.000, 0.003]	[-0.004, 0.001]	
Miscellaneous	**0.002**	-0.003	**0.002**	-0.003	3429
	[0.001, 0.004]	[-0.005, 0.001]	[0.001, 0.004]	[-0.005, 0.001]	

Notes: Cumulative log-CPI response to one-standard-deviation realizations of the financial shock (ε^{par}) and the CBN devaluation shock (ε^{cbn}) at horizons six and twelve months, for each NBS CPI sub-index. Bracketed numbers are 68% credible bands across accepted rotation draws. Median estimates whose 68% band excludes zero appear in bold. Each row is a separate SVAR with the indicated sub-index substituted for headline CPI; identifying sign restrictions and other variables match the headline specification (Section 4).

Spec B augments the baseline with the USD/CNY cross-rate, whose coefficient is statistically indistinguishable from zero at every horizon. All three agree that the dollar is the relevant price.

Table A17: Cumulative Pass-Through to COICOP Sub-Indices, Joint LP

	$h=0$		$h=6$		$h=12$		
Sub-index	$\widehat{\beta}$	$\widehat{\gamma}$	$\widehat{\beta}$	$\widehat{\gamma}$	$\widehat{\beta}$	$\widehat{\gamma}$	N
All items	0.001	0.012*	0.114	-0.089**	0.146*	0.023	81
	(0.015)	(0.006)	(0.089)	(0.039)	(0.085)	(0.051)	
Food	-0.018	0.006	0.049	-0.088**	0.080	0.074	81
	(0.016)	(0.007)	(0.079)	(0.037)	(0.084)	(0.066)	
Imported food	0.005	0.006	0.088	-0.137***	0.039	-0.123***	81
	(0.011)	(0.008)	(0.092)	(0.044)	(0.083)	(0.041)	
Core (ex-farm)	0.014	0.019***	0.136	-0.074*	0.167*	-0.011	81
	(0.015)	(0.007)	(0.098)	(0.043)	(0.093)	(0.051)	
Core (ex-farm, ex-energy)	0.004	0.013*	0.060	-0.067**	0.071	-0.008	81
	(0.009)	(0.007)	(0.066)	(0.028)	(0.059)	(0.033)	
Alcohol & tobacco	0.015**	0.017***	0.112*	-0.071**	0.097	-0.057	81
	(0.007)	(0.006)	(0.057)	(0.029)	(0.065)	(0.039)	
Clothing	0.001	0.019***	0.096	-0.027	0.170*	0.072	81
	(0.013)	(0.007)	(0.088)	(0.040)	(0.096)	(0.058)	
Housing & utilities	0.048	0.027	0.366*	-0.133	0.429**	-0.081	81
	(0.038)	(0.018)	(0.204)	(0.101)	(0.213)	(0.121)	
Furnishings	-0.005	0.004	0.042	-0.087***	0.049	-0.008	81
	(0.010)	(0.009)	(0.074)	(0.031)	(0.072)	(0.034)	
Health	0.003	0.005	0.017	-0.094**	-0.018	-0.050	81
	(0.009)	(0.009)	(0.052)	(0.037)	(0.038)	(0.034)	
Transport	0.006	0.023***	0.142*	-0.074*	0.139	-0.016	81
	(0.009)	(0.008)	(0.086)	(0.039)	(0.085)	(0.049)	
Communication	0.004	-0.006	-0.014	-0.102***	-0.131*	-0.153***	81
	(0.008)	(0.005)	(0.045)	(0.022)	(0.076)	(0.044)	
Recreation	-0.003	-0.008	0.045	-0.093***	0.018	-0.013	81
	(0.013)	(0.007)	(0.038)	(0.026)	(0.034)	(0.030)	
Education	0.029*	0.017*	0.183**	0.050	0.285**	0.064	81
	(0.017)	(0.009)	(0.087)	(0.060)	(0.122)	(0.080)	
Restaurants	0.003	-0.000	-0.006	-0.091**	-0.042	-0.034	81
	(0.008)	(0.006)	(0.040)	(0.036)	(0.031)	(0.037)	
Miscellaneous	-0.002	0.001	0.057	-0.095***	0.035	-0.031	81
	(0.011)	(0.007)	(0.058)	(0.032)	(0.046)	(0.033)	

Notes: Cumulative pass-through to the indicated CPI sub-index at horizons $h = 0, 6, 12$ months, from the joint local-projection specification in Equation (19). $\widehat{\beta}$ is the coefficient on the contemporaneous log change in the parallel rate; $\widehat{\gamma}$ is the coefficient on the contemporaneous log change in the official rate. Sample: monthly Nigerian data from November 2014 to August 2022 (COICOP series end August 2022 due to NBS rebasing). Newey-West standard errors with lag 4 in parentheses. N reports the sample size at $h = 12$. *, **, *** denote significance at the 10%, 5%, and 1% levels.

Table A18: Naira-Dollar versus Naira-Yuan Pass-Through to Headline CPI

	Parallel rate		USD/CNY	
Horizon	Naira-dollar (A)	Naira-yuan (C)	cross-rate (B)	N
$h = 0$	-0.005 (0.013)	-0.005 (0.012)	0.003 (0.034)	102
$h = 3$	0.032 (0.056)	0.034 (0.055)	-0.029 (0.137)	99
$h = 6$	0.147** (0.073)	0.140** (0.069)	0.096 (0.200)	96
$h = 9$	0.195*** (0.071)	0.184*** (0.069)	0.130 (0.310)	93
$h = 12$	0.176** (0.076)	0.145** (0.070)	0.494 (0.443)	90

Notes: Joint local projection of cumulative headline CPI on the exchange rates and the baseline macro controls, Newey-West standard errors at lag four, November 2014 to May 2023. Spec A is the baseline naira-dollar projection (equation 19); spec C replaces the naira-dollar rates with naira-yuan rates (NGN/CNY = NGN/USD ÷ CNY/USD); spec B augments A with the USD/CNY cross-rate. The table reports the parallel-rate coefficient in specs A and C and the USD/CNY coefficient in spec B; standard errors in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels.