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Effectiveness of Monetary Policy Under Climate Constraints in Developing Countries

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Abstract

This study examines the changing configuration of the effectiveness of monetary policy in emerging economies in the context of increasing climate constraints, when traditional instruments face structural constraints. Climate-related physical and transition risks disrupt monetary transmission mechanisms, generating stagflationary dynamics that defy traditional inflation targeting mechanisms. Developing countries face increased vulnerability due to high dependence on fossil fuels, shallow financial markets, and institutional fragmentation, which reinforces policy trade-offs between short-term stabilization and long-term resilience to climate change. The analysis highlights the inadequacy of equilibrium-based models and advocates the need to create adaptive systems that include climate risk scenarios, stress testing, and hybrid policy tools. Crucially, addressing trade-offs between monetary and fiscal policy and climate requires coordinated reforms, including multilateral liquidity mechanisms and institutional innovations that address structural asymmetries. The results highlight the need to review the mandates of central banks in order to harmonize price stability with biophysical realities in the context of climate vulnerability.

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Keywords

Monetary policy transmission, climate constraints, developing economies, structural vulnerability, policy coordination, green finance.

Introduction

The evolving interplay between monetary policy frameworks and intensifying climate constraints presents a critical yet underexplored dilemma for developing economies. Traditional monetary policy paradigms, anchored in stabilizing inflation and sustaining growth, increasingly confront unprecedented challenges arising from climate-related disruptions. These disruptions manifest not merely as exogenous shocks but as structural forces reshaping macroeconomic equilibria.[Arshad, Ahmed, Ramzan et al., 2021] In developing nations, where institutional resilience and economic diversification remain nascent, the dual imperative of mitigating climate risks while preserving monetary stability exposes fundamental tensions within conventional policy toolkits.

Central to this dilemma is the recalibration of monetary transmission mechanisms under climate constraints. Physical risks—ranging from agricultural productivity losses to infrastructure damage—distort supply-side dynamics, generating persistent inflationary pressures that defy standard Phillips curve assumptions. Simultaneously, transition risks linked to global decarbonization efforts threaten asset stranding in carbon-intensive sectors, a vulnerability acutely felt in commodity-dependent developing economies. Such risks compound preexisting structural fragilities: heavy reliance on fossil fuel exports, shallow financial markets, and constrained fiscal capacities limit the scope for countercyclical adjustments. Crucially, the interaction between climate-induced supply shocks and monetary policy responses risks entrenching stagflationary traps, wherein tightening cycles to curb inflation inadvertently exacerbate output volatility.

The originality of this inquiry lies in its explicit focus on the institutional and operational asymmetries distinguishing developing economies from advanced counterparts. Whereas developed central banks increasingly integrate climate scenarios into forward-looking models, their developing peers grapple with fragmented data infrastructures and political economy constraints that impede proactive risk internalization. This analysis contends that climate constraints do not merely add a layer of complexity to monetary policy but fundamentally alter its efficacy by redefining risk horizons and transmission pathways. The resultant policy trade-offs—between short-term stabilization and long-term climate resilience—demand a reconceptualization of central banking mandates in resource-constrained contexts. By elucidating these dynamics, the study aims to advance a framework for climate-aware monetary policy design, tailored to the structural realities of developing nations.

Theoretical Framework: Climate Constraints and Monetary Policy

The integration of climate constraints into monetary policy analysis necessitates a re-examination of foundational macroeconomic relationships, particularly within the context of developing economies. Climate constraints, defined as systemic limitations imposed by both physical and transition risks, constitute structural discontinuities that alter the traditional boundaries of monetary policy effectiveness. Physical risks—encompassing acute environmental disruptions such as floods, droughts, and heatwaves—directly impair productive capacities by destabilizing agricultural yields, energy infrastructure, and labor productivity. Transition risks, conversely, emerge from the global shift toward low-carbon economies, manifesting as abrupt repricing of carbon-intensive assets, regulatory penalties on emissions, and technological obsolescence in fossil fuel-dependent sectors. These dual dimensions of climate risk recalibrate the parameters of monetary policy efficacy, demanding a granular understanding of their transmission pathways.

Central to this recalibration is the interplay between climate-induced disruptions and monetary

transmission mechanisms. The interest rate channel, traditionally viewed as a tool for demand management, assumes new complexity under climate constraints. Supply shocks stemming from physical risks—such as crop failures or energy shortages—generate cost-push inflation that central banks cannot mitigate through conventional tightening without exacerbating output contractions.[Roy, 2024] This stagflationary dynamic undermines the Phillips curve trade-off, compelling policymakers to confront inflation origins that lie beyond cyclical demand fluctuations. Simultaneously, transition risks impose asset-liability mismatches on financial institutions, particularly in developing economies where banks dominate credit intermediation. Stranded assets in carbon-intensive industries erode bank capital buffers, tightening credit availability for productive sectors and amplifying procyclicality during decarbonization shocks.

The exchange rate channel further illustrates the structural vulnerabilities of commodity-exporting developing nations. Global decarbonization pressures depress long-term demand for fossil fuels and emission-intensive commodities, triggering terms-of-trade deterioration and currency volatility. Monetary authorities face a trilemma: stabilizing exchange rates to curb imported inflation may require depleting foreign reserves, while permitting currency depreciation risks amplifying debt sustainability concerns for dollar-denominated borrowers. This dilemma is compounded by the fact that climate-related capital flows—such as green investment allocations or carbon border adjustments—exhibit heightened sensitivity to geopolitical and regulatory uncertainties, distorting interest rate parity conditions.Crucially, the theoretical implications extend beyond additive risk factors. Climate constraints reconfigure the temporal and spatial dimensions of monetary policy impacts. Physical risks introduce non-linear, geographically concentrated shocks that challenge the homogenizing assumptions of aggregate demand management. Transition risks, meanwhile, impose forward-looking constraints on policy flexibility, as central banks must anticipate regulatory cascades and technological tipping points that reshape inflation expectations and investment horizons. For developing economies, these dynamics intersect with preexisting structural rigidities—shallow financial markets, fiscal dominance, and institutional fragmentation—to create a uniquely precarious policy environment.

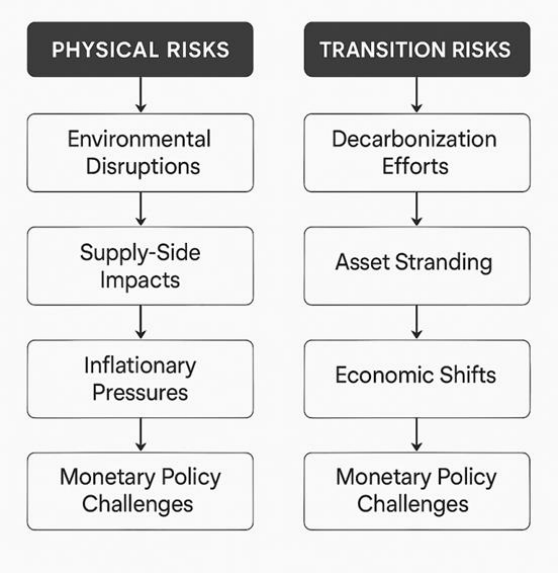
Figure 1 illustrates the parallel transmission mechanisms of physical and transition climate risks on monetary policy effectiveness. The left column traces the impacts of acute environmental disruptions leading to supply-side shocks and inflationary pressures. The right column follows transition risks stemming from decarbonization, resulting in asset stranding and structural economic shifts. Both pathways underscore the multifaceted challenges climate risks pose for monetary authorities in developing countries.

Theoretical rigor thus demands a departure from equilibrium-based models toward frameworks that internalize climate-driven discontinuities. This entails recognizing monetary policy not merely as a cyclical stabilizer but as an institutionally mediated force operating within biophysical and socio-technical boundaries. Such a perspective aligns with the Russian academic tradition’s emphasis on systemic interdependencies and structural heterogeneity, providing a robust foundation for redefining monetary efficacy in an era of climate constraints.

Structural Challenges in Developing Economies

The structural impediments confronting developing economies in reconciling monetary policy objectives with climate constraints are rooted in deeply entrenched macroeconomic and institutional rigidities. These challenges are not peripheral constraints but systemic features that amplify vulnerabilities to both climate shocks and policy misalignments. At the core of these vulnerabilities lies

the high energy intensity of economic output, a structural characteristic that binds growth trajectories to fossil fuel consumption. In economies where industrial and agricultural activities rely disproportionately on carbon-intensive energy inputs, decarbonization efforts risk destabilizing production systems, employment, and fiscal revenues.[Lahiri, Patel, 2016] This dependency creates a paradox: while global climate imperatives demand rapid energy transitions, the immediate costs of such shifts—including stranded assets, workforce dislocation, and inflationary supply-chain disruptions—threaten macroeconomic stability. The energy-GDP elasticity in these contexts reflects not merely technological backwardness but also political economy equilibria, where subsidized fossil fuels serve as short-term social stabilizers, embedding carbon lock-in effects that resist abrupt policy reversals.Compounding this challenge is the limited access to green financing, a bottleneck that constrains the capacity to reorient capital toward sustainable infrastructure. Developing economies often operate within shallow financial markets characterized by fragmented regulatory frameworks and investor risk aversion. Green financing mechanisms—such as climate bonds, blended finance instruments, or sustainability-linked loans—remain nascent or inaccessible due to high borrowing costs, currency mismatches, and inadequate credit-enhancement structures. Consequently, the transition to low-carbon technologies becomes contingent on external financing, exposing these economies to volatile cross-border capital flows and conditionalities imposed by international lenders.This dependency perpetuates a cycle of underinvestment in domestic renewable energy capacity, reinforcing reliance on imported fossil fuels and exacerbating balance-of-payments pressures. Crucially, the scarcity of long-term, patient capital for green projects undermines the credibility of climate commitments, as private investors prioritize short-term returns over structural transformation.[Mukherjee, Ouattara, 2021]



Source: created by the authors

Figure 1 - Transmission Mechanisms of Climate Risks on Monetary Policy

The institutional landscape further entrenches these vulnerabilities. Weak climate data infrastructures hinder the granular risk assessments necessary for aligning monetary policy with climate objectives. Central banks in developing economies frequently lack access to high-frequency environmental datasets, satellite imagery, or sectoral carbon footprints, impairing their ability to model

climate-related financial risks or design targeted interventions. This data deficit fosters reliance on reactive, rather than preemptive, policy measures—a misalignment given the forward-looking nature of climate risks. Simultaneously, institutional silos between monetary authorities and environmental agencies impede coherent policy formulation. While central banks prioritize price stability and financial sector resilience, environmental regulators often operate under conflicting mandates, such as industrial growth targets or energy affordability imperatives. This fragmented governance architecture obstructs the integration of climate scenarios into macroeconomic forecasting, leaving monetary policy frameworks ill-equipped to address nonlinear climate shocks or transition-driven market failures.

The interplay between high energy intensity and constrained green financing creates a self-reinforcing dynamic. Fossil fuel dependency depresses investor confidence in green sectors, while limited access to sustainable finance perpetuates carbon-intensive growth pathways. For monetary policymakers, this duality complicates inflation management, as energy price volatility—amplified by climate shocks and transition uncertainties—transmits rapidly to core inflation through transportation, manufacturing, and agricultural supply chains. Attempts to tighten monetary policy in response risk stifling growth in energy-intensive sectors, whereas accommodative stances risk embedding inflationary expectations.[Breitenfellner, Pointner, 2021] Moreover, exchange rate pressures stemming from fossil fuel import bills and green technology dependencies limit the scope for independent monetary action, particularly in dollarized economies.

These structural challenges demand a reconceptualization of monetary policy's role in climate transitions. Rather than treating climate constraints as externalities, central banks must account for the recursive interactions between energy systems, financial markets, and institutional capacities. This requires advancing hybrid policy frameworks that bridge short-term stabilization goals with long-term structural reforms—such as phased energy subsidy rationalization, green public investment incentives, and coordinated data infrastructure modernization. Only by addressing these foundational rigidities can developing economies navigate the trilemma of achieving price stability, sustaining growth, and fulfilling climate imperatives in an era of escalating ecological constraints.

Monetary Policy Tools under Climate Constraints

The operationalization of monetary policy under climate constraints demands a critical reassessment of both conventional and innovative instruments, particularly within the structural realities of developing economies. Traditional tools, designed for cyclical demand management, face diminishing efficacy in stagflationary environments precipitated by climate shocks—a phenomenon where supply-side disruptions from extreme weather or decarbonization pressures coexist with persistent inflationary trends. In such contexts, interest rate policy encounters inherent contradictions: tightening to curb inflation risks exacerbating output contractions in energy-intensive sectors, while easing to stimulate growth risks entrenching inflationary expectations fueled by climate-driven supply bottlenecks. This dilemma is amplified in economies with high fossil fuel dependency, where energy price volatility transmits rapidly to core inflation through production networks.[Deih, 2023] Consequently, central banks must recalibrate rate-setting frameworks to differentiate between demand-pull and climate-induced cost-push inflation, a task complicated by the lack of granular data on sectoral climate vulnerabilities.

Reserve requirements, another cornerstone of conventional policy, acquire new dimensions when aligned with climate objectives. Imposing higher reserve ratios on banks with significant exposures to carbon-intensive assets could theoretically mitigate financial stability risks from stranded assets.

However, in developing economies where banking sectors dominate credit intermediation and fossil fuel industries constitute systemic economic pillars, such measures risk triggering credit crunches or destabilizing employment in politically sensitive sectors. This underscores the need for phased implementation, coupled with liquidity backstops to prevent abrupt deleveraging. Crucially, the success of reserve requirement adjustments hinges on robust climate risk classification systems—a challenge in jurisdictions with opaque corporate reporting and underdeveloped ESG (environmental, social, governance) disclosure frameworks.

Table 1 - Adaptive Applicability of Monetary Policy Tools under Climate Constraints in Developing Economies

Tool	Traditional Function	Key Challenges	Potential Adaptive Adjustment
Interest Rate Policy	Manage aggregate demand	Ineffective under supply-side shocks	Integrate climate-sensitive forecasting to distinguish inflation drivers
Reserve Requirements	Mitigate credit and systemic risks	High exposure to fossil-fuel sectors may trigger credit contraction	Introduce differentiated requirements based on carbon intensity
GTRO (Green Targeted Refinancing Operations)	Stimulate green investment	Ambiguity in green definitions, weak appraisal capacity	Establish national green taxonomies and technical assistance

Source: created by the authors

Innovative policy instruments, while promising, confront institutional and market barriers unique to developing nations. Green Targeted Refinancing Operations (GTROs), which offer preferential central bank funding for climate-aligned lending, face dual limitations. First, the definitional ambiguity of "green" projects in economies with fragmented regulatory standards risks allocative distortions, channeling liquidity toward superficial compliance rather than transformative investments. Second, commercial banks' risk aversion and capacity gaps in appraising green technologies constrain GTRO uptake. For instance, renewable energy projects in regions with unreliable grid infrastructure or weak contract enforcement may be deemed unbankable, despite their climate relevance. These challenges necessitate complementary investments in technical assistance frameworks and regulatory harmonization to enhance instrument efficacy. Climate-adjusted collateral frameworks, which assign preferential haircuts to green assets in central bank refinancing operations, present another innovative avenue.[Dziwok, Jäger, 2021] By altering the relative cost of capital for sustainable versus carbon-intensive investments, such frameworks could theoretically reorient private sector portfolios. However, their viability in developing economies is contingent on overcoming structural asymmetries. Domestic bond markets often lack sufficient issuance of green securities, forcing central banks to accept climate-ambiguous collateral or rely on external certification schemes misaligned with local priorities. Moreover, the dominance of small and medium enterprises (SMEs) in carbon-intensive informal sectors complicates collateral valuation, as these entities rarely possess standardized assets eligible for central bank operations.

The interplay between conventional and innovative tools reveals deeper institutional tensions. While GTROs and climate-adjusted collateral aim to incentivize green transitions, their effectiveness is mediated by preexisting market failures—information asymmetries, shallow capital markets, and misaligned fiscal-monetary priorities.[Spyromitros, 2023] For example, even if central banks successfully lower financing costs for renewables through targeted operations, the absence of

coordinated fiscal policies (e.g., carbon pricing, infrastructure subsidies) may limit private sector participation due to incomplete risk-return profiles. Similarly, efforts to tighten reserve requirements for high-carbon lenders could inadvertently concentrate systemic risks in shadow banking sectors beyond regulatory reach.

These complexities underscore the necessity of embedding monetary tools within broader institutional reforms. Central banks in developing economies must navigate a dual imperative: maintaining short-term macroeconomic stability while steering long-term climate resilience. This requires iterative policy frameworks that integrate real-time climate risk monitoring, dynamic stress-testing models, and cross-agency coordination mechanisms. For instance, coupling GTROs with public development bank initiatives could de-risk green investments, while climate-adjusted collateral policies might be phased in parallel with efforts to deepen domestic green bond markets. Crucially, such adaptations must account for political economy constraints—such as vested interests in fossil fuel sectors—that resist abrupt financial reallocations.

Ultimately, the recalibration of monetary tools under climate constraints is not merely a technical exercise but a paradigmatic shift in central banking. It demands recognition of monetary policy's role as an enabler of structural economic transformation, rather than a neutral arbiter of price stability. For developing economies, this shift entails balancing global climate commitments with domestic socio-economic stability—a equilibrium achievable only through policy frameworks that harmonize monetary instruments, institutional capacities, and the biophysical realities of climate-vulnerable growth models.

Policy Coordination and Trade-offs

The imperative of aligning monetary, fiscal, and climate policies in developing economies unveils a labyrinth of institutional and strategic trade-offs, exacerbated by the scalar mismatch between short-term stabilization imperatives and long-term decarbonization goals. At the domestic level, the monetary-fiscal-climate nexus is strained by risks of fiscal dominance, wherein expansive public spending to finance green transitions—such as renewable energy subsidies or coal phaseout compensation—collides with central banks' inflation-targeting mandates. This tension is particularly acute in economies reliant on fossil fuel revenues, where abrupt withdrawal of carbon-intensive fiscal bases threatens budget sustainability, compelling monetary authorities to monetize deficits or tolerate inflationary pressures. Concurrently, currency stability objectives conflict with decarbonization investments: aggressive green capital expenditures often necessitate foreign currency borrowing, amplifying exchange rate volatility and external debt vulnerabilities.[D'Orazio, 2025] Central banks thus face a trilemma—balancing exchange rate management, inflation control, and climate-aligned credit allocation—amid constrained policy autonomy.

Internationally, cross-border spillovers distort the efficacy of unilateral climate measures. Carbon leakage effects—where stringent domestic emission policies shift production (and emissions) to jurisdictions with laxer standards—undermine global decarbonization efforts while distorting trade balances for developing economies. Compounding this, divergent global climate policy trajectories generate capital flow volatility, as investors reallocate portfolios in response to regulatory uncertainty. For instance, delayed implementation of cross-border carbon adjustment mechanisms by advanced economies may trigger premature divestment from developing nations' green projects, heightening refinancing risks. These dynamics are magnified in commodity-dependent states, where fossil fuel export revenues remain critical for servicing foreign debt, creating perverse incentives to prolong

carbon-intensive activities despite climate commitments.

The resolution of these trade-offs demands institutional innovations that transcend conventional policy silos. Central banks must engage in iterative dialogue with fiscal authorities to design sequenced transition pathways—phasing fossil fuel subsidy reforms alongside targeted social safety nets to mitigate inflationary shocks. Internationally, coordination mechanisms such as climate-aligned swap lines or multilateral green liquidity facilities could buffer developing economies against speculative capital flight while financing just transitions. Crucially, such frameworks must recognize the structural asymmetries between global climate agendas and local socio-economic realities, avoiding one-size-fits-all prescriptions that overlook the political economy of energy transitions in resource-constrained contexts.

Conclusion

The analysis reveals that climate constraints fundamentally reconfigure the operational logic of monetary policy in developing economies, transforming what were once cyclical management challenges into structural dilemmas with irreversible consequences. Traditional monetary tools, designed under assumptions of energy abundance and stable biophysical conditions, prove inadequate in addressing the dual inflationary pressures from climate-induced supply shocks and decarbonization-driven transition costs. These constraints amplify preexisting vulnerabilities—high fossil fuel dependency, shallow financial markets, institutional fragmentation—creating feedback loops where short-term stabilization measures inadvertently compromise long-term climate resilience. Crucially, the interaction between physical and transition risks generates non-linear macroeconomic disruptions that defy conventional forecasting models, necessitating a paradigm shift in central banking frameworks.The imperative for adaptive policy architectures emerges unequivocally. Central banks must institutionalize climate risk scenarios into their core decision-making processes, moving beyond reactive adjustments to proactive risk internalization. This entails developing granular stress-testing models that account for geographically concentrated climate shocks and sectoral exposure differentials, particularly in agriculture, energy, and export-oriented industries. Such models should quantify the second-round effects of climate disruptions on inflation expectations, credit markets, and fiscal sustainability, enabling policymakers to calibrate instruments with temporal precision.

Concurrently, the transnational nature of climate risks demands reimagined global financial governance. Multilateral green liquidity mechanisms—structured as special drawing rights (SDRs) earmarked for just transition financing or climate-contingent debt relief—could mitigate the capital flow volatility exacerbated by uneven decarbonization policies. These mechanisms must prioritize developing economies' structural realities, recognizing that climate resilience cannot be divorced from energy security and socio-political stability. Ultimately, the path forward lies not in choosing between monetary stability and climate action but in redefining their interdependence through institutional innovations that bridge technocratic mandates with planetary boundaries.

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Эффективность денежно-кредитной политики в условиях климатических ограничений в развивающихся странах

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Аннотация

В данном исследовании рассматривается изменение конфигурации эффективности денежно-кредитной политики в развивающихся экономиках в условиях усиления климатических ограничений, когда традиционные инструменты сталкиваются со структурными ограничениями. Вызванные климатом физические риски и риски переходного периода нарушают механизмы денежной трансмиссии, порождая стагфляционную динамику, которая не поддается традиционным механизмам инфляционного таргетирования. Развивающиеся страны сталкиваются с усугубленной уязвимостью из-за высокой зависимости от ископаемого топлива, неглубоких финансовых рынков и институциональной фрагментации, что усиливает политические компромиссы между краткосрочной стабилизацией и долгосрочной устойчивостью к изменению климата. В анализе подчеркивается неадекватность моделей, основанных на равновесии, и пропагандируется необходимость создания адаптивных систем, включающих сценарии климатических рисков, стресс-тестирование и гибридные инструменты политики. Крайне важно, что решение компромиссов между монетарной и фискальной политикой и климатом требует скоординированных реформ, включая многосторонние механизмы ликвидности и институциональные инновации, учитывающие структурные асимметрии. Полученные

результаты подчеркивают необходимость пересмотра мандатов центральных банков для гармонизации ценовой стабильности с биофизическими реалиями в условиях уязвимости климата.

Для цитирования в научных исследованиях

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Ключевые слова

Трансмиссия денежно-кредитной политики, климатические ограничения, развивающиеся экономики, структурная уязвимость, координация политики, «зеленое» финансирование.

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