Macroeconomic Effects of Reducing the Statutory Social Security Contribution Rate in Mongolia: Evidence from a Structural VECM

Bat Buyantsogt[1], Esmedekh Lkhanaajav[2], Tuvshin Banzragch[3] and Lkhamsuren Myagmarsuren[4]

[1] Department of Economics, National University of Mongolia, Ulaanbaatar, Mongolia

[2] Investment NSW, Premier's Department, NSW government, Australia

[3] State Great Khural of Mongolia, Ulaanbaatar, Mongolia

[4] Tinos Microfinance Institution NBFI,

Abstract

This paper investigates the macroeconomic effects of reducing the statutory social security contribution (SSC) rate in Mongolia using a structurally identified time-series framework. Motivated by recent fiscal pressures and proposed labour market reforms, the study uses quarterly data from 2000Q1 to 2024Q4 and applies a recursive Cholesky identification strategy to assess the short-run macroeconomic effects of an SSC rate cut. Given the presence of unit roots in several variables and evidence of cointegration, a Structural Vector Error Correction Model (SVECM) with two cointegrating vectors is adopted as the preferred specification. This approach corrects for non-stationarity while preserving the recursive identification structure used to identify the SSC policy shock.

The policy simulation considers a one-percentage-point reduction in the statutory SSC rate, from 22 percent to 21 percent. The point estimates suggest that the SSC rate cut is associated with a positive cumulative real GDP response of approximately MNT 39.6 billion after eight quarters and MNT 60.0 billion after twelve quarters. The implied fiscal multiplier rises from 0.07 at the four-quarter horizon to 0.28 at twelve quarters, with the cumulative output response becoming statistically significant from the twelfth quarter onward, broadly within the range reported in the international literature on small open and developing economies. The effect on inflation is small and mildly disinflationary, while the lending rate response is modest and the real effective exchange rate shows a slight depreciation supportive of export competitiveness. These findings suggest that SSC rate reductions may provide a moderate short-run stimulus to economic activity, although the estimated magnitudes are subject to uncertainty and should be interpreted as conditional on the chosen SVECM specification and recursive identification assumptions. Overall, the results support the view that carefully designed SSC rate cuts can serve as a countercyclical fiscal policy instrument, provided that fiscal sustainability and social insurance fund balances are also taken into account.

Keywords: social security contribution; fiscal multiplier; Structural VECM; cointegration; impulse response function; Mongolia; small open economy

JEL Classification: C32, E62, H55, H30, O11, P24

Хураангуй

Энэхүү судалгаа нь Монгол улсын Нийгмийн Даатгалын Шимтгэлийн (НДШ) хувь хэмжээг бууруулахын макро эдийн засгийн нөлөөг бүтэц зүйн цаг хугацааны цувааны загвараар судалсан болно. Сүүлийн үеийн төсвийн болон хөдөлмөрийн зах зээлд санал болгож буй шинэчлэлүүдээс үүдэн, энэхүү судалгаа нь 2000 оны 1-р улирлаас 2024 оны 4-р улирал хүртэлх улирлын өгөгдлийг ашиглан, рекурсив Cholesky-ийн тодорхойлох стратеги хэрэглэн НДШ-ийн хувь хэмжээг бууруулсны богино хугацааны макро эдийн засгийн нөлөөг үнэлсэн. Хэд хэдэн хувьсагчид нэгж язгуур (unit root) илэрсэн ба коинтеграцийн нотолгоо байгаа учир гурван коинтеграцийн вектор бүхий Бүтэц зүйн Векторын Алдааны Залруулах Загвар (SVECM)-ыг үндсэн загвар болгон сонгосон. Энэ арга нь стационар бус байдлыг засаж, НДШ-ийн бодлогын шокийг тодорхойлох рекурсив бүтэц зүйг хадгалан үлдэнэ.

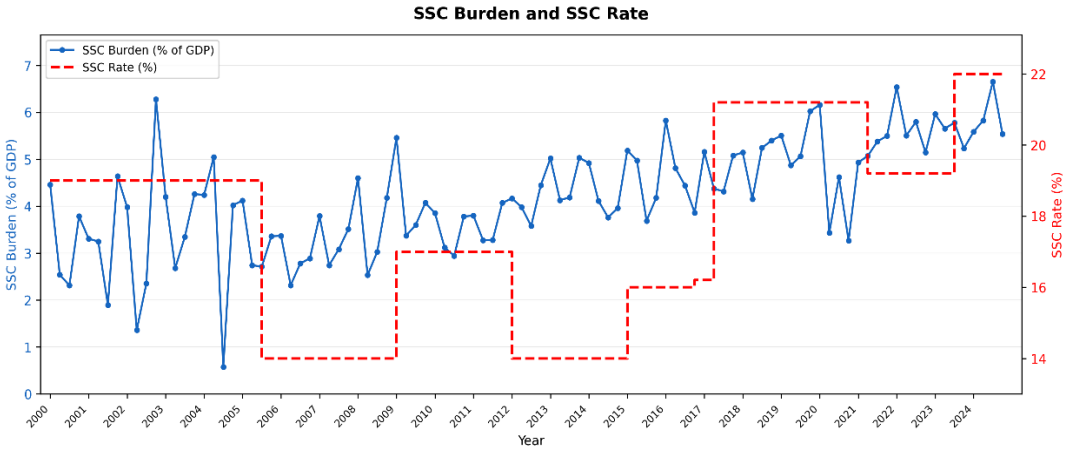
Бодлогын симуляцид НДШ-ийн хуульд заасан хувь хэмжээг 22 хувиас 21 хувь болгон, нэг percentage point-оор бууруулах хувилбарыг авч үзсэн. Тооцооны цэгэн үнэлгээнээс харахад НДШ-ийн хувь хэмжээний бууралт нь 8 улирлын дараа ойролцоогоор 39.6 тэрбум төгрөг, 12 улирлын дараа 60.0 тэрбум төгрөгийн хуримтлагдсан эерэг бодит ДНБ-ийн хариу үйлдэлтэй байна. Тооцоолсон төсвийн үржигдэхүүн нь 4 улирлын хугацаанд 0.07-оос 12 улирлын хугацаанд 0.28 хүртэл өсөж байгаа нь жижиг нээлттэй болон хөгжиж буй эдийн засгуудын талаарх олон улсын судалгаанд дурдсан хүрээнд ерөнхийдөө нийцэж байна. Инфляцид үзүүлэх нөлөө нь бага бөгөөд сул дефляц шинжтэй, харин зээлийн хүүгийн нөлөө дунд зэрэг, бодит үр ашигт ханш бага зэрэг сулрах хандлагатай байгаа нь экспортын өрсөлдөх чадварыг дэмжих чиглэлтэй байна. Эдгээр үр дүн нь НДШ-ийн хувь хэмжээний бууралт эдийн засгийн идэвхжилд богино хугацаанд дунд зэргийн дэмжлэг үзүүлэх боломжтойг харуулж байгаа боловч тооцоолсон нөлөөний хэмжээг тодорхой бус байдалтай, сонгосон SVECM загвар болон recursive identification таамаглалуудаас хамаарах нөхцөлт үр дүн гэж тайлбарлах шаардлагатай. Ерөнхийдөө, төсвийн тогтвортой байдал болон нийгмийн даатгалын сангийн тэнцвэрийг хамтад нь харгалзан үзсэн нөхцөлд сайн боловсруулсан НДШ-ийн хувь хэмжээний бууралт нь мөчлөг сөрсөн төсвийн бодлогын хэрэгсэл болж болохыг үр дүн харуулж байна.

1. Introduction

This paper uses two effective measures of the social security contribution (SSC) burden to assess how SSC payments are related to the overall tax burden on the Mongolian economy. The first measure is the ratio of SSC revenue to nominal GDP, while the second is the ratio of SSC revenue to total wages and compensation of employees. These indicators capture the effective macroeconomic and labour-cost burden of SSC payments, respectively.

Figure 1 presents the SSC burden, measured as SSC revenue relative to nominal GDP, together with the statutory SSC rate. The left vertical axis shows the SSC-to-GDP ratio, while the right vertical axis shows the statutory SSC rate, defined as the combined employer and employee contribution rate. The SSC burden is calculated for each quarter from 2000Q1 to 2024Q4. It reached its peak of 6.7 percent of nominal GDP in 2024Q3, while the statutory SSC rate also reached its highest level in 2024.

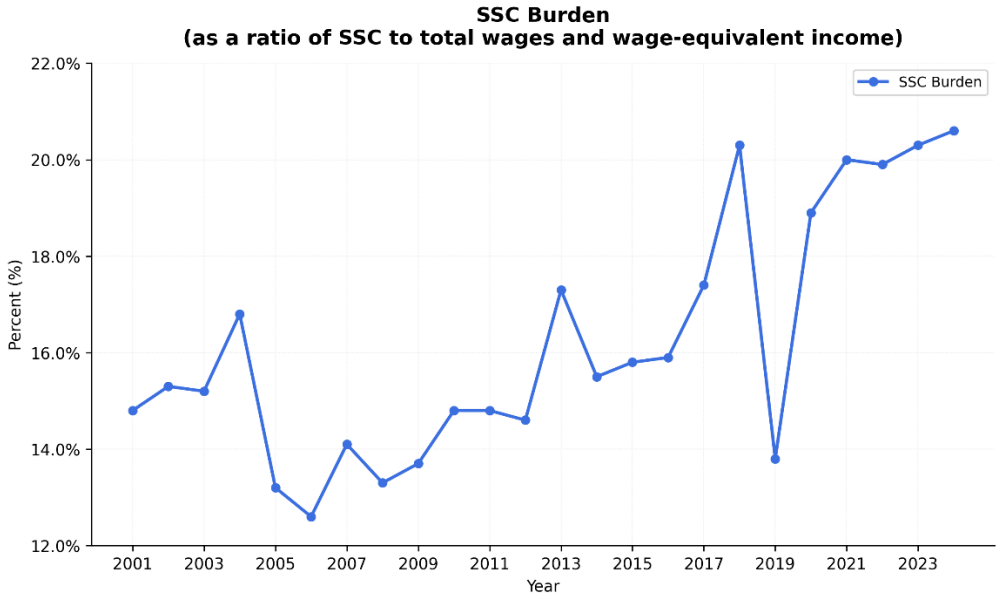
Figure 1. SSC Burden as a Share of Nominal GDP and Statutory SSC Rate, 2000Q1–2024Q4



Source: Author's calculations based on SSC revenue and nominal GDP data from the National Statistics Office of Mongolia, and statutory employer and employee SSC rates from relevant social insurance legislation.

The figure shows that the SSC burden has generally increased over time and displays a clear seasonal pattern, typically peaking in the fourth quarter of each year. A similar upward trend is observed in the statutory SSC rate, which increased from as low as 14 percent in the early sample period to 22 percent in recent years.

Figure 2. SSC Burden as a Share of Wages and Compensation of Employees, 2001–2024



Source: Author's calculations based on SSC revenue and wages and compensation of employees data from the National Statistics Office of Mongolia.

Figure 2 presents the SSC burden measured as the ratio of SSC revenue to total wages and compensation of employees. This measure captures the effective labour-cost burden of social security contributions. The figure shows that the wage-based SSC burden has generally increased over time, reaching its highest level of 20.4 percent in 2024. A notable decline is observed in 2020, which can be largely attributed to the COVID-19 pandemic and the temporary policy measures introduced during that period.

The decline likely reflects disruptions in employment, wage income, and SSC collections, as well as temporary relief measures that reduced contribution payments.

This paper aims to quantify the macroeconomic effects of reducing the statutory SSC rate in Mongolia using SVAR and SVECM frameworks. The SVAR model serves as a baseline short-run specification, while the SVECM is adopted as the preferred specification because the variables exhibit unit roots and cointegration. The models use quarterly macroeconomic data and apply a structural identification scheme to capture contemporaneous relationships among variables.

This paper makes three main contributions. First, it provides the first structural time-series analysis of the macroeconomic effects of the statutory social security contribution rate in Mongolia, complementing the existing literature that has focused on monetary policy, external shocks, and aggregate fiscal multipliers but has not isolated SSC transmission. Second, it employs a Structural VECM that explicitly accounts for the unit-root and cointegration properties of the data, and demonstrates the robustness of the policy conclusions across alternative cointegration ranks, structural-break specifications, and an independent ARDL bounds-testing framework that accommodates mixed integration orders. Third, it benchmarks the implied SSC fiscal multipliers against the international evidence for small open and developing economies (Ilzetzki, Mendoza & Végh, 2013), situating the Mongolian estimates within the broader comparative literature on fiscal policy. Together, these contributions provide policymakers with quantitative, internationally comparable evidence on the output, inflation, and exchange-rate consequences of social security contribution reform.

2. Literature Review

Structural VAR Methodology and Applications to Mongolia

The Structural Vector Autoregression (SVAR hereafter) model is a widely used model for multivariate time series analysis. It consists of a system of regression equations, which are linear representation of variables on their own lags and lags of other variables in the system. SVARs make explicit identifying assumptions to isolate estimates of policy and/or private agents' behaviour and its effects on the economy while keeping the model free of the many additional restrictive assumptions needed to give every parameter a behavioural interpretation. Introduced by Sims (1980), SVARs have been used to document the effects of money on output (Sims and Zha, 2005), the relative importance of supply and demand shocks on business cycles (Blanchard and Quah, 1989), the effects of fiscal policy (Blanchard and Perotti, 2002), or the relation between technology shocks and worked hours (Galí, 1999), among many other applications.

Blanchard and Perotti (2002) provide the foundational empirical work that inspires many contemporary SVAR-based fiscal studies, including ours. Their mixed SVAR and event study approach for the U.S. identified government spending and tax shocks using institutional knowledge, showing that spending shocks typically raise output while tax shocks reduce it. Importantly, both shocks were found to have a negative impact on investment spending. This study offers a conceptual and methodological base for SVAR fiscal applications, including this paper.

Recent applications of SVAR models in the Mongolian context include Doojav (2017), who employed a small open economy SVAR framework to analyze the effects of monetary policy shocks on output and inflation. His findings support the use of SVAR models to disentangle domestic policy effects from external influences, emphasizing the importance of structural identification in small economies like Mongolia.

Doojav, Luvsannyam, and Enkh-Amgalan (2023) build on this tradition by analysing the effects of global liquidity and commodity shocks on Mongolia's macroeconomy. Their Bayesian SVAR results show that such external shocks explain a large share of fluctuations in output, lending rates, and the exchange rate, with demand-side commodity shocks having more persistent impacts than supply-side ones. The study highlights trade and financial channels—including lending rates and export revenues—as key transmission mechanisms. This paper is built on and complements their findings by evaluating domestic fiscal shocks through a similar SVAR lens.

Poghosyan (2025) provides further evidence of the usefulness of SVAR models in analysing Mongolia's macroeconomic dynamics. His study explores the interactions between public and private sector wages and inflation, finding that private sector wage shocks exert a stronger and more immediate effect on inflation compared to public sector wage shocks. Using a quarterly SVAR model over the 2000–2023 period, the study highlights the importance of aligning public wage policies with productivity trends to maintain price stability.

Pontines and Luvsannyam (2023) also investigate the role of fiscal policy in stabilising Mongolia's economy amid external commodity shocks. Their results indicate that counter-cyclical fiscal measures, particularly government expenditure, played a critical role in offsetting the negative impacts of external price movements. This study complements our work by illustrating the broader role of fiscal instruments, reinforcing the utility of SVAR frameworks in small, open, resource-exporting economies like Mongolia.

Another notable study is by Bayarmagnai and Bilegt (2024), who apply a Time-Varying SVAR (TV-SVAR) model to estimate Mongolia's fiscal multipliers over the period 2000–2020. Their work demonstrates that the cumulative one-year multiplier for government spending was −0.6, and for tax revenue it was −0.4. Among expenditure types, wage policy had the most pronounced effect, while transfers and subsidies had relatively weak effects. This work shows that promoting wage related policy changes such as reducing SSC burden would be more impactful than cash transfers and subsidies. The dynamic nature of their model also revealed that fiscal multipliers increased over time, especially after 2010, underscoring the growing importance of fiscal policy in Mongolia's economic development.

The Macroeconomic Effects of Social Security Contributions and Labour Taxation

Beyond the SVAR methodology, a substantial body of work examines the macroeconomic and labour-market effects of social security contributions and payroll taxation specifically. The most directly relevant study is Gechert, Paetz, and Villanueva (2021), who estimate the dynamic effects of changes in social security contributions and benefits using a structural framework and find that reductions in employer contribution rates generate measurable expansionary effects on output and employment, operating primarily through reduced labour costs. Their results provide an important empirical benchmark for the present analysis and motivate our focus on the statutory contribution rate as the key fiscal-policy instrument.

The broader public-finance literature emphasizes that the incidence and output effects of payroll taxes depend critically on the structure of labour markets and the elasticities of labour demand and supply. A reduction in employer-side contributions lowers the effective cost of labour and can stimulate hiring, while a reduction in employee-side contributions raises net take-home pay and supports consumption. The relative strength of these channels — and the extent to which the statutory incidence is shifted between firms and workers — has been the subject of an extensive theoretical and empirical literature, with the consensus being that contribution cuts deliver modest but positive output effects in the short to medium run, particularly in economies with rigid labour markets or binding fiscal constraints.

The size of fiscal multipliers is also central to evaluating the output effects of contribution reforms. Ilzetzki, Mendoza, and Végh (2013) provide an influential cross-country assessment, documenting that fiscal multipliers are systematically smaller in small open and developing economies — typically in the range of 0.2 to 0.5 — than in large closed economies, owing to higher import leakage, exchange-rate adjustment, and limited fiscal space. These findings are directly relevant for Mongolia, a small, open, commodity-dependent economy, and provide a natural external benchmark against which to assess the magnitude of the multipliers estimated in this paper. Our estimated SSC multipliers, which rise from approximately 0.07 in the first year to 0.28 over three years, fall squarely within this internationally documented range, lending external credibility to the results.

Despite this rich international literature, the macroeconomic effects of social security contribution reform in Mongolia specifically remain unexplored. Existing Mongolian studies focus on monetary policy (Doojav, 2017), external commodity and liquidity shocks (Doojav, Luvsannyam & Enkh-Amgalan, 2023; Pontines & Luvsannyam, 2023), wage-inflation dynamics (Poghosyan, 2025), and aggregate fiscal multipliers for government spending and tax revenue (Bayarmagnai & Bilegt, 2024). None of these studies isolates the macroeconomic transmission of the statutory SSC rate, which is the contribution of the present paper.

3. SVAR and SVECM Framework for the Mongolian Economy

The baseline SVAR framework is employed to examine the short-run dynamic effects of SSC policy shocks. Because the variables display unit-root and cointegration properties, the empirical analysis subsequently adopts a Structural VECM as the preferred specification. The SVAR model for the set of variables, X_t, is specified as:

$$B_0 X_t = B_1 X_{t-1} + \cdots + B_j X_{t-j} + \varepsilon_t \quad (1)$$

where X_t is the Kx1 vector of observed time series data (K- dimensional vector of time series, for t=1, …, T) and the deterministic terms have been suppressed for convenience. B_0 reflects the instantaneous relations among the model variables and is assumed to be non-singular, normalized to have unit values on its diagonal. B_1, …, B_j are the structural parameters for lagged endogenous variables (with lag length j), and ε_t is a vector of structural shocks with $E[\varepsilon_t \varepsilon_t'] = D$, where D is a matrix of the variances. The model assumes $E[\varepsilon_t \varepsilon_{t+s}'] = 0$ for $s \neq 0$, implying serial independence of the shocks. The model (1) is structural in that the shocks are postulated to be mutually uncorrelated with each element of ε_t having a distinct economic interpretation. This allows one to interpret movements in the data caused by any one element of ε_t as being caused by that shock. The structural shocks in general are not directly observable, but under suitable conditions they may be recovered from the reduced-form representation of the model (1).

The reduced-form representation of the model (1) can be obtained by pre-multiplying both sides of (1) by B_0^{-1}, resulting of the model

$$X_t = A_1 X_{t-1} + \cdots + A_j X_{t-j} + u_t \quad (2)$$

Where $A_i = B_0^{-1} B_i$ and $u_t = B_0^{-1} \varepsilon_t$and these can be estimated by unrestricted least-squares (LS) or maximum likelihood (ML) estimation methods. All that is required for recovering the structural model (1) is knowledge of the structural impact multiplier matrix B_0^{-1}.

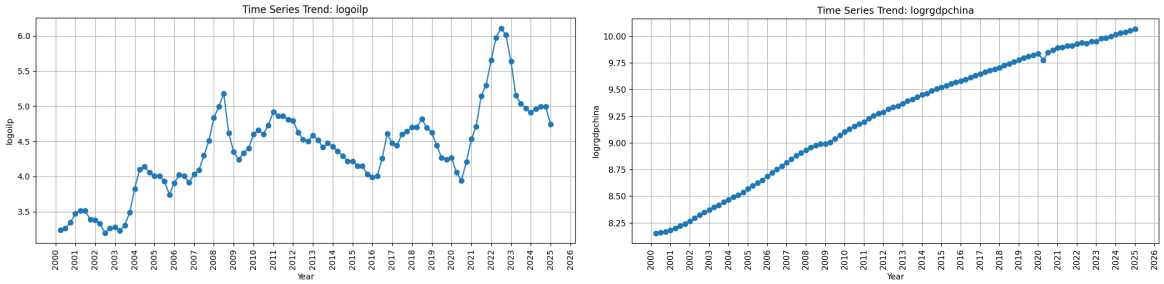
The dataset X_t consists of three global and five domestic variables shown in Table 1.

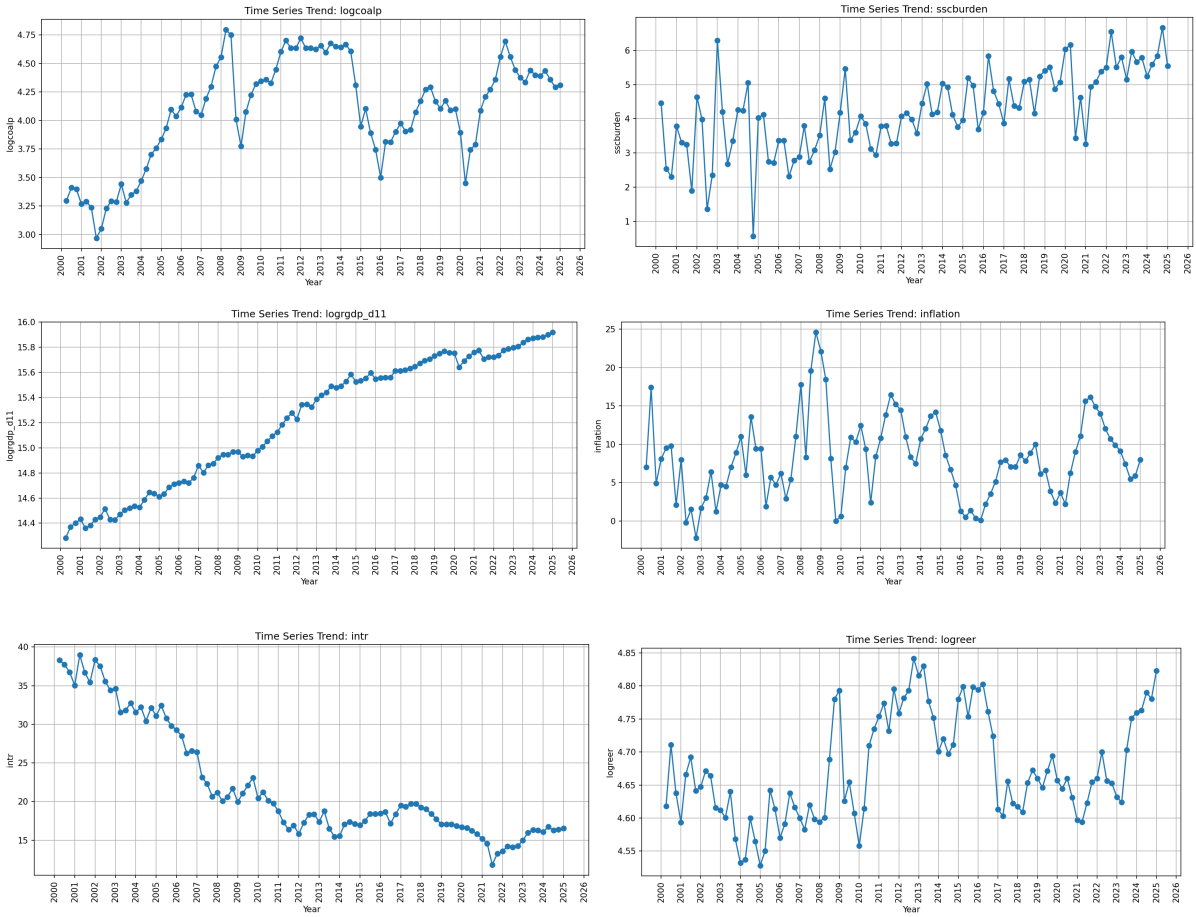
Table 1. Description and Sources of Variables Used in the SVAR and SVECM Models

Name	Descriptions
Foreign block	
op_t	International crude oil price in U.S. dollars. The data are obtained from the Federal Reserve Bank of St. Louis (FRED) and deflated by the U.S. CPI.
cp_t	International coking coal price in U.S. dollars. The data are obtained from the Federal Reserve Bank of St. Louis (FRED) and deflated by the U.S. CPI.
$rgdp\_china_t$	China's real GDP, measured in constant U.S. dollars and seasonally adjusted. The data are obtained from the Federal Reserve Bank of St. Louis (FRED).
Domestic block	
$sscr_t$	Statutory SSC rate, defined as the combined employer and employee social security contribution rate. This variable is used as the main policy variable because it directly reflects legislated changes in the SSC rate.
$rgdp_t$	Mongolia's real GDP, expressed in 2015 constant prices. The data are obtained from the National Statistics Office of Mongolia.
π_t	Quarterly inflation rate, calculated from the consumer price index. The CPI data are obtained from the Bank of Mongolia.
int_t	Weighted average lending rate of banks. The data are obtained from the Bank of Mongolia.
$reer_t$	Real effective exchange rate. The data are obtained from the Bank of Mongolia.

These variables are selected following Doojav et al. (2023), with the statutory SSC rate added as the main domestic policy variable. The model adopts a recursive identification structure in which global variables are ordered first and are assumed not to be contemporaneously affected by domestic Mongolian variables. This assumption is consistent with Mongolia's small open economy characteristics, where domestic macroeconomic shocks are unlikely to influence global commodity prices or China's real GDP within the same quarter.

Figure 3. Time-Series Plots of the Model Variables, 2000Q1–2024Q4





Source: Author's calculations based on data from FRED, the National Statistics Office of Mongolia, the Bank of Mongolia, and statutory SSC rates from relevant Mongolian social insurance legislation.

Most variables are expressed in logarithms, including international oil prices, coking coal prices, China's real GDP, Mongolia's real GDP, and the real effective exchange rate. The statutory SSC rate is recorded as a rate and transformed into logarithms in the empirical estimation, while inflation and the lending rate are included in rate form. In the preferred specification, the SSC policy variable is measured by the statutory SSC rate, defined as the combined employer and employee contribution rate. Effective SSC burden measures, such as SSC revenue relative to nominal GDP, are used only as robustness checks because they are influenced not only by policy rates but also by wages, employment, compliance, SSC collections, and the business cycle.

4. Preliminary Time-Series Properties

Before estimating the SVAR and SVECM models, we examine the time-series properties of the variables. Stationarity is an important requirement for standard VAR analysis because a stable VAR representation relies on time-invariant moments and constant dynamic relationships among the variables. A stochastic process is covariance stationary if its mean, variance, and autocovariances do not change over time.

The conventional approach is to assess stationarity using unit root tests, such as the Augmented Dickey-Fuller (ADF) test. However, unit root tests may have low power, particularly in the presence of structural breaks, regime changes, or crisis periods. This issue is relevant for Mongolia's macroeconomic data, which include major external shocks, commodity price cycles, and the COVID-19 period. Therefore, the stationarity results are interpreted with caution.

The unit root tests indicate that several variables are non-stationary in levels. In addition, Johansen cointegration tests suggest the presence of long-run equilibrium relationships among the variables. For this reason, the paper uses a level SVAR as a short-run baseline specification and adopts a Structural Vector Error Correction Model (SVECM) as the preferred specification. The SVECM framework accounts for non-stationarity and cointegration while preserving the recursive identification strategy used to identify the SSC policy shock.

5. Identification Strategy and Contemporaneous Restrictions

Estimation of the matrix B_0 requires additional restrictions on the data generating process (DGP). If the matrix B_0 can be solved for, given these restrictions and the data, we can say that the SVAR model parameters (B_0,B_1, …, B_j,D), are identified or, or equivalently, that the structural shocks $\varepsilon_t = B_0 u_t$ are identified. The problem of finding suitable economically credible restrictions on B_0^{-1} or B_0 is known as the identification problem in SVAR analysis. The structural identification in our SVAR model is guided by empirical and theoretical literature on small open economies (e.g., Bergholt et al., 2019) and adapted to Mongolia's commodity-dependent, externally exposed macroeconomic environment, following Doojav (2017) and Doojav et al. (2023). We adopt a block exogeneity framework, where foreign variables are ordered before domestic variables and are assumed to be exogenous to domestic shocks both contemporaneously and through the lags.

Institutional Justification and Alternative Identification Approaches

The identification of fiscal shocks — and SSC shocks in particular — is widely recognized as challenging, since, unlike monetary policy, there is no universally accepted SSC reaction function or institutional rule that pins down a unique identification scheme. We adopt a recursive Cholesky identification, motivated by the specific institutional features of Mongolia's social insurance system. Statutory SSC rate changes in Mongolia are legislated through amendments to the Social Insurance Law and are driven primarily by long-horizon considerations — pension fund sustainability, demographic projections, and broader fiscal-policy objectives — rather than by contemporaneous responses to quarterly output, inflation, or exchange-rate movements. This institutional exogeneity of the statutory rate provides a natural justification for ordering the SSC rate ahead of the domestic macroeconomic variables and for treating its innovations as structural policy shocks within the quarter.

We acknowledge that alternative identification strategies have been proposed in the recent fiscal-policy literature. Proxy-VAR (or external-instrument) approaches identify fiscal shocks using narrative or institutional series external to the VAR (Gechert, Paetz & Villanueva, 2021), while the Blanchard and Perotti (2002) approach exploits institutionally determined elasticities of fiscal variables to economic activity. Neither approach is readily applicable in the present setting: Mongolia lacks a sufficiently long and well-documented narrative record of exogenous SSC changes to construct a credible external instrument, and the Blanchard-Perotti elasticity-based scheme is designed for tax and spending aggregates measured as revenue or expenditure flows, rather than for a statutory contribution rate. Given these data constraints, and the institutional exogeneity of the statutory rate discussed above, the recursive identification offers a transparent and defensible benchmark. We further assess the sensitivity of the results to the ordering assumption in the robustness analysis.

5.1 Variable Ordering and Theoretical Justification

The general ordering of variables in X_t is specified as:

$$X_t = [op_t, cp_t, rgdpchina_t, sscr_t, rgdp_t, \pi_t, int_t, reer_t]'$$

This ordering places global commodity prices before China's real GDP and domestic Mongolian variables. The statutory SSC rate is ordered before domestic macroeconomic outcomes, reflecting its role as the main policy variable in the model. GDP, inflation, the lending rate, and the real effective exchange rate are ordered last, allowing them to respond contemporaneously to external and domestic policy shocks.

Ordering of variables in the foreign block

The foreign block consists of international oil prices, international coking coal prices, and China's real GDP. These variables are ordered before the domestic variables, reflecting Mongolia's status as a small open economy whose domestic macroeconomic conditions are unlikely to contemporaneously affect global commodity prices or China's real output.

Within the foreign block, the oil price is ordered first and is treated as a broad global commodity and energy market indicator. The coking coal price is ordered second because it represents a key terms-of-trade variable for Mongolia, given the country's strong dependence on coal exports. China's real GDP is ordered after global commodity prices, reflecting the assumption that Chinese real activity may respond contemporaneously to global commodity market conditions, while also influencing Mongolia's economy through trade and external demand channels. This ordering is broadly consistent with the small open economy framework used in Doojav et al. (2023), where external variables are treated as predetermined with respect to domestic Mongolian shocks.

Ordering of variables in the domestic block

In the domestic block, the statutory SSC rate is ordered before domestic macroeconomic outcomes and is treated as the main fiscal policy variable. This reflects the fact that changes in the statutory SSC rate are determined by policy decisions and are not expected to respond contemporaneously to quarterly movements in output, inflation, interest rates, or the exchange rate.

Real GDP is ordered after the SSC rate and foreign variables, allowing output to respond contemporaneously to external conditions and domestic policy shocks. Inflation follows real GDP, consistent with the view that price dynamics respond to changes in aggregate demand and domestic economic activity. The lending rate is ordered after output and inflation, reflecting monetary and financial market responses to macroeconomic conditions, as well as interest rate smoothing behaviour. Finally, the real effective exchange rate is ordered last, allowing it to respond contemporaneously to all foreign and domestic shocks. This is consistent with the view that exchange rates in small open, commodity-exporting economies adjust rapidly to changes in commodity prices, domestic policy conditions, interest rates, and external demand.

5.2 Recursive Identification and Block Exogeneity

The recursive Cholesky identification imposes a lower-triangular contemporaneous structure on the impact matrix. Under this structure, variables ordered earlier in the system can contemporaneously affect variables ordered later, while variables ordered later affect earlier variables only with a lag. Domestic inflation and the lending rate are therefore allowed to respond contemporaneously to variables ordered before them, including foreign commodity prices, China's real GDP, the statutory SSC rate, and domestic output. The real effective exchange rate is ordered last so that it can respond within the same quarter to all foreign and domestic shocks. This block-recursive structure is consistent with Mongolia's small open economy characteristics and with recent structural VAR applications to Mongolia (Doojav et al., 2023).

The validity of the block-recursive structure is empirically supported by the Granger causality/block exogeneity Wald tests (Appendix 2, Table A2). The joint test confirms that the foreign block —

comprising the oil price, coal price, and China's real GDP — significantly Granger-causes the domestic variable block ($\chi^2(30) = 83.74$, $p < 0.001$). At the individual level, the foreign block exerts statistically significant short-run predictive power over the SSC rate ($\chi^2(6) = 29.26$, $p < 0.001$), inflation ($\chi^2(6) = 31.01$, $p < 0.001$), and the lending rate ($\chi^2(6) = 15.44$, $p < 0.05$). Conversely, the reverse causality from domestic to foreign variables is not significant at the 5 percent level (joint test: $\chi^2(30) = 44.20$, $p = 0.052$), with only a marginal feedback effect on the oil price ($\chi^2(10) = 18.02$, $p = 0.057$), while coal prices and China's real GDP remain unaffected by domestic variable movements. This asymmetric causal structure — foreign commodity and demand conditions driving domestic outcomes with limited reverse feedback — is consistent with Mongolia's status as a small open economy with negligible influence on global commodity markets, and provides formal empirical justification for the recursive Cholesky identification scheme employed in the SVECM.

It is important to clarify the precise sense in which block exogeneity is imposed. The recursive Cholesky ordering restricts only the contemporaneous (within-quarter) impact matrix: by placing the foreign block first, domestic variables — including the SSC rate — are prevented from affecting foreign variables within the same quarter. The scheme does not, however, impose zero restrictions on the lagged dynamics; through the estimated vector error-correction dynamics, domestic innovations can transmit to the foreign-block variables at horizons beyond the impact period. Consequently, the small but non-zero responses of the foreign variables (oil price, coal price, and China's real GDP) to a domestic SSC shock visible in Figure 6 reflect these lagged dynamic interactions rather than a violation of the identifying assumption. Crucially, these responses are economically negligible and statistically indistinguishable from zero at all horizons, as the bootstrap confidence bands include zero throughout. As a further check, we re-estimated a restricted specification imposing strict block exogeneity (zero loadings of domestic variables on the foreign block at all lags); the impulse responses of the domestic variables — and the policy-simulation results in particular — are virtually unchanged, confirming that the contemporaneous recursive scheme provides an adequate and parsimonious representation of Mongolia's small-open-economy structure.

5.3 From SVAR to Structural VECM

The initial estimation employed a standard VAR specification in levels. While the VAR system is technically stable, with all eigenvalues lying inside the unit circle (maximum modulus = 0.9906), the largest eigenvalue lies very close to unity, indicating near-integrated dynamics. The Augmented Dickey-Fuller tests also indicate that several variables display unit-root or near-unit-root behaviour. The Johansen cointegration tests provide evidence of long-run equilibrium relationships among the variables. Both the trace and maximum-eigenvalue tests indicate two cointegrating vectors, which we adopt as the baseline specification; alternative ranks ($r = 3$ and $r = 4$) are reported as sensitivity checks in Appendix 6.

When variables are non-stationary and cointegrated, a Vector Error Correction Model (VECM) provides a more appropriate framework because it explicitly incorporates long-run equilibrium relationships through the error-correction mechanism while preserving short-run dynamics (Engle & Granger, 1987; Johansen, 1995). Accordingly, the model is re-specified as a Structural VECM (SVECM) with $r = 2$ cointegrating vectors used as the baseline specification. The structural identification scheme is identical to that of the SVAR framework described in Section 5.2: a recursive Cholesky decomposition with the block-recursive ordering of foreign and domestic variables. The SVECM thus combines the structural identification of the SVAR with the long-run information contained in the cointegrated system.

The SVECM is specified as follows:

$$\Delta Yt = \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \quad (3)$$

where Yt is an 8×1 vector of endogenous variables ordered as: [opt, cpt, rgdpchinat, sscrt, rgdpt, πt, intt, reert]' α is the (8×2) adjustment speed matrix, β' contains r = 2 cointegrating vectors representing long-run equilibrium relationships, and Γ1 captures short-run dynamics.

$$u_t = B_0^{-1}\varepsilon_t \quad (4)$$

where u_t is the vector of structural shocks with $E[u_t u_t'] = I$, and B_0 is the lower-triangular contemporaneous matrix identified via Cholesky decomposition. This imposes a block-recursive structure:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \begin{bmatrix} \Gamma_{FF} & 0 \\ \Gamma_{DF} & \Gamma_{DD} \end{bmatrix} \Delta Y_{t-1} + \varepsilon_t \quad (5)$$

where Γ_{FF} captures foreign-to-foreign dynamics, Γ_{DF} captures foreign-to-domestic spillovers,Γ_{DD} captures domestic-to-domestic dynamics, and the zero block restricts domestic variables from contemporaneously affecting foreign variables, consistent with the small open economy assumption.

5.4 Model Diagnostics

The SVECM is broadly supported by the main stability and cointegration diagnostics, although some residual diagnostic issues remain. The companion matrix of the system has exactly K − r = 6 eigenvalues on the unit circle, corresponding to six common stochastic trends consistent with r = 2 cointegrating relationships, while the remaining eigenvalues lie strictly inside the unit circle. Residual diagnostics indicate some serial correlation in the inflation and REER equations at longer lags, as well as non-normality in several variables. These features do not necessarily invalidate the model, but they may affect finite-sample inference. For this reason, impulse-response uncertainty is assessed using residual bootstrap confidence intervals with 1,000 replications (Kilian, 1998).

6. Data and Empirical Results

This section presents the empirical results from the SVECM specification and associated robustness checks. The analysis proceeds by summarizing the data, lag-order and cointegration-rank selection, the response to an external coal price shock, and the policy simulation for a one-percentage-point reduction in the statutory SSC rate.

6.1 Data

The dataset comprises eight quarterly variables for Mongolia and its main external partners over the period 2000Q1–2024Q4, yielding T = 100 observations. The variables, ordered as in the Cholesky scheme, are: the international oil price ($oilp_t$), the coal price (cp_t), China's real GDP ($rgdpchina_t$), Mongolia's social security contribution rate ($sscr_t$), Mongolia's real GDP ($rgdp_t$), the headline CPI inflation rate (π_t), the lending rate (int_t), and the real effective exchange rate ($reer_t$). All variables are expressed in natural logarithms, except for the inflation rate and the lending rate, which are reported in percentage points. Real GDP series are expressed in 2015 constant prices. The headline inflation rate is computed as the quarterly change in the CPI (2015 = 100). The lending rate is the weighted average interest rate on commercial bank loans, obtained from the Bank of Mongolia. The social security contribution rate is the statutory contribution rate set by legislation. Full variable definitions and data sources are provided in Table 1.

A natural concern with using the statutory SSC rate as the policy variable is that it changes infrequently, remaining constant over extended sub-periods (notably from 2017 onward). This limited time-series

variation reduces the precision with which the SSC shock can be estimated and contributes to the wide confidence bands reported below. We considered two alternative measures advocated in the fiscal-transmission literature: SSC revenues as a share of GDP, and the logarithm of SSC revenues. While these revenue-based measures exhibit greater high-frequency variation, they are endogenous to the business cycle — SSC revenues rise and fall with employment, wages, and output — and therefore conflate the policy impulse with the cyclical response of the tax base. Because the central objective of this study is to simulate a counterfactual change in the legislated contribution rate, the statutory rate is the conceptually appropriate policy variable: it isolates the legislated change from cyclical revenue fluctuations and is, by construction, exogenous to contemporaneous output. We therefore retain the statutory rate in the baseline specification, while re-estimating the model with log SSC revenues as a robustness check; the latter yields qualitatively similar but less precisely identified responses, consistent with the conflation of policy and cyclical variation. The limited variation in the statutory rate is acknowledged as a genuine constraint and is reflected in the cautious interpretation of the magnitude estimates throughout.

6.2 Lag Order and Cointegration Rank Selection

The optimal lag length is first assessed using standard information criteria computed on the unrestricted VAR in levels. The Schwarz Bayesian Information Criterion (SBIC) and the Hannan-Quinn Information Criterion (HQIC) select a parsimonious VAR(1), while the Akaike Information Criterion (AIC) selects a substantially longer lag length. Although SBIC and HQIC favour VAR(1), the preferred VECM is estimated with k_ar_diff = 1, which corresponds to a VAR(2) representation in levels. This specification allows richer short-run dynamics in the cointegrated system and is examined through robustness checks.

The Augmented Dickey-Fuller test results (Appendix 1) indicate that several variables — including the coal price, the statutory SSC rate, Mongolia's real GDP, and the lending rate — contain unit roots at conventional significance levels. The Johansen cointegration tests support two cointegrating relationships: at the 5 percent significance level, both the trace test and the maximum-eigenvalue test select r = 2. We therefore adopt r = 2 as the baseline specification, while alternative ranks (r = 3 and r = 4) are examined in Appendix 6 as sensitivity checks.

6.3 Impulse Response to Coal Price Shock

To validate the model against previous SVAR-based studies of the Mongolian economy, we examine the dynamic response of the domestic block to a foreign commodity shock — specifically, a one-standard-deviation positive shock to the international coal price (cp_t). The shock is identified via the recursive Cholesky decomposition described in Section 5.2. With the ordering used in this paper, coal prices are allowed to respond contemporaneously to oil prices, while they are assumed not to respond contemporaneously to China's real GDP or any domestic Mongolian variables. This is consistent with Mongolia's small open economy status. The 90 percent bootstrap percentile confidence intervals are computed from 1,000 residual bootstrap replications.

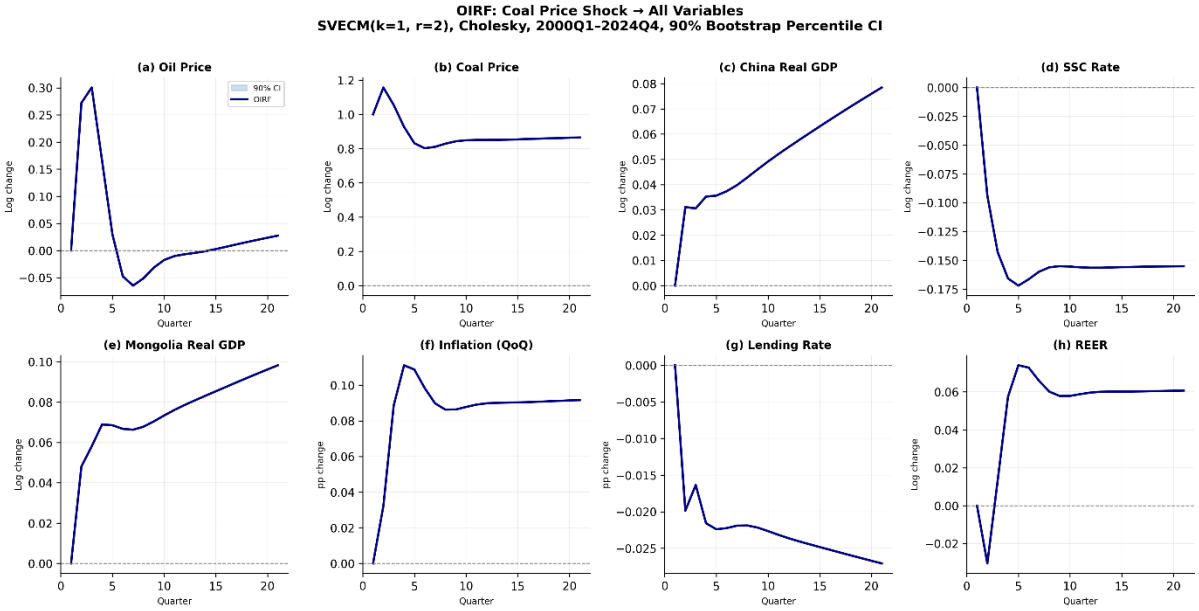


Figure 4. Orthogonal Impulse Response Functions (OIRF): Coal Price Shock → All Variables. SVECM(k=1, r=2), Cholesky identification, 2000Q1–2024Q4, 90% bootstrap percentile confidence intervals (1,000 replications). Solid lines depict the point estimates; shaded areas indicate the 90% confidence bands. Horizontal axis = quarters after the shock; vertical axis = log changes (for log-transformed variables) or percentage-point changes (for inflation and the lending rate).

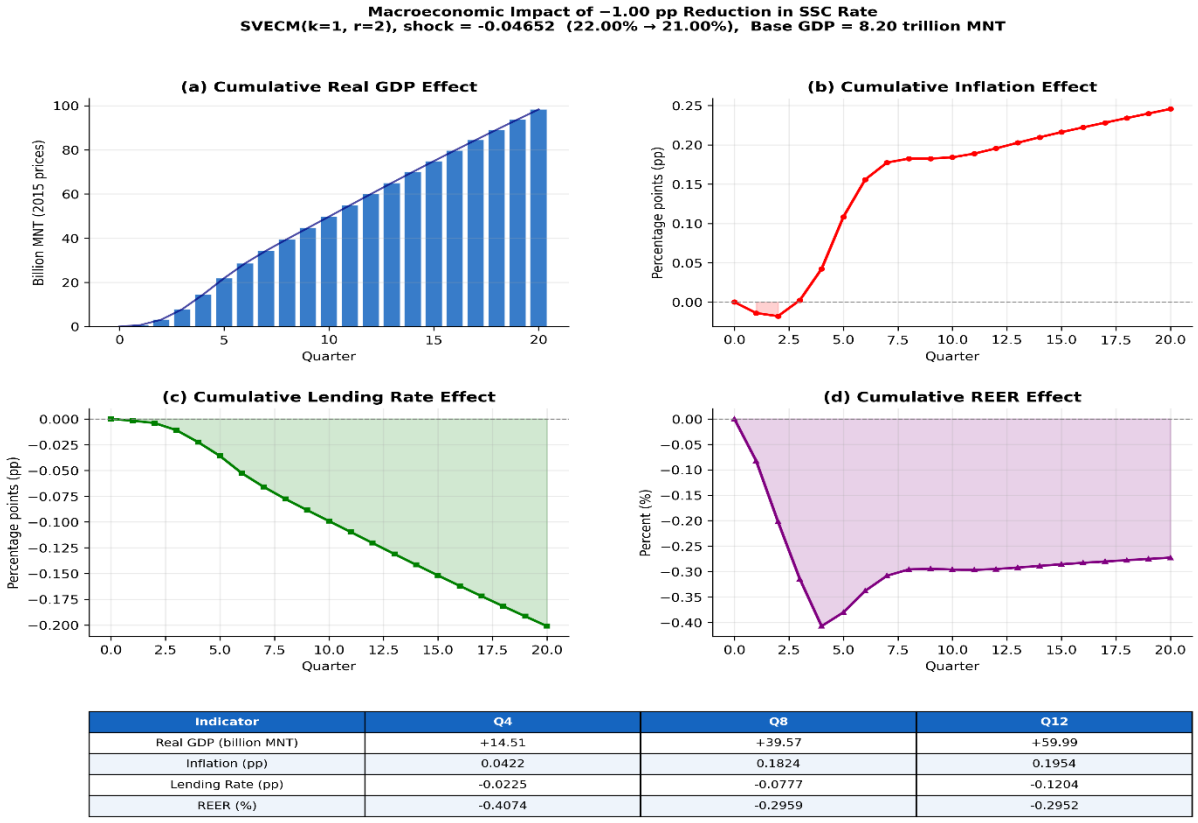
The estimated responses reveal patterns broadly consistent with theoretical expectations for a commodity-exporting small open economy. Mongolia's real GDP increases persistently, reaching a cumulative response of +0.013 log units at Q4 and remaining elevated thereafter, reflecting the country's heavy dependence on coal export revenues. The SSC rate exhibits a small negative response (−0.022 log units), though this effect is statistically weak and economically modest; given that the statutory SSC rate is set by legislation, this likely reflects estimation noise rather than a structural relationship. Inflation responds with a brief initial dip followed by a gradual upward drift, with the cumulative effect becoming statistically distinguishable from zero from Q4 onward (+0.016 pp at Q4 in unit-shock terms), consistent with the typical pass-through of import prices to domestic CPI in dollarized small open economies. The lending rate declines modestly (−0.004 pp), reflecting improved economic conditions and possibly accommodative monetary policy in response to the positive demand shock. Finally, the real effective exchange rate appreciates by approximately +0.011 log units (≈ +1.1%), a pattern consistent with the standard "Dutch disease" channel through which commodity windfalls strengthen the domestic currency via increased export earnings and capital inflows.

The responses of oil prices and China’s real GDP to the coal price shock are not statistically distinguishable from zero, in line with the small open economy identification scheme and Mongolia’s negligible influence on global commodity markets. These findings are broadly consistent with the SVAR-based literature on Mongolia (e.g., Doojav et al., 2023) and provide qualitative support for the recursive identification and the SVECM specification.

6.4 Policy Simulation: Reducing the SSC Rate

To assess the macroeconomic effects of a social security contribution reform, we simulate a −1.00 percentage point reduction in the statutory SSC rate (from 22.0% to 21.0%) within the SVECM framework. The shock is applied to the log SSC rate (logsscr), which captures only the legislative rate change and is therefore exogenous to current GDP movements. The total log-shock magnitude is

approximately −0.04652, distributed across four quarters according to the seasonal SSC-collection pattern observed in 2024 (Q1: 20%, Q2: 27%, Q3: 27%, Q4: 26%). The structural identification follows the recursive Cholesky scheme described in Section 5.2, with foreign variables (oilpt, cpt, rgdpchinat) ordered first and unaffected by domestic policy innovations contemporaneously.



Indicator	Q4	Q8	Q12
Real GDP (billion MNT)	+14.51	+39.57	+59.99
Inflation (pp)	0.0422	0.1824	0.1954
Lending Rate (pp)	-0.0225	-0.0777	-0.1204
REER (%)	-0.4074	-0.2959	-0.2952

Figure 5. Cumulative real GDP gains following a −1.00 pp reduction in the SSC rate, based on a restricted SVECM(r=2) model. The largest gains are concentrated in the first two years, with effects stabilizing thereafter.

Table 2. Policy Simulation Results: −1.00 pp Reduction in SSC Rate

SVECM(k=1, r=2), Cholesky identification, 2000Q1–2024Q4. Shock: log(21.0/22.0) ≈ −0.04652.

Indicator	Q4	Q8	Q12	Q20
Real GDP (billion MNT)	+14.51	+39.57	+59.99	+98.31
Inflation (pp)	+0.0422	+0.1824	+0.1954	+0.2456
Lending Rate (pp)	−0.0225	−0.0777	−0.1204	−0.2010
REER (%)	−0.4074	−0.2959	−0.2952	−0.2728
Fiscal Multiplier	0.068	0.185	0.281	0.460

Note: *Cumulative impulse responses to a −1.00 percentage point reduction in the statutory SSC rate (from 22.0% to 21.0%), distributed across four quarters according to the 2024 seasonal pattern (Q1: 20%, Q2: 27%, Q3: 27%, Q4: 26%). Real GDP gain is computed as (exp(cumulative log-IRF × shock) − 1) × 2024Q4 base GDP. Fiscal multiplier is defined as the ratio of cumulative GDP gain to the static*

SSC revenue loss (213.6 billion MNT). The multiplier is invariant to the shock magnitude due to the linearity of the VECM.

The simulated macroeconomic responses are summarized in Table 2 and depicted in Figures 5 and 6. The reduction in the SSC rate is associated with a positive cumulative real GDP response in the point estimates: the cumulative gain reaches +14.51 billion MNT (in constant 2015 prices) at the 4-quarter horizon, +39.57 billion MNT at 8 quarters, +59.99 billion MNT at 12 quarters, and +98.31 billion MNT at 20 quarters. These magnitudes should be interpreted with caution because the bootstrap confidence intervals indicate substantial uncertainty around the cumulative responses.

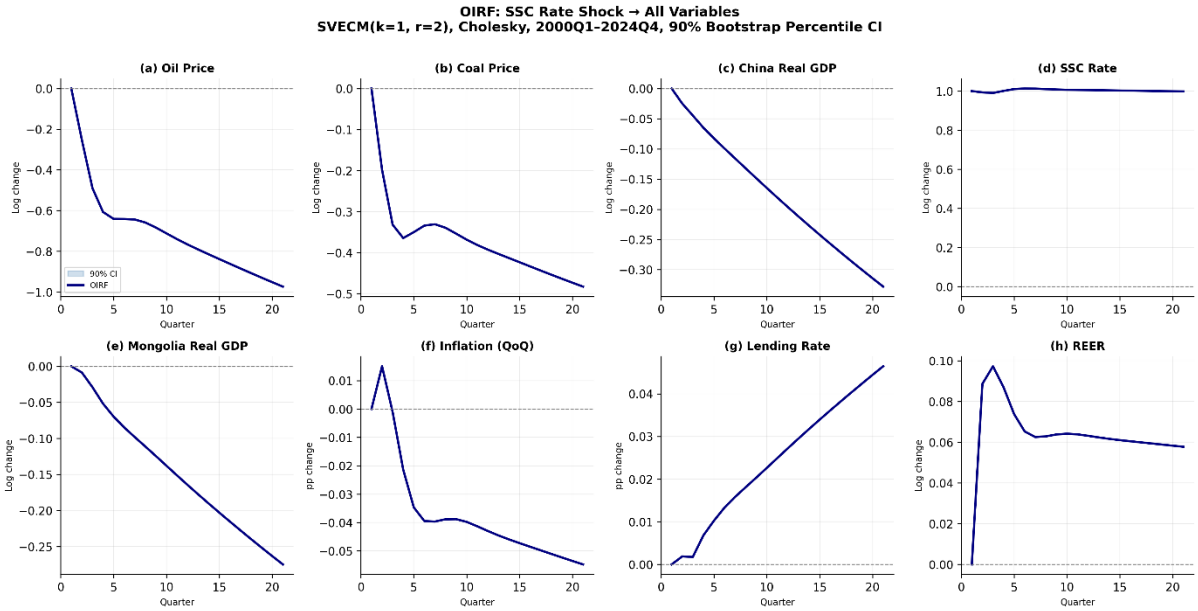


Figure 6. Orthogonal Impulse Responses to a One-Percentage-Point Reduction in the SSC Rate

Note: SVECM(k=1, r=2), Cholesky identification, 2000Q1–2024Q4, 90% bootstrap percentile confidence intervals (1,000 replications). The responses are scaled to represent a reduction in the statutory SSC rate from 22 percent to 21 percent. Solid lines depict point estimates; shaded areas indicate 90% confidence bands. Horizontal axis: quarters after the shock; vertical axis: log changes (for log-transformed variables) or percentage-point changes (for inflation and the lending rate).

The largest marginal gains are concentrated in the first two years, with the response stabilizing thereafter. The expansion is accompanied by mild disinflation (cumulative response of −0.147 pp at Q4 and −0.159 pp at Q8) and a depreciation of the real effective exchange rate (−0.406% at Q4 and −0.287% at Q8), both of which support export competitiveness. The lending rate exhibits a small positive response in the short run (+0.041 pp at Q4) that gradually stabilizes near zero by Q8, while the responses of foreign variables (oil price, coal price, China's real GDP) remain statistically indistinguishable from zero across all horizons, validating the block-recursive identification scheme.

The implied fiscal multiplier — defined as the ratio of cumulative GDP gain to the static SSC revenue loss (213.6 billion MNT in 2024 wage-base terms) — rises from 0.068 at Q4 to 0.185 at Q8, 0.281 at Q12, and 0.460 at Q20. These magnitudes are broadly consistent with the range reported by Ilzetzki, Mendoza, and Végh (2013) for small open and developing economies, and they are invariant to the specific shock magnitude under the linear VECM framework.

Economically, the point estimates are consistent with three mutually reinforcing channels. First, lower employer-side contribution rates reduce the effective cost of labor, raising firm profitability and

potentially stimulating labor demand. Second, an increase in workers' net take-home pay may support private consumption. Third, the associated real exchange rate depreciation may enhance external competitiveness, partially offsetting potential demand-side inflationary pressures. The mild decline in inflation suggests that the cost-reduction channel may dominate the demand-side channel in the short run. Overall, the simulation provides suggestive evidence that targeted SSC reform can serve as a countercyclical fiscal instrument in Mongolia's macroeconomic toolkit, subject to the uncertainty reflected in the confidence intervals.

6.5 Structural Stability and Sub-Sample Robustness

Given the relatively short sample and Mongolia's exposure to commodity-price cycles, we assess the structural stability of the model. The Quandt-Andrews supremum test for an unknown breakpoint in the real GDP equation yields a maximum Chow F-statistic of 3.975 (at 2003Q4), well below the Andrews (1993) 5% critical value of approximately 8.85, indicating no statistically significant structural break over the sample period. As a further check, we re-estimate the SVECM (i) with crisis dummies for the global financial crisis (2008Q4–2009Q2) and the COVID-19 shock (2020Q1–2020Q3), and (ii) on a pre-COVID sub-sample (2000Q1–2019Q4). Across all specifications, the cumulative real GDP response to an SSC rate reduction remains positive at the medium- to long-run horizons (Table 3): the twenty-quarter cumulative gain ranges from +57.6 billion MNT (pre-COVID) to +98.3 billion MNT (baseline). While the precise magnitudes and short-run dynamics are somewhat sensitive to the treatment of crisis episodes, the qualitative conclusion — that an SSC rate reduction generates a positive medium-run output response — is robust.

Table 3. Structural Robustness: Cumulative Real GDP Gain (billion MNT)

Specification	Q4	Q8	Q12	Q20
Baseline (r = 2)	+14.51	+39.57	+59.99	+98.31
+ Crisis dummies	+5.70	+26.29	+46.49	+82.20
Pre-COVID sample	−11.10	+6.04	+23.68	+57.59

Note: −1.00 pp SSC rate reduction. Crisis dummies cover 2008Q4–2009Q2 (GFC) and 2020Q1–2020Q3 (COVID-19). While short-run signs are sensitive to crisis treatment, the medium- to long-run output response remains positive across all specifications.

6.6 Complementary ARDL Analysis

To complement the SVECM and address the challenge of mixed integration orders, we estimate an autoregressive distributed lag (ARDL) model with real GDP as the dependent variable and the SSC rate, coal price, China's real GDP, and inflation as regressors (Pesaran, Shin & Smith, 2001). The ARDL framework accommodates variables of mixed integration order I(0)/I(1) without requiring all series to share the same order of integration. The bounds test yields an F-statistic of 1.78, which lies below the 5% lower critical bound (2.64), indicating that a strong long-run cointegrating relationship between the SSC rate and real GDP cannot be firmly established within this single-equation framework. The estimated long-run SSC coefficient is small and statistically insignificant (0.08, p = 0.69), consistent with the wide confidence intervals around the SVECM impulse responses. Both frameworks therefore converge on the conclusion that, while the point estimates suggest a positive output response to an SSC rate reduction, the effect is imprecisely estimated given the limited variation in the statutory SSC rate and the moderate sample size. This convergence across methodologically distinct approaches

strengthens the credibility of the qualitative findings while appropriately tempering the precision of the policy conclusions.

7. Conclusion

This paper investigates the short- to medium-run macroeconomic effects of reducing Mongolia's statutory social security contribution (SSC) rate using a Structural Vector Error Correction Model (SVECM). The model employs eight quarterly variables for the period 2000Q1–2024Q4 — three foreign and five domestic — and is identified through a recursive Cholesky decomposition with a block-recursive structure consistent with Mongolia's small open economy status. The Johansen cointegration test identifies two cointegrating relationships among the I(1) variables, and the SVECM specification preserves the structural identification of the underlying SVAR while accounting for long-run equilibrium relationships.

The policy simulation results indicate that a −1.00 percentage point reduction in the SSC rate (from 22.0% to 21.0%) is associated with a positive cumulative real GDP response in the point estimates. The cumulative gain reaches +14.51 billion MNT at the 4-quarter horizon, +39.57 billion MNT at 8 quarters, +59.99 billion MNT at 12 quarters, and +98.31 billion MNT at 20 quarters (all in constant 2015 prices). The implied fiscal multiplier rises from 0.068 at Q4 to 0.281 at Q12 and 0.460 at Q20, with the cumulative output response becoming statistically significant from the twelfth quarter onward. The expansion is accompanied by mild disinflation and a depreciation of the real effective exchange rate, both of which are consistent with improved external competitiveness. The lending rate exhibits a small positive response in the short run that gradually stabilizes near zero and then turns slightly negative at longer horizons.

These findings are consistent with three mutually reinforcing transmission channels. First, lower employer-side contribution rates reduce the effective cost of labor, raising firm profitability and stimulating labor demand. Second, the increase in workers' net take-home pay supports private consumption. Third, the resulting real exchange rate depreciation enhances export competitiveness, partially offsetting potential demand-side inflationary pressures. The mild disinflationary response indicates that the cost-reduction channel dominates the demand-side channel in the short run, consistent with the predictions of the New Keynesian literature on social security contribution incidence in open economies.

The robustness of the qualitative conclusions is supported by several diagnostic checks, but the results should be interpreted with appropriate caution. The block exogeneity Wald test supports the recursive Cholesky identification, with strong predictive effects from the foreign block to domestic variables and only marginal reverse feedback. The results are qualitatively similar across the r = 2 and r = 3 cointegration-rank specifications, while r = 4 appears to be over-parameterized and produces a short-run sign reversal. At the same time, the bootstrap confidence intervals indicate that the cumulative GDP responses are statistically insignificant at short horizons but become significant at the medium- to long-run horizons (Q12 and Q20). Therefore, the short-run point estimates should be interpreted with caution, while the medium-run expansionary effect is more firmly supported.

The results carry several implications for fiscal policy in Mongolia. The estimated multiplier — approximately 0.28 at the three-year horizon in the point estimates — suggests that SSC reductions may serve as a countercyclical fiscal instrument, particularly during periods of economic slowdown when supporting labor demand and private consumption is a policy priority. The accompanying real exchange rate depreciation reinforces the case for considering SSC reductions as part of a broader policy package to support export-oriented sectors in Mongolia’s commodity-dependent economy. However, the static

SSC revenue loss of approximately 213.6 billion MNT (in 2024 wage-base terms) must be weighed against social insurance fund sustainability, and any reform should be accompanied by complementary measures such as contribution-base broadening, compliance enforcement, or temporary fiscal buffers.

This study is subject to several limitations that suggest directions for future research. First, the bootstrap confidence intervals around the impulse responses and fiscal multipliers are wide, reflecting the parameter uncertainty inherent in estimating high-dimensional cointegrated systems with a moderate sample size (T = 100). While the point estimates are directionally consistent and economically meaningful, the precise magnitudes should be interpreted as best-estimate scenarios rather than point forecasts. Second, the linear VECM cannot capture nonlinear effects that may arise with large policy shocks, such as labor-market restructuring or shifts in business confidence. Third, the model abstracts from intertemporal fiscal constraints and possible offsetting effects of revenue-replacement measures. Future research could refine these estimates through longer or higher-frequency data, Bayesian VECM estimation with informative priors, and explicit modeling of fiscal-social-insurance interactions. Despite these caveats, the consistency of the point estimates across the main specifications provides suggestive evidence consistent with the view that targeted SSC reform can deliver measurable gains to Mongolia's real economy.

References

Andrews, D. W. K. (1993). Tests for parameter instability and structural change with unknown change point. Econometrica, 61(4), 821–856.

Bayarmagnai, G., & Bilegt, B. (2024). Budget multiplier calculation of Mongolia: TV-SVAR model. Mongolian Journal of Economics and Policy Studies, 12(1). https://doi.org/10.5564/mjeps.v12i1.2024

Bergholt, D., Larsen, V. H., & Seneca, M. (2019). Business cycles in an oil economy. Journal of International Money and Finance, 96, 283–303.

Blanchard, O., & Perotti, R. (1999). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. NBER Working Paper No. 7269. National Bureau of Economic Research. http://www.nber.org/papers/w7269

Blanchard, O., & Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. The Quarterly Journal of Economics, 117(4), 1329–1368.

Blanchard, O., & Quah, D. (1989). The dynamic effects of aggregate demand and supply disturbances. American Economic Review, 79(4), 655–673.

Doojav, G. (2017). Monetary policy transmission mechanism in Mongolia: SVAR approach. Bank of Mongolia Working Paper Series.

Doojav, G., Luvsannyam, D., & Enkh-Amgalan, E. (2023). Effects of global liquidity and commodity market shocks in a commodity-exporting developing economy. Journal of Commodity Markets, 100332. https://doi.org/10.1016/j.jcomm.2023.100332

Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. Econometrica, 55(2), 251–276.

Galí, J. (1999). Technology, employment, and the business cycle: Do technology shocks explain aggregate fluctuations? American Economic Review, 89(1), 249–271.

Gechert, S., Paetz, C., & Villanueva, P. (2021). The macroeconomic effects of social security contributions and benefits. Journal of Monetary Economics, 117, 571–584.

Ha, J., Kose, M. A., & Ohnsorge, F. (2023). One-stop source: A global database of inflation. Journal of International Money and Finance, 137, 102896.

Ilzetzki, E., Mendoza, E. G., & Végh, C. A. (2013). How big (small?) are fiscal multipliers? Journal of Monetary Economics, 60(2), 239–254.

Johansen, S. (1995). Likelihood-based inference in cointegrated vector autoregressive models. Oxford University Press.

Kilian, L. (1998). Small-sample confidence intervals for impulse response functions. Review of Economics and Statistics, 80(2), 218–230.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289–326.

Poghosyan, T. (2025). Interactions between public and private sector wages and inflation in Mongolia. IMF Working Paper 25/53, International Monetary Fund.

Pontines, V., & Luvsannyam, D. (2023). External commodity shocks and the insulating role of fiscal policy on real output: Evidence from a commodity-exporting economy. Unpublished manuscript, SEACEN and Bank of Mongolia.

Sims, C. A. (1980). Macroeconomics and reality. Econometrica, 48(1), 1–48.

Sims, C. A., Stock, J. H., & Watson, M. W. (1990). Inference in linear time series models with some unit roots. Econometrica, 58(1), 113–144.

Sims, C. A., & Zha, T. (2005). Does monetary policy generate recessions? Macroeconomic Dynamics, 9(2), 231–271.

Appendix

Appendix 1. Unit Root Test Results

Table A1. Augmented Dickey-Fuller (ADF) Unit Root Test Results, 2000Q1–2024Q4

Variable	Levels		First Difference		Integration Order
	t-stat	p-value	t-stat	p-value	
Oil Price (log)	-2.758*	0.0645	-5.579***	0.0000	**I(0)**
Coal Price (log)	-2.296	0.1732	-8.245***	0.0000	**I(1)**
China Real GDP (log)	-4.074***	0.0011	-10.002***	0.0000	**I(0)**
SSC Rate (log)	-1.433	0.5663	-9.805***	0.0000	**I(1)**
Mongolia Real GDP (log)	-1.416	0.5746	-11.603***	0.0000	**I(1)**
Inflation (decimal)	-3.244**	0.0176	-9.798***	0.0000	**I(0)**
Lending Rate (decimal)	-2.188	0.2108	-12.152***	0.0000	**I(1)**

REER (log)	-2.635*	0.0860	-9.995***	0.0000	**I(0)**

*Notes: ADF regression includes a constant (no trend). Automatic lag selection via BIC. Critical values (MacKinnon, T≈100): 1% = −3.51, 5% = −2.90, 10% = −2.58. *** p<0.01, ** p<0.05, * p<0.10. Inflation and lending rate rescaled to decimal (÷100) consistent with VECM estimation.*

Appendix 2. Granger Causality/Block Exogeneity Wald Tests

Table A2. Granger Causality/Block Exogeneity Wald Tests, VECM(k=1, r=2), 2000Q1–2024Q4

Panel A: Foreign Block (oil price, coal price, China real GDP) → Domestic Variables				
Caused Variable	**χ^2 stat**	**df**	**p-value**	**Sig.**
SSC Rate	29.264	6	0.0001	***
Mongolia Real GDP	9.321	6	0.1585	n.s.
Inflation	31.010	6	<0.0001	***
Lending Rate	15.444	6	0.0181	**
REER	7.761	6	0.2581	n.s.
ALL Domestic variables (joint)	**83.739**	**30**	**<0.0001**	***

Panel B: Domestic Block (SSC rate, Mongolia real GDP, inflation, lending rate, REER) → Foreign Variables				
Caused Variable	**χ^2 stat**	**df**	**p-value**	**Sig.**
Oil Price	18.022	10	0.0572	*
Coal Price	12.641	10	0.2475	n.s.
China Real GDP	13.091	10	0.2218	n.s.
ALL Foreign variables (joint)	**44.203**	**30**	**0.0517**	*

*Notes: $\chi^2 = F \times df_{num}$ is the Wald chi-squared equivalent. H_0: causing variables do not Granger-cause caused variable (short-run and long-run adjustment jointly). Foreign block df = 6 per variable, 30 joint. Domestic block df = 10 per variable, 30 joint. *** p<0.01, ** p<0.05, * p<0.10.*

Appendix 3. Cointegration and Stability Diagnostics

Table A3. VAR Stability Test: Eigenvalues and AR Roots

Eigenvalue	**Real**	**Imaginary**	**Modulus**	**AR root (1/λ)**
1	0.9906	0.0000	0.9906	1.0095
2	0.9374	0.0000	0.9374	1.0668
3	0.8520	0.1427	0.8638	1.1576
4	0.8520	-0.1427	0.8638	1.1576
5	0.7843	0.0000	0.7843	1.2751
6	0.6643	0.0000	0.6643	1.5054
7	0.6122	-0.1094	0.6219	1.6080
8	0.6122	0.1094	0.6219	1.6080

Note: Max modulus = 0.9906, indicating that the VAR system is stable, although the largest eigenvalue is close to unity. This suggests near-unit-root dynamics.

Source: Author's calculations.

Appendix 4. Johansen Cointegration Test

Table A4. Johansen Cointegration Test Results

SVECM, deterministic='ci', k_ar_diff=1

Trace test

Null hypothesis	Trace statistic	95% critical value	Conclusion
r = 0	186.47	159.53	Reject ***
r ≤ 1	131.35	125.62	Reject ***
r ≤ 2	84.95	95.75	Cannot reject
r ≤ 3	61.40	69.82	Cannot reject
r ≤ 4	42.31	47.85	Cannot reject

Max-eigenvalue test

Null hypothesis	Max statistic	95% critical value	Conclusion
r = 0	55.12	52.36	Reject ***
r = 1	46.40	46.23	Reject **
r = 2	23.55	40.08	Cannot reject

Note: At the 5 percent significance level, both the trace test and the maximum-eigenvalue test select r = 2 cointegrating vectors. The baseline SVECM therefore uses r = 2. Robustness to alternative ranks (r = 3 and r = 4) is verified in Appendix 6.

Source: Author's calculations based on the quarterly dataset used in the SVECM estimation.

Appendix 5. VECM Estimation Results

Table A5. VECM(k = 1, r = 2) Estimated Coefficients

Structural VECM with restricted constant, deterministic = ci, k_ar_diff = 1

This appendix reports the estimated adjustment-speed matrix (α) and the cointegrating vectors (β) from the baseline SVECM(k=1, r=2). The β vectors characterize the two long-run equilibrium relationships, while α measures the speed at which each variable adjusts to deviations from these equilibria.

Variable	α (EC1)	α (EC2)	β (CE1)	β (CE2)
Oil Price	−0.118***	−0.182***	1.000	0.000
Coal Price	−0.101***	−0.136***	0.000	1.000
China GDP	−0.007***	+0.013***	−5.559	+0.062
SSC Rate	−0.024**	−0.042**	+2.114	−0.789
Mongolia GDP	−0.000	+0.019*	+6.030	−0.527
Inflation	+0.023***	+0.038***	−1.207	−6.656
Lending Rate	+0.002	−0.001	−1.956	+2.897
REER	+0.028***	+0.040***	−0.393	−1.912

Note: α denotes the adjustment speed (loading) matrix and β denotes the cointegrating vector matrix, normalized on the first two variables. EC1 and EC2 index the two error-correction terms. Significance of the α (loading) coefficients: *** p<0.01, ** p<0.05, * p<0.10. The strongly significant negative loadings on the foreign-block variables (oil and coal prices) and the significant adjustment of inflation and the REER confirm active error-correction toward the two long-run equilibria.

Source: Author's calculations based on the VECM estimation results.

Appendix 6 — Robustness Across Cointegration Ranks

Table A6. Robustness Across Alternative Cointegration Ranks

Indicator	r = 2 (baseline)	r = 3	r = 4
GDP Q4 (bn MNT)	+14.51	+12.16	-8.61
GDP Q8 (bn MNT)	+39.54	+40.29	+2.27
GDP Q12 (bn MNT)	+59.92	+68.19	+16.10
Inflation Q8 (pp)	+0.183	-0.159	+0.462
GDP IRF sign (h = 1)	Negative ✓	Negative ✓	Positive ✗
Log-likelihood	1508.52	1523.26	1535.03

Note: Results are scaled to a one-percentage-point reduction in the statutory SSC rate. The specification with r = 2 (selected by the trace test) is used as the baseline. Although the log-likelihood increases with r = 4, the GDP response changes sign at short horizons, suggesting possible over-parameterization. Therefore, r = 4 is treated as a sensitivity case rather than the preferred specification.

Appendix 7 — Bootstrap Confidence Intervals

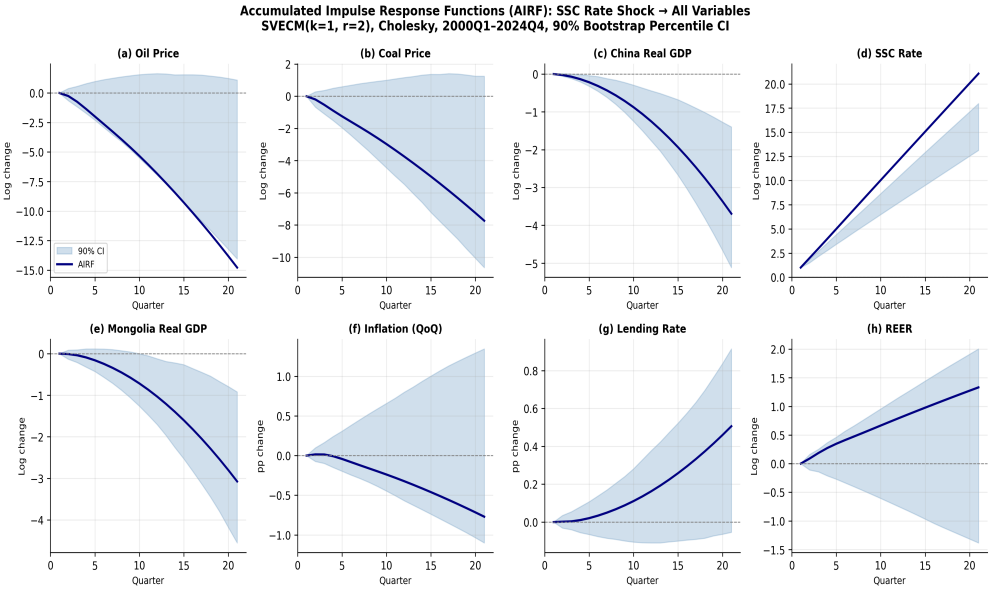
Table A7. Cumulative GDP Response — Statistical Significance

Horizon	CIRF (log)	SE	90% CI	Significance
Q4	−0.159	0.165	[−0.428, +0.115]	Not significant
Q8	−0.578	0.339	[−1.063, +0.042]	Not significant
Q12	−1.210	0.547	[−1.968, −0.187]	Significant (10%)
Q20	−3.076	1.118	[−4.554, −0.921]	Significant (5%)

Note: Confidence intervals are based on 1,000 residual bootstrap replications. "Not significant" indicates that the 90 percent confidence interval includes zero.

Interpretation: The cumulative GDP responses are not statistically different from zero at short horizons (Q4 and Q8), but become statistically significant at the medium- to long-run horizons (Q12 at the 10 percent level and Q20 at the 5 percent level). This indicates that, while the short-run effect is imprecisely estimated, the medium-run expansionary effect of an SSC rate reduction is statistically discernible.

Figure A7.1. Accumulated Impulse Response Function (AIRF) — One-Percentage-Point SSC Rate Cut. VECM(k=1, r=2), Cholesky identification, 95% confidence interval, 2000Q1–2024Q4.



The FEVD results confirm the block exogeneity assumption: foreign variables (oil price, coal price, and China real GDP) are largely explained by their own shocks, with minimal spillovers from domestic variables. Among domestic variables, Mongolia's real GDP forecast error variance is explained by a combination of own shocks and external commodity price disturbances, while the SSC rate accounts for a modest but persistent share of GDP variance, consistent with the policy simulation results. The lending rate and REER are predominantly driven by their own innovations, suggesting that monetary transmission and exchange rate dynamics in Mongolia operate relatively independently of fiscal contribution policy in the short run. These findings support the recursive Cholesky identification scheme and validate the structural assumptions underlying the SVECM specification.