A DYNAMIC CGE-SLUDGE FRAMEWORK FOR PAKISTAN

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ABSTRACT

This study develops a dynamic Sludge-CGE framework to analyze the economy-wide impacts of removing bureaucratic inefficiencies and red tape – sludge – in Pakistan. Our simulation results reveal substantial potential gains across multiple economic dimensions, underscoring the critical importance of streamlining administrative processes and reducing regulatory burdens. Key macro findings include a short-term potentially tripling of Pakistan's investment-to-GDP ratio, real GDP growth to increase by 57.9% while the projected welfare gain is over $142 billion in 2030, driven by increased household consumption across various sectors. Sectoral analysis reveals significant shifts in economic activity, with pharmaceutical sector showing a 950% potential increase and construction sector a 140% projected increase in domestic activities by 2030. Conversely, real estate sector is expected to contract, suggesting a reallocation of investments to more productive sectors.

Keywords: Sludge, GDP, Investment, Welfare level, Dynamic CGE

PREFACE

In recent years, the sludge economy has emerged as a powerful framework for understanding how excessive administrative burdens and bureaucratic inefficiencies can significantly impede economic productivity and individual welfare. While the detrimental effects of bureaucratic red tape have long been recognized, the systematic analysis of sludge - the frictions that make it unnecessarily difficult for businesses to complete basic tasks or access services - has opened up new avenues for improving governance and economic performance.

This study represents a pioneering effort to quantify the macroeconomic impacts of sludge in Pakistan using advanced economic modeling techniques. By developing a dynamic CGE model tailored specifically to analyze sludge, we provide the first economy-wide assessment of how administrative burdens permeate different sectors of the Pakistani economy and influence key macroeconomic indicators.

Our research builds upon and extends the valuable micro-level insights generated by the PIDE Sludge Audit Series. By embedding these sectoral findings within a general equilibrium framework, we are able to capture the complex linkages and spillover effects that amplify the costs of sludge throughout the economic system. The results paint a sobering picture of the enormous opportunity costs imposed by excessive bureaucracy and inefficient processes in Pakistan.

However, this study is not merely an academic exercise. By rigorously quantifying the economy-wide impacts of sludge, we aim to provide policymakers with a powerful evidence base to drive meaningful reform (sludge removal). Our findings illuminate specific areas where targeted interventions could yield substantial economic dividends, offering a roadmap for enhancing Pakistan's productivity and competitiveness.

The journey to combat sludge and unlock Pakistan's full economic potential is just beginning. We offer this study as a foundation for that vital endeavor.

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TABLE OF CONTENTS

ABSTRACT i
PREFACE ii
TABLE OF CONTENTS iii
LIST OF FIGURES v
LIST OF TABLES v
ABBREVIATIONS vi
INTRODUCTION 1
LITERATURE REVIEW 4
2.1 Sludge Economy Literature 4
2.1 CGE Modelling Literature 4
RESEARCH METHODOLOGY: DYNAMIC CGE-SLUDGE FRAMEWORK 7
3.1 Salient Features of the Model 7
3.2 Model Dynamics 7
3.3 Total Factor Productivity 7
3.4 Defining and Explaining Key Variables 8
3.5 Data Base and Aggregations 9
3.6 Social Accounting Matrix (SAM) 9
3.7 Simulation Design 9
SIMULATION RESULTS 11
4.1 Case Study: Sludge Removal in Electricity Sector Only 11
4.1.1 Macro Indicators 11
4.1.2 Welfare 12
4.1.3 Domestic Sales 13
4.1.4 Overall Private HH Demand 14
4.1.5 Private HH Demand for Imports 15
4.2 Sludge Removal in All the Given Sectors 15
4.2.1 Macro Indicators 15
4.2.2 Welfare 16
4.2.3 Domestic Sales 17
4.2.3 Overall Private HH Demand 18

4.2.4 Private HH Demand for Imports 19
CONCLUSION And DISCUSSION 22
KEY POLICY RECOMMENDATONS 24
REFERENCES 25
APPENDIX - SECTOR AGGREGATION SCHEME 28

LIST OF FIGURES

Figure 1 Macro Indicators: Electricity Sector Sludge Removal Only....12
Figure 2 Welfare Level: Electricity Sector Sludge Removal Only....12
Figure 3 Domestic Sales: Electricity Sector Sludge Removal Only....13
Figure 4 Overall private HH demand by sector - Electricity sector sludge removal only....14
Figure 5 Private HH Demand for Imports by Sector:- Electricity Sector Sludge Removal Only....15
Figure 6 Macro Indicators - Multi-Sector Sludge Removal....16
Figure 7 Welfare Level - Multi-Sector Sludge Removal....16
Figure 8 Domestic Sales: Other Sectors - Multi-Sector Sludge Removal....17
Figure 9 Domestic Sales: Pharmaceutical Sector - Multi-Sector Sludge Removal....18
Figure 10 Overall Private HH Demand By Sector - Multi-Sector Sludge Removal....19
Figure 11 Private HH demand for other imports - Multi-sector sludge removal....20
Figure 12 Private HH demand for construction imports by sector - Multi-sector sludge removal....20
Figure 13 Private HH demand for pharma imports - Multi-sector sludge removal....20

LIST OF TABLES

Table 1: Summary of Selected CGE Studies for Pakistan.... 5

ABBREVIATIONS

PIDE	Pakistan Institute of Development Economics
CDA	Capital Development Authority
CGE	Computable General Equilibrium
SAM	Social Accounting Matrix
GTAP	Global Trade Analysis Project
GDP	Gross Domestic Product
TFP	Total Factor Productivity
DROR	Domestic Rate of Return
EV	Equivalent Variation

INTRODUCTION

The concept of a sludge economy has garnered increasing attention in recent years as a framework for understanding the drag on economic productivity and individual welfare created by excessive administrative burdens. Sludge refers to the frictions and inefficiencies that make it unnecessarily difficult for individuals and businesses to complete basic tasks, comply with regulations, or access public services (Sunstein, 2022). Reducing sludge has become a priority for policymakers seeking to streamline bureaucracy, improve service delivery, and promote economic dynamism.

Overall cost of sludge in certain sectors has been estimated as 49% of Pakistan's GDP, equivalent to over $132 billion in 2023, according to the PIDE Sludge Series (1-3) examining the burden of red tape in many industries while starting several types of businesses, registering new pharmaceuticals or administration of the judicial system. In a partial equilibrium and close-economy setting, Faraz & Qasim (2022) find that digitization can reduce time and monetary costs by over 40% and 34%, respectively. However, it is not as effective in reducing opportunity costs unless the government intervenes and eliminates the need for physical documents, which can reduce opportunity costs by over 60%.

Computable general equilibrium (CGE) models have become a cornerstone of economic policy analysis over the past few decades. They provide a powerful framework for assessing economy-wide impacts of policies, shocks, and structural changes across various sectors and regions. Though originally developed to analyze trade policies, CGE models have expanded to study various distortions and frictions that create welfare losses and deadweight costs. The recent unifying theme is using CGE models to measure direct and indirect effects of market imperfections and institutional failures (Socci et al., 2021).

Literature on CGE modeling is vast and diverse, encompassing a wide range of applications and methodological advancements. One of the most prominent CGE frameworks is the Global Trade Analysis Project (GTAP), which has been at the forefront of multi-regional CGE modeling since the 1990s. It maintains a comprehensive global database and hosts annual conferences that showcase hundreds of applications across trade policy, environmental economics, development, and more (Hertel, 1997; Aguiar et al., 2019). This network has fostered a global community of researchers and policymakers, continuously expanding the frontiers of CGE analysis.

Beyond GTAP, several other well-established CGE modeling networks have contributed significantly to the field including International Food Policy Research Institute (IFPRI), which has developed numerous CGE models for various countries, including Pakistan. These models are powerful tools for analyzing the economy-wide impacts of policy changes, external shocks, and structural transformations (Lofgren et al. 2002). Particularly, Cororaton & Orden (2008) outline different interesting scenarios to provide policymakers with a roadmap for forecasting and influencing Pakistan's future economic growth. Similarly, the Partnership for Economic Policy (PEP) focuses on building capacity for CGE modeling in developing countries (Galindev & Decaluwe, 2022). MONASH model, developed at the Centre of Policy Studies in Australia, is renowned for its detailed microeconomic structure and strong forecasting capabilities (Dixon & Rimmer, 2003).

While CGE models have traditionally been used to study market-based policies and distortions, there is growing interest in applying these tools to analyze institutional factors and non-market frictions. This includes studies on governance quality, regulatory burdens, and informal economies (Savard & Melancon, 2013). Application of CGE modeling to analyze sludge - as undertaken in this study - represents a novel extension of this approach to examining bureaucratic inefficiencies in a general equilibrium framework through a productivity lens. However, previously, Zaki (2009) develops a dynamic CGE model to incorporate red tape and trade aspects in Egypt, whereas Fehr et al. (2012) model bureaucratic inefficiency as a tax on intermediate inputs. Inter-industry analysis is really important to quantify how sludge in one sector affects other sectors through backward and forward linkages. Moreover, open-economy analysis is required to examine how it affects domestic activities and international trade in different industries. Analysis of these channels is very important for firms and investors for their business and investment decisions. This knowledge gap motivates the application of a computable general equilibrium (CGE) model to assess how sludge propagates through different sectors in Pakistan.

CGE models provide a powerful simulation tool for quantifying total costs of sector-specific shocks or policies given the input-output linkages in an economy. Social Accounting Matrix (SAM) underpinning a CGE model captures how economic agents interact across activities like production, consumption, trade, and investment. Once calibrated to a SAM, a CGE model can estimate changes in macro aggregates like GDP, employment, prices, and welfare induced by specified shocks or policies (Zeshan, 2019).

Sludge fits squarely within this class of market imperfections that CGE models can provide nuanced assessments of given economy-wide interactions (Zeshan & Shakeel, 2023; Zeshan, 2024). By imposing bureaucratic burdens on firms, workers, investors and consumers, sludge reduces total factor productivity, distorts prices and alters resource allocation – with ripple effects throughout supply chains, labor markets, and trade flows. Fully capturing these complex mechanisms requires a general equilibrium approach like CGE modeling.

The vast literature demonstrates the advantages of CGE analysis, but sludge remains under-explored as a distinct distortion amenable to quantification using economy-wide modeling. To the author's knowledge, no study has employed a dedicated dynamic CGE model to analyze macroeconomic implications of sludge for a developing country like Pakistan. Hence, this study provides novel empirical insights into how the costs of sludge propagate through a general equilibrium framework.

Reducing sludge is an urgent priority for Pakistan's economic development. But the most effective policies require rigorous diagnosis of how sludge permeates the economy. This research will provide that diagnosis by leveraging a CGE model tailored to analyze sludge in Pakistan. This study uses GTAP data and simulates the results of our dynamic CGE sludge model. A detailed mapping of activities studied in the PIDE Sludge Audits (1-3), which forms the starting point for our analysis, and GTAP sectors is provided in the Appendix. Our model will quantify sludge impacts on sectoral outputs, household incomes, government revenue, international trade, and other core macroeconomic outcomes – capturing both direct effects and indirect spillovers.

CGE approach will also permit targeted policy simulations to identify high-return interventions for sludge reduction. Roos et al. (2020) proposes a CGE model approach to identify sectors in which sludge cleaning can provide larger dividends to the economy. By illuminating macroeconomic footprint of sludge and priority areas for reform (sludge removal), this research promises vital insights to guide policy aimed at alleviating one of Pakistan's most binding development constraints.

LITERATURE REVIEW

This study contributes to two main bodies of literature: research on causes and consequences of sludge economies, and applications of CGE models to analyze economic frictions.

2.1 Sludge Economy Literature

The concept of "sludge" originated in behavioral economics to describe excessive bureaucratic burdens that distort individual decision-making and impose wasteful costs on citizens and firms. Seminal works by Sunstein (2013) advocate simplifying processes and choice architecture to reduce sludge. McChesney (1997) provides a theoretical model of how politicians and bureaucrats design sludge to extract rents, showing excessive red tape can persist even with benevolent leaders due to commitment problems. Earlier, Ferguson (1984) finds economic frictions of sludge reduce female labor force participation more than males.

More recently, sludge framework has been applied to analyze administrative frictions in developing countries. However, most of these studies focus on micro-level impacts or individual sectors. Nguyen & Van Dijk (2012) survey firms in Vietnam to quantify sludge costs of starting a business. Fedosov & Paientko (2017) measure productivity losses for Ukrainian manufacturing from bureaucratic burdens and weak governance. While highlighting micro burden of sludge, few studies adopt a macroeconomic lens or quantify economy-wide effects. Bovi (2002) estimates sludge increases size of underground economy in UK by 13% of GDP. These studies point to macro impacts but lack detailed economic modeling of transmission channels.

PIDE Sludge Audits (1-3) examine various micro costs and inefficiencies of sludge in Pakistan. For instance, Sludge Audit 1 focuses on construction and business setup processes (Haque et al. 2022). Obtaining permission for high-rise buildings from the CDA is particularly costly, amounting to 17.5% of one year's (annual) GDP over 4 years. Other processes like residential construction permits, environmental approvals, and setting up businesses like pharmacies or hospitals also incur significant costs and stress. Moreover, Sludge Audit 2 examines costs in different industries and services (Haque et al. 2023). Restaurant businesses face the highest sludge cost at 1.5% of GDP. Setting up electricity connections and intercity private bus services also incur notable costs. Registration of new medicines and intellectual property rights have relatively lower sludge costs.

Finally, Sludge Audit 3 analyzes Pakistan's judicial system (Haque and Qasim, 2023). Criminal trials for theft cases have slightly higher costs than homicide cases. Civil trials for inheritance cases are more costly and time-consuming than divorce cases. Inland revenue court cases are particularly expensive, costing 1.4% of one year's (annual) GDP over 3 years. Other legal proceedings like customs tribunals, anti-corruption trials, and banking suits also incur varying levels of costs and require numerous trips over multiple years.

2.1 CGE Modelling Literature

This study also contributes to applied literature on CGE models for analyzing frictions and distortions affecting economic productivity and efficiency.

One application is quantifying the economic costs of over-regulated governance. Taylor (1990) reviews the use of CGE models since the early 1970s, which are essential to understanding the behavior of developing economies. Fehr et al. (2012) model bureaucratic inefficiency as a tax on intermediate inputs, estimating large productivity and growth impacts in Africa. These applications demonstrate CGE modeling's usefulness for intangible institutional constraints.

More recent studies have applied CGE models to related concepts like informality and red tape (Das et al., 2023; Samuels & Duramany-Lakkoh, 2023). Urbiztondo et al. (2009) model regulations as a tax on Argentinian firms and show gains from reducing delays in customs, courts, and licensing. However, no existing CGE model in mainstream literature focuses specifically on the macroeconomic burden of sludge. This requires tailoring model structure, parameters, and calibration to reflect how sludge manifests institutionally in Pakistan based on micro-evidence. By embedding firm-level impacts into CGE framework, it provides a concrete analytical framework to diagnose policy reforms for alleviating sludge.

In summary, this study makes two main contributions. It provides the first economy-wide analysis of the costs of sludge in Pakistan using a purpose-built CGE model. Second, it demonstrates this modeling approach's potential as a diagnostic tool for analyzing bureaucratic inefficiency in developing countries. Our results will enhance understanding of how sludge drags economic performance and provide an evidence base for meaningful productivity-enhancing reforms. A summary of selected previous CGE studies for Pakistan to which this study contributes an additional dimension is shown in Table 1.

Table 1: Summary of Selected CGE Studies for Pakistan

Authors	Year	Focus Area	Methodology	Key Findings
Ahmad et al.	2022	Agricultural trade, poverty reduction	CGE model	Trade liberalization policies have mixed effects on ultra-poor households, with some benefits depending on crop type.
Ahmed et al.	2013	Infrastructure and economic growth	CGE microsimulation	Public infrastructure investments significantly impact economic growth, employment, and poverty alleviation in Pakistan.
Bhatti et al.	2015	Fiscal policy, income inequality	CGE model	Progressive fiscal policies reduce income inequality, while regressive taxes exacerbate disparities.
Cororaton & Orden	**2008**	Cotton and textile economy, poverty impact	CGE model	Cotton and textile sectors are crucial to rural and urban economies, with significant linkages affecting poverty reduction, especially in rural areas.

Mahmood & Marpaung	2014	Carbon pricing, energy efficiency, climate policy	CGE model	Carbon pricing positively impacts energy efficiency and reduces emissions but can strain economic growth without compensatory measures.
Siddiqui & Iqbal	2001	Tariff reduction, income distribution	CGE model	Tariff reductions benefit higher-income groups, creating concerns about income inequality.
Shaikh et al.	2012	SAFTA, regional trade, economic impacts	CGE model	SAFTA enhances Pakistan's trade opportunities but leads to trade deficits in the short term.
Sarwar	2023	Tax reforms, economic impact	CGE model	Tax reform proposals have varied effects on revenue generation, growth, and income distribution, requiring balanced reforms.
Shaikh & Rahpoto	2009	Trade liberalization, SAFTA	CGE model	Trade liberalization improves economic output but also introduces vulnerabilities in the domestic market.
Shaikh	2009	Bilateral trade, SAFTA	CGE model	SAFTA enhances bilateral trade but requires complementary policies to manage negative effects on smaller industries.
Zeshan et al.	2024	Water resource management, future markets	CGE-Water model	Water market reforms can optimize resource distribution, mitigating future water scarcity risks.
Zeshan & Shakeel	2023	Climate change, adaptation and mitigation policies	CGE-Water-Energy (WE) model	Adaptation and mitigation policies significantly reduce climate vulnerabilities but require substantial investments.
Zeshan & Ko	2019	Climate change adaptation	Gdyn-W model	Climate change adaptation policies are crucial for minimizing economic damage, especially in agriculture and energy sectors.

RESEARCH METHODOLOGY: DYNAMIC CGE-SLUDGE FRAMEWORK

Our CGE-Sludge framework extends the usages of dynamic Global Trade Analysis Project (GTAP) model (Ianchovichina and McDougall, 2000) by incorporating sludge features through productivity channel and accounting for changes over time. In particular, at the macro level in GDP, investment, domestic rate of return on capital and aggregate welfare level are assessed. At the micro level, we focus on domestic sales and household demand for domestic and imported goods and services. This model is designed to analyze medium- and long-run policy impacts.

3.1 Salient Features of the Model

Capital accumulation is a central component of our CGE-Sludge framework. The model uses an integral equation to represent the evolution of capital stock over time. This equation accounts for net investments and the existing capital stock at base period in a recursive dynamic framework.

Investment behavior in our model is driven by expectations of returns and adjustments in capital stocks. It incorporates adaptive expectations, where agents form their investment decisions based on past experiences and anticipated future returns. This lagged adjustment mechanism ensures that capital stocks adjust gradually over time, reflecting the real-world delays in investment responses to economic signals.

The model seeks to balance complexity and computational efficiency. It aims to maintain the strengths of standard GTAP model, such as detailed sectoral disaggregation, while extending its capabilities to dynamic analysis. However, this approach also introduces challenges, such as ensuring accuracy of dynamic equations and dealing with potential inaccuracies in capital accumulation over longer time periods.

3.2 Model Dynamics

Our model utilizes a recursive dynamic methodology, solving each time period sequentially and updating key variables based on outcomes from previous periods. This approach offers several advantages:

1. It allows for the tracing of capital stock evolution and investment flows over time.

2. It provides insights into how investments in earlier periods impact long-term economic outcomes.

3. It incorporates time as a variable, enabling more dynamic and temporally nuanced simulations.

3.3 Total Factor Productivity

Total Factor Productivity (TFP) channel is a crucial aspect of our dynamic CGE-Sludge framework, influencing the efficiency and effectiveness with which inputs are used in production process across different sectors. TFP measures the output produced by inputs of labor, capital, and land, beyond what is accounted for by their mere quantity. It represents technological advancements, efficiency improvements, and the effectiveness of resource use. TFP is crucial for understanding long-term economic growth, as it captures improvements in production processes and technology.

Our model incorporates TFP changes to reflect how economies evolve over time. Our model uses TFP to adjust production functions in various sectors, thereby influencing overall economic output. We

model TFP through production functions that include labor, capital, and land inputs. The general form of production function incorporating TFP in time period t is:

$Y_t = A_t \times F(K_t, L_t, T_t)$

Where for period t:

Y_t = Output

A_t = Total Factor Productivity

K_t = Capital

L_t = Labor

T_t = Land

F = Functional form representing the combination of inputs

TFP in our CGE-Sludge framework serves as a critical indicator of economic efficiency. Its inclusion allows for a more detailed and accurate analysis of economic policies and their long-term effects on the economy. Finally, the key model equation for linking TFP and value-addition is given as:

$$Value\ added_i = f\ (Output_i, TFP_i, Elasticity\ of\ substitution_i, Price\ of\ VA_i i, Price\ of\ output_i)$$

3.4 Defining and Explaining Key Variables

Adding brief explanations for each key macro variable provides more clarity on how our model is quantifying these key macroeconomic impacts. It also helps to specify which particular measure is being used to assess economy-wide performance, such as:

a. Investment:

Definition: The addition to the economy's capital stock.

Measurement: In current dynamic CGE-Sludge framework, it is modeled as a function of expected rate of return on capital relative to the cost of capital. Hence, investment in each period adds to capital stock available for production in subsequent periods.

b. Real GDP growth:

Definition: Percentage change in the total real value of goods and services produced by economy.

Measurement: Calculated as the percentage change in real GDP between periods. Real GDP is typically measured as the sum of value added across all sectors, deflated by a GDP price index.

c. Domestic Rate of Return (DROR):

Definition: The return earned on investments within domestic economy.

Measurement: It is calculated as ratio of capital income to capital stock. In current dynamic CGE-Sludge framework, this is typically an endogenous variable that adjusts to equate savings and investment.

d. Welfare:

Definition: A measure of economic well-being, typically based on household consumption.

Measurement: It is measured using equivalent variation (EV) in GTAP modeling framework. It measures change in income that would be equivalent to the impact of a policy change on household utility. Aggregate welfare changes are typically calculated as sum of EV across all households.

3.5 Data Base and Aggregations

The most recent Global Trade Analysis Project (GTAP) Data Base Version 11 is used for analytical purposes in our dynamic CGE-Sludge model (Aguiar et al. 2022). GTAP Data Base, version 11, encompasses data from 141 countries and 19 aggregate regions, representing 99.1% of the world GDP and 96.4% of global population. For this extensive database, the base year is 2017. As noted above, a mapping of 34 activities for which sludge effects were estimated in the PIDE audits to 12 GTAP sectors is provided in the Appendix. All other GTAP sectors are aggregated into a single "Other" sector, for which the PIDE audits provide no sludge effect estimates. Finally, all trade partners are aggregated into a single "Rest of World". We use the expected rate of return closure (RORE), where capital moves across regions and regions' trade balances change accordingly.

3.6 Social Accounting Matrix (SAM)

GTAP data base represents a comprehensive snapshot of global economy for a specified reference year. It integrates various data sources including national input-output tables, trade statistics, macroeconomic indicators, energy data, and tariff information. Due to the heterogeneous nature of underlying input-output tables in terms of sources, methodologies, base years, and sectoral specifics, significant efforts are invested to ensure consistency and comparability across disparate data sources. Rather than simply providing input-output tables, the primary goal of GTAP Data Base is to support economic simulation models by offering users a reliable and uniform set of economic data.

Construction of GTAP Data Base version 11 aims to harmonize global-scale data sources for analytical purposes, offering comprehensive time series data on value flows, volumes, and various tax measures. This extensive coverage of economic activities enhances its utility in conducting wide-ranging studies on global economic issues.

3.7 Simulation Design

Our dynamic CGE-Sludge framework is initially calibrated to a SAM that reflects Pakistan's current economy, including existing sludge. Baseline equilibrium inherently incorporates productivity losses and distortions caused by sludge across different sectors.

To simulate sludge removal, it adjusts sector-specific total factor productivity parameters based on empirical estimates from PIDE Sludge Audit Series. These adjustments represent productivity gains from removing administrative burdens. For example, the audit data suggests that sludge in construction due to "Obtaining permission for a high-rise building from CDA" causes cumulative productivity loss in Construction equivalent to 17.5% of one year's annual GDP over four years. Our dynamic CGE-Sludge model increases (matches) TFP parameter for construction by corresponding for each year to reflect this effect in each of the four years. Other causes of sludge affecting construction are modeled similarly to obtain our initial sludge removal change in TFP for this sector.

In a model simulating removal of all sludge as estimated in the PIDE audits similar adjustments are made across all sectors based on their specific sludge burdens. After implementing these changes, the CGE model solves for a new general equilibrium, allowing all markets to adjust. Economic impacts of sludge removal are then quantified by comparing key indicators (e.g. GDP, sectoral output, etc.) between no-sludge simulation counterfactual equilibrium and sludge-inclusive baseline.

One point to note is that we model sludge removal by an improvement in TFP only for the one or more years for which the PIDE audits show an effect. After these years, in our model TFP returns to its baseline value. This is a relatively conservative approach. For example, improved permitting for high-rise buildings may result in a multi-year period of expanded construction that then dampens down. Other sludge removal might be expected to have long-term benefits, such as changes to the judicial system that remain in effect and affect legal processes on a continuing basis.

SIMULATION RESULTS

The integration of PIDE sludge estimates with GTAP sectors is a necessary step for our CGE analysis but presents certain conceptual and methodological challenges that require careful explanation. Importantly, the simulation results are tied to GTAP sectors rather than PIDE-specific activities, necessitating clarity in how the mapping is conducted, as described above and in the Appendix.

First, the aggregation of sludge estimates for various sub-sectors into broader GTAP sectors can mask important distinctions. For example, sludge estimates for "Setting Up: Pharmaceutical Unit," "Setting Up: Pharmacy," and "Registration of New Medicine" are aggregated under the GTAP sector "Basic pharmaceutical products." Such aggregation risks losing the nuances of specific sub-sectors, potentially overstating or understating the broader pharmaceutical industry's sludge impacts.

Additionally, the GTAP sectors are often more generalized than the specific activities assessed by PIDE. This results in the application of sludge estimates derived from narrowly defined activities to broader economic categories. For instance, sludge estimates for "Setting Up: Petrol Pump" are mapped to the GTAP sector "Business services nec." This broader categorization could lead to an overgeneralization of sludge effects, misrepresenting inefficiencies in sub-sectors where bureaucratic barriers may not be as significant.

Another limitation arises from the inherent gaps in the PIDE sludge estimates. Many forms of sludge within mapped sectors, as well as in sectors not represented, remain unevaluated. For instance, while several judicial and administrative processes are mapped to the GTAP sector "Public Administration," numerous inefficiencies within this sector likely remain unaccounted for in our analysis.

Given these issues, it is essential to explain the mapping process comprehensively and provide supporting details to aid interpretation of the simulation results. In this regard, we include an Appendix table illustrating the mapping of PIDE activities to GTAP sectors and providing the abbreviated names used in reporting the simulation results, some of which match the GTAP sector name and others of which are more focused based on the PIDE Sludge audits. Future research should prioritize expanding sludge audits across a broader range of sectors and activities. This will enable more precise mappings and enhance the accuracy of CGE models in capturing the economic impacts of sludge.

We present results for two simulations: a) an illustrative removal of sludge in the electricity sector only by reducing burdens on acquiring electricity connections and b) a removal of all sludge as estimated in the PIDE Sludge Audits (1-3). Results of these two scenarios are compared to a baseline simulation with no sludge removal.

4.1 Case Study: Sludge Removal in Electricity Sector Only

4.1.1 Macro Indicators

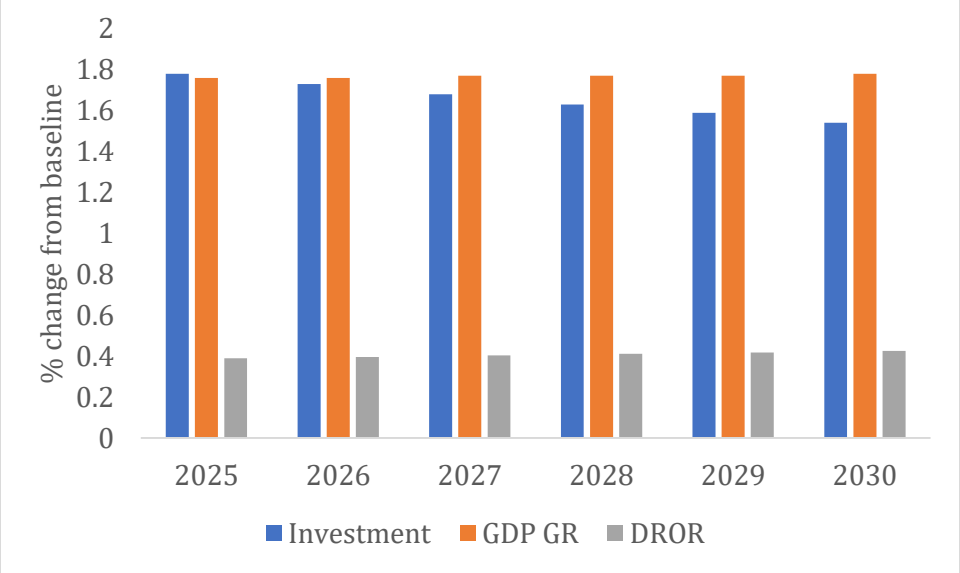
According to the PIDE Sludge Audit Vol 2, the cost of sludge in the electricity sector for year 1 only is around 1.50% of GDP. Compared to the baseline model, a 30.3% TFP productivity gain in the

electricity sector would raise total GDP by this amount. Hence, this scenario increases the baseline productivity parameter by 30.3% in the electricity sector for this single year.

The simulation results of removing sludge in the electricity sector reveal a picture of steady growth and positive trends across multiple sectors. Macroeconomic indicators show an increase of investment, with a slight decline in the pace of investment growth from 1.78% in 2025 compared to baseline outcomes to 1.54% in 2030 (see Figure 1). Nevertheless, the GDP growth rate demonstrates a consistent upward trajectory, with annual GDP rising from 1.76% to 1.78% with the sludge removal compared to the baseline. This suggests improving economic efficiency, generating higher output even with slightly diminished investment growth. DROR shows a steady increase from 0.389% to 0.426%, indicating improving profitability and efficiency in domestic investments.

It is important to note that this simulation implements a single direct intervention only. The observed changes in the economy at the macro and micro levels emerge as a result of this one direct exogenous intervention and from indirect effects through intersectoral linkages and general equilibrium adjustments.

Figure 1 Macro Indicators: Electricity Sector Sludge Removal Only

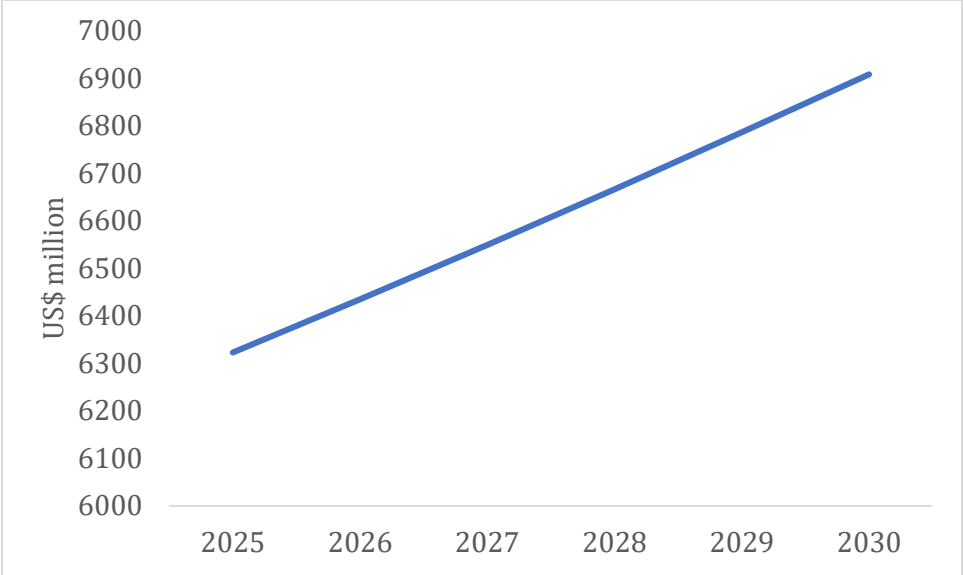


Source: Own calculations.

4.1.2 Welfare

The direct and indirect effects of electricity sector reform (sludge removal) that removes sludge from establishing electricity connections translate into meaningful welfare improvements. Welfare levels exhibit consistent growth, rising from $6.3 billion in 2025 to $6.9 billion in 2030 (see Figure 2). This represents an average annual growth of about 1.8%, suggesting improvements in living standards for the population. The positive trend in welfare indicates that the economic gains from removing sludge in the electricity sector are translating into tangible benefits for households.

Figure 2 Welfare Level: Electricity Sector Sludge Removal Only



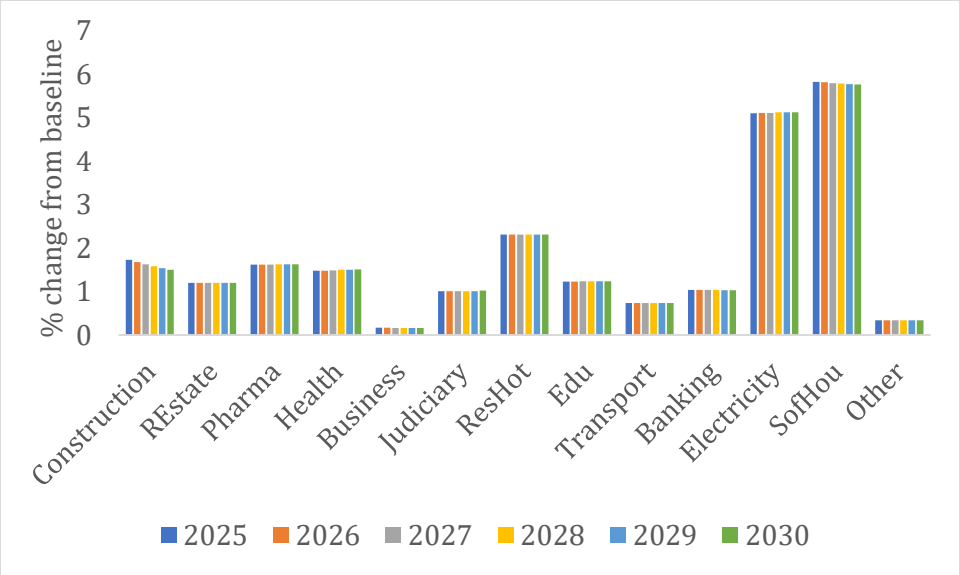
Source: Own calculations

4.1.3 Domestic Sales

Domestic sales show varied performance due to the direct and indirect effects of electricity sector reform. Not surprisingly, the electricity sector where reform occurs shows one of the largest increases in domestic sales compared to the baseline, with computer, electronic and optical products (SofHou, see Appendix) increasing by the largest percentage (5.82% to 5.76%). The effects on all sectors other than electricity arise indirectly through the inter-sectoral linkages and inter-temporal aspects of the model. These effects are largest for accommodation, food and service activities (ResHot) and are minimal for business services nec (Business) and the aggregated "Other" sector. Construction show moderate but declining growth compared to the baseline outcomes.

Looking ahead, it is worth noting at this point that domestic sales of the electricity sector in our second general equilibrium simulation are higher (19.8% in 2025 and 13% in 2030, see Figure 8) compared to the effects when reform occurs only in the electricity sector, (stuck around 5.12%, see Figure 3). The later simulation captures the interlinkages effect of sludge removal in all the given activities of the PIDE Sludge Series (1-3), allowing more substantial ripple effects in the economy. The net effect is the larger increase in electricity domestic sales than from reform in electricity only.

Figure 3 Domestic Sales: Electricity Sector Sludge Removal Only

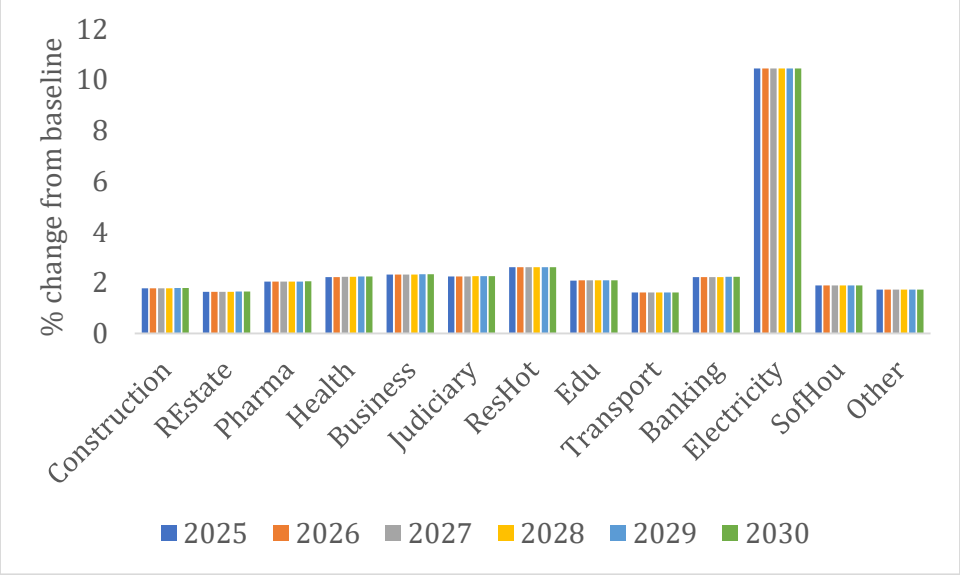


Source: Own calculations.

4.1.4 Overall Private HH Demand

Supportive of improved welfare, household demand shows positive growth across all sectors, with electricity (10.45%), where the reform occurs, experiencing the most significant increase followed by ResHot (2.61%), and business (2.32%). This widespread increase in demand reflects greater purchasing power stemming from the productivity gains in the electricity sector (see Figure 4).

Figure 4 Overall private HH demand by sector - Electricity sector sludge removal only

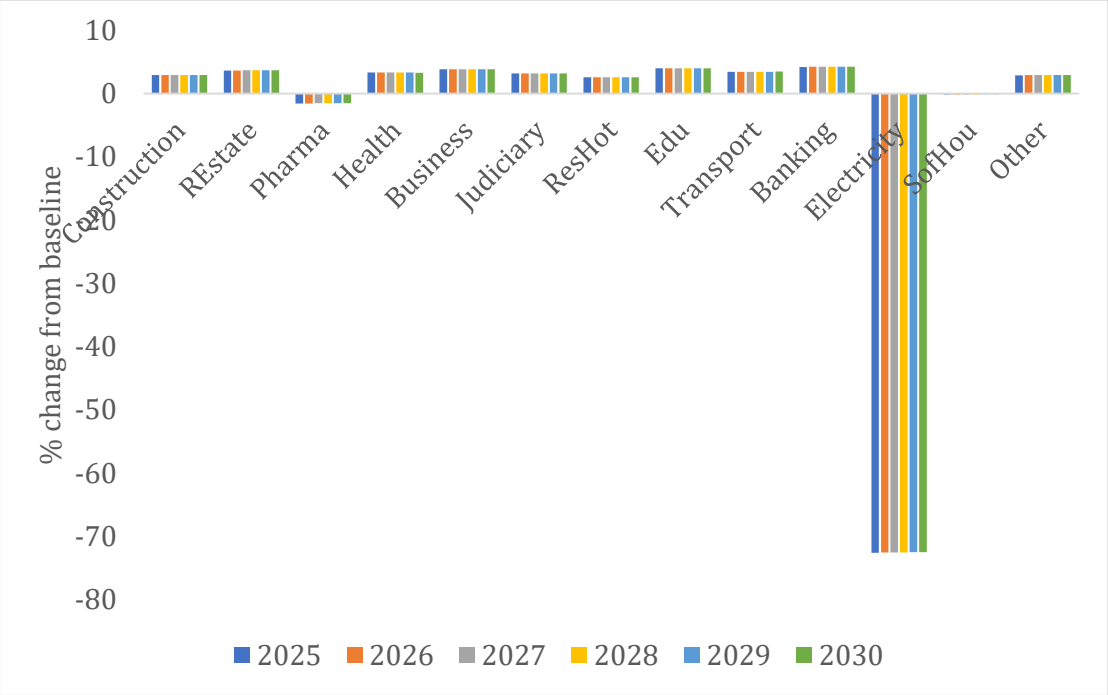


Source: Own calculations.

4.1.5 Private HH Demand for Imports

Demand for imported commodities varies greatly due to the direct and indirect effects of electricity sector reform. There is a dramatic decrease in electricity sector imported products, suggesting a major shift towards domestic energy sustainability, with a smaller decline in imports of basic pharmaceutical products (Pharma, see Figure 5). Conversely, there are modest increases in household demand in other sectors, with financial services (Banking), education, and business showing the strong growth among these sectors in imports, indicating increased reliance on international services in these specific areas.

Figure 5 Private HH Demand for Imports by Sector:- Electricity Sector Sludge Removal Only



Source: Own calculations.

4.2 Sludge Removal in All the Given Sectors

4.2.1 Macro Indicators

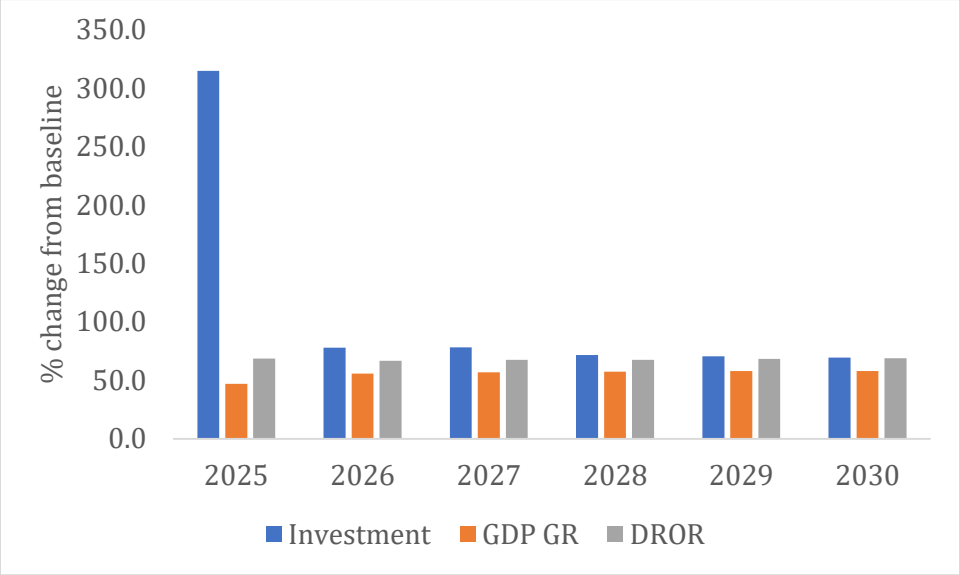
In the simulation for removal of all PIDE-Audit sludge (multi-sector sludge removal scenario), there are direct effects in the 12 sectors for which TFP is increased to model sludge being removed, and also indirect effects on these sectors and on "Other".

The removal of these bureaucratic hurdles unlocks significant investment potential in the early years. Initial effect on investment from removal of sludge in all the given sectors is extraordinarily high, increasing 314.6% compared to the baseline in 2025 (see Figure 6). In 2023, the overall investment to GDP ratio was 12% in Pakistan; hence, in the model removing sludge would temporarily increase overall investment by more than quadruple of its current size in Pakistan, i.e., to 37.8% of GDP. PIDE Sludge Audit Vol 1 explains that obtaining permission for a high-rise building from CDA costs 10.9%

of GDP in year 1, which is the primary cause of such huge investment loss in Pakistan; however, it reduces significantly in subsequent years.

The real GDP shows a consistent increase from 47% in 2025 to 57.9% by 2030 compared to the baseline. Hence, the overall impact of removing sludge in the general equilibrium framework is higher after five years than the combined (1-3) micro Sludge Audits partial equilibrium estimate (49% of GDP) due to inter-temporal effects and backward and forward linkages. Backward and forward linkages between different industries prorogate this impact, which is intensified by the dynamic interaction of sludges in the same sector and across different industries. Hence, the DROR increased around 68% in Pakistan. This substantial increase in the rate of return signifies a more efficient and productive allocation of capital within the economy.

Figure 6 Macro Indicators - Multi-Sector Sludge Removal

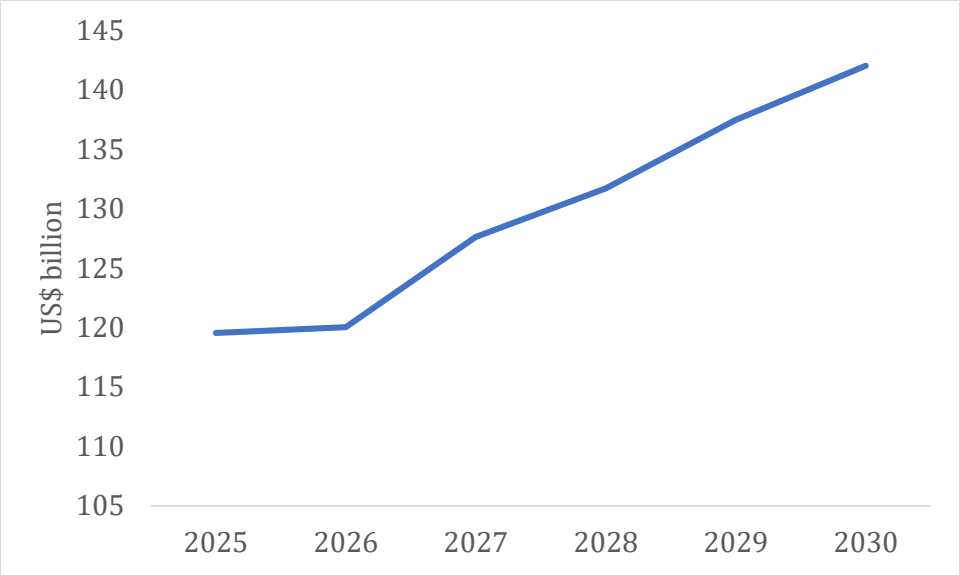


Source: Own calculations.

4.2.2 Welfare

Our simulation results indicate significant welfare gains from removing sludge in Pakistan, with these gains closely tied to increased household consumption. Welfare gains are expected to keep rising, reaching over $142 billion by 2030 (41% higher compared to the baseline, see Figure 7). This substantial increase in welfare demonstrates the positive impact of removing bureaucratic inefficiencies across multiple sectors on the overall well-being of the population.

Figure 7 Welfare Level - Multi-Sector Sludge Removal

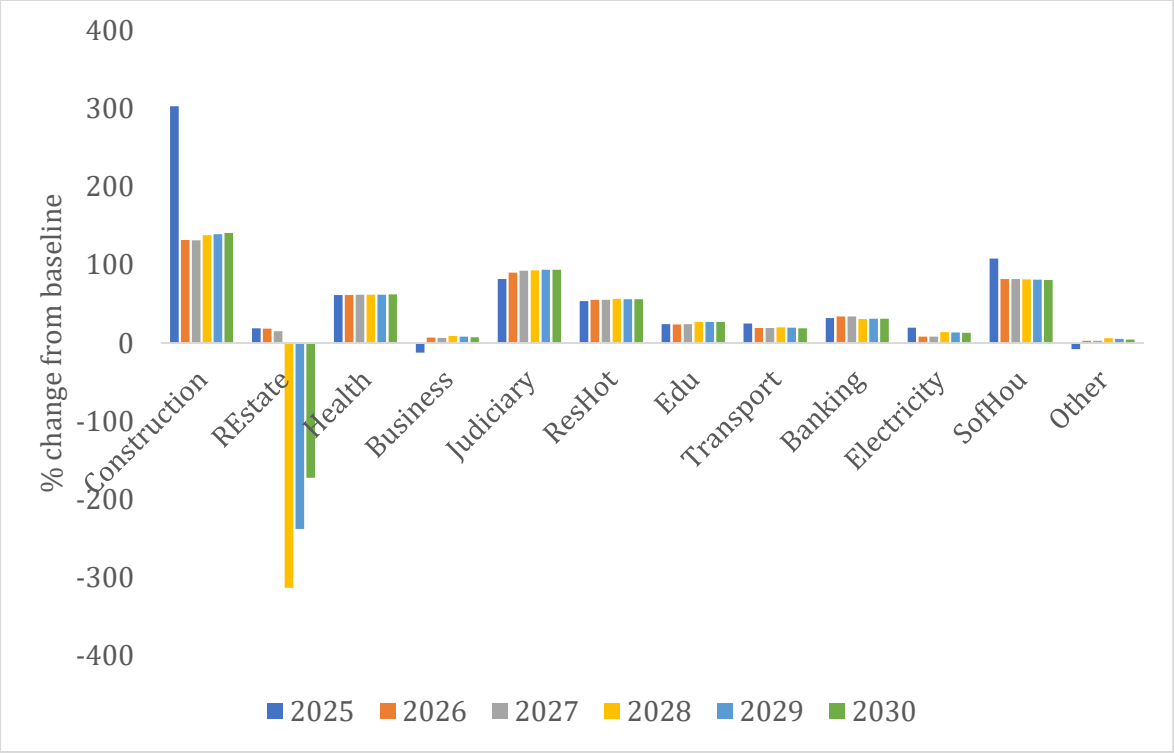


Source: Own calculations.

4.2.3 Domestic Sales

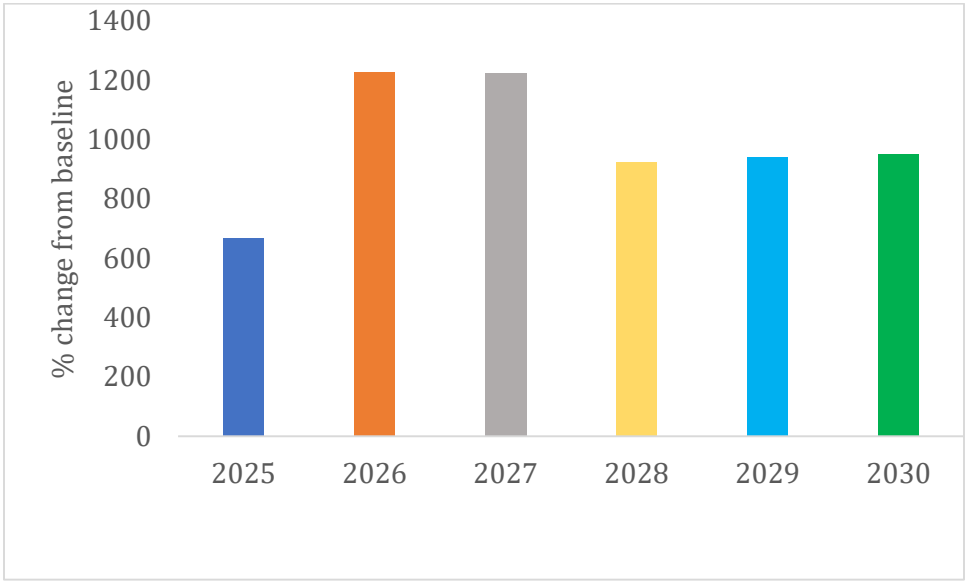
The construction sector experiences a drastic increase in 2025, with a 303% rise in domestic construction activities (Figure 8). The domestic real estate sector, in contrast, is expected to shrink in the coming years. This seems a correction mechanism in the real estate industry after removing the sludge. In Pakistan, people have a tendency to invest in real estate because it is considered a safe investment. However, after removing the sludge, investment shifts from the real estate sector to other more productive sectors. Effects on Pharma are particularly large as shown separately in Figure 9. Removing sludge makes the pharmaceuticals industry more profitable. Since Pakistan imports most of the medicines from abroad, which puts a lot of burden on our foreign exchange reserves, this is an important impact with remarkable growth of 600% in 2025 then further increasing through 2030.

Figure 8 Domestic Sales: Other Sectors - Multi-Sector Sludge Removal



Source: Own calculations

Figure 9 Domestic Sales: Pharmaceutical Sector - Multi-Sector Sludge Removal



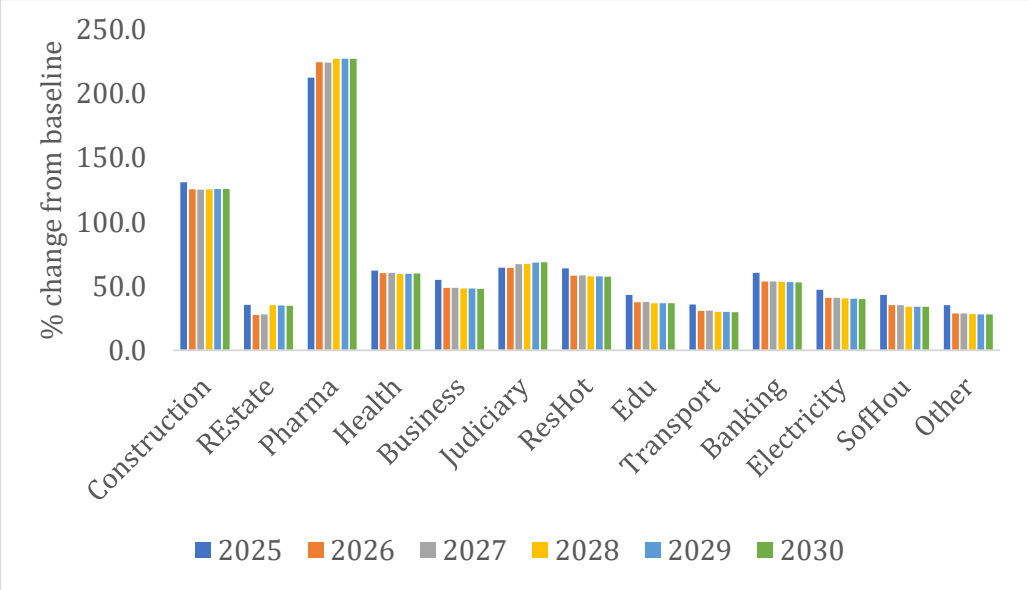
Source: Own calculations.

4.2.3 Overall Private HH Demand

Our simulation results illustrate a persistent boost in private household demand for various commodities in Pakistan from 2025 to 2030. Household spending is higher across the board. In some

sectors, like construction, it rises by more than 130% in 2025 and seems quite stable till 2030 (see Figure 10). This suggests people are spending a lot more on building and buying homes compared to the least performing real estate sector. Easier access to domestically-produced medicines increases Pharma expenditures by more than 200% compared to the baseline and household health expenditures by almost 60%, resulting in a healthier society. Similarly, household demand for other products increases as well, reflecting a broader improvement in economic activity. Household demand for the aggregated "Other" sector, where effects of sludge removal only arise indirectly, increases noticeably. This trend likely reflects domestic supply-chain limitations or price competitiveness of imports in these categories, as domestic producers face capacity constraints or higher input costs. The outsized role of imports in satisfying demand underscores the importance of considering trade dynamics when evaluating the indirect spillovers of infrastructure projects like sludge removal, which can stimulate consumption beyond what local industries alone can absorb.

Figure 10 Overall Private HH Demand By Sector - Multi-Sector Sludge Removal

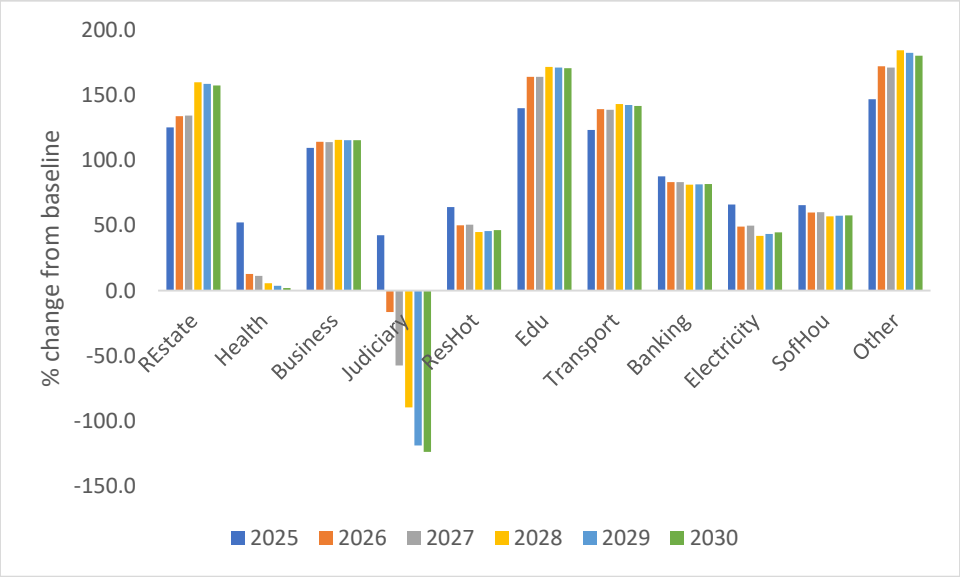


Source: Own calculations

4.2.4 Private HH Demand for Imports

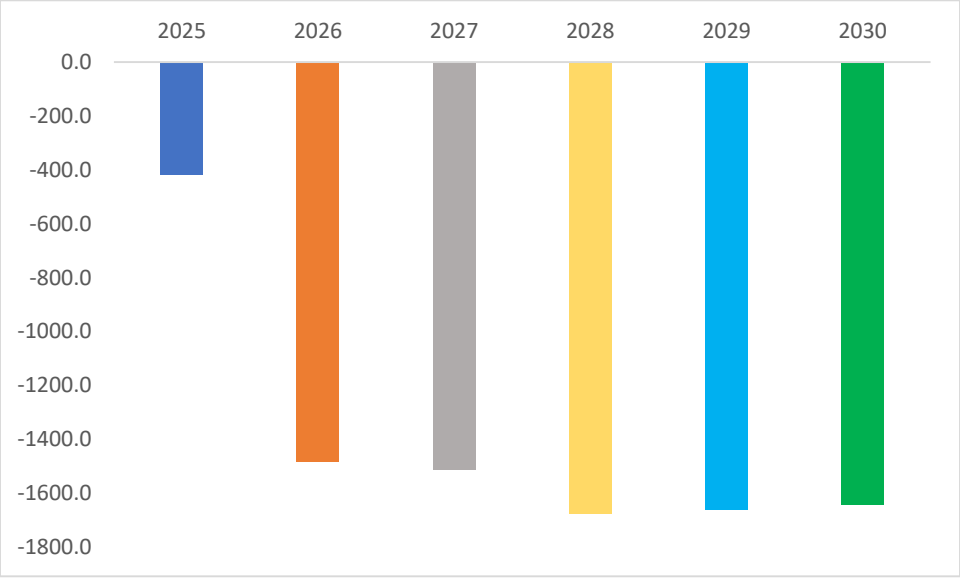
Our simulation results reveal significant changes in private household demand for imported commodities across various sectors. The results project a staggering decrease of over 400% in demand for imported construction materials by 2025, and it keeps reducing over time (see Figures 11-13). This suggests a significant shift away from imported materials, due to increased availability of domestic goods. Similarly, our results reveal an eye-watering decrease in demand for imported pharmaceuticals through 2030. This indicates less dependence on foreign medicines, due to the more availability of certain drugs domestically and an efficient local production system. Conversely, the demand for imported real estate products increases to meet the increase overall household demand in the real estate sector, although domestic sales reduce, as shown above. Most other sectors also show modest increases in import demand.

Figure 11 Private HH demand for other imports - Multi-sector sludge removal



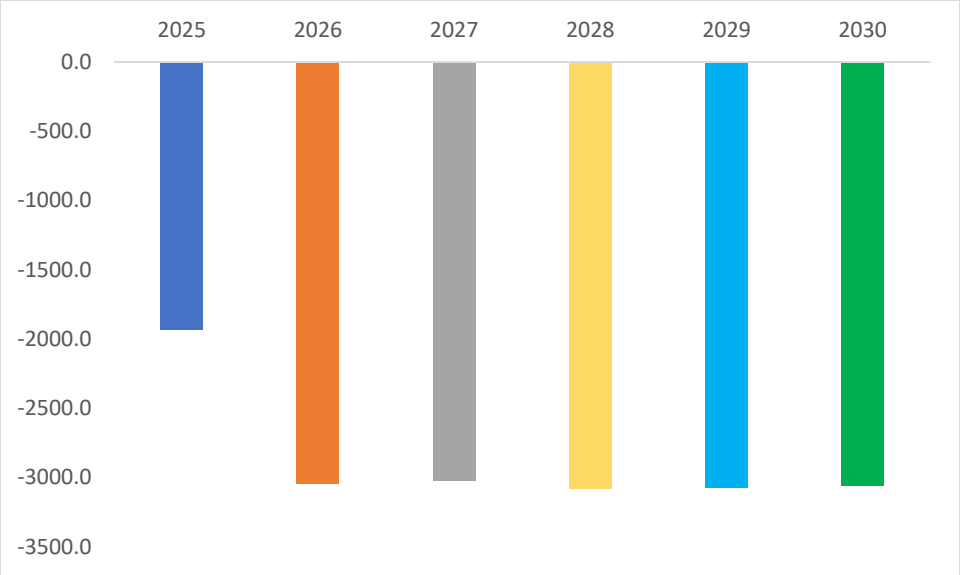
Source: Own calculations

Figure 12 Private HH demand for construction imports by sector - Multi-sector sludge removal



Source: Own calculations

Figure 13 Private HH demand for pharma imports - Multi-sector sludge removal



Source: Own calculations

CONCLUSION AND DISCUSSION

Our simulation results from this dynamic Sludge-CGE framework provide valuable insights into the economy-wide impacts of removing sludge - bureaucratic inefficiencies and red tape - in Pakistan. The findings reveal substantial potential gains across multiple economic dimensions, highlighting critical importance of streamlining administrative processes and reducing regulatory burdens. For instance, even when considering sludge removal in the electricity sector alone, we observe notable improvements in GDP, welfare, and domestic sales, indicating the significant impact of targeted reforms. These effects are magnified further when considering a broader removal of sludge across all sectors identified by PIDE, as discussed below.

One of the most striking outcomes is the projected boost to investment. Our model predicts an extraordinarily high initial increase in investment of 314.6% in 2025 compared to baseline scenario under the multi-sector scenario. This suggests that removing sludge could more than quadruple Pakistan's investment-to-GDP ratio from its current 12% to 37.8%. Such a dramatic increase in investment could be transformative for Pakistan's economic development, potentially accelerating industrialization, technological adoption, and productivity growth. Results are similarly large, but not quite as much, in the PIDE sludge effect estimates in partial equilibrium.

The impact on real GDP growth is equally impressive, with the model projecting an increase from 47% in 2025 to 57.9% by 2030 relative to baseline. This surpasses previous microeconomic estimates, which suggested combined sludge costs of around 49% of GDP. The higher figure in our CGE model can be attributed to the capture of inter-temporal effects and intersectoral linkages, demonstrating the value of a general equilibrium approach in fully accounting for pervasive impacts of sludge throughout the economy. Furthermore, the DROR increases by around 68% under this scenario, signifying a more efficient allocation of capital and higher returns on investment, driving the substantial GDP growth.

Welfare gains projected by the model are substantial, reaching over $142 billion by 2030. This improvement is closely tied to increased household consumption across various sectors, indicating a broad-based enhancement in living standards. Persistent boost in private household demand for commodities over time suggests that removing sludge could lead to a more dynamic and prosperous consumer economy.

At sectoral level, our results reveal significant shifts in economic activity. In particular, pharmaceutical sector stands out with significant increases in domestic sales and household demand followed by construction sector. This boom in pharmaceutical and construction could have far-reaching effects on employment, urban development, and overall economic growth. Interestingly, our model predicts a contraction in real estate sector. This counterintuitive result suggests a potential correction in real estate market as investments are redirected to more productive sectors following sludge removal.

The shift in household consumption patterns is noteworthy. Our model projects increased spending across various sectors, with construction and pharmaceuticals seeing particularly large gains. The rise in pharmaceutical spending indicate improved access to healthcare, potentially leading to better health outcomes for entire population. This aligns with the overall increase in household health

expenditures by almost 60% by 2030, suggesting a healthier society as a beneficial side effect of sludge removal.

One of the most intriguing findings is the projected change in demand for imported commodities. The model predicts a dramatic decrease in demand for imported construction materials and pharmaceuticals. This shift away from imports towards domestic production could have significant implications for Pakistan's trade balance, domestic industry development, and economic self-sufficiency.

The expected decline in demand for imported construction materials and pharmaceuticals suggests a shift towards local production, strengthening Pakistan's trade balance and promoting self-reliance. It enhances efficiency, supporting import substitution and reducing dependence on foreign goods, creating opportunities for exporting locally made products, boosting Pakistan's export potential. In this way, it is a key to transitioning from an import-focused economy to an export-driven one, contributing to sustainable growth and development.

Furthermore, the transition process itself could present challenges. Rapid shifts in economic structure, such as projected contraction in real estate, could lead to short-term dislocations in employment and asset values. Policymakers would need to carefully manage this transition to ensure that the benefits of sludge removal are broadly shared and that vulnerable groups are protected.

KEY POLICY RECOMMENDATONS

This section reinforces several key recommendations validated by our CGE analysis:

Prioritize High-Impact Sectors for Reform: Our CGE analysis reveals that certain sectors offer disproportionate economy-wide benefits when freed from sludge. The large potentials in the domestic activity of pharmaceuticals and construction sectors suggests prioritizing reforms in these sectors. Further, the magnitude of their effects, captured through our general equilibrium framework, is substantially larger than what partial equilibrium analysis alone would suggest due to inter-industry linkages.

Manage Structural Economic Transitions: The CGE results uniquely highlight the need for careful management of structural economic changes. Our analysis shows that removing sludge could cause a significant contraction in the real estate sector while boosting other sectors. This insight, which emerges from the general equilibrium effects, suggests policymakers need to:

. Develop transition strategies for affected sectors

. Implement gradual reform timing to avoid market disruptions

Balance Import Substitution and Export Promotion: The economy-wide analysis reveals complex trade effects that were not visible in sector-specific studies. The projected large decrease in pharmaceutical and construction imports alongside domestic sector growth suggests opportunities for import substitution. However, policymakers should:

. Target sectors showing strong domestic growth potential

. Support export capacity development in newly competitive sectors

. Maintain balanced trade policies during the transition

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APPENDIX - SECTOR AGGREGATION SCHEME[1]

PIDE Sludge activities	GTAP sectors	Abbreviation	Sludge Effect (% of GDP)
High-rise Building	Construction	Construction	17.50%
Residential Construction	Construction	Construction	0.63%
Environmental Protection Agency	Construction	Construction	12.00%
Plot in a Private Housing Society	Real estate activities	REstate	2.75%
Setting Up: Pharmaceutical Unit	Basic pharmaceutical products	Pharma	2.34%
Setting Up: Private Hospital	Human health	Health	0.10%
Setting Up: Diagnostic Center	Human health	Health	0.03%
Setting Up: Pharmacy	Basic pharmaceutical products	Pharma	3.75%
Registration of New Medicine	Basic pharmaceutical products	Pharma	0.03%
Setting Up: Petrol Pump	Business services nec	Business	0.07%
Cash and Carry Business	Business services nec	Business	0.30%
Intellectual Property Rights	Business services nec	Business	0.07%
Restaurant Business	Accommodation, Food and service activities	ResHot	1.50%
Hoteling Business	Accommodation, Food and service activities	ResHot	0.70%
Private School	Education	Edu	0.50%
Public Transport	Transport nec	Transport	0.04%
Private Bus Service	Transport nec	Transport	1.07%
Banking Services	Financial services nec	Banking	0.40%
Bank Loan	Financial services nec	Banking	0.20%
Electricity Connection	Electricity	Electricity	1.50%
Software House	Computer, electronic and optical products	SofHou	0.03%

[1] The sectors are aggregated in "Other" where sludge is not estimated by PIDE audits.

Kick-off Pension	Public Administration	Judiciary	0.06%
Criminal Trial: Homicide Case	Public Administration	Judiciary	0.07%
Criminal Trial: Theft	Public Administration	Judiciary	0.10%
Civil Trial: Divorce Trial	Public Administration	Judiciary	0.22%
Civil Trial: Inheritance Case	Public Administration	Judiciary	0.25%
Inland Revenue Court Case	Public Administration	Judiciary	1.40%
Smuggling and Duty Evasion	Public Administration	Judiciary	0.22%
Income Tax Case	Public Administration	Judiciary	0.46%
Anti-Corruption Trial	Public Administration	Judiciary	0.26%
Banking Court	Public Administration	Judiciary	0.28%
Consumer Courts	Public Administration	Judiciary	0.01%
Fraudulent Investment Trial	Public Administration	Judiciary	0.70%
Competition Appellate Tribunal	Public Administration	Judiciary	0.01%
Total	**Total**		49.54%