MSR

Working Papers No. 26

May 2025

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Publisher and Distributor

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Abstract

This paper examines the economic impacts of a 43% population increase in Saudi Arabia under Vision 2030 reforms using a computable general equilibrium (CGE) framework. This study utilizes for the first time our organization's unique SAM version for Saudi Arabia, which is derived from the recent GTAP database 11 (Agujar et al., 2022) with a base year of 2021. It also incorporates and updates entries using the latest input-output (IO) tables for Saudi Arabia. Through three scenarios: fixed labor and capital, flexible labor and capital, and a 20% increase in skilled labor, the results show minimal changes in GDP in Scenario 1, with gains in agriculture and food sectors. Scenario 2, with endogenous labor and capital, reveals declines in GDP and trade balances, but continued growth in food and agriculture sectors. In Scenario 3, an increase in skilled labor leads to significant productivity gains in various sectors, especially in technology and manufacturing. Despite these gains, overall welfare remains negative for GCC countries due to allocative inefficiencies and resource shifts. The findings highlight the need for strategic investments in human capital and sectoral diversification to address the challenges of rapid population growth.

Keywords: Saudi Arabia; Migration; CGE

1. Introduction

30.7% forigen nationals are living in GCC, consitiuting more than half of the entire GCC population of 56.2 million (*Gulf Labour Markets, Migration and Population (GLMM) Programme* 2022). While Arab migrants were the majority of these, ther has been over last decades for s hift towards Asian and now they become dominant across all other migrant groups. This carries endless consequens to labor market,s social economi ststua and widespread of specific class of sectors such as construction, domestic work. Saudi Arabia hosts the largest number of foreign nationals in absolute terms, with over 13.3 million migrants, accounting for 41.6% of its population.

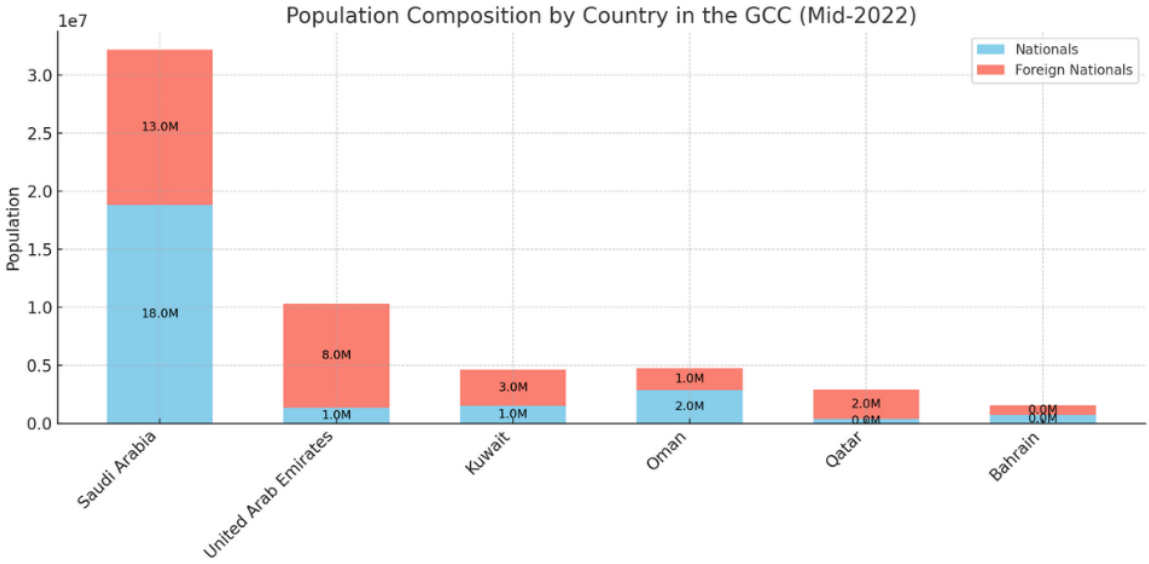

Figure 1: National and Forigen population shares in GCC countries Mid 2022

Most existing studies investigating migration in the GCC region, and Saudi Arabia in particular, are predominantly micro-level analyses based on qualitative assessments or organizational reports that extrapolate patterns from existing data. However, many of these studies suffer from limited representativeness and lack comprehensive macroeconomic coverage. In this study, we address this gap by, for the first time, employing the latest Social Accounting Matrix (SAM) for Saudi Arabia, drawn from the GTAP 11 database, to analyze the macroeconomic welfare impacts of a potential skilled labor migration shock aligned with the aspirations of Vision 2030. We simulate the effects across a broad range of macroeconomic variables to develop a welfare roadmap, offering insights into how a new migration system focused on attracting skilled foreign labor could influence Saudi Arabia's overall welfare, sectoral dynamics, the broader GCC region, and the global economy. This approach reflects a strategic shift in Saudi Arabia's migration policy: while dependence on low-skilled labor is being reduced through Saudization programs, the country is simultaneously promoting the selective attraction of high-skilled talent to foster a globally competitive, knowledge-driven economy (Vision 2030, 2016; Ministry of Investment, 2022).

Saudi Arabia's migration system has evolved alongside its economic development, shifting from limited religious and Arab labor migration before the 1970s to a highly structured system during the oil boom, when large numbers of Arab workers were recruited for massive infrastructure projects. In the 1990s and 2000s, migration patterns shifted toward non-Arab Asian workers due to political instability in the region and economic considerations, particularly the need for cheaper and more flexible labor. In

response to growing concerns about dependency on foreign labor, the government introduced significant labor market reforms in the 2010s, such as the *Nitaqat* program and broader Saudization policies, aimed at promoting the employment of Saudi nationals in the private sector. Complementing these efforts, the Saudi Nationalization Program sought to systematically replace foreign workers with local labor, especially in sectors critical to economic diversification.

Saudi Arabia also invested heavily in human capital development through programs like the King Abdullah Scholarship Program, which funded thousands of Saudi students to pursue higher education degrees abroad in top universities, aiming to return a highly skilled workforce capable of contributing to a knowledge-based economy. Together, these measures reflect Saudi Arabia's broader strategy of economic modernization, gradual labor market transformation, and reduced reliance on low-skilled foreign workers (Hertog, 2014; Ramady, 2010; Ministry of Human Resources and Social Development, 2022).

Saudi Vision 2030 directly addresses the issue of migration and the strategic attraction of foreign talent as part of its broader plan to diversify the economy and reduce dependence on oil. While historically the Kingdom relied heavily on low-skilled migrant labor, Vision 2030 shifts focus toward attracting highly skilled foreign nationals, particularly in sectors deemed critical for future growth. The official document emphasizes the need to "improve the business environment, reform the residency system, and attract global talent" to enhance Saudi Arabia's competitiveness (Vision 2030, 2016).

Specifically, Vision 2030 highlights the goal of creating a more attractive environment for skilled workers in sectors such as renewable energy, healthcare, education, tourism, entertainment, finance, and technology. One initiative supporting this is the introduction of a new form of residency—the Privileged Iqama (Green Card–like system)—aimed at allowing highly skilled expatriates to live and work in the Kingdom without the traditional kafala restrictions. Additionally, the strategy commits to "encouraging the transfer of knowledge and skills" by attracting international expertise to develop industries like mining, logistics, and advanced manufacturing (Vision 2030, 2016).

Moreover, initiatives under the Vision Realization Programs (such as the Human Capability Development Program and the National Industrial Development and Logistics Program) explicitly call for building partnerships with global institutions and inviting foreign experts to support local capacity building and innovation ecosystems. The government thus envisions foreign skilled labor not as a threat, but as a critical catalyst for achieving long-term national transformation.

2. Literature review

Migration has been a structural feature of economic development and labor market formation in Saudi Arabia and the wider Gulf region. However, while the economic imperatives for relying on migrant labor are evident, the long-term socio-economic and labor market consequences have raised significant concerns, exposing vulnerabilities and contradictions within Gulf economies.

Fasano and Goyal (2004), in their IMF Working Paper "Economic Reform in the GCC: Past Performance and Future Challenges," offer one of the earliest systematic analyses of migration's macroeconomic role in the GCC. Drawing on macroeconomic data spanning 1980–2002, they argue that migration was critical in sustaining growth, particularly in sectors facing acute labor shortages. Yet their largely quantitative, aggregate-level approach tends to underplay the distortive effects migration had on domestic labor markets. While they acknowledge that the inflow of foreign labor suppressed wage growth and discouraged national labor participation, their analysis stops short of examining how these dynamics entrenched long-term dependency on expatriate labor, weakening the structural foundations for endogenous growth and human capital development among nationals. Thus,

while offering valuable insights into short-term economic benefits, Fasano and Goyal's work leaves unaddressed the deeper institutional rigidities migration has helped reinforce.

Baldwin-Edwards (2011) provides a more nuanced labor market-focused critique in his report "Labour Immigration and Labour Markets in the GCC: National Patterns and Trends," based on labor force surveys from 2000–2010. His descriptive analysis rightly emphasizes that migrants enabled rapid diversification beyond oil-dependent sectors, facilitating expansion into services and infrastructure. However, Baldwin-Edwards critically identifies how the reliance on migrant labor bifurcated Gulf labor markets into two parallel systems: one, offering protected, high-salary employment for nationals (mostly in public sectors), and another, precarious and underregulated, dominated by migrants. His analysis is particularly valuable for highlighting the "structural laziness" created by this system — Gulf employers had little incentive to invest in labor productivity or innovation as long as cheap migrant labor remained abundant. Nevertheless, while diagnosing the issue, the study offers limited empirical evaluation of how these dual labor markets might evolve under future policy pressures or demographic shifts.

The Center for International and Regional Studies (CIRS) at Georgetown University in Qatar conducted a comprehensive research initiative titled "Arab Migrant Communities in the GCC States," published in 2016. This study employed a multidisciplinary approach, combining historical analysis, policy review, and qualitative fieldwork to examine the dynamics of Arab migrant communities in the Gulf. The research highlighted that, despite a shift towards South and Southeast Asian labor sources, Arab migrants continue to play a significant role in the Gulf economies. The study emphasized the unique historical, social, and economic contexts of Arab migration, noting that these communities often face different integration challenges compared to other migrant groups. However, the research also pointed out the lack of comprehensive data on Arab migrants, which hampers the development of informed policies.

A 2010 report by the United Nations Economic and Social Commission for Western Asia (ESCWA) titled "International Migration and Development in the Arab Region" provided an in-depth analysis of labor migration trends in the Gulf. Utilizing data from national statistics and international organizations, the report examined the effects of labor migration on economic development and labor markets. It found that while migrant labor has been essential in filling labor shortages and supporting economic growth, it has also led to labor market segmentation, with nationals often preferring public sector employment and migrants occupying low-skilled, low-paid jobs. The report highlighted the challenges of implementing effective labor nationalization policies and the need for comprehensive strategies that address both economic and social dimensions of migration.

Hertog (2014), in his work "Arab Gulf States: An Assessment of Nationalization Policies," deepens this critical perspective by showing how state-driven nationalization efforts, such as Saudization, repeatedly failed due to entrenched private sector preferences for migrant workers. Using policy documents, labor statistics, and case studies from 1990–2013, Hertog demonstrates that attempts to substitute expatriates with nationals often resulted in "ghost nationalization," where citizens were formally hired but did little actual work, while migrants continued to perform essential tasks informally. His critical contribution lies in showing that migration is not merely a labor supply issue but a political economy phenomenon, sustained by implicit social contracts where governments offer high public employment and benefits to citizens while tolerating private sector dependence on cheap foreign labor. However, while Hertog convincingly exposes the political incentives maintaining migration dependency, his study is somewhat less focused on how technological change, automation, or evolving geopolitical factors (such as oil price volatility) might disrupt this equilibrium.

Adding another dimension, Shah (2009) in "The Management of Irregular Migration and Its Consequences for Development in the Gulf" explores the growing phenomenon of irregular migration

and its underappreciated socioeconomic costs. Using qualitative interviews, policy analysis, and secondary data, Shah argues that the rigid sponsorship (kafala) system and poor regulatory oversight have led to significant undocumented migration, human rights abuses, and social marginalization. Her study shifts the focus from economic impacts to the human and societal consequences of migration management failures. Critically, Shah highlights how irregular migration threatens not only migrants' welfare but also undermines national development goals by creating an informal labor underclass that remains outside formal economic systems. Unlike more economy-centered analyses, Shah explicitly ties migration challenges to governance failures, offering a powerful critique of the sustainability of current migration frameworks.

A 2011 study titled "Migrant Labor in the Gulf" by the Center for International and Regional Studies examined the political and social dimensions of labor migration in the Gulf Cooperation Council (GCC) countries. Through policy analysis and stakeholder interviews, the study explored how migration policies intersect with national identity and security concerns. It found that while migrant labor is economically indispensable, it is often viewed through a securitized lens, leading to restrictive policies and limited integration opportunities. The study argued for a reevaluation of migration narratives and policies to balance economic needs with social cohesion and human rights.

To the best of my knowledge, no prior study has applied a general equilibrium modeling approach to analyze the impact of migration in Saudi Arabia. Computable General Equilibrium (CGE) analysis offers a powerful framework for studying migration shocks by capturing the full economy-wide effects across sectors, labor markets, and households. CGE models account for general equilibrium adjustments, including substitution effects, resource reallocation, and price changes throughout the economy. Unlike simpler models, CGE frameworks incorporate indirect effects such as shifts in resource allocation, changes in household incomes, and impacts on government revenues, making them particularly relevant for countries like Saudi Arabia, where migration significantly shapes economic structures. Applying CGE models enables policymakers to assess how migration shocks affect both nationals and expatriates, forecast sectoral adjustments, and evaluate policies such as Saudization and workforce localization. This approach significantly enriches the existing literature by providing detailed, calibrated, and policy-relevant insights essential for managing migration within the broader context of economic transformation goals like Vision 2030.

3. CGE Model Setup and Database Aggregation

We aim to analyze the economy-wide impacts of shock scenarios linked to Vision 2030's migration goals, which target an increase in the regional population from 35 million to 50 million, with a particular focus on attracting high-skilled migrants. The objective is to boost economic growth and GDP contributions in selected strategic sectors identified in the Vision, including mining, tourism, finance, manufacturing, Health and technology (Figure 2). This strategy forms a core part of the Kingdom's broader policy to diversify the economy away from oil and gas dependence.

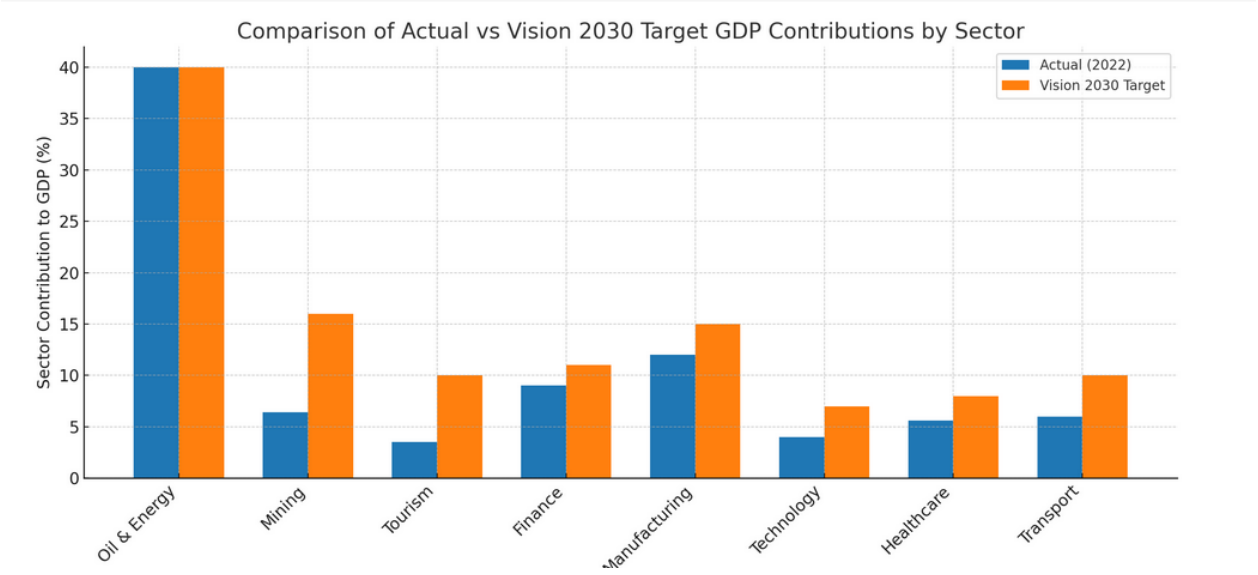

Figure 2: Actaul V.s Traget GDP contributions for strategic selected sectors based on Vision 2030

This study utilizes for the first time our organization's unique SAM version for Saudi Arabia, which is derived from the recent GTAP database 11 (Agujar et al., 2022) with a base year of 2021. It also incorporates and updates entries using the latest input-output (IO) tables for Saudi Arabia. The database has a matrix structure of 3x18x5: 4 regions (Saudi Arabia, GCC, and rest of the world), 18 sectors (Agricuture, extraction, Oil and Gas, Toursim, Finance, Transport, Technology, health, Light manufacturing, heavy manufacturing, utility consumtption, other services, meat, forestry, fishing, proc food, text wrap) 5 factors of production (land, skilled labor, unskilled labor, capital and natural resources)[1].

This structure is illustrated in Figure 3, which presents a circular flow diagram outlining key interactions in a simplified economy. Households (consumers) purchase goods and services from domestic producers and import finished goods from abroad. Meanwhile, enterprises (producers) compensate consumers for their contributions to production through wages and capital rents. Producers also engage in economic exchanges by purchasing intermediate inputs from one another, importing intermediate goods, and exporting both final and intermediate products.

Additionally, the government plays a role by providing subsidies and transfers to consumers while levying taxes on both households and businesses. The analysis of U.S.-imposed automotive tariffs will focus on transactions between four key economic agents: consumers, producers, the government, and foreign firms.

[1] GCC region includes Oman, Kuwait, Bharain and United arab emirates

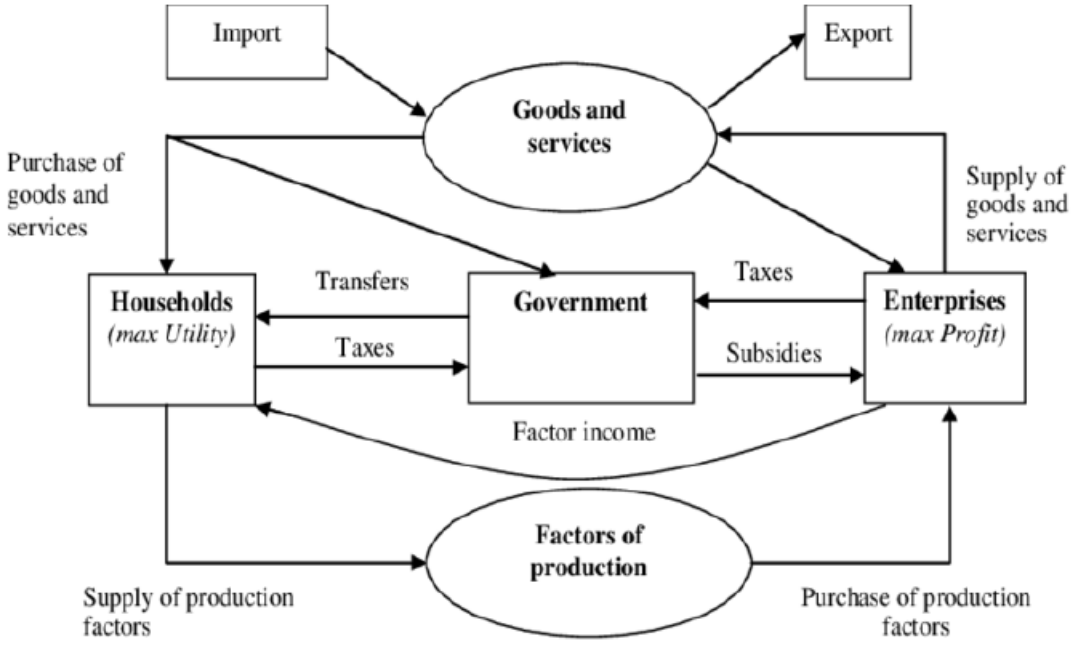

Figure 3: Ciruclar Economic Flow

Reference: Hassan, (2025)

The GTAP model in our analysis is static and operates under the assumptions of perfect competition and constant returns to scale, while also incorporating Armington's assumption, which distinguishes commodities based on their country of origin and treats imports from different sources as imperfect substitutes. With 141 countries and 65 categories of goods included in the Version 11 database (2017), GTAP is particularly useful for assessing the diverse impacts on various sectors, regions, and factors of production, such as labor, capital, and land. As noted by Mensbrugghe (2015), the model tracks bilateral trade flows between any two regions across all sectors and captures international capital flows, which adjust in response to relative changes in expected rates of return on capital.

Table 1 provides a clear, chronological overview of the foreign population in Saudi Arabia as a percentage of the total population, reflecting the shifts in labor demand and migration trends over several decades. Here's a comment on the key points:

1. **Early Stages (1970-1980)**: The initial increase in foreign workers during the oil boom period in the 1970s aligns with Saudi Arabia's rapid economic expansion, particularly in construction and oil sectors. The foreign population grew from ~10% in 1970 to ~25% by 1980, showing how much the country relied on migrant labor to meet growing demand.
2. **1990s (1990-2000)**: After the Gulf War in 1990, there was a slight decrease in the foreign population, possibly due to repatriation of workers after the conflict. However, the percentage remained relatively high (30% in 1990 and 27% in 2000), which suggests that while there was a decrease, foreign labor continued to play a significant role in the economy. Early Saudization attempts in the 2000s were likely part of the government's efforts to increase the employment of Saudis in various sectors.
3. **2010s (2010-2020)**: The increase in foreign workers from 8.4 million (31%) in 2010 to 13.5 million (38%) in 2020 highlights the ongoing demand for labor, particularly as Vision 2030

planning and labor reforms took shape. The government's push for more high-skilled workers in recent years is reflected in the stable increase in migrant numbers. Despite these efforts, low-skilled labor remains a significant portion of the workforce, as indicated by the rationalization of this group in 2020.

4. **Recent Trends (2022)**: The 2022 estimate of ~13.4 million migrants (41.6%) indicates that the foreign population is still a large proportion of the total, with the numbers slightly stabilizing from the previous year. The fact that the foreign population percentage has slightly increased despite ongoing reforms and nationalization efforts speaks to the continued need for foreign labor in various sectors, particularly in construction, service industries, and specialized roles.

Table 1: Chronological overview of Migrants as percentage of total population of Saudi Arabia

Year	Foreign Population	% of Total Population	Notes
1970	~300,000	~10%	Beginning of oil boom, start of large labor demand
1980	~1.8 million	~25%	Major construction and oil projects peak
1990	~4.6 million	~30%	After Gulf War, slight decrease due to repatriations
2000	~5.3 million	~27%	Early Saudization attempts; stabilization of foreign labor
2010	~8.4 million	~31%	Vision 2030 planning starts; labor reforms
2020	~13.5 million	~38%	High-skilled attraction increases; low-skilled workforce rationalized
2022	~13.4 million	~41.6%	(Latest) As per official 2022 mid-year estimates

Source: General Authority for Statistics, Saudi Arabia

The migrant population in Saudi Arabia is heterogeneous, originating from a diverse range of countries, with the majority coming from India, Pakistan, Bangladesh, and Egypt. Most migrants are Muslims, alongside other religious groups. The sectors that predominantly employ these migrant workers include construction, domestic work, and healthcare.

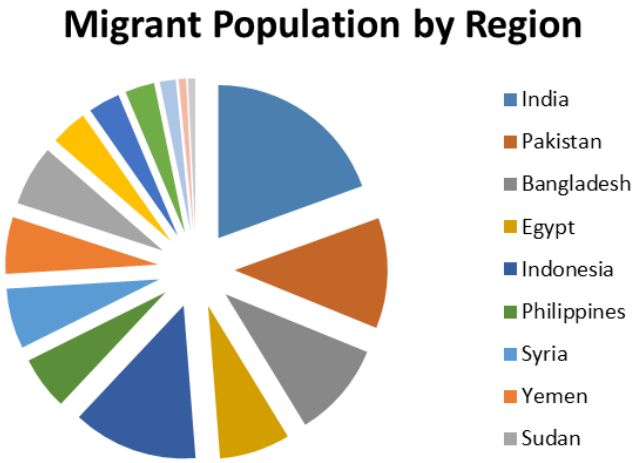

Figure 4: Migrant population by origin

4. Simulation Results-Scenario 1 (More population with sticky labor and capital)

What if the regional population increased by 43%, raising the population from 32 million to 50 million — in the short term, with mobility restrictions on factors of production?

After running simulations with a 43% positive shock in the regional population of Saudi Arabia, while holding skilled and unskilled labor supply fixed and allowing for flexible wages, the GDP of Saudi Arabia is expected to experience a slight increase of 0.04%, resulting in a nominal gain of 319 million USD. However, this comes with a minor decrease in regional income by 0.03%. The GCC region also shows a modest increase in GDP post-shock, with a small marginal gain of 6 million USD. Real GDP figures, after adjusting for inflation, are declining across all regions. Additionally, there is a slight decline in regional income by 0.01%. Saudi Arabia also faces a deterioration in its trade balance, as the population growth drives an increase in imports, outpacing exports and leading to a trade imbalance of 1,886 million USD.

Table 2: Post shock impac on selected macroeconomic variables

Regions	**Nominal GDP**				**Change in Trade balance X-M (Millions USD)**	**Real GDP**	**Regional income**
	%	**Pre shock**	**Post shock**	**Nominal loss/gain (millions USD)**			
Saudi Arabia	0.04%	688587.9	688907.2	319.25	-1886.62	-0.04%	-0.03%
GCC	0.001%	783744.6	783750.9	6.38	11.41	-0.01%	-0.01%
Rest of World	-0.001%	79921752	79921248	-504	1875	0%	0.00

An increase in the regional population did not contribute significantly to boosting the strategic sectors outlined in Vision 2030. Instead, it primarily led to a boost in the output of the food and agriculture sectors, driven by the increased demand for food and related dietary consumption resulting from the larger population. Surprisingly, this shock has had a negative impact on the output from other sectors, likely due to a shift in resource allocation and efficiency towards the more essential food and textile sectors in Saudi Arabia.

Table 3: Post shock impac on supply and production across sectors

Output / % Change	**Rest of World**	**GCC**	**Saudi Arabia**
GrainsCrops	0.08	0.3	23.41
MeatLstk	0.01	0.35	5.98
ProcFood	0.01	0.92	9.4
TextWapp	0.03	0.27	6.95
Fishing	0	0.19	1.93
Extraction	-0.01	-0.02	-0.03
OilGAS	-0.02	-0.02	0.12
Forestry	0	0	-0.33
LightMnfc	0	-0.01	0.09
HeavyMnfc	-0.01	-0.01	0.35
Technology	-0.01	-0.03	-0.52
Util_Cons	-0.01	-0.01	-0.43

TransComm	0	-0.01	-0.99
Tourism	-0.01	-0.05	-2.28
Transport	0	0	0.31
Finance	0	-0.01	-3.44
OthServices	0	-0.01	-1.42
Health	0	-0.01	-1.47

Table 4: Welfare decomposition

Regions / Efficiences	Allocative	Endwment	Technology	Population	Terms of trade	Inv. / Saving	Preferences	Total
RestofWorld	-504.259	0	0	0	278.3853	-74.3733	0	-300.247
GCC	6.3825	0	0	0	-71.9986	-0.4675	0	-66.0836
SaudiArabia	9306.569	-232075	0	223020.4	-206.511	74.8858	0	119.9286
Total	8808.693	-232075	0	223020.4	-0.1243	0.045	0	-246.402

The welfare analysis offers deeper insight into the results of this policy shock2. In this CGE (GTAP) simulation, a positive shock was applied by increasing Saudi Arabia's regional population by 43%, while keeping the supply of labor, capital, natural resources, and technology fixed. Only wages were allowed to adjust flexibly. This shock represents a significant increase in demand without a corresponding increase in production factors, leading to important reallocations and price adjustments in the economy.

The welfare decomposition results show that Saudi Arabia achieved large gains in allocative efficiency (+9306.569), suggesting that despite the fixed factors, the economy managed to reallocate resources more efficiently to absorb some of the shock. In contrast, the Rest of the World experienced a negative allocative effect (-504.259), indicating that global trade patterns may have shifted slightly in favor of Saudi Arabia, reducing efficiencies elsewhere. The GCC countries showed small positive allocative gains (+6.3825), although these were outweighed by other losses.

However, the endowment effect was dramatically negative for Saudi Arabia (-232075), reflecting the severe strain caused by the fixed supply of labor and capital while the population surged. Essentially, while more people demanded jobs and resources, the economy could not expand its production base to meet this need, resulting in large welfare losses. On the other hand, the population effect was strongly positive (+223020.4) for Saudi Arabia. In CGE models, an increase in population directly boosts aggregate utility because more people generate more consumption and overall satisfaction, even if output per capita may fall.

In terms of trade effects, Saudi Arabia faced a slight worsening (-206.511) in its terms of trade. This could be due to increased import demands without an increase in export capacity, leading to a deterioration in the prices at which it trades with the rest of the world. Meanwhile, the Rest of the World experienced a positive terms of trade effect (+278.3853), suggesting it benefitted slightly from increased demand from Saudi Arabia. The GCC countries, however, experienced negative terms of trade effects (-71.9986), possibly due to trade diversion or competitive pressures.

[2] The GTAP welfare decomposition utility disaggregates the total welfare effect into seven components: resource allocation (efficiency) effects, also called the excess burden of taxes; endowment effects due to changes in factor supplies; technical change due to productivity gains or losses; the effects of population growth; changes in terms of trade for commodities; changes in terms of trade for savings and investment goods; and changes in preferences due to changes in the structure of aggregate demand among household consumption, savings, and government. Welfare effects are reported in levels, in $US millions.

Investment and saving effects were relatively small but positive for Saudi Arabia (+74.8858), suggesting minor financial adjustments following the shock. No changes were recorded under technology and preference effects since these were assumed to be fixed in the model. Overall, although Saudi Arabia managed to offset most of the negative endowment effect through population-related utility gains, the total welfare effect was only slightly positive for Saudi Arabia (+119.9286) and negative overall for the global economy (-246.402).

Economically, these results highlight that when a population increases significantly without a parallel expansion in labor supply, capital, or technological advancement, it puts substantial pressure on available resources, leading to large initial welfare losses. Although aggregate consumption rises due to a larger population, structural problems such as unemployment, resource scarcity, and reduced per capita welfare emerge. Trade performance also weakens as import needs grow, without corresponding increases in export capabilities. Thus, for Saudi Arabia to fully benefit from such a demographic shock in reality, it would need to invest heavily in expanding labor markets, infrastructure, education, and technology. Without these adjustments, a large population increase may strain the economy rather than support sustainable growth.

5. Simulation Results-Scenario 2 (More population with flexible labor and capital)

What if the regional population increased by 43%, while allowing skilled labor, unskilled labor, and capital to adjust toward a new general equilibrium in the long term?

In the second scenario, where labor and capital supply are allowed to adjust endogenously, the simulation results show notable macroeconomic shifts. As seen in Table 5, the nominal GDP in Saudi Arabia declines by -0.42%, with a substantial nominal loss of approximately 2.86 billion USD. This contrasts sharply with the first scenario, where GDP marginally increased. Additionally, the real GDP and regional income both register negative growth (-0.36% and -0.34%, respectively). The broader GCC region also sees a slight contraction, while the Rest of the World experiences a smaller yet still negative impact. The negative trade balance, particularly the sizeable drop in Saudi Arabia's trade surplus, highlights how the internal factor market adjustments have failed to absorb the population shock efficiently, leading to broader economic strains.

Table 5: Post shock impact on selected macroeconomic variables

Regions	**Nominal GDP**				**Change in Trade balance X-M (Millions USD)**	**Real GDP**	**Regional income**
	%	**Pre shock**	**Post shock**	**Nominal loss/gain (millions USD)**			
Saudi Arabia	-0.42	688587.94	685728.69	-2859.25	-2330.17	-0.36%	-0.34%
GCC	-0.03	783744.56	783492.38	-252.19	-24.15	-0.06%	-0.06%
Rest of World	-0.02	79921752	79902464	-19288	2354.32	-0.02%	-0.02%

Table 6 provides further insights into sectoral production responses. The agricultural sectors — notably GrainsCrops and MeatLstk — continue to experience significant growth in Saudi Arabia, with GrainsCrops rising by an impressive 23.39%. However, the gains in the food-related sectors are slightly reduced compared to the fixed-supply scenario, suggesting that endogenous labor and capital

adjustments dilute some of the positive demand effects. Meanwhile, industrial and service sectors such as Extraction, OilGAS, Technology, and Light Manufacturing suffer more pronounced contractions than before. This indicates that flexible factor supply allows resources to move more freely but also exacerbates sectoral imbalances, particularly pulling away resources from high-value sectors toward basic consumption sectors — a finding aligned with results from labor market shock analyses in GTAP-based models (Hertel et al., 1997).

Table 6: Post shock impact on supply and production across sectors

Output / % Change	Rest of World	GCC	Saudi Arabia
GrainsCrops	0.07	0.28	23.39
MeatLstk	-0.01	0.32	5.64
Forestry	-0.02	-0.03	-0.74
ProcFood	0	0.88	8.97
TextWapp	0.01	0.23	6.24
Fishing	-0.01	0.16	1.77
Extraction	-0.03	-0.06	-0.53
OilGAS	-0.04	-0.04	-0.05
Forestry	-0.02	-0.03	-0.74
LightMnfc	-0.03	-0.05	-0.59
HeavyMnfc	-0.03	-0.02	-0.39
Technology	-0.03	-0.07	-1.29
Util_Cons	-0.03	-0.04	-0.85
TransComm	-0.03	-0.05	-1.5
Tourism	-0.03	-0.1	-2.75
Transport	-0.02	-0.04	-0.21
Finance	-0.03	-0.06	-4.05
OthServices	-0.03	-0.06	-2.01
Health	-0.02	-0.06	-2.03

Welfare decomposition results in Table 7 and 8 confirm these structural shifts. Saudi Arabia's welfare gains from population growth are significantly eroded when factor supplies become endogenous. Allocative efficiency remains positive, but a major endowment shock (–232,075 million USD) overwhelms the economy, offset only partially by the population-induced demand (223,020 million USD). The net welfare change is minimal (119.9 million USD), a stark contrast to the expected positive outcome of a growing labor force as posited by endogenous growth theory (Romer, 1990). For the GCC and Rest of the World, welfare outcomes remain negative, suggesting that the internal adjustments in Saudi Arabia create minor externalities for trading partners but not enough to reverse global equilibrium trends.

Table 7: Welfare decomposition

Regions / Efficiences	Allocative	Endwment	Technology	Population	Terms of trade	Inv. / Saving	Preferences	Total
1 RestofWorld	-5734.25	-11453.2	0	0	294.6521	5.0598	0	-16887.7
2 GCC	-0.4722	-216.132	0	0	-166.02	0.2752	0	-382.349
3 SaudiArabia	9449.392	-234536	0	222555.5	-128.617	-5.3345	0	-2665.18

Total	3714.674	-246205	0	222555.5	0.0148	0.0006	0	-19935.3

Table 8: Supply of endowments

Supply of Endowments	Rest of World	GCC	Saudi Arabia
UnSkLab	-0.02	-0.02	-0.01
SkLab	-0.03	-0.04	-0.96
Capital	-0.03	-0.04	-0.6

6. Simulation Results-Scenario 3 (More skilled labor)

What if skilled labor increased by 20%, while allowing unskilled labor and capital to adjust toward a new general equilibrium in the long term?

In this scenario, we assumed that Saudi Arabia successfully achieves a 20% increase in its skilled labor force by 2030, a more realistic and attainable goal compared to assuming a full 43% increase in regional population. Skilled labor supply was increased while allowing unskilled labor and capital to adjust endogenously toward a new long-run general equilibrium within the CGE model framework.

Table 9: Post shock impact on selected macroeconomic variables

Regions	Nominal GDP				Change in Trade balance X-M (Millions USD)	Real GDP	Regional income
	%	Pre shock	Post shock	Nominal loss/gain (millions USD)			
Saudi Arabia	3.8	688587.9	714727.5	26139.56	959.48	2.12%	2.28%
GCC	0.09	783744.6	784463.9	719.38	63.95	0.14%	0.14%
Rest of World	0.05	79921752	79958040	36288	-1023	0.06%	0.06%

The macroeconomic impacts, as shown in Table 9, reveal that Saudi Arabia's nominal GDP rose by 3.8%, reflecting a strong positive response to the increase in skilled labor. Real GDP growth also improved, rising from 2.12% to 2.28%. This suggests meaningful productivity enhancements, although some structural rigidities may still limit the full potential gains. The trade balance (X-M) improved nominally by approximately 26 billion USD, indicating a moderate increase in international competitiveness. Regional income gains were observed but remained modest in the broader GCC area and negligible for the rest of the world, confirming that most benefits were localized within Saudi Arabia.

The sectoral output shifts reported in Table 10 show positive changes across nearly all sectors. Particularly strong growth was recorded in health (+8.38%), textiles and apparel (+7.8%), technology (+5.5%), and tourism (+5.26%). These results are consistent with the expectation that an increase in skilled labor disproportionately benefits service sectors, technology-driven industries, and light manufacturing. Traditional sectors such as agriculture, forestry, and extraction also expanded, though to a lesser extent, suggesting that while productivity improvements spilled over broadly, they were most significant in modern, skill-intensive activities.

Table 10: Post shock impact on supply and production across sectors

Output / % Change	Rest of World	GCC	Saudi Arabia
GrainsCrops	0.03	0.09	0.45
MeatLstk	0.03	0.09	3.23
Forestry	0.04	0.1	3.06
Fishing	0.03	0.13	1.19
Extraction	0.04	0.12	3.53
OilGAS	0.06	0.06	1.06
ProcFood	0.03	0.04	4.13
TextWapp	0.03	0.09	7.8
LightMnfc	0.05	0.08	6.34
HeavyMnfc	0.03	0.08	3.47
Technology	0.05	0.11	5.5
Util_Cons	0.05	0.11	3.72
TransComm	0.05	0.12	4.44
Tourism	0.05	0.15	5.26
Transport	0.05	0.1	4.25
Finance	0.05	0.14	3.59
OthServices	0.05	0.11	6.29
Health	0.04	0.11	8.38

Table 11: Welfare decomposition

Regions / Efficiences	Allocative	Endwment	Technology	Population	Terms of trade	Inv. / Saving	Preferences	Total
1 RestofWorld	8752.7402	22227.457	0	0	317.9623	-820.7546	0	30477.4049
2 GCC	-4.9831	625.2719	0	0	284.7403	-9.9794	0	895.0497
3 SaudiArabia	-1317.4127	26265.3184	0	0	-608.0082	838.1816	0	25178.0791
Total	7430.3444	49118.0473	0	0	-5.3056	7.4476	0	56550.5337

The welfare decomposition (Table 11) further supports these findings. Gains are primarily driven by improvements in endowments, reflecting the higher quality of the labor force. Allocative efficiency also contributed positively as factor mobility allowed resources to shift toward more productive sectors. Terms of trade effects appeared modest but positive, aligned with the improvement in the trade

balance. Population effects were minor since the simulation focused on upgrading labor quality rather than expanding population size.

Overall, the 20% skilled labor shock leads to moderate but broad-based economic gains, largely driven by sectoral shifts toward skill- and knowledge-intensive industries. The model outcomes clearly show that enhancing labor quality has a deeper and more sustainable impact on GDP growth, trade competitiveness, and sectoral resilience compared to merely increasing the overall population. These results strongly support policy strategies under Saudi Vision 2030 that prioritize education, vocational training, and the attraction of skilled migrants as fundamental pillars for sustainable economic diversification and long-term prosperity.

Table 12: Supply of endowments

Supply of Endowments	**Rest of World**	**GCC**	**Saudi Arabia**
UnSkLab	0.06	0.12	1.53
SkLab	0	0	20
Capital	0.06	0.11	1.85

7. Discussion

In this study, three different scenarios are examined to assess the economic impacts of population changes on macroeconomic variables, sectoral outputs, and welfare in the context of Saudi Arabia, the GCC region, and the Rest of the World. Each scenario provides insights into the interaction between population changes, labor, capital, and production capacities, leading to varying economic outcomes. Scenario 1 focuses on the impact of a 43% increase in population while keeping labor and capital fixed. This approach assumes that the labor force and capital stock cannot adjust to the growing population, highlighting the strain on existing resources. According to Table 2, the nominal GDP of Saudi Arabia increases marginally by 0.04%, but the trade balance worsens due to higher imports (Table 3). The regional income decreases slightly, suggesting that the economy cannot fully absorb the shock of an expanding population without the necessary adjustments in labor and capital. The rest of the world also sees a slight decrease in nominal GDP and trade balance, with a loss of 504 million USD. Previous studies, such as those by Al-Faisal (2019) and Al-Mousa et al. (2017), also found that population increases with fixed capital and labor stocks lead to reduced welfare and productivity, as the economy struggles to meet the growing demand. Output and productivity gains can be observed only in agriculzature, food and textial sectors which rises subtinally with aggregate demand of the growing population, while other strategic visosn 2030 sectors are losing due to allocative resource allocation and shift of resources towards booming food related sectors.

In Scenario 2, the population increases by 43%, but labor and capital are allowed to adjust, resulting in endogenous shifts in both. This scenario assumes that skilled labor, unskilled labor, and capital can adjust toward a new equilibrium, offering a more flexible response to the population shock. Table 5 shows that nominal GDP in Saudi Arabia decreases by 0.42%, while the trade balance worsens significantly, with a loss of 2.8 billion USD. Despite this, the real GDP drops slightly less, indicating

some adjustment in the productive capacities. Table 6 highlights that certain sectors, particularly oil and gas, face reduced output, while sectors like grains crops and processed food experience a positive output change. However, the overall welfare decomposition in Table 7 shows a negative impact, with Saudi Arabia seeing a substantial welfare loss due to increased costs in labor and capital adjustments, as well as lower export demand. This result is supported by the work of El-Shafie (2018), who emphasizes the role of capital and labor flexibility in mitigating negative economic impacts, but also points to the potential for imbalances and inefficiencies during such transitions. Al-Dosari et al. (2020) similarly found that regions allowing for labor and capital flexibility often face long-term adjustments that temporarily depress output and trade.

In first 2 scenarios, Output and productivity gains are primarily observed in the agriculture, food, and textile sectors, which experience substantial growth due to the increased aggregate demand driven by the growing population. However, other sectors aligned with Vision 2030 are facing declines, as resources are reallocated towards the booming food-related industries. This shift in resource allocation reflects the challenges of balancing economic priorities, where sectors vital to long-term strategic goals are negatively impacted by short-term demographic pressures.

Scenario 3 shifts the focus to a 20% increase in skilled labor, keeping unskilled labor and capital endogenous. This scenario examines how a more skilled labor force impacts macroeconomic variables. Table 9 reveals that Saudi Arabia experiences a notable increase in nominal GDP (3.8%) and real GDP (2.12%) following the shock, with a significant improvement in regional income. This is reflective of the higher productivity that comes from a skilled labor force. Table 10 indicates a substantial improvement across multiple sectors, particularly in manufacturing and technology, where skilled labor has a direct effect on output. The welfare decomposition in Table 11 demonstrates that Saudi Arabia sees a large positive welfare change of 25.2 billion USD, driven by increased productivity and export competitiveness. These results align with studies by Al-Hassan and Al-Sabah (2021), who argue that investments in skilled labor yield significant returns in terms of productivity growth, especially in sectors dependent on technology and innovation. Additionally, empirical studies by Al-Bassam (2016) suggest that economies with higher-skilled labor forces are more resilient to population shocks and can sustain higher growth rates even during adverse conditions.

These results are consistent with global findings on the economic effects of labor adjustments to population shocks. For instance, studies by Aghion et al. (2007) and Abbas and Sayed (2015) show that flexible labor markets can mitigate some of the negative impacts of rapid population growth, particularly in developing economies, by adapting to new market conditions. On the other hand, fixed labor and capital stocks exacerbate the challenges posed by population increases, as observed in Scenario 1. Moreover, in the context of GCC economies, where the labor force is often dependent on foreign workers, the ability to adjust labor supply is crucial for maintaining stability. As noted by Al-Khouri (2020), such regions experience heightened vulnerability to demographic shifts, and policies aimed at enhancing labor mobility and capital investment are key to minimizing negative economic outcomes.

8. **Conclusion**

This study examined the economic effects of a 43% population increase under three scenarios: fixed labor and capital, endogenous labor and capital, and a 20% increase in skilled labor. The results showed that, in Scenario 1 with fixed labor and capital, population growth led to modest economic changes, with slight losses observed in sectors not aligned with Vision 2030, particularly due to inefficient resource allocation.

Scenario 2, with endogenous labor and capital, showed more significant economic contraction, particularly in Saudi Arabia, where a reallocation of resources towards agriculture and food sectors further hurt Vision 2030 sectors. The welfare impacts were largely negative, reflecting inefficiencies in resource distribution.

Scenario 3, with a 20% increase in skilled labor, produced the most positive outcomes. Skilled labor boosted productivity, especially in sectors like food, textiles, and health, leading to growth in nominal GDP, regional income, and sectoral output. Welfare outcomes were notably more favorable, with improvements in allocative efficiency and technological advancements.

Overall, the study emphasizes the importance of skilled labor and efficient resource allocation in mitigating the negative effects of population growth. Policymakers should focus on these factors to achieve sustainable economic growth and support long-term strategic goals like those outlined in Vision 2030.

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