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Enhancing economic diversification in Mongolia: an input–output analysis

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ABSTRACT

The Mongolian economy relies heavily on mineral exports, making it highly vulnerable to external demand and price shocks. Economic diversification is essential to reducing this dependency and enhancing resilience. This study aims to identify key sectors in the Mongolian economy and discuss their potential for economic diversification. An input-output analysis was conducted using the input-output table for 2018, employing backward and forward linkages along with multiplier analysis. The findings highlight energy and manufacturing are key sectors due to their strong linkages and multiplier effects on output, employment, and value-added. In contrast, finance and mining significantly contribute to labour productivity, while labour-intensive public sectors, including education, arts, health, and public administration, play a critical role in household income generation. Prioritizing investments in manufacturing and energy is crucial, as these sectors positively impact upstream sectors by adding value to mineral and livestock-based commodities, thereby playing a vital role in diversification efforts.

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1. Introduction

Since the early 2000s, Mongolia has undergone a significant economic transformation, shifting from an agriculture-based economy to one largely driven by mineral resources. This transition is evident in the increasing dominance of the mining sector, which has accounted for over 90% of total exports and contributed around 20% to the country's GDP by the end of 2022. In parallel, the non-tradable sectors, including services and construction, have seen a steady rise in their share of GDP over the past decade. However, this rapid growth and concentration in the mining and service

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sectors have introduced certain challenges, notably the emergence of Dutch Disease (Tserendorj and Purevjav 2012; Lkhanaajav 2016; Khan and Gottschalk 2017; Li, Gupta, and Yu 2017; Baatarzorig, Galindev, and Maisonnave 2018; Taguchi and Ganzorig 2018; Dagys et al. 2020; Jayanthakumaran and Bari 2021).

The Mongolian economy's heavy dependence on mineral exports, including coal, copper concentrate, and iron ore, has rendered it highly vulnerable to external shocks in demand and price fluctuations (Baatarzorig, Galindev, and Maisonnave 2018; Batdelger et al. 2018; Athukorala et al. 2020). Volatility in global commodity markets can significantly impact export revenues, government finances, and overall economic stability. This reliance on a single sector diminishes the economy's resilience to external shocks. Furthermore, the dominance of the mining and service sectors has frequently occurred at the expense of traditional sectors, further deepening the challenges associated with the lack of economic diversification.

To address the challenges arising from the dominance of the mining sector and to ensure long-term economic stability and sustainability, Mongolia must prioritize economic diversification efforts (Forneris et al. 2018; Athukorala et al. 2020). Taguchi (2018) emphasized that industrial diversification is vital for sustaining economic growth by enhancing resilience to resource sector volatility. Similarly, Davaasuren et al. (2018) highlighted the critical mid-term role of the manufacturing sector in driving economic development. Directing foreign direct investment (FDI) toward manufacturing, specifically processing industries, is essential. This includes light industries focused on livestock-based commodities and heavy industries centred on mineral commodities.

This article aims to determine diversification priorities within the Mongolian economy by analysing sectoral linkages and identifying key sectors using the Input–Output methodology. The analysis specifically examines backward and forward linkages across sectors and conducts a multiplier analysis. It utilizes the 53×53 Input–Output table and sectoral employment data for 2018. Additionally, 11×11 Input–Output tables from 2010 to 2019 are employed to assess the stability of technical coefficients, while the 20×20 Input–Output table is also used to validate the robustness of the analysis.

Input–Output analysis, originally introduced by Wassily Leontief, is the key framework for investigating the interrelationships between sectors within an economy (Yan 1969; Leontief 1986; Raa 2005; Miller and Blair 2009). Building upon Leontief's seminal work, scholars such as Rasmussen (1957), Hirschman (1958), Chenery and Watanabe (1958), and Ghosh (1958) have expanded the theoretical foundations and methodologies for analysing input-output linkages and identifying key sectors, thereby significantly advancing the field of Input–Output analysis.

Several studies have applied the Input–Output framework to explore various aspects of the Mongolian economy. For instance, Tungalag et al. (2019) analysed the impacts of the copper mining subsector on other sectors using a 55×55 Input–Output table, emphasizing the sector's significant role in the national economy. Similarly, Zagdbazar, Begz, and Tuvshintugs (2018) investigated the effects of Foreign Direct Investments (FDI) by estimating the output shares, sectoral value-added contributions, and total investment multipliers based on Input–Output Tables from 2010

to 2015, concluding that investment multipliers varied significantly across sectors due to structural shifts and differences in FDI allocation. Munkhtsetseg and Gantumur (2011) employed Input–Output tables spanning 2010–2013 to assess the impacts of FDI in the mining sector on economic growth, highlighting its positive influence. Additionally, Guo et al. (2020) used a multiregional Input–Output model to estimate greenhouse gas (GHG) emissions and utilised a structural decomposition analysis to identify key drivers of GHG emissions. Despite these contributions, none of these studies specifically applied the Input–Output methodology to analyse sectoral linkages and identify key sectors in the Mongolian economy.

The contribution of this article to the literature is twofold. First, it focuses on Mongolia, a resource-rich country with an economy heavily dependent on the mining sector, highlighting the crucial need for economic diversification. While extensive research exists on other resource-rich countries, such as those by Abdulrahman, Ibrahim, and Muammer (2022), Alsharif, Bhattacharyya, and Intartaglia (2017), Lashitew, Ross, and Werker (2021), Ross and Werker (2024), there remains a notable gap in the literature concerning Mongolia. Second, this article applies input-output and multipliers analysis to propose economic diversification priorities at the sectoral level within Mongolia. Although these methodologies have been widely employed in studies of other countries, such as Stilwell et al. (2000), Sabiroglu and Bashirli (2012), Temursho (2016), San Cristóbal and Biezma (2006), Marconi, Rocha, and Magacho (2016), Kim, Kim, and Yoo (2020), there is a lack of research specifically applying these approaches to the Mongolian case.

The remainder of the article is structured as follows. Section 2 provides an explanation of the data utilised in the analysis and describes the theoretical framework employed for identifying key sectors and analysing sectoral linkages. Section 3 presents the results of the analysis. Section 4 concludes the article and summarising the key findings, and Section 5 outlines the policy implications.

2. Materials and methods

2.1. Theoretical framework

Backward and forward linkages represent the economic effects of production in a specific sector on other sectors and serve as key measures for analysing intersectoral relationships (Hirschman 1958; Miller and Blair 2009).

Backward linkages (BL) represent the inputs or purchases a sector requires from other sectors to support an increase in its output, reflecting the demand for goods from these upstream sectors. In other words, backward linkages measure the extent of interconnectedness between sector i and the upstream sector j, from which it sources inputs. This concept operates as a demand-side model, where the impact on upstream sectors occurs through the influence of backward linkages, which is given by Equation (1) (Miller and Blair 2009).

$$BL = \sum_{i=1}^{n} l_{ij} \tag{1}$$

where: l_{ij} represents the $n\ x\ n$ matrix of the Leontief inverse $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$; $\mathbf{I}$ is the identity matrix; $\mathbf{A}$ is a matrix of technical coefficients a_{ij}, representing the amount of inputs required from other sectors to produce one unit output.

Forward linkages refer to the products or outputs of a sector that are used as inputs by other sectors, reflecting the interconnectedness of sector i with the downstream sector j to which it supplies its outputs. This concept captures the supply-side relationships within an economy, where the influence on downstream sectors occurs from the flow of goods and services facilitated by forward linkages. Mathematical formulation of forward linkages is provided in Equation (2) (Miller and Blair 2009).

$$FL = \sum_{\boldsymbol{j}=1}^{\mathbf{n}} g_{ij} \tag{2}$$

where: g_{ij} represents the nxn matrix of the Ghosh inverse $\mathbf{G} = (\mathbf{I} - \mathbf{B})^{-1}$; $\mathbf{I}$ is the identity matrix; $\mathbf{B}$ is a matrix of allocation coefficients b_{ij}, representing the amount of a sector's output allocated as inputs to other sectors.

The presence of strong backward and forward linkages signifies a high degree of interdependence between sectors, resulting in substantial effects on other sectors. By comparing the magnitudes of backward and forward linkages across sectors, it becomes possible to identify "key" or "leading" sectors within the economy. Specifically, if the backward linkage of sector i exceeds that of sector j, an increase in the output of sector i would exert a greater impact on the economy compared to an equivalent increase in the output of sector j, as it generates a higher demand for inputs from other sectors. Conversely, if the forward linkage of sector i surpasses that of sector j, the expansion of output in sector i is more vital for the economy than an equal expansion of sector j, given its role in supplying goods to other sectors (Hirschman 1958; Miller and Blair 2009).

Rasmussen (1957) proposed normalizing average linkages as an index to facilitate inter-sectoral comparisons. The index, referred to as the *index of power dispersion*, quantifies "*the relative extent to which an increase in final demand for the products in a sector is dispersed throughout the system of industries*." The normalized linkages equations are given in Equations (3) and (4).

Normalized backward linkages (NBL):

$$NBL = \frac{\frac{1}{n}\sum_{\boldsymbol{i}=1}^{\boldsymbol{n}} l_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{\boldsymbol{j}=1}^{\boldsymbol{n}} l_{ij}} \tag{3}$$

Normalized forward linkages (NFL):

$$NFL = \frac{\frac{1}{n}\sum_{\boldsymbol{j}=1}^{\boldsymbol{n}} g_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{\boldsymbol{j}=1}^{\boldsymbol{n}} g_{ij}} \tag{4}$$

where: n is the number of sectors.

Based on the NBL and NFL indices, the relationship of a sector with other sectors within the economy can be determined as follows:

- NBL $>$ 1 and NFL $>$ 1 identifies key or leading sectors, which exhibit strong relationships with other sectors in terms of both output supply and input demand.
- NBL $>$ 1 and NFL $<$ 1 identifies strong backward linkage sectors, which strongly rely on inputs supplied from other sectors.
- NBL $<$ 1 and NFL $>$ 1 identifies strong forward linkage sectors, which are dependent on the demand for their outputs from other sectors.
- NBL $<$ 1 and NFL $<$ 1 identifies weak linkage sectors, which demonstrate minimal dependence or weak interconnections with other sectors.

In addition to analysing linkages, multiplier analysis is employed to identify key sectors. Following the methodology outlined by Miller and Blair (2009), this analysis assesses the impacts of exogenous changes in the final demand of sectors on several economic indicators. These indicators include sector outputs, employment levels, value-added contributions, and labour productivity, and household income generation.

Multiplier analysis estimates the changes in these indicators resulting from an increase in the final demand of a specific sector, such as sector j, by a given amount. For this study, the scenario assumes an exogenous increase in sector j's final demand by USD 10 million.

The output multiplier ($m(o)_j$) represents the total value of production from other sectors that is required to satisfy the additional final demand generated by an increase in sector j's output.

$$m(o)_j = \sum_{i=1}^{n} l_{ij}$$

where l_{ij} is the nxn matrix of the Leontief inverse (**L** matrix).

The income multiplier ($m(h)_j$) represents the increase in household income earnings that occurs as a result of the additional final demand in sector j.

$$m(h)_j = \sum_{i=1}^{n} a_{n+1,i} l_{ij} \tag{5}$$

where $a_{n+1,i}$ is the $n+1$th row of a matrix of technical coefficients (**A** matrix) which indicates the wages earned by households.

The employment multiplier ($m(e)_j$) represents the number of jobs that are created as a result of the additional final demand in sector j.

$$m(e)_j = \sum_{i=1}^{n} a_{n+2,i} l_{ij} \tag{6}$$

where $a_{n+2,i}$ is the $n+2$th row of a matrix of technical coefficients (**A** matrix) which indicates labour-input coefficients, i.e. the number of employees.

The value-added multiplier ($m(v)_j$) indicates the increase in value-added as a result of the additional final demand in sector j.

$$m(v)_j = \sum_{i=1}^{n} v_{ij} l_{ij} \tag{7}$$

where v_{ij} is the share of value added in total output

Labour productivity (P_L) is defined as the ratio of output to direct labour (De Juan and Febrero 2000), capturing the efficiency of labour inputs utilisation in the production of goods and services across different sectors. In this study, changes in labour productivity for the entire economy are measured as a percentage, considering the changes in total value-added and total employment resulting from an increase in the final demand in sector j. This approach facilitates the assessment of how sector-specific changes in final demand influence the overall labour productivity of the economy.

$$P_L = \frac{'\boldsymbol{v}}{'\boldsymbol{e}} \tag{8}$$

where $'\boldsymbol{v}$ is the row vector of value added

$'\boldsymbol{e}$ is the row vector of employment

2.2. Data

This article utilizes the 53×53 Input–Output table and sectoral employment data for the year 2018 (National Statistics Office of Mongolia (NSO)), 2022a). The original Input–Output tables used in this study were presented in Mongolian Tugrik (MNT) at current prices. To ensure consistency and enhance clarity for international readers, the data were converted into USD at 2010 constant prices. The conversion utilized the GDP deflator and exchange rate data sourced from the World Bank's database (World Bank 2022a, 2022b).

The stability of the technical coefficients of the **A** matrix (a_{ij}), has been a topic of discussion among scientists (Christ 1955; Carter 1970; Middelhoek 1972; Ozaki 1972; Sevaldson 1972; Vaccra 1972; Baster 1980; Bess and Ambargis 2011; Dobrescu 2013). In Input-output models, it is typically assumed that inputs are used in fixed proportions without any substitution, implying that the ratios of labour, capital, and intermediate inputs to output remain constant over time. Under the given assumption, the coefficients of the **A** matrix should exhibit stability (Yan 1969; Carter 1970; Leontief 1986; Raa 2005; Eurostat 2008; Miller and Blair 2009). To assess the stability of the technical coefficients, the Levin, Lin, and Chu (LLC) unit-root test (Levin, Lin, and James Chu 2002) was conducted. This test provides a measure of the stationarity of the coefficients, which is essential for ensuring the reliability and validity of the Input–Output analysis.

The stability of the coefficients of the **A** matrix was tested using 11×11 input–output tables of 2010–2019 (National Statistics Office of Mongolia (NSO)), 2022b, 2022c). The test results suggest that the technical coefficients of Mongolia's Input–Output tables during this period were stationary, indicating consistency and minimal fluctuations over time. However, the sector of Education, professional, scientific, and technical activities (*Ed*) showed a different pattern, with its technical coefficients

declining in recent years. This decline may reflect structural changes in the economy. The detailed test results are provided in Appendix 1.

To assess the robustness of the main linkages analysis based on the 53 × 53 Input–Output table from 2018, backward and forward linkages were re-estimated using the 20 × 20 Input–Output table from 2019 (National Statistics Office of Mongolia (NSO)), 2024), and compared with the main results. The selection of the 2019 Input–Output table was guided by its status as the largest recent publicly available 20 × 20 table and its broader sectoral classification, achieved by consolidating 53 sectors into 20. This consolidation is well-suited for testing the robustness of the analysis using a broader sectoral classification. Economic conditions in 2018 and 2019 were considered representative of 'normal' years, with growth rates approximating the long-term average for 2000–2023. Unlike the mining boom period of 2008-2016, 2018 and 2019 marked a return to steady growth. World Bank estimates indicate that Mongolia's economy grew by 7.7% in 2018 and 5.6% in 2019, compared to the long-term average growth rate of 6.2% for the period 2000-2023 (World Bank 2024). Therefore, the data from these 'normal' years provide a reliable basis for understanding the evolution of sectoral linkages and identifying critical sectors for economic diversification. The results of the 2019 backward and forward linkages analysis are included in Appendix 3, while a matching table detailing the correspondence between the 20 sectors in 2019 and the 53 sectors in 2018 is provided in Appendix 4.

3. Results

3.1. Relationships between sectors

Table 1 reveals the numerical results of the backward and forward linkage analysis, highlighting the ten sectors with the highest backward and forward linkages. These

Table 1. Top ten sectors in terms of backward and forward linkages in 2018.

	Backward linkages		Forward linkages	
Rank	Sector	Linkages	Sector	Linkages
1	Manufacture of textiles	2.13	Electricity, gas, steam and air conditioning supply	2.78
2	Electricity, gas, steam and air conditioning supply	1.93	Water supply, sewerage management	2.73
3	Manufacture of food products	1.89	Manufacture of coke and refined petroleum products	2.61
4	Water supply, sewerage management	1.84	Postal and courier activities	2.33
5	Forestry and logging	1.81	Repair and installation of machinery and equipment	2.28
6	Manufacture of other non-metallic mineral products	1.79	Manufacture of other non-metallic mineral products	2.27
7	Manufacture of wearing apparel	1.76	Manufacture of wood and of wood products	2.23
8	Accommodation and food service activities	1.76	Financial service activities	2.09
9	Mining support service activities	1.69	Manufacture of rubber and plastics products	2.08
10	Administrative and support service activities	1.65	Mining support service activities	2.01

linkages provide an overview of the interconnections between sectors within the economy.

The backward linkages statistics reveal the amount of inputs required from other sectors to satisfy an additional USD increase in the final demand of a specific sector. For instance, in the electricity, gas, steam and air conditioning supply sector, an additional USD increase in final demand required USD 1.93 worth of inputs from other sectors.

Forward linkages statistics, on the other hand, indicate the value of products available for use as inputs by other sectors as a result of an additional output of one dollar in a particular sector. For instance, in the electricity, gas, steam and air conditioning supply sector, a forward linkage value of 2.78 indicates that an additional USD 1 of output in this sector generated USD 2.78 worth of products for use by other sectors as inputs.

Figure 1 presents the results of the analysis on normalized backward and forward linkages, which helped to identify key sectors. The sectors with strong linkages and considered key sectors are shown in Plot I. Forward-oriented sectors, which are dependent on the demand of other sectors, are presented in Plot II. Backward-oriented sectors, which rely on the supply of other sectors, are depicted in Plot III.

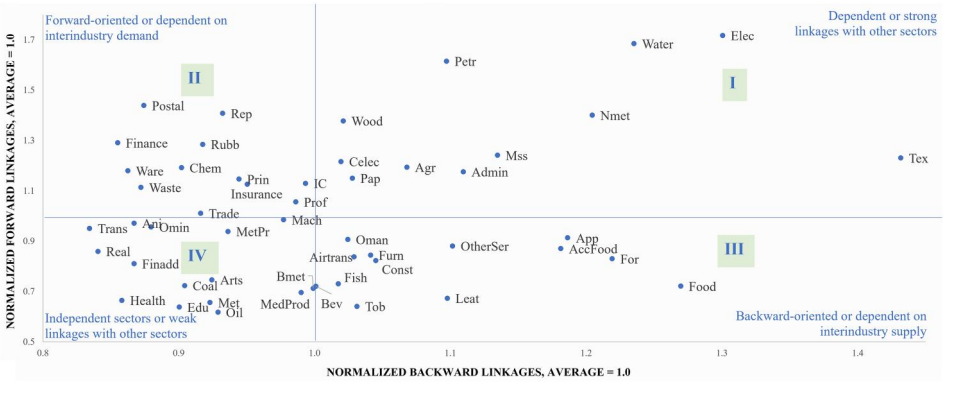

Figure 1. Backward and forward linkages in 2018.

Note. Agr: Crop production; Ani: Animal production; For: Forestry and logging; Fish: Fishing; Coal: Mining of coal and lignite; Oil: Extraction of crude petroleum and natural gas; Met: Mining of metal ores; Omin: Other mining and quarrying; Mss: Mining support service activities; Food: Manufacture of food products; Bev: Manufacture of beverages; Tob: Manufacture of tobacco products; Tex: Manufacture of textiles; App: Manufacture of wearing apparel; Leat: Manufacture of leather and related products; Wood: Manufacture of wood and of wood products; Pap: Manufacture of paper and paper products; Prin: Printing and reproduction of recorded media; Petr: Manufacture of coke and refined petroleum products; Chem: Manufacture of chemicals and chemical products; Rubb: Manufacture of rubber and plastics products; Nmet: Manufacture of other non: metallic mineral products; Bmet: Manufacture of basic metals; MetPr: Manufacture of fabricated metal products; Celec: Manufacture of computer, electronic and optical products; Mach: Manufacture of machinery and equipment; Furn: Manufacture of furniture; Oman: Other manufacturing; MedProd: Manufacture of medical and dental instruments and supplies; Rep: Repair and installation of machinery and equipment; Elec: Electricity, gas, steam and air conditioning supply; Water: Water supply, sewerage management; Waste: Waste management and remediation activities; Const: Construction; Trade: Wholesale and retail trade; Trans: Land and water transport; Airtrans: Air transport; Ware: Warehousing and support activities; Postal: Postal and courier activities; AccFood: Accommodation and food service activities; IC: Information and communication; Finance: Financial service activities; Insurance: Insurance, reinsurance and pension funding; Finadd: Activities auxiliary to financial; Real: Real estate activities; Prof: Professional, scientific and technical activities; Admin: Administrative and support service activities; Public: Public administration and defence; Edu: Education; Health: Human health and social work activities; Arts: Arts, entertainment and recreation; OtherSer: Other service activities; Other: Other activities.

Lastly, independent sectors with weak linkages to other sectors are displayed in Plot IV. Below, the notable findings from the analysis are highlighted.

The key sectors, which are dependent on both the demand and supply of other sectors, include subsectors belonging to the energy, manufacturing, mining support service activities, and crop production. These sectors exhibit strong relationships with other sectors.

The energy sector, encompassing electricity, gas, steam, air conditioning, water supply, and sewerage management, holds significant importance due to its strong relationships with other sectors. It relies on inputs like coal for electricity production, as domestically generated energy primarily comes from coal-fired power plants, while its outputs – electricity, gas, water supply, and public utilities – serve essential resources for other sectors. The sector's importance in driving economic activities is clear, with strong linkages to other sectors. Similarly, crop production also demonstrates strong connectedness with other sectors. This sector is reliant on energy, fuel, and chemicals sourced from upstream sectors while supplying key commodities to downstream sectors like wheat flour industries, food processing, accommodation, and food service subsectors. These insights are valuable for policymakers aiming to foster economic growth and sustainability.

Regarding the backward-oriented sectors, the findings highlight the strong reliance of manufacturing subsectors, such as food production, apparel, and leather goods, on inputs from the livestock sector, including meat, milk, leather, wool, and cashmere. The quality and availability of these inputs directly affect manufacturing outputs. In turn, developing the manufacturing sector can stimulate demand for livestock products. However, the underdevelopment of the manufacturing sector limits demand for livestock-derived products. Therefore, investing in processing industries for animal-originated commodities, like food, wool, and leather, can increase the demand for primary livestock products. For example, while Mongolia has potential for meat production and export, the inability of abattoirs to meet international standards hinders exports. Similarly, poor compliance with slaughtering standards affects the quality of hides and skins for leather production. A targeted policy to improve standards, build capacity, and implement good practices in slaughtering plants could enhance exports and foster the growth of both the manufacturing and agricultural sectors, contributing to economic diversification and expansion.

Some service subsectors, including postal services, finance, printing, insurance, and trade, exhibit strong forward linkages, relying heavily on demand from other sectors. For instance, the trade sector depends on manufacturing (e.g. food and textiles), mining (e.g. coal and metal ores), and construction, while finance and insurance are closely tied to animal husbandry, mining, and construction. Strengthening key industries such as coal, metal ores, animal husbandry, and manufacturing, particularly through value addition and increased participation in global value chains, can significantly enhance the performance of forward-oriented service sectors. According to Hirschman (1958), the strength of forward linkages depends on the demand generated by downstream sectors, which directly influences the performance of these forward-oriented sectors.

On the other hand, several sectors, including parts of the public sector, certain mining subsectors, agriculture, and real estate activities, have been identified as independent or weak linkage sectors. The public sector, primarily focused on non-productive activities, does not heavily engage in input sourcing or contribute substantially to supply chain dynamics. Mining subsectors, including coal and lignite, crude petroleum and natural gas, and metal ores have weak linkages with other sectors despite their significant contributions to Mongolia's exports (about 90%) and GDP (20%). This is due to limited backward and forward linkages. On the backward linkage side, mining relies on imported inputs like electricity and fuel, reducing its dependence on domestic suppliers. Notably, the Gobi region, Mongolia's major mining area, sources over 90% of its electricity from China (Energy Regulatory Commission of Mongolia 2019; Oyunchimeg et al. 2020), further weakening its backward linkages with the domestic energy sector. Conversely, the electricity sector itself is highly dependent on coal, highlighting a significant interdependence within Mongolia's energy production.

Regarding forward linkages, the mining sector predominantly exports raw materials like coal, copper concentrate, and iron ore, with little to no domestic processing or value-addition. This direct export approach further limits the mining sector's linkages with downstream sectors, as there is minimal engagement with other industries for value addition or manufacturing processes. To enhance the interrelationships of the mining subsectors with other sectors, it is crucial to prioritize domestic value addition. This can involve the processing or semi-processing of raw materials prior to export. Although such endeavours often require substantial investments due to the high-tech nature of the processing, they represent a critical pathway for achieving sustainable, long-term economic development. By engaging in domestic value-adding activities, such as producing refined copper or metals, the mining sector can establish stronger interconnections with other sectors, including manufacturing, construction, and energy.

The results of robustness test for the backward and forward linkages of industries based on the 20×20 input-output table from 2019 corroborate the primary findings derived from the 53×53 table. The energy sector, including electricity, gas, steam, water, sewerage, and waste, is highly interconnected with other sectors in terms of both backward and forward linkages, consistent with the main results. Similarly, the manufacturing and construction sectors are backward-oriented, reflecting their high dependency on inputs from upstream industries, while finance and trade-related sectors exhibit forward-oriented, relying significantly on demand from downstream industries. Mining and public-related sectors (such as education, public administration, and health) show independent or weak linkages with other sectors. All these results are consistent with the main findings. However, the agricultural sector, including livestock and crop production, now appears in the forward-oriented sectors' plot in the robustness test. This change may primarily be due to the individual linkage results of crop and animal production activities, where animal husbandry was independent and crop production was strongly related to other sectors. Overall, the robustness test underscores the validity of the original results from the 53×53 table, as they align with the broader sectoral classification.

3.2. Multiplier analysis

This section provides the results of multiplier analyses based on scenario analysis, demonstrating the potential changes in various economic indicators resulting from a UDS 10 million increase in final demand within a specific sector. The analysis is based on the input-output table of 2018.

The effects of an increase in final demand for each sector on the national economy are outlined below, highlighting the top ten sectors that have the most significant impact. The complete effects of all 53 sectors on the economy can be found in Appendix 2.

The analysis covers the following economic indicators: total output, household income, employment, value-added, and productivity. By examining these effects, the study offers valuable insights into how an increase in sector-specific final demand may influence broader economic dynamics, providing valuable information for policymakers and other stakeholders.

3.2.1. Output multiplier ($m(o)_j$)

Figure 2 shows the impact of a USD 10 million increase in the final demand across different sectors on the total output of the economy. Key sectors exhibiting a significant increase in output include textile manufacturing (Tex), electricity, gas, steam, and air conditioning supply (Elec), and food products manufacturing (Food), among others.

An increase in final demand for textile manufacturing (Tex) by USD 10 million would boost the total output of the economy by 0.15%, *ceteris paribus*. As shown in Table 1 and Figure 1, the textile manufacturing sector exhibits the strongest backward linkages, indicating that growth in its final demand has a more pronounced impact on the overall economy than other sectors. This sector primarily processes cashmere,

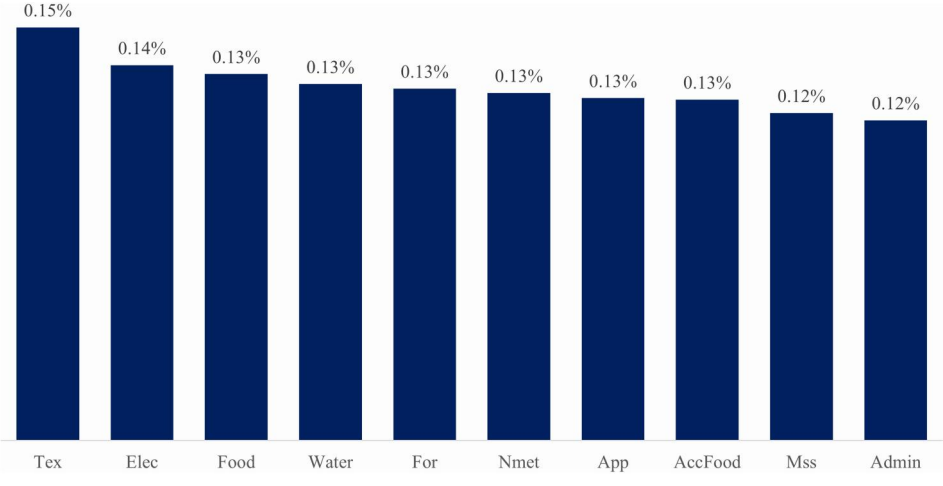

Figure 2. Percentage changes in total output.

Note. Tex: Manufacture of textiles; Elec: Electricity, gas, steam and air conditioning supply; Food: Manufacture of food products; Water: Water supply, sewerage management; For: Forestry and logging; Nmet: Manufacture of other non: metallic mineral products; App: Manufacture of wearing apparel; AccFood: Accommodation and food service activities; Mss: Mining support service activities; Admin: Administrative and support service activities.

camel wool, and yak wool into high-end products, contributing significantly to exports and supporting the livelihoods of nomadic herders. Future investments in processing sheep wool and horsehair, alongside existing textile factories, could further enhance the livestock sector's development and its economic contribution. Likewise, a USD 10 million increase in final demand for electricity, gas, steam, and air conditioning supply (Elec) and food products manufacturing (Food) would result in a 0.14% and 0.13% rise in total output, respectively, *ceteris paribus*. These sectors also demonstrate high output multipliers, underscoring their strategic importance in driving economic growth and development. Supporting and investing in these sectors is not only critical for economic development but also essential for ensuring national security, given the country's significant reliance on imports for electricity and food products.

The effects of changes in final demand for the remaining sectors are detailed in Appendix 2, with contributions to total output ranging from 0.07% to 0.13%.

3.2.2. Income multiplier ($m(h)_j$)

Figure 3 depicts the percentage change in household income earnings resulting from changes in the final demand across different sectors. The key sectors with a notable impact on household income include public sectors, including education (Edu), arts, entertainment, and recreation (Arts), and human health and social work activities (Health), among others.

The results suggest that a USD 10 million increase in the final demand for these public sectors would lead to household income growth ranging from 0.24% to 0.33%, *ceteris paribus*. This can be attributed to the fact that approximately 36% of salaried employees are employed in these public sectors (Edu, Arts, Health, and Public). As a result, these sectors have a substantial impact on household income generation and contribute to the overall economic well-being of Mongolia.

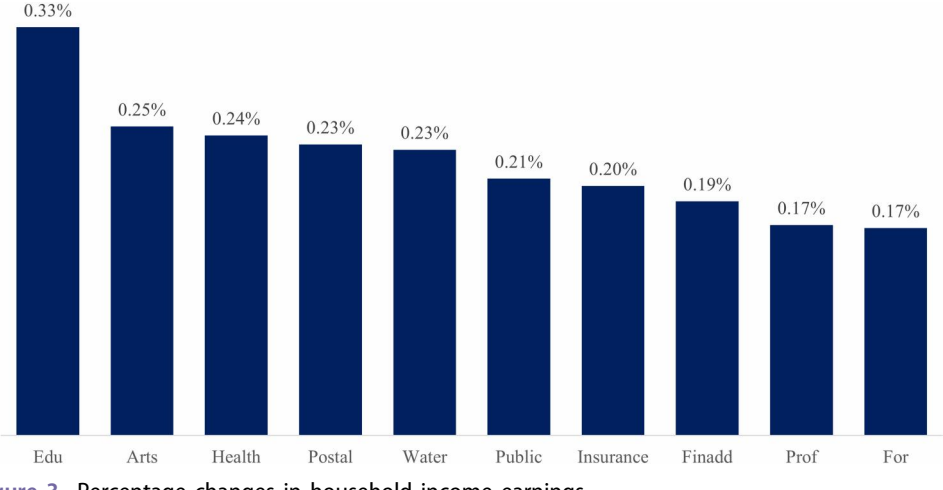

Figure 3. Percentage changes in household income earnings.

Note. Edu: Education; Arts-Arts, entertainment and recreation; Health: Human health and social work activities; Postal: Postal and courier activities; Water: Water supply, sewerage management; Public: Public administration and defence; Insurance: Insurance, reinsurance and pension funding; Finadd: Activities auxiliary to financial; Prof: Professional, scientific and technical activities; For: Forestry and logging.

Government expenditure, the state budget, public employee salaries, and household income are directly tied to the performance of key economic sectors and export earnings. Therefore, to boost household income, it is essential to diversify the economy by increasing export earnings and supporting the development of critical sectors, particularly the manufacturing industry.

The impacts of changes in final demand for other sectors are provided in Appendix 2, with their effects on household income earnings ranging from 0.04% to 0.24%.

3.2.3. Employment multiplier ($m(e)_j$)

One of the essential questions to consider is how changes in final demand affect job creation. Figure 4 shows the number of jobs created in the entire economy as a result of changes in final demand for each sector. Notably, key sectors contributing significantly to employment creation include subsectors of manufacturing, such as the manufacturing of machinery and equipment (Mach), medical and dental instruments and supplies (MedProd), coke and refined petroleum products (Petr), leather production (Leat), as well as the livestock sector (Ani), specifically animal production.

The analysis indicates that job creation is particularly pronounced in labour-intensive sectors. For example, a USD 10 million increase in final demand for the machinery and equipment manufacturing subsector (Mach) is expected to generate approximately 9061 jobs, *ceteris paribus*. This substantial job creation can be attributed to the sector's relatively small GDP size and its high labour dependency. Despite a total output of only USD 1.2 million, a USD 10 million increase in the final demand leads to a substantial number of jobs due to the labour-intensive nature of the sector. Out of the total of 9061 jobs created, around 8,731, or over 95%, are directly generated within this subsector.

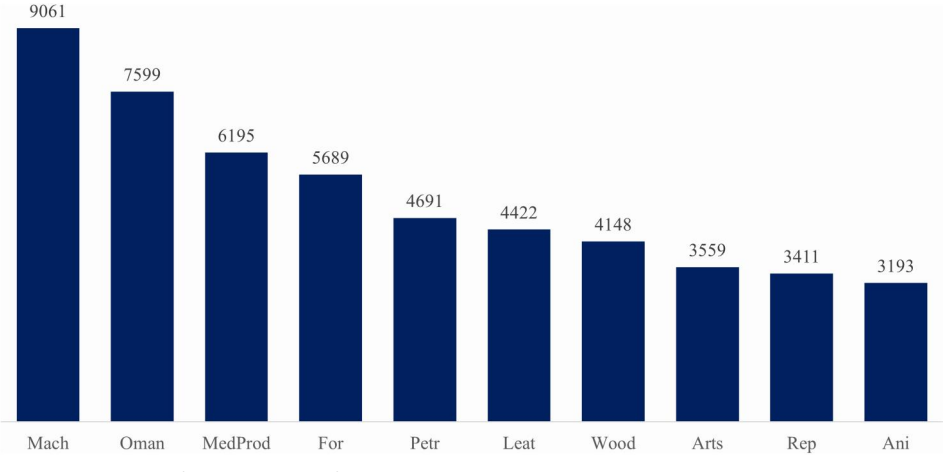

Figure 4. Increase of the number of jobs.

Note. Mach: Manufacture of machinery and equipment; Oman: Other manufacturing; MedProd: Manufacture of medical and dental instruments and supplies; For: Forestry and logging; Petr: Manufacture of coke and refined petroleum products; Leat: Manufacture of leather and related products; Wood: Manufacture of wood and of wood products; Arts: Arts, entertainment and recreation; Rep: Repair and installation of machinery and equipment; Ani: Animal production.

In contrast, the livestock sector, which is the largest employer in the country, contributes to nearly a quarter of all jobs in Mongolia. An increase of USD 10 million in final demand for this sector results in the creation of about 3,193 jobs across the economy. Out of these, around 2,970 jobs, or over 90%, are generated within the livestock sector itself.

The effects of changes in final demand for the remaining sectors on employment creation are detailed in Appendix 2, with the number of jobs created ranging from 205 to 3087.

It is important to note that the mining-related subsectors, such as coal and lignite mining, and the extraction of crude petroleum and natural gas, exhibit the lowest effects in terms of employment creation. This can be explained by the technology-intensive nature of these sectors, which rely less on labour inputs. Additionally, their relatively weak linkages with other sectors contribute to the lower employment effects within the economy.

To foster greater job creation, it is essential to invest in labor-intensive industries. Simultaneously, supporting downstream industries with strong backward linkages can generate employment in upstream sectors, playing a critical role in enhancing the structure and diversification of the economy.

3.2.4. Value-added multiplier ($m(v)_j$)

Figure 5 presents the impact of changes in final demand across sectors on value-added or GDP. Key sectors contributing to value-added growth include service subsectors (real estate (Real), financial service (Finance), and insurance activities (Insurance)), Education (Edu), as well as animal production (Ani), etc. The results suggest that a USD 10 million increase in the final demand for real estate activities, *ceteris paribus*, would lead to a 0.135% increase in the value-added of the economy. This highlights the significant role of the service sector, particularly driven by the mining and construction boom, in driving economic growth and contributing to

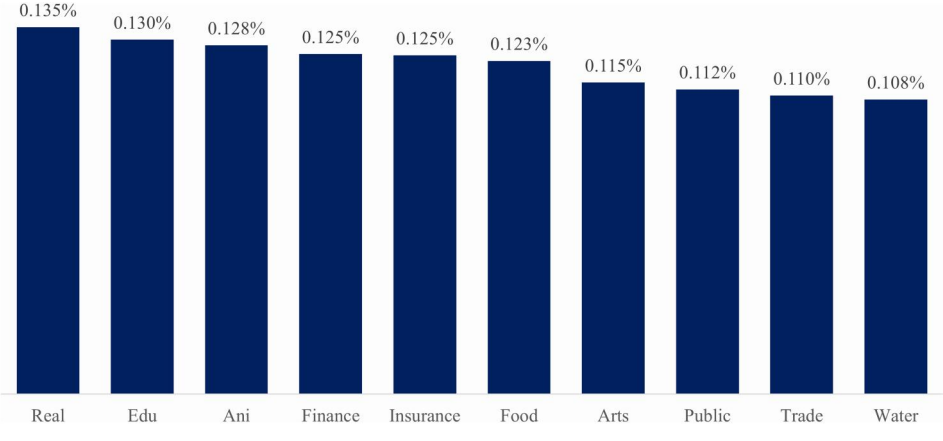

Figure 5. Value-added growth.

Note. Real: Real estate activities; Edu: Education; Ani: Animal production; Finance: Financial service activities; Insurance: Insurance, reinsurance and pension funding; Food: Manufacture of food products; Arts: Arts, entertainment and recreation; Public: Public administration and defence; Trade: Wholesale and retail trade; Water: Water supply, sewerage management.

overall value-added in the economy. As a result of the mining boom that began in 2006, the economic structure has undergone significant transformation, marked by a sharp expansion in non-tradable services sectors. This shift has led to a substantial increase in the contribution of these sectors to overall value-added, highlighting the growing prominence of services and construction in the economy.

In addition to the service sector, animal husbandry (Ani) and food manufacturing (Food) sectors play critical roles in generating value-added. This underscores the importance of supporting the value-added production of animal-derived raw materials such as cashmere, leather, and meat. Furthermore, the development of domestic manufacturing industries can also contribute to GDP growth. This is attributed to the fact that livestock raw materials constitute a significant portion of the total output in the manufacturing sector, with processed cashmere, wool, and leather making up the majority of non-mining exports. As highlighted in the previous analysis, fully processing livestock raw materials and positioning them in the global high-end market will be crucial for economic diversification.

The effects of changes in final demand for the remaining sectors on value-added are presented in Appendix 2, with contributions ranging from 0.056% to 0.108%.

3.2.5. Total labour productivity (P_L)

Figure 6 illustrates the changes in labour productivity of the economy resulting from an increase in final demand in various sectors. Key contributors to overall labour productivity growth include subsectors of financial activities (including real estate activities), mining subsectors (such as mining of metal ores, coal, extraction of crude petroleum and natural gas), and manufacturing of basic metals, among others. These sectors are characterised by their technology-intensive nature, requiring fewer employees compared to labour-intensive sectors. This lower demand for labour, coupled with the adoption of advanced technologies and efficient processes, results in higher labour productivity. The high-tech and capital-intensive operations enable

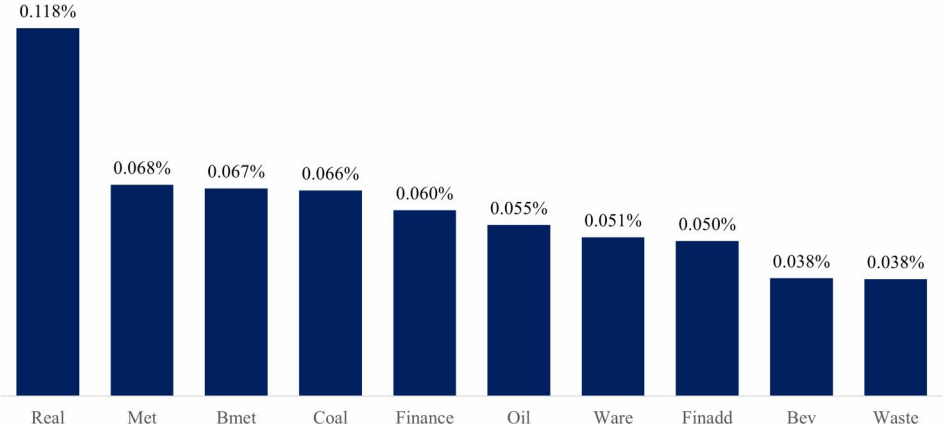

Figure 6. Changes in total labour productivity.

Note. Real: Real estate activities; Met: Mining of metal ores; Bmet: Manufacture of basic metals; Coal: Mining of coal and lignite; Finance: Financial service activities; Oil: Extraction of crude petroleum and natural gas; Ware: Warehousing and support activities; Finadd: Activities auxiliary to financial; Bev: Manufacture of beverages; Waste: Waste management and remediation activities.

these sectors to achieve greater output and value creation per employee, thereby enhancing economic efficiency and performance. Furthermore, value-adding to mineral commodities domestically and exporting higher-value-added products could further improve overall labour productivity and competitiveness of the economy.

The sector of real estate activities (Real) stands out as a significant contributor to labour productivity. A USD 10 million increase in the final demand for this sector is projected to raise total labour productivity by 0.118%, *ceteris paribus*. This sector is closely linked with the construction and energy sectors, and its relatively low labour intensity can be attributed to technological advancements and digitalisation. These factors collectively contribute to higher labour productivity, amplifying its impact on the economy when final demand in this sector increases. Therefore, to achieve economic diversification, it is crucial to enhance labor productivity across all sectors. This is particularly significant in labor-intensive industries, especially within the manufacturing sector. The adoption of new technologies in these sectors can lead to significant productivity gains, reducing the cost of production per unit. This, in turn, would improve the competitiveness of domestically produced goods in the global market, fostering sustainable growth and resilience in the economy.

The effects of changes in final demand on labour productivity for the remaining sectors are detailed in Appendix 2, with impacts ranging from −0.614% to 0.038%. Notably, some sectors exhibit a negative effect on labour productivity, which can be attributed to a disproportionate relationship between increases in value-added and job creation. Specifically, a USD 10 million increase in final demand for the manufacturing of machinery and equipment sector (Mach) would result in a 0.614% decline in labour productivity for the overall economy. This decline is primarily due to the sector's high reliance on labour, where the growth in employment significantly outpaces the increase in value added.

4. Conclusions

The study aimed to analyse the sectoral linkages and identify key sectors in the Mongolian economy using the Input–Output methodology. The analysis evaluated economic indicators such as total output, household income, employment, value-added, and productivity. By assessing how changes in final demand influence these indicators across sectors, the study provided insights into sectoral dynamics and their contributions to the economy.

The analysis reveals that the energy sector, encompassing subsectors such as electricity, gas, steam, air conditioning, water supply, and sewerage management, has the strongest interrelationships with other sectors in the Mongolian economy. Manufacturing subsectors such as food production, apparel, and leather are critical for backward linkages, relying heavily on inputs from other sectors. In contrast, service subsectors, including postal services, finance, printing, insurance, and trade, play significant roles in forward linkages. Some sectors, like public administration, mining, livestock, and certain service subsectors, are relatively independent due to weak linkages.

A multiplier analysis based on total output, household income, employment, GDP growth, and labour productivity highlights high output multipliers in manufacturing subsectors (textiles, food, apparel, and non-metallic minerals) and energy subsectors. Public sectors, including education, arts, health, public administration, and postal activities, are key contributors to household income. Key sectors driving employment include machinery and equipment manufacturing, medical and dental supplies, coke and refined petroleum products, and leather production. GDP growth is notably driven by real estate, financial services, insurance, trade, and public services such as education and administration. High labour productivity is observed in financial activities, particularly real estate, and mining sectors like metal ores, coal extraction, and petroleum.

Based on the findings from the analysis of linkages and multipliers, the key sectors identified are energy and manufacturing. These sectors are highlighted for their strong linkages with other sectors and their significant contributions to overall economic performance. The energy sector plays a vital role in supporting various industries and driving economic growth, while the manufacturing sector is crucial for generating value-added and creating jobs. The service sector, particularly real estate, education, and public administration, also contributes to GDP growth, employment, and income generation.

To summarize, the study confirms that expanding the manufacturing sector is important to overcome Dutch disease, while further development of the energy sector is crucial to achieving this goal.

This study focused on identifying key sectors for economic diversification through an analysis of inter-industry linkages and multipliers. The recommendations provided are based solely on these findings. However, economic diversification is a complex process that involves various factors. Future research should consider additional aspects, such as value chain development and value addition in key mineral and livestock commodities. Analysing opportunities for processing, refining, and manufacturing can help Mongolia leverage its comparative advantage for diversification. Additionally, examining the environmental, economic, and social impacts of developing processing industries and high-tech production would be valuable for informing sustainable diversification strategies. Incorporating these aspects into future research will assist policymakers and stakeholders gain a more comprehensive understanding of the economy's diversification potential.

The main analyses in this study were conducted using the 53×53 input-output table from 2018, supplemented by robust tests with the 20×20 table from 2019 and stability tests based on the 11×11 table spanning 2010–2019. The 53×53 table, being the most recent and comprehensive dataset available, served as the foundation for the analysis. However, the lack of publicly available comprehensive tables beyond 2019 underscores a key limitation of this study. Access to more detailed data, such as a 100×100 input-output table at the product level, would enhance the accuracy of capturing interdependencies among product-level production processes. This would enable a more detailed examination of economic diversification potential and allow for a precise assessment of opportunities at the product level.

5. Policy implications

The findings of this study carry important implications for economic policies aimed at diversifying the economy by reducing its vulnerability by lowering dependency on single-sector activities.

First, given the strong interconnectedness and crucial role of the energy sector in supplying utilities to all other sectors, it is essential to prioritize investments in this sector to ensure its sustainability. As highlighted by the Energy Regulatory Commission of Mongolia, the country's reliance on electricity imports from Russia and China signifies the need to focus on enhancing domestic energy production. Currently, approximately 20% of Mongolia's total electricity needs are imported. The Western region relies on Russia for over 70% of its electricity demand, while the Southern region, home to significant mineral deposits, depends on China for more than 90% of its electricity needs (Energy Regulatory Commission of Mongolia 2019; Oyunchimeg et al. 2020). This heavy reliance on energy imports poses both economic and national security risks. By replacing imported energy with domestically produced power, Mongolia can reduce the outflow of financial resources and improve its energy security. Enhancing domestic energy production will not only contribute to economic growth but also safeguard national security, as a stable and self-sufficient energy supply is essential for the functioning of any economy. Therefore, prioritizing investments in the energy sector, promoting domestic energy production, and reducing reliance on imports are critical steps toward ensuring the sustainability, resilience, and security of Mongolia's energy supply. This will also support the broader goal of economic diversification and development.

Second, the study emphasises the importance of developing the manufacturing sector as a critical step toward economic diversification. This finding aligns with the arguments of other researchers (World Economic Forum 2014; International Finance Corporation 2018; Davaajargal, Zheng, and Changxin 2019; Athukorala et al. 2020; Jayanthakumaran and Bari 2021). Given the positive impact that supporting the manufacturing sector has on economic diversification, it is essential for the government to prioritise this sector in its policies and initiatives. Supporting the manufacturing sector has multiple benefits for economic diversification. One of the key advantages is its positive effect on upstream sectors. Through processing and value-adding to mineral products and livestock-based commodities, the manufacturing sector stimulates demand for raw materials and intermediate inputs from these upstream sectors. This, in turn, creates market opportunities, stimulates the development of supply chains, and facilitates participation in global value-chains, leading to increased employment and income generation. Furthermore, promoting the production of processed, export-oriented products within the manufacturing sector is essential for deepening economic diversification. This shift allows Mongolia to move from being positioned at the upstream stage to a more value-added, downstream role in global value chains. To support the development of both the manufacturing and energy sectors, the government should implement policies that facilitate access to financing, promote research and development, improve infrastructure, and enhance the business environment. Additionally, it is crucial to offer targeted support and incentives to attract investments, foster entrepreneurship, and strengthen the capacity of local

manufacturers. Collaborative efforts between the government, private sector, and relevant stakeholders will be key in driving the growth, competitiveness, and sustainability of these sectors.

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Appendices

Appendix 1. Levin-Lin-Chu (LLC) unit-root test results for technical coefficients

	Without trend			With trend		
Variable	Unadjusted *t*	Adjusted *t*	*p*-value	Unadjusted *t*	Adjusted *t*	*p*-value
A	−8.64	−6.37	0.000***	−12.14	−6.01	0.000***
Mi	−6.04	−2.33	0.010***	−7.94	3.48	0.000***
Mn	−5.98	−1.88	0.030**	−9.65	−4.21	0.000***
El	−5.91	−3.05	0.001***	−9.92	−5.85	0.000***
C	−7.61	−3.73	0.000***	−12.59	−7.24	0.000***
TF	−6.35	−2.74	0.003***	−10.55	−4.99	0.000***
Tr	−7.32	−4.02	0.000***	−12.60	−7.14	0.000***
F	−7.55	−4.67	0.000***	−10.73	−6.93	0.000***
Ed	−4.12	−1.15	0.124	−7.43	−0.51	0.306
H	−8.29	−5.25	0.000***	−9.00	−3.02	0.001***
P	−6.40	−3.76	0.000***	−11.75	−5.85	0.000***
	H_0: Non-stationary					

Abbreviations: A: Agriculture, forestry, fishing; Mi: Mining and quarrying; Mn: Manufacturing; El: Electricity, water, sewerage, waste (Energy); C: Construction; TF: Trade, accommodation, and food services; Tr: Transportation, information, and communication; F: Financial, insurance, and real estate activities; Ed: Education, professional, scientific, and technical activities; H: Human health, social work; P: Administrative, support service, public administration, and other activities.

Appendix 2. Effects of an increase of USD 10 million in final demand of each sector on the economy

Sector	Changes in output	Changes in income	Jobs created	Changes in value added	Changes in labour productivity
Agr	0.11%	0.08%	1207	0.09%	0.00%
Ani	0.09%	0.05%	3193	0.13%	−0.13%
For	0.13%	0.17%	5689	0.10%	−0.35%
Fish	0.11%	0.06%	2143	0.07%	−0.11%
Coal	0.10%	0.05%	418	0.10%	0.07%
Oil	0.10%	0.04%	371	0.08%	0.06%
Met	0.10%	0.09%	412	0.10%	0.07%
Omin	0.09%	0.11%	813	0.07%	0.01%
Mss	0.12%	0.11%	915	0.08%	0.01%
Food	0.13%	0.05%	2164	0.12%	−0.05%
Bev	0.11%	0.07%	630	0.09%	0.04%
Tob	0.11%	0.05%	661	0.06%	0.00%
Tex	0.15%	0.09%	2395	0.10%	−0.09%
App	0.13%	0.13%	2803	0.10%	−0.12%
Leat	0.12%	0.09%	4422	0.10%	−0.25%
Wood	0.11%	0.09%	4148	0.10%	−0.23%
Pap	0.11%	0.10%	1353	0.08%	−0.03%
Prin	0.10%	0.11%	1239	0.08%	−0.02%
Petr	0.12%	0.14%	4691	0.11%	−0.27%
Chem	0.10%	0.09%	740	0.07%	0.01%
Rubb	0.10%	0.09%	708	0.07%	0.01%
Nmet	0.13%	0.12%	1231	0.08%	−0.02%
Bmet	0.11%	0.08%	513	0.11%	0.07%
MetPr	0.10%	0.07%	1537	0.07%	−0.05%
Celec	0.11%	0.04%	546	0.07%	0.02%
Mach	0.10%	0.17%	9061	0.10%	−0.61%
Furn	0.11%	0.10%	3087	0.10%	−0.15%
Oman	0.11%	0.10%	7599	0.10%	−0.50%
MedProd	0.11%	0.15%	6195	0.06%	−0.43%
Rep	0.10%	0.13%	3411	0.08%	−0.19%
Elec	0.14%	0.14%	721	0.09%	0.03%
Water	0.13%	0.23%	1527	0.11%	−0.01%
Waste	0.09%	0.15%	620	0.09%	0.04%
Const	0.11%	0.11%	1174	0.06%	−0.03%
Trade	0.10%	0.12%	1961	0.11%	−0.05%
Trans	0.09%	0.10%	1431	0.07%	−0.04%
Airtrans	0.11%	0.10%	606	0.08%	0.03%
Ware	0.09%	0.10%	460	0.09%	0.05%
Postal	0.09%	0.23%	2586	0.11%	−0.10%
AccFood	0.13%	0.13%	2376	0.10%	−0.09%
IC	0.11%	0.11%	826	0.09%	0.02%
Finance	0.09%	0.14%	816	0.13%	0.06%
Insurance	0.10%	0.20%	1221	0.12%	0.03%
Finadd	0.09%	0.19%	578	0.10%	0.05%
Real	0.09%	0.03%	205	0.13%	0.12%
Prof	0.10%	0.17%	996	0.09%	0.01%
Admin	0.12%	0.15%	1837	0.09%	−0.05%
Public	0.08%	0.21%	1556	0.11%	−0.01%
Edu	0.10%	0.33%	2858	0.13%	−0.10%

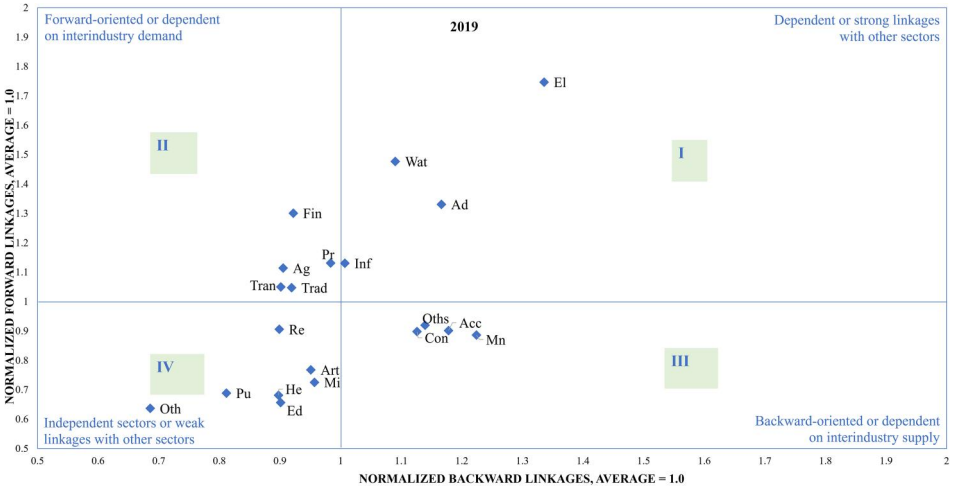
(*continued*)

Continued.

Sector	Changes in output	Changes in income	Jobs created	Changes in value added	Changes in labour productivity
Health	0.09%	0.24%	2254	0.10%	−0.08%
Arts	0.10%	0.25%	3559	0.11%	−0.17%
OtherSer	0.12%	0.17%	2863	0.11%	−0.12%

Abbreviations: Agr: Crop production; Ani: Animal production; For: Forestry and logging; Fish: Fishing; Coal: Mining of coal and lignite; Oil: Extraction of crude petroleum and natural gas; Met: Mining of metal ores; Omin: Other mining and quarrying; Mss: Mining support service activities; Food: Manufacture of food products; Bev: Manufacture of beverages; Tob: Manufacture of tobacco products; Tex: Manufacture of textiles; App: Manufacture of wearing apparel; Leat: Manufacture of leather and related products; Wood: Manufacture of wood and of wood products; Pap: Manufacture of paper and paper products; Prin: Printing and reproduction of recorded media; Petr: Manufacture of coke and refined petroleum products; Chem: Manufacture of chemicals and chemical products; Rubb: Manufacture of rubber and plastics products; Nmet: Manufacture of other non: metallic mineral products; Bmet: Manufacture of basic metals; MetPr: Manufacture of fabricated metal products; Celec: Manufacture of computer, electronic and optical products; Mach: Manufacture of machinery and equipment; Furn: Manufacture of furniture; Oman: Other manufacturing; MedProd: Manufacture of medical and dental instruments and supplies; Rep: Repair and installation of machinery and equipment; Elec: Electricity, gas, steam and air conditioning supply; Water: Water supply, sewerage management; Waste: Waste management and remediation activities; Const: Construction; Trade: Wholesale and retail trade; Trans: Land and water transport; Airtrans: Air transport; Ware: Warehousing and support activities; Postal: Postal and courier activities; AccFood: Accommodation and food service activities; IC: Information and communication; Finance: Financial service activities; Insurance: Insurance, reinsurance and pension funding; Finadd: Activities auxiliary to financial; Real: Real estate activities; Prof: Professional, scientific and technical activities; Admin: Administrative and support service activities; Public: Public administration and defence; Edu: Education; Health: Human health and social work activities; Arts: Arts, entertainment and recreation; OtherSer: Other service activities; Other: Other activities.

Appendix 3. Backward and forward linkages in 2019



Abbreviations. Ag: Agriculture; Mi: Mining; Mn: Manufacturing; El: Electricity, gas, steam; Wat: Water, sewerage, waste; Con: Construction; Trad: Wholesale and retail trade; Tran: Transportation; Acc: Accommodation, food services; Inf: Information and communication; Fin: Financial and insurance; Re: Real estate activities; Pr: Professional, scientific, technical activities; Ad: Administrative and support service activities; Pu: Public administration and defence; Ed: Education; He: Human health, social work; Art: Arts, entertainment and recreation; Oths: Other service activities; Oth: Other activities.

Appendix 4. Matching table for 20 sectors (2019) and 53 sectors (2018)

20 sectors (2019)		53 sectors (2018)	
1	Agriculture	1	Crop production, related service activities
		2	Animal production, hunting
		3	Forestry and logging
		4	Fishing and aquaculture
2	Mining	5	Mining of coal and lignite
		6	Extraction of crude petroleum and natural gas
		7	Mining of metal ores
		8	Other mining and quarrying
		9	Mining support service activities
3	Manufacturing	10	Manufacture of food products
		11	Manufacture of beverages
		12	Manufacture of tobacco products
		13	Manufacture of textiles
		14	Manufacture of wearing apparel
		15	Manufacture of leather and related products
		16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
		17	Manufacture of paper and paper products
		18	Printing and reproduction of recorded media
		19	Manufacture of coke and refined petroleum products
		20	Manufacture of chemicals and chemical products
		21	Manufacture of rubber and plastics products
		22	Manufacture of other non-metallic mineral products
		23	Manufacture of basic metals
		24	Manufacture of fabricated metal products, except machinery and equipment
		25	Manufacture of computer, electronic and optical products
		26	Manufacture of machinery and equipment n.e.c.
		27	Manufacture of furniture
		28	Other manufacturing
		29	Manufacture of medical and dental instruments and supplies
		30	Repair and installation of machinery and equipment
4	Electricity, gas, steam	31	Electricity, gas, steam and air conditioning supply
5	Water, sewerage, waste	32	Water supply; sewerage management
		33	Waste management and remediation activities
6	Construction	34	Construction
7	Wholesale and retail trade	35	Wholesale and retail trade; repair of motor vehicles and motorcycles
8	Transportation	36	Land and water transport
		37	Air transport
		38	Warehousing and support activities for transportation
		39	Postal and courier activities
9	Accommodation, food services	40	Accommodation and food service activities
10	Information and communication	41	Information and communication
11	Financial and insurance	42	Financial service activities, except insurance and pension funding
		43	Insurance, reinsurance and pension funding, except compulsory social security
		44	Activities auxiliary to financial service and insurance activities
12	Real estate activities	45	Real estate activities

(*continued*)

Continued.

20 sectors (2019)		53 sectors (2018)	
13	Professional, scientific, technical activities	46	Professional, scientific and technical activities
14	Administrative and support service activities	47	Administrative and support service activities
15	Public administration and defence	48	Public administration and defence; compulsory social security
16	Education	49	Education
17	Human health, social work	50	Human health and social work activities
18	Arts, entertainment and recreation	51	Arts, entertainment and recreation
19	Other service activities	52	Other service activities
20	Other activities	53	Other activities