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Domestic Production Linkages and Sectoral Shifts in Central Europe: An Input–Output Perspective

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Abstract

This paper examines changes in productive structures and domestic inter-industry linkages in five Central European countries- the V4 group and Austria- over 2000–2023. Despite previous studies, evidence remains limited on how domestic inter-industry linkages and sectoral transformations have evolved across these economies, particularly in the primary sector and agriculture. Using national input-output tables from the Asian Development Bank, demand multipliers (output, import, and value added) were calculated at the industry level and aggregated by sector and subsector to reflect sectoral trends and relationships. The analysis focuses on structural transformation, with emphasis on the primary sector and agriculture. Findings confirm a more stable sectoral structure in Austria, while structural shifts persisted in the V4 countries even after 2010. Transformation was most pronounced in the early period, with the primary sector declining in favour of secondary and tertiary sectors, dominated by manufacturing and services. Agriculture's value added remained relatively stable, despite weakening domestic linkages and rising import dependence. At the same time, integration into global value chains increased reliance on imported inputs across sectors. The results suggest that V4 countries should strengthen agricultural resilience by focusing on innovation to improve domestic value added creation and reduce vulnerability to external shocks.

Keywords

Input-output analysis, sectoral transformation, domestic inter-industry linkages, primary sector, agriculture, V4 countries, Austria.

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Introduction

The input-output tables (IOTs) are a valuable analytical tool for assessing the significance of specific sectors within the national economy. Compared to basic macroeconomic aggregates such as GDP or its main components, IOTs offer a more disaggregated view of the economy while enabling in-dept study of the productive structures, inter-industry linkages, or structural changes at the industry level.

Literature review

IOTs are commonly used to examine national economies from both the demand (consumption) and supply (production) perspectives. On the demand side, the analysis focuses on the composition of the final demand–private and government consumption, investments, and exports. The supply side represents the sectoral distribution of production and gross value added. Sectors of manufacturing and services are often disaggregated into several subsectors.

Although initially developed to study domestic industry linkages, over time, these methods have proven to be versatile and adaptable to other types of analysis. Nowadays, IO analysis is widely applied to current issues, such as environmental impacts, climate change, global value chains disruptions (Uku and Shehu, 2024; Almanáz-Gómez, et al., 2023), or the COVID-19 pandemic (Aponte, 2025). All these phenomena often trigger structural adjustments in the countries' production systems in response to economic shocks, as industries adapt to new economic conditions.

Despite the growing versatility of IO methods, they are still predominantly applied in studies focused on specific industries. Recent literature offers numerous examples: analysis of fisheries and aquaculture in Norway during the pandemic in 2019-2021 (Aponte, 2025); Chinese fisheries

or port sectors in 2002-2017 (Wang and Wang, 2019, 2021); the Australian construction industry (Zhu et al., 2021); agriculture and food industries in V4 countries during 2000-2014 (Bartóková, 2019; Ďurčová and Oravcová, 2019); Turkey's tourism in the early 2000s (Atan and Arslanturk, 2012); the ICT sector in European countries during 1995-2005 (Rohman, 2013); or the Brazilian energy sector (Brito et al., 2025).

The position of an industry within the economy can be evaluated based on IO domestic demand multipliers, or its inter-industry linkages. Demand multipliers reflect how changes in final demand affect output, imports, value added, or employment. Inter-industry linkages, assessed via demand and supply multipliers, reveal the industry's interconnectedness to other domestic industries (Miller and Blair, 2009). The comparison of the industry's linkages to the average requirements of the whole economy determines its position as the buyer/supplier of the intermediate inputs and allows for their classification as more/less connected (dependent/independent) to the rest of the economy (Timmer et al., 2015).

Empirical studies (e.g., Bon and Xu, 2006; Allison, 1994) suggest that the economy's IO structures tend to remain relatively stable over time, unless the economy is undergoing serious structural changes. The study of Aponte (2025) found minimal changes in Norway's industries classification based on normalised demand and supply linkages during the pandemic, which points to only limited structural impact of COVID-19. This suggests that strong domestic demand linkages support industry's resilience and adaptability to supply chain disruptions.

Norbu et al. (2021) examined changes in demand and supply linkages at the industry level across selected Asian countries. The findings confirm that despite certain imbalances in the overall economic development, growing sectors can (indirectly) stimulate production in connected industries. Primary sectors, like agriculture and extractive industries, rely mostly on inputs coming directly from nature and thus tend to manifest weaker demand linkage. Service sectors also show stronger supply-side linkages, while manufacturing industries–often internationally integrated–might depend on strong external stimuli.

As mentioned before, the IOTs are also useful for analysing structural transformation and its impact on domestic linkages, job creation, and value added generation. The study of structural transformation often relies on Hirshman's theory (1958), stating that development of one sector would trigger intermediate demand for inputs in others. Thus, the development policies and investments should prioritise economic activities strongly linked to others.

The processes of the structural transformation, studied mostly within the theories of economic growth, are typically manifested by a shift from primary industries toward manufacturing and, subsequently, to services. (Sen, 2019) This transition also means fundamental structural changes in employment, production, and factor use in general. (Baymul and Sen, 2019) While the traditional development usually means a gradual decline of employment in agriculture, with the simultaneous transfer of workers to industry, some low-income economies now experience more direct transfers of workers from agriculture to non-business services (Baymul and Sen, 2019).

Bilenko (2022) studied the structural transformation of agriculture and its impact on labour productivity in Central and Eastern European countries (CEE) during 1991-2020. His results suggest that even though sources of labour productivity growth were altered considerably by the global financial crisis in 2008, agriculture still recorded the highest average productivity increase (12% p.a.) during the 1990s and 2010s. As for the value added (VA), during the entire period, the dominant factor was the growth of VA in industry, followed by the services sector and agriculture.

This paper focuses on domestic demand industry linkages in the Central European region. The V4 countries, as former transition economies, have undergone a significant structural transformation since the early 1990s. Their initial transition conditions were rather unfavourable due to obsolete productive capacities, lack of modern infrastructure, and weak institutions (Solimano, 1991). EU accession required macroeconomic stabilisation, anchoring inflation, and fiscal reforms. At the same time, the ongoing convergence processes were creating new challenges (Nuti et al., 1993). During the first decade of transformation (1990s), the private sector's share on GDP grew to 60% and trade with the EU increased by nearly 70%. (Feldman and Watson, 2000) EU accession also boosted agricultural output and productivity in the region, with stronger growth in Slovakia and the Czech Republic than in Hungary and Poland (Jambor and Gorton, 2025). Similarly,

Zsarnóczai and Zéman (2019) found greater similarity of various indicators for the agricultural industry between Slovakia, the Czech Republic, and Hungary, while Poland was considered more like Balkan countries. They also confirmed above-average growth in output and VA in agriculture for EU-12 countries compared to the EU-28. However, the overall comparison to EU averages for various agricultural indicators showed that V4 countries were significantly lagging behind the EU countries in the 2010s (Szabó et al., 2018).

Due to their geographical proximity, the V4 countries and Austria are frequently compared. While macroeconomic indicators might suggest similar positions, a detailed analysis of structural factors and inter-industry linkages might point to undergoing structural changes or notable differences, particularly between Austria and V4. However, a certain kind of closeness is expected for V4 countries.

This paper aims to assess the extent to which economic structure and sectoral changes differ among these countries. The analysis focuses on three main sectors, divided into six subsectors, addressing the following questions: *Do V4 countries share similar sectoral structures throughout 2000-2023, and how do these compare with Austria? Has the transformation process in V4 countries continued in the 2010s? Did the V4 countries follow the standard path of economic transformation (i.e., from primary to secondary and tertiary sectors)? What were the impacts of structural changes on agriculture's capacity to generate domestic value added during the observed period? And how have globalisation and foreign trade impacted the domestic inter-industry linkages between 2000 and 2023?*

To address these questions, the paper assesses the evolution of domestic production linkages by quantifying output multipliers (demand linkages) but also other demand-derived multipliers, (import and VA multipliers) over the period 2000-2023. The paper is structured as follows: Introduction and Literature review, Materials and methods, Results and discussion, Conclusions.

Materials and methods

In general, national IO tables supply industry-level data, both from the point of view of producers and buyers of inputs, which enables the analysis of demand and supply inter-industry linkages and the calculation of various types of multipliers.

IO models and the study of structural changes are based on Leontief's theory (Leontief, 1953), which assumes that each national economy is composed of "*n*" interconnected industries. The structure of the production and its uses for industry "*i*" can be presented in linear form as follows (Miller, Blair, 2009):

$$x_i = Z_{i1} + Z_{i2} + ... + Z_{ij} + ... + Z_{in} + y_i \quad (1)$$

The output of each sector (x_i) can either serve as inputs for other industries (i.e., the intermediate consumption Z_{ij}) or be consumed directly by consumers, firms, government, or foreign countries (i.e., the final demand y_i) (Timmer et al., 2015). Based on this equation, we can determine the structure and volume of direct inputs (technical coefficients matrix, A) or the basic IO's analysis equation, i.e., the Leontief inverse matrix *L*:

$$L = (I - A)^{-1} \quad (2)$$

The *L* matrix enables to calculate the total direct and indirect effects of any increases in the final demand for production in each industry (simple output multipliers or demand linkages) or can be used to derive the impacts of changing demand in the domestic economy on imported inputs (import multipliers). These multipliers can be viewed as summary measures for estimating likely effects of economic changes or impacts generated by a particular industry on the national economy (Kubala et al., 2014). Using the same techniques, we can also study the industry-level impacts of changing demand on value added, employment, CO_2 emissions, or energy consumption (Lábaj, 2017).

Results and discussion

This study is based on national input-output data from the Asian Development Bank (ADB) for the period of 2000-2023, which corresponds to the available data (ADB, 2024). The IO analysis focuses on the region of Central Europe, notably the V4 countries (Slovakia–SK, Czech Republic –CZ, Hungary–HU, Poland–PL) and Austria (AT). The analysis was first performed at the individual industry level for all 35 industries in each country, with calculation of output, import, and value added multipliers. The results were then aggregated by sector and subsector to obtain average values, ensuring that the sectoral multipliers accurately reflect the sectoral shifts and inter-industry relationships. For comparability and analysis purposes, the 35 industries were grouped into three sectors as follows: the primary sector comprised agriculture, forestry, fishing,

mining, and quarrying; the secondary sector was subdivided into low-, medium-, and high-tech manufacturing; and the services sector was subdivided into business services and public and personal services. This approach follows OECD and Eurostat methodologies based on R&D intensity (Galindo-Rueda and Verger, 2016; Eurostat, 2025; United Nations Statistics Division, 2025).

Firstly, we looked closely at the composition and use of output (Figure 1). Across the selected countries, GDP composition was comparable, with 50-60% of domestic output being directed to intermediate consumption (IC; input for domestic industries) and 40-50% to final consumption – either domestic (DE; domestic expenditures, 20-30%) or foreign (EX; exports, 10-20%). The share of imports (IM) accounted for 10-20%, mirroring export levels. Over the observed period, the shares of domestic IC decreased, mainly in favour of exports. The most pronounced shifts occurred between 2000 and 2010; afterwards, the values remained relatively stable, as confirmed by the closeness of average and median values. Slovakia exhibited the most significant changes, corresponding with its considerable growth in trade openness.

The declines in shares for domestic IC (average relative change of -5.9% for V4 and -4.7% overall) or DE (average relative change of -13.4% for V4 and -12.8% overall) were more than offset by a substantial rise in foreign demand (average relative change of +70% for the V4 and +61% for the whole sample). These findings support earlier studies indicating that structural shifts tend to occur rather at the sectoral level than within the output distribution (Olczyk and Lechman, 2011).

For the production-side analysis, intermediate consumption matrices were used to evaluate changes in the share of subsectors (Figure 2). Comparison of 2000 values with average shares from 2010-2023 confirms the similarity of production patterns in V4 countries.

Approximately one-third of output comes from business services, while manufacturing generates 40-50% of the domestic output, with high-tech industries ranging from 20% (PL or AT) to 30% (SK). The primary sector's contribution was the lowest, with further declines throughout this period, in all countries except Austria. These findings also conform with Hirshman's theory (Hirshman, 1958) or Sen (2019), who associated structural transformation processes with shifts from the primary sector toward manufacturing and, later, to the services.

The distribution of VA by sectors (Figure 3) showed patterns similar to previous findings. Although certain minor shifts occurred between 2000 and 2010, they were mostly marginal (relative changes often below 1%). The primary sector and low-tech manufacturing experienced slight reductions in their VA shares, while medium- and high-tech manufacturing, along with public and personal services, grew only slightly (not discernible in the figure due to rounding of values). These trends for the primary sector's position and that of agriculture are consistent with Zsarnóczai and Zéman (2019).

While the VA generated by primary sectors mostly copies the sector's share on domestic output, in the case of manufacturing, the VA share consistently lags behind output across all 3 subsectors. The most prominent gap is present

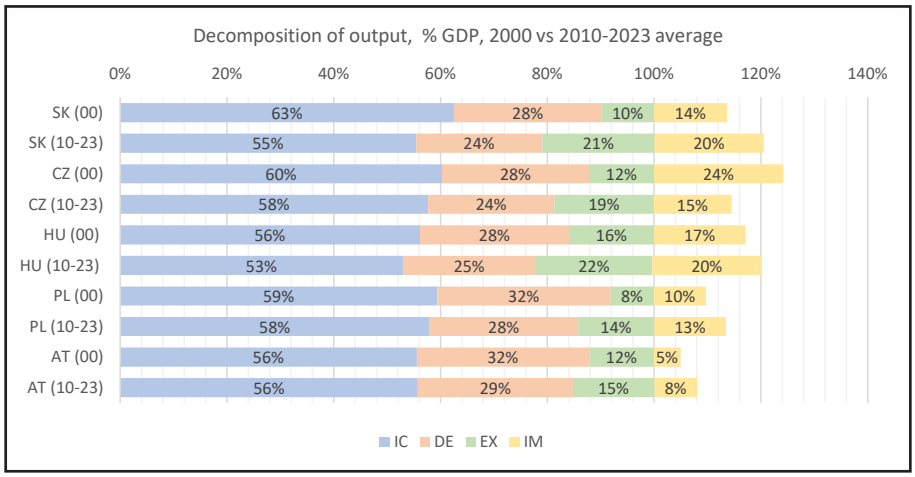

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Figure 1: Decomposition of output, % GDP, 2000 vs 2010-2023 average.

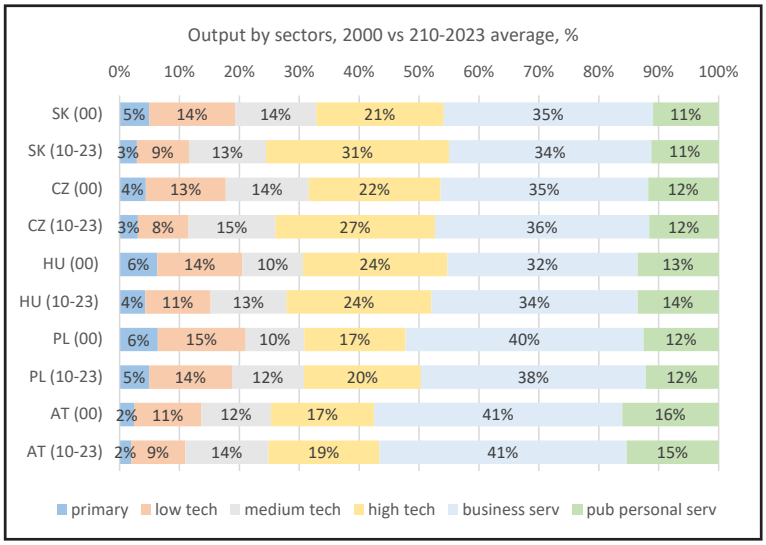

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Figure 2: Output by sectors, 2000 vs 2010-2023 average (%).

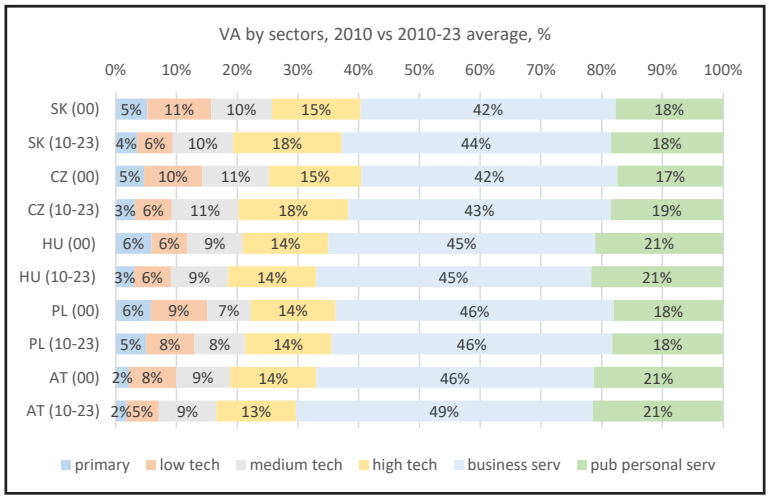

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Figure 3: Value added by sectors, 2000 vs 2010-2023 average (%).

for SK high-tech manufacturing, where a 31% share of output generates only 18% of the VA. For business services, however, the relationship between production and VA is opposite, the share of VA surpasses that of production. Overall, for the sample's countries, the VA is mostly created in services (60-70%) that represent 45%-56% of production, reflecting general trends also observed by Bilenko (2022) in his study of CEE countries.

Export structures (Figure 4) confirm that all 5 countries primarily export manufactured goods (from 70% in PL to 77% in HU and SK), with the highest shares for the high-tech subsector. Exports in both services subsectors accounted for 22% of total exports on average. The import side followed a similar pattern, with manufacturing taking up 77% on average and services around 20% of total imports (Figure 5).

The low export and VA shares of the primary sector (and agriculture in particular) do not necessarily indicate an unfavourable position in international markets. As shown by Zsarnóczai and Zéman (2019) or Jambor and Gorton (2025), agriculture in EU-12 countries experienced above-average growth of output and VA compared to average results of EU-28, which was also reflected in their trade flows. However, according to Zdráhal (2024), in the 1990s only HU demonstrated a comparative advantage in agricultural production, while CZ, PL, and SK showed comparative disadvantages.

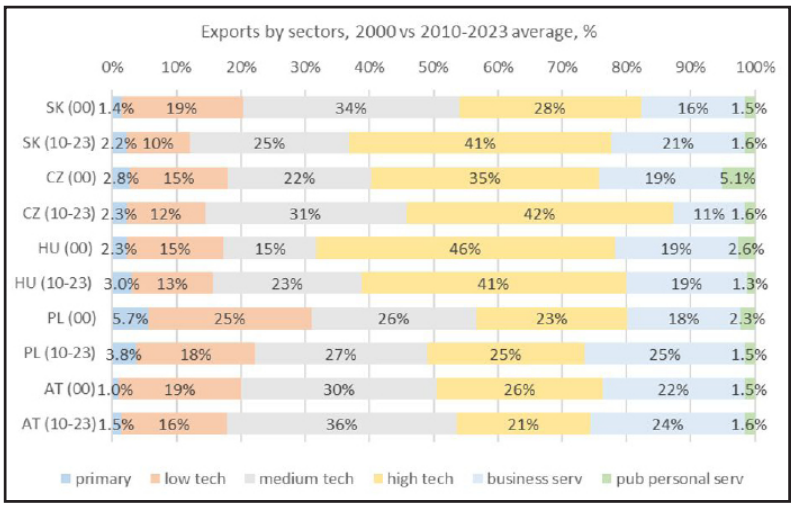

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Figure 4: Exports by sectors, 2000 vs 2010-2023 average (%).

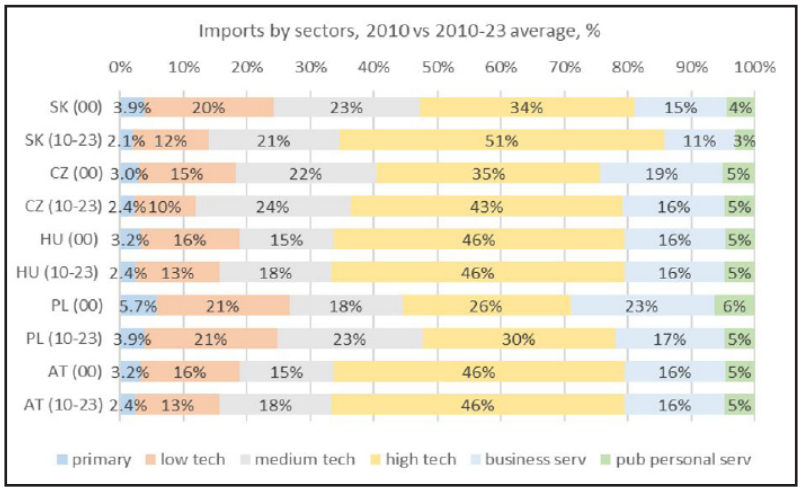

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Figure 5: Imports by sectors, 2000 vs 2010-2023 average (%).

Lastly, we examined the changes in position of the agricultural sector across observed countries (Figure 6). Agriculture accounted for a major share of the primary sector, averaging 82% of output, 78% of VA, 67% of exports, and 83% of imports. Across all countries, shares of output, VA, and IMP decreased, while EXP shares grew. The highest increases were recorded for HU, PL, and SK. In AT, the share of agri-exports remained stable, while shares for other categories decreased slightly, on average by 0.5-0.7% relative to their previous values. This again could point to a more stable structure of the Austrian economy, with stronger domestic linkages resilient to external competition.

The observed decline in domestic linkages, combined with rising export shares, points to increasing integration of agriculture into global markets. This trend represents both opportunities and risks. On the one hand, higher exports can boost domestic revenues and support domestic investment.

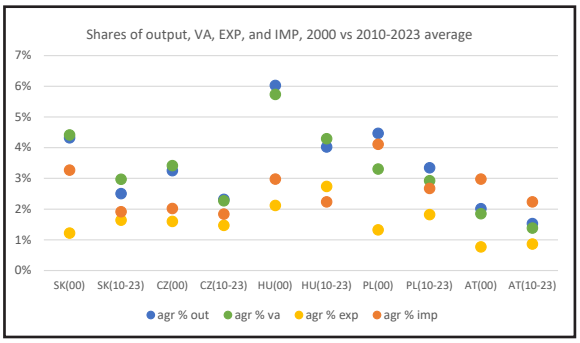

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Figure 6: Shares of agriculture on output, VA, exports, and imports, 2000 vs 2010-2023 average (%).

On the other hand, greater dependence on imported inputs and foreign demand creates vulnerability to price volatility, trade shocks, and supply chain disruptions. As such, policymakers should consider strategies to strengthen domestic supply chains and diversify export destinations. They should also encourage value added creation within the country to retain more benefits locally.

Multiplier analysis

Based on the industry-level data, the output multipliers (om) were calculated for each industry (Figure 7). Here again, the most significant changes occurred between 2000 and 2010, confirming the ongoing structural shifts associated with the transition process in V4. Post-2010 developments were more gradual, with only slight changes on subsector levels. The overall drop in om values would suggest a somewhat general trend of weakening domestic demand linkages accompanied by increasing reliance of industries on imported inputs and their deepening integration into international production chains.

In the primary sector, especially agriculture, *om* values revealed an obvious downward trend across all countries. The largest declines in multiplier values occurred for SK (-20%), and to a lesser extent, for CZ and HU (-5-6%). For AT and PL, the primary sector recorded only minor drops (around 1%). These results are consistent with those of Olczyk and Lechman (2011) or with agri-trends presented by Zsarnóczai and Zéman (2019) and Jambor and Gorton (2025).

The largest overall decreases in *om* averages were present for medium-tech manufacturing with relative declines in multiplier values of around -25%. E.g., in SK, in 2000, 1€ of domestic demand would have been able to generate up to 1.7€ of new domestic production, whereas after 2010, the total effect of the same stimuli would be lower by 0.4€. Similar reductions occurred for all SK subsectors. In the case of CZ, HU, PL, and AT, only the medium-tech experienced the drop in the *om* values exceeding 20%. For AT, the values of *om* confirm the stability of the production structures, with 4 subsectors changing by less than 1%.

The comparison of average and median values for period 2010-2023 shows only minimal differences, revealing no discernible trends. For some subsectors, changes were as small as 0.02€, supporting the view that in the absence of deep structural shifts, economic structures tend to remain stable and resilient, as presented also by Aponte (2025), Timmer et al. (2015), or Bon and Xu (2006).

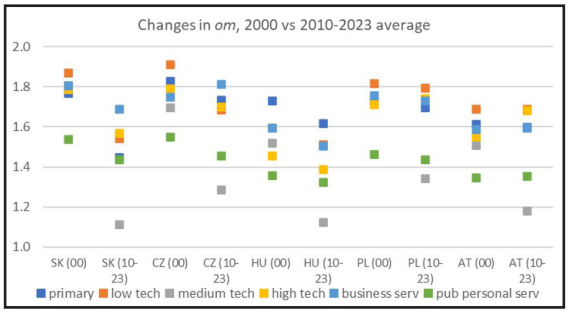

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Figure 7: Changes in output multipliers, 2000 vs 2010-2023 average.

As mentioned before, domestic demand linkages are reflected in the om, while the linkages with foreign suppliers are represented by the import multipliers (*im*). The comparison of im across countries highlights the growing dependence on foreign inputs (Figure 8). As values of *om* were becoming less important, the values of *im* were growing steadily. This pattern, present for every country and every subsector, points to a shift toward international production networks.

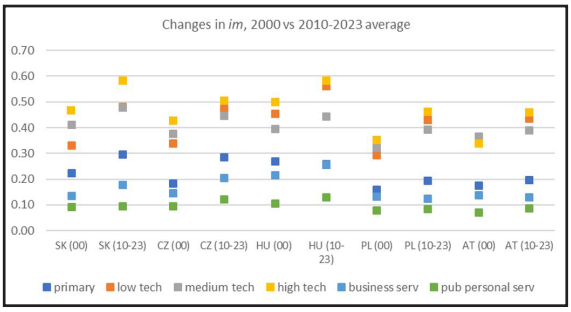

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Figure 8: Changes in import multipliers, 2000 vs 2010-2023 average.

The Figure 9 illustrates this divergence in *im* and *om* values. Over the past 20 years, deeper integration into international production chains also meant the substitution of domestic inputs by the imported ones, resulting in the decline of domestic suppliers (negative changes in *om*) and growing importance of foreign ones (positive changes in *im*) for most of the subsectors of our sample. This trend might be attributed to various cost-reduction strategies through cheaper imports or to the relocation of production processes to V4 countries while keeping the original and established foreign suppliers.

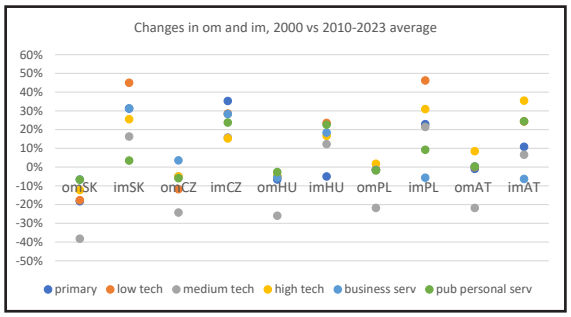

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Figure 9: Changes in output and import multipliers, 2000 vs 2010-2023 average (%).

VA multipliers (*vam*) indicate that public and personal services have the highest impact on the economy, followed closely by business services (Figure 10). Although a slight decline was present after 2010, these subsectors remain the most influential. Interestingly, the lowest vam values appeared for hi-tech manufacturing. This could be explained not only by the smaller VA share of hi-tech but also by a considerable reliance on imported components.

The positions of the primary sectors and agriculture remain relatively stable, with 1€ of new domestic demand generating 0.72€ (SK) to 0.79€ (PL) of new VA. These results are in slight contrast with the findings of Maró et al. (2024), who reported a relatively low agricultural productivity and efficiency in CEE countries compared to Western Europe. However, they align with Jambor and Gorton (2025), who emphasised increases in agricultural output and productivity in this region, especially for SK.

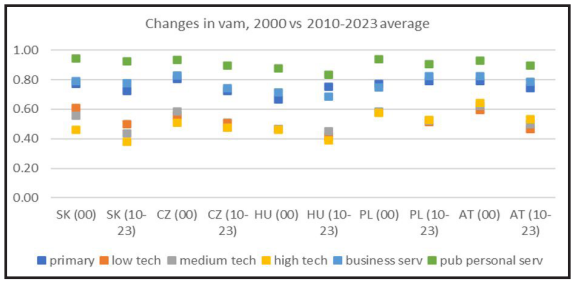

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Figure 10: Changes in VA multipliers, 2000 vs 2010-2023 average (%).

The comparison of the 3 demand multipliers for agriculture (Figure 11) shows overall drops in *om* values and increases in *im* values between 2000 and 2010 for all countries (on average -0.14€ for *om* and +0.08€ for *im*), except for HU, where the trend was reversed (+0.16€ vs -0.16€). Interestingly, the highest increase in *im* values was recorded for CZ and AT, where the impacts of new demand for imported agri-inputs rose by almost 77% or 38%, respectively, compared with 2000 values. Vam values remained largely stable, with slight increases only for HU and PL. Generally, the impact of 1€ of new agriculture demand generated, on average, 0.75€ of overall new VA during the 2010s.

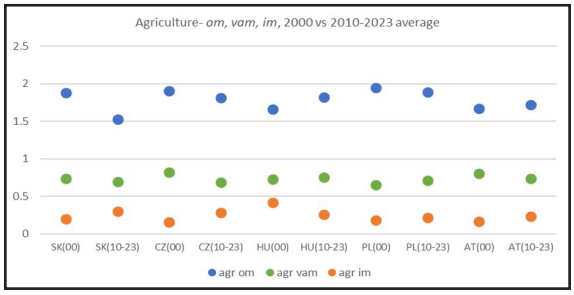

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Figure 11: Agriculture- *om, vam, im*, 2000 vs 2010-2023 average.

This analysis focused on the structural characteristics of V4 countries and Austria. Results suggest that the transformation process can no longer be considered as the main driver of structural changes in V4 countries. Instead, the production structures are now shaped by countries' or industries' integration into global value chains. These findings also highlight a structural gap between the manufacturing sector's dominant role in production and exports and its more modest contribution to VA creation. This reflects a limited national orientation on R&D and innovation domains.

Conclusion

The main objective of the analysis was to verify to what extent the economic structure and its sectoral changes differ among selected countries. We examined production structures and their evolution across six subsectors, following the path set by research questions. The key findings directly address these questions:

Do V4 countries share similar sectoral structures throughout 2000-2023, and how do these compare with Austria? Has the transformation process in V4 countries continued in the 2010s? Did the V4 countries follow the standard path of economic transformation (i.e., from primary to secondary and tertiary sectors)?

The findings indicate that sectoral structures in Central Europe are still quite similar, particularly among the V4 countries. The transformation process continued through the early 2000s and up to 2010.

During 2010-2023, sectoral changes were not as pronounced, with only slight shifts in the positions of industries or subsectors. These followed the typical path of economic transformation, with the primary sector gradually receding in favour of manufacturing and services. The only V4 exception was Poland, with its agriculture and the whole primary sector increasing in relevance. The Austrian economy maintained a relatively stable sectoral composition throughout the observed period.

How have globalisation and foreign trade impacted the domestic inter-industry linkages between 2000 and 2023?

The analysis also showed how the gradual opening to foreign trade impacted domestic production structures – a decrease in domestic demand/supply linkages as shown in intermediate consumption shares (*om*), which was offset by the increase of imported inputs (*im*) but also by higher exports.

The analysis of VA confirmed that despite strong performance in high-tech manufacturing outputs and exports, the largest VA shares come from the two services subsectors. While the high-tech subsector accounts for 20-30% of manufactured output and 21-46% of exports, it generates only 14-18% of VA. This underscores the V4 countries' position in global value chains as assemblers of high-tech goods based on imported components rather than creators of new domestic VA. As such, V4 countries should focus more on supporting innovation and technology to stimulate more technologically driven economic progress.

What were the impacts of structural changes on agriculture's capacity to generate domestic value added during the observed period?

Additionally, the agricultural industry, as one of the key industries (Bartóková, 2019), holds a specific position in national economies. The findings show that the primary sector is impacted mostly by the developments in agriculture. Although its contribution to output and VA has declined, its share in foreign trade has been growing steadily. This creates both an opportunity and a risk. Higher foreign sales could generate more funds for domestic producers, but rising import dependence makes agri-markets more vulnerable to external shocks. That is why policymakers should put more focus on strengthening domestic agricultural resilience, e.g., through targeted subsidies and support for local cooperation. These measures could help ensure that growth in agricultural exports contributes to sustainable domestic economic development.

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