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Modelling the impact of import dependence on the structure of employment in a developed economy: A case study of Germany

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Purpose. *The study provides a comprehensive econometric analysis of the impact of import dependence on the sectoral structure of employment in a developed economy, using Germany as a case study. The relevance of the research is driven by the deepening integration of national economies into global value chains and the growing role of imports as a key determinant of labour market transformation. The purpose of the study is to deliver a quantitative assessment of the impact of import dependence on the industry-level structure of employment in the developed economy (Germany), accounting for threshold effects through the application of a dynamic threshold modelling approach.*

Methodology. *The empirical basis of the study is constructed using panel data for the period 1995–2022, covering 42 economic activities. The methodological framework is based on a dynamic threshold regression model, enabling the identification of nonlinear relationships between variables and the estimation of critical values of import dependence at which both the magnitude and direction of its impact on employment change. A bootstrap procedure is employed to ensure the statistical robustness of the estimates, facilitating the refinement of threshold parameters and the validation of their accuracy.*

Findings. *The findings confirm statistically significant threshold effects, indicating structural heterogeneity in the impact of import dependence on the labour market. The results show that crossing certain critical levels of import dependence is associated with changes in both the sign and magnitude of its effect on employment. Accordingly, three sectoral groups are identified: sectors with a predominantly negative impact (displacement effect), sectors with a positive impact (driven by participation in global production networks), and sectors with mixed or statistically insignificant effects.*

Originality. *The scientific contribution of the study lies in applying a dynamic threshold framework to the analysis of the relationship between import dependence and employment, allowing for capturing the nonlinear, asymmetric, and sectoral heterogeneous effects.*

Practical value*. The practical implications of the findings include providing an analytical basis for selective structural policies targeting sectors with high potential for integration into global value chains. The results are particularly relevant for transition and post-crisis economies, including Ukraine, where optimising import dependence and fostering employment are critical in the context of post-war economic recovery.*

Keywords: *regional development, innovation ecosystem, territorial community, human capital, innovation development, network interaction, competitiveness.*

Introduction

The openness of national economies and the deepening international division of labour are among key drivers of employment dynamics, import flows, and structural shifts across economic activities. On the one hand, imports contribute to enhancing competitiveness, stimulating innovation and technological modernisation, and facilitating the integration of national economies into global value chains. On the other hand, increasing import dependence may generate a range of economic, social and environmental challenges, including inflationary pressures, the displacement of domestic production, and potential job losses, particularly in those sectors most exposed to external competition. Consequently, it is pertinent to evaluate the effects of import dependence on sectoral employment changes within the national economy.

The relevance of this approach stems from the fact that employment trends reflect a wide range of socio-economic processes associated with educational, innovative, technological, and structural transformations, as well as the development of foreign economic activity. Such an analysis enables the identification of sectors that are most sensitive to changes in the level of import dependence, as well as those for which its impact is neutral or less pronounced. Furthermore, the estimation of critical threshold values of import dependence makes it possible to establish limits

beyond which its effect on employment becomes negative. At the same time, it might contribute to a deeper understanding of the mechanisms shaping employment across different sectors of the economy and provide an analytical foundation for the design of evidence-based structural policy initiatives to support employment, taking into account sector-specific characteristics.

Literature Review

There is an ongoing academic debate on whether imports represent a potentially neutral factor for employment, whether they predominantly exert an adverse effect on the labour market through the displacement of domestic production, or whether their impact is context-dependent, varying according sectoral characteristics, labour market flexibility, and firms' capacity to adapt to external competition. Using cross-sectoral and regional variation, W. Dauth, S. Findeisen, and J. Suedekum demonstrate that globalisation did not accelerate the decline in manufacturing in Germany, but rather contributed to the preservation of employment in the manufacturing sector (Dauth, Findeisen, & Suedekum, 2017). Subsequently, W. Dauth, S. Findeisen and J. Suedekum argued that import shocks primarily affect low-skilled workers, particularly in capital-intensive sectors, reduce the earnings of workers leaving high-wage manufacturing firms, and generate long-lasting adverse effects in the case of mass layoffs (Dauth, Findeisen, & Suedekum, 2021).

From the perspective of import dependence, I. Revak and I. Kondro find that in Ukraine's chemical, light and woodworking industries, the share of imported inputs in the production cycle exceeds 30–40%, thereby increasing the employment vulnerability (Revak & Kondro, 2020). Furthermore, L.Sozansky underscores that imports in intermediate consumption within Ukrainian manufacturing account for up to 25% of gross capital formation, potentially crowding out domestic production (Sozansky, 2018). In parallel, I. Shovkun also demonstrates that excessive import dependence constrains the development of domestic production capacity (Shovkun, 2020), while O. Nikishina highlights the relevance of selective import substitution policies to preserve employment within the economy (Nikishina, 2024). Overall, the empirical evidence indicates that certain sectors of Ukraine's economy are highly sensitive to external competition, which necessitates policy initiatives aimed at protecting national employment interests.

Respectively, similar patterns are observed in other studies. Analysing panel data for the period 1991–2008 in the Swiss manufacturing sector, R. Mohler, L. Weder, and S. Wyss find no statistically significant positive relationship between import competition and the likelihood of unemployment, particularly among low-skilled workers, suggesting that imports play a limited role in determining the risk of job losses in this context (Mohler, Weder, & Wyss, (2018). Using panel data for 66 countries over the period 2006–2016 and controlling for trade and labour disputes, J. Cheng, S. Lee, and J. Hwang show that imports are associated with lower unemployment in developing countries with a high degree of industrialisation and a relatively low share of services, whereas exports reduce unemployment in developed economies and in countries with a high share of services and lower industrialisation levels (Cheng, Lee, & Hwang, 2019). Additionally, J.E. Leightner find that increases in imports are associated with rising unemployment in Austria, Greece, Japan, Portugal, South Korea, Slovenia, and Sweden, while in countries such as Australia, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Latvia, the Netherlands, New Zealand, Norway, Poland, Slovakia, Spain, the United Kingdom, and the United States, higher imports are associated with lower unemployment (Leightner, 2021).

Extending these findings to specific regional contexts and employing a dummy-variable approach, A. Maschke provides evidence of the absence of an empirically and statistically significant relationship between competition from German imports

and employment in French manufacturing regions, suggesting that the effects of foreign trade on labour markets are not universally adverse (Maschke, 2024). L. Dargenyte-Kacileviciene, M. Butkus, and K. Matuzevi i t show that growth in imports and exports across EU countries is generally associated with a decline in the sensitivity of employment to economic growth, particularly among young people, while also indicating a potentially positive effect on female employment (Dargenyte-Kacileviciene, Butkus, & Matuzevi i t , 2024). Examining individual- and firm-level data for the period 1995–2007, F. Wang, Z. Liang, and H. Lehmann reveal that reductions in import tariffs increase the likelihood of temporary employment, particularly in small and less productive firms, whereas large firms respond with increased innovation activity (Wang, Liang, & Lehmann, 2025). Collectively, these studies emphasise that the impact of international trade on labour markets is highly context-dependent and shaped by the structure of the economy, the skill composition of the workforce, and the degree of regional specialisation.

Despite a substantial body of empirical literature, most studies focus on the general effects of import competition, threshold mechanisms, and sector-specific characteristics, which limits the ability to assess specific employment risks using threshold estimates. To address this gap, it is relevant to consider international experience, particularly that of Germany, which represents one of the largest economies in the European Union and globally, characterised by a high degree of openness and strong integration into global trade and production networks oriented towards high value-added goods. Accordingly, a sectoral approach to the estimation of threshold effects at which import dependence may adversely affect employment in Germany allows for the identification of critical levels of impact and the provides an empirical foundation for assessing potential challenges and risks to employment.

Purpose of the study

The purpose of the study is to deliver a quantitative assessment of the impact of import dependence on the industry-level structure of employment in the developed economy (Germany), accounting for threshold effects through the application of a dynamic threshold modelling approach.

To achieve the objective, the following research hypotheses are formulated:

H1: Import dependence exhibits a non-linear relationship with the sectoral structure of employment in a developed economy (using Germany as a case study);

H2: The impact of import dependence on employment across sectors of the German economy is characterised by the presence of threshold values beyond which the magnitude and/or direction of this impact changes;

H3: Differentiation in the magnitude and direction of the impact of import dependence on employment enables the identification of typological groups of sectors depending on their sectoral specifics characteristics.

Methodology

The methodology for identifying threshold effects based on regression and correlation analysis enables the determination of critical variable values at which qualitative changes in the interactions among economic indicators occur, thereby providing an analytical foundation for quantitative assessment. In particular, A. Bouattour, M. Kalai, and K. Helali apply a panel smooth transition regression (PSTR) model and identify threshold levels of imported technologies at which their impact on industrial employment becomes positive in developed countries and adverse in developing countries, thus demonstrating the importance of threshold models for the design of effective innovation and industrial policies (Bouattour, Kalai, & Helali, 2024). M.H. Seo and Y. Shin propose an approach for estimating dynamic panel models with threshold effects in the presence of endogeneity, employing first-

difference GMM and a two-stage least squares estimator for strictly exogenous threshold variables, and confirming the validity of the method through Monte Carlo simulations (Seo & Shin, 2016). T. Gшrgens and A.H. Wьrtz develop a methodology for dynamic threshold regression in short-run fixed-effects panels by combining non-parametric threshold estimation with GMM estimation of other parameters, which enables more effective treatment of endogeneity and improves estimation accuracy compared to the conventional GMM approaches (Gшrgens & Wьrtz, 2019).

Additionally, J. Hidalgo, J. Lee, and M.H. Seo advance a complementary approach to robust threshold regression estimation that accounts for uncertainty regarding whether a kink or a jump is observed at the threshold, provides accurate confidence intervals for the threshold via bootstrap inversion, and improves the precision of inferences in small samples (Hidalgo, Lee, & Seo, 2019). Analysing panel threshold regression models with unobserved individual-specific threshold effects, P. Yu, S. Hong, and P.C.B. Phillips propose an estimation and inference framework for both static and dynamic settings that accounts for endogeneity and yields more accurate and reliable estimates of threshold parameters compared to conventional approaches (Yu, Hong, & Phillips, 2022). M. Barassi, Y. Karavias, and C. Zhu justified the use of threshold regression for heterogeneous panel data with interactive fixed effects, allowing slope parameters and thresholds to vary across observation units, thereby improving estimation accuracy under conditions of panel heterogeneity and small sample sizes (Barassi, Karavias, & Zhu, 2023). Building on this literature, a threshold estimation methodology is applied, adapted to the specific characteristics of the dataset and variables of interest, to assess the impact of import dependence on employment across sectors of the German economy.

In general terms, the dynamic threshold model for each sector with a lagged dependent variable can be specified as follows:

$$Y_t^{(i)} = \alpha^{(i)} + \beta_1 X_t^{(i)} \cdot I\left(X_t^{(i)} \le \gamma^{(i)}\right) + \beta_2 X_t^{(i)} \cdot I\left(X_t^{(i)} > \gamma^{(i)}\right) + \varphi Y_{t-1}^{(i)} + \varepsilon_t^{(i)} \quad (1)$$

where $Y_t^{(i)}$ denotes the dependent variable for the *i*-th observation at time *t*; $X_t^{(i)}$ is the explanatory variable for the *i*-th observation at time *t*; $\alpha^{(i)}$ represents the sector-specific intercept for the *i*-th observation; I(·) is an indicator function distinguishing observations below and above the threshold; β_1 captures the effect of $X_t^{(i)}$ when $X_t^{(i)} \le \gamma^{(i)}$; β_2 captures the effect of $X_t^{(i)}$ when $X_t^{(i)} > \gamma^{(i)}$; $\gamma^{(i)}$ denotes the threshold value of $X_t^{(i)}$ at which the effect on $Y_t^{(i)}$ may change; φ is the coefficient of the lagged dependent variable $Y_{i,t-1}$, capturing dynamic persistence; and $\varepsilon_t^{(i)}$ is the idiosyncratic error term.

The indicator functions are defined as:

$$I\left(X_t^{(i)} \le \gamma^{(i)}\right) = \begin{cases} 1, \text{if } X_t^{(i)} \le \gamma^{(i)} \\ 0, \text{if } X_t^{(i)} > \gamma^{(i)} \end{cases} \quad (2)$$

$$I\left(X_t^{(i)} > \gamma^{(i)}\right) = \begin{cases} 1, \text{ if } X_t^{(i)} > \gamma^{(i)} \\ 0, \text{if } X_t^{(i)} \leq \gamma^{(i)} \end{cases} \quad (3)$$

The threshold value $\gamma^{(i)}\gamma^{(i)}$ for each observation is defined as the value of the explanatory variable $X_t^{(i)}$ at which its effect on the dependent variable $Y_t^{(i)}$ changes. Within the threshold regression framework, this is achieved by identifying the threshold that minimises the sum of squared residuals (SSR) of the model:

$$\hat{\gamma}^{(i)} = \arg\min_{\gamma} \sum_{t=1}^{T} \left[Y_t^{(i)} - \alpha^{(i)} - \beta_1 X_t^{(i)} \cdot I\left(X_t^{(i)} \leq \gamma^{(i)}\right) - \beta_2 X_t^{(i)} \cdot I\left(X_t^{(i)} > \gamma^{(i)}\right) - \varphi Y_{t-1}^{(i)}\right]^2 \quad (4)$$

where, for each sector i, all potential values of $X_t^{(i)}$ are iteratively considered as candidate threshold values $\gamma^{(i)}$, and the value of $\gamma^{(i)}$ that minimises the residual variance, thereby ensuring the optimal separation of effects before and after the threshold, is selected. Furthermore, the confidence interval for $\gamma^{(i)}$is estimated using the bootstrap method to account for uncertainty in the threshold estimate.

Results and Discussion

To construct dynamic threshold models for 42 sectors of the German economy over the period 1995–2022, comprising 28 time periods, the following indicators are used: the dependent variable $Y_t^{(i)}$, defined as the share of employment in the sector *i* at time *t* (%); $X_t^{(i)}X_t^{(i)}$, representing import dependence in the sector *i* at time *t* (%); and the R statistical software package. As a result, the estimated regression–correlation equations are presented in Table 1.

The results reveal substantial heterogeneity in the effects of the explanatory variable $X_t^{(i)}$. In certain sectors (e.g. mining, metallurgy), the threshold coefficients β_1 and β_2 are close to zero, whereas in transport, accommodation and services, relatively high coefficient values are observed, indicating pronounced differentiation in the impact of $X_t^{(i)}$ depending on the threshold γ. The coefficient of the lagged dependent variable $Y_{t-1}^{(i)}$ is high in most sectors (0.217–1.082), indicating a strong dynamic component in the evolution of employment shares. High RI values (predominantly above 0.9) confirm the strong overall fit of the model for most sectors, although a moderate fit is observed in some cases. The estimated threshold values of γ range from 0.060 to 0.447, reflecting the varying sensitivity across Germany's economic sectors to changes in the explanatory variables. Sectors with low γ respond to relatively small changes in $X_t^{(i)}$, whereas in sectors with high γ, the effect of changes in $X_t^{(i)}$ emerges only after substantial fluctuations. Accordingly, the results highlight the importance of accounting for threshold effects of import dependence when modelling employment across sectors of the German economy.

Based on the results presented in Table 1, a diagnostic assessment of threshold values was conducted for each industry using the bootstrap method. The median threshold value and its corresponding confidence intervals were obtained, alongside model fit indicators, standard errors, and the statistical significance of the

Table 1

Dynamic threshold regression results across industries in the German economy

Sector No.	Industry / Sector	Industry code	α	γ	β_1 ($X_t^{(i)} \leq \gamma$)	β_2 ($X_t^{(i)} > \gamma$)	φ	R^2
1	Mining and quarrying	B	0.000199	0.1748	−0.001233	−0.000406	0.904449	0.994
2	Coal and lignite mining	D01	0.001915	0.1676	0.004392	0.003273	0.661843	0.734
3	Oil and gas extraction	D02	−0.000049	0.1244	0.001681	0.000957	0.856300	0.982
4	Metal ore mining	D03	0.000083	0.2033	−0.000094	−0.000080	0.217261	0.902
5	Manufacture of food products, beverages and tobacco products	D10T12	0.002226	0.2001	0.005792	0.002105	0.871634	0.964
6	Manufacture of textiles, wearing apparel, leather and related products	D13T15	−0.000923	0.3068	0.003806	0.003342	0.918410	0.998
7	Wood processing and manufacture of paper products	D16	−0.000158	0.1746	0.000790	0.001262	0.970457	0.995
8	Manufacture of chemicals and chemical products	D17T18	−0.000482	0.2223	0.002861	0.002531	0.966001	0.997
9	Manufacture of pharmaceutical products	D19	0.000013	0.4475	0.000258	0.000102	0.832978	0.824
10	Manufacture of rubber and plastic products	D20	0.002551	0.2365	0.00133	−0.000291	0.720025	0.979
11	Manufacture of other non-metallic mineral products	D21	0.001245	0.3234	0.000629	0.000909	0.564197	0.772
12	Metallurgy and manufacture of fabricated metal products	D22	0.000357	0.2610	−0.002474	−0.001418	1.006479	0.829
13	Manufacture of machinery and equipment	D23	0.000724	0.2396	−0.001172	−0.000672	0.900264	0.995
14	Manufacture of basic pharmaceutical products and pharmaceutical preparations	D24	−0.000583	0.3369	0.005114	0.003873	0.858218	0.966
15	Manufacture of transport equipment	D25	−0.005138	0.2280	0.015701	0.013143	1.081680	0.773
16	Manufacture of computers, electronic and optical products	D26	0.003241	0.2892	−0.003463	−0.002499	0.733594	0.862
17	Manufacture of electrical equipment	D27	0.000488	0.2128	0.002900	0.001508	0.919572	0.962
18	Manufacture of machinery and equipment n.e.c.	D28	0.012753	0.2420	−0.006597	−0.004718	0.596723	0.583
19	Manufacture of motor vehicles and transport equipment	D29	0.007168	0.2302	−0.025748	−0.020785	0.912638	0.912
20	Manufacture of other transport equipment	D30	0.002111	0.3444	0.000115	−0.000135	0.372495	0.519
21	Manufacture of furniture, other manufacturing, repair and installation of machinery and equipment	D31T33	0.002049	0.2252	−0.004504	−0.003016	0.916339	0.980
22	Electricity, gas, steam and air conditioning supply	D35	0.001519	0.1513	0.001335	−0.000219	0.770990	0.973
23	Water supply; sewerage, waste management and remediation activities	D36T39	0.001957	0.0981	−0.009001	−0.008140	0.834216	0.91
24	Construction	D41T43	0.006903	0.1559	−0.025054	−0.010733	0.902438	0.995
25	Wholesale and retail trade; repair of motor vehicles and motorcycles	D45T47	0.018836	0.1211	−0.032483	−0.039053	0.894343	0.989
26	Land transport and pipeline transport	D49	0.006626	0.1296	−0.015256	−0.011831	0.767278	0.913
27	Water transport	D50	−0.000014	0.1132	0.000847	0.000301	0.915847	0.923
28	Air transport	D51	0.000035	0.2208	0.000629	0.000358	0.917038	0.904
29	Warehousing and support activities for transportation	D52	−0.001962	0.0944	0.036306	0.008418	1.057652	0.951
30	Postal and courier activities	D53	0.001393	0.1240	0.004129	0.001185	0.855183	0.833
31	Accommodation and food service activities	D55T56	0.002704	0.1374	0.027044	0.017620	0.847430	0.945
32	Publishing activities, motion picture, video and television programme production, sound recording and music publishing	D58T60	0.003697	0.1511	−0.015006	−0.011675	0.751173	0.974

Continuation of Table 1

Dynamic threshold regression results across industries in the German economy

Sector No.	Industry / Sector	Industry code	α	γ	$\beta_1 (X_t^{(i)} \leq \gamma)$	$\beta_2 (X_t^{(i)} > \gamma)$	φ	R^2
33	Telecommunications	D61	−0.000652	0.1197	0.006791	0.004632	0.949545	0.989
34	Information and communication	D62T63	−0.003393	0.1801	0.023704	0.020197	0.987617	0.995
35	Financial and insurance activities	D64T66	0.001222	0.1384	−0.012863	−0.007940	0.991394	0.993
36	Real estate activities	D68	0.000511	0.0603	0.010603	−0.000189	0.952374	0.946
37	Professional, scientific and technical activities; administrative and support service activities	D69T75	0.000967	0.1061	0.028164	0.018947	0.948982	0.997
38	Education, human health and social work activities	D77T82	0.010839	0.0651	−0.059402	−0.016769	0.886639	0.986
39	Public administration and defence; compulsory social security	D84	0.012066	0.1518	−0.057924	−0.045008	0.933668	0.986
40	Education	D85	0.007434	0.1247	−0.019139	−0.013498	0.911723	0.964
41	Human health and social work activities	D86T88	−0.003354	0.1571	0.021659	0.010603	1.019135	0.991
42	Arts, entertainment and recreation	D90T93	0.001766	0.0924	−0.009008	−0.005523	0.915400	0.969

**Calculated by the authors based on Eurostat data (Database. Eurostat: Website, 2026).*

effects (Table 2). The estimated threshold values make it possible to distinguish sectoral behaviour under conditions of low and high levels of import dependence on employment dynamics, thereby reflecting key characteristics of the labour market. From an economic perspective, it is appropriate to interpret the sector-specific threshold values as follows.

According to the results presented in Tables 1 and 2, the sectors of the German economy can be classified into three main groups:

1) Sectors in which import dependence has an adverse effect on the structure of employment. These include mining and quarrying; manufacturing; manufacture of motor vehicles and other transport equipment; manufacture of other transport equipment; manufacture, repair and installation of furniture; construction; wholesale and retail trade and repair of motor vehicles; water supply and waste management; as well as predominantly public-sector activities, namely education, human health and social work, public administration and defence, and arts, entertainment and recreation;

2) Sectors in which import dependence has a positive impact on the structure of employment. These include coal and lignite mining; oil and gas extraction; manufacture of food products; manufacture of basic pharmaceutical products and pharmaceutical preparations; manufacture of other non-metallic mineral products; manufacture of electrical equipment; transport services; accommodation and courier services; telecommunications and information and communication activities; professional, scientific and technical activities; human health and social work activities; and real estate activities;

3) Sectors with a mixed or statistically negligible effect of import dependence on the structure of employment. These include manufacture of computer, electronic and optical products; manufacture of rubber and plastic products; and manufacture of chemicals and chemical products.

Consequently, the estimated heterogeneity in threshold effects indicates the absence of a uniform structural transmission channel linking import dependence and employment. This can be attributed to sector-specific characteristics, differences in innovation and technological advancement, and varying degrees of integration into global value chains. In particular, in sectors of the German economy where import dependence exerts an adverse impact on employment, there is likely a substantial risk of domestic production being displaced by imported goods. This is

Table 2

Threshold values and diagnostic assessment of their validity for employment across industries in the German economy

Industry code	Estimated threhold	Median threhold (Bootstrep)	95% confidential interval		SSR	β_1	SE β_1	p-value β_1	β_2
			Lower bound	Upper bound					
B	0.1748	0.1748	0.1432	0.2678	$1.62\cdot10^{-7}$	-0.001233	$7.16\cdot10^{-4}$	$9.85\cdot10^{-2}$	-0.000406
D01	0.1676	0.1781	0.1523	0.2277	$3.84\cdot10^{-7}$	0.004392	$1.70\cdot10^{-4}$	$1.66\cdot10^{-2}$	0.003273
D02	0.1244	0.1244	0.1124	0.1575	$5.36\cdot10^{-8}$	0.001681	$7.12\cdot10^{-4}$	$2.71\cdot10^{-2}$	0.000957
D03	0.2033	0.2002	0.1945	0.3079	$6.59\cdot10^{-11}$	-0.000094	$1.22\cdot10^{-5}$	$8.66\cdot10^{-8}$	$-8.04\cdot10^{-5}$
D10T12	0.2001	0.2001	0.1645	0.217	$1.17\cdot10^{-6}$	0.005792	$2.72\cdot10^{-3}$	$4.44\cdot10^{-2}$	0.002105
D13T15	0.3068	0.3036	0.268	0.3138	$1.46\cdot10^{-7}$	0.003806	$1.35\cdot10^{-3}$	$9.65\cdot10^{-3}$	0.003342
D16	0.1746	0.1746	0.1456	0.1778	$5.90\cdot10^{-8}$	0.000790	$1.15\cdot10^{-7}$	$5.01\cdot10^{-7}$	0.001262
D17T18	0.2223	0.2223	0.1965	0.2387	$8.88\cdot10^{-8}$	0.002861	$1.22\cdot10^{-3}$	$2.82\cdot10^{-2}$	0.002531
D19	0.4475	0.5233	0.4475	0.6750	$1.54\cdot10^{-8}$	0.000258	$1.00\cdot10^{-4}$	$1.69\cdot10^{-2}$	0.000102
D20	0.2365	0.2365	0.2203	0.3630	$4.87\cdot10^{-7}$	0.00133	$1.12\cdot10^{-3}$	$2.48\cdot10^{-1}$	-0.000291
D21	0.3234	0.2887	0.1845	0.3285	$1.26\cdot10^{-7}$	0.000629	$4.02\cdot10^{-4}$	$1.31\cdot10^{-1}$	0.000909
D22	0.2610	0.2506	0.2150	0.3236	$9.08\cdot10^{-7}$	-0.002474	$2.44\cdot10^{-7}$	$3.21\cdot10^{-1}$	-0.001418
D23	0.2396	0.2046	0.1359	0.2561	$1.50\cdot10^{-7}$	-0.001172	$7.86\cdot10^{-7}$	$1.50\cdot10^{-1}$	-0.000672
D24	0.3369	0.3369	0.2935	0.3543	$4.84\cdot10^{-7}$	0.005114	$1.73\cdot10^{-7}$	$7.13\cdot10^{-3}$	0.003873
D25	0.2280	0.2104	0.1768	0.2280	$5.14\cdot10^{-6}$	0.015701	$7.46\cdot10^{-3}$	$4.64\cdot10^{-2}$	0.013143
D26	0.2892	0.2892	0.2494	0.3610	$6.31\cdot10^{-7}$	-0.003463	$1.98\cdot10^{-7}$	$9.32\cdot10^{-2}$	-0.002499
D27	0.2128	0.2128	0.1773	0.3062	$1.38\cdot10^{-6}$	0.0029	$3.08\cdot10^{-3}$	$3.55\cdot10^{-1}$	0.001508
D28	0.2420	0.2291	0.1860	0.2453	$4.97\cdot10^{-6}$	-0.006597	$4.70\cdot10^{-7}$	$1.74\cdot10^{-1}$	-0.004718
D29	0.2302	0.2134	0.1898	0.2506	$3.94\cdot10^{-6}$	-0.025748	$7.62\cdot10^{-3}$	$2.60\cdot10^{-3}$	-0.020785
D30	0.3444	0.3396	0.2900	0.3795	$1.32\cdot10^{-7}$	0.000115	$6.03\cdot10^{-4}$	$8.51\cdot10^{-1}$	-0.000135
D31T33	0.2252	0.2252	0.1958	0.2733	$5.02\cdot10^{-7}$	-0.004504	$2.34\cdot10^{-3}$	$6.63\cdot10^{-2}$	-0.003016
D35	0.1513	0.1493	0.1330	0.1783	$4.98\cdot10^{-7}$	0.001335	$1.57\cdot10^{-3}$	$4.03\cdot10^{-1}$	-0.000219
D36T39	0.0981	0.1002	0.0955	0.1035	$9.52\cdot10^{-8}$	-0.009001	$2.86\cdot10^{-3}$	$4.52\cdot10^{-3}$	-0.008140
D41T43	0.1559	0.1408	0.1256	0.1564	$1.50\cdot10^{-5}$	-0.025054	$1.91\cdot10^{-2}$	$2.02\cdot10^{-1}$	-0.010733
D45T47	0.1211	0.1152	0.1034	0.1347	$9.23\cdot10^{-6}$	-0.032483	$1.49\cdot10^{-2}$	$3.95\cdot10^{-2}$	-0.039053
D49	0.1296	0.1296	0.1148	0.1625	$3.53\cdot10^{-6}$	-0.015256	$6.79\cdot10^{-3}$	$3.45\cdot10^{-1}$	-0.011831
D50	0.1132	0.1132	0.0751	0.1364	$1.54\cdot10^{-8}$	0.000847	$5.43\cdot10^{-4}$	$1.32\cdot10^{-1}$	0.000301
D51	0.2208	0.2208	0.1629	0.2433	$3.42\cdot10^{-8}$	0.000629	$4.17\cdot10^{-4}$	$1.46\cdot10^{-1}$	0.000358
D52	0.0944	0.0944	0.0944	0.1356	$4.27\cdot10^{-6}$	0.036306	$1.81\cdot10^{-2}$	$5.71\cdot10^{-2}$	0.008418
D53	0.1240	0.1222	0.0916	0.1484	$1.72\cdot10^{-6}$	0.004129	$4.78\cdot10^{-3}$	$3.97\cdot10^{-1}$	0.001185
D55T56	0.1374	0.1374	0.1093	0.1461	$2.31\cdot10^{-5}$	0.027044	$2.32\cdot10^{-2}$	$2.56\cdot10^{-1}$	0.017620
D58T60	0.1511	0.1174	0.0781	0.1511	$1.39\cdot10^{-6}$	-0.015006	$6.10\cdot10^{-3}$	$2.19\cdot10^{-2}$	-0.011675
D61	0.1197	0.1197	0.1180	0.1241	$7.87\cdot10^{-7}$	0.006791	$3.47\cdot10^{-3}$	$6.29\cdot10^{-2}$	0.004632
D62T63	0.1801	0.1801	0.1719	0.2245	$2.66\cdot10^{-6}$	0.023704	$6.04\cdot10^{-3}$	$6.81\cdot10^{-4}$	0.020197
D64T66	0.1384	0.1080	0.0887	0.1384	$2.27\cdot10^{-6}$	-0.012863	$7.65\cdot10^{-3}$	$1.06\cdot10^{-1}$	-0.007940
D68	0.0603	0.0603	0.0588	0.0810	$4.23\cdot10^{-7}$	0.010603	$5.44\cdot10^{-3}$	$6.35\cdot10^{-2}$	-0.000189
D69T75	0.1061	0.1061	0.0945	0.1346	$4.07\cdot10^{-6}$	0.028164	$1.25\cdot10^{-}$	$3.41\cdot10^{-2}$	0.018947
D77T82	0.0651	0.0744	0.0641	0.1612	$5.60\cdot10^{-5}$	-0.059402	$2.29\cdot10^{-2}$	$1.62\cdot10^{-2}$	-0.016769
D84	0.1518	0.1497	0.1374	0.1784	$2.37\cdot10^{-5}$	-0.057924	$2.06\cdot10^{-2}$	$9.99\cdot10^{-3}$	-0.045008
D85	0.1247	0.1232	0.1045	0.1423	$6.22\cdot10^{-6}$	-0.019139	$7.28\cdot10^{-2}$	$1.50\cdot10^{-2}$	-0.013498
D86T88	0.1571	0.1562	0.1327	0.1698	$3.75\cdot10^{-5}$	0.021659	$2.55\cdot10^{-2}$	$4.05\cdot10^{-1}$	0.010603
D90T93	0.0924	0.0924	0.0664	0.1321	$6.58\cdot10^{-7}$	-0.009008	$3.30\cdot10^{-3}$	$1.19\cdot10^{-2}$	-0.005523

**Calculated by the authors based on Eurostat data (Database. Eurostat: Website, 2026).*

especially characteristic of capital-intensive or standardised industries, in which price competition plays a dominant role. As a result, employment in these sectors becomes more vulnerable to external shocks, while import dependence exacerbates structural imbalances in the labour market.

At the same time, the opposite effect observed in a number of sectors can be interpreted in terms of the complementarity between imports and employment through the productivity channel. In these sectors, imports play a non-substitutive rather than a substitutive role by providing access to cheaper or technologically

specialised intermediate inputs. This generates effects associated with lower production costs and higher total factor productivity, which, in turn, expands the productive capacity of firms within the sector and support growth in labour demand. Such a transmission mechanism is characteristic of sectors integrated into global value chains, where imports do not act as a source of displacement.

For sectors of the German economy characterised by a mixed or weak relationship between import dependence and employment, specific transmission mechanisms may be at work. In such cases, imports may contribute to job creation as import dependence increases. However, once a certain threshold level is reached, competitive effects become dominant, gradually exerting an adverse influence on the employment structure. At the macroeconomic level, the impact of import dependence on employment in Germany may also be shaped by labour market policy initiatives, innovation policies, and sector-specific characteristics. According to the estimated regression equations (Table 1) and the identified threshold values (Table 2), employment in more technologically advanced sectors appears to be less sensitive to adverse shocks associated with import dependence. This further underscores the importance of implementing policy initiatives aimed at fostering innovation and upgrading the technological level of production.

The findings on the sectoral structure of employment in Germany complement existing research, which has shown that the impact of import competition on employment and workers' incomes varies across countries and sectors. According to M. Wang and L. Ma, import competition increases the skill premium through innovation and technological modernisation, although its effect diminishes in regions characterised by high labour market flexibility, indicating the presence of threshold effects (Wang & Ma, 2025). S. Basco, M. Liйgey, M. Mestieri, and J. Smagghue reveal that import competition from China in France reduces workers' incomes in occupations most exposed to trade shocks, with the magnitude of this effect being comparable to that of sectoral employment structure (Basco, Liйgey, Mestieri, & Smagghue, 2025). Additionally, Y. Xiao, X. Zhu, and J. Ma find that greater variety in imported goods in China contributes to employment growth through higher productivity and export expansion, particularly in capital-intensive sectors and in eastern and western regions (Xiao, Zhu, & Ma, 2025). In contrast, F. Shi demonstrates that import competition from China in India between 1999 and 2011 had a mixed impact on local labour markets: average wages declined in certain districts, while employment shares increased, with effects varying by age, gender, occupation and sectoral grouping (Shi, 2025). Overall, these studies underscore that the relationship between the sectoral employment structure and external shocks associated with imports is complex and reflects heterogeneity in global value chain configurations.

Furthermore, there are intricate interdependences within national economies that shape employment dynamics. The results of the correlation and regression analysis conducted by M. −A. Georgescu and E. Herman show that high levels of labour productivity, an efficient sectoral structure of employment, and low levels of precarious and vulnerable employment contribute to reducing in-work poverty and strengthening the economic resilience of countries (Georgescu & Herman, 2019). Using structural equation modelling, M. Kichurchak finds that employment in EU countries is influenced by demographic trends, the dynamics of resource productivity, public funding frameworks in higher education, and environmental taxation policies (Kichurchak, 2024). By comparing human capital levels in Central and Eastern European countries with those in EU member states, I. Ja wi ski highlights the need for differentiated approaches to employment policy design across national economies (Ja wi ski, 2024). Accordingly, it is crucial to account not only for the threshold effects of import dependence and their role in shaping the sectoral structure of

employment, but also for country-specific institutional factors, employment policy frameworks, and the social conditions underpinning human capital development.

Conclusions and Directions for Further Research

Thus, dynamic threshold modelling for each of Germany's economic sectors has made it possible to identify critical thresholds for the impact of import dependence on the sectoral structure of employment, while the statistical reliability of the estimated threshold values has been confirmed using bootstrap methods. On this basis, three groups of sectors are identified, namely sectors where import dependence has an adverse effect on employment, sectors where it has a positive effect, and sectors where the effect is mixed or negligible. The adverse impact of import dependence is most frequently observed in sectors characterised by strong external competition or high regulatory constraints and limited domestic resource endowments. The positive effect is typically associated with technological specificity and integration into global production networks, where imported goods and technologies act as complementary inputs to the development of domestic production. Sectors with a mixed or negligible effect include high-tech or diversified industries, where threshold effects of import dependence are weakly expressed. In these sectors, the coefficients β□ and β□ are negligible in magnitude or differ in sign, indicating a weak or statistically insignificant relationship between import dependence and employment.

Moreover, the results of the study highlight that the impact of imports on employment in Germany is heterogeneous and depends on sector-specific characteristics, the level of technological advancement, and the degree of integration into global value chains. The adverse effect predominates in highly competitive and heavily regulated sectors of economic activity, whereas a positive effect is observed in high-tech and innovation-oriented sectors.

Meanwhile, the study has several limitations. First, the modelling of the impact of import dependence on the sectoral structure of employment is conducted using a single developed economy – Germany – which limits the generalisability of the results to other countries. Second, the use of data for the period 1995–2022 captures structural transformations typical of developed economies over this period, including crises and structural changes, but does not account for potential inter-sectoral linkages and multiplier effects. Furthermore, the import dependence indicator used does not reflect the quality dimension of imported goods and technologies, which may affect sectoral productivity and innovation dynamics. These limitations should be taken into account when interpreting the results and deriving implications for economic policy. At the same time, in the context of Ukraine's post-war economic recovery, the findings of the study may serve as an analytical framework for justifying selective policies designed to support sectors with high potential for integration into global value chains, as well as for applying a threshold approach to assessing the impact of import dependence on employment and identifying the most vulnerable economic activities.

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Кічурчак М. В., Созанський Л. Й. Моделювання впливу імпортної залежності на структуру зайнятості в розвиненій економіці: на прикладі Німеччини

Мета. *Дослідження здійснює комплексний економетричний аналіз впливу імпортної залежності на секторальну структуру зайнятості у розвиненій економіці на прикладі Німеччини. Актуальність роботи зумовлена поглибленням інтеграції національних економік у глобальні ланцюги створення вартості та зростанням ролі імпорту як основного детермінанта трансформації ринку праці. Метою дослідження є кількісне оцінювання впливу імпортної залежності на галузеву структуру зайнятості у розвиненій економіці (Німеччина) з урахуванням порогових ефектів на основі застосування динамічного порогового підходу моделювання.*

Методологія. *Емпіричну базу дослідження сформовано на основі панельних даних за 1995–2022 рр., що охоплюють 42 види економічної діяльності. Методологічна рамка ґрунтується на динамічній пороговій регресійній моделі, яка дає змогу ідентифікувати нелінійні зв'язки між змінними та оцінювати критичні значення імпортної залежності, за яких змінюються як сила, так і напрям її впливу на зайнятість. Для забезпечення статистичної надійності оцінок застосовано bootstrap-процедуру, що дозволяє уточнити параметри порогів і перевірити їх коректність.*

Результати. *Отримані результати підтверджують наявність статистично значущих порогових ефектів, що свідчить про структурну неоднорідність впливу імпортної залежності на ринок праці. Встановлено, що перетин певних критичних рівнів імпортної залежності супроводжується зміною як знаку, так і величини її впливу на зайнятість. Відповідно, ідентифіковано три групи секторів: сектори з переважно негативним впливом (ефект витіснення), сектори з позитивним впливом (зумовленим участю у глобальних виробничих мережах) і сектори зі змішаними або статистично незначущими ефектами.*

Оригінальність. *Науковий внесок дослідження полягає у застосуванні динамічного порогового підходу до аналізу взаємозв'язку між імпортною залежністю та зайнятістю, що дає змогу врахувати нелінійні, асиметричні та секторально гетерогенні ефекти.*

Практичне значення. *Практичні імплікації результатів полягають у формуванні аналітичної основи для селективної структурної політики, спрямованої на сектори з високим потенціалом інтеграції у глобальні ланцюги створення вартості. Отримані результати є особливо релевантними для перехідних і посткризових економік, зокрема України, де оптимізація імпортної залежності та стимулювання зайнятості є критично важливими в контексті післявоєнного економічного відновлення.*

Ключові слова: *регіональний розвиток, інноваційна екосистема, територіальна громада, людський капітал, розвиток інновацій, мережева взаємодія, конкурентоспроможність.*

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