# ROMANIAN ECONOMIC AND BUSINESS REVIEW

*Statement of Purpose*

The *Romanian Economic and Business Review* (ISSN 1842-2497) intends to provide a forum for academic analysis of the economic phenomena and institutions affecting the world economy in general, and Romania, in particular. *REBE* examines a wide variety of phenomena related to economic growth and business development and attempts to publish high quality research focusing on the role of institutions and public policy, within both a national and international context. *REBE* encourages cross-disciplinary research work of Romanian and foreign scholars.

*Indexed* and/or *Abstracted* in:
EBSCO; EconLit; ProQuest; Index Copernicus; RePec

*Author Information*

The ROMANIAN ECONOMIC AND BUSINESS REVIEW (REBE) is a refereed journal published four times annually by the Romanian-American University. The editors invite submissions of articles that deal with important issues in economy and business. Papers that focus on specific phenomena and events affecting Romanian economy are particularly encouraged. Because REBE seeks a broad audience, papers should be comprehensible beyond narrow disciplinary bounds.

Manuscripts should not exceed 8,000 words and must conform to the REBE's style requirements, which are guided by The Chicago Manual of Style (14th edition). All submissions must include a cover sheet explaining the scope of the article, and including the authors' names and affiliations, telephone and e-mail address. The text should be single-spaced. References are cited with parentheses using the author/date/page style. *Example*: (Marcus, 2005, p. 74). Authors should use footnotes, not endnotes to add only short comments. Bibliography should include only references cited in the text, in the alphabetical order of authors. An abstract of no more than 200 words should be included.

Submission of a paper implies that the paper will not be submitted for publication to another journal unless rejected by the REBE editor or withdrawn by the author, and that it is an original work. All submissions should be sent to the journal Editor:

Dr. Bogdan Glăvan
Romanian-American University
Bulevardul Expoziţiei nr. 1B
Bucureşti
E-mail: bogdan.nicolae.glavan@rau.ro

# ROMANIAN ECONOMIC AND BUSINESS REVIEW

FALL 2025 VOLUME 20 NUMBER 3

PRO UNIVERSITARIA
BUCUREŞTI
2025®

ISSN 1842 – 2497

# ROMANIAN ECONOMIC AND BUSINESS REVIEW

***CONTENTS***

# THE EU VERSUS THE US:
# FACTS, FIGURES, AND LATEST DEVELOPMENTS

*Mona Maria Ivănescu*[1]

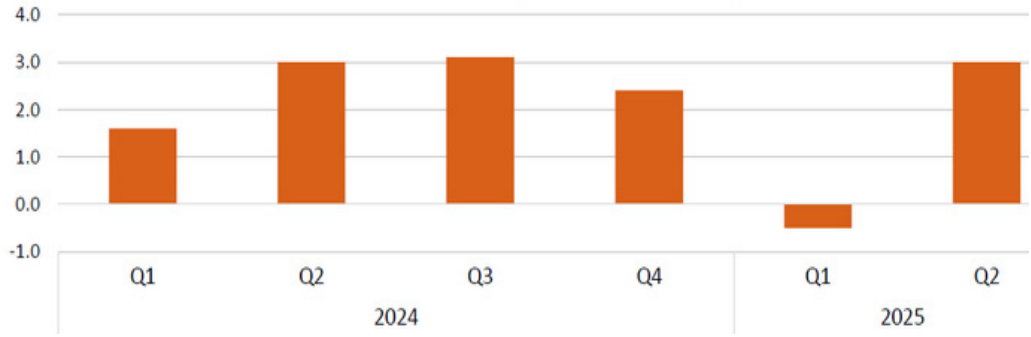
**Abstract**

*The European Union and the United States are truly the world's most advanced and interconnected economies, despite all political differences. This article reviews this bilateral cooperation (GDP, trade in goods, services and FDI's), trying to explain the economic architecture and, the most recent events, notably the July tariff framework and its unresolved implementation.*

**Keywords:** *transatlantic cooperation, protectionism, economic diplomacy.*
**JEL Classification**: *O11, F50, E60.*

The European Union and The United States form the world's most advanced and intertwined economic partnership. Every year, trade in products and services exceeds hundreds of billions of dollars; investment stocks are measured in trillions; and policy coordination, while occasionally rocky, creates global norms in technology, finance, and sustainability. Even with the recently rising tariff tensions in 2025, the transatlantic economic region remains in a combined view the world's main source of value added, innovation, and highly skilled quality jobs. This article investigates the numbers and the implications behind the visible bilateral cooperation (GDP, demography, commerce in goods and services, investment), explaining the policy architecture and the most recent developments.

***Figure 1: Real GDP US - percent change from previous quarter-***

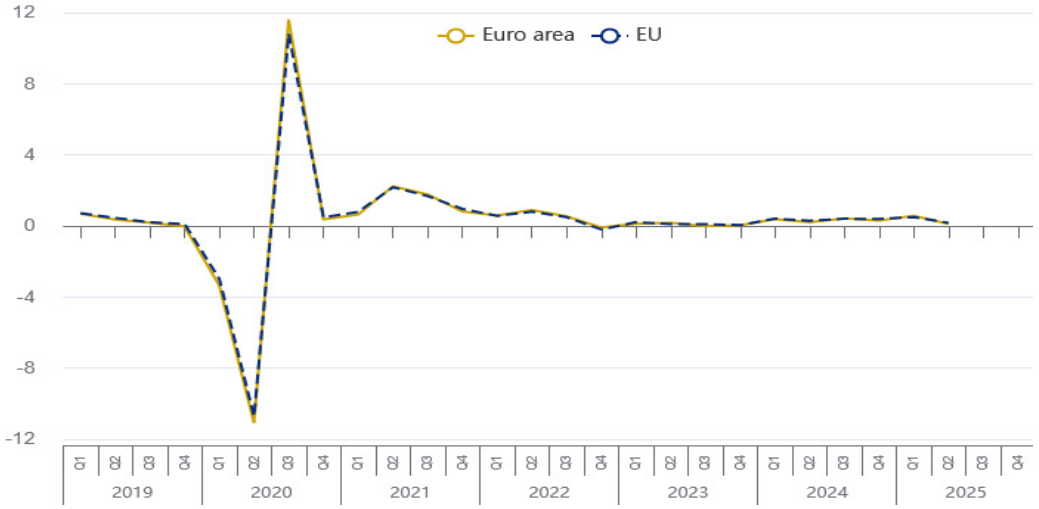



*source: "https://www.bea.gov/sites/default/files/2025-01/gdp4q24-adv.pdf"*

[1] Mona Maria IVĂNESCU, PhD, Assistant Professor at the Romanian American University in Bucharest. E-mail: mona.ivanescu@rau.ro

The USeconomy remained in 2024 the world's largest by nominal GDP. According to BEA reports[2], real GDP grew 2.8% in 2024, with current-dollar GDP levels being around $29 trillion by the end of 2024. 2025 might also confirm this trend, with growth accelerated in the first two quarters of 2025.

***Figure 2: Real GDP EU - percent change from previous quarter-***




*source*: *"https://ec.europa.eu/eurostat/web/products-euro-indicators/w/2-30072025-ap"*

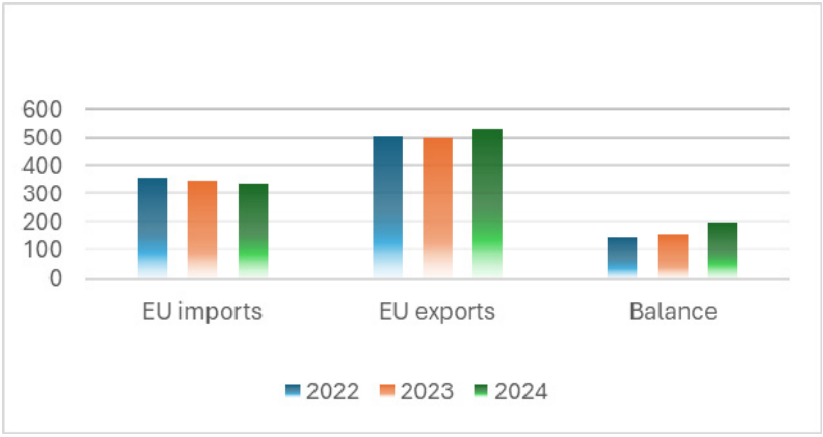
Eurostat offers some official aggregates for the same time period in the EU. According to the most current "Statistics Explained" synthesis, EU GDP in 2024 was €17.9 trillion in buying power standards (PPS)3. Taken together, the data show the EU as a near-peer continental economy smaller than the US in nominal currency, but equivalent in scale when assessed in purchasing power.

In terms of demographics, both Europe and the United States have aging populations. Last year, the median age in the United States had surpassed 39.1 years[4] while the European Union had the same indication at 44.7 years [5]. US proves to be a little bit "younger" but still, it remains similar. Over the last decade, the EU population has grown more reliant on migration to offset unfavorable natural trends, while USimmigration policy is also linked to a countrywide aging trend, since immigrants, particularly younger ones, are vital to preserve the workforce equilibrium, covering the declining USborn working population. However, an increasing proportion of elderly immigrants encounter obstacles, all future

[2] The Bureau of Economic Analysis (BEA), https://www.bea.gov/
[3] "https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National_accounts_and_GDP "
[4] "https://www.census.gov/library/stories/2025/06/metro-areas-median-age.html"
[5] "https://ec.europa.eu/eurostat/fr/web/products-eurostat-news/-/ddn-20250221-2"

policies being meant to balance the economic benefits of immigration against an aging electorate.

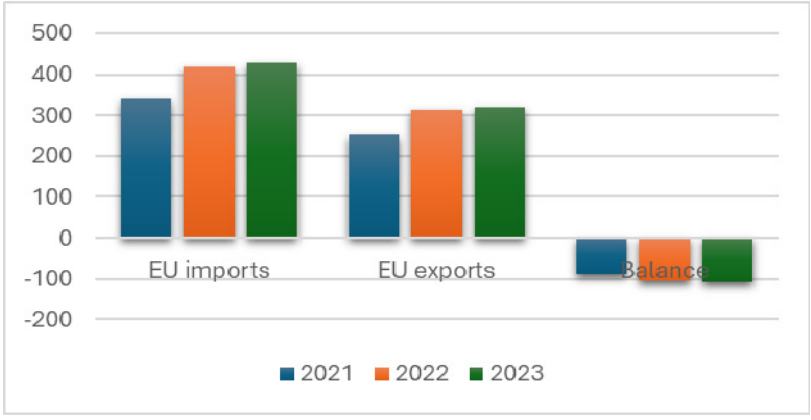
***Figure 3: EU vs US -trade in goods (Eur. billion)***




*source: "https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/ countries-and-regions/united-states_en"*

From the trade perspective, the bilateral goods exchanges reached €953.2 billion in 2024, with EU exports to the US recorded at €578.6 billion and imports at €374.6 billion[6]. That caused a surplus of €204.1 billion on the EU side and placing US as EU's largest export destination in 2024.

***Figure 4: EU vs US -trade in services (Eur. billion)***



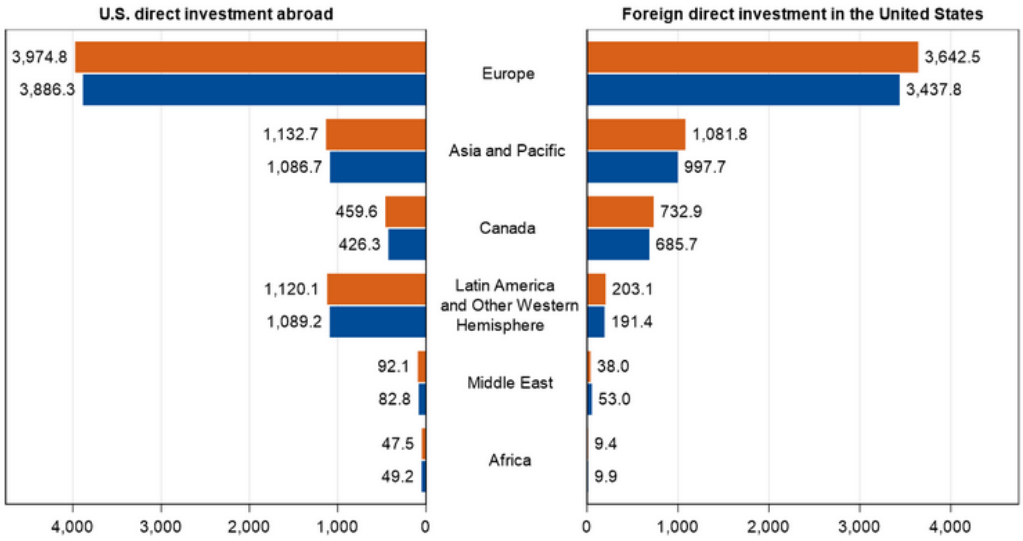

*source: "https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/ countries-and-regions/united-states_en"*

[6] https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/united-states_en

Analyzing services, we will notice that the US typically runs a surplus with the EU. USTR's 2024 figures report US services exports to the EU at $402.9 billion and US services imports at $302.2 billion, causing a trade surplus of $100.7 billion[7]. Other data published by DG trade factsheet shows an EU services deficit of €108.6 billion.[8]

Foreign direct investments (FDI) are the foundation of the transatlantic economy, and the best channel for technology transfer and job creation. The United States absorbed in 2023 almost 27% (€2.437 trillion) of EU outward FDI stocks, making it the EU's top FDI destination[9]. In terms of member states, the Netherlands ($726.4b) and United Kingdom ($742.7b) are top individual investing countries.[10]

***Figure 5: Direct Investment Positions, 2023-2024 ($ billion)***




*source: "https://www.bea.gov/news/2025/direct-investment-country-and-industry-2024 "*

The 2024 EU main export categories to the US were high value chemicals (ex. pharma), machinery, transport equipment, some specialized industrial products and agricultural products, while on imports, EU bought mainly energy-related commodities (fuels and mining), and some specialized chemicals. Concerning services, both countries proved appetite for business, professional services, financial, IT and telecom, R&D, travel and education, and intellectual property

[7] https://ustr.gov/countries-regions/europe-middle-east/europe/european-union
[8] https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/united-states_en
[9] https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20241203-1
[10] https://www.bea.gov/news/2025/direct-investment-country-and-industry-2024

services, placing US as a top leader, when we are discussing about R&D capabilities.

*The economic cooperation and political diplomacy between EU and US can be compared with a roller coaster, being chronologically marked by numerous ups and downs*. Only in the last decades have there been some moments to be mentioned in this context.

The Obama administration for example failed to reach a comprehensive trade cooperation agreement with the EU, therefore, the Transatlantic Trade and Investment Partnership (TTIP) has been abandoned. While not a total failure of all cooperation, the failure to finalize TTIP marked a significant setback for major trade integration under the Obama administration. The official reports underlined as main causes of significant public concern and opposition in both the US and Europe regarding the potential impacts of this agreement on consumer protection, environmental standards, and the balance of power between governments and corporations, but, more obviously, the US and EU had different priorities and concerns, which made reaching a mutually agreeable compromise impossible.[11]

On the other hand, Trump administration, during the first mandate, did not considered EU as a true potential economic partner but instead placed Europe on the competitor's map. Despite the obstacles, the EU pursued a strategic response and avoided significant damage from the trade perspective. The EU institutions proved their true capacity to adapt to new circumstances and leverage the two mechanisms of the strategic partnership to advance their interests.

Based on these perspectives, we appreciate that the EU US relationship was also anchored, alongside the diplomacy efforts, into the WTO system, though bilateral mechanisms increasingly supplement the EU institutional results.

As an argument to support the previous statement can be mentioned the June 2021 truce, in the 17-year Airbus–Boeing subsidy disputes, suspending retaliatory tariffs for five years and encouraging both parties to pursue a cooperative framework. The truce eased pressure on agri-food, wines & spirits, and industrial goods previously hit with duties.

Year 2024 came, along with other things, with the inauguration of the second mandate for the president Trump and the EU institutions were once again tested by the new president appetite to negotiate and to promote his 'America First' mantra.

Not further than last month, US President Trump and EU Commission President, Ursula von der Leyen, agreed a new political framework to avert a broader clash, concerning import tariffs because of the already mentioned trade deficit reported by the US agencies. The essence of this agreement lies in the

[11] https://www.clingendael.org/publication/ttip-dead-long-live-transatlantic-trade

US15% baseline tariff on most EU goods, lower than earlier threatened 30% (or higher) extensive rates. In exchange, the EU promised large energy purchases and supplementary investment commitment. Steel and aluminum tariffs were decided at 50%, with a quota-based system to be negotiated in the next months[12].

Did this recent agreement cure all the tensions? I would rather say no. It's just a diplomatic result meant to deescalate, even for some months, the possible even more negative measures possible to be promoted by the American administration. The already tested principle to negotiate, promoted by the Washington administration "argue, then compromise" is still alive and well.

As in a "family" photo, meant to last for the time to come, transatlantic cooperation is defined today by the following landmarks:

- EU as market potential has a significant, with 450.4 million inhabitants[13] while US recently reported 341.1 million[14].
- Economic growth rate is bigger in the US compared with the EU. Also, the unemployment rates are showing US again in a favorable position.
- NATO's future increase contribution up to a 5% by 2035 can be seen aggregately as a potentially transformational trigger for Europe's defense industry, offering UE a better chance to develop and growth if those investments will address mainly the intra EU economy.
- From the AI readiness perspective, EU adopts an ex-ante digital/AI regulation strategy and coordinated industrial policy. US emphasizes enforcement-first plus large-scale incentive. This clearly will shape innovation and competition model promoted by each one.

*In conclusion, the US currently holds a significant competitive advantage over the European Union, marked by higher GDP per capita growth and lower unit labor costs in export-oriented industries. Key factors contributing to the US competitive advantage include a strong entrepreneurial culture, more developed capital markets, and dominance in innovative sectors like Information and Communications Technology (ICT), while Europe faces challenges from lower productivity growth, higher energy costs, and declining investments.*

In this context, the political cooperation and the economic perspectives between the US and the EU depends a lot both on the executive actions and EU legal texts to be issues in the next weeks or months to convert these already agreed topics into enforceable measures and the EU economic capability to become more competitive.

---

[12] https://www.reuters.com/business/us-eu-avert-trade-war-with-15-tariff-deal-2025-07-28/?utm_source=chatgpt.com

[13] https://www.statista.com/statistics/253372/total-population-of-the-european-union-eu/

[14] https://www.worldometers.info/world-population/us-population/#:~:text=The%20current%20population%20of%20the%20United%20States,elaboration%20of%20the%20latest%20United%20Nations%20data1

*On medium run (up to 2030) the common agenda will need to pivot around topics like critical minerals, clean-tech subsidies, defense industrial cooperation, and data governance. New agreements for EVs, batteries, semiconductors, and health tech will temper the American administration and will probably unlock fresh investment both ways. If politics, on both Atlantic shores will not be able to avoid future whiplash, these prospects will not be possible.*

If both sides will decide to embrace some already tested "traditions", authentic bilateral cooperation based on rules, institutions and reciprocity, with future-oriented pragmatism, the transatlantic economic partnership, as imperfect as it is, will remain maybe the world's most reliable engine for shared prosperity on a large scale, being at the same time a guarantee of the survival of the idea of functional democracy, based on the existence of a solid market economy.

## Bibliography

https://ec.europa.eu/eurostat/fr/web/products-eurostat-news/-/ddn-20250221-2, accessed on 20.08.2025

https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National_ accounts_and_GDP, accessed on 16.08.2025

https://ec.europa.eu/eurostat/web/products-euro-indicators/w/2-30072025-ap, accessed on 16.08.2025

https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20241203-1, accessed on 16.08.2025

https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/united-states_en. accessed on 16.08.2025

https://ustr.gov/countries-regions/europe-middle-east/europe/european-union, accessed on 20.08.2025

https://www.bea.gov/news/2025/direct-investment-country-and-industry-2024, accessed on 20.08.2025

https://www.bea.gov/sites/default/files/2025-01/gdp4q24-adv.pdf, accessed on 20.08.2025

https://www.census.gov/library/stories/2025/06/metro-areas-median-age.html, accessed on 20.08.2025

https://www.clingendael.org/publication/ttip-dead-long-live-transatlantic-trade, accessed on 20.08.2025

https://www.reuters.com/business/us-eu-avert-trade-war-with-15-tariff-deal-2025-07-28/?utm_source=chatgpt.com, accessed on 20.08.2025

https://www.statista.com/statistics/253372/total-population-of-the-european-union-eu/, accessed on 20.08.2025

https://www.worldometers.info/world-population/us-population/#:~:text= The%20current%20population%20of%20the%20United%20States,elaboration%20of%20the%20latest%20United%20Nations%20data1, accessed on 20.08.2025

# The spatial layout of bank locations and industrial clusters in the kanto region in 1905: a quantitative analysis using voronoi diagrams and ms-ssim

*Yuki Yasaku*
*Nobumichi Watahiki*
*Cristian Vlad**

**Abstract**

*This study aims to elucidate the spatial relationships between banks—which functioned as financial pumps circulating capital into various industries—and administrative boundaries or natural geographic features, and to examine how their distribution related to the spatial structure of industrial clusters. The authors analysed the development of industrial clusters in Japan at the beginning of the 20th century, indicating that the locations of early financial institutions served as important indicators reflecting the realities of regional economic activities and their networks.*

**Keywords:** *clusters, industrial, space, development, banking, urban, talent, governance, management, Japan, innovation, emotion, transformation.*

**JEL Classification:** *L60, L63, M14.*

## 1. Introduction

In 1905, Japan was undergoing a significant historical transition, as the conclusion of the Russo-Japanese War marked the acceleration of industrialization and urbanization alongside the development of the modern nation-state system. During this period, the establishment of small and medium-sized banks proliferated even in regional areas, gradually expanding the financial infrastructure across the country (Okazaki, 2005). Simultaneously, as transportation methods shifted from river shipping to railways, natural geographic conditions such as terrain and waterways played a major role in shaping the economic networks that connected cities and rural regions.

Against this backdrop, the locations of banks serve as important indicators that reflect the realities of regional economic activities and their networks. In particular, local banks established during the Meiji period were often founded

* Yuki Yasaku is at Nagaoka University of Technology.
Nobumichi Watahiki is Professor at Nagaoka University of Technology.
Cristian Vlad is Ph.D. Candidate, Babes Bolyai University, and Globis University Partner Faculty. E-mail: cristian@japancreativeenterprise.jp.

by local merchants and entrepreneurs, demonstrating strong ties with the local economy. These banks are thus valuable for understanding the initial conditions of economic agglomeration. Accordingly, this study seeks to clarify the spatial distribution of banks in relation to institutional and geographic structures.

Examining the spatial correspondence between bank locations, administrative divisions, and natural geography is essential for interpreting the formation of regional economies during this period. Banks were not merely financial infrastructures; they were central to economic activities closely connected with commerce, logistics, and administration. Their placement thus serves as a key to visualizing the spatial structure and developmental stage of local economies. This study analyzes how natural geographic factors—such as major river basins and the boundaries between mountainous and flatlands—and institutional factors—such as cities and counties—influenced the placement of banks, testing the hypothesis that their locations were shaped by these institutional and geographic structures.

Previous studies have primarily focused on qualitative analyses of modern clusters, such as Silicon Valley (Porter, 1998), or spatial economic theories based on mathematical models (e.g., Krugman, 1991). Few studies have empirically examined the relationship between geographic conditions and industrial agglomeration using historical data. However, Yoshizu (1978) demonstrated that bank locations during the Meiji period were concentrated in commercial centers and strategic points of transportation and administration, suggesting spatial consistency between bank distribution and the regional central place hierarchy. Building on this discussion, the present study reexamines the spatial characteristics of bank locations through quantitative analysis.

Specifically, Voronoi diagrams are generated based on the locations of banks in 1905 and are overlaid with contemporary administrative boundaries and natural geographic features (such as water systems and elevation). The structural consistency between these layers is then quantified using the Multi-Scale Structural Similarity Index (MS-SSIM), a metric for image similarity. This approach enables the study to uncover the spatial order of bank locations based on quantitative evidence, rather than relying on visual impressions alone.

Ultimately, this research aims to clarify the mechanisms of economic formation grounded in institutional and geographic structures from a historical perspective.

## 2. Study Scope and Period

### *2.1. Target Region*

This study focuses on the Kanto region of Japan as it existed in 1905. The Kanto region encompasses the largest plain in Japan—the Kanto Plain—and is

characterized by a complex interplay of plains, hills, and mountainous terrain. Even during the Meiji era, the region had a well-developed network of railways and river transport routes, with Tokyo emerging as the nation's political and economic center.

The analysis covers seven prefectures: Tokyo, Kanagawa, Chiba, Saitama, Ibaraki, Tochigi, and Gunma. These areas include the Tone River, which has the largest watershed in Japan, along with other major Class A rivers, and the massive consumer market of Tokyo. In the Meiji period, these prefectures served as critical hubs of industry and distribution. In northern Kanto—specifically Gunma, Tochigi, and Ibaraki—textile and warehousing industries flourished. Meanwhile, Kanagawa Prefecture conducted outward-facing trade through Yokohama Port, and Tokyo experienced rapid urbanization and the concentration of banking institutions.

### *2.2. Target Period of Analysis*

Under these circumstances, the location of banks was not merely a matter of establishing financial infrastructure, but became a crucial factor in driving regional economic growth. Yoshino & Taghizadeh-Hesary (2018) demonstrated that the density of banks is a decisive factor influencing economic growth, suggesting that clarifying the spatial arrangement of banks is essential for understanding the structural foundations of economic development at the time.

Yoshizu (1978) showed that the establishment of banks during the Meiji era tended to concentrate in commercial centers and strategic nodes of transportation and administration—locations that correspond to upper hierarchical levels in central place theory. In the Kanto region, these "central places" often overlapped with junctions of railway and river transportation networks, indicating that institutional and logistical factors played a significant role in shaping bank locations.

Furthermore, during this period, Japan was transitioning from river to rail transport, and the spatial overlap between transport and financial infrastructure became increasingly evident. In particular, the year 1905 marked a turning point in industrial policy following the end of the Russo-Japanese War. The number of banks nationwide was increasing, and local financial networks led by small institutions were actively forming.

According to Okazaki (2005), even before the financial panic of 1907, regional banks were undergoing mergers aimed at rationalizing management and increasing capital, especially in northern Kanto. Around the same time, a boom in company formation occurred, and local financial institutions played a vital role as providers of startup capital.

Taken together, these observations suggest that bank locations were not merely the result of economic activity, but may have functioned as a "precondition" that shaped the structure of regional economies.

In this study, bank locations in the seven prefectures as of 1905 are identified, and their distribution is analyzed in relation to geographical features (e.g., mountainous and flat areas) and hydrological systems. In addition, the degree of spatial alignment with administrative boundaries is measured to elucidate the relationship between bank distribution and industrial clustering from a spatial perspective.

## 3. Methodology

### *3.1. Data Sources*

To clarify the spatial distribution of banks in the Kanto region and their relationships with topography and administrative boundaries, this study utilized a range of official documents and geospatial datasets. The location data for banks were extracted from the *Directory of Executives of Companies Nationwide in Japan (1905)*. Bank names and addresses listed therein were converted into latitude and longitude coordinates and geocoded using GIS software.

For topographic data, elevation information provided by the Geospatial Information Authority of Japan was used. Areas were classified into plains and mountainous zones using an elevation threshold of 500 meters. This classification follows criteria adopted by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and previous studies in geography. Regarding river systems, spatial data for Class A rivers were obtained from the National Land Numerical Information database (MLIT) to visualize waterborne transportation routes at the time.

In addition, historical administrative boundaries at the county (郡) level during the Meiji period were reconstructed and digitized within a GIS environment. This allowed the study to capture structural characteristics that would be overlooked by relying solely on modern administrative units.

For the reconstruction of administrative divisions, the "Historical Administrative Boundary Dataset (Beta Version)" was employed. This dataset provides map-based information reflecting the city, town, and village system established in 1889, enabling precise GIS-based recreation of county-level administrative structures of the period.

### *3.2. Analytical Procedure*

The analytical procedure in this study is composed of two stages. First, Voronoi diagrams were generated using bank coordinates as seed points. A Voronoi diagram partitions a space into regions where each region corresponds to the area closest to a given point, making it an appropriate method for visually

analyzing the service coverage or spheres of influence of banks. The generated Voronoi regions were overlaid with geographic layers—such as the plains and mountainous classification, hydrological networks, and administrative boundaries—to examine the spatial relationships between bank locations and natural or institutional features. The generation of diagrams followed the method described by Matoschek (2002).

Second, to quantitatively evaluate the spatial similarity between the Voronoi diagrams and administrative boundaries, the Multi-Scale Structural Similarity Index (MS-SSIM) was employed. Originally proposed by Wang et al. (2003), MS-SSIM compares the structural, luminance, and contrast features of images across multiple scales, offering human-perception-aligned assessments of structural consistency.

The appropriateness of MS-SSIM for this study was confirmed from several perspectives. First, map data inevitably involve scaling, rotation, or distortion. MS-SSIM is robust against such transformations. In contrast, traditional metrics such as Intersection over Union (IoU), pixel matching rate, or Dice coefficient are primarily designed for comparing binary images and are less suitable for quantifying structural consistency when dealing with subtle boundary shifts or continuous gradations. Particularly in this study—where complex shapes based on Meiji-era bank locations and administrative boundaries are analyzed—comprehending overall structural integrity is more important than exact pixel-level matches. MS-SSIM excels in this regard due to its multi-level structural evaluation capability.

To demonstrate the superiority of MS-SSIM over conventional similarity metrics, a comparative table is presented below (Table 1).

***Table 1: Comparison of Spatial Similarity Metrics – Characteristics of MS-SSIM vs. Traditional Methods***

| Metric | Characteristics | Advantages | Disadvantages | Suitability for Spatial Structure Comparison |
|---|---|---|---|---|
| MS-SSIM | Multi-scale comparison of structure, luminance, and contrast | Strong for hierarchical structure analysis; robust to scale/rotation | Requires specialized understanding; interpretation is context-dependent | Very High |
| IoU | Measures area overlap (Intersection over Union) | Simple and intuitive; suited for binary mask comparisons | Sensitive to minor boundary shifts; cannot handle gradations | Rather Low |

| | | | | |
|---|---|---|---|---|
| Dice Coefficient | Symmetric area overlap index similar to IoU | Effective in medical imaging; good for small objects | Weak at capturing geometric differences | Rather Low |
| PSNR | Pixel-value-based image quality metric | Extremely fast and simple | Ignores structure/ luminance; misaligned with visual relevance | Low |
| Pixel Match Rate | Ratio of matching pixel values | Simplest to compute | Extremely fragile to translation or deformation | Low |

As shown in Table 1, each metric has its strengths and weaknesses depending on the nature of the image and the evaluation goal. MS-SSIM stands out in its ability to evaluate structural features across scales. While IoU and Dice coefficients are useful for comparing binary regions, they are limited in addressing subtle structural discrepancies. Simpler metrics like PSNR and pixel match rate are particularly vulnerable to distortions common in map data, such as scaling, rotation, or warping. In contrast, MS-SSIM offers high robustness and reliability for real-world spatial comparisons, establishing its superiority in terms of accuracy, applicability, and resilience.

Furthermore, MS-SSIM has been increasingly applied in urban growth modeling (Zhang & Du, 2016) and regional spatial comparisons (Hagenauer & Helbich, 2012), confirming its relevance in urban planning and GIS-based research. Incorporating such precedent strengthens both the methodological rigor and empirical foundation of this study.

Practically, the Voronoi and administrative maps were standardized to a resolution of 224×224 pixels and converted into grayscale using OpenCV. This resolution was chosen as a common standard in image recognition and geospatial analysis, balancing structural detail retention and computational efficiency. Bicubic interpolation was used to maintain aspect ratios and minimize structural distortion during conversion. Furthermore, consistency across resolutions was verified by executing MS-SSIM at multiple resolutions, with no significant variation in scores observed.

Pixel values were normalized to the [0,1] range, and the ms_ssim() function from the PyTorch library was used to compute scores for each region. These scores ranged from 0 to 1, with scores above 0.8 interpreted as indicating high structural similarity.

To rule out the possibility that high MS-SSIM scores were due to chance, a Monte Carlo test was conducted. In this procedure, for each prefecture, Voronoi-administrative map pairs were randomly sampled from other prefectures to generate 1,000 synthetic pairs. MS-SSIM scores were then calculated for

each pair. The probability of obtaining a score equal to or greater than the observed value was taken as the p-value.

Statistical significance was set at $p < 0.05$. Score generation and random sampling were conducted using consistent parameters within the PyTorch ms_ssim() function. The choice of 1,000 iterations follows precedent in prior studies such as Zhang & Du (2016), ensuring reproducibility and computational efficiency. Through the introduction of the Monte Carlo test, the study provides quantitative evidence that the structural similarity between bank Voronoi regions and administrative boundaries is not a result of visual impression or random coincidence, but reflects a statistically significant spatial correspondence.

## 4. Results

### *4.1. Spatial Consistency between Bank Locations and Administrative Boundaries*

#### *4.1.1 Visual Correspondence*

A Voronoi diagram was created based on bank locations in the Kanto region as of 1905, and this was overlaid with county-level administrative boundaries of the same period for visual examination of their spatial correspondence (see Figure 1). Additionally, topographic features were considered by classifying the region into mountainous and plain areas using an elevation threshold of 500 meters.

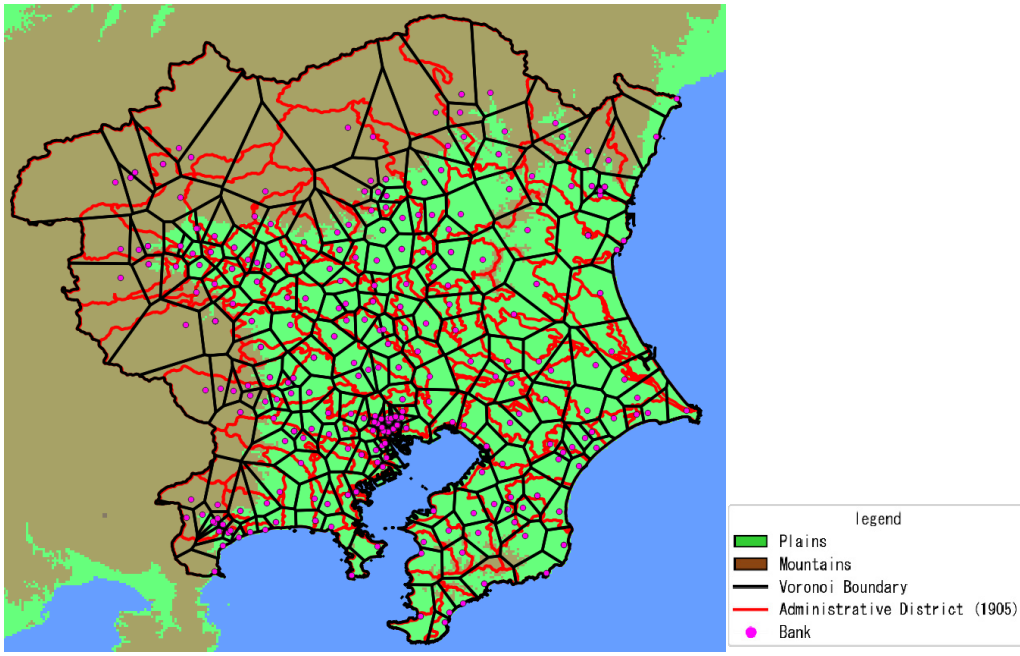



***Figure 1: Administrative Boundaries and Voronoi Diagram of the Kanto Region in 1905***

As shown in Figure 1, in Gunma, Tochigi, and Kanagawa prefectures, the boundaries of the Voronoi regions closely align with administrative boundaries, indicating a high degree of spatial consistency. While some deviations are observed in Tokyo, the overall alignment remains relatively strong. In contrast, Saitama and Chiba exhibit more noticeable mismatches between the Voronoi diagram and administrative divisions, suggesting relatively low spatial correspondence.

To quantify these visual impressions, the MS-SSIM index was used to evaluate the structural similarity between the Voronoi diagram and county images for each prefecture. Table 2 presents the MS-SSIM scores and the associated p-values obtained through Monte Carlo testing.

### *4.1.2 Quantitative Evaluation Using MS-SSIM*

***Table 2: MS-SSIM Scores and p-values for the Spatial Similarity between Administrative Boundaries and Voronoi Diagrams in the Kanto Region***

| Prefecture | MS-SSIM | p-value |
|---|---|---|
| Gunma | 0.882 | 0.010** |
| Tochigi | 0.868 | 0.032* |
| Kanagawa | 0.865 | 0.035* |
| Ibaraki | 0.831 | 0.047* |
| Tokyo | 0.809 | 0.050* |
| Chiba | 0.788 | 0.061 |
| Saitama | 0.785 | 0.073 |

*Note: $p < 0.05$ was considered statistically significant.*

Gunma, Tochigi, and Kanagawa recorded MS-SSIM scores above 0.86, indicating "high similarity." Ibaraki and Tokyo also exceeded 0.8 and were deemed structurally consistent. In contrast, Chiba and Saitama fell below 0.8, suggesting relatively weaker alignment compared to other prefectures.

To determine whether these scores could be due to random chance, Monte Carlo testing was conducted using MS-SSIM calculations via PyTorch. Specifically, MS-SSIM scores were computed for county and Voronoi image pairs in each prefecture, and 1,000 random pairs from other images in the same directory were generated for comparison. The probability of obtaining a score equal to or higher than the observed value was used as the p-value.

The results indicated statistically significant spatial alignment ($p < 0.05$) in Gunma, Tochigi, Kanagawa, Ibaraki, and Tokyo. This suggests that the structural match between the Voronoi diagram and administrative boundaries in these regions is unlikely to be coincidental. Although Chiba and Saitama showed relatively high scores, they did not reach statistical significance,

implying that their structural resemblance is not distinct enough to reject the null hypothesis.

#### *4.1.3 Summary: Structural Alignment between Bank Locations and Administrative Boundaries*

Integrating visual observations, quantitative scores, and statistical testing reveals clear regional variation in the spatial alignment between bank locations and administrative boundaries in the Kanto region. In particular, the three northern prefectures—Gunma, Tochigi, and Ibaraki—along with Kanagawa and Tokyo, exhibit a strong structural alignment between bank locations and county boundaries, suggesting that bank distribution tends to conform to Voronoi-based spatial partitioning.

Importantly, these administrative units were not imposed top-down by central authorities but were often shaped by local private organizations and enterprises. This implies that the alignment between counties and bank locations may reflect autonomous decision-making within regional economies. In other words, counties were not merely administrative constructs but were shaped in mutual interaction with local economic functions and human networks. Thus, the observed spatial alignment can be interpreted as the product of dynamic interactions between institutional and economic structures.

Notably, in prefectures such as Gunma, Tochigi, and Kanagawa, it has been reported that network-based entrepreneurs consciously established banks in accordance with administrative boundaries (Suzuki & Kobayakawa, 2010). The spatial consistency confirmed in this analysis empirically demonstrates, through quantitative and statistical methods, the presence of historically rooted spatial structures. Hence, bank locations were not randomly distributed independent of topography or institutions, but rather formed an orderly spatial pattern shaped by institutional and economic structures.

### *4.2. Relationship Between Bank Locations, Water Transport, and Topography*

#### *4.2.1. Rationale for Focusing on Water Transport Systems*

To understand the relationship between bank locations and natural topography during the Meiji period, it is essential to first consider the role of water transport. Although Japan's railway network was expanding rapidly at the time, rivers remained a principal means of transporting goods—particularly heavy and voluminous cargo such as rice, coal, timber, and iron. The Class A rivers in the Kanto region, including the Tone River, spanned broad catchment areas from upstream zones to Tokyo Bay, serving as critical lifelines connecting regional industries to the capital region.

Consequently, logistical hubs emerged at strategic points along these waterways, creating concentrated demand for financial services. It is therefore reasonable to assume that banks tended to be located in areas where river-based logistics were concentrated.

*4.2.2 Results: Bank Concentration in Class A River Basins, Centered on the Tone River*

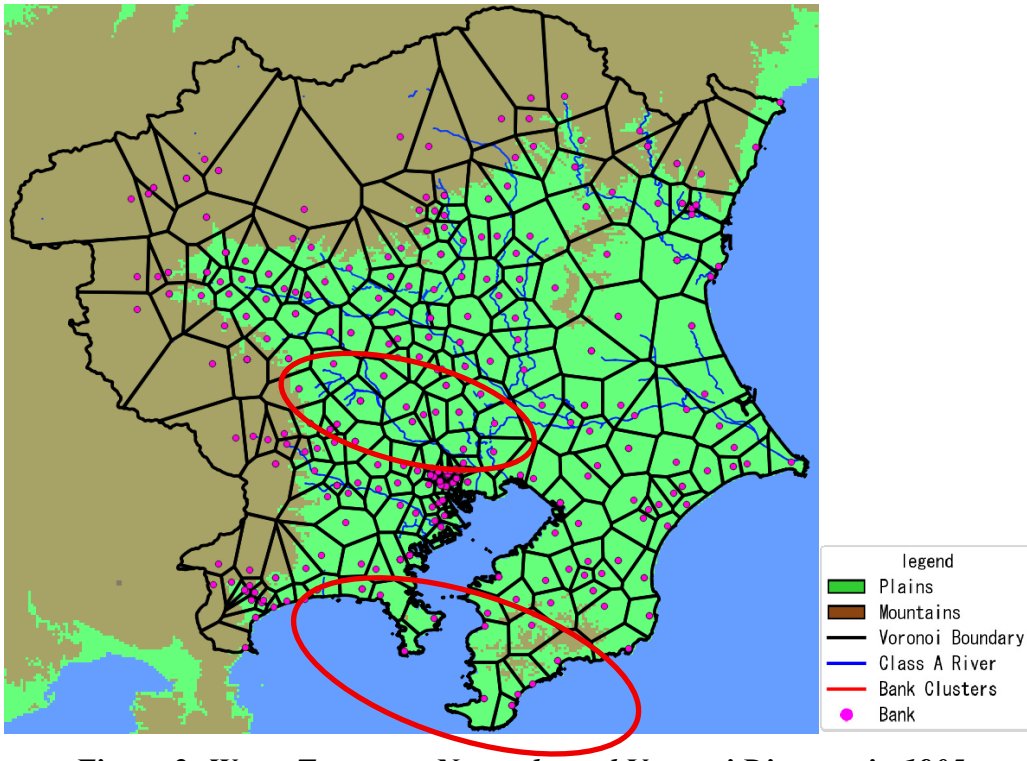



***Figure 2: Water Transport Networks and Voronoi Diagram in 1905***

As shown in Figure 2, bank locations in the Tone River basin—stretching from Gunma through Saitama to Chiba—are densely concentrated along riverbanks. This suggests that financial institutions were distributed in alignment with the water transport network. Similar trends were observed along other major rivers, including the Arakawa and Tama Rivers. In particular, the downstream areas flowing into Tokyo Bay served as key logistical endpoints, where large volumes of cargo converged and economic activity intensified. As a result, Tokyo had already become a major banking center by 1905, serving as a vital hub for capital inflows and outflows within the greater metropolitan economy.

*4.2.3. Structural Characteristics of River Mouths, Coastal Zones, and Plains*

Bank locations were not limited to upstream and midstream zones; notable concentrations were also observed near river mouths. These areas served as intersections between inland and maritime transport. For example, Tokyo Bay's coastal zones—including Yokohama Port and Shinagawa Port—were hubs of commercial activity linked to foreign trade. In Kanagawa Prefecture, banks were densely distributed near these ports, reflecting high demand for financial transactions related to exports and shipping.

In addition, banks were often established in floodplains where river transport intersected with agricultural economies. This pattern was particularly noticeable in eastern parts of Saitama and Chiba. However, since these areas were primarily agricultural—dominated by fields and rice paddies—they had lower population densities compared to urban areas and more limited large-scale financial demand, which may have influenced the degree of bank concentration.

*4.2.4. Limitations of Water Transport and Connections to Land Routes*

Despite its importance, river transport had limitations. In areas with steep terrain or shallow water, boats could not pass easily, necessitating the transfer of goods to land routes. These intermodal transfer points—where waterborne goods were offloaded for land transport—often developed into warehouse hubs, post towns, and settlements, which were conducive to the establishment of banks.

In fact, in mountainous and hilly areas of Gunma and Tochigi, banks were found at the boundaries between mountain ranges and plains, suggesting their role as intermodal nodes for water and land transport.

*4.2.5. Spatial Significance of "Warehouse-Banks"*

The functional duality of banks as logistical and financial hubs was embodied in institutions known as "warehouse-banks." Examples include the Hokuetsu Warehouse Bank and the Tochigi Warehouse Bank, which combined financial and storage functions to support both regional distribution and liquidity management. The location of such institutions along waterways and river basins supports the idea that bank placement was guided by both topographical and economic rationality.

## 5. Discussion

The results of this study reveal that the spatial distribution of banks in the Kanto region in 1905 exhibited a high degree of alignment with institutional

administrative units (i.e., county boundaries) and natural geographic conditions such as rivers and elevation. In particular, in prefectures such as Gunma, Tochigi, and Kanagawa, bank locations closely matched county boundaries, suggesting that institutional regional units also functioned as economic network frameworks. This finding indicates that administrative boundaries were not merely units of governance, but also served as foundations for the formation of economic and spatial networks.

According to Yoshizu (1978), local banks during the Meiji period were often established in locations corresponding to the central-place hierarchy—such as county offices and transportation hubs—and were embedded in commercial centers within each region. This aligns with the results of this study, which confirmed the spatial consistency between Voronoi diagrams and administrative boundaries, indicating that the formation of bank locations followed an orderly pattern rooted in institutional and geographic context.

Furthermore, the concentration of banks along river basins and topographic boundaries suggests that they functioned as spatial nodes that mediated between logistics and finance. This is also consistent with the existence of multifunctional institutions such as "warehouse-banks" at the time. In other words, bank locations were not only determined by existing administrative and logistical structures, but also served as dependent variables that responded to these contexts. At the same time, they acted as mediating variables that influenced the formation and growth of local economic structures by serving as financial service hubs.

Thus, the spatial distribution of banks reflected the institutional and geographic conditions of their time, while also contributing to the reinforcement and stabilization of those very structures. Notably, in prefectures such as Gunma, Tochigi, and Kanagawa, network-oriented entrepreneurs reportedly established banks with a keen awareness of administrative boundaries (Suzuki & Kobayakawa, 2010). This study provides quantitative and statistical confirmation of such spatial coherence, rooted in historical and institutional background.

Therefore, bank locations were not randomly or uniformly distributed. Rather, they formed structured spatial patterns that were aligned with the institutional and economic systems of their time.

## 6. Conclusion

This study has demonstrated that the spatial distribution of banks in the Kanto region in 1905 showed a notable degree of alignment with natural geographic features—such as topography and river systems—as well as institutional boundaries, particularly administrative units at the county level. By

constructing Voronoi diagrams based on bank locations and comparing them with county boundaries and physical geographic features, the study employed the image similarity metric MS-SSIM to quantitatively evaluate the degree of structural correspondence. The results indicate a high level of spatial consistency between banking service areas and administrative units in Gunma, Tochigi, and Kanagawa, suggesting that the regional financial network was closely linked to institutional divisions.

In contrast, in Tokyo and Saitama, a certain degree of spatial discrepancy was observed. One explanation is that, by 1905, Tokyo had already developed a functional role as the nation's capital, transcending county-level administrative boundaries. As a center of national industrial policy and administrative authority, Tokyo was home to the headquarters of major banks strategically concentrated under state planning. Thus, bank locations in Tokyo were increasingly determined not by administrative boundaries but by policy objectives and central economic functions.

In southern Saitama, the cities of Kawagoe, Omiya, and Urawa were expanding across county lines, forming wider regional markets interconnected by railway networks. This likely enabled a more flexible deployment of bank branches in response to broader economic integration (Inoue, 1995; Sato, 2004).

Furthermore, the fact that many banks were concentrated near key nodes of river transport and topographic boundaries—particularly at the interface between mountainous and flatland zones—demonstrates their role not merely as financial service providers, but as spatial nodes mediating between logistics and economic activity. The existence of "warehouse-banks" in the Tone River basin provides compelling evidence that banks also functioned as distribution hubs. This finding highlights the geographic significance of bank locations as centers of economic activity embedded within the physical landscape.

Although statistical significance was not confirmed in Chiba Prefecture, this may be attributed to the region's relative lack of major Class A rivers, which limited water-based transport and reduced opportunities for economic centralization. Additionally, the peninsula-like shape of the Bōsō region may have restricted inland access, contributing to the fragmentation of economic zones and hindering the spatial expansion and coherence of bank locations.

These findings support Porter's (1998) theory that geographic proximity fosters concentrated networks and competitive advantage, suggesting that such dynamics were already at work during the Meiji era—embedded within both institutional frameworks and natural geography. Similarly, Krugman's (1991) proposition that spatial initial conditions exert lasting influence on the distribution and clustering of industries is empirically validated through the alignment between bank locations, river systems, and topographic boundaries.

Taken together, these results align with the view of Yoshino & Taghizadeh-Hesary (2018), who emphasized the decisive role of banking density in shaping economic growth. The spatial configuration of financial networks, therefore, was not merely a passive outcome variable, but rather an active agent that shaped the skeletal structure of regional economies. Bank locations were simultaneously a result of institutional and geographic conditions and a precondition that contributed to the formation and reinforcement of regional economic structures and networks.

## References


Asashima, A. (2009). Intra-group transactions of prewar zaibatsu-affiliated insurance companies and the role of subsidiaries. *Senshu University Economic Review, 44*(1), 35–59.

Hagenauer, J., & Helbich, M. (2012). Multi-scale spatial data modeling using structural similarity indices. *Computers, Environment and Urban Systems, 36*(6), 542–552.

Inoue, K. (1995). *Urban formation and urban issues: The modernization of Tokyo*. Yoshikawa Kōbunkan.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy, 99*(3), 483–499.

Matoušek, J. (2002). *Lectures on discrete geometry*. Springer-Verlag. (Okamoto, Y., Trans.). *Risan kikagaku kōgi* [離散幾何学講義]. Springer-Verlag Tokyo, 2005.

Naoki, Y. (1978). The locational process of banks in the Kanto region during the Meiji period: Especially in relation to the central place system. *Jinbun Chiri (Human Geography), 30*(5), 406–428.

National Institute of Informatics. (n.d.). *Historical administrative boundaries dataset* [歴史的行政区域データセット]. Retrieved May 22, 2025, from https://geoshape.ex.nii.ac.jp

Okazaki, T. (2005). Financial and corporate systems and economic development in prewar Japan. *The Economic Review, 56*(2), 117–129.

Porter, M. E. (1998). Clusters and the new economics of competition. *Harvard Business Review, 76*(6), 77–90.

Satō, S. (2004). *The formation of the Tokyo metropolitan area and the development of urban planning*. Kajima Publishing.

Suzuki, T., & Kobayakawa, T. (2010). Formation of network-based entrepreneur groups and the influence of administrative divisions. *Gakushuin University Economic Review, 43*(2), 112–128.

Tōyō Keizai Shinpōsha. (1905). *Nihon zenkoku shokaisha yakuinroku* [Directory of executives of companies nationwide, Meiji 38]. Tōyō Keizai Shinpōsha.

Wang, Z., Bovik, A. C., Sheikh, H. R., & Simoncelli, E. P. (2003). Multiscale structural similarity for image quality assessment. In *Proceedings of the 37th Asilomar Conference on Signals, Systems & Computers* (Vol. 2, pp. 1398–1402). IEEE.

Yoshino, N., & Taghizadeh-Hesary, F. (2018). Optimal credit guarantee ratio for small and medium-sized enterprises' financing: Evidence from Asia. *Economic Modelling, 74*, 127–137.

Zhang, Y., & Du, Q. (2016). MS-SSIM-based remote sensing image change detection. *IEEE Geoscience and Remote Sensing Letters, 13*(8), 1152–1156.

# THE RELATION BETWEEN THE TWIN DEFICITS IN ROMANIA

*Andrei Rădulescu, Ph.D.*[*]

**Abstract**

*The Romanian economy has been confronted with the persistence of macroeconomic imbalances (the so-called twin deficits) over the past decades. Romania has recorded both a budget deficit and a current account deficit every year since 1992, while the cumulated weight of these deficits in the GDP reached a historical high level in 2024 (around 17%), according to the database of the International Monetary Fund (2025). In this paper we apply standard econometric tools and use the databases of several institutions (including the International Monetary Fund (2025) and of the World Bank (2025a)) in order to assess the relation between the trade balance and the budget balance in Romania in a comparative analysis with the developments in Poland (the largest economy in Central and Eastern Europe) over the past 25 years (the period 2000 – 2024). The results of our analysis indicate a positive relation between the trade balance and the budget balance in both Romania and Poland during the analysed period. However, we also identified a negative relation between the trade balance and the dynamic of the real wage (more pronounced in Romania), which provides a solid explanation for the divergence between these economies in terms of trade balance.*

**Keywords***: trade deficit, budget deficit, Romania, Poland.*
**JEL Classification:** C22, F32, H62.

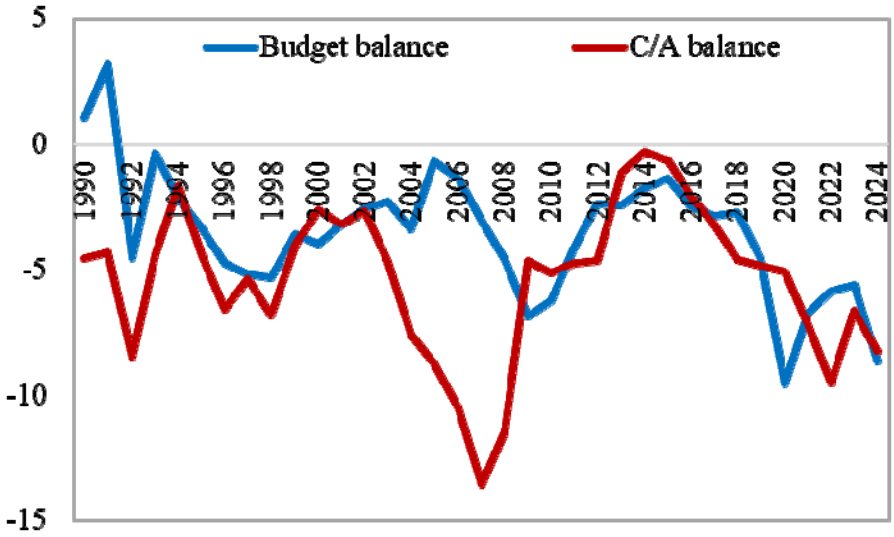
## 1. Introduction

The Romanian economy has been the champion of the EU economic convergence over the past decades, as emphasized by Rădulescu (2024). On the other hand, Romania has also been confronted with the persistence of macroeconomic imbalances, in the context of pro-cyclical fiscal measures, according to the World Bank (2025b). In fact, in several years Romania was the EU champion in terms of cumulated twin deficits (budget deficit and trade deficit/current account deficit).

Since 1992, Romania has recorded simultaneously a budget deficit and a current account deficit of the balance of payments, the combined share of the twin deficits in GDP reaching a record high level (around 17%) in 2024, according to the statistics of the International Monetary Fund (IMF, 2025), represented in the following chart.

[*] Andrei Rădulescu is Senior Researcher at the Institute for World Economy, Romanian Academy. E-mail: iemradulescu@gmail.com

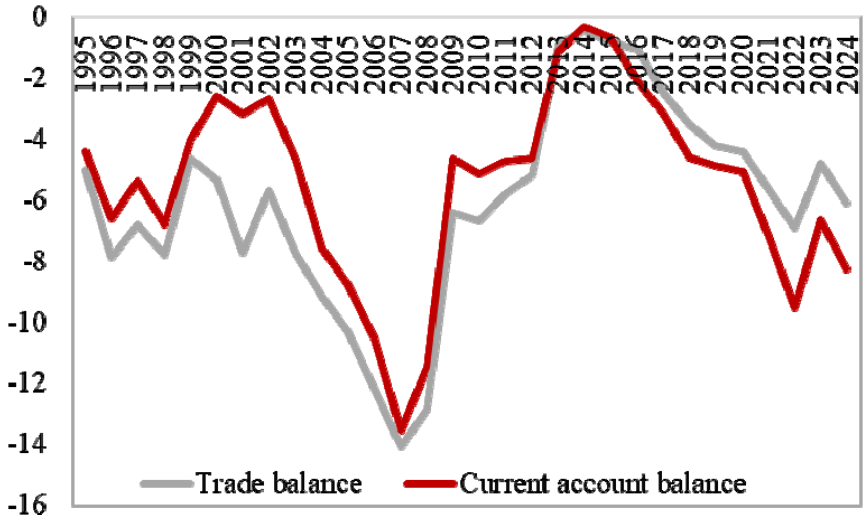
***Figure 1. Budget balance (% GDP) vs. current account balance (% GDP) in Romania, 1990 – 2024***




*Source: representation of the author based on the statistics of the International Monetary Fund (2025).*

We point out that the current account deficit in Romania is largely driven by the deficit of the trade balance in goods and services (over 70% in recent years), as can be noticed in the following chart.

***Figure 2. Trade balance (% GDP) vs. current account balance (% GDP) in Romania, 1995 – 2024***

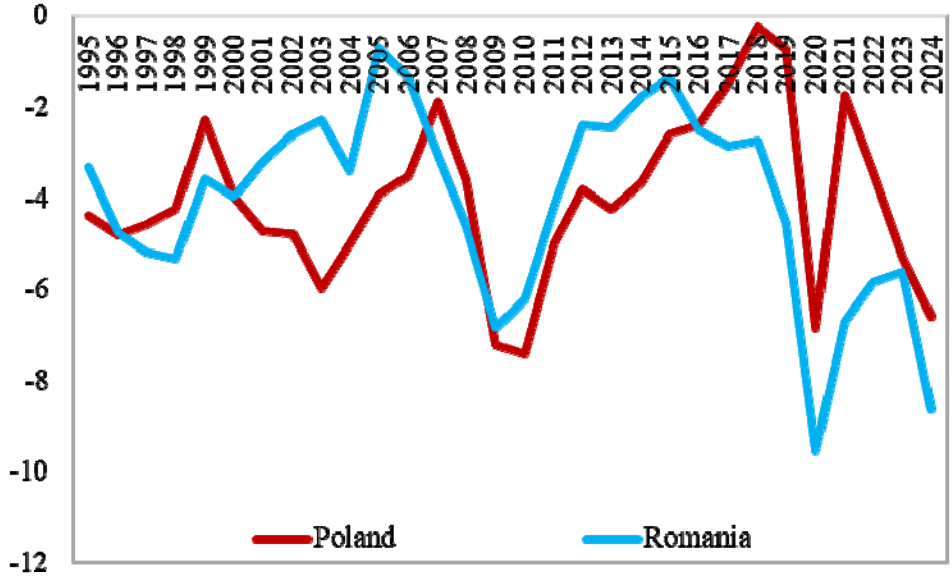



*Source: representation of the author based on the statistics of the International Monetary Fund (2025), and of the World Bank (2025a).*

Romania is not the only country in Central and Eastern Europe with persistent budget deficits for several decades in a row. This stance is also noticed in Poland, the largest economy in the region, with a nominal dimension of around EUR 850bn in 2024, according to Eurostat (2025).

According to the statistics of the International Monetary Fund (IMF, 2025), the average annual weight of the budget deficit in the GDP stood at the same level (4%) in both Romania and Poland during the period 1995 – 2024, as can be noticed in the following chart.

***Figure 3. Budget balance / GDP ratio in Romania and Poland, 1995 – 2024***




*Source: representation of the author based on the statistics of the International Monetary Fund (2025)*

However, unlike Romania, Poland has also recorded years with a current account surplus in recent decades, for example, in 2023 and 2024. In this context, the average annual weight of the current account balance in GDP in Poland has been significantly lower compared to Romania over the past decades, according to the statistics of the International Monetary Fund (2025). Furthermore, Poland has recorded a trade balance surplus every year since 2013, according to the database of the World Bank (2025a).

In this paper, we analyze the relation between the trade balance and the budget balance (as % of GDP) in Poland and Romania over the past 25 years (the period 2000 – 2024). We apply standard econometric tools and use the databases of the International Monetary Fund (2025) for the budget balance and

of the World Bank (2025a) for the trade balance in these countries, the first and second largest economies in Central and Eastern Europe, according to Eurostat (2025).

The rest of the paper has the following structure: Chapter 2 briefly presents the literature review on the relation between the budget deficit and the current account deficit/trade deficit; the methodology applied is presented in Chapter 3; the main results are analysed in Chapter 4; the conclusions are drawn in the last chapter.

## 2. Literature Review

The relation between the trade balance (current account balance) and the budget balance has been analysed by many economists in the past decades, as several countries have been confronted with the syndrome of the twin deficits.

It is the case of the United States - the largest economy in the world (with a nominal GDP above USD 30tn in the second quarter of this year, according to the estimates of the Department of Commerce (2025a)) has recorded federal budget deficit and current account deficit since 2002, according to the databases of the US Department of the Treasury (2025) and US Department of Commerce (2025b).

In this respect, there can be noticed the development of the literature on the twin deficits hypothesis, that the budget balance has an impact on the current account balance.

For instance, according to Bernheim (1988), an increase of the budget deficit by one dollar determined a decline of the current account balance by USD 0.3 in the USA (the largest economy in the world) during the period 1960-1984.

In a recent article, Dudley (2025) pointed out that the deterioration of the public finance in the USA (since the beginning of this century) has contributed to the widening of the current account deficit, its share in the GDP hovering at present at the highest level since 2008, the moment of the outbreak of the Great Financial Crisis, the most severe global economic and financial crisis since the end of the Second World War.

At the same time, the analysis elaborated by Afonso et al. (2022), considering a sample of 65 countries, confirms that budget balance had an impact on the current account balance during the period 1985 – 2015.

In Europe, Koukouritakis and Panousis (2020) applied standard econometric tools and identified a strong relation between the current account deficit and the budget deficit in Italy and Greece during 1999 – 2017. However, according to the results of this paper, the relation between these macroeconomic variables is

weak in Portugal and Spain, where the households did not increase their consumption when expansionary fiscal policies were implemented, and preferred to save more, anticipating higher taxes in the future.

The analysis of Mirdala (2015) also confirmed the twin deficits hypothesis in the European transition economies (10 countries, including Poland and Romania) during the period 2000 – 2012.

## 3. Methodology

In this paper we apply standard econometric tools (OLS regressions and the Hodrick-Prescott filter) and use the databases of the International Monetary Fund (2025), the World Bank (2025a), Eurostat (2025), the National of Statistics of Poland (2025), and the National Institute of Statistics of Romania (2025) in order to assess the relation between the trade balance and the budget balance in Romania and Poland over the past 25 years, the period 2000 – 2024.

We included in our analysis the evolution of the real wages in these economies.

On the one hand, we implemented the Hodrick-Prescott filter in order to distinguish between the structural/trend and the cyclical components of the macroeconomic indicators considered in our analysis: the trade balance, the budget balance, and the real wages.

This method, developed by Hodrick and Prescott (1997) is widely used in the macroeconometric research due to its transparency and simplicity, as emphasized by Bouthevillain et al. (2001) and de Castro Souza (2005). The filter of based on the following relation:

$$\text{Min}\sum_{t=1}^{T}(\ln Y_t - \ln Y_t^*)^2 + \lambda \sum_{t=2}^{T-1}((\ln Y_{t+1}^* - \ln Y_t^*) - (\ln Y_t^* - \ln Y_{t-1}^*))^2 \quad (1)$$

where Yt, Yt* and $\lambda$ represent the macroeconomic variable, its trend component, and a smoothness parameter, for which we considered a value of 100, as recommended by the authors in the analysis with annual observations.

In our analysis, the macroeconomic indicators are the trade balance (as % of GDP), the budget balance (as % of GDP), and the annual rate of the real wage (the average nominal net wages adjusted for inflation).

On the flipside, Castro Souza (2005) emphasized the disadvantages of this filter, including the arbitrariness, imposition of symmetry on the gap (between the macroeconomic indicator and its structural component), and the end-of-sample bias.

On the other hand, we estimated the following regression for both Romania and Poland:

TRADEBALANCETR=C(1)+C(2)*BUDGETBALANCETR+C(3)*REALWAGETR (2)

in which TRADEBALANCETR is the trend component of the weight of the trade balance in the GDP (our estimates considering the data from the World Bank (2025)), BUDGETBALANCETR represents the trend component of the weight of the budget balance in the GDP (our estimates considering the statistics of the International Monetary Fund (2025)), while REALWAGETR is the trend component of the annual rate of the real wages, estimated considering the statistics of Eurostat (2025), National Institute of Statistics of Romania (2025), and National Institute of Statistics of Poland (2025).

In this paper, we tested for the stationarity and autocorrelation by applying the tests Augmented Dickey-Fuller and Durbin-Watson.

Therefore, in the regression (2) we considered the first difference and we also added a lagged value of the dependent variable.

The econometric software E-Views was used in this paper.

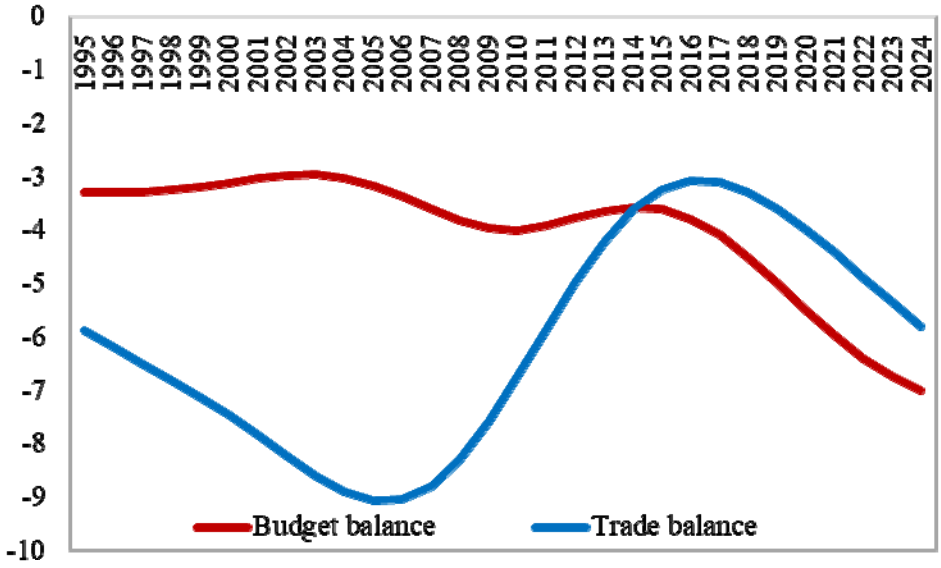
## 4. Interpretation of the Results

According to the results of our econometric analysis, there is a positive relation between the trade balance and the budget balance in Romania, with an estimated coefficient of 1.92 for the period 2000 – 2024. In other words, the increase of the budget deficit / GDP ratio (trend component) by 1pp contributed to the deterioration of the trade deficit / GDP ratio (trend component) by 1.92pps over the past 25 years.

Therefore, the twin deficits hypothesis is confirmed in the case of Romania, where the intensification of the budget deficit has led to a significant widening of the trade deficit.

The evolution of the trend components for the trade balance and for the budget balance, expressed as percentage of GDP, in Romania, is represented in the following chart.

Figure 4. Trade balance vs. Budget balance in Romania (% of GDP, trend components)




*Source: representation of the author based on the statistics of the International Monetary Fund (2025)*

It can be easily seen in Figure 4 that the fiscal consolidation process in the aftermath of the Great Financial Crisis contributed to the adjustment of the trade deficit. On the other hand, the end of the fiscal consolidation and the start of the expansionary fiscal and income policies in 2015 contributed to the widening of the trade deficit in Romania.

On the other hand, according to our econometric estimates, in 2024 the trend component of the budget deficit / GDP ratio stood at a record high level, around 7%. Last, but not least, the trend component of the trade deficit / GDP ratio in Romania widened to almost 6% in 2024, the highest level since 2011, during the period of the adjustment following the outbreak of the Great Financial Crisis.

The same positive relation is also identified in the case of Poland, but the estimated coefficient is significantly lower, only 0.79. In other words, an increase of the budget deficit / GDP ratio (trend component) by 1pp contributed to the deterioration of the trade balance / GDP ratio (trend component by 0.79pps.

Furthermore, our analysis identified a negative relation between the trade balance and the annual rate of the real wages (nominal wages adjusted for inflation) in both Romania and Poland, with estimated coefficients of -0.90 and -0.40, respectively.

In other words, the increase of the real wages (trend component) in Romania by 1pp contributed to the widening of the trade deficit / GDP ratio (trend component) by 0.90pps in the analysed period, 2000 – 2024.

In the case of Poland, the increase of the real wages (trend component) by 1pp contributed to the deterioration of the trade balance / GDP ratio (trend component) by only 0.40pps. These results are very important, as they provide an explanation for the trade surpluses in Poland since 2013. In fact, the impact of the increase in real wages on the deterioration of the trade balance is almost double in Romania during the analysed period.

Furthermore, we point out that the real wages in Romania advanced by an average annual rate of 6.1% during 2000 – 2024, three times higher than in Poland (2.0%), according to our estimates considering the databases of the National Institute of Statistics of Romania (2025), National Institute of Statistics of Poland (2025), and Eurostat.

## 4. Conclusions

The results of our analysis are very important, as the focus is on the causes of the trade deficit in Romania, in a comparative analysis with the developments in Poland over the past 25 years. We identified a positive relation between the trade balance and the budget balance in both countries, but with a significant difference in terms of the estimated coefficient.

Furthermore, we also confirmed a negative relation between the trade balance and the evolution of the real wages in both countries, with a large gap in terms of the estimated coefficient.

These results point out that Romania should adjust its public finance in order to record an improvement in the trade balance. In our view, the fiscal consolidation process initiated in 2025 is very important to maintain the sovereign rating, but also to adjust the trade deficit.

However, the fiscal consolidation process is not enough to address the persistence of the trade deficit. There are also needed other structural reforms in order to improve the international competitiveness of the Romanian economy, including a balanced income policy (correlated with productivity) and measures to improve the supply in sectors with potential in this country, such as agriculture, food processing, the chemicals industry, and tourism.

In this respect, we point out that the volume of the total exports (goods and services) grew by an average annual rate of 7.2% in Romania during 2000 – 2024, similar to the pace recorded in Poland. However, the volume of the total imports (goods and services) advanced by an average annual rate of 9.8% in Romania, a higher pace than in Poland (only 5.9%).

Therefore, in order to adjust the huge trade deficit (above 6% of GDP in 2024, according to the World Bank (2025)), the policymakers should revise the income policy and address the structural challenges the supply is confronted with in several sectors with potential for development.

## References


Afonso, A., Huart, F., Jalles, J.T., and Stanek, P. (2022). Twin deficits revisited: A role for fiscal institutions? *Journal of International Money and Finance*, Volume 121, March 2022, 102506. https://www.sciencedirect.com/science/article/abs/pii/S0261560621001571.

Bernheim, D.B. (1988). Budget Deficits and the Balance of Trade. NBER Chapters, in: *Tax Policy and the Economy*, Volume 2, pp. 1-32, National Bureau of Economic Research, Inc. https://ideas.repec.org/h/nbr/nberch/10935.html.

Castro Souza, J.R. (2005). Produto Potencial: Conceitos, Metodos de Estimcao e Aplicacao a Economia Brasileira. https://www.ipea.gov.br/portal/images/stories/PDFs/TDs/td_1130.pdf.

Dudley, W. (2025). BWC Backgrounder: Trade, Tariffs, and Budget Deficits. https://brettonwoods.org/bwc-backgrounder-trade-tariffs-and-budget-deficits/.

*International Monetary Fund (IMF) (2025). Download WEO Data: April 2025 Edition. https://www.imf.org/en/Publications/WEO/weo-database/2025/april.*

Koukouritakis, M., and Panousis, K. (2020). Twin Deficits : Evidence From Portugal, Italy, Spain and Greece. *Intereconomics, Review of European Economic Policy*, Volumes, 2020, Number 5. https://www.intereconomics.eu/contents/year/2020/number/5/article/twin-deficits-evidence-from-portugal-italy-spain-and-greece.html.

Mirdala, R. (2015). Twin Deficits in European Transition Economies. *In Neo-Transitional Economics* (pp. 299-333). Emerald Publishing Limited. https://www.emerald.com/books/edited-volume/14796/chapter-abstract/85873834/Twin-Deficits-in-European-Transition-Economies?redirectedFrom=fulltext.

*National Institute of Statistics of Poland (2025). www.insse.ro*

*National Institute of Statistics of Romania (2025). https://stat.gov.pl/en/*

*RĂDULESCU, A. (2024). Romanian economy - the champion of the EU economic convergence. In:* Economic growth in the face of global challenges. Consolidation of national economies and reduction of social inequalities: Conference proceedings*: International Scientific-Practical Conference, XVIIIth Edition, October 10-11, 2024, Chisinau. Chisinau: [S. n.], INCE, ASEM, 2024, vol. I, pp. 12-19. ISBN 978-9975-167-78-9. ISBN 978-9975-167-79-6 (PDF).*

U.S. Department of Commerce (BEA) (2025a). Gross Domestic Product, 2nd Quarter 2025 (Second Estimate) and Corporate Profits (Preliminary). https://www.bea.gov/index.php/news/2025/gross-domestic-product-2nd-quarter-2025-second-estimate-and-corporate-profits-preliminary

U.S. Department of Commerce (BEA) (2025b). International Transactions. https://www.bea.gov/data/intl-trade-investment/international-transactions.

U.S. Department of the Treasury (2025). U.S. Deficit by Year. https://fiscaldata.treasury.gov/americas-finance-guide/national-deficit/#us-deficit-by-year.

*World Bank (2025a). External balance on goods and services (% GDP). https://data.worldbank.org/indicator/NE.RSB.GNFS.ZS*

World Bank. (2025b). Romania Overview, https://www.worldbank.org/en/country/romania/overview