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implies that the paper will not be submitted for publication to another journal unless rejected by the REBE editor or withdrawn by the author, and that it is an original work.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

Subscription rates:
Institutions - $100/year
Individuals - $30/year

ROMANIAN ECONOMIC AND BUSINESS REVIEW

SUMMER 2025 VOLUME 20 NUMBER 2

PRO UNIVERSITARIA 2025
BUCUREŞTI

ISSN 1842 – 2497

ROMANIAN ECONOMIC AND BUSINESS REVIEW

CONSIDERATIONS ON HUMAN CAPITAL AS A KEY ELEMENT OF IT PRODUCT SALES MANAGEMENT

Elisabeta Andreea Budacia[1]

Lucian Constantin Gabriel Budacia[2]

Abstract

Over the last two decades, Romania has developed into a true regional hub for IT services, becoming a point of reference in Central and Eastern Europe. A key factor is the availability of a well-trained workforce. The higher education system has consistently produced graduates with solid skills in areas such as computer science, software engineering, artificial intelligence or cybersecurity. The workforce in the information and communications technology sector represents one of the most valuable resources of the Romanian economy. Therefore, the coordinates of sales management in an IT organization represent the key elements that structure and guide the sales activity, so that it is efficient, customer-oriented and aligned with the strategic objectives of the company. The specifics of the technology market must also be taken into account, as it is dynamic, competitive and innovative. The main elements of interest are: sales strategy, sales team structure, sales processes, performance management, support technology, training and development, customer relationship.

Keywords: *sales management, sales strategy, workforce, sales process.*

JEL Classification: M41, M50.

1. Introduction

Sales activity involves establishing the ways, forms and methods by which products (goods and/or services) and markets of interest to the organization are to be sold.

Sales management is the subcomponent of commercial management that studies the processes and management relationships at the sales department level, in order to identify management methods, systems and techniques that will increase the efficiency and effectiveness of sales. The exercise of sales management functions covers both the activities of the sales department and the personnel dealing with sales.

Sales management is a component of the commercial function and has as its main objective the sale of products in safe conditions.

[1] Elisabeta Andreea BUDACIA, PhD, Associate Professor at the Romanian American University in Bucharest. E-mail: andreea.budacia@rau.ro.

[2] Lucian Constantin Gabriel Budacia, PhD, Lecturer at the Romanian American University in Bucharest. E-mail: lucian.constantin.budacia@rau.ro.

Among the activities specific to sales management we find:

- Elaboration of marketing studies to ensure the portfolio of orders and commercial contracts, knowledge of demand and the competitive situation, the prices of new products that can be assimilated, the conditions to which they must respond in order to better satisfy the preferences of the customers they are addressed to;
- Collection of orders issued by customers and the establishment of their portfolio, the conclusion of commercial contracts in strict accordance with customer requests and available production/service capacities;
- Development of the strategic plan and delivery-sales programs of the contracted products;
- Organization of operational activities for the delivery-sales of the products, rhythmic serving of scheduled and unscheduled customers in accordance with their requests specified in the contracts, in the orders issued;
- Monitoring the operational progress of deliveries to customers;
- Traceability of the behavior of the products delivered to customers, monitoring their functionality, and prompt intervention for recalibration of the products or remedying the detected and reported defects, applying the suggestions from the customers.

The sales strategy represents a complex action established in the medium and long term that aims to achieve the objectives regarding the sale of products under certain conditions determined by various endogenous and/or exogenous factors.

The sales strategy must target two important aspects: the development of the sales process at normal parameters and the expansion of product sales. It must also take into account all the activities of the relevant department, as well as the interdependencies between them, from specific marketing activities such as: market research in order to determine the demands of future customers, studying sales forecasts, concluding contracts with product and service suppliers and tracking products to users. Among the sales strategies, we can identify: Market coverage strategies; Rationalization strategies; Corporate image promotion strategies; Internationalization strategies.

Market coverage strategies can be classified, in turn, depending on how they aim to achieve their proposed objectives in:

- Intensive distribution strategies – aim to achieve the highest possible sales volume for the best possible market coverage;
- Selective distribution strategies – distribution channels are chosen depending on: the quality of distributors' services, technical equipment, after-sales assistance, etc.;
- Exclusive distribution strategies – a single distributor is used, in a well-established area, within a determined period of time.

Rationalization strategies aim to streamline activities by performing tasks with minimal costs and by ensuring the best possible management possibilities.

Strategies for promoting the organization's image consider various forms of advertising, participation in fairs and exhibitions, etc.

Internationalization strategies aim to expand sales on foreign markets.

2. Specific elements of sales management in an IT organization

The coordinates of sales management in an IT organization represent the key elements that structure and guide the sales activity, so that it is efficient, customer-oriented and aligned with the strategic objectives of the company. The specifics of the technological market must also be taken into account, as it is dynamic, competitive and innovative. The main elements of interest are: sales strategy, sales team structure, sales processes, performance management, support technology, training and development, customer relationship.

- The sales strategy requires the organization to consider: alignment with the organization's overall strategy; market segmentation and choice of IT niche (software, hardware, cloud services, outsourcing, etc.); establishing commercial objectives: revenue growth, customer retention, geographical expansion; differentiating the offer from the competition.
- The structure of the sales team is based on defining roles: account managers, sales engineers, business development, ethnic support; team organization; collaboration with marketing, support and technological development teams.
- Sales processes are mainly based on: defining a clear sales funnel: lead - opportunity - proposal - negotiation - closing; use of sales methods: SPIN Selling, Solution Selling, Challenger Sales, etc.; CRM integration (e.g. Salesforce, HubSpot) for automation and visibility.

a. **Lead (Initial Contact)** = a person or company that might be interested in the product. It is obtained through digital marketing, event participation, website forms, cold-calling, email campaigns. Example: someone fills out a form for a software demo.
b. **Opportunity (Qualified Lead)** = the lead has demonstrated real interest, has a clear need and is open to discussions, which involves exploratory meetings, questions about business challenges, starting a consultative relationship. The BANT method (Budget, Authority, Need, Time) is used for evaluation. Example: An IT startup needs a scalable cloud hosting solution and requests a quote.
c. **Proposal (offer)** = the sales team makes a personalized offer (technical proposal, commercial offer, live demo, free trial, POC -proof of concept)

that directly responds to the customer's needs. Example: sending a quote to a customer.

d. Negotiation = the stage where financial, legal, technical terms, schedule, etc. are discussed. Example: The customer requests certain volume discounts or flexible terms for data migration.

e. Closing = signing the contract, granting licenses, launching the implementation, onboarding, invoicing, integration into the client's systems. An essential role falls to those who deal with Account Management/Customer Success to maintain the long-term relationship. Example: A 1-year contract for an IT project management platform and training is provided to the client's team.

In principle, a sales process can be presented as follows:

Lead →	**Opportunity →**	**Proposal →**	**Negotiation →**	**Closing**
100%	60%	40%	20%	10%

Fig. no.1: The sales process

At each stage, a percentage of potential customers "fall" out of the funnel for various reasons; thus, optimizing each stage is essential to maximize conversion.

- Sales methods such as SPIN Selling, Solution Selling, and Challenger Sales are essential tools in IT companies, where selling is often complex, consultative, and solution-oriented.

A. SPIN Selling is a method focused on consultative questions to discover the customer's real needs.

Situation	→ understanding the client's context (technologies used, team, processes).
Problem	→ identifying current challenges (e.g. frequent downtime, lack of scalability).
Implication	→ what risks the respective problem produces (e.g. loss of revenue, user dissatisfaction).
Need	→ creating an urgency and orientation towards your solution/sold by you.

Fig. no.2: The SPIN Selling method

B. Solution Selling focuses on selling a customized solution to a specific problem, not a generic product, and involves several steps: identifying latent or explicit problems; co-creating a solution with the client; aligning the solution

with business objectives. It is very useful in the IT field, where the client needs consulting for the integration of several products and works very well when the solution offered also involves services (customization, training, onboarding, etc.).

C. The Challenger Sale is based on the idea that salespeople who challenge the customer's status quo and bring insights are the ones who close the most sales. The method has 3 components: Teach the customer something new about their business; Personalize the message according to role and industry; Control the sale, especially in the negotiation phase. It is an indicated method for IT products because many customers do not know exactly what they want – but they know what problem they have. In this way, Challengers can lead the conversation and educate the customer (e.g. about AI, automation, cybersecurity, etc.).

- Performance management aims to establish KPIs (performance indicators): number of qualified leads, conversion rate, revenue/agent, lifetime value. Periodic evaluations, feedback sessions and coaching are another important component. Bonus policies and incentives for results are dependent on the indicators achieved, fulfilled.
- Support technology aims at: CRM and integrated ERP systems; automation for outreach (email, LinkedIn, cold calling); business intelligence and predictive reports based on AI.
- Training and development is another equally important aspect in sales management, as it aims at aspects such as: continuous training in sales, but also in technology; workshops for developing soft skills (negotiation, storytelling, active listening); simulations and role-playing for real scenarios.
- Customer relationship or focusing on Customer Success and the value brought to the customer, not just on the product sold; long-term relationship management; collecting feedback and adapting solutions.

3. Human capital in the romania IT sector – a key driver of quality of performance and sales management

Over the past two decades, Romania has developed into a true regional hub for IT services, becoming a reference point in Central and Eastern Europe in terms of business process outsourcing (BPO), software development and the provision of technological solutions. This rise is due to a combination of factors that offer Romania significant competitive advantages in an increasingly digitalized global economic context.

A first essential factor is the availability of a well-trained workforce. The higher education system has consistently produced graduates with solid skills in areas such as computer science, software engineering, artificial intelligence or

cybersecurity. This quality human resource is highly valued on the domestic and international labor market.

Also, the low operational costs, compared to those in Western Europe, have attracted numerous multinational companies that have chosen to outsource their IT activities to Romania. This economic efficiency, combined with a high level of productivity, offers an advantageous quality-price ratio for investors.

Knowledge of foreign languages is another important asset. A significant proportion of Romanian IT specialists are fluent in English, and many of them also know other foreign languages, such as French, German or Italian, which facilitates interaction with international clients and contributes to efficient integration into cross-border projects.

The continued development of digital infrastructure – especially in terms of high-speed internet networks and data centres – supports Romania's transition to an advanced digital economy. Public and private investments in this area have led to competitive connectivity at European level, providing the necessary technical conditions for large-scale IT operations.

Thus, Romania's positioning as a regional hub in the IT services sector is the result of a favourable combination of economic, educational and technological factors, and maintaining and consolidating this position depends on continued investment in education, digital infrastructure and innovation.

The workforce in the information and communications technology (IT&C) sector represents one of the most valuable resources of the Romanian economy, contributing decisively to the country's positioning as a relevant regional player in the technology field. In 2024, the total number of employees in this sector exceeded the threshold of 230,000, reflecting a sustained growth compared to previous years, both in terms of volume and diversification of skills.

This evolution is influenced by several structural factors: the development of the educational infrastructure in the IT field, the constant demand from the international market, as well as the tendency of multinational companies to locate their development and technological support centers in Romania.

Regarding the geographical distribution of the IT workforce in Romania, it is mainly concentrated in the large university and economic centers, especially in cities that offer infrastructure, access to educational resources and developed entrepreneurial ecosystems. Bucharest concentrates approximately 45% of the total IT&C employees, benefiting from the largest number of companies and a diversified educational offer in the technical field. Cluj-Napoca, often considered the "Silicon Valley of Romania", attracts approximately 15% of the IT workforce, especially in the areas of software development, artificial intelligence and outsourcing services. Cities such as Iași, Timișoara and Brașov are also experiencing a steady increase in the number of IT specialists, becoming emerging centers

with booming local technology ecosystems, thanks to investments in educational infrastructure, technology parks and public-private partnerships.

In terms of remuneration, the Romanian IT&C sector offers some of the most competitive salaries in the economy. In 2024, a junior programmer had an average net salary of between 1,200 and 1,500 euros, depending on the technologies used, the city of residence and the specifics of the employer (start-up vs. corporation). At the same time, the salaries of senior programmers generally vary between 3,000 and 5,000 euros net per month, especially in cases where they hold advanced certifications, expertise in niche technologies or technical leadership roles (tech lead, software architect, etc.).

This competitive salary policy contributes to maintaining talent on the domestic market, although the international mobility of IT specialists remains a significant phenomenon. At the same time, the salary differences between major cities tend to fade, amid the generalization of remote work and the increase in demand for global projects.

4. Conclusions

The structure of the Romanian IT services market reflects the maturity of the sector and its capacity to cover the entire spectrum of technological needs of the modern economy. The diversification of service segments and the increasing complexity of delivered projects attest not only to the competitiveness of the local IT industry, but also to its potential to become an essential driver of innovation and digitalization at regional and European level.

The Romanian IT workforce is in a continuous process of consolidation and sophistication, being one of the main factors supporting the accelerated development of the sector. Through its qualified human capital, expanding geographical distribution and competitive salary packages, Romania manages to maintain its attractiveness to international investors and to actively contribute to European technological innovation.

The IT sector is in a continuous transformation, marked by emerging technologies, new work models and increasingly complex requirements from users and organizations. Adapting to these trends is no longer an option, but an essential condition for long-term competitiveness and relevance.

The challenges facing the IT sector in Romania concern aspects such as: legislative stability, talent retention policies, ensuring a sustainable and resilient development of this strategic sector of the economy.

Romania is at a strategic moment in which it can leverage a wide set of financial, institutional and entrepreneurial instruments to support the transition from an outsourcing model to one focused on innovation and sustainable development. The prospects for the Romanian IT market are favorable, but

realizing its full potential requires a paradigm shift – from execution to innovation, from outsourcing to intellectual property, and from traditional training to adaptive digital education. By capitalizing on human capital, through smart public policies and by supporting the entrepreneurial ecosystem, Romania can become not just a provider of IT services, but a generator of technology with regional and global impact.

Bibliography

1. Alavi, S., Habel, J., Kassemeier, R., Schmitz, C. & Wieseke, J. (2020). Value creating sales and digital technologies. European Journal of Marketing, 57(3), 653–658.
2. Băşanu, Gh., Pricop, M., *Managementul aprovizionării şi desfacerii*, Ediția a treia, Editura Economică, București, 2004.
3. Blythe J., Managementul vânzărilor și al clienților cheie, Editura Codecs, București, 2005. 3
4. Bosworth M., *Solution Selling: Creating Buyers in Difficult Selling Markets*, Editura McGraw-Hill, 1994.
5. Budacia E. A., Bărăgan L.G., Managementul comercial: de la aprovizionare la vânzare, Editura Universitară, București, 2013.
6. Conde, R., Prybutok, V. & Thompson, K. (2023). The Moderating Role of Cultural Controls on the Relationship between Traditional Formal Sales Controls and Inside Salesperson Performance. Journal of Business & Industrial Marketing, 38(3), 622–636.
7. Dixon M., Adamson B., *The Challenger Customer*, Editura Portfolio (Penguin Group), 2015.
8. Epler, R. T., Schmitt, L., Mathis, D., Leach, M. & Hochstein, B. (2023). Do Salesforce Management Systems Actually Drive Salesperson Intentions? Industrial Marketing Management, 113, 42–57
9. Huang, Y. (2020). Situation Awareness and Information Fusion in Sales and Customer Engagement: A Paradigm Shift.
10. Popescu, L., Principii de management: aprovizionare și desfacere, Editura Cimer*Es, București, 1998.
11. Rackham N., T*he SPIN Selling Fieldbook: Practical Tools, Methods, Exercises and Resources*, Editura McGraw-Hill, 1996
12. Rapp, A. & Beeler, L. (2021). The state of selling & sales management research: a review and future research agenda. Journal of Marketing Theory and Practice, 29(1), 37–50.
13. Salonen, A., Terho, H., Böhm, E. et al. (2021). Engaging a product focused sales force in solution selling: interplay of individual and organizational level conditions. Journal of the Academy of Marketing Science.
14. Tienken, C., Classen, M. & Friedli, T. (2023). Engaging the Sales Force in Digital Solution Selling: How Sales Control Systems Resolve Agency Problems to Create and Capture Superior Value. European Journal of Marketing, 57(3), 794–833.
15. Zhang, M., Li, Y., Sun, L., Wang, G. A., Du, J. (2023). The Effects of Comparative Reviews on Product Sales. Journal of Interactive Marketing, 59(2).

Dark patterns in Romanian online retail: manipulative design and its impact on consumer trust

Ionut Tanase,
Lucia Nicoleta Barbu,
Daniela Marinica,
Denisa-Roxana Botea-Muntean[*]

Abstract

Our study investigates dark patterns (manipulative user interface designs) in Romanian e-commerce and their impact on consumer experiences. Analysing survey data from 70 Romanian consumers who have encountered such patterns in websites, we examined the occurrences of specific manipulative tactics, their consequences on purchasing behavior, and attitudes toward potential regulation. Our findings reveal that price manipulation (77.1%) and artificial urgency techniques (75.7%) are the most commonly experienced patterns among affected consumers. Significantly, 61.4% of respondents reported making regretted purchases due to dark pattern influence, with frequency of exposure correlating with increased vulnerability. These practices generate substantial negative emotional responses, with approximately 70% of consumers feeling annoyed, manipulated, or distrustful. Nearly half (47.1%) abandoned online stores due to manipulative practices, challenging assumptions about dark patterns' business value. With a strong support for regulation (81.4%) shows the need for better protection from these abusing tactics. We conclude that using dark patterns damage business sustainability by affecting customer relationships, suggesting that transparent and honest design practices may offer a more viable long-term approach to e-commerce websites.

Keywords: *Dark patterns; E-commerce; Consumer manipulation; User interface design; Digital ethics; Consumer protection*

JEL Classification: M31, L81, D18

1. Introduction

Our paper examines the usage of dark patterns in Romanian e-commerce websites, deceptive user interface designs that manipulate consumers into making

[*] Ionut Tanase is PhD student at Bucharest University of Economic Studies, Bucharest. Email address: ionut.tanase@mk.ase.ro
Lucia Nicoleta Barbu is PhD student at Bucharest University of Economic Studies, Bucharest. Email address: lucia.barbu@mk.ase.ro
Daniela Marinică is PhD student at Bucharest University of Economic Studies, Bucharest. E-mail address: daniela.marinica@mk.ase.ro
Denisa-Roxana Botea-Muntean is PhD student at Bucharest University of Economic Studies, Bucharest. Email address: munteandenisa21@stud.ase.ro

unintended choices. We created a survey and we gathered data from 70 Romanian consumers who have encountered these manipulative practices, we investigate the prevalence of specific dark pattern types, their impact on consumer behavior, and attitudes toward potential regulation. We found that price manipulation and artificial urgency tactics are the most commonly experienced dark patterns among affected consumers, with over 60% reporting regretted purchases. We demonstrate that dark patterns generate significant negative emotional responses and often lead to service abandonment, challenging assumptions about their business value. The paper is structured to first explain the concept of dark patterns in user interfaces, establish a methodological framework for studying dark patterns in the Romanian context, then present detailed results regarding consumer experiences, followed by a discussion of implications for multiple stakeholders, and concluding with recommendations for creating a more transparent and trustworthy online market. Our research contributes to the growing body of literature on manipulative design practices by providing insights specific to the Romanian e-commerce and highlighting the tension between short-term conversion optimization and sustainable business-consumer relationships.

2. Hypothesis

2.1. Definition

Dark patterns refer to deceptive or manipulative design elements in user interfaces that intentionally steer users toward actions they might not otherwise take, typically benefiting the service at the user's expense (Narayanan et. al., 2020). The term was created by UX designer **Harry Brignull** in 2010, who defined dark patterns as *"tricks used in websites and apps that make you do things that you didn't mean to, like buying or signing up for something."* (NLIU Law Review, 2023). Unlike legitimate persuasive design, dark patterns cross an ethical line by misleading or pressuring users. For example, a site might hide the "skip" button in a sign-up flow or pre-select add-ons, exploiting the fact that many users skim content and do not read every detail.

These interface tricks are carefully crafted to increase conversions – e.g. getting users to purchase costly add-ons or divulge personal data – by exploiting cognitive biases or user habits. In effect, dark patterns trade off user trust and clarity for short-term gains. Over the past decade, dark patterns have proliferated across online services and especially in e-commerce, leading to growing awareness and research into their prevalence and effects. A 2019 Princeton study of 11,000 shopping websites found dark patterns on approximately 11% of sites, encompassing

15 distinct tactics used to mislead consumers (NLIU Law Review, 2023). This indicates that manipulative design practices are not isolated incidents but rather a widespread phenomenon in online retail. In summary, dark patterns are an umbrella term for various deceptive UX strategies originating from Brignull's early "darkpatterns.org" initiative (now *deceptive.design*), and they continue to manipulate user behavior on many e-commerce platforms today.

2.2. Classification of dark patterns

Researchers have proposed taxonomies to classify dark patterns by their characteristics. Gray et al. (2018) identified five broad categories: *Nagging* (repeated intrusions or requests), *Obstruction* (making a process more difficult than necessary), *Sneaking* (hiding or adding things without user awareness), *Interface Interference* (manipulating the look or sequence of UI elements to influence choices), and *Forced Action* (requiring an unwanted action to access something) (Ghica & Gabor, 2024). Subsequent work and industry examples have expanded on these categories. In e-commerce contexts, several specific dark pattern types are particularly common such as:

- **False Urgency** – Creating a false time pressure to rush the user. For instance, fake countdown timers or flashing "Sale ends in 5 minutes!" banners push users to purchase quickly, even if the deadline simply resets afterwards. Similarly, messages about "Only 2 left in stock!" can be used even when inventory is not actually scarce. This tactic leverages fear of missing out to short-circuit rational deliberation. (European Commission, 2023)
- **Sneaking/Hidden Costs** – Concealing information or sneakily adding items. An example is *drip pricing*, where additional fees (taxes, shipping, insurance) only appear at checkout, or automatically adding extra products/ warranties to the cart without clear consent (Ghica & Gabor, 2024). Users may proceed under the impression of a lower price, only to encounter surprise charges at the final step.
- **Confirmshaming** – Guilt-tripping the user for declining an offer. This pattern presents an opt-out choice with shame-inducing phrasing. For example, a newsletter popup might have a bright "Yes, sign me up" button alongside a dimmer "No, I prefer to pay full price" link. The latter response is worded to make the user feel foolish for not accepting a discount.

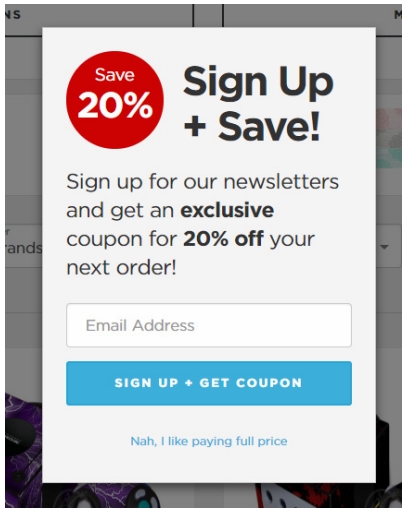


Figure 1: Example of a ***confirmshaming*** *dark pattern in an e-commerce signup pop-up. The offer promises 20% off for subscribing, while the decline option reads "Nah, I like paying full* price," *shaming users who opt out.* Such language uses social pressure and emotion (here, self-deprecation) to nudge users into compliance. Confirmshaming appears frequently in retail email sign-ups and subscription offers, coercing users by implying they are making an irrational choice by saying no.

This exemplifies how copywriting can be used as a dark pattern alongside visual design. Many other dark patterns exist (e.g. *Bait-and-Switch*, *Disguised Ads*, *Trick Questions*, etc.), but the key types above are frequently observed on shopping websites. Notably, these deceptive patterns are often combined. A single checkout flow might employ multiple dark patterns – for example, an overlay that uses false urgency ("Deal ends soon!"), social proof ("500 people viewing now"), and sneaky pre-ticked add-ons – all at once.

Such classifications help researchers and regulators systematically identify dark patterns. By naming and exemplifying them (as Brignull's Dark Patterns library originally did), we can better recognize these tactics in the wild.

2.3. Impact on e-commerce

Dark patterns can indeed deliver short-term boosts in user metrics, such as higher sign-up rates, more items in carts, extra revenue from slipped-in fees, which is why some e-commerce operators resort to them. By manipulating consumers into purchases or consents they might not otherwise choose, dark patterns can artificially inflate conversion rates and average order values. For instance, a false urgency timer may spur indecisive shoppers to complete a purchase "before the deal expires," thereby reducing cart abandonment in the immediate term. Similarly, pre-ticked add-ons will yield additional sales from those who fail to opt out. In the aggregate, these tactics can create an uptick in a site's performance numbers. However, numerous studies and industry surveys indicate that the **long-term effects on consumer trust and business sustainability are overwhelmingly negative**.

Dark patterns often lead to consumer **regret and dissatisfaction**. A customer who was tricked into a costly warranty or a subscription they didn't intend will

likely feel deceived once they notice the charge. This can result in refund requests, product returns, or costly customer support cases to undo the unintended transactions. More significantly, users who feel manipulated tend not to remain loyal customers. An international survey by Dovetail in 2023 (covering e-commerce and social media users) found that **nearly 56% of respondents had lost trust in a website or platform because of manipulative design patterns**, and **43% of online shoppers said they stopped buying from an online retailer after encountering dark patterns** (Williams, 2023)

2.4. Ethical and Legal Implications

The use of dark patterns raises serious **ethical concerns and legal questions**. At an ethical level, dark patterns violate principles of transparency, respect for user autonomy, and informed consent. They are designed to *benefit the business at the expense of the user*, often leading users to make choices against their own interests (such as spending more money or surrendering privacy). This erodes the fundamental trust between consumers and online services (Williams, 2023). When users eventually realize they were misled or coerced, for example, discovering an unwanted subscription or hidden fee, it can breed resentment and diminish their trust in the brand and in e-commerce generally. Dark patterns also disproportionately affect less experienced or more vulnerable users, who may be less aware of these tricks or less confident in navigating convoluted interfaces. From an ethical standpoint, many argue that employing such manipulative designs is **unprofessional and exploitative**, akin to tricking customers rather than serving them. Professional codes in design and software engineering emphasize honesty and user welfare, which dark patterns directly contravene (Mathur et. al., 2019).

Data protection and privacy law also come into play, since many dark patterns aim to obtain user consent for data sharing. The EU's **General Data Protection Regulation (GDPR)** requires that consent be informed, freely given, specific, and unambiguous. Interfaces that "nudge" users into consenting through dark patterns (for example, a confusing cookie banner that makes the "Accept All" button obvious but hides the opt-out) are considered invalid under GDPR. Recently, new legislation explicitly targets dark patterns. The **Digital Services Act (DSA)**, which came into force in 2024 across the EU, contains a provision (Article 25) that *bans online platforms from deploying dark patterns* that materially distort or impair users' ability to make free and informed decisions (European Commission, 2023). This means large e-commerce marketplaces and online platforms operating in the EU must refrain from deceptive interface designs or face regulatory penalties. The upcoming **Digital Markets Act (DMA)** similarly expects higher standards of user-friendly design from big "gatekeeper" firms, and the proposed EU AI Act would prohibit certain dark pattern-like manipulations in AI systems (Cooper, D. et al., 2023)

2. Methodology

This study employed a quantitative research design using a structured survey to investigate Romanian consumers' experiences with and perceptions of dark patterns in e-commerce environments. The research was designed to capture both the prevalence of specific dark pattern types and consumers' emotional and behavioral responses to these manipulative design practices. The survey instrument was developed based on established dark pattern taxonomies from the literature, particularly drawing on classifications by Gray et al. (2018) and examples documented by Brignull. The questionnaire consisted of six closed-ended questions focused on:

1. Types of dark patterns encountered
2. Frequency of dark pattern encounters
3. Purchase regret resulting from dark patterns
4. Emotional responses to dark patterns
5. Discontinuation of service use due to dark patterns
6. Attitudes toward potential regulation

The survey was intentionally kept brief to maximize completion rates while still capturing essential data points on consumer experiences and attitudes. The questionnaire was administered in English, which is widely understood among Romanian online consumers.

Participants were recruited through a combination of convenience and purposive sampling techniques. The survey was distributed through various online channels including social media platforms, consumer forums, and e-commerce-related groups. Inclusion criteria required participants to be Romanian residents aged 18 or older who had made at least one online purchase in the past year and who had encountered at least one dark pattern during their online shopping experiences. This selective sampling approach was intentionally employed to focus exclusively on consumers with direct experience of manipulative design practices. No demographic data was collected to keep the survey brief and focused on the research questions.

Data collection took place over a two-week period in February 2025. The survey was administered electronically using a secure web-based survey platform. Participants were informed about the purpose of the research and assured of the anonymity of their responses. A total of 70 valid responses were collected from consumers who had encountered at least one dark pattern. It is important to note that this sample represents only those consumers who have experienced dark patterns, not the entire population of Romanian online shoppers.

Survey responses were analyzed using descriptive statistics to identify patterns in consumer experiences and perceptions. For multiple-choice questions allowing multiple selections, each option was treated as a separate variable for frequency analysis. Cross-tabulations were performed to explore relationships

between frequency of dark pattern encounters, emotional responses, and attitudes toward regulation. The results were synthesized to provide a comprehensive understanding of dark pattern experiences among Romanian consumers who have encountered these practices. It is important to emphasize that the findings cannot be generalized to all Romanian online shoppers, as the study specifically targeted those with dark pattern experiences.

3. Results

It is important to note that all 70 respondents in this study have encountered at least one type of dark pattern during their online shopping experiences, we have filtered them from a broader database to focus only on the consumers that actually were aware of the existence of a dark pattern. Therefore, the results presented below represent the experiences and perspectives of Romanian consumers who have been exposed to dark patterns, rather than the general online shopping population.

3.1 Prevalence of Dark Pattern Types Among Affected Consumers

Table 1 presents the frequency of each dark pattern type encountered by respondents who have experienced at least one dark pattern. Among these affected consumers, additional fees appearing only at checkout emerged as the most commonly experienced dark pattern (77.1%), followed closely by countdown timers creating false urgency (75.7%) and messages about limited stock (72.9%).

Table 1: Types of Dark Patterns Encountered by Romanian Consumers

Dark Pattern Type	Number of Respondents	Percentage
Additional fees or costs appearing only at checkout	54	77.1%
Countdown timers creating urgency	53	75.7%
Messages about limited stock	51	72.9%
Difficulty finding how to unsubscribe or cancel a service	47	67.1%
Misleading language that tricks you into accepting something	41	58.6%
Pre-selected add-ons or extras in your cart	39	55.7%
Guilt-inducing language when declining offers	35	50.0%

The data indicates that price manipulation (additional fees) and urgency creation (countdown timers, limited stock messages) are the most prevalent dark patterns encountered by Romanian consumers who have experienced dark patterns, while confirmshaming techniques (guilt-inducing language) are relatively less common but still experienced by half of all respondents in this study.

3.2 Frequency of Dark Pattern Encounters

The frequency with which respondents encounter dark patterns is presented in Table 2. The majority of respondents (68.6%) reported encountering dark patterns either occasionally or frequently during their online shopping experiences.

Table 2: Frequency of Dark Pattern Encounters

Frequency	Number of Respondents	Percentage
Very frequently (almost every time I shop online)	15	21.4%
Frequently (most times I shop online)	18	25.7%
Occasionally (sometimes when I shop online)	30	42.9%
Rarely (only a few times)	7	10.0%
Total	**70**	**100.0%**

The results show that among Romanian consumers who have encountered dark patterns, nearly half (47.1%) encounter these practices frequently or very frequently, suggesting that for affected consumers, dark patterns are a recurring element of their e-commerce experience.

3.3 Purchase Regret Due to Dark Patterns

Table 3 shows the extent to which dark patterns have led to regretted purchases among respondents.

Table 3: Purchases Regretted Due to Dark Patterns

Experience with Regretted Purchases	Number of Respondents	Percentage
Yes, multiple times	13	18.6%
Yes, once or twice	30	42.9%
No, I've recognized the tactics and avoided unwanted purchases	27	38.6%
Total	**70**	**100.0%**

A majority of respondents (61.4%) reported having made at least one regretted purchase due to dark pattern tactics, indicating the effectiveness of these manipulative techniques in influencing consumer behavior against their better judgment.

3.4 Emotional Responses to Dark Patterns

Table 4 presents respondents' emotional reactions when encountering dark patterns during online shopping.

Table 4: Emotional Responses to Dark Patterns

Emotional Response	Number of Respondents	Percentage
Annoyed	52	74.3%
Manipulated	49	70.0%
Distrustful of the company	47	67.1%
Indifferent, it's normal business practice	20	28.6%
Understanding, they need to make sales	19	27.1%

The data reveals predominantly negative emotional responses to dark patterns, with feelings of annoyance, manipulation, and distrust being reported by more than two-thirds of respondents. Only a minority expressed indifference or understanding toward these practices.

3.5 Discontinuation of Service Due to Dark Patterns

Table 5 shows whether respondents have stopped using online stores due to encountering dark patterns.

Table 5: Discontinued Use of Online Stores Due to Dark Patterns

Discontinued Use	Number of Respondents	Percentage
Yes	33	47.1%
No	27	38.6%
Not sure	10	14.3%
Total	**70**	**100.0%**

Nearly half of the respondents (47.1%) reported having stopped using at least one online store because of dark patterns, indicating significant business risk for e-commerce operators employing these tactics.

4.6 Attitudes Toward Regulation of Dark Patterns

Table 6 presents respondents' views on whether dark patterns should be regulated.

Table 6: Attitudes Toward Regulation of Dark Patterns

Attitude Toward Regulation	Number of Respondents	Percentage
Yes, they should be strictly regulated	31	44.3%
Yes, but only the most deceptive practices	26	37.1%
No, companies should be free to design their websites as they wish	11	15.7%
No opinion	2	2.9%
Total	**70**	**100.0%**

A strong majority of respondents (81.4%) favored some form of regulation for dark patterns, with 44.3% supporting strict regulation of all such practices and 37.1% favoring regulation only for the most deceptive tactics.

The results reveal several important insights about Romanian consumers' experiences with dark patterns:

1. Among consumers who have encountered dark patterns, price manipulation and artificial urgency are the most commonly experienced tactics in the Romanian e-commerce landscape.
2. The majority of affected consumers (61.4%) have made at least one regretted purchase due to dark pattern influence, with this likelihood increasing among those who encounter dark patterns more frequently.
3. Dark patterns evoke predominantly negative emotional responses among affected consumers, with feelings of annoyance (74.3%), manipulation (70.0%), and distrust (67.1%) being most common.
4. Nearly half of affected consumers (47.1%) have stopped using at least one online store due to dark patterns, indicating potential business costs of these practices.
5. There is strong support for regulation of dark patterns among Romanian consumers who have experienced these practices, with 81.4% favoring some form of regulatory intervention.

4. Discussion

Our findings show a significant impact of dark patterns on Romanian consumers who encounter them. Among affected consumers, price manipulation (hidden fees reported by 77.1%) and urgency creation techniques (countdown timers 75.7%, limited stock messages 72.9%) are particularly prevalent, mirroring international trends identified in previous research. These patterns transcend cultural boundaries, suggesting their widespread adoption as standard industry practice.

The most troubling result is that over 60% of consumers who experienced dark patterns made purchases they later regretted, demonstrating how these techniques effectively override rational decision-making. We observed a correlation between frequency of dark pattern exposure and likelihood of regretted purchases, suggesting a "wearing down" effect where repeated exposure diminishes consumer resistance over time.

The emotional impact is substantial, with approximately 70% of affected consumers reporting feelings of annoyance, manipulation, and distrust. Notably, nearly half (47.1%) abandoned at least one online store due to these practices, challenging the business assumption that dark patterns necessarily benefit bottom

lines. While they may increase short-term conversions, they appear to exact a heavy price in customer retention and trust. Consumer support for regulation is strong, with 81.4% favoring some form of intervention. Interestingly, those who reported feeling manipulated were more inclined to favor strict regulation, suggesting that subjective experiences drive regulatory preferences more strongly than mere exposure to specific tactics.

From this perspective, the implications are on multiple levels, such as:

For consumers, education about dark patterns appears valuable, as 38.6% reported successfully recognizing and avoiding unwanted purchases despite encountering these tactics. However, the high prevalence of regretted purchases even in our sample suggests individual vigilance alone provides insufficient protection against sophisticated psychological manipulation.

For businesses, our findings present a compelling case against dark patterns. The high rate of service discontinuation contradicts assumptions about their long-term profitability. Romanian e-commerce businesses might differentiate themselves by rejecting these practices and embracing transparent design as consumer awareness grows.

For regulators, the strong consumer support suggests initiatives to restrict dark patterns would likely receive public backing. The differentiated support we observed—44.3% favoring strict regulation and 37.1% supporting regulation only of the most deceptive practices—suggests a nuanced approach targeting the most harmful tactics might achieve broader consensus.

Several limitations should be noted. Our study exclusively sampled consumers who had encountered at least one dark pattern, meaning we cannot determine overall prevalence among Romanian online shoppers. Self-reporting biases, lack of demographic analysis, and the study's cross-sectional design also limit our ability to establish causal relationships or generalize across different consumer segments.

Future research should quantify economic costs of dark patterns, explore vulnerability factors across demographic groups, track longitudinal effects, compare patterns across European markets, and evaluate regulatory effectiveness. Experimental studies testing different dark patterns and countermeasures could provide stronger causal evidence and inform intervention strategies.

5. Conclusion

Our research into the usage of dark patterns in Romanian e-commerce websites shows a complex landscape where manipulative design practices can significantly impact consumer experiences and behaviors. Among those who have encountered dark patterns, price manipulation and artificial urgency techniques emerge as particularly prevalent tactics, with over 70% of respondents reporting

exposure to these strategies. The emotional toll of these practices is important, generating feelings of annoyance, manipulation, and distrust which ultimately damage the relationship between consumers and online retailers.

Probably, the most concerning is the finding is that 61.4% of affected consumers made purchases they later regretted due to dark pattern influence, demonstrating these tactics' effectiveness in overriding consumer agency. The correlation we observed between frequency of dark pattern exposure and likelihood of regretted purchases points to a potential cumulative vulnerability effect that warrants attention from both consumer protection advocates and business ethicists alike.

Our findings challenge the conventional business wisdom that dark patterns necessarily benefit retailers' bottom lines. With nearly half of affected consumers abandoning online stores due to manipulative practices, the short-term conversion gains these tactics might deliver appear to come at a significant cost to customer retention and trust. Forward-thinking businesses might therefore consider transparent interface design as a competitive advantage rather than a limitation.

There is also strong support for regulation among affected consumers (81.4%) indicates a clear mandate for policy intervention in this space. Romanian regulators could draw upon existing EU frameworks while developing targeted approaches that address the dark patterns most commonly encountered and most harmful to consumers in the local market.

Though our study focused specifically on consumers who have already encountered dark patterns, limiting generalizability, it nonetheless provides valuable insights into the experiences of those affected by these practices in the Romanian context. As e-commerce continues to grow in significance for Romania's economy, addressing dark patterns becomes increasingly important for ensuring a marketplace that respects consumer autonomy and fosters trust.

Future efforts should focus on developing multi-faceted approaches that combine regulatory oversight, business practice evolution, and consumer education. By working toward more transparent and ethical digital interfaces, stakeholders can help create an e-commerce environment that balances business objectives with genuine consumer interests, ultimately creating more sustainable value for all participants in Romania's digital marketplace.

References

Brignull, H. (2010) *Dark Patterns* (Original darkpatterns.org website). Definition available at Deceptive Design: https://www. deceptive. design/ (Accessed 2025-03-18).

Gray, C. M., Kou, Y., Battles, B., Hoggatt, J., & Toombs, A. (2018) 'The dark (patterns) side of UX design', *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, Paper 534, 1–14. ACM.

Mathur, A., Acar, G., Friedman, M., Lucherini, E., Mayer, J., Chetty, M., & Narayanan, A. (2019) 'Dark Patterns at Scale: Findings from a Crawl of 11K Shopping Websites', *Proceedings of the ACM on Human-Computer Interaction (CSCW)*, 3, pp. 1–32.

Narayanan, A., Mathur, A., Chetty, M., & Kshirsagar, M. (2020) 'Dark Patterns: Past, Present, and Future', *Communications of the ACM*, 63(9), pp. 42–47.

Luguri, J. & Strahilevitz, L. (2021) 'Shining a Light on Dark Patterns', *Journal of Legal Analysis*, 13(1), pp. 43–109.

Williams, S. (2023) 'Study highlights consumer distrust due to dark design patterns', *CMOtech UK*, 15 December 2023.

European Commission (2023) 'Consumer protection: manipulative practices in the online environment identified in 148 of 399 virtual stores', Press Release IP/23/418, 20 January 2023. Brussels: European Commission.

Bondoc & Asociatii (Ghica, A. & Gabor, A.) (2024) 'Brightening the path for understanding certain dark patterns', *Lexology* (Company & Commercial, Romania), 4 July 2024.

NLIU Law Review (2023) 'Beyond the Click: Unveiling the Psychology of Dark Patterns', *NLIU Law Review Blog*, October 2023.

Covington & Burling LLP (Cooper, D. et al.) (2023) 'The EU Stance on Dark Patterns', *Inside Privacy* blog, 31 January 2023.

Determinants of renewable energy: a note

*Bogdan Glăvan**

Abstract

Renewable energy has become a buzzword in policy papers and public debates. Economists have attempted to identify what are the determinants of the increase in renewable energy production and consumption. This is a concise review of these efforts.

JEL Classification: Q40.

Keywords: renewable energy, GDP, corruption, economic freedom.

Renewable energy has become a buzzword in policy papers and public debates. Moreover, the interest around renewables has surged to unprecedented peaks and both private sector and households become anxious to increase consumption of renewable energy.

Perhaps the most important factor associated with the development of renewable energy (RE) is Gross Domestic Product. GDP per capita is a well-known determinant of renewable energy consumption, but only in developed countries. This illustrates the so-called "environmental Kuznets curve" according to which, at an early stage of development, the increase in income leads to pollution and other environmental damages, but at a more advanced stage of development, when people preferences change, economic growth improves the environmental quality and increases the share of renewable energy. The causal relation between GDP and RE was noticed, among others, by Menyah and Wolde-Rufael (2010), who studied this issue in US for almost half a century. Table no. 1 summarizes the recent empirical research on the influence of GDP on renewable energy consumption.

Table no. 1. Empirical evidence about the nexus between GDP and RE

Study	Sample; Study Period	Results
Sadorsky (2009)	18 emerging countries; 1994 to 2003.	A 1% increase in real income per capita increases the consumption of renewable energy per capita by 3.5%.

* Bogdan Glăvan is Professor of economics at the Romanian American University in Bucharest. E-mail: bogdan.nicolae.glavan@rau.ro.

Sadorsky (2009)	G7 countries; 1980-2005.	A 1% increase in real GDP per person increases the consumption of renewable energy per capita by 8.44%.
Li et. al. (2020)	OECD economies over the period from 1990 to 2017.	Income is an important factor in explaining renewable energy consumption.
Tudor and Șova (2021)	94 countries; 1995-2019.	Positive correlation between GDP per capita and renewable energy consumption, but only for the countries with middle–high, high and very high income levels.
Polcyn et. al. (2022)	10 european countries; 2000-2018.	A 1% rise in GDP per capita leads to the growth of renewable energy consumption by 0.69%.

Intuitively, the quality of government should be associated with the development of renewable energy, because honest decisionmakers will pursue policies reflecting the preferences of their population. Therefore, one could expect corruption to prevent investment or consumption of renewable energy. However, the relation between corruption and renewable energy seems to be complex. Corruption can reduce investment and consumption of renewable energy if the lobbying power of fossil fuel sector is overwhelming, but it can also increase them if the environment regulations are exploited by the interest groups associated with wind and solar energy. A consistent review of the literature can be found in Leitao (2021). Cadoret and Padovano (2016) show that an improvement in the quality of governance, as measured by corruption perception index, increases the share of renewable energy consumption in European countries. However, a similar study over a different time period illustrates inconclusive results: corruption is negatively associated with REC in the European Union, but the result is not statistically significant (Tu *et. al*., 2022). Details about the empirical research in this area are summarized in Table no. 2.

Table no. 2. Empirical evidence on the relation between corruption and RE

Study	**Sample; Study Period**	**Results**
Strunz et. al. (2016)	Germany, before 2016.	The "Energiewende" narrative is determined by ideology and rent-seeking.
Gennaioli, C., Tavoni (2016)	Italy; 1990–2007	Government subsidies for renewable energy can determine the formation of criminal associations between entrepreneurs and politicians.
Mahmood et. al. (2021)	Pakistan, India, Bangladesh, and Sri Lanka;1996–2019	Control of corruption has a positive impact on natural gas consumption, but insignificant effects on renewable energy.

Uzar (2020)	38 countries; 1990–2015.	Institutional quality has a positive impact on renewable energy consumption in the long run.
Amoah et. al. (2022)	32 African countries; 1996–2019.	A 1% increase in Corruption Perception Index reduces the share of renewable energy consumption by 0.31%.
Cadoret and Padovano (2016)	26 EU countries; 2004-2011.	Positive effect of the quality of governance on renewable energy consumption share.

The political orientation of governments may be a significant factor of renewable energy development. The general ideological inclination of governments is well illustrated by the level of economic freedom. Economic freedom is a multi-dimensional concept used in measuring the quality of institutional framework, covering the rule of law, business freedom, fiscal and regulatory burden and other elements. Various studies have shown that, in relation to the environmental and climate issues, it can work both ways: it can sometimes increase the environmental damage and, in other cases, enhance sustainable development. While Loris (2015) argues that economic freedom supports environmental performance, Amoah et. al. (2020) and Rapsikevicius *et. al*. (2021) discover different nuances in this relation: some aspects of economic freedom have a negative impact on the environment in general, and on the share of renewable energy consumption in particular, while other aspects have a positive effect. Also, Le *et. al*. (2020) comprehensive study find that economic freedom improves environmental performance in high-income countries only. Tu *et. al*. (2022) show that in Europe there is a clear and positive connection between economic freedom and RE, but this study covers only ten years (2011-2020). Additional information about this line of research is presented in Table no. 3.

Table no. 3. Empirical evidence on the relation between economic freedom and REC

Study	Sample; Study Period	Results
Tu et al. (2022)	27 european countries; 2011-2020.	A rise in the Economic Freedom Index by 1 point increases the share of renewable energy consumption by 0.21%.
Amoah et al. (2020)	32 african countries; 1996-2017.	The rule of law and the tax burden have a negative impact on the share of renewable energy consumption, while business freedom and trade freedom have a positive influence.

Rapsikevicius et al. (2021)	23 european countries; 2005–2018).	Economic freedom reduces pollution, but increases CO_2 emissions.
Marinescu, C.; Fucec, A.A. (2014)	5 european countries; 1995-2011.	Economic freedom positively influences renewable energy investments in some of these countries.

A central indicator defining political orientation is the attitude on gender issues. The growing political representation of women has led many scholars to investigate the relation between gender and decision-making. In particular, a number of authors studied how women participation in politics influences the environmental and energy policy. Fredriksson and Wang (2011) show that women legislators are more inclined than men to vote for severe environmental regulations, a conclusion that was confirmed by Mavisakalyan and Tarverdi (2019). Salamon (2022) finds that a higher presence of women in parliament determines a higher consumption of renewable energy in developed countries. Finally, a very recent study shows that "a 1 percentage point increase in the proportion of women in the legislature increases the renewable energy production between 0.74 and 1.64 percentage point" (D'Agosti, 2022).

Considering the above literature review, we have found a consistent research indicating that ideology matters when it comes to environmental and energy policies.

References

Alesina, A., Perotti, R., 1995. The Political Economy of Budget Deficits. *IMF Econ Rev* **42**, 1–31 https://doi.org/10.2307/3867338

Amoah, A., Kwablah, E., Korle, K., *et al.,* 2020. Renewable energy consumption in Africa: the role of economic well-being and economic freedom. *Energ Sustain Soc* **10**, 32 (2020). https://doi. org/10.1186/s13705-020-00264-3

Amoah, A., Asiama, R. K., Korle, K., Kwablah, E. 2022, Corruption: Is it a bane to renewable energy consumption in Africa?, *Energy Policy*, Volume 163, 2022, 112854, ISSN 0301-4215, https://doi. org/10.1016/j.enpol.2022.112854

Belke, A., and Potrafke, N., Does government ideology matter in monetary policy? A panel data analysis for OECD countries, *Journal of International Money and Finance*, Volume 31, Issue 5, 2012, Pages 1126 - 1139, https://doi.org/10.1016/ j.jimonfin. 2011.12.014.

Isabelle Cadoret, Fabio Padovano, 2016. The political drivers of renewable energies policies, *Energy Economics*, Elsevier, vol. 56(C), Pages 261-269, ISSN 0140-9883, https://doi.org/10.1016/j.eneco. 2016.03.003.

Cahan, D., Doerr, L. & Potrafke, N., 2019, Government ideology and monetary policy in OECD countries. Public Choice 181, 215–238, https://doi.org/10.1007/s11127-019-00652-0

D'Agosti, N. 2022. Gender of Legislators and Renewable Energy. Working Paper. https:// www.nataliadagosti.com/files/gender_of_legislator_ RE.pdf

Dutt, P., and Devashish M., 2005. Political Ideology and Endogenous Trade Policy: An Empirical Investigation, *The Review of Economics and Statistics,* vol. 87, no. 1, pp. 59–72. JSTOR, http://www.jstor.org/stable/40042922.

Fredriksson, P. G., Wang, L., 2011. Sex and environmental policy in the US House of

Representatives, *Economics Letters*, 113 (3), 228–230, https://doi.org/10.1016/ j.econlet. 2011.07.019

Gennaioli, C., Tavoni, M., 2016. Clean or dirty energy: evidence of corruption in the renewable energy sector. *Public Choice* 166, 261–290, https://doi.org/ 10.1007/ s11127-016-0322-y

Jahn, D., 1998. Environmental performance and policy regimes: Explaining variations in 18 OECD-countries. *Policy Sciences* 31, 107–131, https://doi.org/10.1023/ A:1004385005999

Le, Thai-Ha, Chang, Youngho and Park, Donghyun, 2020. Renewable and Nonrenewable Energy Consumption, Economic Growth, and Emissions: International Evidence, *Energy Journal*, vol. 41(2), pages 73-92. https://doi.org/10.5547/01956574. 41.2.thle

Leitão, Nuno Carlos, 2021. The Effects of Corruption, Renewable Energy, Trade and CO_2 Emissions. *Economies* 9, no. 2: 62. https://doi.org/10.3390/economies 9020062

Li, Jingwen & Zhang, Xueyuan & Ali, Shahid & Khan, Zeeshan, 2020. Eco-innovation and energy productivity: New determinants of renewable energy consumption. *Journal of Environmental Management*. 271. https://doi.org/10.1016/j.jenvman. 2020. 111028

Loris, N.D., 2015. Economic freedom, energy, and development. Miller, T. and Kim, A. B. (eds.), *Index of economic freedom*, Washington, DC: The Heritage Foundation, pp. 57-68.

Mahmood, Haider, Muhammad Tanveer, and Maham Furqan., 2021. Rule of Law, Corruption Control, Governance, and Economic Growth in Managing Renewable and Nonrenewable Energy Consumption in South Asia. *International Journal of Environmental Research and Public Health* 18, no. 20: 10637. https://doi.org/ 10.3390/ ijerph182010637

Marinescu, C.; Fucec, A.A., 2014. The Impact of Economic Freedom on Renewable Energy Investments' efficiency. Proceedings of the 14th International Multidisciplinary Scientific GeoConference SGEM, Sofia, Bulgaria, 19–25 June 2014; pp. 447–454.

Mavisakalyan, Astghik & Tarverdi, Yashar., 2018. Gender and climate change: Do female parliamentarians make difference? *European Journal of Political Economy*. 56. https://doi.org/10.1016/j.ejpoleco. 2018.08.001

Menyah, K. & Wolde-Rufael, Y., 2010. CO_2 emissions, nuclear energy, renewable energy and economic growth in the US. *Energy Policy*. 38. 2911-2915. https://doi.org/10.1016/j.enpol.2010.01.024

Polcyn, J.; Us, Y.; Lyulyov, O.; Pimonenko, T.; Kwilinski, 2022. A. Factors Influencing the Renewable Energy Consumption in Selected European Countries. *Energies*, 15, 108. https://doi.org/10.3390/en 15010108

Rapsikevicius, J.; Bruneckiene, J.; Lukauskas, M.; Mikalonis, S., 2021. The Impact of Economic Freedom on Economic and Environmental Performance: Evidence from European Countries. *Sustainability*, 13, 2380. https://doi.org/10.3390/ su13042380

Rothman, S. and Lichter, S. R., 1987. Elite Ideology and Risk Perception in Nuclear Energy Policy, *American Political Science Review*. Cambridge University Press, 81(2), pp. 383–404. doi: 10.2307/ 1961958

Sadorsky, P., 2009. Renewable Energy Consumption, CO_2 Emissions and Oil Prices in the G7 Countries. *Energy Economics*.31. 456-462. https://doi.org/10.1016/ j.eneco.2008.12.010.

Sadorsky, P., 2009. Renewable Energy Consumption and Income in Emerging Economies. *Energy Policy*, 37, 4021-4028. https://doi. org/10.1016/j.enpol. 2009.05.003

Salamon, H., 2022. The Effect of Women's Parliamentary Participation on Renewable Energy Policy Outcomes. *European Journal of Political Research*, 62. https://doi.org/10.1111/1475-6765.12539

Sánchez-Vellvé, F. and León, M., 2021. EU minimum wages: To what extent does ideology matter?, *Estudios de Economía*, 48(1), pp. pp. 35–57. Available at: https://estudiosdeeconomia.uchile.cl/ index.php/EDE/article/view/63748

Strunz, S.; Gawel, E.; Lehmann, P., 2016. The Political Economy of Renewable Energy Policies in Germany and the EU. *Util. Policy*, 42, 33–41. https://doi.org/ 10.1016/j.jup.2016.04.005.

Tu, Y.-X.; Kubatko, O.; Piven, V.; Sotnyk, I.; Kurbatova, T., 2022. Determinants of Renewable Energy Development: Evidence from the EU Countries. *Energies*, 15, 7093. https://doi.org/10.3390/ en15197093

Tudor, C.; Sova, R., 2021, On the Impact of GDP per Capita, Carbon Intensity and Innovation for Renewable Energy Consumption: Worldwide Evidence. *Energies*, 14, 6254. https://doi.org/10.3390/ en14196254

Umut, U., 2020. Political economy of renewable energy: Does institutional quality make a difference in renewable energy consumption? *Renewable Energy*, Volume 155, August 2020, Pages 591-603. https://doi.org/10.1016/j.renene. 2020.03.172.

The Euroland vs. the USA – comparative macroeconomic performance since the launch of the euro

Andrei Rădulescu, Ph.D.[1]

Abstract

The launch of the euro in 1999 was one of the most important macroeconomic events in the history of the world, and the most relevant in Europe in the past century, especially in the context of the World Wars. However, the macroeconomic performance of the Euroland since its inception was significantly weaker when compared to the USA, the largest economy in the world. According to our econometric estimates, the gap in terms of annual potential growth pace between the USA and the Euroland widened to 1.4pps in 2024, a record high level since the launch of the euro. This was mainly determined by the fact that the Euroland economy was significantly more affected than the US economy by the shocks (endogenous and exogenous) that occurred since 1999, including the Great Financial Crisis, the coronavirus pandemic, and the intensification of the geo-political tensions. These shocks have had a negative impact on the investment climate in the Euroland, given the consequences for the international competitiveness of the region and the weaknesses and challenges in terms of economic policy decisions, in the context of the incomplete structure of the European Monetary Union (EMU).

Keywords: *Euroland economy, potential output, investments*

JEL Classification: C22, E22, F10

1. Introduction

Since the launch of the euro (on 1st of January 1999) the economy of the Euro Area (with a nominal dimension of EUR 15.2tn in 2024, representing around 85% of the GDP of the European Union) grew by an average annual pace of 1.3%, according to the database of Eurostat (2025).

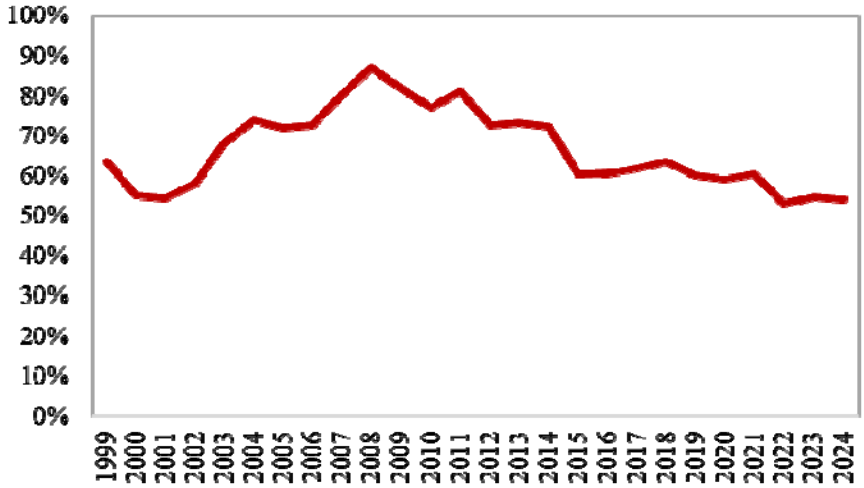
During the same period 1999 – 2024 the economic activity in the USA, the largest economy in the world (with a nominal GDP of USD 29.2tn in 2024, according to the estimates of the Bureau of Economic Analysis (2025)), advanced by an average annual pace of 2.2%.

This important gap in terms of the growth pace from 1999 to 2024 determined a divergence of the Euroland from the USA in terms of GDP/capita. The GDP/capita (expressed in nominal US dollars) in the Euroland represented 54.3% of the level in the USA in 2024, down from 63.8% in 1999 (the year when the euro was launched), if we consider the database of Federal Reserve St. Louis (FED) (2025), as reflected in the Figure 1. In fact, at present, the GDP/capita in the

[1] Senior Researcher, Institute for World Economy, Romanian Academy, e-mail: iemradulescu@gmail.com

countries that today compose the Euroland as a percentage of the GDP/capita in the USA (expressed in nominal US dollars) is very close to the lowest level since 1985.

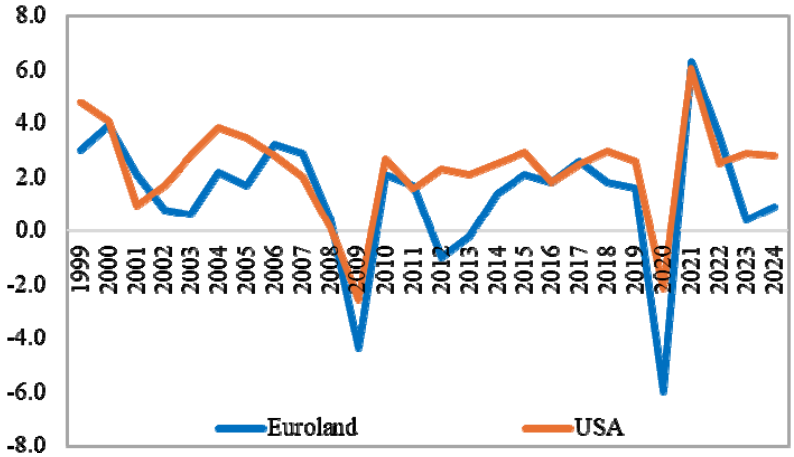
Figure 1. GDP/capita in the Euroland as % of GDP/capita in the USA (nominal US dollars)



Source: representation of the author considering the statistics of the Federal Reserve St. Louis (FED) (2025)

We point out that only in 8 years out of the 26 years under analysis the annual rate of the GDP was higher in the Euro Area than in the USA, according to the databases of Eurostat (2025) and BEA (2025), as can be noticed from the following figure.

Figure 2. GDP pace in the USA and the Euro Area during 1999 – 2024 (%, YoY)



Source: representation of the author considering the statistics of Eurostat (2025) and Bureau of Economic Analysis (2025)

The main objective of the paper is to compare the performance of the GDP in the Euroland and the USA during the period 1999 – 2024 by applying standard econometric tools, while using the databases of Eurostat (2025), and Bureau of Economic Analysis (2025).

2. Methodology

In this paper we use standard macroeconomic analysis tools and the databases of Eurostat (2025) and of the Bureau of Economic Analysis (2025) in order to assess the macroeconomic performance of the USA and of Euroland during the period 1999 – 2024. On the one hand, we analyse the evolution of the components of the GDP from the demand side perspective, with a focus on the gross fixed capital formation.

We estimated the CAGR indicator (compound annual growth pace) for these macroeconomic indicators for a broad comparative analysis of the performance over the past 25 years.

On the other hand, the Hodrick-Prescott filter was implemented in order to distinguish between the structural and the cyclical components for the annual pace of the GDP and of the gross fixed capital formation in these economic blocks (working with annual data), but also for the annual pace of the exports in the Euroland (quarterly observations).

This filter has been widely used in macroeconomic analysis over the past decades, being a simple and transparent method.

The method is based on the following relation:

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

where Yt, Yt* and λ represent the macroeconomic variable (GDP, gross fixed capital formation, exports), its trend, and a smoothness parameter.

In this paper we used a value of 100 for this smoothness parameter, as recommended by Hodrick-Prescott (1997), as we worked with annual observations – GDP and gross fixed capital formation.

However, we used a value of 1 600 for this smoothness parameter when estimating the trend of the exports in the Euroland, as in this case we worked with quarterly data.

Afterwards, we compared the performance of the annual potential growth pace of GDP, and gross fixed capital formation (the USA and Euroland).

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

3. Euroland – USA – the GDP performance gap during 1999 - 2024

From 1999 to 2024 the economy of the Eurozone increased by an average annual pace of 1.3%, taking into account the database of Eurostat (2025). This

was a weaker performance than in the USA, where the economic activity advanced by an average annual pace of 2.2% during the same period, if we consider the database of the Bureau for Economic Analysis (2025).

There can be noticed the strong divergence in terms of GDP pace following the outbreak of the shocks (either endogenous, such as the Great Financial Crisis, or exogenous, such as the coronavirus pandemic, or the geo-political tensions).

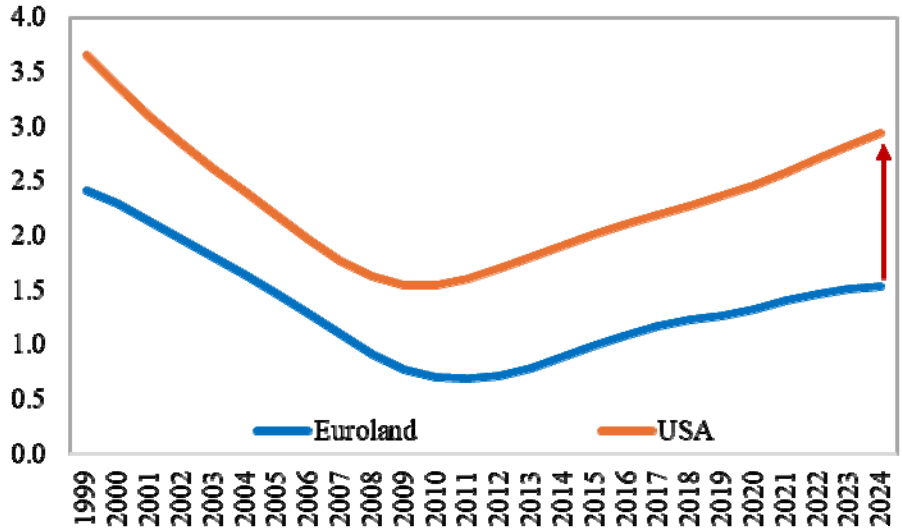
For instance, the GDP of the Euroland contracted by annual rates of 4.4% in 2009, and 6.0% in the pandemic year 2020, a severe adjustment than in the USA (decline by annual paces of 2.6%, and 2.2%, respectively), according to the database of Eurostat (2025).

Furthermore, since the outbreak of the geo-political tensions in Ukraine (in February 2022) the economy of the Euroland merely increased, as the European growth model over the past decades (dependent on the imports of cheap energy from Russia and exports to China) was confronted with unprecedented challenges.

The GDP climbed by annual rates of 0.4% in 2023, and 0.9% in 2024 in the Euroland, lower than in the USA (2.9%, and 2.8%, respectively).

In this context, the gap in terms of annual potential growth pace between the USA and the Euroland widened to 1.4pps in 2024, the highest level for the period under analysis, as can be noticed in the Figure 3.

Figure 3. The annual potential growth pace – the Euroland vs. the USA (%)



Source: representation of the author based on the estimates of the econometric analysis, considering the databases of Eurostat (2025) and Bureau of Economic Policy Analysis (2025)

We point out that the annual potential growth rate in the Euroland presented a downward trend since 1999, from 2.4% to a record low level of 0.7% during 2010-2012, when the region was confronted with the waves of the Great Financial Crisis – the private debt crisis, followed by the public debt crisis.

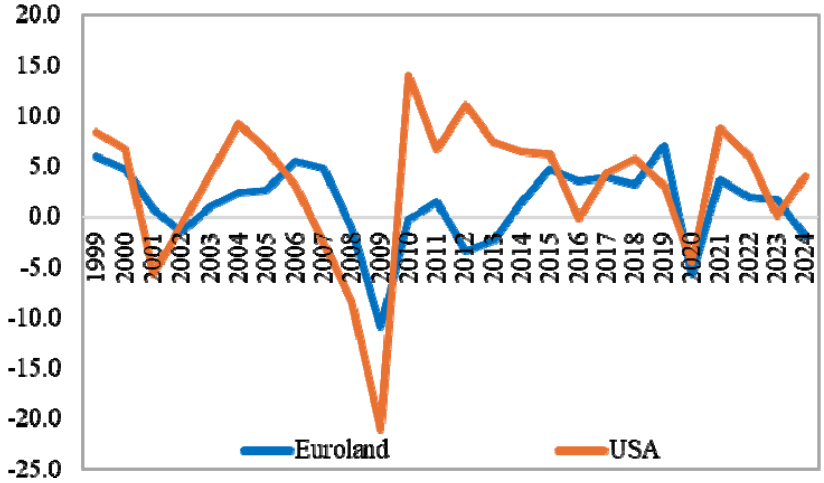
The annual potential growth rate gradually improved starting 2013 (when the economy of the region initiated the post-crisis cycle) to 1.3% in 2019, the year before the outbreak of the coronavirus pandemic, according to the results of the econometric estimates, presented in the Figure 3.

Afterwards, it consolidated at 1.3% in 2020, and improved to 1.4% in 2021, and 1.5% in 2022, 2023, and respectively 2024, as the region was severely affected by the consequences of the intensifying geo-political tensions, in the context of the outbreak of the crisis in Ukraine, including the severe increase of the energy prices.

In other words, from the structural point of view, the annual potential growth pace in Euroland never returned to the level of 1999, given the severe impact of the global shocks and their consequences for the investment climate in the region.

In this context, we point out that the gross fixed capital formation in the Eurozone advanced by an average annual growth pace of only 1.1% during 1999 – 2024. It is a significantly slower pace than the average annual dynamic of the gross private investments in the USA, of 2.6% for the period 1999 – 2024, as reflected in the Figure 4.

Figure 4. Gross fixed capital formation in the Euroland vs. gross private investments in the USA (%, YoY)



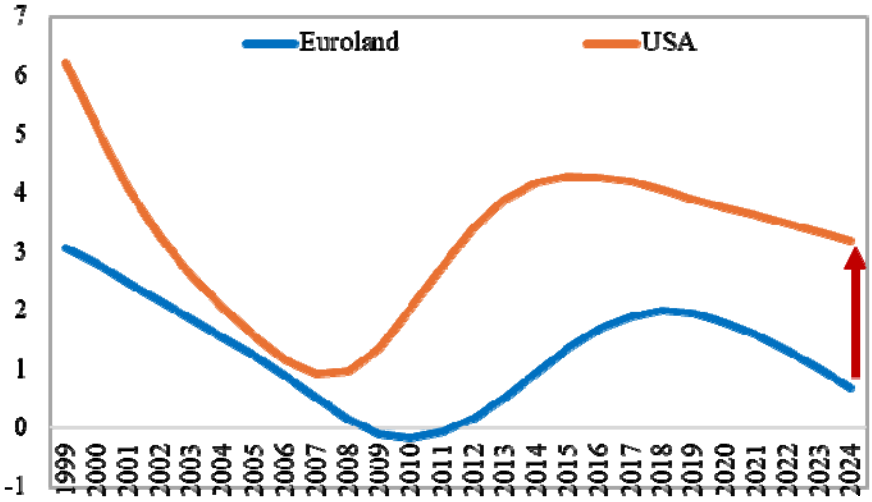
Source: representation of the author based on the databases of Eurostat (2025) and Bureau of Economic Policy Analysis (2025)

It can be noticed from Figure 4 that the impact of the global shocks was significantly higher for the investments in Euroland, than for the investments in the USA.

Furthermore, in 2024 the gross fixed capital formation in the Eurozone contracted by the most severe annual pace since the pandemic year 2020, 1.9%. On the other hand, the annual pace of investments in the USA accelerated to 4.0% in 2024, the best performance since 2022.

If we estimate the annual potential growth pace for the investments, the results emphasize the widening gap between the USA and the Euroland to 2.5pps in 2024, the highest level since 2016, as reflected in the Figure 5.

Figure 5. The annual potential pace of the investments – Euroland vs. USA (%, YoY)



Source: representation of the author based on the estimates of the econometric analysis, considering the databases of Eurostat (2025) and Bureau of Economic Policy Analysis (2025)

According to the results of the econometric estimates, the annual potential growth pace of the gross fixed capital formation in the Euroland decelerated to 0.7% in 2024, the weakest dynamic since 2013.

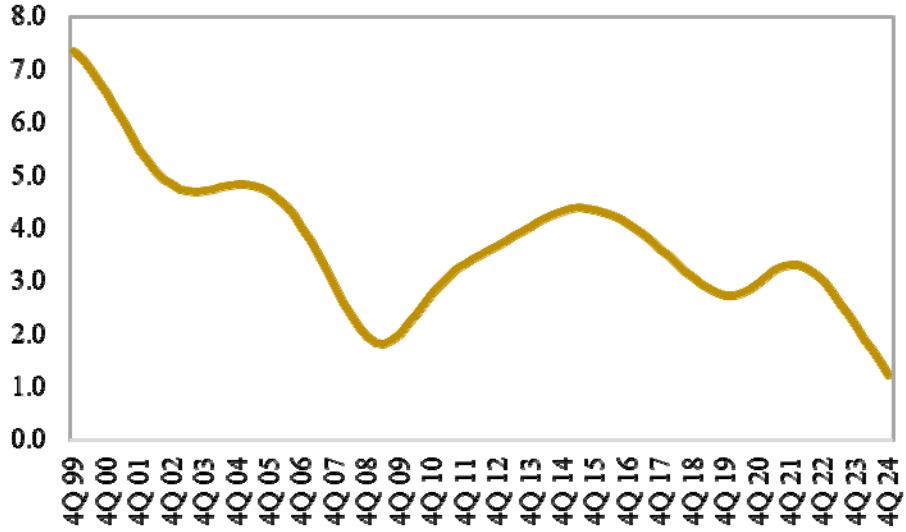
There can be noticed the significant deterioration of the annual potential growth pace of the gross fixed capital formation in the Euro Area, from around 2.0% in 2019 (the year before the outbreak of the coronavirus pandemic, the worst health crisis in the world in more than one century) to 1.8% in 2020, 1.6% in 2021, 1.3% in 2022, 1.0% in 2023, and 0.7% in 2024. These are very low levels when we compare to an estimated dynamic of over 3.0% in 1999, as can be noticed in the Figure 5.

In our view this unfavourable evolution of the investments in the Euroland over the past years was determined by several factors, including the deterioration of the international competitiveness of the region, and the high level of the risk perception, as reflected by the evolution of the market risk premium.

In this respect, we point out the severe deterioration of the annual potential growth pace for the volume of the exports of the Euroland after the outbreak of the crisis in Ukraine, an evolution also influenced by the increase of the prices of energy.

We estimated the annual potential growth pace for the total exports (goods and services) in the region by considering the Eurostat database (quarterly observations) and applying the Hodrick-Prescott filter. According to the results of the estimates the annual potential growth pace of the total exports in Euroland decelerated from around 3.3% at the end of 2021 to only 1.2% in the last quarter of 2024, a record low level, as can be noticed from the Figure 6.

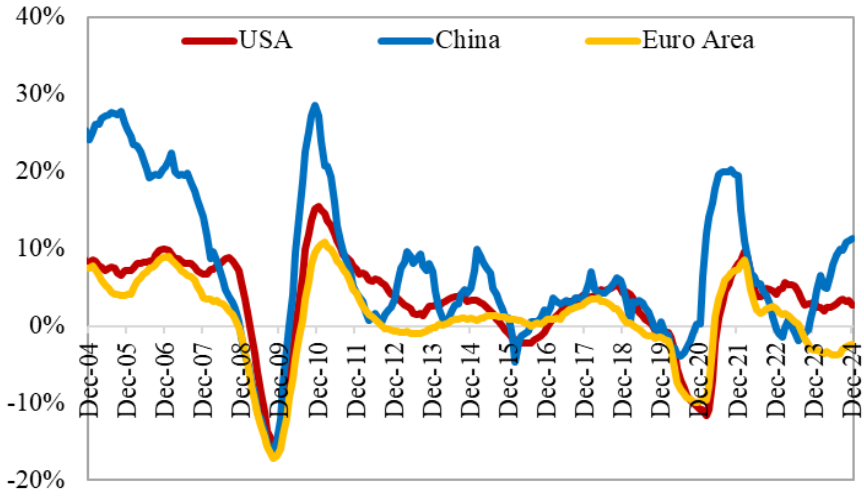
Figure 6. The annual potential pace of the total exports in Euroland (%)



Source: representation of the author based on the estimates of the econometric analysis, considering the database of Eurostat (2025)

This evolution was mainly determined by the deterioration of the volume of exports of goods. According to the figures of the Netherlands Bureau for Economic Policy Analysis (CPB, 2025) the volume of exports of goods contracted for the second year in a row in 2024 in Euroland, by an average annual pace of 2.4%, as can be noticed in the Figure 7.

Figure 7. The volume of exports of goods (MA12, YoY)



Source: representation of the author based on the data of Netherlands Bureau for Economic Policy Analysis (CPB, 2025)

Furthermore, the market risk premium in Germany (the largest economy in the Euroland, with a nominal GDP of over EUR 4.3tn in 2024, according to the estimates of Eurostat (2025)) presented a higher level than in USA, with an average gap of over 2pps for the period 2002 – 2024, according to the estimates of MarketRiskPremia (2025).

4. Conclusions

The results of our econometric analysis pointed out the widening gap in terms of the annual potential growth pace, between the USA and the Euroland, to a record high level for the period 1999 – 2024.

This evolution was mainly determined by the severe impact of the shocks on the investment climate in Euroland, in a context also influenced by the weaknesses in terms of economic policy reaction, given the incomplete structure of the European Monetary Union.

In this context, measures are needed more than ever in order to support the investment climate in Euroland, a very important aspect in order to contribute to the improvement of the potential growth pace in the region and to the resumption of the convergence process towards the level of the development in the USA.

On the one hand, the economic policy measures should focus on the improvement of several fundamental indicators: labour productivity, incorporation of the technological progress, R&D expenditure, capital markets, circular economy, promoting Europe in the world, and communication with

stakeholders, as emphasized in the article published by the Bretton Woods Committee (2024).

On the other hand, the efforts to accelerate the green transition and to cut the regulatory burden should be intensified. In this respect, the launch of the Competitiveness Compass by the European Commission (2025) is very important.

Last, but not least, we point out that there are positive examples in the Euroland, of countries that are very competitive in the world, according to the IMD Annual Competitiveness Report (IMD, 2025). In this context, several measures are needed in order to reduce the performance gaps among the member countries of the region in terms of the fundamental indicators that impact international competitiveness.

Bibliography

Bretton Woods Committee (2024). Transforming Europe – a Vision from the East, available at the link https://www.brettonwoods.org/ article/ transforming-europe-a-vision-from-the-east

Bureau of Economic Analysis (BEA) (2025). Interactive Data Application, available at the link https://www.bea.gov/itable

European Commission (2025). An EU Compass to regain competitiveness and secure sustainable prosperity, available at the link https:// ec.europa.eu/commission/ presscorner/detail/en/ip_25_339

Eurostat (2025). Database available at the link https://ec.europa.eu/eurostat/ web/main/ data/database

Federal Reserve St. Louis (FED) (2025). Gross Domestic Product Per Capita for the Euro Area, available at the link https://fred.stlouisfed.org/series/ NYGDPPCAPCDEMU

Hodrick, R. and Prescott, E. C. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. Journal of Money, Credit and Banking, 29 (1), pp. 1-16

International Institute for Management Development (IMD) (2025). World Competitiveness Ranking, available at the link https://www. imd.org/centers/wcc/world-competitiveness-center/rankings/world- competitiveness-ranking/

Market Risk Premia (2025). Implied Market Risk Premia, available at the link https:// www.market-risk-premia.com/us.html

Netherlands Bureau for Economic Policy Analysis (CPB) (2025). World Trade Monitor, available at the link https://www.cpb.nl/en/world- trade-monitor-december-2024

Capturing influential people: effective public relations activities on Instagram

Ryo Kogawa,
Kosei Togashi,
Watahiki Nobumichi,
Luiza Gatan, Cristian Vlad[*]

Abstract

This study aims to clarify how small and medium-sized enterprises (SMEs) can effectively utilise social media to increase their number of followers, with a focus on raising awareness of their company name and products. Specifically, we will examine the Instagram-based publicity activities of Company I, an agricultural machinery manufacturer located in the Tohoku region of Japan, which has not previously engaged in social media-based publicity activities. The authors aim to clarify how the structure of followers is formed from this starting point.

***JEL classification**: L60, L63, M14*

***Keywords**: talent, global, management, cross-border, Japan, innovation, transformation*

1. Overview

For small and medium-sized enterprises in rural areas, labour shortages are a serious problem, and the COVID-19 pandemic has led to an increase in marketing efforts using Instagram. Generally, small and medium-sized agricultural machinery manufacturers in Japan often supply products to large agricultural machinery manufacturers on an OEM basis and entrust them with sales. These large manufacturers then sell the products through agricultural cooperatives composed of farmers at trade shows. However, some small businesses have also sold their products through agricultural cooperatives and provided delivery and after-sales service.

As the aging of farmers progresses and more farms go out of business, there is also an increase in young people from completely unrelated fields entering the agricultural industry. This means that more farmers are choosing not to join agricultural cooperatives, making it increasingly difficult to rely solely on sales through traditional cooperatives. Agricultural machinery can now be purchased online. In such agricultural machinery industry, it is extremely important to research marketing strategies that utilise social media.

[*] Ryo Kogawa, Kosei Togashi, Watahiki Nobumichi are at the Nagaoka University. Luiza Gatan is at the Bucharest University of Economic Studies. Cristian Vlad is at the Globis University. E-mail: Cristian.Vlad@jp.kpmg.com.

2. Experimental Subjects and Analysis Methods

2.1 Survey Target Company

The survey target company, Company I, is an agricultural machinery manufacturer with over 100 years of history. It is a small-to-medium-sized enterprise located in the Tohoku region of Japan with approximately 60 employees. From this number of employees, five are sales representatives who primarily conduct sales activities in the Tohoku region and the Tokai and Kansai regions (300–700 km from the head office). Its main products include rice transplanting machines and seedling cultivation machines. Due to the COVID-19 pandemic and resulting travel restrictions, the company explored alternative sales methods. Initially, they implemented measures using a TV conferencing system, but this proved ineffective as the majority of customers were individual farmers in rural areas, many of whom were elderly. As a result, the company felt the need to enhance the recognition of its brand name and products.

Instagram is a relatively late entrant in the social media space and was acquired by Meta. While similar to Facebook, it is a photo-centric social media platform, making it easier to showcase products and relatively accessible for data collection, which is why it was selected. Company I has been using YouTube to demonstrate the assembly and usage of agricultural machinery since 2017. Regarding Facebook, the company initially used it under the CEO's personal account from 2019 for four years and began using it under the company name for public relations in 2022. This study focuses solely on Instagram for analysis, and no integration with other social media platforms was conducted during the data collection period.

2.2 Analysis Methods

2.2.1 Data Sources and Visualisation

In this study, we obtained user IDs using the Instagram API. We identified the users' locations based on their self-introductions. We used “follower data” showing the follow/follower relationships between users who directly follow I Company's Instagram account (hereinafter referred to as “direct followers”) as the data source. We created a network diagram based on this data. This network diagram visualises the follow-follower relationships as a graph, where ‘users’ are nodes and ‘follow-follower relationships’ are edges. Hereinafter, this graph will be referred to as the ‘follower network.’

2.2.2 Evaluation indicators: Influencer index and ‘like’ rate

In this study, in order to extract high-quality influencers from among followers, we defined ‘users with 1,000 or more followers.’ The influencer index is expressed by the following formula 1.

$$Influencer\ index = \left\{\left(\frac{Number\ of\ 'likes'\ +\ number\ of\ comments}{Number\ of\ followers}\right) \div Number\ of\ posts\right\} + \frac{Number\ of\ followers}{Number\ of\ followings} \cdots Formula\ 1$$

Equation 2 is used by Tafesse and Wood (2021) and many other marketing studies to calculate the 'engagement rate' on Instagram, and we will use it in this study as well.

$$\left\{\left(\frac{Number\ of\ 'likes'\ +\ number\ of\ comments}{number\ of\ followers}\right) \div number\ of\ posts\right\} \ldots \text{Formula 2}$$

Next, for equation 4, we introduce the calculation method for the 'FF ratio,' which is one of the important indicators for X.

$$\frac{Number\ of\ followers}{Number\ of\ followings} \ldots \text{Formula 4}$$

As described above, the 'engagement rate' and 'FF ratio' are combined to derive the 'influencer index,' which is used to extract high-quality influencers from the followers of Company I's Instagram account.

In order to quantify the degree of interest that the extracted influencers have in I Company's posts using the 'influencer index,' this study proposes the 'like rate.' The like rate is an indicator that quantifies the degree of interest that influencers have in a post, and represents the ratio of likes per post for each influencer. The formula for the like rate is shown below.

$$\frac{1\ Number\ of\ 'likes'\ per\ post\ by\ influencer}{Total\ number\ of\ posts} = Like\ rate \ldots Formula\ 5$$

2.3 Centrality analysis

To perform centrality analysis in a follower network, we use the adjacency matrix in graph theory from the follow-follower relationship. Let be the nodes, and the follow-follower relationship is represented as the adjacency matrix A.

2.3.1 Degree centrality

The higher the degree centrality, the more connections a node has to other nodes, indicating that it has numerous relationships (Kanemitsu, 2003). When the network used in this study is a directed graph, degree centrality can be separated into in-degree centrality and out-degree centrality. In-degree centrality is a measure of the number of edges entering a node, while out-degree centrality is a measure of the number of edges leaving a node. In this study, in-degree centrality corresponds to the behaviour of 'following a user,' while out-degree

centrality corresponds to the behaviour of 'being followed by a user.' In this study, individuals who cite others frequently have higher in-degree centrality, while those who are frequently cited have higher out-degree centrality.

2.3.2 Eigenvector centrality

Eigenvector centrality is a measure of centrality calculated by taking into account the centrality of adjacent nodes (Bonacich 1987). This measure is an indicator that takes on larger values when a node is adjacent to nodes that are connected to important nodes.

2.3.3 Community extraction

Simply measuring the centrality of the people you follow is not enough to reveal how information spreads. This is because visualising the connections between the people you follow reveals mutual follow relationships, resulting in a structure like Figure 1. When considering diffusion, it is necessary to know what communities each person forms and belongs to. Therefore, it is necessary to divide the network into circles and squares, cutting off the weak connections, to see what kind of network structure it has (Murata 2009).

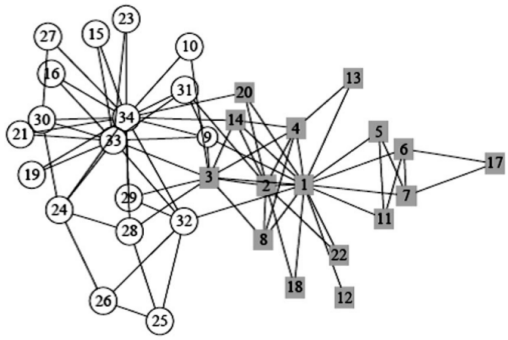


Figure 1: Example of community extraction

To visualise the quality of influencers, we adopted the 'link community extraction method.' This graph theory-based method is divided into hard clustering and soft clustering. The Louvain method is commonly used for hard clustering, but since this method does not allow community overlap, it cannot accurately express the influence of influencers. Therefore, in this study, we introduced the link community extraction method, which is a soft clustering method. This method clusters links based on edge similarity and visualises influencer influence. Specifically, it leverages the feature that 'nodes can belong to multiple communities simultaneously' to calculate 'community multiplicity' and evaluate influence.

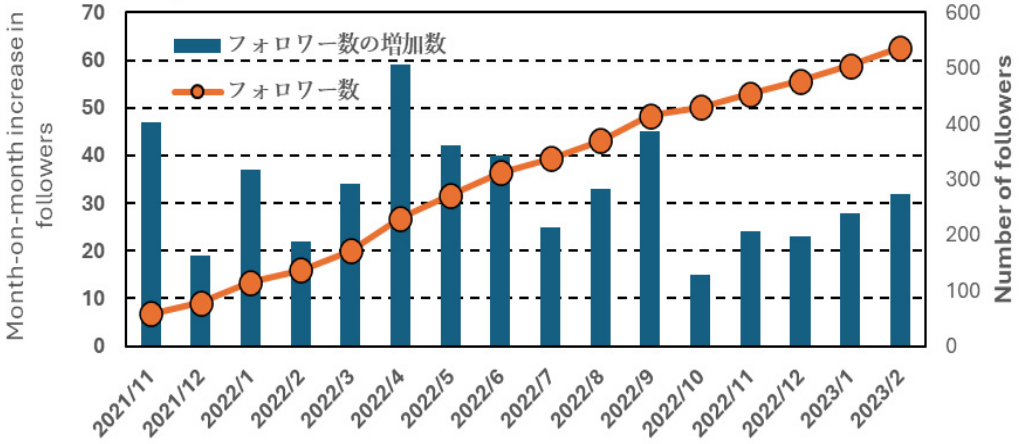
3 Results

3.1 Overview of the follower network

Graph 1 shows the relationship between the month-on-month increase in followers and the number of followers. Fifty followers were gained in the month when activities began, but these were employees who used Instagram personally and existing customers. From the second month onwards, sales activities were conducted without deliberately mentioning to sales targets that promotional activities were being carried out on Instagram.

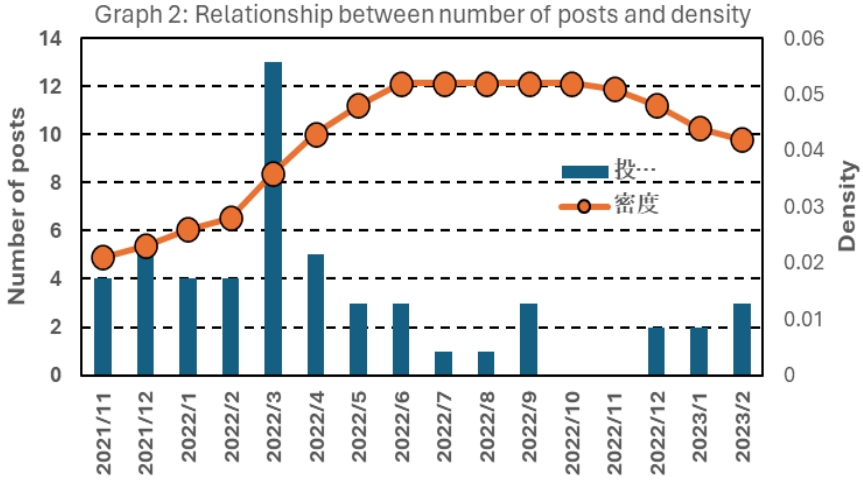
Graph 1 shows that the number of followers has increased steadily.

Graph 1: Increase in followers and number of followers

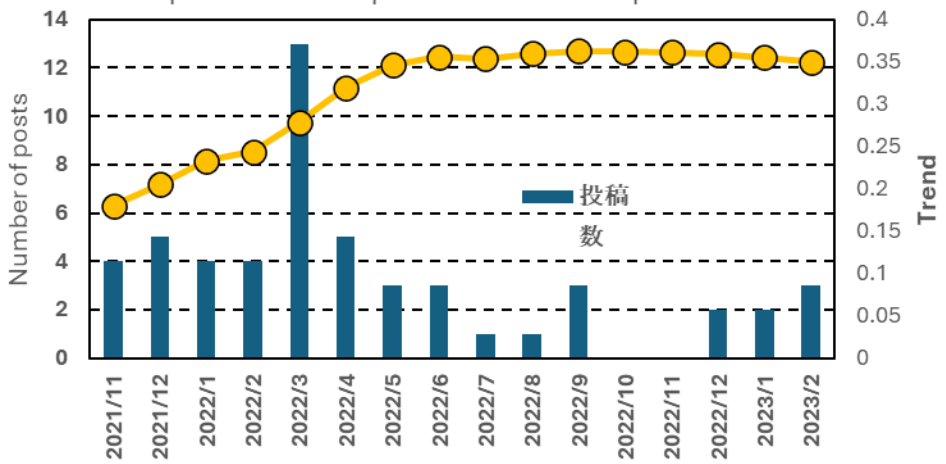


Comparing Graphs 2 and 4, it can be seen that when the number of increases is low, there were no new posts during that month. Graphs 2 to 4 compare density, trend, and interactivity with the number of posts.

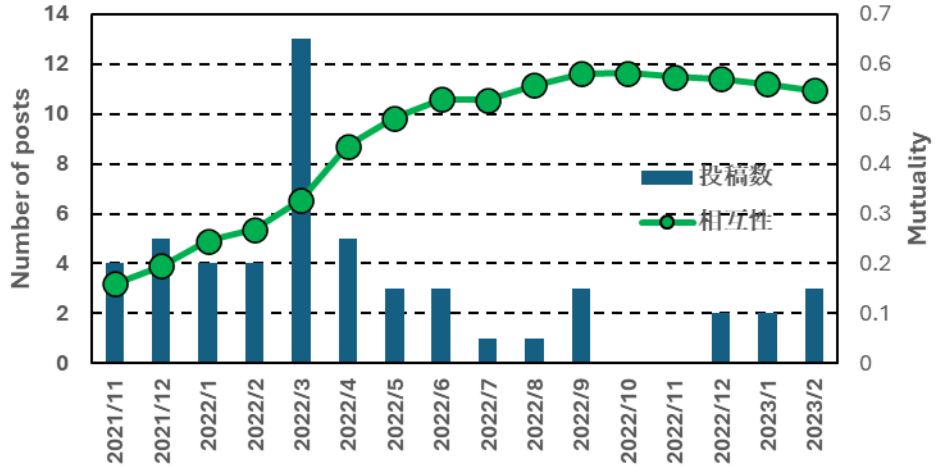
Graph 2: Relationship between number of posts and density



Graph 3: Relationship between number of posts and trend



Graph 4: Number of posts and mutuality



As shown in Graphs 2 to 4, when comparing the density, transitivity, and mutuality of the entire network with the number of posts per month, the density, transitivity, and mutuality increased significantly in March 2022, when the number of posts per month was the highest at 13. On the other hand, there were no posts in October and November 2022, and during those two months, the values of the three variables decreased slightly. In particular, density, which had been stable at 0.5 or above, dropped to around 0.4 after the month with no posts.

3.2 Results of Influencer Index and 'Like' Rate

As mentioned above, we defined influencers as 'users with 1,000 or more followers' and applied the influencer index to users with 1,000 or more followers among all followers. Note that 30.4% of all followers of Company I had 1,000 or more followers.

Table 1 shows the top 15 accounts with the highest influencer index. In addition, we calculated the 'like' rate, which quantifies the level of interest in I Company's posts for each influencer.

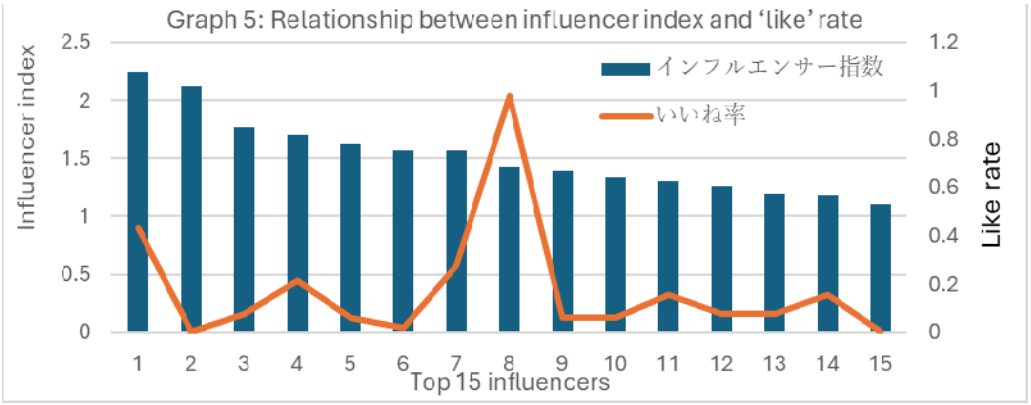
Engagement rates of 0.05 or higher and FF ratios of 0.7 or higher are shown in red. Furthermore, in the influencer index, which combines engagement rate and FF ratio, values of 0.75 or higher are considered high. Users with values of 0.75 or higher are shown in red.

Table 1: Influencer Index and 'Like' Rate (as of February 2023)

ID	Distance from company	Number of posts	Number of followers	Number of followings	Number of likes	Number of comments	FF ratio	Engagement rate	Influencer index	Like rate
1	98	262	2129	993	3040	88	2.144	0.098	2.242	0.431
2	465	406	3298	1635	4947	16	2.017	0.1	2.117	0
3	1430	945	12000	7200	18141	110	1.667	0.101	1.768	0.078
4	48	55	5876	3800	12783	652	1.546	0.152	1.699	0.216
5	632	130	1821	1213	3339	22	1.501	0.123	1.624	0.059
6	175	112	1017	782	3992	50	1.301	0.265	1.565	0.02
7	722	437	2681	1789	2579	14	1.499	0.064	1.563	0.275
8	718	127	1018	791	2053	43	1.287	0.137	1.424	0.98
9	162	48	1256	1095	4454	125	1.147	0.243	1.39	0.059
10	53	31	1050	919	3057	4	1.143	0.194	1.337	0.059
11	981	24	1502	1304	3377	44	1.152	0.152	1.304	0.157
12	902	16	1133	1023	2531	35	1.108	0.151	1.259	0.078
13	374	715	4397	3814	2727	57	1.153	0.042	1.195	0.078
14	20	288	1113	1147	3480	45	0.97	0.211	1.181	0.157
15	1050	181	1361	1276	787	0	1.067	0.039	1.105	0

It was found that all but one of the top 15 influencers were currently working in agriculture, with the exception of one agricultural university student.

Graph 5 shows the relationship between the influencer index and the 'like' rate for the top 30 accounts with the highest influencer index. The X-axis represents the user ID of the influencer, the first Y-axis represents the influencer index, and the second Y-axis represents the 'like' rate.



Looking at Graph 5, no clear relationship can be seen between the two variables, and the graph clearly shows the characteristics of each influencer. Within this range, it cannot be said that a high number of 'likes' necessarily means that an influencer is influential.

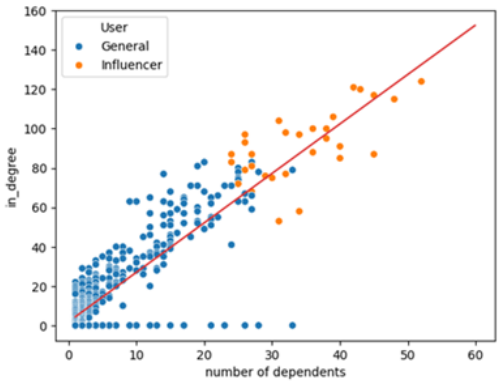
3.3 Comparison of the results of centrality analysis and link community extraction

3.3.1 Multiple relationships between each centrality and community weight

Graphs 6 to 8 show the relationship between the in-degree centrality, out-degree centrality, eigenvector centrality, and community multiplicity in the follower network during the experiment period in February 2023. Initially, there was no correlation, but a certain trend began to emerge around the fourth month, and the data from the final day of the experiment, which showed the most pronounced trend, is shown. Influencers are indicated in orange.

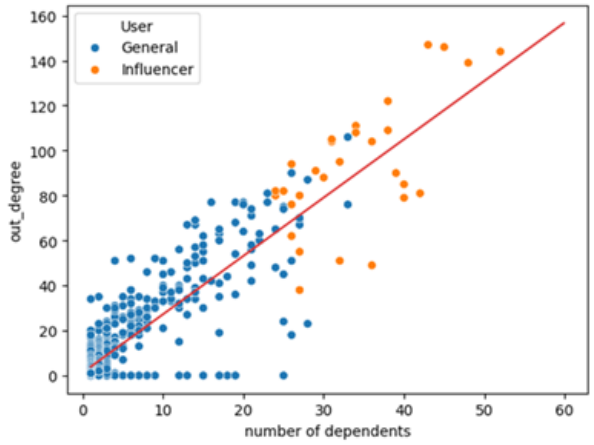
Regarding in-degree centrality, there are groups that do not form communities but have a high number of citations. Excluding these groups, a relationship between citations and community multiplicity becomes evident.

Graph 6: In-degree centrality and community multiplicity.



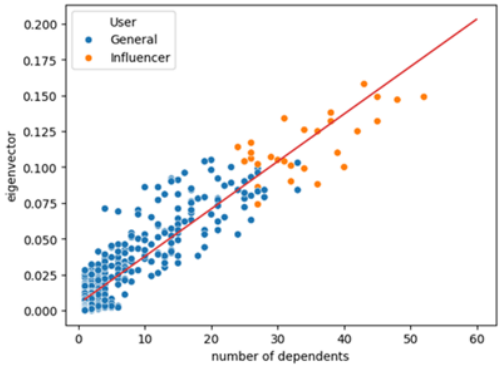
Next, from the perspective of the side being quoted, it can be seen that the structure is quite similar to Graph 6.

Graph 7: Degree centrality and community multiplicity



When viewed in terms of eigenvector centrality and community weight, the picture becomes clearer. As mentioned earlier, this centrality is an indicator of the position of members within a community. As can be seen from this, influential influencers tend to appear at the top.

Graph 8: Eigenvector centrality and community weight (February 2023)



Thus, the three centralities and the number of overlapping communities are closely related, with some overlap, but it was found that the influence increases as one moves to the upper right. From these results, the number of overlapping communities for each centrality was approximated by a regression line ($y = ax + b$). The optimal parameters a and b were determined using the least squares method. Table 2 shows the approximated regression lines, their determination coefficients, and correlation coefficients from Figures 6 to 8.

Table 2: Each centrality and regression line

Centrality	Regression line	Coefficient of determination	Correlation coefficient
Number of entries centrality	$y = 2.513x + 1.905$	0.787	0.88
Number of exits centrality	$y = 2.593x + 1.311$	0.771	0.88
Eigenvector centrality	$y = 3.313 \times 10^{-3} x + 4.528 \times 10^{-3}$	0.876	0.92

4 Discussion

4.1 Network Structure and Number of Posts

We compared the overall density, trend, and mutuality of the network each month with the number of Instagram posts. The results revealed that the overall density (0.008), trend (0.035), and mutuality (0.059) of the network in March 2022, which had the highest number of posts per month at 13, had increased compared to the previous month. There were no posts in October and November 2022, and during this period, the values of the three variables decreased to 0.001, 0.002, and 0.007, respectively. In particular, density had remained stable above 0.5 until September 2022 but decreased to around 0.4 after the period when posting ceased. This may be because, on Instagram, even if users do not interact directly, they may be connected through common followers or by taking actions on the same posts, leading to recommendations through the platform's algorithm. When posting stops, the 'hubs' that connected unknown users may have disappeared. Therefore, even if new users follow Company I, an environment where existing followers do not follow new users may have been created. Additionally, as shown by Park et al. (2021), when density decreases, information does not spread, leading to stagnation or reduction in the number of followers. Therefore, consistent posting is crucial for expanding the follower network.

4.2 Influencer Index and 'Like' Rate

The Influencer Index requires careful consideration when applied. The index combines two variables, 'engagement rate' and 'FF ratio,' but if one of these values is extremely high, the index will also be high. Therefore, when using the Influencer Index, it is important to check both the 'engagement rate' and the 'FF ratio.' It is also important to consider the context, such as the influencer's occupation and location. Companies should confirm the relevance of the influencer to their product image and select appropriate influencers to ensure that their publicity activities are effective and that appropriate information is disseminated even in regions where sales are difficult.

4.3 Centrality Analysis and Community Weight Comparison

To visualise the quality of influencers extracted using the Influencer Index, we conducted centrality analysis and community weight comparison, and found the following. Influencers have high values for in-degree centrality and out-degree centrality, frequently cross-reference each other's posts, and do so at a very high frequency.

Influencers belong to many communities and have high values for eigenvector centrality. In other words, since they have influence in influential communities, using the extracted influencers to disseminate information can potentially reach a wider audience and increase the number of followers.

Furthermore, this research on influencers was essentially revealed by Ryan & Gross (1943) and Rogers (2003). According to a study conducted by Ryan & Gross (1943) on the spread of agricultural technology in the United States, farmers obtained knowledge from sales representatives, but when it came to persuasion, they were more strongly influenced by farmers who had already used the new product. In other words, for farmers, information from influential farmers in their local community is more important than information from sales representatives. Therefore, in the agricultural industry, when seeking to promote a product, it is crucial not only for company sales representatives to conduct sales activities but also to identify influencers with influence within the industry and utilise them in marketing efforts.

5. Conclusion

Based on the results of the two analyses, the following four points can be concluded.

(1) The values for density, transitivity, and mutuality of the entire follower network increased in the month with the highest number of posts but decreased in the month when posting ceased. (2) All extracted influencers were engaged in some form of agricultural activity, such as farming or the sale of agricultural machinery. (3) The location of influencers showed the highest proportion (27%) in the Tohoku region, which is the core area of I Company's business activities. On the other hand, influencers were also found in the Kansai and Chubu regions and the Chugoku and Shikoku regions, where I Company does not have sales offices. Furthermore, the ‘like’ rate, which quantifies the level of interest in I Company's posts, was highest among influencers residing in the Kansai and Chubu regions at 98%. (4) The extracted influencers belonged to multiple communities and had high in-degree and out-degree centrality as well as mediating centrality.

Based on these four points, we propose methods for increasing followers on Instagram for small and medium-sized companies in the agricultural machinery industry. First, (1) post more consistently. When I Company's account was posting consistently, direct followers may have used the account or posts as a ‘hub’ to follow each other, even if they did not know each other. Therefore, by stabilising

the number of posts, the posts themselves could serve as 'hubs,' increasing connections between new users within the follower base and potentially leading to follower growth. Second, use the 'influencer index' proposed in this study to identify influencers and utilise them in product advertisements. As shown in (4), influencers with a high 'influencer index' also act as bridges between communities within their follower base. Furthermore, (2) and (3) show that influencers are mostly farmers and are concentrated in the Tohoku region (within 200 km), but also exist in regions more than 1,000 km away. For small and medium-sized companies like Company I, it is difficult to spend a lot of money on marketing in regions where they do not have sales offices. By using the proposed 'Influencer Index' to identify influencers and have them promote the company's products, it is possible to disseminate information to regions where the company does not have a presence and potentially acquire a large number of followers.

References

Anggrainia, Ni Putu Nita (2021)."The impact of SNS marketing use on women entrepreneurs in the new normal era". *International Journal of Data and Network Science*, vol. 6, pp. 769-778.

Bonacich, Phillip (1987). "Power and centrality: A family of measures". American journal of sociology, vol.92, No. 5, pp. 1170-1182.A, Erz. (2018). "Hashtags: Motivational drivers, their use, and differences between influencers and followers". *Computers in Human Behavior*, vol. 89, pp. 48-60.

Kanemitsu, Jun (2003), Fundamentals of Social Network Analysis: Toward a Theory of Social Capital, Keiso-Shobo

Kubota, Shuhei (2018). 'Extracting Social Issues from Social Media Using Contextual Information.' Web Intelligence and Interaction Research Group, No. 3, pp. 77-80.

Murata,Tuyoshi（2009）,"Community Detection from Networks"., Intelligence and information, Vol.21, No.4, pp.500-508

Park, Gwijeong., Chen, Fangxin and Cheng, Le (2021). "A Study on the Millennials Usage Behavior of Social Network Services: Effects of Motivation, Density, and Centrality on Continuous Intention to Use". *Sustainability*, vol. 13, No. 5, pp. 660-679.

Rogers, Everett (2003), *Diffusion of innovation.* New York, NY: Free Press.

Ryan, Bryce. & Neal C. Gross. (1943), *The Diffusion of Hybrid Seed Corn in Two Iowan Communities*., *Rural Sociology*, No. 8, pp. 15-24.

Wondwesen, Tafesse., and Wood, Bronwyn P.. (2021). "Followers' engagement with instagram influencers: The role of influencers' content and engagement strategy". *Journal of Retailing and Consumer Services*, vol. 58, pp.102303.

Web accessibility in Romania's hosting industry: a comparative evaluation of digital inclusion practices

Ionut Tanase,
Lucia Nicoleta Barbu,
Daniela Marinica,
Lucian Botea[*]

Abstract

Our study investigates the web accessibility compliance among Romanian web hosting providers, addressing a significant research gap in private sector digital inclusion practices. While the Romanian public institutions' websites have demonstrated poor accessibility, limited attention has been given to commercial platforms that serve all citizens, including those with disabilities. We conducted a systematic evaluation of five major Romanian web hosting companies (Roleaf, Romarg, CyberFolks, Hostico, and Gazduire.net) using the WAVE accessibility assessment tool in March 2025. We examined critical errors, contrast issues, structural elements, and ARIA implementation across all homepages. Results showed substantial accessibility variations: Roleaf demonstrated minimal critical errors (2) but significant contrast issues (44); Romarg showed contradictory compliance with numerous errors (7) but few contrast problems (4); CyberFolks exhibited severe contrast failures (91) and excessive alerts (134); Hostico presented complex structural issues and minimal ARIA usage; while Gazduire displayed the most problematic profile with 8 critical errors and potentially counterproductive ARIA implementation (201 instances). As the internet develops, the need for more accessible and inclusive designs in Romania's commercial web ecosystem is becoming mandatory to remain in line with European accessibility standards.

Keywords: *web accessibility, WCAG compliance, Romanian websites, digital inclusion, automated testing, web hosting platforms*

JEL Classification: L86; L15; O52; M31; M37; L81

1. Introduction

Our paper examines web accessibility implementation among Romanian web hosting providers, an understudied segment of Romania's digital landscape. While previous research documented poor accessibility in Romania's public sector

[*] Ionut Tanase is PhD student at Bucharest University of Economic Studies, Bucharest.
Email address: ionut.tanase@mk.ase.ro
Lucia Nicoleta Barbu is PhD student at Bucharest University of Economic Studies, Bucharest.
Email address: lucia.barbu@mk.ase.ro
Daniela Marinică is PhD student at Bucharest University of Economic Studies, Bucharest.
E-mail address: daniela.marinica@mk.ase.ro
Lucian Botea is PhD Lecturer at Romanian-American University, Bucharest.
E-mail address: lucian.botea@rau.ro

websites (Pribeanu et al., 2019; Androniceanu & Ciocan, 2015), private commercial platforms remain largely unexamined despite serving all citizens, including those with disabilities. Our study evaluates five major Romanian web hosting companies—Roleaf, Romarg, CyberFolks, Hostico, and Gazduire—against established Web Content Accessibility Guidelines (WCAG) using WebAIM's WAVE evaluation tool. The analysis reveals significant variations in accessibility compliance, from Roleaf's relatively minor issues to Gazduire.net's extensive barriers. We identify critical errors, contrast problems, structural inconsistencies, and ARIA implementation patterns across all platforms. The paper is organized in five sections: introduction, methodology (describing our WAVE-based evaluation approach), comparative analysis (examining key accessibility metrics across all five providers), discussion (contextualizing findings within European and Romanian digital inclusion efforts), and conclusion (offering practical recommendations for Romania's commercial web sector). This research contributes actionable insights toward addressing Romania's persistent digital accessibility challenges.

2. Hypothesis

Web accessibility in Romania has historically lagged behind desired standards, according to several studies. As mentioned, despite the governmental push for accessible public-sector websites by 2020, evaluations of Romanian websites have revealed low compliance levels. Pribeanu et al. (2019) conducted a large-scale assessment of 186 municipal websites and found that only one website met the WCAG 2.0 Level AA . The overall picture was that most local government sites contained numerous accessibility errors, with no significant improvement over an earlier 2010 baseline review. Similarly, an investigation into social services websites by Androniceanu & Ciocan (2015) reported “relatively low accessibility” across the board, with large variations between sites. In the education sector, a study of Romanian university websites noted prevalent issues affecting visually impaired users, such as lack of alternative text for images and missing form labels, resulting in generally poor conformance with WCAG criteria (Cojocaru & Guran, 2013, as cited in Pribeanu 2018). Overall, web accessibility in Romania remains low – a review of e-government sites ranked Romania 24th out of 27 EU countries in terms of accessibility, placing it near the bottom of the league. These findings point to a need for greater awareness and enforcement of accessibility guidelines in both public and private sectors. Globally, the scenario is similar, with many countries facing challenges in implementing web accessibility. As noted earlier, automated scans by WebAIM show that the majority of websites have multiple WCAG failures.

However, there are signs of gradual progress. The EU’s European Accessibility Act (2019) and the Web Accessibility Directive (2016) are driving

improvements by requiring not just public institutions but also private companies (in certain industries) to make their digital products accessible. In the US, regulations like the ADA and Section 508 standards have led many organizations to adopt WCAG guidelines. International efforts by the W3C and groups like Web Accessibility Initiative (WAI) continue to provide resources and training to improve compliance. Despite these developments, specific sectors and locales may still significantly trail behind. In Romania, beyond the public sector, private websites (such as those of businesses and service providers) are not yet legally required to comply with WCAG, and their accessibility levels can vary widely. Little research to date has focused on the accessibility of Romanian commercial websites or platforms. This study helps fill that gap by examining a sample of important private-sector websites (web hosting providers) against established accessibility standards. By comparing five competitors in the same industry, we can also highlight differences in how – or if – each has implemented accessibility features. Such comparisons can reveal best practices as well as common shortcomings. In the following sections, we present the evaluation results for Roleaf, Romarg, CyberFolks, Hostico, and Gazduire, analyze their degree of WCAG compliance using the WAVE tool findings and manual verification, and discuss the differences observed in their accessibility implementations. The aim is to contribute actionable insights into improving web accessibility within Romania's digital marketplace, aligning it with the broader goal of web inclusion for all users.

2. Methodology

In this study, we used a standardised accesibility evaluation tool called WAVE (Web Accessibility Evaluation Tool) by WebAIM to systematically assess each platform. WAVE identifies accessibility issues through automated testing, categorizing findings as errors (critical accessibility barriers), contrast errors (insufficient text-to-background contrast ratios), alerts (potential accessibility issues), features (positive accessibility elements), structural elements, and ARIA implementation.

Data collection occurred during March 2025, examining only the homepage of each site, which provides a representative but not exhaustive assessment. This comparative approach allows for identification of common patterns and unique challenges across similar service providers.

3. Comparative Analysis

We used WAVE to identify accessibility issues through automated testing, categorizing findings as errors (critical accessibility barriers), contrast errors (insufficient text-to-background contrast ratios), alerts (potential accessibility

issues), features (positive accessibility elements), structural elements, and ARIA implementation.

3.1. Critical Errors

The evaluation revealed considerable variation in fundamental accessibility errors:

Table no.1 Critical Errors

Platform	Errors	Key Issues
roleaf.ro	2	Missing form label (1), Empty table header (1)
romarg.ro	7	Linked images without alt text (2), Missing form label (1), Empty links (4)
cyberfolks.ro	5	Linked images without alt text (2), Missing form label (1), Empty links (2)
hostico.ro	5	Empty buttons (5)
gazduire.net	8	Linked images without alt text (2), Missing form label (1), Empty button (1), Empty links (4)

Source: *Author's own research*

Gazduire.net demonstrated the highest number of critical errors (8), presenting multiple accessibility barriers. Conversely, roleaf.ro exhibited the fewest critical errors (2), though this alone does not indicate overall superior accessibility.

3.2. Contrast issues

Contrast errors—reflecting insufficient differentiation between text and background—varied dramatically:

Table no.2 Contrast Errors

Platform	Contrast Errors
cyberfolks.ro	91
gazduire.net	63
roleaf.ro	44
hostico.ro	40
romarg.ro	4

Source: *Author's own research*

This difference is particularly noteworthy; romarg.ro's minimal contrast issues (4) compared to cyberfolks.ro's substantial problems (91) shows fundamentally different approaches to visual design by these companies. These

contrast issues particularly impact users with visual impairments, including color blindness and low vision, as well as those viewing sites under challenging lighting conditions.

3.3 Structural Elements and Semantic Markup

The platforms demonstrated varying degrees of structural complexity and semantic correctness:

Table no.3 Structural elements

Platform	Structural Elements	Heading Hierarchy Issues
hostico.ro	108	Skipped level (1)
gazduire.net	59	Multiple H1s (6), Skipped levels (4)
cyberfolks.ro	57	None identified
romarg.ro	42	Skipped levels (3)
roleaf.ro	38	None identified

Source: *Author's own research*

Hostico.ro presented the most structurally complex page with 108 elements, including 76 headings across multiple levels. Gazduire.net exhibited serious structural anomalies with six H1 headings (violating the principle of a single H1 per page) and four instances of skipped heading levels, disrupting the logical hierarchical navigation critical for screen reader users.

3.4. ARIA Implementation

ARIA (Accessible Rich Internet Applications) attributes, which enhance accessibility for dynamic content, showed remarkable variation in implementation:

Table no.4 ARIA Implementation

Platform	ARIA Instances	Notable Patterns
gazduire.net	201	97 ARIA hidden attributes
cyberfolks.ro	39	Diverse ARIA implementation
romarg.ro	14	Moderate usage
roleaf.ro	4	Minimal implementation
hostico.ro	2	Almost no ARIA usage

Source: *Author's own research*

Gazduire.net's extraordinary number of ARIA attributes (201)—particularly the 97 instances of ARIA-hidden—suggests potential misuse or overimplementation. This contrasts sharply with hostico.ro's minimal ARIA usage (2), raising questions about whether complex dynamic functionality is being made adequately accessible.

3.5. Alerts and Potential Issues

Alerts, representing potential but not definitive accessibility barriers, also showed significant variation:

Table no.5 Alerts and Potential Issues

Platform	Alerts	Primary Issues
cyberfolks.ro	134	Redundant links (27), Very small text (56), Redundant title text (44)
hostico.ro	113	Redundant alt text (45), Very small text (20), Redundant title text (38)
gazduire.net	15	Skipped heading levels (4), Very small text (6)
roleaf.ro	10	Suspicious alt text (10)
romarg.ro	6	Mixed issues

Source: *Author's own research*

The high number of alerts for cyberfolks.ro (134) and hostico.ro (113) indicates potential information redundancy and navigation inefficiencies for assistive technology users.

3.6. Individual Platform Assessments

Roleaf.ro

Roleaf.ro presents a relatively straightforward accessibility profile with few critical errors (2), though its 44 contrast errors remain concerning. The site maintains proper heading hierarchy and semantic structure but features minimal ARIA implementation (4 instances), potentially limiting the accessibility of dynamic elements. The primary deficiencies are in contrast ratios and form labeling, which could be remediated with modest effort.

Romarg.ro

Romarg.ro exhibits a contradictory accessibility profile—having the most critical errors (7) among the examined platforms, yet the fewest contrast issues (4). The site's structural inconsistencies include skipped heading levels that disrupt logical navigation flow. While ARIA implementation (14 instances) suggests some attention to dynamic content accessibility, the empty links and missing alternative text represent fundamental accessibility failures that violate WCAG Success Criterion 2.4.4 (Link Purpose) and 1.1.1 (Non-text Content).

Cyberfolks.ro

Cyberfolks.ro demonstrates the most severe contrast issues (91 errors) among all platforms examined, creating significant barriers for users with visual

impairments. Despite maintaining proper heading hierarchy, the site generates the highest number of alerts (134), including 56 instances of very small text. The moderate ARIA implementation (39 instances) suggests attention to dynamic content, yet the volume of contrast and potential issues indicates substantial accessibility shortcomings.

Hostico.ro

Hostico.ro features the most complex structural implementation (108 elements) with an unusually high concentration of heading elements (76 total), including 48 H5 headings. The site's 5 empty buttons represent critical accessibility failures, violating WCAG Success Criterion 4.1.2 (Name, Role, Value). The minimal ARIA implementation (2 instances) combined with complex structure suggests potential accessibility gaps for dynamic content. The 113 alerts further indicate numerous potential issues requiring review.

Gazduire.net

Gazduire.net presents the most problematic accessibility profile with the highest number of critical errors (8) and second-highest contrast errors (63). The site exhibits serious structural anomalies with multiple H1 headings (6) and skipped heading levels (4). Most concerning is the extraordinary ARIA implementation (201 instances), including 97 ARIA-hidden attributes, suggesting potential misuse that could actually worsen accessibility rather than improve it. This platform would require substantial remediation to approach WCAG compliance.

4. Discussion

What does it mean to truly build an accessible website? The findings show a complex picture of Romania's online landscape, one where accessibility seems more like an afterthought than a foundation. The huge variations we discovered between hosting providers reflect broader inconsistencies within the used design rules of the UI. Looking at Gazduire.net's curious implementation: 201 ARIA instances with 97 ARIA-hidden attributes, having such an excessive approach could actually worsen accessibility rather than improve it. It's like building a house with too many doors – eventually, you've just created more barriers. Contrast this with Hostico's mere 2 ARIA instances, and we're seeing opposite ends of the implementation spectrum.

Why such variation? Probably it's the absence of legal requirements, unlike public sector websites bound by EU directives, Romania's commercial platforms operate in a regulatory vacuum regarding accessibility. Without legal pressure, accessibility becomes optional or implemented inconsistently based

on individual developer knowledge, corporate priorities, or sometimes just accidental compliance.

The contrast issues found (particularly CyberFolks' staggering 91 errors) speak to a deeper problem: visual design typically trumps accessibility concerns. When companies prioritize aesthetic trends over readability, they unconsciously exclude users with visual impairments.

"But does accessibility really matter for business websites?" some might ask. The numbers suggest it does. Web accessibility affects approximately 16% of users, a significant market segment any business should be reluctant to exclude. For hosting providers specifically, their accessibility practices likely influence client websites, creating a ripple effect throughout Romania's digital economy.

Our findings align somewhat with Pribeanu's 2019 study of municipal websites, though with an interesting twist. While public sites showed uniformly poor compliance, commercial hosting providers displayed wildly inconsistent implementation – from Roleaf's reasonable effort to Gazduire's problematic approach. This suggests the private sector might actually contain both the worst and best accessibility practices in Romania.

Perhaps most concerning was the prevalence of basic errors like missing form labels and empty links – issues easily addressed with minimal development effort. These represent low-hanging fruit that companies have inexplicably left unpicked. What might drive improvement? Beyond regulation, increased awareness and competitive advantage could motivate change. If even one major hosting provider embraced comprehensive accessibility as a market differentiator, it might shift industry standards. Education plays a role too – many developers simply don't recognize the barriers their design choices create.

5. Conclusion

This comparative analysis of Romanian web hosting providers shows significant accessibility shortcomings across the sector, with inconsistent implementation patterns suggesting the absence of systematic approaches to digital inclusion. The heterogeneity of compliance levels, from Roleaf's minimal critical errors to Gazduire.net's extensive implementation failures, indicates that accessibility remains largely peripheral to commercial web development practices in Romania.

Perhaps most concerning was our discovery of fundamental barriers that require minimal technical effort to address. Simple omissions like unlabeled form elements and empty interactive components represent low-complexity, high-impact improvements that remain unimplemented. Such oversights suggest not merely technical deficiencies but possibly deeper organizational factors: limited awareness, insufficient prioritization, or perhaps misconceptions about the costs and benefits of accessibility implementation.

These findings presented earlier by Pribeanu et al. (2019) and Androniceanu & Ciocan (2015) in the public sector, yet with a crucial distinction—while public websites demonstrated uniformly poor compliance, commercial platforms exhibited highly variable implementation quality. This variance might potentially offer opportunities for industry leadership and differentiation.

From a theoretical perspective, our research contributes to understanding how accessibility standards diffuse within market environments lacking explicit regulatory frameworks. The observed implementation patterns suggest both mimetic and normative institutional pressures may be insufficient drivers for accessibility adoption without complementary coercive mechanisms.

Several practical implications emerge from this analysis. First, Romanian web hosting providers would benefit from establishing systematic accessibility evaluation procedures within their development workflows. Second, basic WCAG education appears necessary throughout the sector. Third, the variability in compliance suggests potential competitive advantages for early comprehensive adopters.

Our methodology carries certain limitations worth acknowledging. Homepage analysis, while representative, cannot capture the full user experience. Automated testing, though efficient, misses certain context-dependent accessibility issues. Future research might productively expand to examine complete user journeys, incorporate manual testing methodologies, or investigate correlations between accessibility implementation and business performance metrics.

As Romania continues its digital transformation, the commercial sector has both opportunity and responsibility to embrace inclusive design principles. The current findings suggest this transformation remains incomplete, with considerable room for improvement. Addressing these gaps in Romania's web hosting industry could not only better serve all users but potentially create leadership in digital inclusion practices within the broader regional context.

References

Androniceanu, A. & Ciocan, F. (2015). "Accessibility of Social Assistance Websites in Romania". *Proceedings of the International Conference on Administration and Business*, Bucharest, 37–44.

Berners-Lee, T. (1997). W3C Web Accessibility Initiative: Accessibility in Context. W3C. *Available at W3C Web Accessibility Initiative website*.

Cojocaru, D. & Guran, M. (2013). *Web Accessibility Evaluation of Romanian University Websites*. Economy Informatics, 13(1), 131–142.

European Union (2016). *Directive (EU) 2016/2102 on the accessibility of the websites and mobile applications of public sector bodies*. Official Journal of the EU, L327, 1–15.

Pribeanu, C. et al. (2019). *Large-scale accessibility evaluation of Romanian municipal websites*. International Journal of User-System Interaction, 12(2), 83–98.

Pribeanu, C. (2018). *Exploring the website accessibility of Romanian universities*. Revista Română de Informatică și Automatică, 28(4), 253–264.

WebAIM (2024). *The WebAIM Million Report – Accessibility Analysis of Top 1,000,000 Home Pages*. WebAIM.org.

WebAIM (n.d.). *WAVE Web Accessibility Evaluation Tool – Documentation*. WebAIM.org.

W3C Web Accessibility Initiative (WAI) (n.d.). *Introduction to Web Accessibility*. W3C. (Definition of web accessibility and its benefits)

Unemployment rate gap and the Hybrid New Keynesian Phillips Curve: an application of empirical mode decomposition

Mariem Mejri[1],
Moez Labidi and Ramzi Farhani[*]

Abstract

Although theoretically robust, the Hybrid New Keynesian Phillips Curve (HNKPC) exhibits certain limitations in adequately capturing the stylised facts widely acknowledged by economists and central bankers. Numerous authors attribute these shortcomings primarily to the way fluctuations in real economic activity are measured. To address this issue, the present study investigates the empirical validity of the HNKPC in the context of the Brazilian economy, employing an innovative approach: Empirical Mode Decomposition (EMD). This method allows for the calculation of the unemployment gap and the identification of business cycle events, while also assessing the empirical relevance of the HNKPC framework.

The analysis is based on quarterly data from the Brazilian economy. The model developed by Gali and Gertler (1999) is estimated using the Generalised Method of Moments (GMM). The main findings are as follows: (i) EMD effectively captures cyclical fluctuations in the economy through the unemployment gap; (ii) in the short run, the Brazilian monetary authority faces a trade-off between stabilising inflation and stabilising real economic activity; (iii) in the long run, expansionary monetary policy proves ineffective, resulting solely in higher inflation; (iv) historical pricing behaviour by firms exerts a stronger influence on current inflation dynamics than forward-looking expectations.Taken together, these results support the theoretical predictions of the HNKPC and challenge previous empirical studies that had questioned its validity in the Brazilian context.

Keywords: *New Keynesian Phillips Curve, empirical mode decomposition, unemployment rate gap, inflation, generalized method of moments*

***JEL Classification**: C26, E31, E24, E52*

1. Introduction

The Phillips curve, understood broadly as an inverse relationship between inflation and unemployment rate, has been widely criticized (Roberts, 1995; Mavroeidis, 2005; Villieu, 2015; Forder, 2018; Mankiw, 2019; Hagemann, 2020; Rancan, 2022). Each criticism gave rise to a new formulation. As a result, the

[*] Mariem Mejri holds a PhD in Economics from the Faculty of Economics and Management, University of Sousse, Tunisia. E-mail address: meriemsalhi146@gmail.com.
Moez Labidi is a Professor in Economics at the Faculty of Economics and Management, University of Monastir, Tunisia.
Ramzi Farhani is a Teaching Assistant in Economics at the Faculty of Economics and Management, University of Sousse, Tunisia.

Phillips curve is found today to be central to a many number of macroeconomic analyses, particularly in the area of monetary policy, but in far removed forms from the original formulation.

Since the end of the 1990s, the introduction of the "hybrid New Keynesian Phillips curve" (HNKPC) in the new theories of monetary policy has appeared relevant and promising. On the one hand, recourse to the microeconomic model of the economic agents behavior enriches, by rendering the HNKPC immune to Lucas' criticism, the analytical framework of monetary policy. On the other hand, the HNKPC increasingly retains the need for a redesigned empirical validation compatible with two important stylized facts: the persistence of inflation and disinflation generates an economic recession. In order to provide reliable normative policy implications, a short-term model of inflation dynamics must imperatively reproduce these two consensual facts.

The HNKPC presents current inflation dynamics as a function of past inflation and expected future inflation, and a measure of fluctuations in real economic activity, such as the real marginal cost and the output gap. Generally, researchers use the Hodrick-Prescott filter (1997) or the Baxter-King filter (1999) to calculate the output gap. More recently, Lai (2017) used another approach called: "Empirical Mode Decomposition, EMD". Since its introduction in 1998 by Huang et al., it has been well used in a variety of scientific analyses and studies, including those involving biomedical signal, seismic signals, power signals, atmospheric and climate studies, geophysical studies, and oceanographic studies (such as Huang and Schmitt, 2014; Liu et al., 2016; Kim et al., 2018; Yousefi Rizi, 2019; Zhang and Li, 2020; Long et al., 2021; Aslan, 2022; Dubey et al., 2022; Zare and Nouri, 2023; Nath et al., 2023 and many more). The application of the EMD approach in economic and financial studies is not only sparse, but also limited to asset-price forecasting (e.g., Zhang et al., 2008; Hua and Jiang, 2015).

Fidrmuc and Daniková (2020) identified nearly 200 empirical papers estimating the HNKPC, confirming that it is one of the most debated questions in economics. It should be noted, however, that most of the empirical works on the HNKPC are done for developed economies. It is only recently that a similar work for developing countries has gained momentum. Given their state of economic development, especially in the context of important macroeconomic variables such as inflation and unemployment, we think that it is important to know whether the HNKPC is adequate to improve the understanding of the monetary policy practiced today in certain developing countries.

Moreover, despite the strong theoretical foundations of the HNKPC, some researchers have shown that its empirical relevance remains open to further discussion (see, e.g., Galí and Gertler, 1999; Minella et al., 2003; Schwartzman, 2006, 2007; Rudd and Whelan, 2005, 2007; Chowdhury and Sarkar, 2016;

Arruda et al., 2018; Fidrmuc and Danišková, 2019). Contrary to the theoretical prediction, they found that the HNKPC fails to capture the statistically significant impact of fluctuations in real economic activity on inflation dynamics. One of the debates concerns the measurement of fluctuations in real economic activity. In order to overcome this shortcoming, Lai (2017) measured fluctuations in real economic activity of the US economy using the EMD approach. He concluded that this approach offers a new avenue for re-examining the empirical relevance of the HNKPC.

Hence, the objective of this document is to examine the suitability of the HNKPC in analyzing the effects of real economic activity fluctuations and economic agents' expectations on inflation dynamics in a developing country, specifically Brazil. Additionally, it expands on the research conducted by Lai (2017) by investigating the empirical mode decomposition approach's capability to identify business cycle events and validate the theoretical prediction of the HNKPC.

In order to achieve our goals, we will estimate the HNKPC developed by Gali and Gertler (1999). In fact, their model assumes that the proportion of agents using a backward-looking pricing rule varies with the monetary regime. Therefore, it is considered to be the most suitable as it can reproduce different degrees of inflation persistence, which is not the case for other models such as: Fuhrer and Moore (1995), Christiano, Eichenbaum and Evans (2005). As Gali and Gertler's model assumes that a fraction of agents have rational expectations, we will use the Generalized Method of Moments (GMM) as the estimation method.

We will calculate fluctuations in real economic activity using the EMD approach. It has many advantages: (1) It is model-free (empirical-based), since it has assumed linearity and stationarity on time-series data; (2) The EMD contributes a better insight to time series structure. Not only by decomposing a time series into trend and cycle, but also by providing an effective procedure to further decompose the cycle series into orthogonal components of different frequencies; (3) This approach enables synthesizing the decompositions driven by the data since distortions have been established by subjective judgments frequently applied to standard time series analysis, such as the difference-stationary, linear ARIMA and trend-stationary processes. Nevertheless, from the literature, we found that only Lai (2017) exploited the EMD approach to examine the empirical validity of the HNKPC in the US economy.

The rest of this article is structured as follows. Section 2 describes the literature review. Section 3 presents the data and the research methodology adopted. Section 4 presents the empirical results and the discussion. Finally, section 5 is devoted to the conclusion.

2. Literature review

The history of macroeconomics is characterized by a chain of "revolution" and "counter-revolution", presenting as many battles between "classical" and "Keynesian" economists, since the "revolution Keynesianism" of the 1930s through the fight between "Keynesian" and "monetarist" in the 1960s, the "counter-revolution" of rational anticipations in the 1970s, then the new conflict between the supporters of the "cycles real people" and the "new Keynesians" of the 1980s. In this story, the Phillips curve has quickly become an important macroeconomic relationship and also one of the most controversial.

In his seminal paper published in 1985, Phillips showed that there is an inverse and stable relationship between the rate of unemployment and the growth rate of nominal wages. The underlying premise is that: the increase in the demand for labor will reduce unemployment and, as a result, workers will be in a strong position to demand an increase in their nominal wages (the contrapositive is also true). Samuelson and Solow (1960) reinterpreted Phillips' relationship as a trade-off between inflation and unemployment. This meant that economic policy makers should be able to choose between a low rate of unemployment versus a certain rate of inflation and vice versa. Moreover, they considered that the inflation-unemployment trade-off is stable, which implies that expansionary monetary policy could durably reduce the unemployment rate. This idea was strongly criticized by monetarists.

Phelps (1967) and Friedman (1968) criticized the idea of stable arbitrage using the adaptive expectations hypothesis. More specifically, they mentioned that in the short-term workers carry out a scenario of price anticipation error because of their retrospective characters: they form their expectations of what will happen in the future on the basis of what is done in the past. Consequently, any increase in the money supply can lead to an increase in inflation accompanied by an equivalent reduction in unemployment in the short term. Nevertheless, expectations will be corrected in the long term and any monetary injection aimed at lowering the unemployment rate will only cause inflation to accelerate. The stagflation of the 1970s confirmed their interpretations and showed the weaknesses of Keynesianism.

Monetarist critics set the stage for the revolution of the new classics, notably Lucas (1972, 1973, 1976) who questioned the validity of Phillips' relationship even in the short term. Lucas (1972) criticized standard Keynesian models for two reasons; Firstly, because of its empirical failure to explain the stagflation of the 1970s and secondly for its lack of microeconomic foundations. To overcome these shortcomings, the New Keynesian literaturehas been primarily concerned with finding rigorous and convincing models of nominal price rigidity based on the optimizing behavior of economic agents. In

this regard, two broad categories of models can be distinguished: models that adopt a "time-dependent" price adjustment rule, in which prices adjust "from time to time" [such as the Taylor model (1980) and the Calvo (1983) model] and those that adopt a "state-dependent" rule in which prices adjust according to the state of the economy.

The different models of nominal price rigidity lead to a new specification of the Phillips curve known as the "New Keynesian Phillips curve (NKPC)", according to the name introduced by Clarida, Gali and Gertler (1999). It predicts a positive relationship between the inflation rate (π_t) the expected future inflation rate ($E_t\pi_{t+1}$) and the companies' real marginal costs (cm_t) which can be translated by the following general expression:

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \lambda cm_t + \varepsilon_t \quad (1)$$

Where E_t is the anticipation operator and β is the discount factor. The coefficient λ designates the slope of the NKPC. It is a function of the structural parameters, namely: $\lambda = \frac{(1-\theta)(1-\theta\beta)}{\theta}$.

This formula indicates that at each period, a firm can adjust its price only with a certain probability $1 - \theta$ and must keep its price unchanged with probability θ, regardless of the previous adjustment date. Calvo (1980) considered this probability the fraction of firms that adjust their price. ε_t is the random error term.

The NKPC managed to evade Lucas' criticism. The interpretation is nevertheless very different from the traditional Phillips curve. Indeed, it represents inflation as a phenomenon essentially turned towards the future ("forward-looking"), resulting from the dynamic optimization behavior of companies. The intuition of this forward-looking behavior is as follows: companies redefine their prices today knowing that these are likely not to be able to be adjusted for a certain period of time. They will, therefore, incorporate their expectations of future production costs to set their current prices. This property has two implications: on the one hand, the non-persistence of inflation and on the other hand, disinflation that can be caused by economic decision-makers without incurring any costs in terms of unemployment or production.

The implications of the NKPC are in stark contrast to two stylized facts of consensus among economists and central bankers. The first is that disinflation policies always cause economic recessions (see, for example, Ball 1994; Romer and Romer 1989). The second resides in the fact that the response of inflation, following a monetary shock, will only be gradual and highly persistent (see, for example, Fuhrer and Moore, 1995; Fuhrer, 1995; Christiano, Eichenbaum and Evans, 1999; Mankiw, 2001). In order to provide reliable normative implications, a

short-term model of inflation dynamics must imperatively reproduce these two consensual elements. Indeed, one can doubt the validity of the structural implications provided by a model that reproduces without success the responses of the economy to very simple shocks.

In an attempt to make the NKPC compatible with stylized facts, some authors, following Fuhrer and Moore (1995), have proposed to include an inflation lag to increase its degree of persistence. One of the most interesting contributions in this regard is that of Gali and Gertler (1999) who extended Calvo's (1980) model by assuming that a fraction ω of firms that can change their price uses a pricing rule backward-looking and a fraction $(1 - \omega)$ uses a forward-looking one. This led to a hybrid version of the NKPC which predicts a positive relationship between current inflation, (π_t) expected future inflation ($E_t\{\pi_{t+1}\}$) past inflation (π_{t-1}) and the evolution of the real marginal cost (cm_t) supported by companies. The equation of the hybrid version of the NKPC of Gali and Gertler (1999) is the following:

$$\pi_t = \gamma_f E_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1} + \lambda cm_t \quad (2)$$

Where γ_f and γ_b are weights assigned respectively to expected future inflation and lagged inflation.

In the equation of the hybrid New Keynesian Phillips curve (HNKPC), all the coefficients are explicit functions of three structural parameters: θ which measures the fraction of firms that do not adjust their prices, ω which determines the degree of lag in pricing and β which is the discount factor. These coefficients were defined by the following expressions:

$$\begin{bmatrix} \gamma_f = \beta\theta\phi^{-1} \\ \gamma_b = \omega\phi^{-1} \\ \lambda = (1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1} \\ avec\ \phi = \theta + \omega[1-\theta(1-\beta)] \end{bmatrix} \quad (3)$$

Rotemberg and Woodford (1997) showed that under certain assumptions, the output gap is linearly related to the real marginal cost, which justifies the introduction of the output gap in the Phillips curve equation. Again, Fuhrer and Moore (1995), Fuhrer (1997), Neiss and Nelson (2005) also used the output gap as a proxy for real marginal cost. In this context, Gali and Gertler (1999) established an approximate log-linear relationship between these two indicators as follows:

$$cm_t = K\hat{y}_t \quad (4)$$

Where $\hat{y}_t$ denotes the output gap, i.e. the gap between real production and its equilibrium level. Using equations (2) and (4), we obtain the following HNKPC equation:

$$\pi_t = \gamma_f \mathrm{E}_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1} + \lambda' \hat{y}_t + \varepsilon_t \tag{5}$$

Where $\lambda' = K\lambda$ designates the sensitivity of inflation to fluctuations in real output around its equilibrium value which represents the optimal value. The variables and coefficients are defined above. According to this equation, a positive output gap means that real GDP is above its potential level. This excess demand generates inflationary pressures. On the other hand, a negative output gap implies an economic recession. In this context, the central bank must use its key rate, in the short term, to stabilize the output gap (as well as inflation).

In their famous papers, Gali and Gertler (1999) estimated the HNKPC for the United States by the Generalized Method of Moments (GMM). They used two measures of fluctuations in economic activity: the labor income share and the output gap. They found that the retrospective component coefficient (π_{t-1}) is non-zero and statistically significant, implying that the purely prospective model (i.e. NKPC) is rejected by the data. However, their results indicate that the coefficient of expected future inflation was quantitatively larger than that of lagged inflation. This means that the forward-looking behavior of firms in pricing has a dominant effect over the backward-looking one on inflation dynamics. Moreover, their estimation results indicated that the labor income share coefficient is positive and statistically significant. This finding is consistent with the theoretical predictions of the HNKPC. However, the output gap coefficient turns out to be incorrectly signed (negative) and statistically insignificant.

In support of the findings of Gali and Gertler (1999), many studies have estimated NKPC and its hybrid version (HNKPC) for developed economies (see, e.g., Bloch, 2012; Lubik and Teo, 2012; Lanne and Luoto, 2013; Lagoa, 2017; Coibion et al., 2018; Dur and García, 2020; Juselius and Takáts, 2021; Zobl and Ertl, 2021; Aguiar-Conraria et al., 2023 and many more). The availability and quality of data explain why studies on the HNKPC for developing economies are rare (Vašíček 2011). In order to fill this gap in the literature, some economic researchers have tried to examine the validity of the HNKPC in developing economies (see, e.g., Agénor and Bayraktar, 2010; Ben Ali, 2013; Zhang, 2013; Başer Andiç et al., 2015; Chowdhury and Sarkar, 2016; Sakurai, 2016; Kobbi and Gabsi, 2017; Salunkhe and Patnaik, 2019; Ayisi and Afful-Mensah, 2023).

Moreover, despite the strong theoretical foundations of the HNKPC, some researchers have shown that its empirical relevance remains open to further investigation (see, e.g., Gali and Gertler, 1999; Minella et al., 2003; Schwartzman,

2006; Rudd and Whelan, 2005, 2007; Chowdhury and Sarkar, 2016; Arruda et al., 2018; Fidrmuc and Danisková, 2020). Contrary to the theoretical prediction, they found that the HNKPC fails to capture the statistically significant impact of fluctuations in real economic activity on inflation dynamics. One of the debates concerns the measurement of fluctuations in real economic activity.

Chowdhury and Sarkar (2016) conducted a study on the HNKPC in four major emerging economies: Brazil, Russia, India, and South Africa. They employed a Modified Hamilton Markov Switching Model to estimate the production gap. The results of their estimation revealed that the coefficient associated with the output gap was insignificant for Brazil, India, and Russia. In another study, Arruda et al. (2018) estimated both the NKPC and HNKPC for the Brazilian economy. They utilized three indicators of nocturnal fluctuations in real economic activity, namely the real marginal cost of businesses, the output gap, and the unemployment gap. To estimate the output and unemployment gaps, they employed the well-known Hodrick-Prescott filter (1983). Similarly, their findings demonstrated the inadequacy of the output gap as a measure to capture the transmission of real economic activity fluctuations to inflation. Conversely, Jašová et al. (2020) demonstrated the undeniable role of the output gap in inflation dynamics for twenty-six advanced economies and twenty-two emerging economies, both globally and domestically. They also noted the increasing similarity between emerging and advanced economies in terms of output gaps as a determinant of inflation.

In the context of examining the validity of the HNKPC in the US economy, Lai (2017) pointed out that one can use a new technique called “empirical mode decomposition, EMD” to estimate the output gap. He showed that this technique offers a new way to re-examine the empirical relevance of HNKPC

3. Data and Methodologies

3.1. Data

Most economists use the real marginal cost and/or the output gap as an indicator of fluctuations in real economic activity. However, other economists have pointed out that one can also use the unemployment rate gap based on Okun's law (such as Lai 2017; Kobbi and Gabsi 2017; Arruda et al. 2018 and many more). In 1962, Okun established a negative relationship between unemployment and production. This relationship has been explained by the fact that any increase in production generates an increase in the demand for labor and therefore a decrease in the unemployment rate.

Several economists, such as Vašíček (2011) and Ben Ali (2013), have pointed out that supply shocks directly impact inflation and such effects should be included in the HNKPC. In particular, the inclusion of exchange rates in the

HNKPC of Gali and Gertler (1999) appeared to be a relevant measure of supply shock.

Thus, we will use quarterly unemployment rate, inflation rate and real effective exchange rate data. Inflation rate, measured by the consumer price index, is taken from the Organisation for Economic Co-operation and Development (OECD, 2019). Unemployment rate and real effective exchange rate are extracted from the IMF's monthly International Financial Statistics (IFS, 2019). The analysis period extends from the fourth quarter of 2001 to the fourth quarter of 2018. To estimate the unemployment rate gap, we will use the Empirical Mode Decomposition Technique.

Empirical Mode Decomposition Technique

The empirical mode decomposition (EMD) is a decomposition technique by which the data series could be decomposed into a rapidly oscillating part d_1 and a slower oscillating part r_1, this later being decomposable in turn on the same principle. Indeed, consider a series $Z(t) = d_1 + r_1$. The EMD will also decompose the slower oscillating part r_1 into a finite sum of oscillating modes d_s named "intrinsic mode function (IMFs)", which gives the following writing:

$$Z(t) = \sum_{s=1}^{N} d_s + r_s$$
$$= \sum_{s=1}^{N} IMFs + r_s \qquad (6)$$

The IMFs should satisfy the following two conditions: (i) must have a zero mean and (ii) the number of its extremes (minima and maxima) and the number of zero crossings cannot differ by more than one unit. By fulfilling the above conditions, it is implied that all IMFs have positive maxima and negative minima. Moreover, the final residue r_N does not present any more oscillation. This residual represents the general trend of the data series used. This leads to a final decomposition of the form:

$$Z(t) = r_N + \sum_{s=1}^{N} IMFs \qquad (7)$$

3.3. Estimation technique and diagnostic tests

By replacing the output gap by the unemployment rate and by introducing the variation in the real effective exchange rate as an approximation of the

supply shock, the expression of the HNKPC of Gali and Gertler (1999) becomes as follows:

$$\pi_t = \gamma_f E_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1} + \lambda' u_t + \delta \Delta v_t + \varepsilon_t \quad (8)$$

According to this equation, current inflation (π_t) depends on past inflation (π_{t-1}) expected future inflation $E_t\{\pi_{t+1}\}$, unemployment rate gap u_t and the supply shock Δv_t measured by the change in the real effective exchange rate. Signs are expected for all variables, but for the unemployment rate, it should not be positive.

We will estimate the above equation using the Generalized Method of Moments (GMM). Since the theoretical model assumes that agents are rational, a natural way to form current expectations of future inflation is based on lagged variables included as instruments in the regression. The validity of the instruments must be checked by the over-identification J test of Hansen (1982).

A number of studies, such as: Roberts (1995), Dufour et al. (2006), Paloviita (2006), Zhang et al. (2009), Adam and Padula (2011), used survey data on inflation expectations to examine the validity of the NKPC or its hybrid version. Although the survey data reflected agents' behavior in inflation expectation and showed the empirical validity of the HNKPC, they are heavily criticized. One of the important criticisms is related to its validity. Indeed, survey responses may be of limited interest and sometimes an irresponsible response from officers. In this context, the empirical success of the HNKPC with survey data remains questionable (Kapounek and Lacina, 2011; Lunn and Duffy, 2015; Abbas et al., 2016; Güler and Polat, 2018).

The presence of autocorrelation and heteroscedasticity of the error term implies poor model specification and parameter instability. It, thus, suggests that the estimates are biased. For these reasons, the Breusch-Godfrey error autocorrelation LM test and the Breusch-Pagan-Godfrey (PBG) heteroscedasticity test will be performed.

4. Results and discussion

4.1. Graphical analysis

By applying the EMD technique, we have determined the general tendency (or the trend component) of the series of unemployment rates. Thus, to calculate the unemployment rate gap, we eliminated the trend component estimated by the EMD technique from the original series of unemployment rates. The graph below represents the difference in the unemployment rate obtained.

Reading the chart above shows that between 2004 and 2007 the unemployment rate gap was negative, which implies that the unemployment

rate was lower than its level of balance. This is explained by the fact that during this period, the Brazilian economy recorded a contained drop in the unemployment rate, although it reached 9.29% in 2007 . The significant drop in the unemployment rate is in turn explained by the contained increase in the real GDP growth rate, reaching 6.07% in 2007. This increase was stimulated by the economic interventions of the State and the reduction of income inequalities. Specifically, during this period, public spending was increased and Lula's government devoted more resources to income transfers to poor families and implemented a minimum income program; "Bolsa Familia". In addition, the minimum wage has seen a faster increase following an agreement between the country's unions and the government. The remarkable drop in the unemployment rate is also explained by the fact that a large part of the Brazilian population has benefited from better education and increased access to educational programs. Young people between the ages of 15 to 17 and 18 to 24 are considered to be in training.

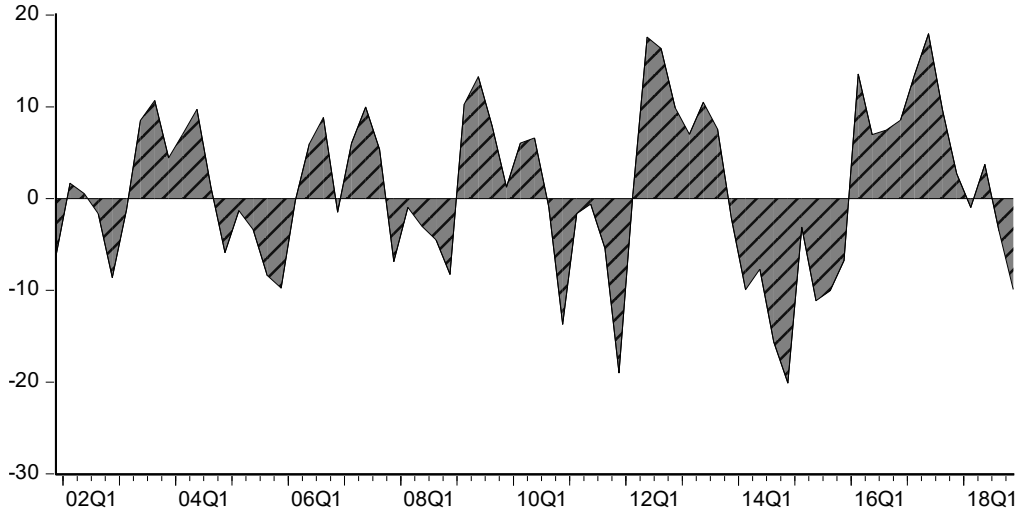
In 2008 and 2009, the gap in the unemployment rate becomes positive, which means that the unemployment rate has risen sharply compared to its equilibrium level. This increase is explained by the financial crisis of 2008 that generated a recession in the Brazilian economy. The real GDP growth rate was -0.13% in 2009. To reduce the extent of the effects of the crisis, economic decision-makers adopted counter-cyclical economic policies. After a year, their effect was absorbed without major disruption to the Brazilian banking system and the economy resumed its growth in 2010. More precisely, the real GDP growth rate becomes positive, i.e .7.54%. The actions and programs implemented before and respected until the end of the crisis also contributed to the strengthening of Brazilian economic growth. In fact, income transfers between 2003 and 2008, the decision not to lower the social protection established for 2009 and to maintain the increase in the minimum wage planned for 2009 and 2010 ensured a slight contraction in private demand during the period of crisis and its rapid recovery thereafter. As a result, from the graph, we see that at the end of 2010 the gap in the unemployment rate fell until it became negative at the start of 2012.

At the end of 2012, the economic team Dilma Rousseff has exploited several instruments, such as credit expansion and tax exemption for most sectors of the economy, to stimulate both demand and supply. GDP growth started to pick up in 2013, reaching an annualized rate of 3%. However, the inflation rate increased from 5.4% in 2012 to 6.2% in 2013. The monetary authorities reacted by implementing a series of increases in the key rate. This restrictive monetary policy largely explains why the gap in the unemployment rate is positive during this period.

The Brazilian economy stagnated between 2014 and 2016 due to poor governance at Petrobras, the sharp decline in domestic demand and the depreciation of the exchange rate since 2011. In 2017, it recovered and real GDP

grew by 1.01%. Several factors may explain this growth; First, the adoption of several structural reforms since the end of 2016, notably the reduction of obstacles, the reduction of corruption and the improvement of the efficiency of the public sector. Then, the rapid improvement in fiscal performance. Third, inflation closer moving to its target, leading to a recovery in investment and consumption. Finally, the increase in exports, which exceeds that of imports, thanks to favorable external conditions and a depreciation of the real effective exchange rate. The Brazilian economy confirmed its return to growth, recording a growth rate of 1.4% in 2018. As a result, the graph above represents a negative unemployment rate gap between 2017 and 2018. This graphical analysis confirms that the empirical mode decomposition technique is adequate to detect all events of the economic cycle.

Graph no.1 The unemployment rate gap estimated by the EMD technique, 2001:Q4-2018:Q4



Source: *Prepared by the authors.*

4.2. Unit root tests

A time series who's mean and/or variance varies over time is said to be non-stationary. It can lead to "spurious" regressions if left untreated. Several tests help to verify the stationary character (existence of a unit root) or not of a series such as: augmented Dickey-Fuller/ADF test, Phillippe-Perron /PP test, KPSS test, etc. These tests are easy to apply and commonly used. In this study, we used the ADF and KPSS tests. The results are grouped in the table below. They provide information that all the variables (inflation, unemployment rate gap and variation in the real effective exchange rate) are stationary at the level, I (0).

Table no.1 Unit root tests

		ADF-Test		KPSS-Test
	t-Statistic	Prob.	t-Statistic	Prob.
π_t	-4.53*	-3.53	0.12*	0.21
u_t	-5.6*	-2.6	0.03*	0.73
Δv_t	-5.98*	-2.59	0.05*	0.21

Note: *,** and *** denote stationarity at the 10%, 5%, and 1% levels, respectively.

Source: *Prepared by the authors.*

4.3. Results of the diagnostic tests

The table below shows that the value of the J statistic is significant at the 1% level, which implies acceptance of the null hypothesis related to the instruments validity. We applied other tests, namely the Breusch-Godfrey error autocorrelation LM test and the Breusch-Pagan-Godfrey (PBG) heteroscedasticity test. According to these two tests, the estimation residuals turned out to be non-heteroscedastic and uncorrelated, thus showing that the estimation is consistent and reliable.

Table no.2 Diagnostic tests

Tests	Values (probability)
Over-identifying restrictions test (J-statistic)	0.35 (0.94)
Breusch-Godfrey Serial Correlation LM Test	0.58 (0.44)
Heteroskedasticity Test: Breusch-Pagan-Godfrey	1.07 (0.30)

Source: *Prepared by the authors.*

4.4. GMM estimation of the HNKPC

As can be read in Table 3 below, the Brazilian economy past inflation and expected future inflation have a statistically significant impact, at the 1% level, on the dynamics of current inflation. The sum of the estimated values of these two variables is close to one, i.e. $y_b + y_f \approx 1$. Based on the theoretical model of Gali and Gertler (1999) and that of Blanchard and Gali (2009), this result indicates that any application of a long-term expansionary monetary policy to reduce the unemployment rate only causes acceleration in inflation. Graphically, the HNKPC of the Brazilian economy is vertical in the long run.

The lagged inflation rate coefficient is different at zero, $y_b \approx 0.51$, implies the presence of a fraction of firms that adjust their price using a look-back rule. This suggests that Brazilian inflation is not a purely forward-looking phenomenon.

Consequently, the Brazilian monetary authorities cannot cause disinflation without incurring costs in terms of unemployment.

The coefficient of expected future inflation, $y_f \approx 0.48$, is relatively lower than that of past inflation, $y_b \approx 0.51$. This means that the retrospective behavior of firms in pricing has a relatively predominant effect compared to the prospective one on the dynamics of Brazilian inflation. The predominance of retrospective behavior in price setting reflects a high degree of persistence of Brazilian inflation following a monetary shock. This degree is largely explained by the history of hyperinflations and the recent increase in the indexation of the Brazilian economy.

The estimated coefficient of the unemployment rate gap has a negative sign. It is also statistically significant at the 5% level. Indeed, the 1% increase in the unemployment rate differential calculated by the EMD technique will be accompanied by a 0.01% drop in the inflation rate. Thus, in the event of an exogenous shock, the Brazilian monetary authority will be faced with a trade-off between stabilization of inflation and stabilization of the unemployment rate differential. This result overcomes a number of empirical works that have found that the HNKPC is inadequate to correctly capture the impact of fluctuations in real economic activity on the dynamics of inflation in the Brazilian economy (see, e.g., Schwartzman, 2006; Minella et al., 2003; Chowdhury and Sarkar, 2016; Arruda et al., 2018).

The change in the real effective exchange rate has a statistically significant impact at the 1% threshold on Brazilian inflation. More specifically, an appreciation of the real effective exchange rate of 1% translates into a reduction in inflation of 0.01% in the first quarter. This reflects the effectiveness of the real effective exchange rate as an instrument for stabilizing Brazilian inflation. Moreover, this result is in line with works that demonstrated the relevance of the exchange rate as a measure of the supply shock, such as Vašíček (2011) and Ben Ali (2013).

The appreciation of the real effective exchange rate inevitably has effects on the level of inflation. On the one hand, it leads to a fall in the prices of imported products. This decline reduces production costs and, consequently, a drop in inflationary pressures. On the other hand, the decline in import prices leads to an increase in imports of foreign products. This causes domestic companies to lower their prices in order to attract and retain potential customers. Similarly, the appreciation of the real effective exchange rate leads to an increase in the price of exports, which reduces export price competitiveness. This, in turn, puts downward pressure on domestic prices.

Table no.3 Estimation Results of the HNKPC

Variable	Coefficient	Std. Error	t-Statistic	Prob.
π_{t-1}	0.510145	0.035245	14.47420	0.0000
π_{t+1}	0.484072	0.031210	15.51029	0.0000
u_t	-0.010947	0.004861	-2.252098	0.0283
Δy_t	-0.013804	0.004368	-3.160594	0.0025

Source: *Prepared by the authors.*

5. Conclusion

The analysis carried out in this study confirms the empirical validity of the hybrid New Keynesian Phillips Curve (HNKPC) in the context of the Brazilian economy. By employing Empirical Mode Decomposition (EMD) to estimate the unemployment rate gap, we were able to detect cyclical events and demonstrate that real-activity fluctuations exert a significant influence on inflation dynamics. The results indicate that the Phillips curve is vertical in the long run, emphasising that an expansionary monetary policy cannot sustainably reduce unemployment without engendering inflationary pressures. In the short term, Brazil's monetary authority faces a trade-off between stabilising inflation and closing the unemployment gap, thereby corroborating the theoretical predictions of the model.

Moreover, the study highlights the preponderant impact of firms' historical pricing behaviour on current inflation dynamics, relative to forward-looking expectations. It also underscores the relevance of the real effective exchange rate as a valuable indicator for assessing the effects of supply shocks on price movements.

Importantly, this result overcomes a number of empirical studies that have previously rejected the validity of the HNKPC in the Brazilian context (see, e.g., Schwartzman, 2006; Minella et al., 2003; Chowdhury and Sarkar, 2016; Arruda et al., 2018). In this regard, the EMD technique proves to be a relevant and powerful tool for detecting cyclical events and supporting the theoretical predictions of the HNKPC.

Nevertheless, this study has certain limitations. It focuses exclusively on a single emerging economy—Brazil. To enhance the generalisability and robustness of our findings, extending the analysis to other emerging or advanced economies would be beneficial. Furthermore, our investigation relied solely on the unemployment rate gap as a measure of real-activity fluctuations. A fruitful avenue for future research would be to incorporate the output gap, likewise estimated via EMD, in order to compare the sensitivity of the Phillips curve to different measures of economic activity.

These perspectives for future research offer promising directions for deepening our understanding of the role of real variables in inflation dynamics and contributing to current debates in monetary policy.

Bibliography

Abbas, S. K., Bhattacharya, P. S., and Sgro, P. M. 2016. "The New Keynesian Phillips Curve: An Update on Recent Empirical Advances." *International Review of Economics & Finance*, 43: 378–403.

Adam, K. and Padula, M. 2011. "Inflation Dynamics and Subjective Expectations in the United States." *Economic Inquiry*, 49(1): 13–25.

Agénor, P. R. and Bayraktar, N. 2010. "Contracting Models of the Phillips Curve: Empirical Estimates for Middle-Income Countries." *Journal of Macroeconomics*, 32(2): 555–570.

Aguiar-Conraria, L., Martins, M. M., and Soares, M. J. 2023. "The Phillips Curve at 65: Time for Time and Frequency*." Journal of Economic Dynamics and Control*: 104620.

Arruda, E. F., Oliveira de Olivindo, M. T. A., and Castelar, I. 2018. "Business Cycles, Expectations and Inflation in Brazil: A New-Keynesian Phillips Curve Analysis." *CEPAL Review*.

Aslan, Z. 2022. "An Empirical Mode Decomposition Approach for Automated Diagnosis of Migraine." *Biomedical Signal Processing and Control*, 73: 103413.

Ayisi, R. K. and Afful-Mensah, G. 2023. "A Model of New Keynesian Phillips Curve and Inflation Dynamics in Ghana." *Journal of Quantitative Economics*: 1–17.

Ball, L. 1994. "Credible Disinflation with Staggered Price-Setting." *The American Economic Review*, 84(1): 282–289.

Başer Andiç, S., Küçük, H., and Öğünç, F. 2015. "Inflation Dynamics in Turkey: In Pursuit of a Domestic Cost Measure." *Emerging Markets Finance and Trade*, 51(2): 418–431.

Baxter, M. and King, R. G. 1999. "Approximate Band-Pass Filters for Economic Time Series." *Review of Economics and Statistics*, 81(4): 575–593.

Ben Ali, S. 2013. "Estimating the New Keynesian Phillips Curve for Tunisia: Empirical Issues." *Middle East Development Journal*, 5(3): 1350016-1.

Blanchard, O. and Galí, J. 2007. "Real Wage Rigidities and the New Keynesian Model." *Journal of Money, Credit and Banking*, 39: 35–65.

Calvo, G. A. 1983. "Staggered Prices in a Utility-Maximizing Framework." *Journal of Monetary Economic*s, 12(3): 383–398.

Carlin, W. and Soskice, D. 1990. *Macroeconomics and the Wage Bargain*, Oxford University Press.

Chowdhury, K. B. and Sarkar, N. 2017. "Is the Hybrid New Keynesian Phillips Curve Stable? Evidence from Some Emerging Economies*." Journal of Quantitative Economics*, 15: 427–449.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. 1999. "Monetary Policy Shocks: What Have We Learned and to What End?" *In Handbook of Macroeconomics*, Elsevier, Amsterdam, 1: 65–148.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. 2005. "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy." *Journal of Political Economy*, 113(1): 1–45.

Coibion, O., Gorodnichenko, Y., and Kamdar, R. 2018. "The Formation of Expectations, Inflation, and the Phillips Curve." *Journal of Economic Literature*, 56(4): 1447–1491.

Dubey, R., Kumar, M., Upadhyay, A., and Pachori, R. B. 2022. "Automated Diagnosis of Muscle Diseases from EMG Signals Using Empirical Mode Decomposition Based Method." *Biomedical Signal Processing and Control*, 71: 103098.

Dufour, J. M., Khalaf, L., & Kichian, M. 2006. "Inflation dynamics and the New Keynesian Phillips Curve: an identification robust econometric analysis." *Journal of Economic Dynamics and Control*, 30(9-10): 1707-1727.

Dur, A., & García, E. M. 2020. "Mind the gap!—A monetarist view of the open-economy Phillips curve." *Journal of Economic Dynamics and Control*, 117: 103959.

Fidrmuc, J., & Danišková, K. 2020. "Meta-analysis of the New Keynesian Phillips curve in developed and emerging economies." *Emerging Markets Finance and Trade*, 56(1): 10-31.

Forder, J. 2018. "What was the message of Friedman's Presidential Address to the American Economic Association?" *Cambridge Journal of Economics*, 42(2): 523-541.

Friedman, M. 1968. "The role of monetary policy." *American Economic Review*, 58(1): 1-17.

Fuhrer, J., & Moore, G. 1995. "Inflation persistence." *The Quarterly Journal of Economics*, 110(1): 127-159.

Fuhrer, J. C. 1995. "The Phillips curve is alive and well." *New England Economic Review*: 41-57.

Fuhrer, J. C. 1997. "Inflation/output variance trade-offs and optimal monetary policy." *Journal of Money, Credit, and Banking*: 214-234.

Galı, J., & Gertler, M. 1999. "Inflation dynamics: A structural econometric analysis." *Journal of Monetary Economics*, 44(2): 195-222.

Güler, M. H., & Polat, T. 2018. "New measures for inflation uncertainty and disagreement from treasury auctions: Alternative to surveys." *Emerging Markets Finance and Trade*, 54(4): 881-900.

Hansen, L. P. 1982. "Large sample properties of generalized method of moments estimators." Econometrica: *Journal of the Econometric Society*: 1029-1054.

Hagemann, H. 2020. "Inflation Expectations and the Phillips Curve: Then and Now." *In Expectations: Theory and Applications from Historical Perspectives*, 131-144.

Hodrick, R. J., & Prescott, E. C. 1997. "Postwar US business cycles: an empirical investigation." *Journal of Money, Credit, and Banking*: 1-16.

Hua, Q., & Jiang, T. 2015. "The prediction for London gold price: improved empirical mode decomposition." *Applied Economics Letters*, 22(17): 1404-1408.

Huang, N. E., Shen, Z., Long, S. R., Wu, M. C., Shih, H. H., Zheng, Q., ... & Liu, H. H. 1998. "The empirical mode decomposition and the Hilbert spectrum for nonlinear and non-stationary time series analysis." *Series A: Mathematical, Physical and Engineering Sciences*. Proceedings of the Royal Society of London, pp. 903-995.

Huang, Y., & Schmitt, F. G. 2014. "Time dependent intrinsic correlation analysis of temperature and dissolved oxygen time series using empirical mode decomposition." *Journal of Marine Systems*, 130: 90-100.

Jašová, M., Moessner, R., & Takáts, E. 2020. "Domestic and global output gaps as inflation drivers: What does the Phillips curve tell?" *Economic Modelling*, 87: 238-253.

Juselius, M., & Takáts, E. 2021. "Inflation and demography through time." *Journal of Economic Dynamics and Control*, 128: 104136.

Kapounek, S., & Lacina, L. 2011. "Inflation perceptions and anticipations in the old eurozone member states." *Prague Economic Papers*, 20(2): 120-139.

Kim, T., Shin, J. Y., Kim, S., & Heo, J. H. 2018. "Identification of relationships between climate indices and long-term precipitation in South Korea using ensemble empirical mode decomposition." *Journal of Hydrology*, 557: 726-739.

Kobbi, I., & Gabsi, F. B. 2017. "The nonlinearity of the new Keynesian Phillips curve: The Case of Tunisia." *Economies*, 5(3): 24.

Lai, Y. W. 2017. "Output gaps and the New Keynesian Phillips curve: An application of the Empirical Mode Decomposition." *Economics Bulletin*, 37(2): 952-961.

Lagoa, S. 2017. "Determinants of inflation differentials in the euro area: Is the New Keynesian Phillips Curve enough?" *Journal of Applied Economics*, 20(1): 75-103.

Lanne, M., & Luoto, J. 2013. "Autoregression-based estimation of the new Keynesian Phillips curve." *Journal of Economic Dynamics and Control*, 37(3): 561-570.

Liu, S., Xu, L., & Li, D. 2016. "Multi-scale prediction of water temperature using empirical mode decomposition with back-propagation neural networks." *Computers & Electrical Engineering*, 49: 1-8.

Long, L., Wen, X., & Lin, Y. 2021. "Denoising of seismic signals based on empirical mode decomposition-wavelet thresholding." *Journal of Vibration and Control*, 27(3-4): 311-322.

Lubik, T. A., & Teo, W. L. 2012. "Inventories, inflation dynamics and the New Keynesian Phillips curve." *European Economic Review*, 56(3): 327-346.

Lucas Jr, R. E., & Rapping, L. A. 1969. "Real wages, employment, and inflation." *Journal of Political Economy*, 77(5): 721-754.

Lucas Jr, R. E. 1972. "Expectations and the Neutrality of Money." *Journal of Economic Theory*, 4(2): 103-124.

Lucas, R. E. 1973. "Some international evidence on output-inflation tradeoffs." *The American Economic Review*: 326-334.

Lucas Jr, R. E. 1975. "An equilibrium model of the business cycle." *Journal of Political Economy*, 83(6): 1113-1144.

Lucas Jr, R. E. 1976. "Econometric policy evaluation: A critique." *In Carnegie-Rochester Conference Series on Public Policy*, North-Holland, pp. 19-46.

Lunn, P. D., & Duffy, D. 2015. "Perceptual noise and perceived inflation after the Euro currency changeover." *Journal of Behavioral and Experimental Finance*, 7: 1-16.

Mankiw, N. G. 2001. "*US monetary policy during the 1990s*."

Mankiw, G. N. 2019. *Macroéconomie*. De Boeck supérieur.

Mavroeidis, S. 2005. "Identification issues in forward-looking models estimated by GMM, with an application to the Phillips curve." *Journal of Money, Credit and Banking*, 421-448.

Minella, A., De Freitas, P. S., Goldfajn, I., & Muinhos, M. K. 2003. "Inflation targeting in Brazil: constructing credibility under exchange rate volatility." *Journal of International Money and Finance*, 22(7): 1015-1040.

Nath, S., Chetia, B., & Kalita, S. 2023. "Ionospheric TEC prediction using hybrid method based on ensemble empirical mode decomposition (EEMD) and long short-term memory (LSTM) deep learning model over India." *Advances in Space Research*, 71(5): 2307-2317.

Okun, A. M. 1963. "Potential GNP: its measurement and significance." *Cowles Foundation for Research in Economics at Yale University*.

Paloviita, M. 2006. "Inflation dynamics in the euro area and the role of expectations." *Empirical Economics*, 31(4): 847-860.

Phillips, A. W. 1958. "The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957." *Economica*, 25(100): 283-299.

Prescott, E. C. 1986. "Theory ahead of business-cycle measurement." *In Carnegie-Rochester Conference Series on Public Policy*, North-Holland, pp. 11-44.

Rancan, A. 2022. "The "place of the Phillips curve" in macroeconometric models: the case of the federal reserve board's model (1966–1980s)." *Journal of the History of Economic Thought*, 44(2): 161-181.

Roberts, J. M. 1995. "New Keynesian economics and the Phillips curve." *Journal of Money, Credit and Banking*, 27(4): 975-984.

Romer, C. D., & Romer, D. H. 1989. "Does monetary policy matter? A new test in the spirit of Friedman and Schwartz." *NBER Macroeconomics Annual*, 4: 121-170.

Rotemberg, J. J. 1982. "Sticky prices in the United States." *Journal of Political Economy*, 90(6): 1187-1211.

Rotemberg, J. J., & Woodford, M. 1997. "An optimization-based econometric framework for the evaluation of monetary policy." *NBER Macroeconomics Annual*, 12: 297-346.

Rudd, J., & Whelan, K. 2005. "New tests of the new-Keynesian Phillips curve." *Journal of Monetary Economics*, 52(6): 1167-1181.

Rudd, J., & Whelan, K. 2007. "Modeling inflation dynamics: A critical review of recent research." *Journal of Money, Credit and Banking*, 39: 155-170.

Salunkhe, B., & Patnaik, A. 2019. "Inflation dynamics and monetary policy in India: A New Keynesian Phillips Curve perspective." *South Asian Journal of Macroeconomics and Public Finance*, 8(2): 144-179.

Samuelson, P. A., & Solow, R. M. 1960. "Analytical aspects of anti-inflation policy." *The American Economic Review*, 50(2): 177-194.

Sakurai, H. 2016. "The New Keynesian Phillips Curve in Thailand Through Two Financial Crises." *Asian Economic and Financial Review*, 6(4): 190-195.

Schwartzman, F. F. 2006. "Estimativa de curva de Phillips para o Brasil com preços desagregados." *Economia Aplicada*, 10: 137-155.

Sheshinski, E., & Weiss, Y. 1977. "Inflation and costs of price adjustment." *The Review of Economic Studies*, 44(2): 287-303.

Snowdon, B. & Vane, H. R. 2005. *Modern Macroeconomics: Its Origins, Development and Current State*, Edward Elgar Publishing.

Taylor, J. B. 1980. "Aggregate dynamics and staggered contracts." *Journal of Political Economy*, 88(1): 1-23.

Vašíček, B. 2011. "Inflation dynamics and the new Keynesian Phillips curve in four Central European Countries." *Emerging Markets Finance and Trade*, 47(5): 71-100.

Villieu, P. 2015. *Macroéconomie*, Economica.

Yousefi Rizi, F. 2019. "A review of notable studies on using Empirical Mode Decomposition for biomedical signal and image processing." *Signal Processing and Renewable Energy*, 3(4): 89-113.

Zhang, X., Lai, K. K., and Wang, S. Y. 2008. "A new approach for crude oil price analysis based on empirical mode decomposition." *Energy Economics*, 30(3): 905–918.

Zhang, C., Osborn, D. R., and Kim, D. H. 2009. "Observed inflation forecasts and the New Keynesian Phillips curve." *Oxford Bulletin of Economics and Statistics*, 71(3): 375–398.

Zhang, C. 2013. "Inflation dynamics and an extended new Keynesian Phillips curve for China." *Emerging Markets Finance and Trade*, 49(5): 82–98.

Zhang, S., and Li, Y. 2020. "Seismic exploration desert noise suppression based on complete ensemble empirical mode decomposition with adaptive noise." *Journal of Applied Geophysics*, 180: 104055.

Zare, M., and Nouri, N. M. 2023. "A novel hybrid feature extraction approach of marine vessel signal via improved empirical mode decomposition and measuring complexity." *Ocean Engineering*, 271: 113727.

Zobl, F. X., and Ertl, M. 2021. "The Condemned Live Longer–New Evidence of the New Keynesian Phillips Curve in Central and Eastern Europe." *Open Economies Review*, 32(4): 671–699.