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Industrial Policy and Development: Time for Disciplined Action*

Olivér Kovács

This essay seeks to answer one of the key paradoxes of the fourth industrial revolution (Industry 4.0) that has been unfolding since 2011: Despite the multitude of dedicated industrial policy strategies and policy interventions put in place since then, why have we not seen spectacular success? Using the US and EU industrial policy landscape, I argue that, although it will take time for the effects of Industry 4.0 to materialise, the strategy of "patience is a virtue" (respice finem) cannot be sustained indefinitely, i.e. until certain systematic industrial policy paradoxes are resolved, because only a systemic and primarily resilience-driven industrial policy can be expected to yield results.

Journal of Economic Literature (JEL) codes: O10, O25, O38, L16, L52

Keywords: Industry 4.0, industrial policy, USA, Europe

1. Introduction

In developed countries, economic history in the last 30–40 years has led economists to believe that industrial policy no longer features on the map of countries' and the world's economic governance. Nevertheless, industrial policy has long been part of the life of advanced economies, as a sort of invariable policy aspect – one way or another, even if unnamed as such – insofar as its narrative has permeated the ideological battles of the political playing field over time. The imposition of tariffs is usually seen as protectionism, i.e. an industrial policy act to boost the international competitiveness of domestically-owned companies; and when there are negative feedbacks from a competitor, it is referred to as none other than a trade war centred on industrial policy. Those who advocate the primacy of the free market, on the other hand, would have none of either.

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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The reality is that the competitive situations induced by hyper-globalisation, intensifying with each cycle, have organically generated the application of industrial policy in various forms. From a European perspective, for example, the current rise of China is very similar to what was seen in the 1970s and 1980s when the strengthening competitive position of the United States and Japan was the driving force behind a number of industrial policy interventions. After this, industrial policy was relegated to the margins of economic governance and lost its former lustre. Today, however, owing to the growing range of crisis phenomena (e.g. Covid-19, surging inflation, deteriorating productivity dynamics, gaping inequalities, demographic problems, natural disasters and climate change, shrinking fiscal space due to sovereign debt crisis, migration crisis, war, etc.), economists and economic policymakers have had to realise that harnessing the potential benefits of digitalisation and Industry 4.0[1] (*Kovács 2018*) requires strong, refocused industrial policy.

In addition to the detailed literature review, this essay is innovative in that it can help the profession to clarify the paradox of why, over more than a decade, the many dedicated industrial policy strategies and policy interventions adopted since the emergence of Industry 4.0 have not led to spectacular success. In *Section 2*, I briefly take stock of industrial policies. In *Section 3,* I then proceed to outline the industrial policy trajectories of the two major competitors, the United States and the European Union, which may help resolve the paradox. Building on their experience, *Section 4* delves deeper into industrial policy paradoxes – going beyond the available literature – without addressing them the success of any Industry 4.0-focused industrial policy is fairly doubtful. Finally, the key conclusions are discussed in *Section 5*.

2. The Balance of Industrial Policies

Two issues need to be clarified very briefly when talking about industrial policy. First, what do we know about the effectiveness of industrial policy in the light of historical economic experience? And second, in what way should a new industrial policy differ from the old one? Regarding the first question, the sobering fact is that the message of past empirical analyses is very mixed (*Criscuolo et al. 2019*). It seems that almost everyone can find their own narrative, i.e. there are many studies arguing for the success of industrial policy, but there are just as many papers claiming that such policy can actually distort competition policy which is aimed to promote consumer welfare (*Aiginger – Rodrik 2020*). In a nutshell, given the

[1] Industry 4.0 is a new manufacturing philosophy and way of functioning based on the Internet of Things (IoT) where smart factories are set up by connecting and integrating resources, machines and even logistics systems into a cyber-physical system, creating independent and self-optimising local production processes.

imperfect functioning of the market, various economic administrations in various eras have made use of interventions to further structural change (e.g. from an agrarian economy to a more advanced industrial economy, such as South Korea, Taiwan, Ghana, Nigeria, or Finland, for example, which is dominated by modern services and characterised by a transition to a knowledge-based economy that produces higher added value). There are many documented success stories, but also plenty stories of failure. Since structural change is a qualitative transformation and therefore involves change in many processes, it should come as no surprise that there is no and cannot be a universal definition of industrial policy for all ages, as is also suggested by *Éva Voszka* (*2019*) in her article.

Undoubtedly, even today, there are publications with the premeditated intent of pointing out the uselessness of industrial policy. However, for professionals who are more aware of the nuances and the socio-economic realities, the question is not "*Is it necessary?"* but rather "*How should we implement it?"* (*Juhász et al. 2023*). As for the how, it is a matter of what can (and should) be done differently from the old industrial policy approach. Earlier industrial policy approach was essentially top-down, focused on selected sectors, sought to protect the domestic market with a touch of nationalism, and was deeply imbued with an assumption of honesty, competence, the feasibility of quality implementation, and that solutions had in fact been already recognised elsewhere (typical of Taiwan or South Korea).

By contrast, the new approach to industrial policy dismisses these naive assumptions, abandons the belief in the omnipotence of the state, and, focusing on general-purpose technologies, upholds the principle of neutrality with regard to interventions, and, as such, is embedded in the modern development policy approach, accompanied, of course, by hidden market protection mechanisms[2] (*Szalavetz 2015*). However, it believes in the power of institutional planning, i.e. it does not seek to pick up the winners or pursue classical objectives (technology, innovation, R&D, export promotion, etc.), but focuses on the retention and creation of "good and productive jobs", also citing the paradigm of quality growth. In other words, the new industrial policy focuses on one aspect of subjective well-being, i.e. job satisfaction, the real creation of jobs that enable us to tap our potential through work while being beneficial for productivity dynamics. *Vasvári et al.* (*2019*) point out that industrial policy should also focus on enhancing learning ability, that is, it should prioritise industries where domestic actors can learn more and better things.[3] In what follows, I will look at the United States and Europe to see whether their industrial policy gradients point in this direction.

[2] E.g. environmental regulations, standards.
[3] For more on this in the European dimension, see *Mazzucato et al.* (*2015*).

3. Industrial Policy Panorama: The USA and Europe

What industrial policy in the United States and the European Union have in common is that in recent decades they have both become increasingly sharp, coordinated and holistic in the sense that they are designed to serve socio-economic development and competitiveness in general, embedded, if you like, in a more macro-conscious innovation strategy.[4]

3.1. The USA: The Practice of a Furtive and Increasingly Direct Industrial Policy

Previous US industrial policies were not particularly in the limelight, since their primary focus was on the defence sector (e.g. supporting technological development of interest to the Pentagon), while the dimension of civilian life and everyday industrial activities was long treated as taboo. The Cold War period and the fear of competitors eventually led to industrial policy playing a growing role in US economic governance with some creeping normality, and the USA has now become the home of the largest industrial policy programmes in the world.

The US professional discourse of the 1980s began to be dominated by the articulation of the need for a more strategic and coordinated industrial policy (*McKay 1983*). All this was due to declining (industrial) productivity (relative to major competitors such as France and Japan) and, through this, fading growth dynamics. In fact, it was nothing more than a forced acknowledgement of the cyclical nature of technological progress and policy considerations to facilitate the shift to a new stage of technological development, since by the 1980s it had become clear that technological modernisation and the change of direction called for state intervention (*Solo 1984*). One of the side effects of the restructuring power of the information and communications technology (ICT) revolution at the beginning of the installation phase in the 1980s was the inherent deindustrialisation of the service sector as the ICT revolution brought it up to speed.[5] To counteract this, industrial policy considerations had to be taken into account to bring about a renaissance of industry. Also, it was good to be aware of the impact that the development policies in competitor countries had on trade, and to shape industrial policy accordingly.[6] One of the central elements of US industrial policy – beyond the fact that military-based industrial policy has been the main factor determining the development trajectory of US capitalism for at least a century – was, and continues to be, the support of small and medium-sized, often young enterprises (e.g. the *Advanced*

[4] By the end of the 1990s, US and European industrial policy, which was more of an innovation policy considering its real content, had begun to converge. See: *Gulbrandsen and Etzkowitz* (*1999*).
[5] *Nagy et al.* (*2019*) or *Boda et al.* (*2023*) contrast the trend of deindustrialisation in Western Europe with the reindustrialisation observed in some countries of Central and Eastern Europe.
[6] Developments in Japan's industrial policy and science and technology policy have affected US global trade opportunities in many ways. See: *Audretsch and Yamawaki* (*1988*).

Technology Program and the *Manufacturing Extension Partnership* programme), as they innovate and create jobs much faster and more often than large firms (*Hayden et al. 1985:387*). It did so primarily through selective enterprise policies to strengthen economic resilience (e.g. selecting and subsidising certain companies to mitigate global energy challenges – which have gone down in the history of US industrial policy as failures rather than success[7]), and through technology support programmes aimed at commercialisation (e.g. the ARPANET programme, which later became the basis for the Internet, etc.). It undertook all of this while still having a significant share of policy objectives that did not encourage the spirit of competition in innovation but, rather, had the effect of restraining it, e.g. through forced job creation, the forging of domestic business coalitions, and the promotion of global industrial alliances (*Fong 2000*). Meanwhile, the nature of the innovation ecosystem in a hyper-globalised world economy had obviously changed – in a service-dominated, ICT-based knowledge economy, innovations[8] were harder to protect than before – and it proved easier to enter the market as a follower, finding a way to improve efficiency and profitability through incremental improvements. Moreover, with the advance of ICT and the rise of network industries, the spatial decentralisation of production intensified, undermining the number one argument against industrial policy that as a consequence of the US federal institutional architecture, industrial policy would lead to inhospitable relations (*Schrank – Whitford 2009*). Many initiatives were taken in the decentralised system (e.g. export incentives independent of industry and company size; the individual states, nonetheless, competed with each other to attract a wide variety of innovative and, in terms of technology, promising businesses and the highly skilled, young and agile workforce they needed), but the stranglehold of high-tech industries and the US military industry never fully weakened.[9] Therefore, by the 1990s, US industrial policy had changed its "instrumentation". The previous mission of supporting innovators with innovations that bring global and national productivity and create jobs was replaced by a philosophy and policy of promoting diffusion, shifting the focus from innovators to developing the ability to adopt and adapt and other capacities needed to do so.

From the 2000s onwards, energy technology initiatives were also put on the agenda, with the organisational background undergoing significant changes (the Department of Energy became an innovation and technology organisation into which the Advanced Research Projects Agency – ARPA-E – and several other energy

[7] See: *Hufbauer and Jung* (*2021*).
[8] See *Kovács* (*2011*) on the characteristics of service innovations, or *Tengely* (*2020*) on the additional expansion of services in the manufacturing industry.
[9] Fiscal incentives were used by many to attract foreign manufacturers (KIA, Volkswagen, Honda, Toyota), building on the continued dominance of the car industry, while Silicon Valley also developed, the labour drain effect of which is now well known.

efficiency agencies have been incorporated). Work was helped by a group of Tech-to-Market Advisors to support promising projects even in times of crisis (this is how Tesla, for example, avoided bankruptcy and became today's leading electric car manufacturer). The 2010s were marked by a firm move towards advanced manufacturing technology. This was also spurred by China's relentless advance as a dangerous competitor, and that after decades of double-digit growth, it wished to remain a dominant economic force in the world through its industrial policy.[10] In addition, the concept of Industry 4.0 popped up in more and more places. Major industrial policy programmes were launched focusing on semiconductor manufacturing, critical technology development, energy demonstration projects, the reinforcement of domestic supply chains in critical areas, and stepping up domestic vaccine development and production. These programmes required new support infrastructures, including the establishment of 16 manufacturing innovation institutes, which were more or less structured around the various subtechnologies of Industry 4.0 (e.g. additive manufacturing, robotics, etc.). A multidisciplinary and essentially organic approach involving a wide range of stakeholders (small and large manufacturers, universities, government players) came to be dominant, with industry, state, regional and federal government funding (e.g. the 2022 Inflation Reduction Act,[11] or the unprecedented USD 53 billion incentive programme for the semiconductor industry – CHIPS). The driving force behind this was the industrial policy panacea that many believe ensured the success of Covid-19 vaccine development, Operation Warp Speed (OWS). The OWS was a public-private partnership initiated by the US government to facilitate and accelerate the development, production and marketing of vaccines, therapies and diagnostics against Covid-19. Indeed, the literature indicates that it supported the development of many successful vaccines, but the reality is that it did not help and *even hindered* the development of the most effective one (Pfizer) (*Lincicome – Zhu 2021*). That said, the industrial policy horizon also changed, with more emphasis put on creating a new talent base,[12] facilitating the integration of research relations, developing solid manufacturing bases and supply chains, modernising technology certifications, enabling more flexible conditions for contracting, expanding funding sources and further exploiting the potential of government purchases. What we see, then, is that in addition to pursuing the principles of strategic autonomy (e.g. energy independence) and economic efficiency (e.g. boosting industrial productivity), US industrial policy today also embraces the global decarbonisation mission. There

[10] On the advance of China, see *Balogh* (*2017*), and for an overview of Chinese industrial policy, see *Szunomár* (*2020*).
[11] The Inflation Reduction Act of August 2022 is an industrial policy tool in disguise, as it seeks to boost industrial productivity by tackling climate change.
[12] The *IMD World Talent Report* rankings since 2019 show that the US slipped from 12th place in 2019 to 16th in 2022 (it is no longer as outstanding at developing, retaining and attracting talent, and the available skills and competencies are not up to the level required by the challenges of the times).

is still plenty of work to be done, and more and more targets need to be set, as, according to authoritative surveys, from the early 2020s, the US started to lose ground to China on the technology front.[13]

3.2. The European Union: Towards an Industrial Policy Driven by Resilience

In a certain sense, industrial policy in Europe is also characterised by a kind of "stealth mode", but unlike in the United States, there is no sign of a serious, coordinated industrial policy, not even in the defence sector.[14] The Treaty of Rome made no reference to industrial policy at the Community level, and by no accident: it proclaimed the principle of neutrality and the non-distortion of competition. However, under Article 92, it is possible if it is targeted, specific, has a temporary effect and facilitates a more successful adaptation to a changed environment. Taking into account the most general definition of industrial policy, i.e. the facilitation of structural change, this immediately provides the basis for the evolution of industrial policy which, in the EU today, is primarily aimed at strengthening systemic *resilience* through structural change.

By the 1970s, the unprecedented competitiveness gains of Japan – also mentioned in the context of the United States – were a regular feature of Western European policy discourse, and many attributed this to the closer relationship between state and industry. This is why industrial policy became a focus of attention. Japan was already explicitly mentioned in the Memorandum of 1967, and the aim of Community industrial policy was stated as being to enable industry to contribute as much as possible to improving overall productivity, maintaining a high level of employment and strengthening the international competitiveness of enterprises by means of measures which, on the one hand, facilitate adaptation to changing economic and technical conditions and, on the other, do not distort competition within the common market.[15] It is no coincidence that the issue of joining the techno-economic paradigmatic shift (ICT-based knowledge economy dominated by the service sector) that started in the early 1970s was also put on the agenda (*Perez 2010*).[16] Nevertheless, until the Maastricht Treaty, the policy landscape was dominated by Member States' "maverick" policies, which furthered the differentiation of integration rather than improved competitiveness at the Community level. In 1985, Karl-Heinz Narjes, Commissioner for the Internal Market,

[13] For example, in terms of the so-called Hamilton Index, which measures international competitiveness in advanced manufacturing, we see that the overall global market share of the United States in advanced industries has fallen to 6 per cent under the global average since 1995, while China's share in advanced industries is 34 per cent higher than the global average (*Atkinson 2022*).

[14] All the more so because we have only been able to talk about a common security and defence policy since 2009.

[15] See: *Mémorandum sur la politique industrielle de la Communauté = Memorandum on Community industrial policy*. SEC (67) 1201 final, 4 July 1967.

[16] On the relationship between the transition to a knowledge economy and intellectual property, see *Csath* (*2023*).

the Customs Union, Industrial Innovation, the Environment, Consumer Protection and Nuclear Safety, specifically pointed out that – despite the aid schemes of unprecedented magnitude which dedicated millions of euros to stimulating industrial projects and business development – only an ever-longer agony of uncompetitive zombie firms was achieved, as these could survive on the market thanks to the aid provided. Therefore, no innovation dynamism and productivity explosion induced by organic development occurred. Even the Single European Act of 1986 has no industrial policy mentioned. The "point of inflection" came with the Maastricht Treaty in the early 1990s, after which the restoration and cultivation of industrial competitiveness at EU level became an explicit Community objective. According to Article 173 of the Treaty, the EU's industrial policy is aimed at encouraging an environment that enables the adjustment of industry to structural changes and is favourable to SMEs by looking more closely at the aspects of general policies of innovation, research and development that are relevant to industry. Contrary to the USA, Europe could then start to converge on all common policies affecting industrial activities.[17]

Since the dawn of the new millennium, both Member States and the EU have become increasingly active in developing industrial policy. Sectoral (vertical) interventions were replaced by more targeted horizontal measures. This was mainly due to globalisation, EU enlargements, deindustrialisation, and unfavourable and sometimes anaemic growth and productivity rates which fell short of those of major competitors, such as the United States (e.g. one of the most important core integration countries, Germany, had negative real GDP growth in 2002 and 2003, and France also recorded virtually stagnant growth of only 0.8 per cent in 2003). In fact, by the mid-2000s the European Commission had come up with an integrated industrial policy at the EU level.[18] This 2005 strategy reflected on horizontal issues, accepting and building on sectoral specificities with the already well-known aim of improving the framework conditions for industrial development and policy coherence in a proactive manner.[19] The coordination exercise was

[17] This was a task set out in the 1993 White Paper *Growth, Competitiveness, Employment: The Challenges and the Ways Forward into the 21st Century. {COM(93) 700}*. https://op.europa.eu/en/publication-detail/-/publication/4e6ecfb6-471e-4108-9c7d-90cb1c3096af/language-en

[18] "*Industrial policy in an enlarged Europe*" *{COM(2002) 714}*. https://eur-lex.europa.eu/EN/legal-content/summary/industrial-policy-in-an-enlarged-europe.html; "*Some Key Issues for Europe's Competitiveness – Towards an Integrated Approach*" *{COM(2003) 704}*. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2003:0704:FIN:en:PDF; "*Fostering structural change: an industrial policy for an enlarged Europe*" *{COM(2004) 274}*. https://eur-lex.europa.eu/EN/legal-content/summary/fostering-structural-change-an-industrial-policy-for-an-enlarged-europe.html; "*Implementing the Community Lisbon Programme: A policy framework to strengthen EU manufacturing – towards a more integrated approach for industrial policy*" *{COM(2005) 474}*. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0474:FIN:en:PDF

[19] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions – "*i2010 – A European Information Society for growth and employment*" *{SEC(2005) 717}*. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52005DC0229. Downloaded: 7 September 2023.

necessary, but by no means sufficient.[20] The global financial and economic crisis of 2008 and its aftermath played a key role in governments allocating financial resources to support industry. Seeing that after the 2008 crisis the USA (*America First*), China (*Made in China 2025*) or India (*Make in India*) became determined to modernise industry through more direct state intervention, the EU also took increasingly decisive steps towards a more dedicated industrial policy. In order to maximise the impact of industrial policy, since 2008 the policy agenda has shifted to a more favourable entrepreneurial environment. A comprehensive *Small Business Act* (SBA) was launched, which drew heavily on good practice from abroad (e.g. the subobjective of giving failed businesses the chance to try again as soon as possible followed the Israeli model). To put the principles of the SBA into practice, the *Entrepreneurship 2020 Action Plan*[21] was drawn up in 2013 to reignite the entrepreneurial spirit in Europe, building on three pillars – entrepreneurial education and training; creating an environment where entrepreneurs can flourish and grow; and role models and reaching out to special groups – to act as a blueprint for improving the potential of industrial policy. All of this indicated that the EU was ready to join the reindustrialisation frenzy to tap the potential of Industry 4.0 that started in 2011. One of the flagship industrial policy programmes was *Smart Specialisation* launched in 2011 to close the innovation gap by integrating Industry 4.0 technologies into manufacturing. The European Commission spoke of the real advent of the European industrial renaissance.[22] Although the programme was a step forward, it failed to address the structural asymmetries that dominated the continent: rather, it was only able to catalyse the industrial development of the more developed regions where the conditions for specialisation were already in place, while the less developed regions continued to lag behind.[23] And all along the EU stressed in several of its communications that industry had to be strengthened to boost competitiveness, and it required intervention in a number of areas (e.g. better market conditions, improved human capital, completion of the single market, etc.).[24] This type of industrial policy, even if it benefited from significant budgetary resources (e.g. the *Competitiveness and Innovation Framework Programme 2007–2013* or the framework programme to support SMEs between

[20] See: *Korres (2007*). For example, the lack of a techno-economic paradigmatic shift is sometimes explained by the feebleness of industrial policy (for the Italian example, see *Lucchese et al. 2016*), sometimes by its absence (for the Portuguese case, see *Godinho and Mamede 2016*).

[21] https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/entrepreneurship-2020-action-plan. Downloaded: 7 September 2023

[22] *For a European Industrial Renaissance*. COM/2014/014. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52014DC0014

[23] See: *Wigger (2023*). Moreover, the results of the various convergence studies also tend to point in the direction of an opening gap between the developed world and the other regions. For a discussion of the latter, see *Gergics* (*2023*).

[24] *Industrial policy: Reinforcing competitiveness*. COM(2011) 642. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0642&from=EN; *A Stronger European Industry for Growth and Recovery*. COM(2012) 582. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0582:FIN:EN:PDF

2014 and 2020), tended to reinforce a pattern of differentiated integration, despite the best intentions. This is depressing also because the reason for the persistently worsening productivity growth trend in both the USA and the EU is not the nature of the industrial structure, which was roughly similar (*Sayed – Gordon 2019*), but rather a difference in the pace of technological change (contrary to the USA, the EU lacks the greater capacity for the diffusion of new technologies across sectors and company sizes). This implies that European industrial policy had not for a long time sought to create real interactions between the different spheres; instead, it had pursued more specific and measurable (economic) objectives one by one. Especially in the era of Industry 4.0, such an approach is needed, which is not merely focused on the return on investment.

Industrial policy ideas and strategies organised around Industry 4.0 at the supranational level have thus been largely in place in Europe since the early 2010s, while at the Member State level, only the period 2016–2019 was fruitful in this respect.[25] Strategies and programmes at the EU level, such as the 2015 *Digital Single Market Strategy,*[26] can help boost industrial competitiveness by increasing investment in ICT infrastructure and Industry 4.0 subtechnologies (e.g. cloud services, Big Data technologies) and R&D. Launched in 2016, the *Digitising European Industry Initiative*[27] has brought a sector-neutral edge to industrial policy with the objective of overall digitalisation. This is no longer just about the nearly 2 million companies in the industrial sector – which employ nearly 33 million people – but about the roughly 26 million active enterprises across the EU which employ more than 144 million people. The Communication "*Investing in a smart, innovative and sustainable Industry: A renewed EU Industrial Policy Strategy"*[28] published in 2017 was one of the first to go beyond the need to reindustrialise and to address the changes that the EU will have to face in the context of increased digitalisation and the transition to a low-carbon and circular economy. These are additional dimensions that can be addressed through Industry 4.0, and not simply a matter of progressing towards improved productivity.[29] In addition, the *Smart Specialisation Strategy* (S3) is expected to have a beneficial impact in the period 2021–2027 in that it may boost innovation-led growth in EU regions affected by

[25] Most of the programmes started between 2016 and 2019: Belgium *(Made Different*); Denmark *(Manufacturing Academy of Denmark*); France *(Industrie du Futur*); Germany *(Deutschland: Industrie 4.0*); Italy *(Impresa 4.0*); the Netherlands *(Smart Industry*); Portugal *(Indústria 4.0*); Spain *(Industria Conectada 4.0*); Czechia (*Průmysl 4.0*); Hungary *(Ipar 4.0 – National Technology Platform*); Poland *(Morawiecki Plan – Future Industry Platform*); Slovakia *(Smart Industry Platform*), etc.

[26] *Digital Single Market Strategy for Europe*. COM(2015) 192. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52015DC0192. Downloaded: 7 September 2023.

[27] https://digital-strategy.ec.europa.eu/en/library/digitising-european-industry-initiative-nutshell. Downloaded: 7 September 2023

[28] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52017DC0479&from=EN

[29] It is not simply a matter of considering the cost-price coordinate system of competitiveness *(Wigger – Horn 2018*). *Pianta et al. (2020*) also argued for the inevitability of a broader European industrial policy. For the circular economy, see *Baral et al. (2023*), and for the green economy transition, see *Javaid et al.* (*2022*).

industrial transformation, integrate regional economies into European value chains, and promote green innovation processes that respond to global environmental challenges in line with the UN Sustainable Development Goals, and should include the whole spectrum of European industry. To this end, in early February 2023, the Commission presented the *Green Deal Industrial Plan,*[30] a programme for the development of a net-zero industry (capable of producing clean technologies and environmentally friendly products). Such technologies used by industry will improve the EU's industrial competitiveness, the continent's strategic energy autonomy and the resilience of its entire energy system, while enabling the transition to clean energy (a compelling necessity brought about by the Russia-Ukraine war). The 2022 *REPowerEU*[31] plan also supports the achievement of these goals. In an effort to speed up access to finance, the *InvestEU*[32] programme also runs in the background, aiming to generate a EUR 372 billion investment wave by 2027.[33] The EU has therefore, albeit slowly, reached a point where more than a decade after the emergence of Industry 4.0, it surpassed itself in the sense that it no longer takes different, inconsistent industrial policy actions, but seeks to pursue a broader industrial policy in a more comprehensive and consistent policy framework, adapted to the challenges of our time.

4. Industrial Policy Paradoxes

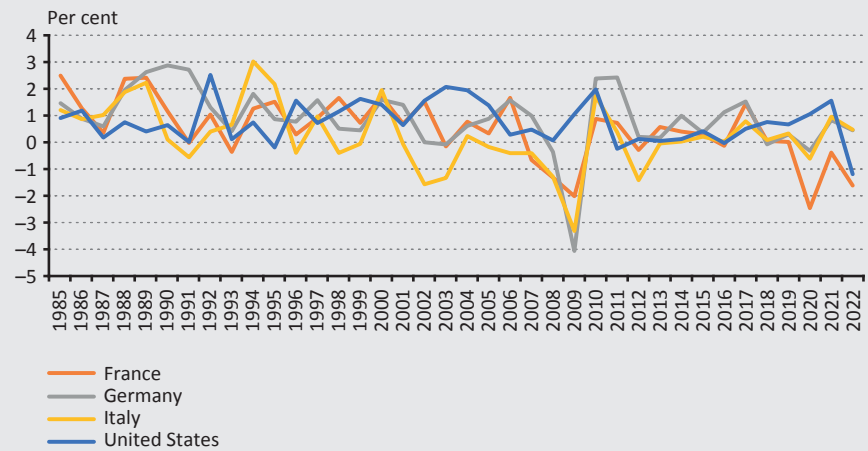
The above shows that both the USA and the European Union have been directing their industrial policies towards Industry 4.0 (and beyond) for almost a decade now. Yet at least three major industrial policy and Industry 4.0 development paradoxes can be detected, along the following lines: (i) the nature of Industry 4.0 and economic growth; (ii) industrial policy and institutional constellation; and (iii) industrial policy and fiscal policy. These paradoxes should not be ignored, if only because their existence sends a message that serious problems can arise if the state is not vigilant. Let us note that this is in fact no different from what Károly Polányi long ago explored in his pioneering work (*Polányi 1944*|*2001*), namely that technological development can be accompanied by serious socio-economic upheaval, and that countervailing mechanisms need to be worked out, and paradoxes need to be dealt with in a disciplined way. Obviously, this implicitly

[30] *A Green Deal Industrial Plan for the Net-Zero Age*. COM(2023) 62. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0062. Downloaded: 7 September 2023.
[31] https://investeu.europa.eu/investeu-and-repowereu_en. Downloaded: 7 September 2023.
[32] See: https://investeu.europa.eu/investeu-programme_en. Downloaded: 7 September 2023.
[33] However, for example, the second pillar of Horizon Europe *(Global Challenges and European Industrial Competitiveness*) will account for three quarters of SMEs' total share and two thirds of all EU contributions to SMEs between 2021 and 2022, representing around EUR 1.9 billion in support for SMEs. *Horizon Europe implementation – Key data for 2021–2022*. https://www.horizontevropa.cz/files_public/elfinder/4182/Horizon%20Europe%20Implementation%202021-2022%20-%20Key%20figures%20v2.pdf

means that the state also needs to improve its own innovativeness, as *Kovács* (*2023*) argues.

First, since 2011, we all expected[34] that the industrial revolution would ultimately lead to higher, greener and more inclusive economic growth, but none of these things have happened. The secularly deteriorating trend in productivity growth rates has not been reversed since 2011 and set on an upward path, neither in the EU core countries nor in the USA. The total factor productivity of even the most productive manufacturing firms is also on a downward path (*Figure 1*).[35]

Figure 1
Evolution of multifactor productivity for the USA and some selected EU core countries between 1985–2022



Source: OECD.Stat

According to a very important finding of *Tibor Erdős* (*2006*), an internationally renowned researcher of the nature of economic growth, (qualitative) change in the structure of production is continuous: it is sometimes faster, sometimes slower, and sometimes really spectacular. The latter is an era of techno-economic paradigmatic shift, including the ongoing Industry 4.0 and digitalisation. Erdős concludes that new industries can expect a rapidly expanding market because labour demand is rising at a quick pace and wages can be relatively high, which in turn requires accelerated

[34] The term Industry 4.0 was first used at the 2011 Hannover Industrial Technology Fair.
[35] See: https://www.hcamag.com/us/specialization/employee-engagement/worker-productivity-now-at-lowest-in-75-years-report/445147. Downloaded: 7 September 2023. Whether we look at manufacturing or the broader industrial sector, in the European Union we see that the periodic percentage change in hourly real labour productivity shows a downward trend over the period 1995–2022. See: *Eurostat (NAMA_10_LP_A21*).

technical development. By contrast, the reality reflected in productivity statistics is that the use and diffusion of Industry 4.0 has not yet reached a level that would allow the rehabilitation of productivity dynamics. In their analysis of 300,000 US firms, *Acemoglu et al.* (*2023*) found that about half of the US firms in the sample did not use any Industry 4.0-related technology between 2016 and 2018, but the FDI and Covid-19-focused analysis by *Kalotay and Sass* (*2021*), for example, also points to a slowdown in Europe, including the Visegrad countries.

In the context of green growth, it is important to recognise that since Industry 4.0 set out to conquer the world in 2011, greenhouse gas emissions have stagnated, with a moderate decline in EU core countries starting in 2019, in sync with the economic slowdown caused by Covid-19 (*Campos – Macchiarelli 2021*). The illusory nature of greening expectations is confirmed by the fact that primary energy consumption (in million tonnes of oil equivalent) is stagnating in both the USA and the EU core countries. Moreover, greenhouse gas emissions from industrial processes also fail to show any significant reduction.[36] Nor has there been any notable progress on the dimension of inclusiveness. If we only take the OECD definition of inclusive growth as economic growth that is evenly distributed across society and offers opportunities for all to make a value-creating and valuable contribution, we see that inequality in most OECD countries is at its highest in 30 years and has been exacerbated by the Covid-19 crisis. Wealth inequality is systematically increasing. Based on the last data for the 2010 decade (see *Table 1*), approximately 80 per cent of the total wealth held by US households was owned by the richest 10 per cent of households. The European figures are lower, but in many cases they are still above the OECD average (52 per cent) (Germany: 55 per cent, Denmark: 62 per cent, Austria: 56 per cent, the Netherlands: 63 per cent, etc.).

[36] *European Union emission inventory report 1990–2021*. EEA Report No 4/2023. https://www.eea.europa.eu/publications/european-union-emissions-inventory-report-1990-2021/download

Table 1
The share of certain groups in the total net wealth of households (2017 or last data for the 2010 decade, OECD countries)

	Bottom 20% (%)	Bottom 40% (%)	Top 10% (%)	Top 5% (%)	Top 1% (%)
Australia**	0	4	49	35	16
Austria	0	1	56	43	23
Belgium	0	4	47	35	16
Canada***	0	3	51	37	18
Denmark***	–7	–7	62	46	23
Estonia	0	3	58	45	25
Finland*	–1	2	47	33	14
France	0	2	49	36	17
Germany	–1	1	55	41	19
Greece**	–1	4	41	27	9
Hungary	1	5	51	39	20
Ireland**	0	3	50	36	15
Italy*	0	5	43	30	12
Japan***	–2	1	47	33	13
Latvia	0	3	52	39	19
Lithuania*	2	9	48	36	15
Luxembourg**	0	4	50	38	20
The Netherlands***	–3	–2	63	49	27
Norway**	–4	–3	54	41	23
Poland*	1	8	41	30	14
Portugal**	0	4	54	42	23
Slovak Republic	2	9	41	29	12
Slovenia	0	6	44	32	15
Spain**	0	4	53	40	20
United Kingdom	0	4	52	40	23
United States***	–1	0	79	68	40
OECD**	–1	3	52	38	19

*Note: Net wealth refers to financial and non-financial assets minus liabilities held by private households. * 2016, ** 2018 and *** 2019.*

Source: OECD Wealth Distribution Database (WDD) (https://www.oecd.org/els/soc/WDD-Key-Indicators.xlsx)

The widening gap further erodes trust in that it restrains and prevents social mobility. Currently, it takes roughly 5 generations until a child born into a low-income family in the USA can ascend to the middle class, but EU countries are not doing any better.[37] Those in the lowest income quintile or the highest income quintile of the working-age population were unable to change their position for four years. If we add to this that the advances in Industry 4.0 technologies, especially automation, are accompanied by a reduction in the employed workforce (*Acemoglu et al. 2023*), we can say that deteriorating inclusiveness is a concomitant of the socio-economic innovation ecosystem of our time, which can inflict severe wounds on political stability, aiding the rise of populism (*Gozgor 2022*).

Second, the experience of the USA and the EU highlights that it does matter what institutional architecture industrial policy is embedded in. Our thesis on the paradoxical situation of the United States can be summarised as follows: despite the apparent obstacles posed by the US institutional structure (federalism), it is a hotbed of industrial policy learning and thus a foundation for innovation dynamism; on the other hand, it is also a background mechanism causing social inequalities in the longer term. It is true that the formal institutional architecture of the United States, one of the most decentralised economies, in principle makes any form of national industrial policy fragmented and therefore difficult to coordinate, so a high degree of decentralisation and industrial policy are therefore, theoretically, on quite unfriendly terms. A high degree of decentralisation, on the other hand, enables more experimentation in tackling certain challenges at the local level, the lessons of which can be shared (parallel learning) for faster and more efficient knowledge diffusion, which in turn is beneficial for innovation dynamics and the common good. The innovation dynamics generated by such an institutional constellation may lead to the reinforcement of one of the specific features of capitalism, namely income and wealth inequalities which could undermine social confidence in economic governance, including the effectiveness of industrial policy, and thus give rise to political instability. Compared to Europe, which tends to stagnate or improve in terms of income inequality, US statistics show an almost continuous deterioration (e.g. the Gini coefficient was 35.2 in 1980, 40.2 during the 2008 crisis, and 41.5 in 2019 at the onset of the Covid-19 crisis compared to an average of 31.6 in 1990, 30.4 in 2008, and 29.9 in 2019 for the European core countries of Austria, Belgium, the Netherlands and Germany).[38] Thus, the EU pays the price for its socio-economic and institutional configuration in which its welfare system ensures lower income and wealth inequality relative to the USA with falling behind in the technology competition, innovation dynamics that are worse

[37] E.g. Austria (5), Germany (6), France (6), etc. (*OECD 2018*).
[38] World Bank data, or *Milanovic* (*2018*).

than its competitors' and its diverging productivity.[39] It is therefore not surprising that the experience of comprehensive or regional EU projects related to Industry 4.0 is that the level of adoption of Industry 4.0 technologies is still modest.[40] Nonetheless, the EU also shows a high degree of heterogeneity in industrial policy, and it is not possible, nor even necessary, to think in terms of a single industrial policy concept.[41] The institutional architectures of the EU Member States show a heterogeneous picture: the highest degree of (federal) decentralisation is found in Belgium, Germany and Spain; they are followed by Finland, Italy and Austria, where the institutional setup is more unitary or quasi-federal, even though the degree of decentralisation is also remarkable; then come Denmark and Sweden with a medium degree of decentralisation; and then the countries with an increasingly centralised institutional architecture: Czechia, Poland, Croatia, Portugal, France, the Netherlands, Hungary, Greece, Slovakia and Romania.[42] Despite a series of national but rather uncoordinated industrial policy programmes in the Member States, there is a very telling divide with regard to Industry 4.0. *Castelo-Branco et al.* (*2023*) showed that when looking at only three aspects (Industry 4.0 infrastructure; Industry 4.0 applications; Big Data analytics), Denmark, Finland, the Netherlands and Sweden stand out from the EU average in the first two areas, while in Big Data analytics, France and Luxembourg also perform above the EU average, while the rest of the EU is well below the EU average, despite their more centralised institutional systems (e.g. Bulgaria, Hungary and Greece). This suggests that *progress in Industry 4.0 is greater where industrial policy is run in an institutional constellation that is more supportive of learning capacity, and where the focus of industrial policy is not only on increasing productivity but also on achieving more inclusive and greener quality growth*.[43] A conclusion similar to that of *Johnson and Acemoglu* (*2023*) can be drawn, namely that progress is most dramatic where there has been a conscious effort to distribute the gains from technological progress more equitably. This leads us to the area of good governance, the possibility of which is influenced by the question of how well the formal institutions (reviewed above) are in harmony with the informal institutions (culture, norms, etc.). Undoubtedly, this harmony takes

[39] For example, the combination of social transfers and income taxes reduces the Gini coefficient by just over 20 per cent. See: *Fischer – Strauss (2021*).

[40] See the experience of the 4STEPS project that run from 2019 to 2022: https://programme2014-20.interreg-central.eu/Content.Node/4STEPS.html. Downloaded: 7 September 2023.

[41] *Domonkos and Kovács (forthcoming*) use economic history to point out that the FDI-dependent and labour-constrained growth model for the Visegrad countries offers the prospect of uncertain reindustrialisation, as decisions on Industry 4.0 development projects in these countries are more likely to be made abroad. But even after German reunification, there was still a significant degree of path dependency (*Kovács – Orosz 2011*) in the EU's growth engine economy where it is also not possible to pursue a homogeneous industrial policy, as most of the so-called hidden champions (mostly medium-sized family businesses which are front-runners in their respective segments in Europe) are concentrated in West German regions (*Simon 2022*).

[42] European Commission, *Division of Powers* database: https://portal.cor.europa.eu/divisionpowers/Pages/Decentralization-Index.aspx#. Downloaded: 7 September 2023.

[43] *Tagliapietra and Veugelers* (*2020*) show, through the case of Denmark, the Netherlands or Sweden, that an industrial policy with a green focus requires the involvement of a wide range of actors of society, and thus catalyses more inclusive development.

a long time to develop, and any major change that disrupts it (e.g. technological progress through Industry 4.0) can only hint at slower progress.[44]

Thirdly, the case of the USA and the EU highlights another contradiction, namely that industrial policy efforts have not been able to deliver breakthrough results, not even in an era of abundant liquidity and cheap capital. But it also suggests that, as Industry 4.0 development projects require significant initial investment – which only large companies can afford – the fiscal policy of the state must also line up behind industrial policy in order to promote the spread of Industry 4.0.[45] The OECD trend is for the cost of capital to fall (lower corporate tax burden, lower interest rate trend), yet the business investment rate followed an almost stagnant trend between 2000 and 2020 (*Hanappi et al. 2023*). The state therefore has (or has had) to compensate for the capital projects and the aid granted for them which has (or has had) the effect of overburdening public finances. The average debt ratio of OECD countries rose from 69.2 per cent in the early 2010s to 89.2 per cent in 2021, while the average debt ratio of the United States doubled between 2000 and 2022 (from 72 per cent in 2000 to 144 per cent in 2022), while the average debt ratio of the European Union climbed from 66.4 per cent in 2000 to 84 per cent at the end of 2022. One could say that in the developed part of the world economy, it is not necessarily public debt that is to be feared today (but rather political ambitions that use debt for one purpose or another, as such decisions may worsen the fiscal stress tolerance of foreign investors); nevertheless, reasonable steps should be taken to alleviate the excessive burden carried by the state for it to be able to support the transition to Industry 4.0 in a sustainable way.[46] The latter, however, suggests a systemic problem, namely that the financial system has more or less ceased to play its role as an effective intermediary for the real economy (for example, in the context of the Industry 4.0 mission). Therefore, in order to develop an industrial policy, the state must also do something about the financial system because what we thought was the immune system of the economy through the work of Nobel Prize winners *Ben S. Bernanke, Douglas W. Diamond* and *Philip H. Dybvig* (see

[44] Informal institutions also have a role to play in the roll-out of Industry 4.0. As *William F. Ogburn* (*1922*|*1964*) warned in his classic work, culture resists change.

[45] The durability of the current bloated inflation induced by the post-Covid era and war is doubtful, so a period of low interest rates could re-emerge (*Blanchard 2023*); moreover, the relative room for manoeuvre for fiscal policy could retain its focus on climate change, on moving towards the sustainable development of economies, also because, for example, in developed economies, debt growth has so far had no impact on inflation expectations. On the latter, see: *Brandao-Marques et al.* (*2023*). The various debt trajectory studies also tend to predict manageable or even declining trends (*Baksay – P. Kiss 2023*).

[46] Between 2019 and 2021, OECD countries still did not spend much (around 3 per cent of total industrial policy support and tax incentives) on promoting the digital transition (a corollary of Industry 4.0). See: *OECD* (*2023*).

Világi 2023), turns out to be more of an autoimmune system today.[47] This essay can only superficially suggest that the harmony between the financial system and the real economy has been broken to the extent that investors have increasingly turned away from riskier and longer-term real economic investment projects; and therefore the old ordoliberal view that industrial policy can only work as long as its application can improve the conditions of competition; as long as it can adjust the price mechanism so that prices better reflect scarcity; and as long as the system is willing to make investments for the longer term, is no longer fully valid.[48] In other words, if industrial policy wants to make a future-oriented and sustainable medium and longer-term Industry 4.0 feasible in a self-organising structure that is also supported by an efficient financial system, then the expanding financial universe must be re-regulated. Curbing the overexpansion of the transnational financial system brings us back to the need for an institutional constellation that allows for centralisation in this respect, but provides a more decentralised framework for industrial policy.

5. Conclusion

This paper provides, perhaps, sufficient ammunition to conclude that *industrial policy is a set of multidimensional instruments and regulations that promote (or inhibit, for that matter) structural change when a qualitatively new configuration of the socio-economic system emerges*. Today's industrial policy must take a very complex approach: it must use and manage various (supply-side, demand-side, regulatory, etc.) instruments – at times top-down, at times bottom-up – while balancing different approaches and building on the smart involvement of a changing and diverse range of actors for it to be able to take part in the coordination of diverging objectives such as boosting economic efficiency, global decarbonisation

[47] A financial system freed from the shackles of strict rules and unleashed has long been thought to be the foundation of long-term economic growth. But as it expanded, it left its traditional role behind. This is what OECD statistics tell. The added value of the financial sector within GDP was 5 per cent and 4.5 per cent in the 1980s in the USA and the euro area countries, respectively, but by 2010 it had risen to 8 per cent and 6 per cent, respectively; since the 1970s, the share of loans granted by banks and other financial intermediaries within GDP has grown significantly (from 90 per cent in the USA in 1980 to around 200 per cent in 2010, and from 60 per cent to close to 150 per cent in the euro area), and the sector became primarily self-sustaining, supporting the real economy to an ever lessening degree as it began to favour investments that promised high returns in the short term. This is confirmed by the substantial increase in the buyback of shares, i.e. companies are forced to raise their share prices gradually because real economy processes are no longer sufficient; or by the global frenzy to save (decline in real economy orientation, proliferation of non-production areas). The impact of this is reflected in weaker average real GDP growth between 2005 and 2020 compared to the 1985–2000 period; a deteriorating trend in market entry rates across OECD countries (see *OECD DynEmp3*); and a widening gap between the productivity of leading companies and companies lagging behind (see *Andrews et al. 2016*).

[48] Unfortunately, the latter is no longer the case (as indicated, for example, by the EU KLEMS database or *Ranaldi and Milanovic* (*2022*): labour income share is declining secularly, while capital income share is increasing). It is therefore appropriate, for example, to force banks to write down losses, to reduce leverage – as suggested by *Mérő* (*2023*) – or to launch a reform of insolvency/bankruptcy regimes. In short, restoring the symmetry between the financial universe and the real economy also demands the introduction of governance to the financial sphere to better serve a sustainable Industry 4.0 transformation.

or strategic autonomy. For this reason, industrial policy is a particularly important cog in the economic policy machine that works to build resilience.

In addition to demonstrating the mutual catalysis of industrial policies between the two continents, this industrial policy overview of the United States and Europe offers three lessons that can help both the domestic and international community of economists and politicians responsible for the economy to better understand the magnitude of the Industry 4.0 challenge.

First, we are living in an age of epochal challenges (geopolitical competition, supply shocks brought about by Covid-19, surging inflation, overburdened states, etc.) that have suspended the validity of old-fashioned evidence on industrial policy (for example, that governments rarely know better than the market which technologies will be successful, and often make efforts to reach goals that have nothing to do with the development of the given industry). Governments everywhere are therefore keeping a watchful eye on the pace of industrial development. Both US and European industrial policy is driven by the dual technological-economic transition (green and digital economy). There is a degree of alignment between the USA and the EU in terms of industrial policy missions, but there is also divergence of implementation and particularities. More importantly, this divergence will remain institutionally wired in the future, affecting the time needed for Industry 4.0 to show more spectacular success.

Second, the techno-economic paradigmatic shifts mean that the observation of *Károly Polányi*, quoted above, that the pattern of capitalism's dynamics is essentially determined by different political cycles, one representing *laissez-faire*, and the other more strongly focused on reinforcing the social welfare safety net, remains valid. Two things follow from this concerning the nature of industrial policy: (i) economic governance is on a more secure footing if industrial policy is seen as a policy matrix with moving targets (missions), whose direction and instruments change dynamically over time; and (ii) industrial policy must have a long-term framework, but keep the horizon of its actions predominantly on the short term, i.e. impulsiveness is key to avoiding cultural capture of subsidies and preventing counter-incentives for companies.

Third, the existence of industrial policy paradoxes leads to at least four insights: (i) industrial policy should not be applied for the sake of industry, to rehabilitate the dominant position of the classical conception of competitiveness, but should also actively serve to prioritise areas beyond the pure economic dimension; (ii) paradoxically, industrial policy seems to be more successful when the institutional system of the economy is relatively more decentralised so that the more centralised aspects of industrial policy can open the way to quicker learning about and thus the diffusion of Industry 4.0 by weakening and possibly eliminating systemic counter-

incentives. Excessive decentralisation leaves the underlying distortions of the system (e.g. a financial universe that extends beyond the real economy) intact, and thus reinforces the *status quo*, which is dead-end development in terms of the evolution of the socio-economic system; with full centralisation, local autonomy, initiative, more innovative learning, the possibility of interactions disappear, which will lead to slowing or stagnating innovation dynamics; (iii) industrial policy must also take into account the configuration of the complex ecosystem of socio-economic innovation (e.g. industrial policy without restoring the broken symmetry between the financial system and the real economy can only lead to the overburdening of the state); and (iv) the modernisation of industrial policy requires that the public sector also becomes more innovative, as there needs to be more room for creative, adaptive and exploratory (experimentation) capabilities to flourish also within the public sector in order to talk about a public sector that catalyses industrial policy. Obviously, an inventory of aid policy instruments that enhances transparency must be produced.

Overall, neither greening nor digitalisation can succeed if they fuel social tensions that undermine social trust and thus political stability, and, ultimately, the state's ability to act. The complexity of the socio-economic system should be respected, i.e. an industrial policy that seeks to meet the requirements of political stability, economic feasibility and social acceptability should be preferred over one that shaped by constantly optimising and therefore interventionist economic governance. This is more likely to happen if industrial policy is carefully and slowly developed responding to the global megatrends that permeate daily life in our modern global economy and whose effective management calls for a complex public policy approach, in which industrial policy must play a significant role on several fronts (increasing energy efficiency as required by climate change; new employment challenges brought about by migration; mitigating inequality and strengthening social cohesion, etc.). Only this kind of disciplined approach to industrial policy can be resilience-driven, the outcome of which is really worth waiting for. As the Latin proverb says: *respice finem*!

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How Major Central Banks Reacted to the Inflationary Wave of the Early 2020s – The Case of the ECB*

Ruben Durkó

From 2021 onwards, inflationary pressures around the world have forced most central banks to raise interest rates from a level that had long been around 0 per cent. However, some central banks, including the European Central Bank (ECB), have often been the subject of criticism for not paying enough attention to the emerging inflationary spiral. The author examines whether there is evidence that the ECB started to tighten monetary conditions later than it had done in the past. The interest rate rule widely applied by the academic community and the results of the pseudo-forecast based on this rule show that the ECB moved later than its historical behaviour would suggest, i.e. it started tightening three quarters later than indicated in the model; nevertheless, by the end of 2022, the actual and the theoretical rates were in line thanks to the intensive rate hikes.

Journal of Economic Literature (JEL) codes: E31, E52, E43, E47

Keywords: inflation, monetary policy, euro area, interest rate rule

1. Introduction

After two decades of low, stable inflation, the coronavirus pandemic put the world under extreme price pressure from 2021 onwards (*Hardig et al. 2023*). Inflation in most developed countries rose to levels not seen for decades, while interest rates were slow to follow the surge (for the euro area, see *Figure 1*). The sudden change in the environment due to the pandemic and an uncertain future posed a major challenge for governments and central banks around the world, which announced ambitious stimulus packages to help the economy starting from spring 2020 (*Fenz and Valderrama 2023*). Partly thanks to the extensive fiscal stimulus, partly to vaccinations and thus the easing of the pandemic, developed economies have recovered unexpectedly quickly. The extra income injected into the economy

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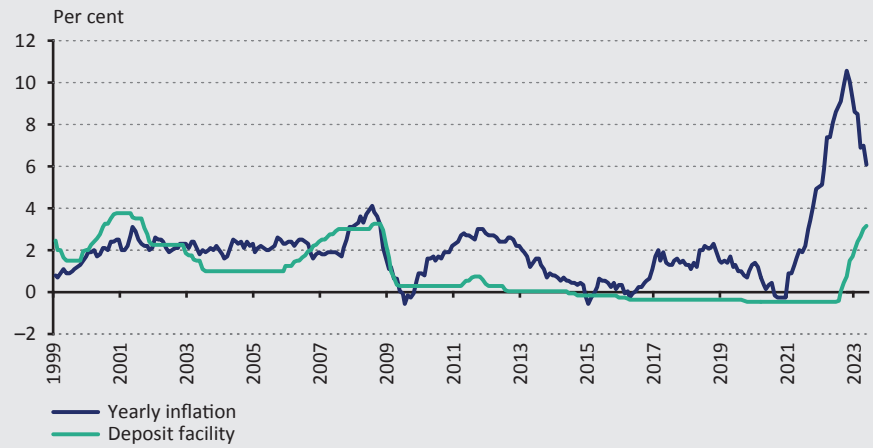
translated into a rise in demand, which may have contributed significantly to the higher inflation (*Cochrane 2022*).

Figure 1
Yearly inflation and deposit facility in the euro area



Source: Eurostat, FRED

In contrast to the rise in demand, there was a severe drop on the supply side due to fragmentation in global value chains. Excess demand was the result of stimulative monetary and fiscal policies, on the one hand, while households started to use up their previously accumulated forced savings during this period, on the other (*Ascari et al. 2023*). In addition, consumption shifted from services to goods with stronger demand for food, consumer durables, semiconductors, raw materials and energy (*Fenz and Valderrama 2023*). Demand for many products boomed when supply was the weakest. China's prolonged zero Covid policy further exacerbated the supply chain situation (because of its dominant role), and the Russia-Ukraine war that broke out in February 2022 worsened food and energy inflation (*Kryvtsov et al. 2023*). The increase in producer prices was easily passed on to consumer prices because high demand was able to absorb it (*Ascari et al. 2023*). The rise in inflation was initially triggered by external factors, but its persistence led to inflationary pressure spreading to more and more segments of the consumer basket (*Várnai 2022*).

Besides inflation, inflation expectations also started to move on an upward path from 2021 onwards, and this already called for central bank intervention (*Kryvtsov et al. 2023*). Most central banks around the world reacted quite similarly to the inflationary pressures that emerged in 2021: at first, practically all authorities disregarded them, leaving their monetary policy unchanged (*Beaudry et al. 2022*). With anchored expectations, a change in interest rates in response to a temporary price shock may take its toll on the real economy; hence, it does no good when

central banks react to temporary surges if a credible monetary policy is pursued (*Ábel et al. 2014*). However, if inflation expectations are not rational, it is no longer optimal for the central bank to disregard mounting inflation; instead, it should take action to influence the inflation expectations of economic agents (*Beaudry et al. 2022*). The Magyar Nemzeti Bank (MNB, the central bank of Hungary) was the first central bank in Europe to initiate its rate-hiking cycle in June 2021.

Starting from 2021, an increasing number of central banks have come under fire for having been too slow to act as they believed for too long that the increases in inflation were temporary. Notably, the Federal Reserve (Fed) and the European Central Bank were the main focus of attention, since – due to their size – they play a key role in shaping international monetary policy. Both of these central banks left their monetary conditions unchanged for a long time, citing the temporary nature of the surge in inflation and uncertainties in the macroeconomic environment. Of the two, the Fed was the first to start normalising its monetary policy, as considering the extraordinary size of the government package, it made more sense to talk about inflationary pressures sparked by demand in the US (*Cochrane 2022*).

The ECB started tightening its monetary policy later than the other major central banks (such as the Fed or the Bank of England) and therefore drew even more criticism. (See, for example, *Koranyi and Meier 2022*,[1] *Nair 2022*,[2] *Böhme 2022*[3] or *Brzeski 2022*).[4] In its communication, the ECB long emphasised the temporary nature and external inflation factors. But as inflation continued to rise and new shocks made it increasingly clear that more persistent inflationary trends were occurring, the central bank also began its tightening cycle *(Fenz and Valderrama 2023)*. Later, ECB Vice-President Luis de Guindos also admitted that the central bank had underestimated inflation (*ECB 2023*).[5]

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[1] "Some economists argued that the ECB was already too late in tacking inflation so raising rates to the neutral level (...) will not be enough. 'The ECB remains behind the curve' Commerzbank chief economist Jörg Krämer said. 'It is not enough to just take its foot off the gas, it must also step on the brakes' Krämer said. The ECB's first rate hike in over a decade will still leave it trailing most of its global peers, including the U.S. Federal Reserve and the Bank of England." – *Koranyi and Meier* (*2022*): *paragraphs 17–20.*

[2] "All but one of the 63 economists polled July 8-15 expected the ECB to stick to its pre-committed quarter-point rise on Thursday. (…) But a majority of respondents to an extra question, 19 out of 35, said the ECB should abandon its negative interest rates policy now with a 50 basis point hike. (...) 'The ECB is far behind the curve and risks losing its credibility by not taking decisive action... It should rapidly abandon negative interest rates in July and then increase policy rates by another 50 basis points in September and October' said Martin Weder, senior economist at ZKB." – *Nair* (*2022*): *paragraphs 3–4 and 9.*

[3] "In the end, the pressure on the European Central Bank (ECB) became too great for its policymakers; they could no longer ignore skyrocketing inflation rates in the euro area and dismiss them as "a temporary phenomenon," as ECB President Christine Lagarde said as recently as in December." – *Böhme* (*2022*): *paragraph 2.*

[4] "Today's rate hike provides further evidence of the extreme paradigm change at the ECB. A year ago, ECB president Christine Lagarde said at a press conference that "the lady is not tapering". Now, the ECB has conducted the most aggressive rate hikes in its history, despite a war in Europe. (...) The current ECB, however, has woken up very late to the fact that even if inflation is driven by supply-side factors, too high inflation for too long can damage a central bank's credibility and plant the seeds for unwarranted second-round effects." – *Brzeski* (*2022*): *paragraph 6.*

[5] "Central banks and many other organisations believed for a long time that the increase in inflation was temporary. I have to admit: that was a mistake, but the level of uncertainty was enormous. We all underestimated the persistence of inflation." – *ECB* (*2023*): *paragraph 10.*

With the help of models, I examine the topical issue of whether the view that the ECB started monetary tightening amidst the inflationary pressures of the 2020s later than it had done in the past is correct. To do so, I first estimate interest rate rules of different specifications for the ECB with the OLS method, and then use the results to determine how to interpret the ECB's interest rate policy since the coronavirus pandemic. Do these results show that the ECB acted later than had been customary of it in the past in order to curb inflation? I use the models above to run a pseudo-forecast for the last quarters to obtain an objective, data-based assessment to support my answer.

In *Section 2*, I review the literature to gain an insight into some common interest rate rules derived from the Taylor rule. In *Section 3*, I present the data used for this research, and in *Section 4*, I review the calculations made with the data and the interpretation of the results. Finally, I draw the conclusions.

2. Literature review

In the 1980s, the world experienced extreme inflationary pressures, and thus identifying what factors can help to achieve stable inflation became a common research topic (*Owusu 2020*). In addition, the factors influencing central bank decisions also came to be the subject of examination. In general, monetary policy decisions can be grouped into two broad categories: ad hoc decisions and rule-driven decisions (*Hidi 2006*). With ad hoc decisions, central banks always decide on monetary policy on the basis of newly available data, invoking the data-dependent approach. For rule-driven decisions, a so-called reaction function can be set up to describe the general behaviour of central banks.

One possible course of reaction functions is the simple interest rate rule. It describes how central banks react to changes in the various macroeconomic variables or, to put it another way, how monetary authorities should react (*Owusu 2020*). Typically, most central banks do not explicitly follow any decision model, so the interest rate rules defined by economists can at best be approximations, but in some cases one can find very accurate reaction functions that can provide useful information. Moreover, it is important to stress that the interest rate rule is never a strict constraint, as there are many phenomena that can occur in the economy which are difficult to quantify and thus cannot be compressed into a simple reaction function (*Hidi 2006*). To sum up, the strength of interest rate rules is that they explain the evolution of interest rates in a simple and transparent way and serve as a good guiding principle. However, as with all models, simplifications have to be made, and the suggestions should therefore be treated with careful consideration.

2.1. The Taylor rule

The most common interest rate rule used in academic literature was created by John Taylor in 1993. In his research, Taylor found that the US short-term nominal policy rate (Federal Funds Rate) over the period 1987 to 1992 could be described quite well by the inflation and output gaps *(Taylor 1993)*. Furthermore, he complemented his model with the equilibrium real interest rate, which then took the following form:

$$i_t = r^* + \pi_t + 0{,}5 * (\pi_t - \pi^*) + 0{,}5 * (y_t - y_t^*), \quad (1)$$

where i_t is the nominal policy rate for a given period, r^* is the equilibrium real interest rate, π_t is the actual rate of inflation for a given period, π^* is the central bank's inflation target, y_t is output, and y_t^* is the theoretical potential output for a given t period (*Sauer and Sturm 2007*). Since the Taylor rule includes both inflation and output gaps, it reflects the classic economic policy trade-off between low inflation and economic growth. By its very design, it can be used to examine both demand and supply shocks in a transparent and simple way. However, it is important to stress that Taylor himself warned that the reaction function he estimated was not a rule to be followed mechanically, but rather a guiding principle for monetary policy (*Regős 2013*). The interest rate rule can not only help central banks with their decision-making; it can also make monetary policy actions more transparent to private economic agents (*Owusu 2020*).

By regrouping the members of the original formula as follows, we get the form below which is more widespread in academic literature and is used as reference from here on in this paper:

$$i_t = (r^* + \pi^*) + 1{,}5 * (\pi_t - \pi^*) + 0{,}5 * (y_t - y_t^*). \quad (2)$$

The Taylor rule can be interpreted in two ways. First, it connects the monetary policy stance with real variables, i.e. it establishes a link between the considerations and the regularities in accordance with which monetary policy decides on interest rates and the potential reaction of central banks to changes in macroeconomic fundamentals (*Abaligeti et al. 2018*). Second, the model can be used to determine whether the current interest rate is lower or higher than the theoretical rate, i.e. if a given central bank pursues a looser or tighter monetary policy based on the macroeconomic fundamentals (*Hidi 2006*).

2.2. Common interest rate rules derived from the Taylor rule

Since Taylor's 1993 paper, a number of modifications to the Taylor rule have been proposed with the aim of capturing the monetary policy stance of central banks more precisely and comprehensively (*Belke and Klose 2011*). Today, most models

are supplemented with projections, are based on real-time data and/or include an interest rate smoothing parameter (see the rest of this section for details). In addition, other variables may also be relevant for the estimation, such as exchange rate, foreign reference rate or changes in money supply (*Owusu 2020*). Furthermore, if we want to estimate the interest rate rule of a small open economy, the model may best be complemented by foreign trade variables or the risk premium (see e.g. *Hidi 2006* or *Regős 2013*).

Examining *equations (1) and (2)*, we see that the original Taylor rule has only present-time members and no forward-looking variables. However, according to the standard practice of central banks, policymakers place at least as much emphasis on the projected data as on the historically observed data. Monetary policy has some inertia because, due to the nature of monetary transmission, central bank decisions typically have a delayed impact on the economy (*Owusu 2020*). So, if a monetary authority were to rely exclusively on present and past data, it would be constantly lagging behind reality on account of this inertia, and would thus tend to make inappropriate decisions (*Belke and Klose 2011*).

Considering the above, it is worth adding expectations to the original Taylor rule (*Svensson 2003* or *Clarida et al. 1998*). If, instead of actual figures, projections are used, the original equation takes the following form:

$$i_t = (r^* + \pi^*) + \beta_\pi * \left[E\left(\pi_{t+j} \middle| \Omega_t\right) - \pi^* \right] + \beta_y * (y_t - y_t^*), \qquad (3)$$

where $E\left(\pi_{t+j} \middle| \Omega_t\right)$ is the predicted value of inflation j later based on the set of information (Ω_t) available in the period t. The literature contains not only inflation forecasts but also output forecasts; however, this paper focuses only on inflation forecasts. One possible way to improve this research would be to use output gap projections in the estimation.

The interest rate smoothing parameter is also regarded as a standard addition. Historically, central bankers have tended to be reluctant to take big interest rate decisions abruptly, as unpredictability can cause considerable turbulence (*Sauer and Sturm 2007*). For example, even if the interest rate rule or macroeconomic conditions warrant a drastic increase in interest rates at once, central banks typically prefer to do so in smaller steps to ensure predictability. Interest rates have therefore a certain stickiness or persistence, which is why an interest rate smoothing parameter, as one of the most ordinary extensions of the Taylor rule, should be added to the original reaction function (*Gorter et al. 2008*). Technically, this means that the model will converge towards the rate of the previous period with some weight (λ), and will prevent it from freely adjusting to the level justified by the

model. Where an interest rate smoothing parameter is included in the reaction function, the original equation changes as follows:

$$i_t = \lambda * i_{t-1} + (1 - \lambda) * \left[(r^* + \pi^*) + \beta_\pi * (\pi_t - \pi^*) + \beta_y * (y_t - y_t^*)\right]. \quad (4)$$

Predictability is not the only reason though why the use of the interest rate smoothing parameter can give us a picture that is closer to reality: in the case of an economic shock, not even central banks have a perfect set of information at their disposal; hence, they tend to modify interest rates cautiously and hold off to avoid causing more trouble (*Owusu 2020*).

The literature distinguishes between real-time data (available at the time of the decision) and ex-post data (*Sauer and Sturm 2007*). Macroeconomic data are usually only available with some delay; for example, when a quarter ends, the GDP data for that quarter will only be known 1.5 to 2 months later, which means that central banks cannot use such data to guide their decision. Furthermore, data are revised periodically, for instance, because of a previous error, new information or seasonality. Statistical offices may also revise their estimation method from time to time; hence, data can change retrospectively in response to the modified methodology. It should be noted, however, that these ex-post adjustments do not always represent a significant difference relative to the previous data.

The use of real-time data only is another option that could make the estimation of the Taylor rule more realistic. The above considerations imply that the data series available when a central bank decides on interest rates do not necessarily correspond to the actual statistics at the time. For this reason, it may be useful to include in the model only (real-time) data that were actually available to the central bank at the time of the decision (*Belke and Klose 2011*). This way, we can better simulate the circumstances of a given central bank decision.

3. Presentation of the data used in the research

Based on the considerations presented in the introduction, different interest rate rules can be calculated for the ECB which will later help us understand the interest rate policy the central bank followed from 2020 onwards. The research uses quarterly data and its time horizon extends from 1999 Q2 to 2022 Q4, covering a total of 95 observations.

The literature review above cited an argument that real-time data make the estimation of the interest rate rule more realistic. However, this approach is applied here with limited scope due to the assumption that it only changes the values minimally, and the ex-post data reflect the underlying economic processes in an

unbiased way. Nevertheless, one possible way to improve this research is to produce estimates using only real-time data, as this would make the results more reliable.

- *Output gap* ($y_t - y_t^*$) – The output gap is the difference between actual GDP and potential output expressed as a percentage. The European Commission gives an annual frequency estimate of potential output for the euro area using a production function, which is published in its *AMECO* database alongside actual GDP (*Havik et al. 2014*). Annual frequency data can be easily converted to quarterly frequency data by linear interpolation, and the difference of the logarithms of the two data series is the output gap.

  This research was based on the assumption that the information obtained from the output gap in period *t* can be used by the central bank when deciding on interest rates in period *t*. Although at the end of a quarter we do not yet know the actual data for the quarter concerned, high-frequency business cycle indicators (such as the Purchasing Managers' Index) can provide central banks with a good approximation of GDP trends.

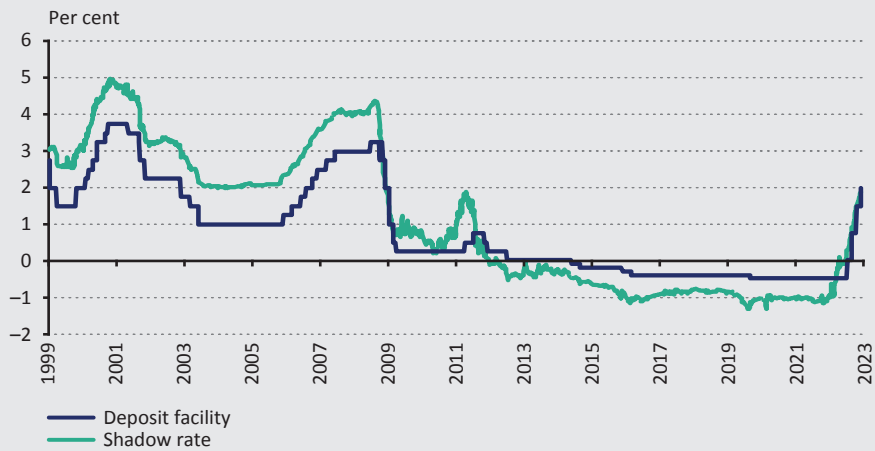
- *Inflation gap* ($\pi_t - \pi_t^*$) – Quarterly frequency, year-on-year inflation figures are taken from the ECB's data warehouse (*ECB Data Portal*[6]), which are based on Eurostat monthly data. The ECB originally aimed at maintaining an annual inflation rate below but close to 2 per cent, and thus an inflation target approaching a limit from below was set. However, an important change in methodology is that from 8 July 2021, the ECB wanted to see a symmetric inflation target of 2 per cent in the medium term, rather than one below but close to (*Benigno et al. 2021*). Regarding the period prior to July 2021, *Paloviita et al.* (*2021*) concluded that the ECB's effective (*de facto*) inflation target ranged from 1.6 to 1.8 per cent. In view of the authors' findings, it seems reasonable to assume a hypothetical inflation target of 1.7 per cent, and 2 per cent after the revision of the methodology until the very end of our time horizon. The resulting time series shows by how many percentage points actual inflation in the euro area deviated from the inflation target in the quarter reviewed.

  As with the output gap, it can be assumed that the information obtained from the inflation gap in period *t* can be used by the central bank when deciding on interest rates in period *t*. Although the central bank cannot yet know the value of actual inflation for the whole quarter at the end of the quarter, it can estimate it with a high degree of accuracy from the figures of the other two months.

[6] https://data.ecb.europa.eu/, previously ECB Statistical Data Warehouse (ECB SDW)

- *Inflation forecasts* ($E(\pi_{t+h}|\Omega_t)$) – Previous studies clearly show that it is appropriate to include forecasts in the interest rate rule for a more realistic outcome. It is standard practice for the ECB to make quarterly macroeconomic projections at the end of each quarter, which are also available in the ECB's data warehouse (*ECB Data Portal*[7]). The exact use of this variable will be discussed later under the model specifications because of its significance.

Figure 2
The ECB deposit facility rate and the shadow rate used in the research



Source: FRED, De Rezende and Ristiniemi (2022), Bloomberg

- *Shadow rate* (i_t) – The outcome variable of the interest rate rule requires some short-term interest rate that is influenced by the ECB. However, in the second half of the 2010s, the ECB's policy rates hardly changed due to the phenomenon of the zero lower bound, and the central bank chose to shape the monetary policy of the euro area by unconventional means. This bias can be overcome, for example, by using a calculated rate that takes into account other monetary policy actions of the ECB, rather than the actual key rates. For this purpose, I adopted the shadow rate from the study of *De Rezende and Ristiniemi* (*2022*), which is derived from the 1-month OIS rate. The purpose of the shadow rate is to reflect not only the central bank's conventional interest rate moves, but also the ECB's unconventional policy. This reveals a much more realistic picture of the monetary policy stance of the central bank, which is a major benefit for my modelling exercise.

[7] https://data.ecb.europa.eu/data/datasets/MPD

The rate calculated by the authors applies from 1999 Q1 to 2022 Q2. For the last two quarters missing from the time horizon of the research, the ESTR (Euro Short Term Rate)[8] is used, taken from the *Bloomberg* database. The ESTR aptly captures the short-term financing conditions in the euro area, and is calculated similarly to the one in *De Rezende and Ristiniemi* (*2022*). *Figure 2* shows the difference between the shadow rate calculated in the paper and the deposit facility rate in the euro area *(FRED)*.

- *Equilibrium real interest rate* (r_t^*) – In the vast majority of interest rate rules, the equilibrium real interest rate is assumed to be constant over the entire time horizon (as in the original Taylor rule). However, many studies (e.g. *Belke and Klose 2011*) warn that the real interest rate can also change dynamically, and therefore it is inaccurate to consider it to be constant. Following the practice of the authors, a forward-looking real interest rate is obtained using the Fisher equation by subtracting one-year projected inflation from the nominal interest rate (which, in our case, is the shadow rate), and determining the trend of the time series with the help of the HP filter.[9]

4. Results

4.1. Model specifications

An objective assessment of the ECB's monetary policy of recent years requires an interest rate rule that aptly represents the functioning of the central bank. For this reason, I estimated different Taylor-type model specifications using the method of ordinary least squares (OLS). The estimate covers the entire available sample, assuming that the ECB's monetary policy stance has not changed since 1999. One possible way to develop this research further is to estimate a time-varying rule (see, for example, *Abaligeti et al. 2018*).

An obvious question that arises when constructing models is the endogeneity of variables. Endogeneity may be present in the model because the forecasts of central banks are made along an endogenous policy path, i.e. the future decisions of central banks are expected to shape the macroeconomic environment in a way so that the

[8] The shadow rate data series ends in 2022 Q2, from then on I prorated the daily changes (differences) in the ESTR so that by the end of the time horizon of the analysis, 31 December 2022, the extended shadow rate equals the original ESTR.

[9] For quarterly data, a filtering parameter of λ = 1600 is recommended. It should be noted that, due to the specificity of the HP filter, endpoint uncertainty may occur, so the result of filtering may be doubtful at the end of the sample. In addition, because of the HP filter calculation, each data point is calculated using the entire sample, which violates the principle of using real-time data as mentioned in *Subsection 2.2.* This research could possibly be improved by applying a filtering method that tackles endpoint uncertainty and uses only real-time data.

variable follows the indicated path over the forecast horizon, where future inflation is a function of interest rate decisions. The explanatory variables are therefore not independent but correlate with the error term, since besides affecting the interest rate, they themselves are affected by the interest rate, in which case the results may be biased.

However, in the shorter term, this effect is not yet reflected in the forecasts due to the specificities of monetary transmission, as in the short run central banks may consider expected inflation as given, exogenous. *Romer and Romer* (*2004*) also argue that in the very short run (0 to 2 quarters), central bank forecasts do not contain any inside information on the expected monetary policy trend; therefore, they used a 2-quarter inflation forecast for their research. In addition, *Jarociński and Karadi* (*2020*) also showed that the immediate impact of a monetary policy shock on GDP and the GDP deflator is practically negligible. Precisely in order to minimise any endogeneity bias, I myself used the inflation forecast two quarters ahead (t+2) in the model.

It is important to stress, however, that the forward-looking operation of central banks typically exceeds half a year due to the specificities of the transmission mechanism, and, as mentioned in the introduction, there may be real economic loss if a central bank adjusts interest rates in response to a temporary price shock. Accordingly, longer-term forecasts would yield a more realistic interest rate rule, but this demands more caution because of the endogeneity problem just mentioned.

Overall, as an alternative estimation, it may be worth examining an interest rate produced by the model using projections for t+4. This is a time horizon where the bias from endogeneity is not yet too large, but – in line with the central bank's operation – it covers a longer time span. If the two specifications yield similar results, this proves the robustness of the model, since there is no significant difference compared to the model with a longer time horizon when the t+2 model is used, and it even ensures the exogeneity of the variables, which makes the t+2 model a reasonable choice.

In addition to OLS, the literature typically uses instrumental variable (IV) models to estimate interest rate rules. IV models are useful because if the appropriate instruments are specified, endogeneity in the model can be eliminated (*Baum et al. 2003*). Instruments are usually introduced to interest rate rules that have expectations. Although the interest rate rule estimated in this paper does contain

inflation expectations, they are of such a short horizon – as explained above – that it renders the endogeneity bias negligible. Instruments are, on the other hand, usually introduced to interest rate rules that have variables that respond quickly to interest rates, such as the exchange rate (*Hidi 2006*); this research, however, does not estimate interest rate rules with such variables. Consequently, it is appropriate to use OLS to estimate the interest rate rule under this specification. For the sake of robustness, one possible way to improve this research would be to use IV estimation in addition to OLS.

The models were run using the HAC weighting matrix created by *Newey and West* (*1987*), which has since been enhanced by researchers on several occasions. As a result, the t-statistics computed in the model remain robust even in spite of the heteroskedasticity and autocorrelation of the error term. All of this is necessary for us to be able to make an informed decision about the significance of the explanatory variables.

This paper tests the relevance of two different inflation variables: the inflation gap in a given period (also included in the original Taylor rule) and the inflation gap forecast for period t+2.[10] Furthermore, based on the considerations in the relevant literature, it seemed sensible to include an interest rate smoothing parameter, which represents the t–1 value of the outcome variable as an explanatory variable. I examined a total of four specifications which are summarised in *Table 1*.

Table 1
Variables of the model specifications used in the research

	1 – current inflation gap	**2 – forward-looking inflation gap**
(a) baseline models	**a1** output gap + real interest rate + current inflation gap	**a2** output gap + real interest rate + forward-looking inflation gap
(b) baseline models + interest rate smoothing	**b1** output gap + real interest rate + current inflation gap + interest rate smoothing	**b2** output gap + real interest rate + forward-looking inflation gap + interest rate smoothing

[10] The model with t+4 forecasts was only run to test robustness (see below).

The equations of the models are shown below:

a1) $$i_t = \alpha + \beta_y * (y_t - y_t^*) + \beta_r * r_t^* + \beta_{\pi 1} * (\pi_t - \pi_t^*) + \epsilon_t \quad (5)$$

a2) $$i_t = \alpha + \beta_y * (y_t - y_t^*) + \beta_r * r_t^* + \beta_{\pi 2} * [E(\pi_{t+2}|\Omega_t) - \pi_{t+2}^*] + \epsilon_t \quad (6)$$

As seen in *equation (4)*, inclusion of the interest rate smoothing parameter changes all coefficients of the original model to be higher by a factor of $(1 - \lambda)$. Thus, the parameters estimated with the OLS method do not yet show the pure effect of the variables, but rather the value adjusted for interest rate smoothing. To retrieve the pure effect, the regression coefficients of the original model are divided by $(1 - \lambda)$, which gives us the following equations:

b1) $$i_t = \frac{\alpha}{1-\lambda} + \frac{\beta_y}{1-\lambda} * (y_t - y_t^*) + \frac{\beta_r}{1-\lambda} * r_t^* + \frac{\beta_{\pi 1}}{1-\lambda} * (\pi_t - \pi_t^*) + \lambda * i_{t-1} + \epsilon_t \quad (7)$$

b2) $$i_t = \frac{\alpha}{1-\lambda} + \frac{\beta_y}{1-\lambda} * (y_t - y_t^*) + \frac{\beta_r}{1-\lambda} * r_t^* + \frac{\beta_{\pi 2}}{1-\lambda} * [E(\pi_{t+2}|\Omega_t) - \pi_{t+2}^*] + \lambda * i_{t-1} + \epsilon_t \quad (8)$$

In these equations, ϵ_t denotes the error term which represents the exogenous monetary policy shock. This variable is intended to grasp why the actual interest rate in a given period may differ from that suggested by the model. This may be because the decision-making body of a central bank does not operate as a simple equation, but is a complex outcome of individual opinions and perceptions which may change constantly. In addition, central bankers take into account unquantifiable or difficult-to-quantify factors in their decisions, which may result in deviations from the model. Central banks may also change their behaviour over time, shift their attention to other factors, or may reconsider the weights assigned to the various variables according to their importance, which may also cause interest rates to vary (*Edelberg and Marshall 1996*).

4.2. Regression results

Table 2 shows the regression results of the four models. At a significance level of 10 per cent, most explanatory variables significantly explain the changes in the shadow rate between 1999 Q2 and 2022 Q4. The hypothesis that the coefficient of the output gap in model a2 and the coefficient of the equilibrium real interest rate in model b1 is 0 in reality (apart from the intercept) cannot be clearly rejected.

The information criteria show that the accuracy of the models marked b is substantially better than that of the specifications without interest rate smoothing. The fairly high values of the t-quotients calculated from the table indicate that the

interest rate smoothing parameter is very significant in the interest rate rule and is worth including. Of the specifications examined, the b2 model provided the best fit, signifying that the forward-looking inflation gap is a useful element in the model for interest rate smoothing. Based on the past, this model shows that if the ECB forecasted a negative inflation gap of 1 percentage point two quarters ahead, then, *ceteris paribus*, the ECB's move typically reduced the shadow rate by 78 basis points.

The results obtained differ from the interest rate rules previously estimated for the ECB. *Belke and Klose (2011*) added an interest rate smoothing parameter to their model and arrived at an interest rate persistence of 0.83 and an inflation coefficient of 0.6. Replacing the original inflation member with the 6-month inflation forecast, they estimated a substantially higher parameter of 1.83, while the interest rate smoothing coefficient equalled 0.61. *Sauer and Sturm* (*2007*) found that when the Taylor rule was augmented with the interest rate smoothing parameter, the inflation coefficient did not deviate significantly from 0 between January 1991 and October 2003. However, when 12-month forecasts were added, significant variables were obtained: 1.85 for the inflation parameter and 0.87 for the interest rate smoothing parameter. *Owusu* (*2020*) calculated estimates for the euro area from 2003 to 2018: the model with an interest rate smoothing parameter and a 3-month inflation forecast estimated an inflation coefficient of 1.1 and an extremely high interest rate smoothing parameter of 0.98. *Gorter et al.* (*2008*) obtained similar results: they also estimated the interest rate smoothing parameter to be high, at 0.98 between January 1997 and December 2006, and 1.35 for the projected inflation parameter.

It should be noted that the models marked b bespeak multicollinearity. This is due to the fact that the equilibrium real interest rate and the first lag of the outcome variable correlate and explain each other. This phenomenon entails that the effects of the variables intermingle, which translates into greater variance and uncertainty. However, as the VIF indicators were (though by a small degree) below 10, it is not necessary to address this phenomenon (see *Table 3* in the *Appendix*).

Table 2
Regression results of the different model specifications

	a1 equation (5)	a2 equation (6)	b1 equation (7)	b2 equation (8)	b2" equation (8)
	1999 Q2 – 2022 Q4				1999 Q2 – 2019 Q4
Intercept α	1.5954 *** (0.1266) –	1.0204 *** (0.1475) –	0.2719 ** (0.1244) *1.4453*	0.0237 (0.0922) *0.1242*	–0.0695 (0.1382) *–0.3000*
Output gap β_y	0.0974 * (0.0586) –	0.0835 –0.0580 –	0.0808 ** (0.0358) *0.4296*	0.0666 ** (0.0305) *0.3490*	0.0859 *** (0.0298) *0.3709*
Equilibrium real interest rate β_r	0.9824 *** (0.0624) –	0.9976 *** (0.0653) –	0.1258 (0.0768) *0.6691*	0.1411 * (0.0761) *0.7392*	0.1580 ** (0.0706) *0.6824*
Current inflation gap $\beta_{\pi 1}$	0.2733 *** (0.0515) –	–	0.0942 *** (0.0269) *0.5007*	–	–
Forward-looking inflation gap $\beta_{\pi 2}$	–	0.3492 *** (0.0655) –	–	0.1498 *** (0.0362) *0.7847*	0.2429 ** (0.1023) *1.0490*
Interest rate smoothing parameter λ	–	–	0.8119 *** (0.0822) –	0.8091 *** (0.0786) –	0.7685 *** (0.0721) –
Observations	95	95	95	95	83
Global F-test	102.17 ***	98.48 ***	484.78 ***	631.35 ***	613.11 ***
Adjusted R^2	90.42%	90.17%	97.54%	97.79%	97.94%
BIC	185.89	188.37	60.39	49.93	38.68
HQIC	179.80	182.28	52.78	42.32	31.45

Note: The table shows the regression output of equations (5) to (8). All estimates were made using OLS, the outcome variable in each case being the shadow rate calculated for the ECB in the study of De Rezende and Ristiniemi (2022). In all cases, the top value of the explanatory variables is the raw regression coefficient of the variable, with an asterisk next to it indicating the significance of the variable (significant at 10 per cent, ** significant at 5 per cent and *** significant at 1 per cent), the middle value in brackets shows the standard errors calculated with the HAC matrix, and the bottom value in italics is the regression coefficient adjusted for interest rate smoothing (see equations (7) and (8)). The latter is only meaningful in the models marked b, but obviously not in the row of the interest rate smoothing parameter. The global F-test row shows the test statistic value and, using the markings mentioned above, the significance of the test.*

Next, I compare the actual monetary policy of the ECB with the rate justified by the model. In this case, the estimated interest rate rule can be seen as the standard central bank behaviour in the almost 25 years of the ECB's history, which encapsulates how the central bank usually reacts to different shocks. Comparison with the actual interest rate enables us to assess how far the ECB has deviated from its own historical standard behaviour in the recent inflation period. To do so, I used the results of the b2 model, as this specification ensured the best fit over the whole period, and therefore this model is the most suitable to describe the ECB's decision-making process.

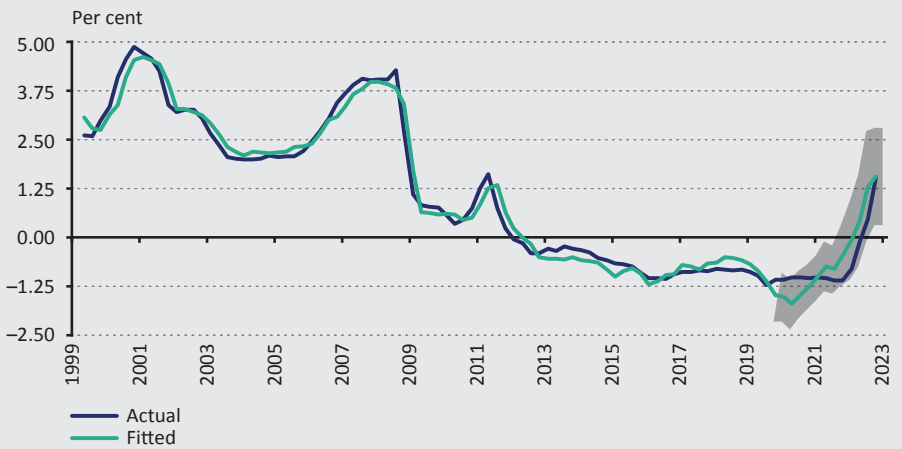
To compare actual and theoretical interest rates, I used a pseudo – out-of-sample – estimation. The main idea of this method is that even if a longer sample was available, parameter estimates would still be made for a somewhat shorter period. The model is then run for the period not used for parameter estimation, and a forecast is produced where the behaviour of the model can be examined. In the context of interest rate rules, this method is convenient because the model does not use data from the future, so the extracted data series can be directly compared with real data.

As above, I re-estimated the b2 model for the period from 1999 Q2 to 2019 Q4 (83 observations). Thus, the time horizon used for the pseudo-forecast is the period from 2020 to the end of 2022 (12 observations). The reason for splitting the sample at this point is that before 2020, there was no sign of a coronavirus epidemic, supply chain difficulties or a sharp rise in energy prices in the euro area. Therefore, this provides a good benchmark of the central bank's behaviour before the turbulences of recent quarters. For the re-estimation, I used the OLS estimation as in the previous runs, with the standard errors again weighted with the HAC weighting matrix. If we look at the regression results of the interest rate rule estimated on the shorter sample in the last column of *Table 2*, we see that it is equally significant. This may prove that inflation forecasts have not only become important in the context of the extraordinary inflationary pressures of recent quarters, but they also play a fundamental role in the ECB's interest rate policy.

For robustness checks, I also ran the b2" model with t+4 inflation forecasts in view of the considerations mentioned above and made a pseudo-forecast in the same way. The resulting values are basically the same as the original regression results, and the trend remains unchanged. The variables are significant also in the alternative model (again, the intercept is not significant). Among the significant variables, the only main shift is observed in the coefficient of the modified inflation parameter: while in the past the ECB typically responded to one unit of inflation gap widening expected to occur six months later by adjusting the interest rate by 105 basis points,

the same shift usually triggered a 184-basis point change in interest rate conditions over a one-year horizon. The higher inflation coefficient was to be expected, given that a jump in inflation expected a year later is a sign of more drastic and lasting change in the inflation environment than if it occurred over a six-month horizon, and could thus spur a stronger central bank reaction. As previously argued, because the original and the alternative models produce similar results, the results of the original model are reliable and the analysis can be continued (the results of the alternative model are shown in *Table 4* and *Figure 7* in the *Appendix*).

Figure 3
The shadow rate estimated by the b2 model and the actual shadow rate



Note: The regression results are taken from model b2" in Table 2. Starting from 2020 Q1, I used a pseudo-forecast based on data available from 1999 Q2 to 2019 Q4. The grey band indicates the 95 per cent confidence interval of the forecast.

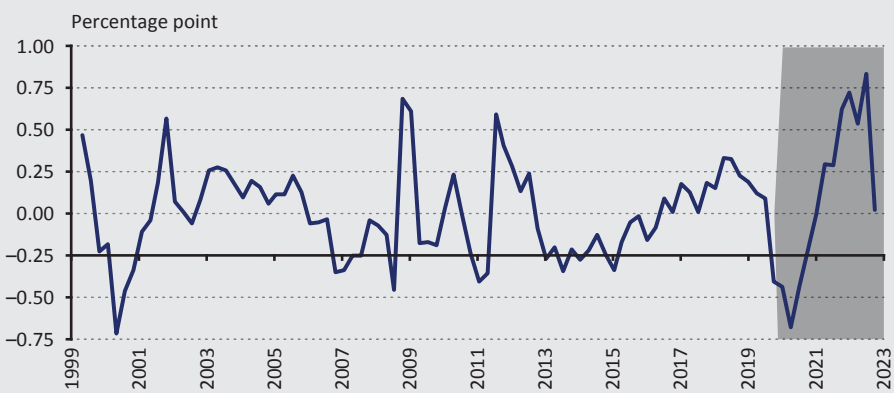
The pseudo-forecast (*Figure 3*) and the resulting residuals (*Figure 4*) call for several points to be considered. The interest rate rule suggested significantly looser monetary conditions from the beginning of 2020 during the coronavirus pandemic than the ECB actually implemented. It should be noted that, going into the coronavirus pandemic, both the actual rate and the calculated shadow rate were already in the negative range (*Figure 2*). Moreover, the ECB launched an ambitious pandemic emergency purchase programme (PEPP) in response to the pandemic, in addition to its existing asset purchase programme (APP) to further ease monetary conditions (*Blot et al. 2020*).

As the economy recovered, the theoretical interest rate rule proposed gradual tightening. After the pandemic waves, the negative output gap in the euro area closed gradually as the economy recovered, while inflation started to rise as

demand-supply frictions intensified. The model first indicated tighter conditions in 2021 Q2 compared to the shadow rate at the time, and from then on until the end of the forecast horizon it suggested a level higher than the one that actually materialised. The interest rate rule implicitly indicates that in the past, when the ECB saw a surge in six-month forecasts of this kind, it typically responded by raising the rates, but this time this happened later.

The ECB started tightening later than the theoretical level, but by the end of 2022 the two rates were nearly equal. Contrary to the model, the actual shadow rate started to increase in 2022 Q1, three quarters later, when the central bank announced that it would trim its asset purchase programmes. The first actual rate hike was effected by the monetary authority in July 2022, so we see a later reaction compared to its historical practice, but by the very end of the time horizon of the analysis, in 2022 Q4, the actual rate had almost reached the theoretical rate. Although the model predicted an earlier rate hike based on past behaviour, by the end of 2022 the ECB had arrived at a level consistent with its own historical behaviour, thanks to rigorous tightening.

Figure 4
Differences between the shadow rate estimated by the b2" model and the actual shadow rate



Note: The residuals are taken from model b2" in Table 2. The pseudo-forecast period starts from 2020 Q1 (grey band). If the value is positive (negative), the rate estimated by the model is higher (lower) than the actual value.

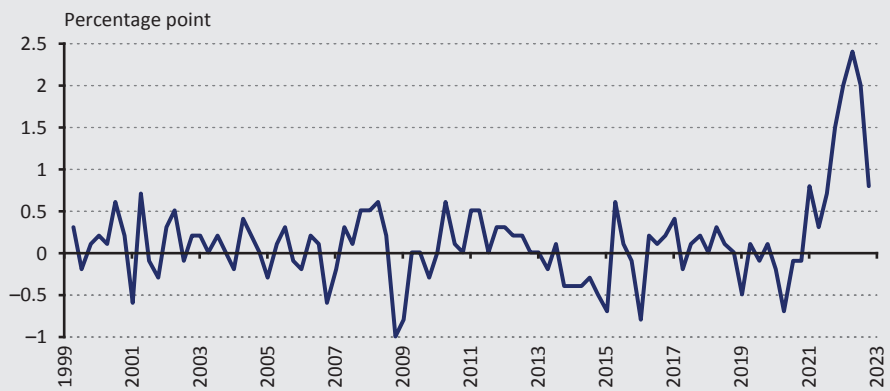
4.3. Possible explanation for the ECB's actions

In theoretical terms, the interest rate rule indicates that in the past, such a change in the macroeconomic environment prompted the ECB to raise interest rates earlier relative to the steps it actually took. To conclude this study, we should examine why the ECB might have decided to intervene later. The central bank's behaviour may,

among other factors, be explained by the accuracy of the forecasts, the uncertain economic environment or inflation expectation trends.

The perception that inflation is transitory is one possible explanation for the central bank's actions. For a long time, the central bank took the position in its decisions that although in the short run inflation may appear to be rising, its experts deemed this to be a temporary phenomenon not requiring monetary policy intervention. The same thinking prevailed in the justification given by the Fed or the Bank of England. As a result, the ECB's longer-term forecasts (on which its monetary policy decisions primarily rest) did not reflect the elevated inflation environment. This may explain why we saw a later reaction from the central bank compared to its historical behaviour.

Figure 5
ECB forecast errors for t+2 inflation



Note: The figure shows the forecast error of the ECB for t+2 inflation. If the value is positive (negative), the t+2 actual figure ended up being higher (lower) than the ECB forecast, meaning that the central bank underestimated (overestimated) inflation.

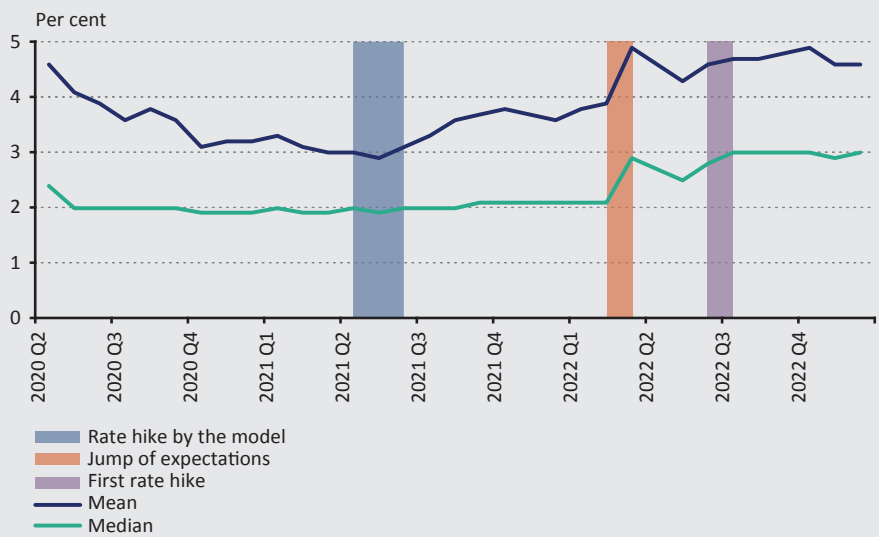
Source: ECB Data Portal

Inflation forecasts have recently lost much of their accuracy, which may have affected the euro area's policy rate path. New, unexpected shocks pushed inflation higher than anticipated, and the situation continued to fail to normalise. The error of the inflation forecast for t+2 in this paper hovered around 0 for almost the entire period under review, showing a nearly constant standard deviation; from 2021 onwards, however, the central bank's forecast accuracy worsened in an unprecedented way (*Figure 5*). The underestimated inflation path could be one reason why the ECB moved later compared to its historical behaviour.

Poorer forecast accuracy may be attributed primarily to the uncertain macroeconomic environment. Central banks were in a quite difficult situation:

demand and supply factors in the 2020s intermingled, making it difficult to tell what central bank action would be appropriate, since a tight monetary policy could have easily stalled economic recovery. A burning question over the time horizon of this paper's analysis was how the coronavirus pandemic would evolve, whether there would be further waves, and incorporating these processes into forecasts and decisions represented a new challenge. In addition, the Russia-Ukraine conflict that erupted in February 2022 added to the uncertainty of the macroeconomic environment. As a result, not only the ECB's forecasts, but also those of other central banks proved to be less accurate than before. All things considered, the uncertain economic environment may also explain why the ECB acted later compared to its previous practice.

Figure 6
Long-term (3-year) inflation expectations of euro area consumers



Source: ECB Consumer Expectations Survey

The evolution of inflation expectations could also justify the central bank's behaviour. The median long-term inflation expectation of euro area consumers remained stable around the target for a long time, but then increased significantly in March 2022 (*Figure 6*). The interest rate rule first indicated a higher interest rate than the actual rate in 2021 Q2, when median expectations were still around 2 per cent. In reality, the ECB decided to raise interest rates for the first time in July 2022 when median expectations rose to almost 3 per cent. The fact that consumer inflation expectations remained anchored for a long time could be another reason why the ECB moved later than it had in the past.

The Fed started tightening earlier than the ECB, but this different timing can be explained by, among other things, the different macroeconomic environment. While both central banks stressed the temporary nature of inflation, the ECB tightened later than the Fed in several respects. While the Fed ended its asset purchase programmes and started its rate-hiking cycle in March 2022, the ECB stopped expanding its balance sheet in June 2022 and began raising interest rates in July. Quantitative tightening started in June 2022 in the US, but only in March 2023 in the euro area. Nonetheless, it should be stressed that a different macroeconomic environment may warrant a different central bank response. Thanks to the massive government programme, the US recovered from the crisis more quickly, and the recovery of the countries in the euro area was heterogeneous. In addition, there were profound differences among the inflation rates of euro area countries, which could also justify slower but more prudent decision-making. All of this made the ECB's situation more difficult. Moreover, the Russia-Ukraine war that broke out in early 2022 had a more severe impact on Europe than it had on the United States. Hence, all things considered, the different timing between the Fed and the ECB should come as no surprise.

5. Summary and conclusions

This paper looked at how the ECB's monetary policy responded to inflationary pressures in the 2020s. In my research, I examined whether there was *any evidence that the ECB started tightening monetary conditions later than it had done in the past*. To provide an objective analysis, I applied the interest rate rule frequently used in the literature, which, by describing the general behaviour of central banks, serves as a good benchmark for evaluating actual monetary policy.

First, I gave a brief insight into the origin and meaning of the Taylor rule in my literature review, and looked at how it could be improved. I then presented the variables used for the research and the transformations performed on them. I used the resulting database to create different specifications based on the literature, and tested their fit to the data using the OLS method. The results show that the best fit is obtained when the equation includes an interest rate smoothing parameter and uses forecasts instead of a real-time inflation term.

I then made a pseudo – out-of-sample – forecast to test what theoretical interest rate the model would suggest based on the data for the years 2020–2022, the focus of the study. The results show that the ECB reacted later than it had done in the past. Beginning from 2021 Q2, the model proposed stricter conditions, while in reality monetary policy started to tighten from 2022 Q1, three quarters later. However, from 2022 H2, the ECB took strong measures to curb inflation, bringing the actual interest rate to a level consistent with the central bank's standard practice

by the end of 2022. It can be concluded that the uncertainty of the forecasts, the adverse economic environment, the large inflation differences across euro area member states and, accordingly, the dissimilarities in inflation expectations, or the fact that each country managed the recovery from the downturn brought about by the coronavirus pandemic in a different way, could, among other factors, explain why it took the ECB longer to decide than before.

The research could be further improved in several ways. One such way is to use output gap forecasts in the estimation. Another option is to base the estimates solely on real-time data, which can produce more realistic results. A filtering method that tackles endpoint uncertainty and uses only real-time data could also be applied. Or, as another option, a time-varying rule could be estimated. Yet another possible way to improve this research is to use IV estimation in addition to OLS for the sake of robustness.

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Appendix

Table 3
VIF indicators measured in the models

	a1 equation (5)	a2 equation (6)	b1 equation (7)	b2 equation (8)	b2" equation (8)
	1999 Q2 – 2022 Q4				1999 Q2 – 2019 Q4
Output gap β_y	1.724	1.809	1.728	1.813	1.710
Equilibrium real interest rate β_r	1.575	1.622	9.679	9.187	7.383
Current inflation gap $\beta_{\pi 1}$	1.155	–	1.483	–	–
Forward-looking inflation gap $\beta_{\pi 2}$	–	1.214	–	1.445	1.583
Interest rate smoothing parameter λ	–	–	9.634	8.932	8.018

Note: The numbers indicate the factor by which the variance of a given explanatory variable is inflated because the explanatory variables within that regression all influence one another. For a VIF below 5, multicollinearity is not a problem in the model, between 5 and 10 it needs attention but the model remains stable, for a VIF above 10, multicollinearity needs to be addressed.

Figure 7
Differences between the shadow rate estimated by the b2 model using alternative t+4 forecasts and the actual shadow rate

Note: The residuals are taken from the second column of Table 4. The pseudo-forecast period starts from 2020 Q1 (grey band). If the value is positive (negative), the rate estimated by the model is higher (lower) than the actual value. Compare: Figure 4.

Table 4
Robustness check

	b2" with t+2 forecasts	b2" with t+4 forecasts
	1999 Q2 – 2019 Q4	1999 Q2 – 2019 Q4
Intercept α	–0.0695 (0.1382) *–0.3000*	–0.3589 (–0.2180) *–1.4391*
Output gap β_y	0.0859 *** (0.0298) *0.3709*	0.0883 *** (0.0312) *0.3540*
Equilibrium real interest rate β_r	0.1580 ** (0.0706) *0.6824*	0.1798 ** (0.0723) *0.7209*
Forward-looking inflation gap $\beta_{\pi 2}$	0.2429 ** (0.1023) *1.0490*	0.4601 *** (0.1682) *1.8448*
Interest rate smoothing parameter λ	0.7685 *** (0.0721) –	0.7506 *** (0.0800) –
Observations	83	83
Global F-test	613.11 ***	667.46 ***
Adjusted R^2	97.94%	97.86%
BIC	38.68	41.79
HQIC	31.45	34.55

Note: The table shows the regression results of the original models using t+2 forecasts and of the alternative models using t+4 forecasts. Both estimations were made using OLS, the outcome variable in both cases being the shadow rate calculated for the ECB in the study of De Rezende and Ristiniemi (2022). In all cases, the top value of the explanatory variables is the raw regression coefficient of the variable, with an asterisk next to it indicating the significance of the variable (significant at 10 per cent, ** significant at 5 per cent and *** significant at 1 per cent), the middle value in brackets shows the standard errors calculated with the HAC matrix, and the bottom value in italics is the regression coefficient adjusted for interest rate smoothing. The global F-test row shows the test statistic value and, using the markings mentioned above, the significance of the test.*

Analysis of the Relationship between Money Growth and Inflation Using Wavelet Coherency*

Péter Simon

Different theories of money lead to different conclusions about whether there is a stable long-run relationship between money growth and inflation. In this analysis, the author examines the wavelet coherency between the growth in the M2 monetary aggregate and inflation in Hungary. Based on the findings, there is no robust long-run relationship between the two variables. When filtering out movements in the HUF exchange rate, the coherency between money growth and inflation is eliminated even over the period from the mid-2000s to the early 2010s. This also empirically supports the assumption that monetary policy does not affect inflation by shaping the money supply.

Journal of Economic Literature (JEL) codes: C10, E31, E40

Keywords: inflation, money supply, interest rates, wavelet transform

1. Introduction

Regarding the impact of monetary policy, one recurring question is whether there is a clear, stable relationship between the evolution of money supply and inflation. This is not an easy issue to assess as different theories of money yield different conclusions about whether there is a relationship, and if so, how robust and how volatile it is over time.

The quantity theory of money suggests a linear relationship between money growth and inflation, with an increase in the former, *ceteris paribus*, resulting in an increase in the latter. However, in other theoretical models of money, the link between money growth and inflation is far from clear: for example, proponents of Modern Monetary Theory and Post-Keynesian Economics argue that there is no simple, linear relationship between money growth and inflation (*Mitchell et al. 2019*). Non-linearity is particularly conspicuous where there is a high level of dollarisation in an economy. In such cases, money growth may lead to a high rate of inflation (*Levy*

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Yeyati 2006), posing significant challenges for monetary policy (*Alvarez-Plata – Garcia-Herrero 2008*).

Moreover, empirical studies have not clearly confirmed the relationship between inflation and money growth. Based on an analysis by *McCallum – Nelson* (*2010*), macroeconomic data from the G7 nations support the conclusions based on the model of the quantity theory of money. The relationship between the two variables has deteriorated considerably since the 1980s and shows significant heterogeneity among countries depending on the level of development (*Gertler – Hofmann 2018*). In economies with more liberalised financial systems and lower rates of inflation, the link is weaker (*Estrella – Mishkin 1997; De Grauwe – Polan 2005; Teles et al. 2016; Benati 2009*). In the current global economic environment characterised by supply shocks, the relationship between the two variables may also be distorted by the evolution of supply factors due to inflation being at a high level (*Fornaro – Wolf 2023*).

At the same time, the question has practical significance for central banks as many of them also conduct asset purchase or sale programmes, in addition to shaping interest rates. If money growth results in inflation, a central bank may generate inflation via asset purchases or contribute to curbing inflation via asset sales. However, analyses show that the asset purchase programmes implemented by major global central banks over the last decade had no clear inflationary effect, despite considerable money growth (*Borio – Zabai 2018; Csiki 2022*). In New Keynesian monetary policy models – such as the basic monetary policy model applied by the Magyar Nemzeti Bank (the central bank of Hungary, MNB) (*Békési et al. 2016*) – money growth is either not reflected in or does not affect the equilibrium of real variables.

This empirical analysis assesses the robustness of the relationship between domestic money growth and inflation. To the best of my knowledge, it is the first in Hungary to examine the relationship between these two variables by using wavelet coherency, which allows the evolution of the relationship to be tracked over time, while also being able to describe the changes in different frequency components of the time series. Many studies underline the variability of the relationship between the two components over time (*Hofmann 2006; Gertler – Hofmann 2018; Berger et al. 2023*). Tracking both the time and frequency dimensions allows for studying general, non-stationary time series, while also exploring how close the relationship between the two variables is in different frequency domains (*Hajnal et al. 2023*). In addition, the wavelet decomposition procedure also makes it possible to study the lead-lag relationship.

Wavelet decomposition involves using the sum of functions of limited lengths (so-called "wavelets") to approximate a time series at each point in time. Wavelets are translated and scaled to varying degrees and thus are capable of appropriately describing the time series components at different frequencies. Wavelet coherency is a key indicator in this study and, by analogy with correlation, it shows how robust the relationship between the two variables is at a given point in time and a given frequency.

The findings show that, overall, no robust relationship can be established between the increase in the domestic money supply and inflation. In the context of Hungary, *Komáromi* (*2007*) argues that the monetary base is a given for the central bank and thereby does not directly provide any input to expected inflation. The present analysis expands on that argument by calling into question not only the inflationary effect of the change in the monetary base, but also whether there is a stable relationship between total money supply in the economy and inflation. The findings were verified using a number of robustness tests. Significant coherency between money growth and inflation was identified during the period from the mid-2000s to the early 2010s, which, however, is eliminated when one filters out the movements in the HUF exchange rate. Consequently, it can be concluded that the evolution of money supply did not have any effect on inflation in the period under review.

Section 2 of the study provides an overview of the main arguments for and against the relationship between inflation and money growth with both an international and a domestic dimension. In *Section 3*, the wavelet decomposition process that was the basis for this analysis is discussed, along with the data used in the analysis. *Section 4* contains the key findings of the study. A summary of the conclusions is presented in *Section 5*.

2. Review of literature

A central theme in monetary economics is the theory of money and, as a related issue, the long-run relationship between money growth and inflation. In the period before the 2008 global financial crisis, many economists found empirical evidence for the existence of a one-to-one relationship between an increase in broad money supply in the economy and in the price level (*e.g. Vogel 1974; Lucas 1996; Gertler – Hofmann 2018*). These observations are consistent with the quantity theory of money, where the key idea is that each unit of exogenous money growth results, *ceteris paribus*, in a unit increase in nominal variables in the long term, without affecting real variables in the economy (*McCallum – Nelson 2010*). This is equivalent to the long-run neutrality of money.

The key idea of the quantity theory of money is far removed from real-world applications. The monetary base directly controlled by central banks does not fundamentally provide any direct information on the expected evolution of inflation, as even this includes many factors that are external and should be thought of as a given for the central bank (*Komáromi 2007*). The endogenous theory of money is more suitable to describe the functioning of modern monetary policy (*Ábel et al. 2016*). According to this theory, banks make decisions on their activities in response to the relevant economic circumstances, and thus, overall, the banking system, which provides a significant share of the money supply, shapes its money supply endogenously. *McCallum – Nelson* (*2010*) and *Ábel* (*2019*) point out that, fundamentally, money creation by central banks is also an endogenous response to economic processes, and accordingly money growth cannot be considered exogenous. The endogenous theory of money can be supplemented to establish a consistent framework by assuming that inflation is essentially determined by labour market conditions in the economy, including, in particular, the state of the labour market in relation to full employment (*Mitchell et al. 2019*). Consequently, the theory suggests no linear relationship between the two variables. Non-linearity is particularly conspicuous where there is a high level of dollarisation in an economy, because in such cases money growth may lead to a high rate of inflation (*Levy Yeyati 2006*). As a result, the margin for monetary policy is significantly limited (*Alvarez-Plata – Garcia-Herrero 2008*).

Empirical results support the conclusions of the quantity theory of money in certain cases and those of the endogenous theory in others. In general, a robust empirical relationship was observed between money growth and inflation in the pre-2000s (*Lucas 1996; Haug – Dewald 2004*). However, a number of findings suggest that, from the 2000s, the strength of the relationship deteriorated (*Hofmann 2006; Carstensen 2007; Gertler – Hofmann 2018*). This observation is also supported by the fact that the asset purchase programmes implemented by central banks in the wake of the crisis have had unclear direct effects on inflation in developed economies (*Yu 2016; Borio – Zabai 2018; Csiki 2022*). The deterioration of this link can also be explained by the liberalisation of financial systems and an environment characterised by persistently lower inflation (*Estrella – Mishkin 1997; De Grauwe – Polan 2005; Teles et al. 2016; Benati 2009*). However, *McCallum – Nelson* (*2010*) note that using cross-country averages and taking long moving averages of time series in empirical analyses may also distort the relationship and, by excluding them, a strong link is identified between the two variables based on G7 data.

There are certain cases where supply shocks may have a lasting impact on inflation, also distorting the link. Studying the period of the COVID pandemic and the energy price shock, *Fornaro – Wolf* (*2023*) concluded that negative supply shocks may

generate permanent output losses. This, however, is accompanied by a permanent rise in inflation that cannot be addressed by tight monetary policy in itself, but rather only in coordination with fiscal policy (*Fornaro – Wolf 2023*). Against this background, in the current period of inflation, other factors, such as energy prices or the evolution of the tightness of the measures taken during the pandemic, may have significantly distorted the link between money growth and inflation.

As the quantity theory of money assumes a long-run relationship between money growth and inflation, empirical analysis also looks back at a long-run period in order to work with low-frequency time series components. In these types of analyses, one of the processes that is gaining increasing attention in literature is wavelet decomposition. Using wavelets, *Mandler – Scharnagl* (*2014*) found that comovements between the 8- to 16-year components of money growth and inflation in the Eurozone deteriorated after the 1990s.[1] Based on US data, the link between the two variables also weakened after the turn of the millennium (*Scharnagl – Mandler 2015*). At the same time, *Jiang et al.* (*2015*) also used wavelets to show that, from the mid-2000s, the relationship between money growth and inflation strengthened in China as opposed to developed countries.

The wavelet decomposition process is not widespread in the domestic economic literature. Applications in Hungary include *Uliha* (*2016*), who identified links between oil prices and economic variables in Sweden and Norway. *Uliha – Vincze* (*2018*) studied the relationship between the evolution of exchanges rates and consumer prices, while *Hosszú – Lakos* (*2021*) used the wavelet transform to determine the credit-to-GDP gap with the best early warning performance. In its Financial Stability Report, the MNB uses the wavelet transform to analyse the time required for monetary transmission in different countries in the region (*MNB 2023: pp. 65–66*). The Hungarian application closest to the present study in its theme is *Hajnal et al.* (*2023*). Its authors used wavelet decomposition and error correction models to analyse household and corporate deposit transmission in the Central and Eastern European region. Their findings show that in recent years the region's higher-inflation environment was characterised by weakening deposit transmission and a slowdown in deposit-rate repricing, particularly in the household segment (*Hajnal et al. 2023*). To my knowledge, my study is the first to deploy wavelet decomposition to examine the relationship between money growth and inflation in Hungary.

[1] However, for components with periods longer than 16 years, the authors found a stable, almost one-to-one relationship.

3. Methodology

3.1. Wavelet transform

In my analysis, I apply the wavelet decomposition process, which is a part of the spectral analysis toolkit. Spectral analysis is aimed at decomposing the time series into the sum of periodic functions at different frequencies, while maintaining variance. The best-known example for this is the Fourier transform that uses sinusoidal functions for decomposition. The disadvantage of the Fourier transform is that it requires the stationarity of the time series as a prerequisite. Moreover, as the decomposition is constant over time, it does not provide any information about the temporal distribution of each frequency component. Thus, the Fourier transform does not allow for identifying any structural breaks that may change the dominant frequency.

Wavelet decomposition addresses these shortcomings of the Fourier transform. The process and the associated mathematical/theoretical background is a result of multidisciplinary efforts (*Daubechies 1992; Torrence – Compo 1998; Grinsted et al. 2004*). The decomposition itself is about locally approximating a time series with the sum of so-called "wavelets" of limited lengths, instead of breaking it up into sinusoidal functions at different frequencies. Accordingly, with wavelet decomposition, the time series is not bound by stationarity restrictions.

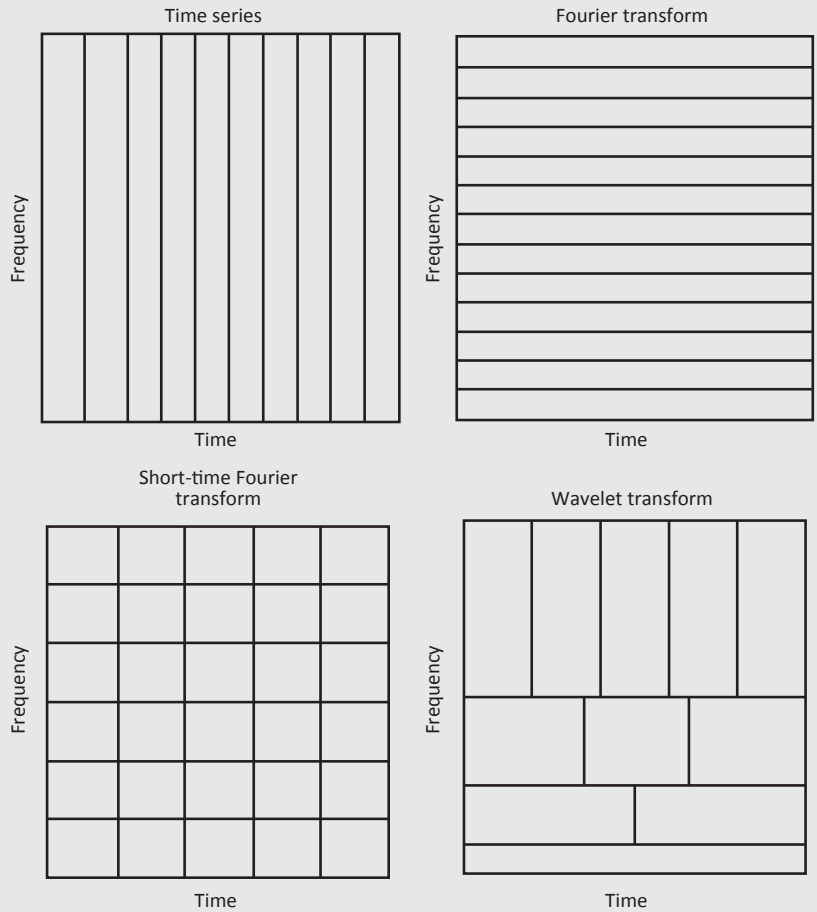
Wavelets have a window of interpretation that can be translated and also stretched or compressed (scaled), making them suitable for describing periodical movements at different frequencies. More time-stretched wavelets capture the information content of the lower-frequency components of a time series, while more compressed wavelets capture the higher-frequency components. By choosing an appropriate form for the function (the so-called "mother wavelet"), all square-integrable functions can be generated as a sum of translated, stretched and compressed wavelets, meaning that this process can be applied to any economic time series. Wavelet decomposition can be carried out through discrete or continuous wavelet transform. I used the continuous version in this analysis.[2]

As a result of compressing, the resolution of the wavelet decomposition is scale-dependent. This means that it assigns shorter time windows to higher-frequency components of a time series and longer time windows to lower-frequency components (*Figure 1*). This is important because it shows higher-frequency components in the best detail possible, while also being capable of representing the evolution of lower-frequency components. However, due to methodological specificities, the resolution will be distorted at certain points in time and on certain

[2] I used the R package "biwavelet" by *Gouhier et al.* (*2021*) for the analysis.

scales. The distortion-free area is called the cone of influence (COI) in wavelet literature (*Torrence – Compo 1998*). Results outside the COI are generally ignored.

Figure 1
Comparison of different time-frequency resolutions



Source: Uliha (2016: 512)

A correlation-like indicator, called wavelet coherency, can be calculated between two time series at a given point in time and on a given scale. This indicator is between 0 and 1 and essentially represents how strong the relationship between the two time series is at a given time-frequency point. If the evolution of wavelet coherency between the two time series is to be studied while also eliminating the effect of an additional variable, partial wavelet coherency can be used, as defined and interpreted analogously to partial correlation.

In a wavelet decomposition analysis framework, an indicator that can be thought of as similar to the sign of correlation is wavelet phase difference. It shows the lead-lag relationship between the wavelets of the two time series at the relevant time-frequency point. It is important to note that a lead-lag relationship does not mean causality: if time series *x* is ahead of *y*, it is still possible that, for example, it is actually *y* that causes *x*, but its effect is spread over more than the entire period of the wavelet.

One central task of the present analysis is to identify the level of wavelet coherency between inflation and money growth at different points in time and frequency. I ran Monte Carlo simulations to determine the points where coherency is significantly different from noise-generated coherency. A detailed description of the methodology applied is included in the *Appendix*.

3.2. Data

In the empirical analysis, I explore the robustness of the relationship between M2 money growth and inflation in Hungary. M2 is a monetary aggregate that includes assets that can be liquidated quickly and at little cost; its growth is considered by many as an indication of inflationary pressures (*Hallman et al. 1991; De Grauwe – Polan 2005*).[3]

I used monthly observations for the period from January 1999 to September 2022. CPI inflation data for Hungary were obtained from the Hungarian Central Statistical Office (HCSO). The year-on-year growth of the unadjusted M2 monetary aggregate was calculated based on MNB data. Besides the two main variables, additional time series were also used in order to assess the robustness of the findings in several aspects. These included the core inflation indicator (HCSO), the year-on-year growth of unadjusted M1 and M3 monetary aggregates (calculated based on MNB data), annualised GDP growth observed on a quarterly basis and adjusted for seasonality and calendar effects (HCSO) and the 3-month interbank (BUBOR) rate and HUF/EUR exchange rate observed on a daily basis (Bloomberg). Monthly averages of daily-frequency data were calculated. In preparation for the wavelet decomposition process, the time series were standardised and differentiated.[4]

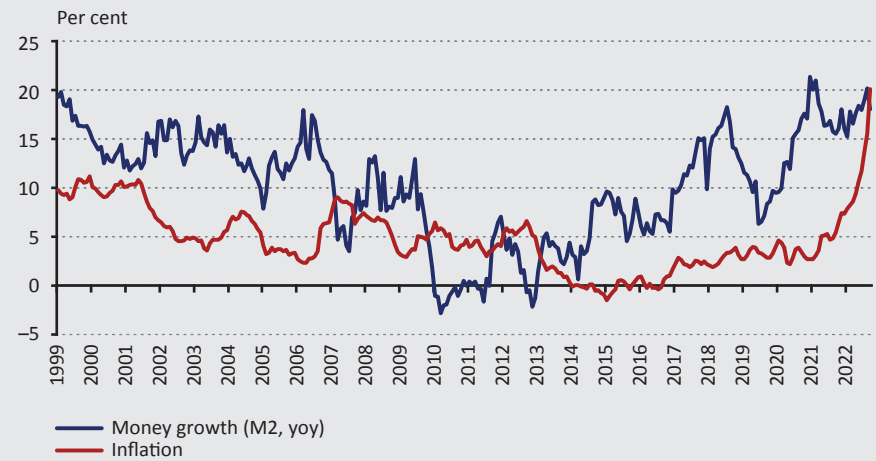
The two main time series studied in the analysis are presented in *Figure 2*. Based on this figure, there is no stable long-run relationship between the two variables. In certain periods, the change in the rate of money growth is followed by a change in inflation, with a few months' delay. Of these, the period from July 2019 to December

[3] M2 is comprised of cash outside monetary financial institutions, demand and current-account deposits and time deposits with an original maturity of up to 2 years.

[4] The wavelet methodology is based on a local approximation, and so dispensing with standardisation would not have had a qualitative impact on findings. Differentiation was necessary due to outliers at the end of the inflation time series and the coefficient estimation process applied during wavelet decomposition; this, however, also did not have any effect on the findings.

2020 stands out as one when the M2 growth rate rose from 6.5 per cent to over 20 per cent, followed by inflation moving on an upward trajectory from January 2021. Overall, however, there was a substantial part of the period under review when inflation did not follow the fluctuations in the growth rate of money, nor is there an inverse correlation to be established based on the figure.

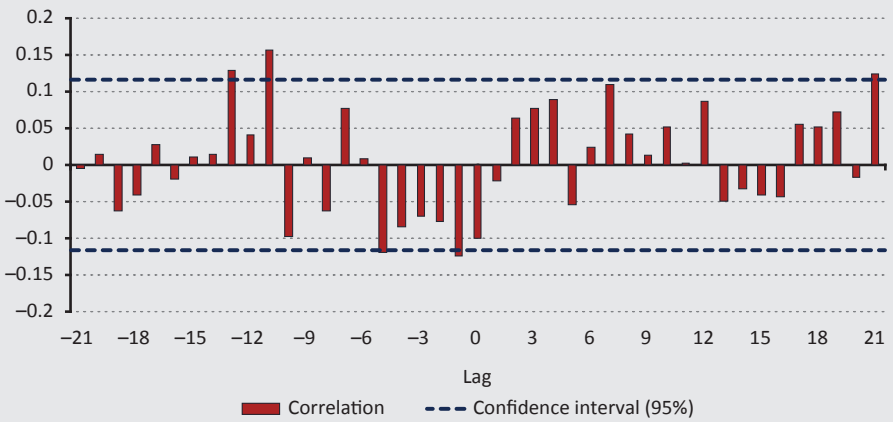
Figure 2
Annual M2 money growth and the evolution of inflation in Hungary



Source: HCSO, MNB

Prior to wavelet decomposition, I explored the cross-correlation structure between money growth and inflation, as presented in *Figure 3* with different lags. With most lags, the correlation between the two variables does not significantly differ from 0. However, with lag configurations where inflation was 13, 11, 5 months or 1 month ahead of money growth, the correlation differed significantly from 0, as it did when money growth was 21 months ahead of inflation (*Figure 3*). This may suggest that changes in inflation might lead to the transformation of lending processes and thereby a change in money growth in the short run, while, in the long run, the evolution of money supply may determine inflation. However, these are the only handful of cases where correlation indicators differ significantly from zero, meaning that the relationship can also be attributed to coincidence, especially considering correlations calculated with nearby lags.

Figure 3
Correlation between annual M2 money growth and inflation with different lags



Note: For negative lag values, money growth follows inflation, while positive values indicate the opposite.

Source: Calculation based on HCSO and MNB data

4. Findings

4.1. Coherency between money growth and inflation

The correlation structure provides no clear evidence on whether there is a relationship between money growth and inflation. Accordingly, it is necessary to continue the analysis using wavelet decomposition. In this section, I present the resulting findings.

The colour scale in *Figure 4* shows how robust wavelet coherency is between the two time series at a given point in time and on a given scale. Coherency should be thought of as a correlation coefficient in this context. The areas with black outlines indicate wavelet coherency significantly different from the coherency structure generated by red noise,[5] where significance was determined using Monte Carlo simulations.

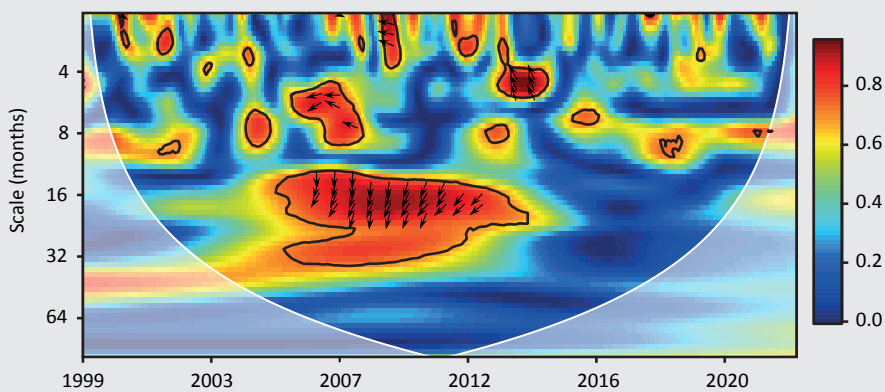
Using wavelet decomposition, it is established that there is no stable long-run relationship between the two variables. *Figure 4* shows that changes in money growth and inflation in the short run (scales of up to a few months) exhibit significant wavelet coherency over certain periods, but this phenomenon is essentially not stable. However, the roughly 16- to 32-month trends of the two

[5] The coherency structure of red noise is one where coherency increases as frequency decreases (scale increases). On the other hand, the coherency structure of white noise is constant across frequencies (see *Torrence – Compo 1998*).

variables were significantly correlated between 2005 and 2013, and the value of the wavelet coherency indicator was typically over 0.8 in this time frame and over those scales. Coherency here may well be related to an event in economic history. In 2001, Hungary's central bank implemented inflation targeting, which may have contributed to a considerable shift in the relationship between inflation and money growth.

Within the significant ranges, the direction of the arrows shows the phase difference between coherent wavelets: for arrows pointing down, money growth is ahead of inflation, for arrows pointing up, inflation is ahead of money growth, for arrows pointing right, the two wavelets are in phase and for arrows pointing left, the two wavelets are in an antiphase relation. Based on the phase difference between coherent wavelets, the direction of the relationship evolved in line with the quantity theory of money: the change in money growth rate was ahead of the change in inflation. However, apart from this range that spans 16 scales and 8 years, wavelet coherency was quite low and did not differ significantly from 0 in the time frame and over the scales under review (*Figure 4*).

Figure 4
Wavelet coherency and phase difference between annual M2 money growth and inflation



Note: The horizontal axis shows time and the vertical axis shows wavelet scale s (in months) which corresponds to the component of the time series with the same period. The colour scale shows how robust wavelet coherency is between the two time series at a given point in time and on a given scale, to be understood as a correlation coefficient in the time-frequency domain. In the figure, the white outlines indicate the COI, outside of which the wavelet decomposition is distorted.

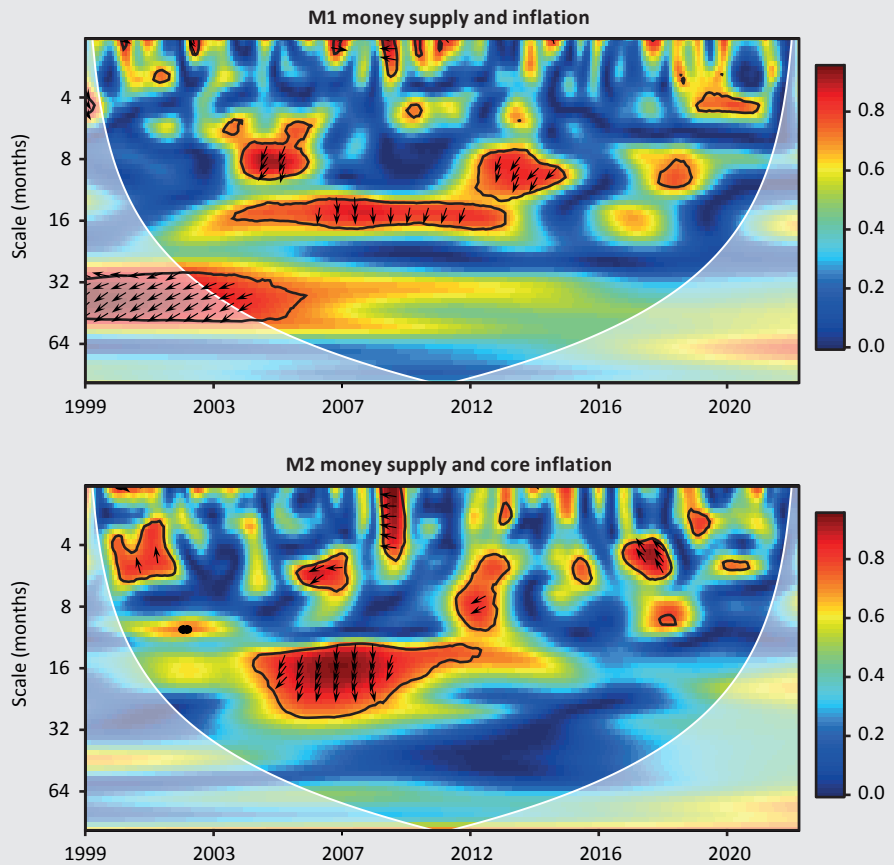
Source: Compiled from MNB and HCSO data

4.2. Robustness testing

The findings are robust with respect to the selection of both the monetary aggregate and the inflation indicator. As seen in *Figure 5*, there is no qualitative change in the key findings compared to the previous subsection if the growth rate of the

M1 aggregate is studied instead of that of the M2 aggregate or if core inflation is considered instead of the headline inflation indicator.[6] As before, these cases also show periodic coherency over the short scales as well as coherency at 16- to 32-month scales from the mid-2000s to the early 2010s. Overall, however, wavelet coherency did not differ significantly from 0 in most time-frequency ranges.

Figure 5
Wavelet coherency and phase difference between the annual growth of different money supplies and inflation/core inflation



Note: The horizontal axis shows time and the vertical axis shows wavelet scale s (in months) which corresponds to the component of the time series with the same period. The colour scale shows how robust wavelet coherency is between the two time series at a given point in time and on a given scale, to be understood as a correlation coefficient in the time-frequency domain. In the figure, the white outlines indicate the COI, outside of which the wavelet decomposition is distorted.

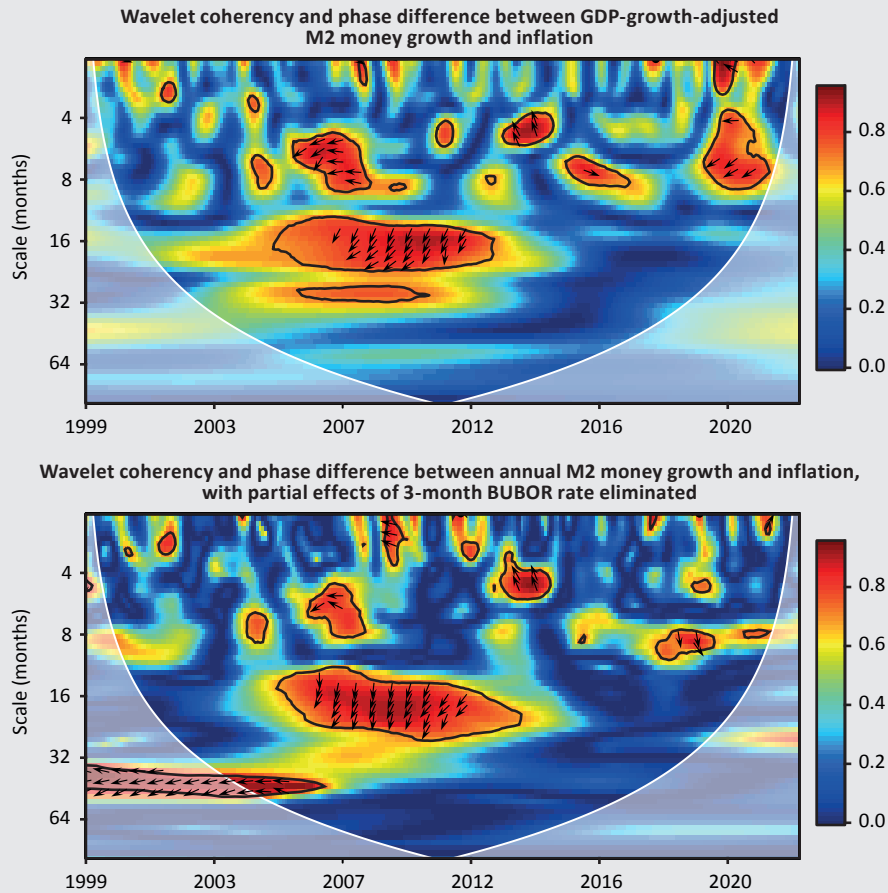
Source: Compiled from MNB and HCSO data

[6] In addition to M1, robustness testing was also carried out using the M3 monetary aggregate, with no changes in the key findings.

4.3. A look at omitted explanatory variables

I also studied the impact of additional variables on the findings. High economic growth may generate considerable money demand and thereby significant money growth. As the omitted variable might distort findings, I also performed the analysis with money growth adjusted for GDP growth.[7] I made the adjustment using rolling GDP growth. The key findings remained unchanged in this case as well.

Figure 6
Impact of GDP growth and interest rates on findings



Note: The horizontal axis shows time and the vertical axis shows wavelet scale s (in months) which corresponds to the component of the time series with the same period. The colour scale shows how robust wavelet coherency is between the two time series at a given point in time and on a given scale, to be understood as a correlation coefficient in the time-frequency domain. In the figure, the white outlines indicate the COI, outside of which the wavelet decomposition is distorted.

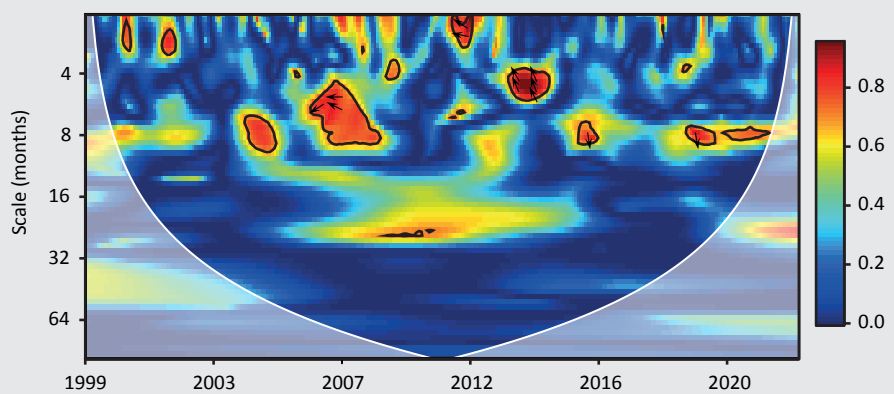
Source: Compiled from MNB, HCSO and Bloomberg data

[7] I.e. by subtracting the GDP growth rate from the monetary aggregate growth rate.

In addition, the evolution of interest rates may affect both inflation and money growth at the same time, thus producing endogeneity issues. Accordingly, as an additional robustness test, I repeated the wavelet analysis of the relationship between the two variables by eliminating the partial effects of the 3-month BUBOR rate. To eliminate rate effects, I calculated partial wavelet coherency analogously with partial correlation.[8] This also resulted in a coherency heat map similar to the original findings (*Figure 6*).

However, additional conclusions could be drawn from filtering out the effects generated by the fluctuations in the exchange rate.[9] When also considering the evolution of the exchange rate, coherency between the 16- to 32-month scales of the variables is found to be almost completely eliminated over the period from the mid-2000s to the early 2010s. As shown in *Figure 7* presenting the evolution of partial wavelet coherency, the range where wavelets were coherent in previous figures essentially never differs significantly from 0 when the partial effects of movements in the HUF/EUR exchange rate are eliminated (*Figure 7*). Therefore, it can be concluded that the coherency between the two variables in the early 2010s is partly attributable to exchange rate movements. Consequently, this provides stronger support for the key finding of the analysis that there is no permanent, long-run relationship between money growth and inflation.

Figure 7
Wavelet coherency and phase difference between annual M2 money growth and inflation, with partial effects of HUF/EUR exchange rate eliminated



Note: The horizontal axis shows time and the vertical axis shows wavelet scale s (in months) which corresponds to the component of the time series with the same period. The colour scale shows how robust wavelet coherency is between the two time series at a given point in time and on a given scale, to be understood as a correlation coefficient in the time-frequency domain. In the figure, the white outlines indicate the COI, outside of which the wavelet decomposition is distorted.

Source: Compiled from MNB, HCSO and Bloomberg data

[8] Partial wavelet coherency is presented in the *Appendix*.
[9] The partial effects of exchange rate movements were also eliminated by calculating partial wavelet coherency.

The above suggest that foreign currency lending reaching significant proportions in the mid-2000 may have been the underlying factor driving the previously seen relationship. Foreign currency lending is sensitive to the evolution of the HUF exchange rate as a stronger forint has the effect of reducing repayments of foreign currency loans. As a result, the exchange rate maintained through tight monetary policy increased money supply through lending, while interest rate spreads and relatively stable exchange rates made foreign currency lending more attractive than HUF-denominated loans, providing the population access to more credit in this structure (*Bethlendi et al. 2005; Kolozsi et al. 2015*). By boosting consumption *ceteris paribus*, this generated inflationary pressures on the demand side. Despite tight monetary conditions, inflation overall rose in the Hungarian economy, also driven by imported inflation and fiscal imbalances. A strong forint in this period contributed to the overheating of the economy, resulting in an apparent relationship between the two variables in question.

5. Conclusions

The analysis revealed that there is no stable relationship between money growth and inflation in Hungary which is consistent with the branch of literature that argues that no clear relationship can be found between the two variables since the 2000s (*Gertler – Hofmann 2018; Csiki 2022*). These findings are supported by a number of robustness tests. Of these, the analysis of partial exchange rate effects is highlighted. In the few years starting from the mid-2000s, comovements between the medium-run trends of the two variables disappeared with exchange rate effects eliminated, suggesting that the movements of both variables in question during part of the period under review were determined by the evolution of the exchange rate.

In the context of Hungary, *Komáromi* (*2007*) argues that the monetary base does not directly convey any information concerning expected inflation. The present analysis calls into question not only the monetary base, but also the relationship between total money supply in the economy and inflation. However, an important limitation to the study is that, although it looks at coherency between time series across multiple frequencies, there is only limited opportunity to interpret the relationship between lower frequencies due to the narrow COI.

The reasons for the absence of a relationship between inflation and money growth were partly revealed; other reasons, however, may be explained by different theories of money. Accordingly, future analyses may address the impact of other factors on the link between money supply and inflation in Hungary, such as financial innovations, financial regulation and the state of the labour market in relation to full employment. A deeper understanding of this relationship may also be facilitated by applying additional approaches besides wavelet decomposition, such as those based on error correction models.

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Appendix: The Mathematics of Wavelet Transform

As a starting point, the mother wavelet is defined. A square-integrable function $\psi(t) \in L^2(\mathbb{R})$ may be a mother wavelet if it meets the following admissibility condition (*Daubechies 1992*):

$$0 < C_\psi := \int_{-\infty}^{\infty} \frac{|\Psi(\omega)|}{|\omega|} d\omega < \infty, \quad (1)$$

where $\Psi(\omega)$represents the Fourier transform of $\psi(t)$, that is $\Psi(\omega)=\int_{-\infty}^{\infty} \psi(t)\, e^{-i\omega t} dt$. Here, ω represents the angular frequency from which the Fourier frequency can be derived using the formula $f=\frac{\omega}{2\pi}$. However, when identifying the mother wavelet, other criteria are often applied to the decay of the function in addition to condition (1). For a mother wavelet function decaying at the appropriate rate, a condition equivalent to the admissibility condition is that $\Psi(0)=\int_{-\infty}^{\infty} \psi(t)\, dt = 0$ holds. This means that the function oscillates a few times, and then vanishes.

The $\psi_{\tau,s}$ family of wavelets is generated by translating in time and scaling the mother wavelet ψ.[10] Temporal translation by τ means that the wavelet at time t takes the mother wavelet's value at time $t-\tau$, while scaling by *s* means that the wavelet takes *s* times the value of the (translated) mother wavelet. Thus, if $|s| > 1$, it is stretched, otherwise it is compressed.

Now, let $x(t) \in L^2(\mathbb{R})$. The continuous wavelet transform of *x* can be defined with respect to the mother wavelet ψ as follows:

$$W_{x,\psi}(\tau, s) = \frac{1}{\sqrt{s}} \int_{-\infty}^{\infty} x(t) \psi^* \left(\frac{t-\tau}{s}\right) dt, \quad (2)$$

where * denotes complex conjugation. The wavelet's temporal position is determined by τ and the degree of scaling by *s*. Thus, the wavelet transform localises the time series in both time and scale dimensions. This, however, results in significant redundancy as it decomposes a time series consisting of *n* observations into *n* time series of *n* elements.

Clearly, the time series includes no observations for many points in time where the application of formula (2) requires the mother wavelet be translated. In most applications, the start and end of the time series is padded with zeros in this case; I did the same in this analysis.[11] However, zero padding causes distortion at the edges of the interpretable time series. The level of distortion depends greatly on the scale as the greater *s* is, the longer time series is needed to generate the wavelet transform $W_{x,\psi}(\tau, s)$. The line within which there is no distortion is referred to as

[10] In the analysis, "mother wavelet" always means a function that meets the admissibility condition in equation (1), while "wavelet" means its translated and scaled form.
[11] It is also possible to loop the time series so that it "restarts from the beginning" at the end.

the cone of influence (COI) in the wavelet literature (*Torrence – Compo 1998*).[12] Results outside the COI are usually disregarded.

Generally, due to redundancy, the inversion of the wavelet transform is not well-defined. However, the transform has an energy-preserving feature and thus, if the mother wavelet is real-valued, the original time series can be reconstructed from the transform using the formula $x(t)=\frac{2}{C_\psi}\int_0^\infty\left[\int_{-\infty}^{\infty} W_{x,\psi}(\tau,s)\,\psi_{t,s}(t)d\tau\right]\frac{ds}{s^2}$. If the wavelet is complex-valued, but analytical, that is $\Psi(\omega)=0$ for each $\omega<0$ (meaning that its Fourier transform vanishes at negative frequencies), and $x(t)$ is real, the inversion can also be performed with the so-called Morlet formula (*Aguiar-Conraria – Soares 2014*):

$$x(t)=2\Re\left[\frac{1}{K_\psi}\int_0^\infty W_{x,\psi}(\tau,s)\frac{1}{s^{3/2}}ds\right], \tag{3}$$

where $\Re$ denotes the real part of the complex number and $K_\psi:=\int_0^\infty\frac{\Psi^*(\omega)}{\omega}d\omega$. Based on equation (3), it is possible to perform band-pass filtering of the time series x, which can be accomplished by performing the integration in the equation on a selected subset of scales.

So far, the functional form of the mother wavelet ψ has not been addressed. Following the majority of the wavelet literature, I used the Morlet mother wavelet for my analysis, which takes the following functional form:

$$\psi_{\omega_0}(t)=\pi^{-\frac{1}{4}}e^{i\omega_0 t}\,e^{-\frac{t^2}{2}}, \tag{4}$$

where ω_0 is a parameter.[13] The most frequently used value in the literature is $\omega_0=6$ (e.g. *Torrence – Compo 1998; Aguiar-Conraria – Soares 2014; Scharnagl – Mandler 2015*). This parameter value makes the conversion between scale and angular frequency simple as in this case $\omega\approx\frac{1}{s}$. Furthermore, this is when the wavelet reaches optimal joint time-frequency resolution (*Aguiar-Conraria – Soares 2014*). Generally, the Morlet mother wavelet is complex-valued and is analytical, thus allowing the original time series to be clearly reconstructed from the wavelet transform using equation (3). Additionally, the time series can also be band-pass filtered. As ψ is the same in almost all applications found in literature, hereinafter the simpler $W_{x,\psi}$ will be used instead of W_x.

The wavelet power spectrum can be calculated from the continuous wavelet transform as follows:

$$WPS_x(\tau,s)=\frac{1}{s}|W_x(\tau,s)|^2, \tag{5}$$

[12] On the functional form of the COI, see also *Torrence – Compo* (*1998*).
[13] The functional form defined in equation (4) does not meet the admissibility condition set in equation (1); however, when $5\leq\omega_0$, the difference becomes negligible.

where $|\cdot|$ denotes the absolute value operator. The wavelet power spectrum captures the local variance of the time series x. The correction of the power spectrum with $\frac{1}{s}$ is necessary so that the local variance is not distorted at higher frequencies, and therefore it does not underestimate variance in the physical sense (*Liu et al. 2007*).

As the Morlet mother wavelet is generally complex-valued, it can be decomposed into real and imaginary parts. The real part represents the local amplitude of the time series based on the formula $AMP_x(\tau, s) = \sqrt{WPS_x(\tau, s)}$. The imaginary part provides information on what phase each wavelet is in. This can be described with the phase angle: $\phi_x(\tau, s) = Arctan\left(\frac{\Im(W_x(\tau,s))}{\Re(W_x(\tau,s))}\right)$ where $\Im$ represents the imaginary part.

Now, let $x(t), y(t) \in L^2(\mathbb{R})$. In this case, cross-wavelet transform can be defined as follows (*Hudgins et al. 1993*):

$$W_{x,y} = W_x W_y^*, \tag{6}$$

where W_x and W_y are the wavelet transforms of time series x and y. The local cross-spectrum describing the covariance between the two time series can be calculated analogously to the power spectrum WPS. Spectrum correction is needed in this case as well (*Veleda et al. 2012*):

$$WCS_{x,y}(\tau, s) = \left|\frac{1}{s} W_{x,y}(\tau, s)\right|. \tag{7}$$

Following the definition of the correlation indicator, the so-called wavelet coherency indicator can be defined in the following form:

$$R_{x,y}(\tau, s) = \frac{S(WCS_{x,y}(\tau,s))}{\left[S(WPS_x(t,s))\, S\left(WPS_y(t,s)\right)\right]^{1/2}}, \tag{8}$$

where S is a smoothing operator in the time and scale dimensions.[14] Calculated using formula (8), $0 \leq R_{x,y}(\tau, s) \leq 1$, while $R_{x,y}(\tau, s)$ would be equally 1 across all points in time and scales without smoothing.[15]

For more than two variables, similarly to partial correlation, partial wavelet coherency can be calculated. To do so, first, the concept of complex wavelet coherency should be introduced. The latter can be defined in the following form:

$$\varrho_{x,y}(\tau, s) = \frac{S(\frac{1}{s} W_{x,y}(\tau,s))}{\left[S(WPS_x(t,s))\, S\left(WPS_y(t,s)\right)\right]^{1/2}}, \tag{9}$$

[14] On the functional form of the smoothing operator see, for example, *Torrence – Webster* (*1999*) and *Cazelles et al.* (*2007*).
[15] If the denominator in equation (8) is 0 somewhere, $R_{x,y}$ is set to 0.

meaning that the difference between equation (9) and equation (8) is that the former has a complex number in its numerator in a general case. Then, complex partial coherency is calculated using the following formula (*Aguiar-Conraria – Soares 2014*):

$$\varrho_{x,y\,-z}(\tau,s) = \frac{\varrho_{x,y}(\tau,s) - \varrho_{x,z}(\tau,s)\,\varrho^{*}{}_{y,z}(\tau,s)}{\sqrt{\left(1-R^2{}_{x,z}(\tau,s)\right)\left(1-R^2{}_{y,z}(\tau,s)\right)}}, \tag{10}$$

where $\varrho_{x,y\,-z}$ represents partial coherency between x and y calculated by eliminating the effects of time series $z(t) \in L^2(\mathbb{R})$. Based on this, the (real-valued) partial wavelet coherency is given as:

$$R_{x,y\,-z}(\tau,s) = \left|\varrho_{x,y\,-z}(\tau,s)\right|. \tag{11}$$

The phase angle can be generalised for the two-variable case as follows (*Grinsted et al. 2004*):

$$\phi_{x,y}(\tau,s) = Arctan\left(\frac{\Im(W_{x,y}(\tau,s))}{\Re(W_{x,y}(\tau,s))}\right), \tag{12}$$

therefore $\phi_{x,y} = \phi_x - \phi_y$. As a result, the indicator defined in equation (12) is also called wavelet phase difference.[16] The indicator can take values between $-\pi$ and π and shows the lead-lag relationship between the wavelets of the two time series at a given scale and at a given point in time. When $\phi_{x,y} = 0$, there is perfect comovement between the two wavelets; when $\phi_{x,y} \in \left(0, \frac{\pi}{2}\right)$, x and y are in phase (i.e. their peaks coincide) and time series x is ahead of y; when $\phi_{x,y} \in \left(0, -\frac{\pi}{2}\right)$, the two variables are also in phase and time series y is ahead of x. When $\phi_{x,y} \in \left(\frac{\pi}{2}, \pi\right)$, the two time series are not in phase (i.e. their peaks do not coincide) and y is ahead and when $\phi_{x,y} \in \left(-\frac{\pi}{2}, -\pi\right)$, x is ahead. If $\phi_{x,y} = \pi$ or $-\pi$, the two variables are in an antiphase relation (i.e. their peaks are in an exact opposite position). Phase difference can be converted to time difference as follows:

$$\Delta T_{x,y}(\tau,s) = \frac{\phi_{x,y}(\tau,s)}{\omega(s)}. \tag{13}$$

With the Morlet mother wavelet, this is approximately $s\phi_{x,y}(\tau,s)$, that is the product of the phase difference and the scale. It is important to note that a lead-lag relationship does not mean causality: if the time series x is ahead of y at a given point in time and on a given scale, it is still possible that, for example, it is actually y that causes x, but its effect is spread over more than one entire period.

[16] Other studies consider the argument of the smoothed cross-wavelet transform to be the phase angle, i.e. perform smoothing in equation (12) using operator S. In this case, generally, the relation $\phi_{x,y} = \phi_x - \phi_y$ does not hold (*Aguiar-Conraria – Soares 2014*).

I ran Monte Carlo simulations to test the significance of power spectrum (and coherency). Although a number of studies address the asymptotic distribution of wavelet coefficients and wavelet coherency (e.g. *Ge 2008; Cohen – Walden 2010*), the analytical density function always depends on the form of the mother wavelet and so it cannot be generalised. Furthermore, asymptotic distributions are also derived from Monte Carlo simulation, so it is evident to apply this procedure directly. I fit an $ARIMA(p, i, q)$ model to the time series and generated new time series using the estimated coefficients and by drawing from the standard normal distribution. Finally, I also calculated wavelet transforms and wavelet power and cross-spectra for them, thereby constructing the approximation of the asymptotic distribution (*Torrence – Compo 1998*).[17]

[17] Following the practice established in the literature, I only calculated phase differences for significantly coherent points in time and scales. I did not perform significance testing on phase differences as they are always distributed evenly between $-\pi$ and π so critical values cannot be established for the test (*Ge 2008*).

Changes in the Attitudes of Hungarian Shoppers in Times of Crisis*

Mária Törőcsik – László Csóka – Péter Németh – Ágnes Neulinger

The world is currently facing at least four simultaneous crises, including the still relevant shadow of the Covid-19 pandemic, the consequences of the Russia–Ukraine war, an economic crisis with significant inflationary pressures and a climate crisis that has been a decades-long source of anxiety for many. Each of these crises influences consumer and shopping behaviour and attitudes towards the future, with spill-over effects on the work of economic actors. Our study aims to contribute to an understanding of the relationship between crisis situations and shopping. Our findings are based on the results of an online survey conducted between 7 July and 20 July 2022. The online sample of 1,000 respondents is representative of the Hungarian population aged 18–74 in terms of gender, age, type of municipality, educational level and region. The aim of this study is to show how the four crises affect attitudes towards shopping, while it also touches upon the role of pleasure in shopping and the significance of anxiety about the future.

Journal of Economic Literature (JEL) codes: M31, M21, M30

Keywords: crises, consumer behaviour, quantitative research

1. Introduction; theoretical background to the analysis

People's lives and behaviour are affected by a wide range of national and global conflicts and critical life situations, such as disasters and emergencies. We are currently facing several crises, of which the Hungarian population is particularly affected by the livelihood crisis, the crisis linked to the Russia–Ukraine war, climate change and the lingering shadow of the Covid-19 pandemic. Based on the literature and our own empirical research, this paper explores the relationship between crisis situations and consumption, with the aim of showing how consumers' attitudes to shopping are affected by these crises.

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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Following the typology of *Shaluf et al.* (*2013*), modern society is faced with multiple crises around the world, including international political conflicts, social crises, economic crises and natural crises. The challenges associated with crises can also have a significant impact on people's consumption patterns. Crises can be sources of stress that force consumers to change their behaviour (*Mucci et al. 2016*). As found by *Durante and Laran* (*2016*), stressful circumstances lead to higher consumer spending in some cases and lower spending in other situations, depending on the control over perceived pressures. In their research, they found that people who have low stress tolerance are more likely to save or spend on essentials in order to successfully manage the situation and regain control. They also stress that the threat can affect spending through two channels: (1) the level of control over the threat, and (2) how this control affects the perception of certain products as essential necessities. With regard to future plans, the assessment of risks, the various effects of the consequences of a decision and even its ethical aspects are not only examined by economic organisations (*Somogyvári 2020*), but also by households and consumers in times of tensions and crisis.

In relation to the threat of *natural disasters*, *Larson and Shin* (*2018*) concluded that higher levels of fear were associated with higher levels of utilitarian and hedonic shopping behaviour. This means that a natural disaster, while making it difficult to shop, will lead some consumers to compensate for the stress of the situation by shopping. Furthermore, individual conditions (such as fear) and external conditions (such as limited access to goods) can both lead to consumer vulnerability (*Baker et al. 2005*), which may be most likely reflected in the consumer's inability to satisfy their needs at all, or only to a lesser extent or at a lower standard of quality. This vulnerability has been studied in a number of contemporary crises, such as the Covid-19 pandemic (*Yap et al. 2021; Yazdanparast and Alhenawi 2022*).

Numerous studies have investigated and continue to investigate the changes in lifestyle and consumption that occurred as a result of the *Covid-19 pandemic* (*Jakopánecz 2021*). These clearly indicate that the pandemic has changed consumer behaviour globally (*Komonen and Seisto 2022*). In China, for example, people preferred smaller retail stores or opted to shop online to avoid close contact with other shoppers in crowded stores *(Li et al. 2020*). Indian consumers showed a high level of intentionality in terms of their financial situation during the pandemic (*Mehta et al. 2020*), while a study by *Komonen and Seisto* (*2022*) found significant changes and adaptability in the lifestyle of Finnish consumers.

Less information is available on the impact of *military conflicts* on consumption. Before Russia invaded Ukraine, the impact of war on consumer behaviour was an area that had hardly been researched. Although there have been studies on the attitudes of consumers living in war environments for extended periods (*Rawwas et al. 1998*) and on changes in markets and consumption during post-war recovery

(*Shultz 2005; Manfredo and Shultz 2007*), global effects have been less studied, and local military conflicts have rarely been evaluated from a consumption perspective. By contrast, in the context of the Russia–Ukraine war, several studies have now assessed the economic impact of this conflict, focusing on energy consumption and the related difficulties (*Khudaykulova et al. 2022*), the negative impact of the war on global stock market returns (*Boungou and Yatié 2022*) and the issues with food security (*Yazbeck et al. 2022*).

A number of studies are available that examine *global economic crises* at the macro level. Among the economic impacts, consumers are particularly affected by the cost of living crisis, which is '*a situation in which the cost of everyday essentials like groceries and bills are rising faster than average household incomes*' (*Webster and Neal 2022:475*). This situation is associated with a slowdown in the global economy, uncertainty and high inflation, which has a significant impact on consumers' options and may thus change their consumption patterns as well.

Of the four major global crises examined in this study, the problem of *climate change* is not new and clearly affects consumers' lifestyles (*Bogáromi et al. 2020*). The threat of a climate disaster has become part of everyday reality for people around the world. Climate change, i.e. a change in the climate caused directly or indirectly by human activity (*Kolbert 2006*), is '*a socially represented phenomenon, environmental problem, threat, and narrative of environmental and societal risk and change*' (*Reser et al. 2011:21*). The link between consumption and environmental problems is a well-studied issue, and there is a rare consensus among academics in acknowledging the clear link between the climate crisis and consumption (*Assadourian 2010*). Consequently, consumption patterns need to be reviewed, but adopting pro-environmental behaviour, including conscious, sustainable consumption, can be a challenge for people (*Gifford et al. 2018*). As *Sanne* (*2002*) has noted, consumers are often constrained by systemic circumstances that make it difficult for them to change their consumption patterns.

A review of the research on crises and disasters shows that the relationship between crisis and consumption is under-researched, which may be related to the complexity and ambiguity of the study of the characteristics and aftermath of chaos and disaster (*Iacobucci 2019*). Studies are available on specific situations, such as climate change, the Covid-19 pandemic and inflation, and to a lesser extent on the perception of war risks. However, understanding how these threats, individually and collectively, relate to the relationship to shopping has not been a focus of interest for researchers before. While much is already known about the motivations of consumers and the factors influencing their behaviour (*Hofmeister-Tóth 2014*), our study aims to contribute to a specific area, that of the relationship between crisis situations and consumption. The aim of this research is therefore to show how the four crises that define life today (inflation, Covid-19, the Russia–Ukraine war, the

climate catastrophe) affect attitudes towards shopping, touching upon the role of pleasure in shopping and the significance of anxiety about the future.

2. Research history

The topic has not only prompted theoretical study, as global and Hungarian research institutes, consultancies, governmental and public bodies have also conducted their own related research. The aim of this section is to give an overview, based on data for 2022, of what people fear and perceive as problems in the areas that are the subject of this paper, i.e. rising inflationary pressures, the coronavirus pandemic, the climate situation and the war. As our primary research was also conducted in 2022, we collected analyses that relate to that period.

A *GfK* (*2022*) study points out that the primary problems of the events cited above, together with supply chain disruptions, are causing market problems, through which they affect consumers. *Ipsos* (*2022a*) conducted a comprehensive survey of this topic in autumn 2022, interviewing 30,506 respondents aged 16–74 in 29 countries. The survey primarily measured the issues and topics that people were most concerned about globally, the ones they found the most worrying, and also asked respondents whether they thought things overall were heading in the right direction in their own countries. The aggregate results show that the biggest problem globally, by a wide margin, was inflation in October 2022 (42 per cent said it was a problem) (this had been the most frequently cited problem since April 2022). This was followed by poverty and social inequality (with a 32 per cent ratio). In October 2022, as inflation rose and coronavirus fears fell during the period under review, only 10 per cent of respondents said that the pandemic was a problem. In Hungary, 6 per cent of respondents said the same.

The countries with the highest rates of respondents considering inflation as a problem (*Ipsos 2022a*) were the following:

– Poland – 70 per cent

– Argentina – 66 per cent

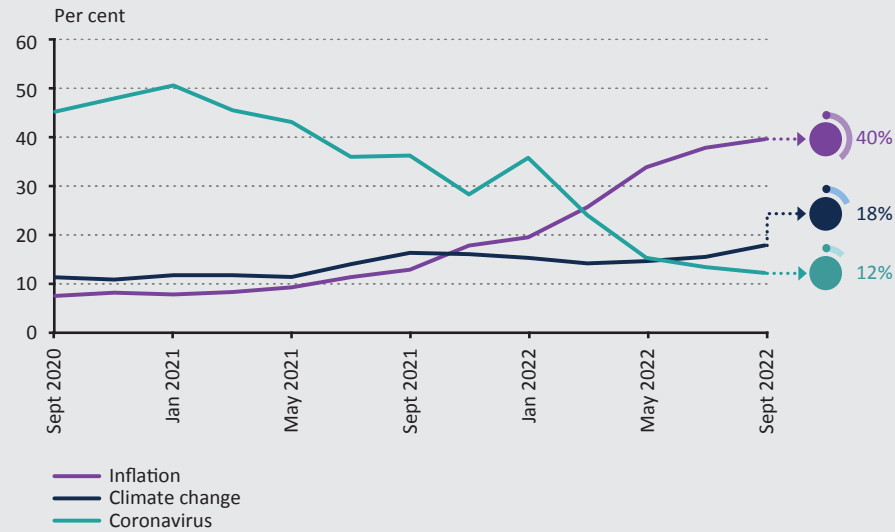
– Canada – 56 per cent

– Hungary – 53 per cent

– Turkey – 52 per cent

Looking at the data over the longer term (2020–2022) and including climate change, we see that as panic about the Covid-19 pandemic subsided, inflation concerns increased, while climate change fears increased minimally (*Figure 1*).

Figure 1
Longer-term trends in inflation, climate change and coronavirus concerns



Source: Ipsos (2022a:11)

In Hungary, climate change was considered a problem at a lower rate (9 per cent) than the global average (17 per cent) (*Ipsos 2022a*). The survey also asked respondents whether they considered military conflicts between nations to be a problem. 11 per cent of all respondents (i.e. the global average) responded affirmatively, compared to 12 per cent in Hungary.

The last key finding of the *Ipsos* (*2022a*) survey was that, globally, 64 per cent thought that things were not heading in the right direction in their own country, compared to 81 per cent in Hungary.

We also present the results of another survey by Ipsos (*Ipsos 2022b*), as we believe that they all contribute to our understanding of how people think about the future in the present situation. The research surveyed 24,471 18–74-year-olds in 36 countries using the Global Advisor online platform in the second half of October 2022.

Table 1 summarises the main findings, which indicate that Hungarians seem to be more pessimistic than the global average about the issues under review (most notably inflation, unemployment and an end to the war). There were also some signs of optimism in some areas: for example, lower proportions of Hungarians thought that 2023 would be the hottest year on record and lower proportions thought there would be lockdowns due to Covid.

Table 1
Expectations for 2023 globally and in Hungary

Statement	Global proportion of respondents who consider it likely	In Hungary, proportion of respondents who consider it likely
Prices will increase faster than people's incomes.	79	86
Inflation in my country will be higher in 2023 than in 2022.	75	79
Interest rates in my country will be higher in 2023 than in 2022.	74	72
Unemployment in my country will be higher in 2023 than in 2022.	68	76
The war in Ukraine will end in 2023.	40	36
There will be more extreme weather events in my country in 2023 than there were in 2022.	65	65
2023 will be the hottest year ever recorded in my country.	57	45
There will be no further Covid-19 lockdowns in my country.	60	51
2023 will be a better year for me than 2022 was.	65	69
The global economy will be stronger in 2023 than it was in 2022.	46	31

Source: Ipsos (2022b)

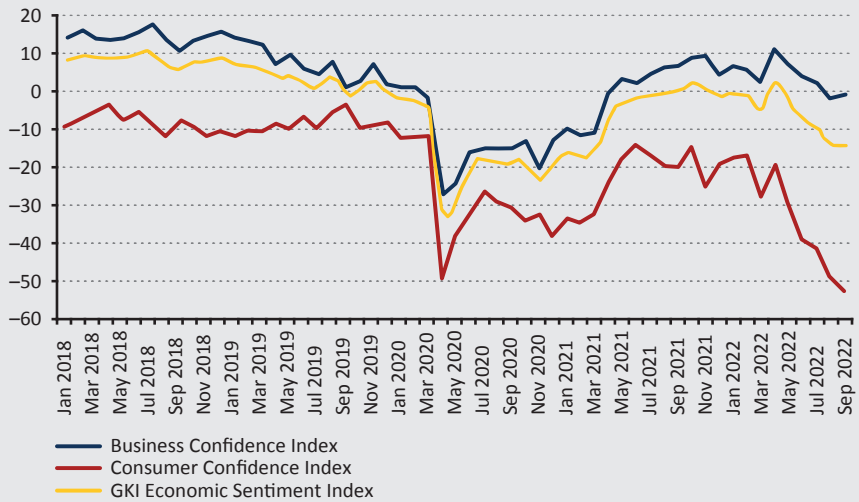
The research results reported by *Bazzoni et al.* (*2022*) show that the proportion of people with more pessimistic expectations increased in 2022 H2, rising from between 17 and 24 per cent in 2021 to 43 per cent in September 2022 (in this case, a sample of more than 5,000 people was surveyed in Europe).

Condon et al. (*2022*) found in an online survey of 1,247 people that inflation was the main risk factor, but that geopolitical instability and conflict were also a concern for many. The survey was conducted as part of the McKinsey Global Survey, which included interviews on several continents around the world, including Europe, North America, China, Asia–Pacific, South Asia, Middle East, Latin America and Africa.

Although we have referred to some Hungarian data above, we will supplement these with further, specifically Hungarian research results. The consumer confidence index measured by *GKI* (*2022*) fell even lower by the end of 2022 than at the start of the Covid-19 pandemic in Hungary (*Figure 2*), indicating pessimism in the Hungarian

population. Although the reasons for the decline in consumer confidence have not been investigated, the above data also suggest that inflation and geographical proximity to war played a major role.

Figure 2
GKI Economic Sentiment index and components, 2018–2022



Source: GKI (2022:2)

The *Hétfa Kutatóintézet és Elemző Központ* (*2022*) conducted a telephone survey of 1,000 people in Hungary in the first half of February 2022, in the days before the outbreak of the war in Ukraine. The survey found that Hungarians saw rising prices and the healthcare situation as the biggest challenges, followed by education, poverty and concerns due to coronavirus. Respondents put the sustainability challenges they perceived after these five factors.

The current situation is clearly a matter of interest to research institutes and economic actors with different profiles, and many studies provide a snapshot or a longer-term analysis of trends. Summarising the results of the surveys presented in this section, it seems that inflation is the biggest concern for populations in 2022, whether they were respondents from Hungary or other countries. The coronavirus situation was the least of people's concerns, but there was no direct fear of war or a climate crisis.

3. Material and method

We conducted an online survey to assess different areas of Hungarian consumer and shopping habits. The data was collected between 7 July and 20 July 2022 with the help of a professional market research company. Constituting part of a larger survey, our questionnaire (see *Appendix*), included, *inter alia*, statements on the relationship between crisis situations and shopping, voluntary restrained consumption, attitudes to sustainability and concerns about the future, some of which are analysed in this article.

The online sample is representative of the Hungarian population aged 18–74 with online access in terms of gender, age, type of municipality, educational attainment (primary, secondary or tertiary) and region. It is important to note that, by itself, the sample is not fully representative given its size of 1,000; therefore, to ensure representativeness, we have weighted the survey results back in line with the national ratios. The original sample size was 1,000, but following *Szűcs et al.* (*2023*), we carried out thorough data cleaning, so that the final sample consists of the answers of 839 respondents. Based on our experience with previous online questionnaires, we opted for a thorough data cleaning exercise to avoid inconsistent results later on. Our aim was to exclude from the sample respondents who probably simply 'clicked through' in their answers to the Likert-type questions without actually understanding them. For this reason, we excluded respondents who had a 0 standard deviation in their responses to Likert-type questions (33 in total) and respondents who gave significantly inconsistent answers (118 in total). Differences between the original and the cleaned sample were tested primarily by using the Chi-squared test based on *Sajtos and Mitev* (*2007*), and the Mann-Whitney U test for the single continuous variable. Based on these tests, the two samples do not differ significantly with respect to gender (p=0.385), age (p=0.567), regions (p=0.873), type of municipality (p=0.942) or education (p=0.828), so it can be concluded that the data cleaning procedure used to eliminate selection bias did not result in demographic-level bias, and the cleaned sample is suitable for analysis. Study participants were aged between 18 and 74 years (Mean=46.9, SD=15.31); for descriptive statistics on the sample, see *Table 2*.

Table 2
Presentation of the sample

	Sample (n=839)	Total population, Central Statistical Office (HCSO)
Gender (%)		
Male	48.1	48.0
Female	51.9	52.0
Age (%)		
18–29 years	18.8	21.0
30–39 years	20.3	22.4
40–49 years	18.2	18.4
50–59 years	19.8	19.1
60–69 years	16.3	14.5
70–74 years	6.6	4.6
Region (%)		
Central Hungary	31.2	31.5
Northern Hungary	11.7	11.3
Northern Great Plain	14.1	14.6
Southern Great Plain	12.0	12.5
Southern Transdanubia	10.6	8.9
Central Transdanubia	10.6	11.0
Western Transdanubia	9.8	10.2
Type of settlement (%)		
Budapest	18.6	17.5
City with county rights, county seat	21.9	20.3
Other city/town	30.1	32.2
Village, settlement	29.5	29.9
Education (%)		
Primary education	47.5	50.6
Secondary education	33.1	32.3
Tertiary education	19.5	17.1

Source: Compiled based on online research and HCSO (2023)

To measure crisis situations, we used specific statements that focus on the relationship to shopping in relation to the crises under review. Our statements measured a general subjective impression of each crisis situation, which for our purposes did not specifically quantify the monetary changes in shopping. We included four crisis situations in our study: 1. Covid-19 pandemic, 2. Russia–Ukraine war, 3. rising inflation, 4. climate catastrophe. The questions were formulated similarly in all the topics, such as for example: 'How much has rising inflation

changed your attitude towards shopping?'. Respondents expressed their opinions on a 10-point scale, where the end points were (1): 'changed in a negative direction' and (10): 'changed in a positive direction'.

Respondents expressed their concerns about the future with the help of a statement where responses ranged from (1) 'strongly disagree' to (5) 'strongly agree' on a 5-point Likert scale. The question used represents a scenario from the Worry Domains Questionnaire (WDQ) developed by *Tallis et al*. (*1992*).

Attitudes to shopping were measured using the approach of *Babin et al*. (*1994*), asking whether or not shopping was a real pleasure for respondents. Opinions were measured on a Likert scale of 10, from 1 (I really dislike shopping) to 10 (I definitely like shopping). In this case, the use of a 10-point scale as opposed to a 5-point scale was justified by the need to align with previous literature.

Attitudes towards sustainable shopping were also measured by the consumption reduction associated with sustainability. This phenomenon has been measured in a variety of ways in previous studies (*Pangarkar et al. 2021*) due to the lack of a uniform definition. Our survey included three items on reducing consumption, such as 'I have reduced my consumption to protect the environment', 'I am more careful about what I buy because I know how harmful overconsumption is' and 'I have recently stopped buying more products because I am more environmentally conscious'. To check the consistency of these three statements, a Cronbach's alpha test was performed with a value of 0.76, which can be considered a reliable measure of the phenomenon.

3.1. Statistical analyses performed

3.1.1. Descriptive analyses

Attitudes towards shopping, taking into account the crises and concerns about the future included in the survey, were assessed using descriptive statistics. The analyses also included statistical comparisons of the topics studied in terms of different demographic groups (*Malhotra and Simon 2009*).

3.1.2. Regression

General attitudes towards shopping ('How much do you like shopping in general?') may influence how respondents report changes in their attitudes towards shopping in the context of the crises under review. This relationship was assessed using linear regression analysis. Four analyses were conducted for each of the four crises, and as a first step, we checked in each model whether the variables to be included in the analysis met the basic conditions for performing linear regression.

In the analysis process, the following five conditions were checked, based on *Tranmer et al*. (*2020*):

1. The variables to be included in the analysis are continuous or ordinal variables;

2. There is a linear relationship between the dependent and independent variables;

3. The error terms follow a normal distribution;

4. The data are homoscedastic;

5. No multicollinearity between independent variables.

This paper presents only those linear regression models that fully satisfy these conditions.

In our regression models, we used shopping preference as an independent variable and shopping attitudes due to the four crises as a dependent variable. IBM SPSS 28 software was used to analyse the data and Microsoft Excel 2021 software was used to visualise the results.

3.1.3. Cluster analysis

The cluster analysis was carried out using variables measuring the change in the attitude towards shopping due to the crises. Prior to analysis, our variables were standardised to facilitate the interpretation of the resulting groups. Using the clustering characteristics, we first performed a hierarchical cluster analysis to determine the optimal number of groups (*Simon 2006*). We then identified the groups using K-means clustering, taking into account the optimal number of groups, and checked that, based on the ANOVA table of the analysis, all the parameters we examined were indeed classified as group-constituting. Based on their characteristics, we allocated names to the resulting groups that best capture their characteristics and thus express their essence. As a final step in the cluster analysis, we conducted a background analysis of the clusters, examining the demographic differences between them and their agreement with the statements highlighted in the research. To determine significant differences, a Chi-squared test was performed for nominal variables and an analysis of variance for Likert-type ordinal variables (*Sajtos and Mitev 2007*).

The data were analysed using SPSS 28 software.

3.2. Results

3.2.1 Attitudes to shopping in the context of the current crises

Our results show that all the crisis situations we investigated have a negative impact on attitudes towards shopping, but by different magnitudes. Attitudes towards shopping are most threatened by rising inflation and are less affected by the war in Ukraine, the climate disaster and the Covid-19 pandemic (*Table 3*). This is demonstrated by the fact that there is more than a full scale value difference

between the average values of rising inflation and of the Russia–Ukraine war. To facilitate interpretation, we refer back to the characteristics of the questions: 'How much has... changed your attitude to shopping?'. Respondents expressed their opinions on a 10-point scale, where the end points were (1): 'changed in a negative direction' and (10): 'changed in a positive direction'.

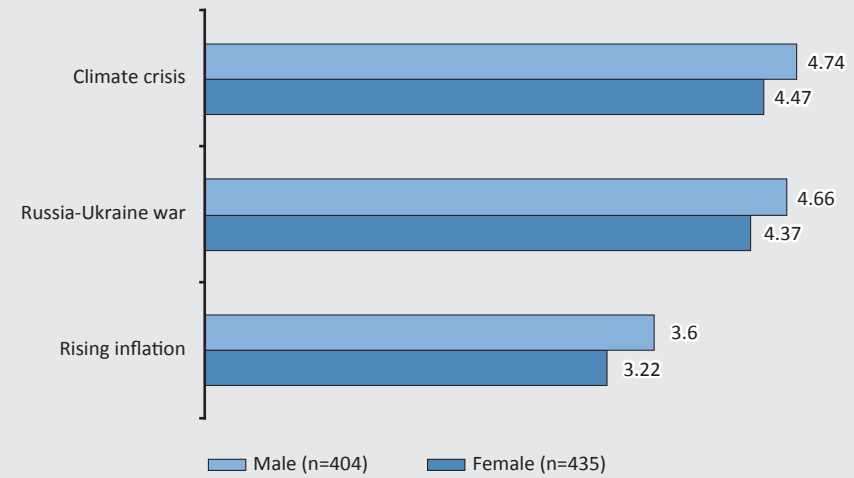
Table 3
Impact of crisis situations on attitudes towards shopping (n=839)

Reason for changed attitude towards shopping	Mean	Deviation
Rising inflation	3.40	1.828
Russia–Ukraine war	4.51	1.688
Climate change	4.60	1.468
Covid-19 pandemic	4.81	1.634

Source: Compiled based on online research

When examined by demographic group, there is a statistically significant difference between men's and women's views on the shopping implications of inflation, climate change and war. In all cases, women's perceptions changed more negatively than men's in relation to these crises, see *Figure 3* for details.

Figure 3
Significant gender gaps in perceptions of crises



Source: Compiled based on online research

The extent of public perception of the problem in the current multi-crisis situation can be illustrated by understanding how many respondents have had a negative change in their attitude to shopping as a result of one or more crises. Overall, the majority of respondents feel that their shopping attitudes have not changed due to crisis-induced threats (46.8%), with only 5.7 per cent of the sample reporting that all four crises have had a negative impact on their shopping attitudes, 13.8 per cent of the sample feeling the negative consequences of two threats and 26.5 per cent reporting a worsening of their shopping attitudes in relation to only one crisis. The latter were mainly motivated by rising inflation.

Taking into account the respondents who consider that all of the threats studied negatively affected their attitude towards shopping, women, 40–49-year-olds, those with lower educational qualifications and households without children are above average.

3.2.2. Concerns about the future and changing attitudes to shopping due to the crises

The majority of respondents are worried about the future (62.4%). The ratio is higher among women than men (67.4%, Pearson Chi-Square p<0.001). Differences between groups in terms of other demographic characteristics were not found to be significant. *Table 4* shows the mean and the standard deviation of the group of apprehensive consumers compared to the total sample for each case of attitude towards shopping. The table shows that those who are worried about the future tend to rate the worsening of their attitude towards shopping as greater in relation to every crisis situation. This is evidenced by the fact that their averages are lower for each of the crisis situations, which implies a larger negative change.

Table 4

Influence of crisis situations on attitudes to shopping among the group of people worried about the future

Reason for changed attitude towards shopping	Whole sample (n=839)		Worried about the future (n=523)		Not worried about the future (n=108)	
	Mean	Deviation	Mean	Deviation	Mean	Deviation
Rising inflation	3.40	1.828	3.10	1.882	3.89	1.602
Russia–Ukraine war	4.51	1.688	4.29	1.808	4.63	1.435
Climate change	4.60	1.468	4.44	1.594	4.75	1.378
Covid-19 pandemic	4.81	1.634	4.71	1.784	4.80	1.462

Note: The scale used for measurement: 1 – changed in negative direction, 10 – changed in positive direction.

Source: Compiled based on online research

3.2.3. Love of shopping and the impact of the crisis on attitudes towards shopping

Our results show that, although with low R^2 values, i.e. weak correlations, the more a person likes shopping, the less likely it is that the pandemic situation, the war and the climate crisis have negatively changed their attitude towards shopping (*Table 5*). In the case of inflation, no statistically significant correlation was found in terms of changes in attitudes towards shopping.

Table 5
Relationship between the love of shopping and the influence of crises on attitudes to shopping

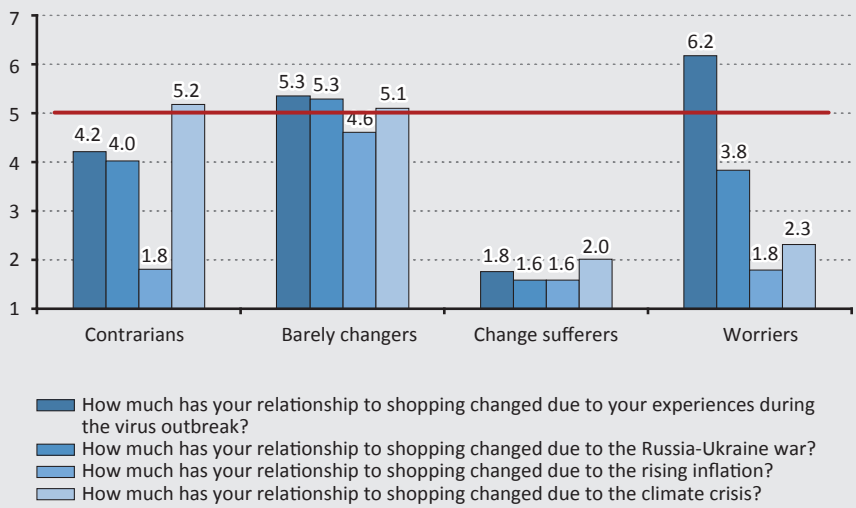
Reason for changed attitude towards shopping	R^2	Adjusted R^2	F	Significance level
Russia–Ukraine war	0.116	0.012	26.192	<0.001
Climate change	0.174	0.029	11.426	<0.001
Covid-19 pandemic	0.211	0.043	39.094	<0.001

Source: Compiled based on online research

3.3. Consumer groups, clusters

Not all of the factors studied which have a major impact on consumers have changed attitudes to shopping to the same extent. In order to obtain a more nuanced view of the changes in the behaviour of Hungarian consumers, it seemed necessary to form groups and interpret the shifts within them. In our cluster analysis, we used four clustering criteria, which were our questions relating to the four different crisis situations. All of these concerned how much the respondents thought each crisis had changed their attitudes towards shopping. As a result of our analysis, we divided the population into four groups based on their response to the effects that are likely to cause change (*Figure 4*). The optimal number of clusters was determined by hierarchical cluster analysis, where the diagram produced from the 'Agglomeration schedule' showed that both 4- and 6-group solutions would have been optimal. Ultimately, the 4-group solution proved to be the better solution for our research purposes and was chosen. Values above the red line in *Figure 4* indicate that the situation has had a positively valued effect, while values below the line indicate a negative change. It is important to point out that although there is no middle value on the scale of one to ten, where there is an even number of scale points, experience shows that respondents consider a value of five to be a middle, quasi-neutral value, so we have drawn the red line representing the middle value here, too. Our claim is supported by the fact that, for attitudes measured on the ten-point scales, the proportion of respondents who rate a five is outstandingly high.

Figure 4
Perception of change by cluster group



Note: Proportions of each cluster group within the sample: Contrarians: 24.4%; Barely changers: 58.0%; Change sufferers: 9.1%; Worriers: 8.5%. Red line is for the quasi-average value.

Source: Compiled based on online research

The characterisation of each cluster group is given in the description below, highlighting the characteristic features that explain the differences in response, although it is clear that validating and deepening these explanations requires a different methodology.

Contrarians (24.4%)

Members of this group show a positive shift in their attitude towards shopping due to the climate crisis, while inflation has induced a contrasting perception. They are mainly more highly educated persons, including high numbers of young people at the start of their lives, and mature single people. The perception of the climate crisis has led to a positive change in their shopping habits, but typically they have not really changed the content of their shopping basket in order to protect the environment. Inflation has clearly had a negative impact on their attitude to shopping. They appear to have marked concerns about the future.

Barely changers (58.0%)

The opinion of the members of the group is basically close to the line indicating 'no movement' for all factors, with a minimal negative impact of inflation, which is, uniquely, barely perceived by this group. The pandemic, the climate situation and the war have led to a minimal positive shift in their attitude towards shopping.

The group is of significant size and is dominated by males, older and with the highest income levels. The members of this group are the least worried about the future, tending towards the mean for almost all other attitudes tested. Since this group represents about 60 per cent of the sample, it may be true for a large part of the Hungarian population that the factors examined did not have a significant impact on their shopping routines at the time of the data collection. They have not reduced their consumption to protect the environment, nor do they tend to buy as little as possible.

Change sufferers (9.1%)

This group is negatively affected by all the changes, and they believe that all the factors examined have worsened their attitude to shopping. The members of this group are disadvantaged to start with, and are characterised by low levels of education and poor income. The segment is made up of older people living in small towns and villages, mainly women, and, of all the groups examined, this one includes the largest number of respondents who are unemployed or are in other status. They are cutting back on their shopping (their responses show that they are buying less because of environmental concerns), while they are the most concerned about the future. Their concern about the future is presumably intensified by livelihood issues, rather than as a consequence of other crisis phenomena of concern. It is important to point out that, since this is a group of persons in difficult financial situations, it is presumably inflation that dominates the changes in their shopping behaviour, even if they consider the impacts of all the crisis situations to be similar.

Worriers (8.5%)

This is the group most concerned about the future, which is understandable as it is the youngest age group, with a high proportion of people at the start of their adult lives and those with young children. Group members are characterised by a predominance of female respondents and a not very good income situation. They perceived a positive change in terms of the pandemic, while inflation had the most negative impact on their attitude towards shopping. Also prominent is the negative attitude towards shopping because of the climate crisis, with a high proportion indicating that they have recently given up buying more products because they are more environmentally aware.

As a result of the cluster analysis, we found that the 'Barely changers' group, which is of dominant size, is markedly resistant to various crisis situations in their attitude towards shopping, while for the smaller groups, we observed different reasons for change, ranging from being stuck in the minimal decision space provided by the financial situation to a marked expression of concern for the future. It may be assumed that a study combined with a qualitative research method would reveal

further implications. The interpretation of the results also needs to take into account the timing of the survey, as a more significant increase in inflation occurred after the July 2022 collection of the data, the impact of which would have been more pronounced at a later date.

4. Summary

In our study, we examined how people's attitudes towards shopping are changing as a result of the various crises we are currently experiencing. We included in the analysis the impact of the pandemic and the climate crisis, the Russia–Ukraine war and the inflation-triggered crises. A survey of 1,000 Hungarian adults (aged 18 to 74), conducted in 2022 on a representative sample of the Hungarian adult population, found that respondents reacted most negatively to inflation, while the impact of the other three crises was less pronounced, although those resulted in negative changes as well. Unsurprisingly, rising inflation was the main threat that changed the attitude of Hungarians towards shopping; after all, while average inflation in the EU-27 peaked in October 2022 (HICP: 11.5%) and has been slowing since then, in Hungary inflation peaked (26.2%) in January 2023, and started to fall only thereafter.[1] It is also worth adding that, overall, the majority of Hungarians are worried about the future, and the anxious are more likely to feel that crisis situations will negatively change their attitude towards shopping. However, Hungarians are widely known to be more pessimistic than the global average (*Ipsos 2022b*), which may have influenced this result.

The results of our research also suggest that women, who are typically the main shoppers in the family, are more sensitive to crises in their attitudes towards shopping, more open to reducing consumption for environmental reasons and more likely to be concerned about the future. Our results also show that not only gender, but also age and educational attainment influence the extent to which shopping attitudes change in a negative direction in the wake of crises. Thus, those in their thirties or with lower education levels are also more sensitive to the impact of crises on attitudes towards shopping. This conclusion is in line with previous studies: women are more likely to buy sustainable products *(Mohr and Schlich 2016*), more interested in and concerned about the future (*Tonn and Conrad 2007*), have a greater need for security and are more sensitive to crises (*Silva et al. 2022*). Previous studies have also shown that the more vulnerable are less able to cope with crises (*Quisumbing et al. 2008*). These factors should be taken into account in business activities that concern the groups indicated.

[1] https://www.ksh.hu/stadat_files/ara/en/ara0065.html

Cluster analysis has shown that there are also special response groups in addition to the 60 per cent dominant segment. The attitude of the 'Barely changers' group towards shopping has hardly changed as a result of the crises, and the respondents showed a remarkably low level of concern about the future. Another interesting result that deserves further investigation is that the members of the 'Worriers' cluster feel that the Covid-19 crisis has changed their attitude towards shopping in a positive way, even if only to a small degree. This may be linked to the changes in shopping habits developed by the Hungarian population during the pandemic. This points to the need for further research.

Limitations of our research include the difficulty of the survey questions and the complexity of the topic. Respondents may have had difficulty understanding the questions, which affects the reliability of the results. A further limitation is that both shopping and crises are associated with emotions, and it was not possible to explore this during this research. Likewise, there is a lack of understanding of the extent to which responses indicate desired or actual behaviour, which is particularly important in the case of environmentally conscious consumption. All this means that while our analysis was suitable for identifying correlations, we cannot reliably answer the question of what consumer considerations and explanations are associated with the responses and the related behaviour. To understand this, qualitative research will be needed in the future.

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Appendix

Questionnaire questions used in the analysis

Screening questions

Gender? female – male

Age? ……..

Where do you live habitually?

1. capital city
2. city with county rights, county seat
3. other city/town
4. village, parish

Which region do you live in?

What is your highest completed level of education?

1. Up to 8 years of primary
2. Secondary technical school, vocational school
3. Grammar school
4. College, university

Questions

How much do you like shopping in general? Please rate your opinion on a scale of 10, where 1 means you strongly dislike shopping and 10 means you strongly like shopping.

I really don't like shopping	1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10	I really like shopping

How much of a task or joy is shopping for you? Please give your opinion on a scale of 1 to 10, where 1 means that shopping is definitely a task for you and 10 means that it is definitely a joy.

task	1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10	joy

How much has your attitude to shopping changed as a result of what you experienced during the pandemic? Express your opinion on a scale of 10, where 1 means that it has changed in a negative direction and 10 means it has changed in a positive direction.

changed in a negative direction	1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10	changed in a positive direction

How much has the Russia–Ukraine war changed your attitude to shopping? Express your opinion on a scale of 10, where 1 means that it has changed in a negative direction and 10 means it has changed in a positive direction.

changed in a negative direction	1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10	changed in a positive direction

How much has rising inflation changed your attitude to shopping? Express your opinion on a scale of 10, where 1 means that it has changed in a negative direction and 10 means it has changed in a positive direction.

changed in a negative direction	1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10	changed in a positive direction

How much has the climate crisis changed your attitude to shopping? Express your opinion on a scale of 10, where 1 means that it has changed in a negative direction and 10 means it has changed in a positive direction.

changed in a negative direction	1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10	changed in a positive direction

How much do you agree with the following statements? Please express your opinion on a scale of 5, where 1 means you strongly disagree and 5 means you strongly agree.

1.	I am happy to buy as many things as I can.	1	2	3	4	5
2.	I am worried about the future.	1	2	3	4	5
3.	I am happy to try new brands.	1	2	3	4	5
4.	I want to slow down my life.	1	2	3	4	5
5.	I feel a great deal of uncertainty about how to implement my plans.	1	2	3	4	5
6.	Nowadays I consider multiple options for my shopping plans, because I do not know what will be feasible due to the changing circumstances.	1	2	3	4	5
7.	I love shopping.	1	2	3	4	5
8.	I want to speed up my life.	1	2	3	4	5
9.	I try to buy as few things as possible.	1	2	3	4	5

Which of the following groups would you most likely fit yourself into?

1 – Young person starting out in life
2 – Person with small child(ren)
3 – Person with older child(ren)
4 – Person with child(ren) no longer living at home
5 – Mature single
6 – No longer actively working

Where would you classify your family's monthly net income?

1. They make a very good living and can also set aside savings.
2. They make a living, but can put little aside.
3. Just enough to live on, and they can no longer save.
4. Sometimes it is not even enough to make a living.
5. They have daily livelihood problem(s).

Based on economic activity, where would you classify yourself?

1 – Full-time worker
2 – Part-time worker
3 – Public worker
4 – On maternity leave, childcare benefit
5 – Student
6 – Retired
7 – Unemployed
8 – Other

Are Default Rate Time Series Stationary? A Practical Approach for Banking Experts*

Gábor Szigel – Boldizsár István Gyűrűs

As the IFRS 9 accounting standard requires banks to recognise impairments based on a forward-looking expected loss concept, banks must estimate the quantitative relationship between default rates and macroeconomic indicators (GDP, unemployment, etc.). In such models, the stationarity of the (usually short) default rate time series is often the most critical issue. In this article, we provide practical advice for banking experts on how (under which circumstances) they can still use short default rate time series in OLS regressions even if those fail regular stationarity tests. We argue that if margin of conservativism is requested for the underlying default rate projections, then applying (seemingly) non-stationary default rate time series in OLS models might not necessarily be problematic.

Journal of Economic Literature (JEL) codes: C22, C53, G21, G32

Keywords: default rates, probability of default, stationarity, time series analysis

1. Introduction

It is not obvious why anyone should care about analysing the stationarity of default rate time series[1] *in general*. After all, if someone wants to use a specific default rate time series in a regression model, they can check the stationarity of it and act accordingly: for example, if they find that the given time series is non-stationary, then they will not use it as a target variable of an OLS regression and if they do not find other alternative modelling approaches, then they can look for other data or simply abandon their publication ambitions in the given topic.

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* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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[1] By default rate time series, we mean the default ratios of banks' loan portfolios defined based in the "Basel approach": the default ratio means the share of borrowers in the loan portfolio that will suffer a default event – over 90 days arrears or any other unlikely-to-pay event, e.g. bankruptcy. etc. – within 12 months.

This type of freedom is often not available to banking experts. The IFRS 9 accounting standard and the obligatory supervisory stress testing exercises "force" banks to estimate a quantitative relationship between bank-level risk parameters, e.g. probability of default (PD), or loss given default (LGD), and macroeconomic indicators to calculate the forward-looking adjustment of the former. To meet these external expectations, banks often must be satisfied with less ideal circumstances, such as default rate time series spanning only 10-15 years or (not independently of the aforementioned) contradictory or inconsistent stationarity test results that might change with each annual update.

In this paper, we provide some practical advice to banking experts who are required to work with default rate time series for IFRS 9 or stress testing purposes, where there is no obvious evidence that the series are stationary (or non-stationary).

Our approach is not without precedent as there has been much discussion in the literature on the stationarity of frequently used macroeconomic indicators, such as the GDP time series (examples: *Christiano – Eichenbaum 1990; Rapach 2002; Ozturk – Kalyoncu 2007*). To our knowledge, however, no similar analysis of the general stationarity of default rate time series has been conducted so far.

The article proceeds as follows: Section Two provides some context on the modelling exercises banks face in relation to default rates. Section Three summarises the concept of stationarity. In Section Four, we assess the circumstances under which default rate time series can be regarded as stationary, based on theoretical considerations. In Section Five, we use Monte Carlo simulations to illustrate that short, default rate like stationary time series tend to fail in the most common stationarity (unit root) tests. In Section Six, we show that alternative modelling techniques which can also be used for non-stationary time series often provide less conservative projections. Finally, we present our conclusions.

2. Modelling exercises with default rate time series in banking practice

Banks use quantitative models on the loan portfolio's default rate time series mostly for forecasting purposes. The approach goes usually as follows: first, they quantify the relationship between default rates and other external variables (mostly macroeconomic indicators, such as GDP, unemployment, etc.) based on historical observations and then they create (or take over) future scenarios for macroeconomic variables. Finally, they calculate projections for default rates from those scenarios based on the quantified relationship between them.

Banks prepare such default rate projections under different scenarios for at least four purposes:

- for internal purposes: to support business decisions of the management;
- to estimate expected loss-based impairments under IFRS 9;
- to conduct stress tests to meet supervisory expectations; and
- to estimate long-term (through-the-cycle, or TTC) probability of defaults (PD) (i.e. to calculate their capital requirements according to the IRB[2] approach).

When using the default rate projections for internal purposes, the only expectation of them is that they "work", i.e. they do not mislead the decisionmakers.

However, in the rest of the cases, external stakeholders such as auditors and supervisors also evaluate those models. These stakeholders have their own expectations: they request banks to find a statistically robust relationship between default rates and macro variables that can be properly documented. For example, during the regular stress testing exercise of the European Banking Authority (EBA), banks are requested to quantify their forecasts for loan losses conditional to very specific macroeconomic scenarios that the European Systemic Risk Board (ESRB) provides (*ESRB 2023*). Under IFRS, banks must estimate expected losses (along with the most important composite: probability of default) using quantitative models[3] for several different macroeconomic scenarios (for the relevant requirements of IFRS 9 models, see also: *Háda* (*2019*), for IRB models, see: *Nagy – Bíró* (*2018*)).

Although it is clear that there is some relationship between the default rates of banks' loan portfolios and the main indicators describing the general state of the economy, this relationship is usually not robust in time and not independent of the underlying structures; in fact, in this regard one should apply the "Lucas critique",[4] as was pointed out by *Simons and Rolwes* (*2009*). This was highlighted by the Covid-19 crisis as well: although Hungary suffered an economic contraction in

[2] Internal Ratings-Based

[3] It should be noted though that the IFRS 9 standard and its implementation in EU legislation does not explicitly require the application of quantitative models to calculate forward-looking expected losses. However, in actual practice, auditors and financial supervisory authorities tend to expect the development of such models. Interpreting IFRS 9 literally, an approach in which forward-looking PDs are set to the last observed default rate if no economic recession is expected and are otherwise set to 150 per cent of the previous observation would fulfil the general requirement of using forward-looking indicators, but in reality, auditors and supervisors expect banks to have much more sophisticated models in place.

[4] The Lucas critique – as formulated by *Robert Lucas* (*1976*) – originally states that impacts of changes in economic policy cannot be assessed purely based on dependencies between variables observed in the past and measured by econometric models. The reason is that the underlying structures influencing the decisions of the actors are not constant, and therefore the impacts of policy changes are unpredictable and cannot be reliably prognosticated by models in the long run. Lucas allows that econometric models might provide good forecasts in the short run, but only in cases when the structures and incentives of actors do not change abruptly.

2020 comparable to the Great Recession from 2008, the default rates of banks' loan portfolios remained low and very far away from the high levels of the post-Lehman episode, due to the different characteristics and government responses to this crisis.

Nevertheless, the expectations of auditors and financial supervisors force banks to model the correlations between default rates and macroeconomic indicators based on historical time series and apply those in their forecasts. Although the weaknesses of such models can be adjusted by (expert-based) "overlays", the application of some kind of quantitative model is inevitable. These are mostly simple, OLS-based regression models (although there are alternative approaches, as we show in *Subsection 3.5*.).

3. The concept of stationarity and its role in OLS regressions

In this section, we briefly summarise the concept of stationarity and its necessity in the case of time series applied in OLS models. As there are numerous textbooks on econometrics (e.g. *Békés – Kézdi 2019*) that cover this topic abundantly, we will keep this as short as possible.

3.1. The concept of stationarity

A time series – or to be more precise, the process generating it – is considered stationary if the characteristics of its distribution do not change over time. In banking practice, this definition is often simplified, and a process is considered stationary if its mean and standard deviation are constant over time ("weak stationarity").[5] Time series generated by stationary processes show random fluctuations around a constant mean, from which observations may deviate over the short run, but which they return to sooner or later ("mean reversion").

3.2. What makes processes non-stationary?

Processes and the generated time series can be non-stationary for several reasons:

- *Deterministic trend:* the process follows a time-dependent trend, e.g. it has a constant tendency to increase or decrease. Such processes do not have a constant mean. For example, stock exchange indices are non-stationary, because they tend to increase over the long run.

[5] Note that this is not the exact definition of weak stationarity. More precisely we would require that the mean of the process as well as the autocovariance of any two elements (of any distance away) are constant.

- *Stochastic trend (random walk)*: a process follows a random walk with an autoregressive coefficient between the adjacent observations larger than or equal to 1. For example, individual stock prices can be characterised by random walk, as today's share prices will be always close to yesterday's ones, but it is unpredictable where the prices will be in the long run. Such processes do not have a constant standard deviation (it increases in time) and their mean is not independent of previous realisations of the process,
- *Seasonality:* the mean of the process depends on a seasonal time factor. For example, ice cream sales are seasonal, as people tend to consume more ice cream during the warm summer months.
- *Structural break:* a structural break causes a permanent change of either the mean or other characteristics of the distribution of the process, and therefore they will not be constant over time. For example, sales of candles before and after the invention of electric lighting.

3.3. Stationarity and cyclical variables

We take a closer look at cyclical variables as our subject, as default rate time series are usually also cyclical. At first glance, cyclicality seems to be similar to seasonality: in both cases, there are alternating periods in which our variable takes values characteristic for the given period (winter/summer, crisis/non-crisis). However, there is a big difference: cyclicality – as opposed to seasonality – is not predictable,[6] as the length of the cycles is not constant or known in advance. Therefore, cyclical variables (such as GDP growth) can have constant mean and standard deviation if we look forward over a sufficiently long period. Moreover, the essence of cyclicality is that the process reverts to its mean after swings ("mean reversion"), which is one of the central assumptions of stationarity. Hence, cyclicality does not, *per se*, imply that a certain process is non-stationary.

3.4. Problems with non-stationary variables in OLS regressions: spurious correlations

The stationarity properties of a process are not interesting in isolation, but rather only when the time series generated by the process is used in a regression model. Using non-stationary time series in OLS regressions leads to "spurious correlation", as is well known since at least the 1970s from the article by *Granger and Newbold* (*1974*).

[6] Although in the past the economic literature raised the possibility that the economic cycles obey some kind of "laws of nature" and occur with more or less regular frequency ("the Kondratiev wave"), this idea is not accepted by most economists.

We speak of spurious correlations if variables seem to correlate in the observation period without a real reason,[7] i.e. only due to coincidence. This occurs most likely in the following circumstances:

- when both variables follow a *deterministic trend* (both are permanently increasing): these are the best-known examples of spurious correlations (e.g. the average temperature of Earth and the GDP of Hungary in the last 30 years);
- when both variables follow a *stochastic trend*, e.g. both are random walks. This is less intuitive, but the article of *Granger and Newbold* (*1974*) referenced above showed that spurious correlations can be easily found between random walks as the random shifts might make them change persistently and seemingly in the same direction;
- when both variables are *seasonal* (e.g. ice cream sales, number of drownings);
- when both variables have *structural breaks* or persistent changes (e.g. volume of candle sales and number of work horses in the last 100–150 years: both decreased due to the development of technology).

Spurious correlations (regressions) cannot be used properly for forecasting, because the relationship between the variables that they capture does not exist in reality and therefore will probably also not prevail over the forecast horizon. Typically, such spurious correlations in OLS regressions can be identified by very high R^2 and strongly correlated error terms (with Durbin-Watson statistics far below 1). The mathematical consequence of the autocorrelated error terms is that the t-statistics of regression coefficients (betas) will be overestimated and p-value becomes unreliable. Thus, the statistics based upon which we should decide whether the given explanatory variables have a statistically significant impact on the target variable are useless.

It is important to emphasise though that the decision as to whether our regression is spurious should not be based purely on statistical parameters. Theoretical considerations also need to be taken into account: can a direct causal relationship between the variables be explained, or are they driven by the same root cause, etc.? Only if they are, can one expect the relationship between the variables to be true based on such theoretical arguments.[8]

[7] I.e. without any direct or indirect causal relationship, or at least without a stable general root cause.
[8] Even though the correlation between the variables might be still much weaker in such cases than it is implied by our regression.

3.5. Alternative modelling approaches for non-stationary time series

There are modelling techniques that can capture the relationship between probability of default and macroeconomic variables and yet do not require the stationarity of portfolio-level default rate time series. For example, borrower-level estimation of PD including both borrower characteristics and macroeconomic variables by a logistic regression does not require the use of such time series, and this means there is also no issue with stationarity (as the estimator in such regressions is not OLS). Furthermore, non-stationary variables can also be estimated by OLS if they are co-integrated.

The authors are aware of the existence of such alternative approaches. However, these solutions usually require significantly more data and/or different circumstances that might not be available in the given environment. Therefore, the stationarity of portfolio-level default rate time series remains a relevant topic (at least for a while yet).

4. Stationarity of default rates based on theoretical considerations

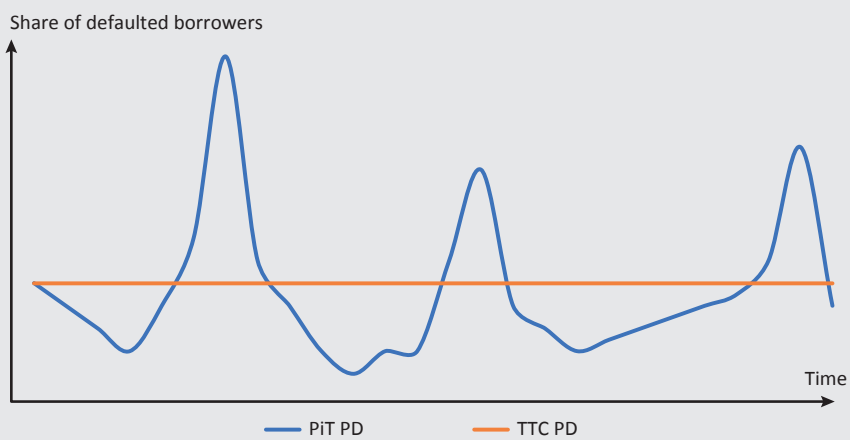
4.1. Stationary characteristics of default rate time series

Portfolio-level default rate time series, or to be more precise, the portfolio-level probability of default process generating such, have a number of stationarity properties based on economic theory:

- *Constant mean in the long term:* according to banking practice and the basic concept of the IFRS 9 accounting standard, banks' portfolio-level probability of default fluctuates around a long-term, through-the-cycle average, the so-called TTC PD (*Figure 1*). This would imply that the mean of the process is constant, that is, if the structural characteristics of the underlying loan portfolio (lending standards, composition, external regulation, etc.) are also constant. This is an important limitation which we will return to in *Subsection 4.3*.
- *Mean reversion*: after the high values of a crisis period, default rates tend to revert to lower values as the economic environment improves, thus coming back to a long-term average.

- *Time independency:* as deviations from the TTC PD are driven usually by the economic cycle, in which shocks often result from external and random events (such as the Covid-19 pandemic or the Russian-Ukrainian war), forward-looking realisations of PD do not depend on the actual default rates. Therefore, the cyclicality of PD is not as regular as, for example, a sinus curve (even though it is often depicted like that). On the contrary, it is much more common that "long, calm" periods are followed by a short crisis period (*Figure 1*). Therefore, this cyclicality is not deterministic as opposed to seasonal variables. Although annual default rates are usually autocorrelated (the default rate this year is similar to the one last year), this autocorrelation is not constant and not independent of the actual position of the cycle. It is also important to emphasise that even if there is a strong correlation between adjacent observations of the default rate time series, this does not imply non-stationarity as long as the autocorrelation coefficient is smaller than 1.

Figure 1
Illustration of the TTC and PiT PD



Note: PiT = Point-in-Time (actual), TTC = Through-the-Cycle (long-term average).

All in all, default rate time series are cyclical time series with mean reversion and – under the premises of constant portfolio composition and regulatory environment – a constant mean in the long run. These are stationary characteristics.

Furthermore, there are some general non-stationary characteristics (as presented in *Subsection 3.2*) that can obviously be ruled out in case of portfolio-level PD:

- as PD has a limited value set (between 0–1[9]), it cannot follow a deterministic trend;
- this limited value set also rules out the presence of a stochastic trend;
- PDs are clearly non-seasonal: the Basel regulation defines PD as the probability of default over a 1-year period, and therefore PD cannot exhibit intra-year seasonality.

4.2. Cyclicality and stationarity of default rate time series

Default rate time series are cyclical, but as we pointed out in *Subsection 3.3* cyclicality does not imply non-stationarity. However, another problem can be raised: if we try to regress default rates on other cyclical indicators, we might find relationships that are not causal, but only a consequence of the cyclicality. In banking practice, this problem is usually not relevant, as banks use the "root cause" indicators which represent the economic cycle the best (GDP growth, unemployment, etc.) for modelling purposes (as presented in Section 2).[10]

4.3. Stationarity and structural breaks in default rate time series

There is one factor that can endanger the stationarity of a portfolio-level default rate time series: possible structural breaks. These can be caused specifically by the following phenomena:

- *Changes in definitions or changes in the data collecting process*: these are the most obvious examples of structural breaks, such as the change in the EBA's definition[11] of default in 2017. Although these can be corrected by statistical methods, they inevitably increase modelling uncertainties.
- *Changes in lending conditions:* a bank can change its business strategy voluntarily or as a result of regulatory pressure and enter or withdraw from more risky client segments, which will necessarily change the portfolio's TTC PD (the mean of the process).

[9] In reality, PDs fluctuate usually in an even smaller range: e.g. mortgage loans typically have PDs between 0–5 per cent.

[10] However, the utmost caution is necessary here as there are many macroeconomic indicators that are cyclical, but do not represent the economic cycle the best. Certain components of GDP or their proportion to GDP – despite being often cyclical – might not capture the actual state of the economy the best. For example, exports/GDP might show cyclical patterns, but this indicator is clearly not a good representative for the state of the economy: it can deteriorate both when GDP is increasing or decreasing. Using such indicators to forecast default rates might be very misleading.

[11] Guideline *EBA/GL/2016/07* introduced a new default definition in 2017 that caused a level shift in the default time series of European banks which were not able to implement the new definition retroactively.

- *Changes in the external environment*: there may be other factors independent of banks' own actions which can have an impact on the TTC PD of loan portfolios such as government incentives (increase or decrease in moral hazard that may incentivise borrowers' willingness to pay, such as rescue programmes), changes in the legal environment (e.g. introduction or suspension of the "right of walk away" or bans on evictions, impacts of court decisions) or other cultural factors (e.g. the education process of borrowers).

If such changes are frequent, random and of limited impact, then they will not change a portfolio's TTC PD significantly in the long run, and thus they do not ruin the stationarity of the process. However, if there are only a few, but large structural breaks in the default rate time series, then the underlying process cannot be regarded as having a constant mean and being stationary.

Overall, default rate time series can be considered stationary based on purely theoretical arguments if the presence of significant structural breaks in its historical data can be ruled out with great certainty (or we can at least filter out their effects reliably).

5. Reliability of testing for stationarity in the case of default rate time series

Although, as shown above, it can often be decided based on theoretical-economic arguments whether a specific default rate time series can be assumed to be stationary, formal stationarity tests must be also performed, both due to practical and documentational reasons. The most widespread formal approaches to test stationarity tests are unit root tests such as the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, as well as some others. However, as highlighted in the following sections by a short literature review and by our own Monte Carlo simulations, these tests are not reliable on *short* time series and can often lead to a false identification of stationary processes as non-stationary.

This is a problem, because default rate time series – especially in the Central Eastern European region – tend to be short. As banks only started to collect default data from about the mid-2000s in line with the introduction of Basel II, the data collected by the 2020s ranges back 15 years at best. Additionally, this time span covers only one whole economic cycle (the post-Lehman crisis episode and the subsequent recovery, as data from the Covid-19 pandemic cannot be used for modelling due to the special circumstances of that period).

5.1. Challenges with testing on short time series

It is well-known in the literature that stationarity tests (in reality: unit root tests) are unreliable on short time series. *Arltová and Fedorová* (*2016*) showed via their Monte Carlo simulations that most stationarity tests provide misleading results with a sample size less of than 50 observations and show stationary processes to be non-stationary. The KPSS test, which – in contrast to other stationarity tests – operates with a null hypothesis that the process is stationary, provided the most precise results.[12] Autocorrelation in the underlying process makes the situation even worse: an autocorrelation of above 0.5 drastically reduces the reliability of all but the KPSS test, while an autocorrelation of above 0.7 will make even the KPSS test unreliable. This poses a problem for our particular case, as empirical experience – to which we will come back in *Section 5 and 6* – suggests that default rate time series (on annual frequency) tend to be highly autocorrelated (on a magnitude of 0.5–0.7).

There are alternative solutions to test stationarity on small samples: some authors provide alternative critical values for short time series, e.g. *Jönsson* (*2006*) for the KPSS test, and *Otero and Smith* (*2003*) and *Cheung and Lai* (1995) for the ADF test. Using these decreases the probability that the test will falsely identify a stationary process as non-stationary; in return, however, it increases the probability of the other type of error (identifying a non-stationary process as stationary). Furthermore, application of these alternative critical values has not become widespread. *Cochrane* (*1991*) also points out that highly autocorrelated processes – such as probability of defaults generating the default rates – might always be misrecognised by the tests on finite samples. All in all, the "philosophers' stone" of stationarity testing for small samples could not be found, and this is not surprising given that the basic challenge results from the fact that there are just simply not enough observations in small samples to see whether the underlying process has a constant mean and other stable distribution characteristics.

The way the length of the time series impacts the results of stationarity tests is illustrated by *Figure 2*: here, we see the default rates of the Moody's Ba[13] corporate rating class as observed each year between 1920 and 2006,[14] and the relevant t-statistics of the ADF test for each year calculated from the beginning of the time

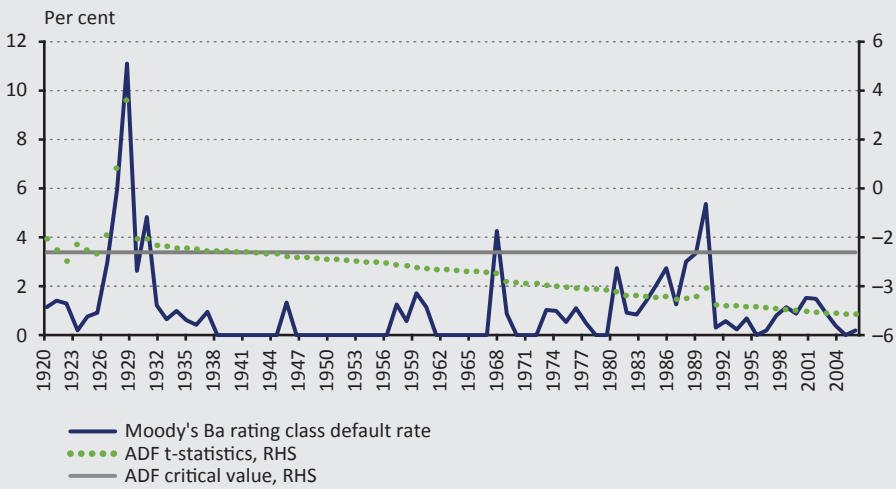
[12] While most stationarity tests (e.g. the ADF test) use the null-hypothesis that the time series has a unit root and thus the alternative hypothesis is that the data are stationary, the null-hypothesis of the KPSS test is the opposite, namely that the time series is stationary.

[13] We selected the Ba rating class because, in contrast to better rating classes, there have been enough default rate observations differing from zero over the years. Such default rates are much more similar to those of banks' loan portfolios, that include also more vulnerable borrowers than the AAA type of corporations.

[14] *Moody's* (*2007:20–21*): *Exhibit 21 – Annual Issuer-Weighted Corporate Default Rates by Letter Rating, 1920–2006*.

series up to the given year.[15] If the t-statistic is below the critical value of –2.6, the ADF test identifies the process as stationary at a confidence level of 10 per cent. As can be seen, for the first 20 observations/years, the t-statistic is larger than the critical value, implying that the process is non-stationary. This judgement of the test could also be confirmed by visual inspection to some extent: one can easily see an increasing trend in the default rates up to the 1930s. Over the long run, however, the ADF test clearly identifies the Moody's default rates to be stationary at the 10 per cent confidence level (moreover, from the 1970s at the 1 per cent confidence level as well). This example underlines how much the length of the observation period impacts the results of the test.

Figure 2
Default rate time series of Moody's Ba corporate rating class between 1920 and 2006, and the corresponding t-statistics and critical values of the ADF test



Note: t-statistic at time t shows what the t statistic of the ADF test would be if we calculated it for a time span from 1920 to time t. For more information on the number of lags applied in the test: see Footnote 15. Critical values are calculated without trend, but with constant for T=25 at the 10 per cent confidence level. Although critical values change slightly as the number of observations change, the difference is so small that it would not have an impact.

Source: Moody's (2007) and own calculations

[15] Calculated with constant. When choosing the appropriate lag order, we did the following: using the full-length time series, we assessed which lags were significant at a confidence level of 10 per cent and we omitted insignificant lags from the regression of the ADF test. As no lags were significant in the case of this particular time series, we did not include any of them – thus running a simple Dickey–Fuller test instead of the ADF. We note that including more lags would not change the decreasing trend of the t-statistic, though it would cause a shift in its value upwards. The ADF test would identify the Ba default rates as stationary up to 6 lags on the full length of the data up to 2006.

5.2. Results of our Monte Carlo simulations

The unreliability of stationarity tests on small samples is well-known from the literature, but the relevant research does not focus on default rate like processes, but rather on ones based on normal distribution. Default rate time series tend to have special types of distributions: their value set is limited (portfolio-level default rates cannot be outside of the 0–100 per cent range) and they are cyclical (crisis/non-crisis episodes following each other). Therefore, portfolio-level default rates cannot follow normal distributions.

This motivated us to assess the reliability of the ADF and KPSS tests for default rate like processes with the use of Monte Carlo simulations. We introduce two novelties compared to other authors such as *Arltová and Fedorová* (*2016*):

- We use the ADF and KPSS tests at the same time for the generated time series to assess whether this would increase the overall reliability of the tests ("at least one would recognise stationary processes correctly"). We pick these two tests because they are the most widespread ones in banking practice, and, even more importantly, they have an opposite null hypothesis and can thus complement each other (see also: Footnote 12).
- We test explicitly default rate like processes – ones with limited value sets and cyclical properties.

We assess the stationarity of eight processes, altogether: four non default rate like and four default rate like.

The *non default rate like processes* – which we test as a "control group" and to replicate the results of the literature – are the following:

Process No. 1: Stationary, non-autocorrelated, following normal distribution;

Process No. 2: Random walk (non-stationary);

Process No. 3: Stationary, highly autocorrelated ($\rho = 0.7$);

Process No. 4: Stationary, very highly autocorrelated ($\rho = 0.9$).

The following four are the *default rate like processes*. These processes were created in a way that they are all stationary:

Process No. 5: Limited value set, non-autocorrelated, cyclical: a variable with a randomly changing crisis and non-crisis mode (with two constant means, one for crisis, one for non-crisis), limited to the 0–1 value set;

Process No. 6: Limited value set, autocorrelated, mean-reverting cyclical: autoregressive process with random crisis shocks and with an additional error correction, that pulls back the process to its long-term average based on how high the deviation from this average was during the previous realisation. Limited to the 0–1 value set;

Process No. 7: Generated from corporate bankruptcy rates in Hungary by bootstrapping, non-autocorrelated: we chose randomly from the realised corporate bankruptcy rates in Hungary as presented in *Subsection 6.1* in more detail. The results will be default rate like, non-autocorrelated cyclical time series ranging between 0–1*;*

Process No. 8: Generated by fixed-length sections of the Moody's Ba rating class's historical default rate, autocorrelated: we chose fixed-length sections of the real Moody's Ba default rate time series from randomly selected starting date. The benefit of this approach is that the $\rho = 0.5$ autocorrelation of the Moody's default rates will be kept in the simulated time series*.*

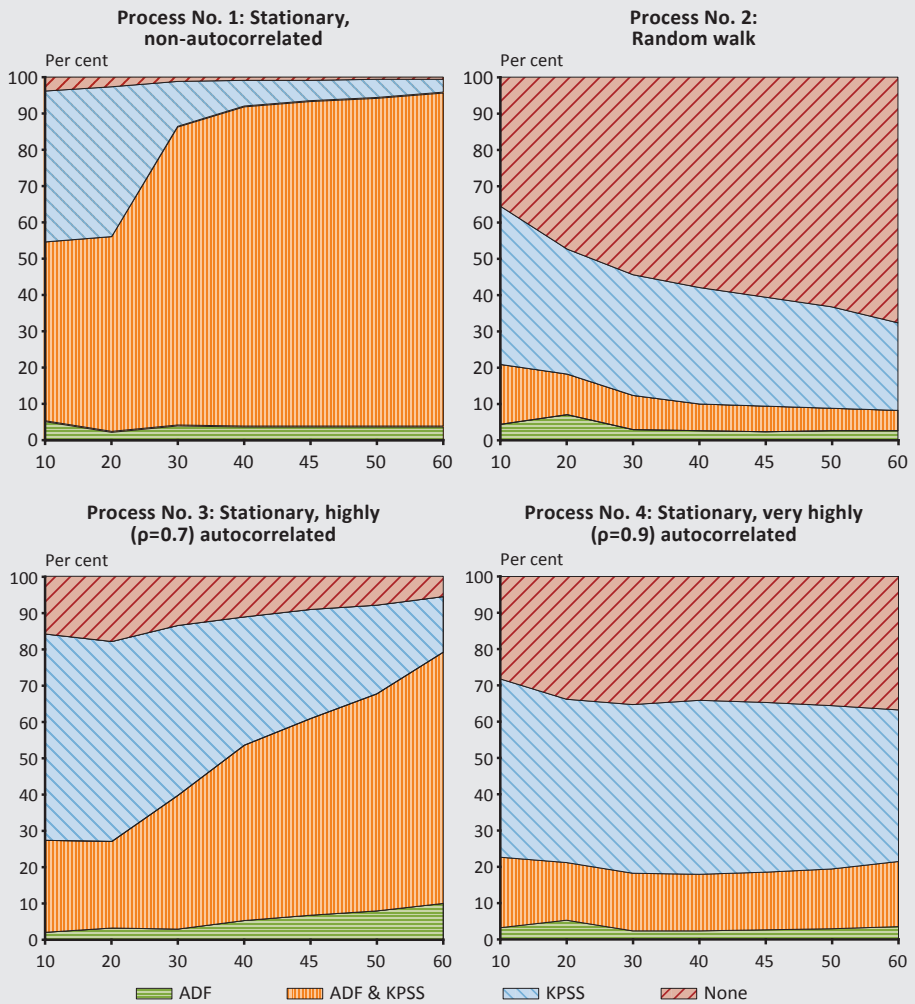
The exact definition of the above processes can be found in the *Appendix*. We generated 100,000 simulations for each process (except for *Process No. 8*, because the length of the original Moody's time series limited our possibilities; for further details, see the *Appendix*). The length of the generated time series varied between 10 and 60 observations (10, 20, 30, 40, 45, 50, 60). After this the relevant test statistics of the ADF and KPSS test were calculated using an embedded Python package (called "statsmodels.tsa.stattools") and compared to the critical values at the 10 per cent confidence level from *Dickey – Fuller* (*1979*) and *Kwiatkowski et al.* (*1992*)*.* Finally, the generated time series were categorised based on their test results:

- stationary according to only the ADF,
- stationary according to only the KPSS,
- stationary according to both,
- non-stationary according to both.

The simulation results for the non default rate like processes are summarised by *Figure 3*. These are in line with the literature: the ADF test often provides "false negative" results (recognising stationary time processes as non-stationary) for short samples consisting of 10–20 observations. Although the KPSS test mostly identifies the stationary processes correctly (i.e. as stationary) it fails to correctly categorise the non-stationary random walk process (Process No. 2), and therefore it is also unreliable. Both tests tend to accept their null hypothesis for the very short samples irrespective of the real characteristics of the underlying process. In the case of

strongly autocorrelated stationary processes (Process No. 3–4), the performance of both tests deteriorates further for the very short samples compared to how they behaved for the non-autocorrelated processes. In the case of lower autocorrelation, the precision of the tests improves with the sample size, but in the case of very high autocorrelation (ρ = 0.9) even increasing the sample size does not help.

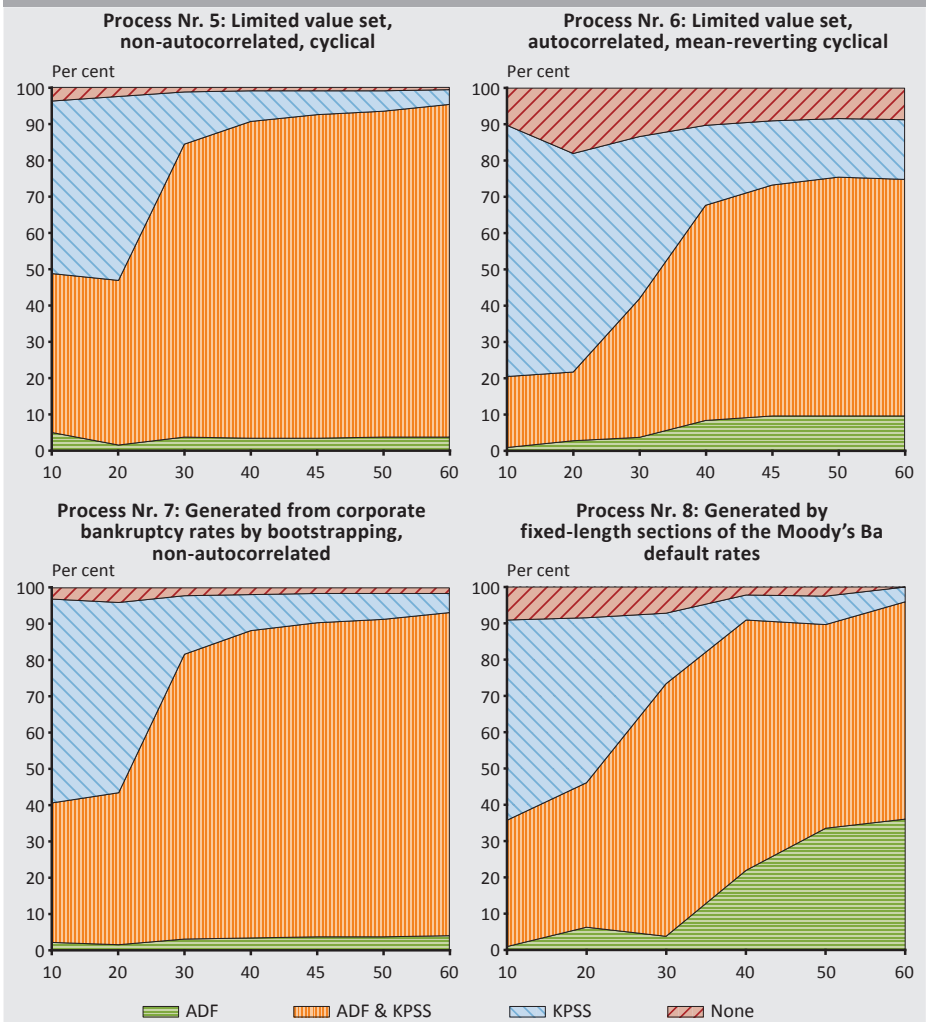
Figure 3
Results of the ADF and KPSS tests for the non default rate like processes for different time series length



Note: The figure shows what percentage of the simulated time series of different length (10, 20, 30, 40, 45, 50, 60) "passes" the stationarity tests (are recognised as stationary by the tests). The labels are the following: "ADF" = stationary only according to ADF, "ADF&KPSS" = stationary according to both tests, "KPSS" = stationary only according to KPSS, "None" = non-stationary according to both tests.

Figure 4 shows similar results for the default rate like (known to be stationary) processes as for the non default rate like stationary processes. Results for the non-autocorrelated processes (Process No. 5 and 7) are very much similar to the ones for the non-autocorrelated normal distribution process (Process No. 1): ADF often provides a "false negative" assessment for 10–20 observations and then its precision improves with an increase in sample size. For the autocorrelated processes

Figure 4
Results of the ADF and KPSS tests for the default rate like processes for different time series length



Note: The figure shows what percentage of the simulated time series of different length (10, 20, 30, 40, 45, 50, 60) "passes" the stationarity tests (are recognised as stationary by the tests). The labels are the following: "ADF" = stationary only according to ADF, "ADF&KPSS" = stationary according to both tests, "KPSS" = stationary only according to KPSS, "None" = non-stationary according to both tests.

(No. 6 and 8), ADF performs even worse on very small samples (T=10 or 20), and its reliability improves only gradually with more observations (it often misrecognises the stationary processes even with a sample size of 30 or 40). Although the KPSS test identifies the default rate like processes correctly as stationary with a high probability, the merits of this result are limited due to the known weakness of the test to misrecognise non-stationary time series as stationary. Even worse, KPSS fails to accept the stationarity of the autocorrelated Process No. 6 and 8. in a relatively high proportion of the cases.

All in all, the ADF test is not appropriate for correctly identifying stationary processes on very small samples (10–20 observations) and the same can be said for the KPSS test: even though the latter can recognise a stationary process as stationary if it is not highly autocorrelated, it will do so with non-stationary processes as well and furthermore it fails to correctly identify stationarity if the underlying process – as default rate time series are – is highly autocorrelated.

Therefore, if a time series consisting of only 10–20 observations fails these stationarity tests, that still does not mean it is certain that the underlying process is indeed non-stationary.

5.3. Increasing the sample by using a higher frequency of observations

The previous section also showed that the reliability of stationarity tests – especially that of the ADF test – improves as the sample size increases. In banking practice, it is a widespread approach to "enlarge" the sample sizes of default rate time series by increasing the observation frequency from annual to quarterly, i.e. by taking default rates for Q1 2007, Q2 2007, etc. instead of for 2007, 2008, etc. (whereby the default rate still reflects the share of defaulting borrowers within 12 months, only the frequency of starting points increases). With this approach, modellers can significantly increase the length of time series, as we have, for instance, 52 observations from the period between 2007–2019 at quarterly frequency as opposed to just 13 observations on an annual basis.

Nonetheless, increasing data frequency is not a "silver bullet" to solve stationarity issues with short time series: *Pierse – Snell* (*1995*) argue[16] that it is less effective than increasing the length of the sampling period. Additionally, there is a special challenge with increased frequency in the case of default rate time series: as the default ratio must be measured for a 12-month observation period (and

[16] The underlying argument is that "mean reversion" prevails only with the increase of the length of the observation period, but not with the increase of frequency. The same article also shows that in the case of a sufficiently long time series, data frequency does not have an impact on the results of stationarity (unit root) tests.

measurement for a shorter period is practically not feasible[17]), adjacent default rate observations at quarterly frequency will overlap by 75 per cent and will therefore be even more autocorrelated. This is a problem, because – as shown in Subsection 5.2 – the more autocorrelated the time series are, the less reliably the stationarity tests will work on them (especially KPSS).

Empirical experience shows that default rates on an annual frequency are highly autocorrelated in themselves. Autocorrelation increases further with the switch to quarterly frequency due to the overlap: for example, the corporate bankruptcy rates presented in Section 6 show an autocorrelation of 0.76 at annual frequency, but that jumps to 0.98 at quarterly frequency! Practical experience of the authors suggests that the autocorrelation of default rates of banks' different portfolios ranges between 0.6–0.8 at annual frequency, but 0.9–0.99 at quarterly frequency. If a process is so highly autocorrelated as given by the latter range, then even a sample size of 50–60 is not sufficiently large for the stationarity tests (especially for KPSS) to work reliably.

All in all, if we have annual default rate data from only 15–20 years, then transforming them into quarterly frequency will not solve the reliability problems of the stationarity tests: what we gain from the increase in the sample size, we might easily loose through the additional autocorrelation we cause.

6. Challenges with alternative modelling approaches

The false identification of stationary default rate time series as non-stationary takes a toll if it pushes banks to choose alternative modelling approaches that might generate worse forecasts for loan portfolios' PD than model types that require stationarity. What banking modellers often do to be able to use OLS estimations (which requires stationarity) is the following: they difference the (seemingly) non-stationary default rate time series and, as the differences of the adjacent default rate observations tend to constitute a stationary time series, they then enter those as the target variable into the OLS regressions. This practice is very widespread with many examples in the literature (*Balatoni – Pitz 2012*; *Gál 2019*), and it is often completely justified and correct.

[17] A series of challenges can be raised: intra-year seasonality of defaults, or the fact, that the default trigger of the 90+ days arrears can often simply not occur within a quarter in case of newly originated loans.

However, differencing the variables may also be unjustified as the models for the differenced target variable provide unreasonable results. In such cases, we can speak of over-differencing. *Cochrane* (*2018*) describes the underlying mechanism: the model with the differenced variable can often show only a much weaker relationship between the target and the explanatory variables, because such models do not only try to quantify the correlation (and causal relationship, ideally) between the variables, but implicitly also the timely co-movement between them (or in other words: the impulse response of the target variable on the explanatory variable).

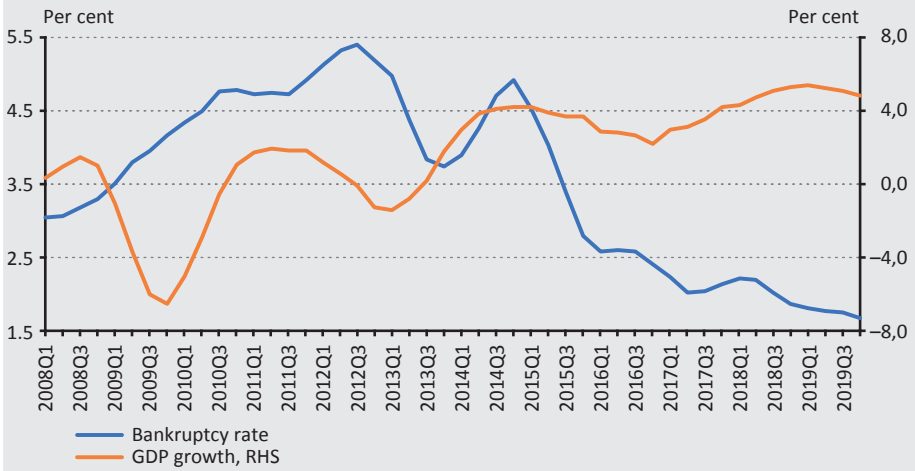
Translating this for our default rate case: PD models applied on the differences of the portfolio-level default rates will show a much weaker relationship between those and the macroeconomic variables, ultimately leading to forecasts in which the predicted default rates are completely insensitive to the state of the external environment. This is especially a problem, if estimates are expected by third parties (supervisors, auditors) to be conservative – similarly to the case of stress testing. In the following subsection, we illustrate a case of over-differencing with an example.

6.1. Example of the challenges of over-differencing

In our example, we regress the 12-month bankruptcy rate of Hungarian companies – which is a publicly available default rate like variable – on the 12-month GDP growth rate of Hungary, at a quarterly frequency. In order to simulate the data availability that is typical in Hungarian banks, the bankruptcy rate time series used is limited to the period between Q1 2008 and Q4 2019 (this is the time span for which Hungarian banks usually have default rate data to model with).[18] Overall, we have data from only one complete economic cycle. *Figure 5* provides an overview of the two time series we are using.

[18] In reality, corporate bankruptcy rates are available for the period between Q1 1996 – Q4 2022. We omitted the data between 2020 and 2022, i.e. the Covid-19 period from our modelling exercises, because that was a very special crisis period: GDP dropped abruptly and significantly, and then rebounded in a similar way, while bankruptcy and default ratios hardly increased, due to government and regulatory interventions (e.g. payment moratorium on loans). Treating this period appropriately still poses a challenge in banks' PD modelling exercises as well.

Figure 5
Corporate bankruptcy rate and real GDP growth in Hungary between 2008–2019



Source: MNB, Macroprudential indicators

Looking at the figure above, even without conducting any stationarity test one can immediately suspect that the bankruptcy rate will be stationary, because it shows a downward trend. It also seems likely in advance that an OLS regression will find a relationship between the bankruptcy rate and GDP growth as the former takes high values during the 2008–2013 crisis episode and low values during the recovery, while the latter has values the other way around. However, this relationship will be dominated by the experiences from the post-2008 crisis episode which will limit its usefulness for forecasting purposes – as the next crisis might not be like that of the previous one (the Covid-19 crisis was in fact not similar).

Conducting the ADF test on the bankruptcy rate finds it indeed non-stationary (t-statistic: –1.04, presence of a unit root can be rejected at a probability of 73 per cent). The first difference of the bankruptcy rate is clearly stationary by the test though (t-statistic: –2.03, presence of a unit root can be rejected at a probability of 96 per cent).[19] (We also note that GDP growth appears to be clearly stationary by the ADF test even for the period between 2008–2019, and for the full length of the time series).

[19] For both tests, the maximum number of lags was 7.

Then, we prepare two different models: we regress both the level and the difference of the bankruptcy rate[20] on GDP growth. The results are shown in *Table 1*. GDP is a significant explanatory variable in both models (at a 10 per cent confidence level), but the coefficients – expressing the strength of the relationship – differ by a magnitude: the β is 0.2 in the model on the level-variable, but is only 0.02 in the case of the model on the difference. Of course, none of the models is particularly good (R^2 is low, although the F-statistic is significant, but the Durbin-Watson statistics are very low, especially in the model on the level variable). However, our motivation here was not to find the best possible model, but rather to illustrate the consequences of treating non-stationarity problems by differencing. Moreover, in banking practice, similar situations regarding the availability of data and the quality of the models are common.

Table 1
Results of the two OLS regressions

Number of model	Target variable	Explanatory variables	Constant	β (of GDP growth)	R^2
1	Bankruptcy rate (level)	Constant, GDP growth	0.04***	–0.21***	0.27
2	Bankruptcy rate (difference)	Constant, GDP growth	Not significant	–0.02*	0.06

*Note: We also tried to use the difference of GDP growth as an explanatory variable in the models, but it turned out to be insignificant. Asterisks next to the coefficients have the usual meanings: *** significant at 1 per cent, * significant at 10 per cent.*

In model-technical terms, the model on differences seems to be the correct one, as the OLS estimations are run on a stationary target variable. However, this model shows hardly any relationship between GDP growth and the bankruptcy rates: according to this, an economic contraction of –1 per cent would lead to an increase of barely 0.02 percentage point in the bankruptcy rate in a quarter (+0.08 percentage points in a year).

[20] We note that it would be more appropriate to use some kind of logistically transformed version of the target variables in both models so that forecasts based on these models cannot fall outside the reasonable value set of default rates between 0 and 1. However, this would render the interpretation of the model coefficients more complicated, and therefore we follow this simplified approach for the purposes of illustration.

The insensitivity of the model on difference is reflected if we use the two models to predict bankruptcy rates during the Covid-19 crisis and compare those forecasts to what actually happened. To do so, we assume "perfect foresight", i.e. that the modellers would have known the realised GDP trajectories in advance. The results of this comparison are shown in *Table 2*. As we can see, none of the models would have been particularly successful in predicting bankruptcies: the model on levels would have provided strongly fluctuating forecasts for the first two years of the Covid-19 pandemic and would have overestimated the actual bankruptcy rates by far (even for the year of the economic rebound). It would have hit the bankruptcy rate in 2022 though. The model on differences would have predicted a relatively flat bankruptcy rate despite the big economic ups and downs and would have underestimated the rates over the whole forecast horizon, but especially in 2022. It is true that the model on differences would have been closer to reality – but only because bankruptcy rates proved to be just as insensitive to the deterioration of the economic circumstances in the first year of the pandemic as the model on differences.

Table 2
Predictions of the two models and reality

Quarter	Bankruptcy rate as predicted by the models one year in advance (%)		Bankruptcy rate in reality (%)	GDP growth (%)
	Model on levels	Model on differences		
2019Q4	–	–	1.7	4.9
2020Q4	4.9	1.7	1.4	–4.5
2021Q4	2.4	1.3	1.7	7.2
2022Q4	3.0	1.1	2.9	4.6

Note: In case of the model on difference, the forecast is prepared on the basis of the actual bankruptcy rate each year, to which we added the change of PD based on the forecasted GDP growth as predicted by the model assuming "perfect foresight".

However, we can assess the performance of the two models not only based on their precision in forecasting reality, but also based on their ability to meet the expectations of banks' external stakeholder – such as supervisors or auditors – with a preference for *conservative* approaches. For example, at the onset of the pandemic, when expected GDP growth was –4.5 per cent under perfect foresight, the model on differences would have predicted a flat bankruptcy rate, whereas the model on level would have anticipated a substantial rise in the number of bankruptcies similar to the levels experienced after the Lehman collapse. We have good reasons to assume that stakeholders targeting conservative, "prepare-for-the-bad-times" approaches (supervisors, auditors) would have hesitated to accept the results of the model on differences and would have preferred the model on levels

(even though reality would have proven them wrong). It is also hard to imagine that European banks could submit projected default rate trajectories like those coming from the model on differences, for example during an EBA stress testing exercise (which uses assumptions on GDP growth similarly severe to the first year of the Covid-19 crisis).

All in all, it would have been a mistake to dismiss the model on levels only because the level of bankruptcy rates fails on stationarity tests, because:

- it would have been probable that the test is wrong on the stationarity of the process generating the data because of the small sample size, and that bankruptcy rates are stationary in reality (although we did not assess the possibility of a structural break here);
- economic theory suggests that there is a causal relationship between economic growth and bankruptcy rates; and
- the alternative of the model on levels would have resulted forecasts that are completely insensitive to the change in the economic environment.

At the same time, it is also important to emphasise that the model on levels could have been used for predictions only if its limitations were presented transparently during the interpretation of results: namely, that it exclusively reflects the experience of the Great Recession after 2008, which might not be relevant for the actual economic environment (as it proved not to be relevant, in fact).

7. Conclusions and practical advice

In this paper, we analysed whether loan portfolios' default rate time series, or to be more precise the underlying processes generating them, can be considered stationary based on theoretical-economic arguments and whether the relevant unit root tests are appropriate to identify them in practice, with due consideration of the usually short length of these time series (observations often only from 15–20 years).

We found that default rate time series can be assumed to be stationary if there are no structural breaks in them, i.e. the underlying default definition, data gathering process, lending standards, legal environment and other borrower incentives, etc. did not cause a level-shift in the expected value of probability of default.

While to some extent these assumptions hold in many cases, default rate time series that are collected from an observation period with a relatively short time span often fail the regular stationarity tests (unit root tests). This is not surprising, as stationarity tests are unreliable for short samples (less than 30 observations),

especially if the assessed time series (and the underlying data generating process) are highly autocorrelated. As default rate time series tend to have these properties, it is probable that stationarity tests identify them falsely as non-stationary, especially if the number of observations is less than 30.

Using non-stationary variables in an OLS regression is not advisable as it can lead to "spurious correlations". Accordingly, modellers choose alternative modelling approaches such as differencing of the target variable if it is thought to be non-stationary. However, this is often a bad choice for banks' default rates, at least for purposes which require conservativism (such as stress testing or IFRS 9 forward-looking expected loss models): although models on differences usually have better properties in econometric terms, they tend to quantify weak relationships between default rates of loan portfolios and the macroeconomic environment. Predictions based on such models will often be unsensitive to the expected deterioration of economic circumstances and hence not conservative enough.

As a conclusion of our analysis, we provide the following advice to banking experts:

- Take extra care when assessing the stationarity of default rate time series if the data is of less than 20-30 years (be careful in general, of course).
- As stationarity (unit root) tests with opposite null hypotheses (such as ADF and KPSS) tend to accept their own null hypothesis on small samples, it is a good rule of thumb to accept their results if those are consistent (meaning that at least one of the tests with opposing hypotheses rejected its null).
- Short default rate time series should not be assessed as non-stationary solely based on the results of stationarity tests, especially if they fail only one of the tests. Expert judgement should be used to consider theoretical-economic arguments that might justify the stationarity of the default rate time series.
- When undertaking the above, special attention should be paid to the presence of structural breaks: if these are absent, then short default rate time series can be assumed to be stationary even if they fail stationarity tests or if different tests provide inconsistent results.
- If the purpose of default rate modelling requires conservative predictions (e.g. in the case of stress testing), then it is not necessarily incorrect to use the level of default rates as target variables in OLS regressions, even if they fail stationarity tests. Especially if the only alternative is a model on differences that is insensitive to the explanatory variables (to the change of the external environment)
- However, when interpreting model results, it should be presented transparently in what way the above model-technical choices might distort the predictions, and when (under what circumstances) they might work well and when they cannot.

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Appendix: Formal definition of the processes used in the Monte Carlo simulations

We used the following processes in our Monte Carlo simulation exercise:

1. Stationary non-autocorrelated $(\rho = 0)$ *process*

$$y_t \sim \mathcal{N}(\mu;\ \sigma^2)$$

2. Random walk, non-stationary unit root $(\rho = 1)$ *process*

$$y_t = y_{t-1} + \varepsilon_t$$

$$y_0 \sim \mathcal{N}(\mu; \sigma^2)$$

$$\varepsilon_t \sim \mathcal{N}(0;\ \sigma^2)$$

3–4. Stationary, strongly-correlated $(\rho = 0.7 \text{ and } \rho = 0.9)$ *processes*

$$y_{t+1} = \rho y_t + \varepsilon_t$$

$$y_0 \sim \mathcal{N}(\mu;\ \sigma)$$

$$\varepsilon_t \sim \mathcal{N}\left((1-\rho)\mu; \sqrt{1-\rho^2}\sigma\right)$$

where $\mathcal{N}()$ stands for the normal distribution.

5. Bounded, non-autocorrelated, cyclic stationary process

$$y_t = \begin{cases} \mathcal{N}(\mu * 0.8;\ \sigma), & Rnd_t > p \\ \mathcal{N}(\mu * 2.4;\ \sigma), & Rnd_t \leq p \end{cases},$$

where the generated values are bounded to the 0.003–1 region,

$$y_0 \sim \mathcal{N}(\mu;\ \sigma),$$

where $\mathcal{N}()$ stands for the normal distribution, Rnd_t is a random value between 0 and 1 corresponding to time t, and *p* is the probability of crisis shock (chosen to be 12.5 per cent). There are two states in this process: the crisis phase, when the generated values fluctuate around a "crisis mean value" and the non-crisis phase, when the generated values fluctuate around a "non-crisis mean value". The crisis and non-crisis mean values and the value for the probability of crisis shock was chosen in such a way that the overall mean of the process is μ, while the variance is σ. 5 per cent was selected for the value of μ (which is not an unrealistic estimate for

the default rate of a loan portfolio), and thus the boundary associated with the 0.003–1 interval rarely applied. Note that the choice of the minimum (0.3%) is set to be non-zero, because of the non-zero PD in the Basel regulation.

6. Bounded, autocorrelated, mean-reverting stationary

$$Shock\_d_t = \begin{cases} 0, Rnd_t > p \\ 1, Rnd_t \leq p \end{cases},$$

$$y_t = \begin{cases} 3 * y_{t-1} + \mathcal{N}(0; \sigma) + (y_{t-1} - \mu * 0.8)/3, Shock\_d_t - Shock\_d_{t-1} = 1 \\ y_{t-1} + \mathcal{N}(0; \sigma) + (y_{t-1} - \mu * 0.8)/3, Shock\_d_t - Shock\_d_{t-1} \neq 1 \end{cases},$$

wehere *Shock_d* denotes a shock dummy and the generated values are limited to the 0.003–1 region.

$$y_0 \sim \mathcal{N}(\mu; \sigma),$$

where $\mathcal{N}()$ stands for the normal distribution, Rnd_t is a random value between 0 and 1 corresponding to time t, and *p* is the probability of crisis shock (chosen to be 12.5 per cent)*. The effects of the crisis shock are somewhat different compared to those in the previous processes.* If a crisis shock occurs in a non-crisis year the following datapoint will be three times that of the previous one. If the crisis shock occurs in a crisis year, the process will simply take the value of the previous observation as a basis. These values are then supplemented by a normal error term and a mean reversion term, the latter of which is responsible for pulling the value back the current value of the series to the average. This reversion becomes stronger as the values start to diverge. 5 per cent was selected for the value of μ and thus the boundary associated with the 0.003–1 interval rarely had to apply. Note that the choice of the minimum (0.3%) is set to be non-zero, because of the PD floor in the Basel regulation.

Although it might seem like this process is non-stationary, after careful numerical analysis (e.g. Monte Carlo simulation), one can quickly deduce that the mean and the variance are independent of time.

7. Generated from corporate bankruptcy rates in Hungary by bootstrapping, non-autocorrelated process[21]

Table 3 summarises the corporate bankruptcy rates in Hungary between 1996 and 2022 (i.e. 27 observations). During this process, selecting the data points is done by randomly selecting values from this table, allowing for repetition.

Table 3
Corporate bankruptcy rates in Hungary between 1996–2022

Year	Bankruptcy rate (%)	Year	Bankruptcy rate (%)	Year	Bankruptcy rate (%)
1996	2.9	**2005**	2.8	**2014**	4.9
1997	2.5	**2006**	3.1	**2015**	2.8
1998	2.3	**2007**	3.0	**2016**	2.4
1999	2.2	**2008**	3.3	**2017**	2.1
2000	2.5	**2009**	4.2	**2018**	1.9
2001	2.7	**2010**	4.8	**2019**	1.7
2002	2.6	**2011**	4.9	**2020**	1.4
2003	3.0	**2012**	5.2	**2021**	1.7
2004	2.8	**2013**	3.8	**2022**	2.9

Source: MNB (2023) Report on Financial Stability, May 2023, Macroprudential indicators, Chart M11. (https://www.mnb.hu/letoltes/melleklet-abrai-2023-majus.xlsx)

8. Generated by fixed-length sections of the Moody's Ba rating class's historical default rate, autocorrelated

One takes the Moody's Ba rating class's historic default rate (shown in *Figure 2*) and selects fixed sized sections of it (10, 20, 30, 40, 50, 60 observations) using every starting point. As the longest interval is 60 observations long, there are only 27 possible starting points in the 87-datapoint long dataset. To preserve statistical consistency, it was decided to use 27 randomly selected sections for all the other lengths (10, 20, 30, 40, 50) as well.

[21] Note that a slightly different version of this process was also examined, in which the technique of bootstrapping was used on the Moody's Ba rating class's historical default rate instead of the Hungarian corporate bankruptcy rates. The results of this version were almost identical, and so it is not presented here.

Trends in Income Inequality and Its Impact on Economic Growth*

Réka Vitkovics

In recent years, climate change and the pandemic have brought the issue of the link between inequality and economic growth to the fore. In my essay, I examine this relationship, focusing on whether inequality has a positive or negative effect on economic growth. I approach the issue through the lens of income inequality without seeking to explore all aspects of inequality. Starting from the relevant conceptual framework, I present the link between global inequality and long-term growth. Since inequalities affect both developed and developing countries, I compare them and show why the latter cannot repeat the economic progress achieved by earlier industrialisers. Finally, I conclude that the clear objective should be to reduce excessive inequalities.

Journal of Economic Literature (JEL) codes: B55, D63, F63, O15

Keywords: social inequality, income inequality, income distribution, economic growth

1. Introduction

Issues of rising inequality have been a subject of economic thinking for centuries, but in recent years they have become increasingly important and are a critical problem in most countries around the world. As the IMF, the World Bank and other institutions have predicted, one of the most acute current problems is that the pandemic has brought about a further increase in inequality. Looking back over the past few years, we find many examples of this.

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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Inequality is a complex issue with many facets that is present within individual countries as well as between countries. In some parts of the world, divisions based on identity are becoming more pronounced, while in other there are disparities in access to basic services such as education or health care. There are also those who lack access to the basic necessities of life such as water, food of an adequate quality and quantity, and a secure home. Additionally, new areas have emerged, such as access to the online space and to different technologies, where differences pose challenges.

Circumstances beyond an individual's control also affect their chances of managing in life, such as gender, race, ethnicity, and for children, the socio-economic status of the parents or whether they were born in a developed or developing area, as well as migrant status. Since not all of us start out on an equal footing, these social inequalities can affect the economy in myriad ways through its driving forces. A child born in a developing country or into the poorest class of a developed country will not receive the same education as a child born in a developed economy or the upper social class. As a result, they will not have the opportunity to tap their potential later on, they will not be able to contribute to economic growth, or at least, not as much as they could have had they received the right education.

Similarly, inequalities in people's health have an impact on economic performance. Access to health care among the poor, be it a country or a social group, is also a major challenge. In a developing country, for example, society is mostly made up of young people. This age trend can be explained by low life expectancy, on the one hand, and high infant and child mortality rates, on the other. This is due to a lack of health care, as there are not sufficient resources – money and knowledge – to run an adequate health care system. The health indicators listed above can be considered as relevant measures of the level of development, and accordingly this is not only a social issue but also, like education, a matter of economics and politics.

The aim of my essay is to explore whether inequalities encourage or hinder economic growth. It is not possible to describe all areas of inequality with a single indicator, but the best way to illustrate the topic is perhaps through income inequality.

2. Definition of inequality

Inequality is a multidimensional challenge that can take many different forms, and so it is important to clarify some basic concepts. The relevant literature distinguishes between the inequality of outcome and the inequality of opportunity which often

determine each other. For us, the most important is income inequality, which falls into the first category and shows the distribution of income earned in an economy across the population, usually calculated at the household level, weighted by the number and age of household members. It is measured by a number of indicators, among which the internationally applied Gini coefficient is the most common. It ranges from 0 to 1: the higher the value, the greater the inequality (*EC 2017*). *Deininger and Squire* (*1996*) explain that the coefficient is based on the Lorenz curve, which plots the share of population against the share of income received. However, when Lorenz curves intersect, a change in the Gini coefficient may not accurately reflect changes in the welfare of particular groups of the population, i.e. despite the apparent stability of the Gini coefficient, there may be significant changes in the income shares of the quintiles of the population within the countries. The share of quintiles, or income fifths, in total income gives an idea of the degree of inequality. The closer the share of each quintile is to 20 per cent, the smaller the inequalities (*Siposné Nándori 2017*).

Income inequality is a measure of outcome which is a matter of opportunities available at birth, choices made throughout one's life and luck. Therefore, introducing the concept of equal opportunity is essential. While more challenging to measure, it is a policy goal for which there is a clearer consensus to act than for achieving equal outcomes. Inequality of opportunity can contribute to inequality of income (*EC 2017*), as it prevents people from making the most of their abilities, and this in turn can lead a country down a path of rising income and wealth inequality. The adverse impact of inequality can be even greater if, in times of rapid technological change, entire groups of the population are unable to acquire the new skills needed for – and share the benefits associated with – technological innovation (*EBRD 2017*).

As *Stiglitz* (*2015*) points out, perhaps the most detrimental aspect of inequality is that affecting opportunity. Stiglitz explains the problem through the concept of the United States of America and the "American dream". The data show that one of America's most cherished ideals is a myth: the US has become the advanced country not only with the highest level of inequality, but one of those with the least equality of opportunity. The life prospects of young Americans are more dependent on the income and education of their parents than in other developed countries. When there are large inequalities of income, those at the top can buy privileges for themselves and their children that are not available to others. In contrast, without

equality of opportunity, those born in the bottom of the distribution are likely to end up there: inequalities of outcomes perpetuate themselves (*Stiglitz 2015*).

Neckerman and Torche (*2007*) believe it is important to examine the subtler ways in which inequality can shape our institutions. They explain this process through risk aversion. A system of great inequalities, in which failures become more and more expensive, can prompt risk-averse choices when people select schools and neighbourhoods for their children or choose their own career, partner and friends. Growing inequality in higher education can increase competition for scarce goods and services, such as the most desirable neighbourhood or the most prestigious college, raising prices for the wealthy and limiting opportunities for everyone else. These show that inequalities can be "passed on" from one generation to the next through several channels. This can happen because children in low-income households are less able to study due to poor health, and as a result, will earn less as adults. Political processes can also lead to similar outcomes if low-income voters lose their political voice and thus are unable to support policies that would improve their living standards (*Neckerman and Torche 2007*). According to *Jerrim and Macmillan* (*2015*), a key reason why many believe income inequality and intergenerational mobility are linked is that income inequality tends to be higher also in countries where a larger part of economic (dis)advantages are transmitted from parents to their children. This relationship is usually represented by what is known as the "Great Gatsby Curve" (*Corak 2013*). This graph plots income inequality as measured by the Gini coefficient against intergenerational income elasticity, a measure of social mobility: an upward-sloping line demonstrates that income inequality is associated with less social mobility (*Jerrim and Macmillan 2015*).

According to the European Commission (*EC 2017*), it is generally considered that some inequality may provide incentives to invest in human capital, promote mobility and stimulate innovation, since economic incentives — which are important for growth — rely on the possibility for an individual to achieve better outcomes through their own hard work. However, when inequality becomes too large, it can threaten growth. This is especially true when it is driven by increased poverty at the bottom of the income distribution. In this case, individuals at the bottom lack the resources to invest in their skills and education, and may be unable to reach their full potential. This can result in less equality of opportunity for the next generation, which is harmful for overall growth (*EC 2017*).

3. The link between global inequality and long-term growth

The relation between income distribution and economic growth has become a popular topic of recent economic research, especially in the context of the contrasting experience of post-World War II Latin America and East Asia. In Latin America, initial income inequality was high and long-term economic growth low. East Asia, on the other hand, had low initial inequality and high long-term growth (*Chen 2003*). *Berman* (*2021*) compares data from the post-World War II era with later data. This comparison suggests that rising inequality correlates with slower economic growth: in the 20th century, when inequality was on the decline, growth was faster than today, and in recent decades, countries with high inequalities have grown more slowly than those with lower levels of inequality. While some theoretical works postulate a negative relationship between initial inequality and economic growth, other empirical studies have found a positive relationship (*Chen 2003*). Although no theory proposes the coexistence of a positive and a negative relationship, *Chen* (*2003*) thinks it is very likely.

A number of studies and theories point to the two-way correlation between inequality and growth, i.e. that growth also affects inequality. The core literature on the relation between these two factors is provided by *Kuznets* (*1955*) who theorised that in earlier periods of industrialisation, even when the non-agricultural population was still relatively small in total, the gains of growth were distributed unevenly across the country as only a smaller fraction had the advantage of technology. Over time, however, the effects of a growing economy – a result of improving productivity – on employment and wages trickle down to lower income categories, thus reducing inequality. This hypothesis is the basis of the Kuznets curve (*Tóth and Benkő 2018*) which is now considered obsolete as recent research suggests the existence of multiple development paths (*Baranyai 2018*). In his article, *Kuznets* (*1955*) also cautions against any far-reaching conclusions, pointing out that he had little reliable information, his paper being perhaps 5 per cent empirical information and 95 per cent speculation.

Freeman (*2012*) assumes that optimal economic performance can be achieved at either extremely low or extremely high levels of inequality. This means that the relation between output and inequality follows an inverse U-shaped curve. When inequality is zero and output is low, there is no incentive for people to try harder or invest in risky economic performance. In this state, an increase in inequality increases output. Furthermore, when inequality is extremely high, output will be low again. The few who have the skills or the background to get the best jobs work hard, while others have no chance of achieving similar results. Optimal inequality lies between these two extremes (*Freeman 2012*), i.e. the optimal level of inequality

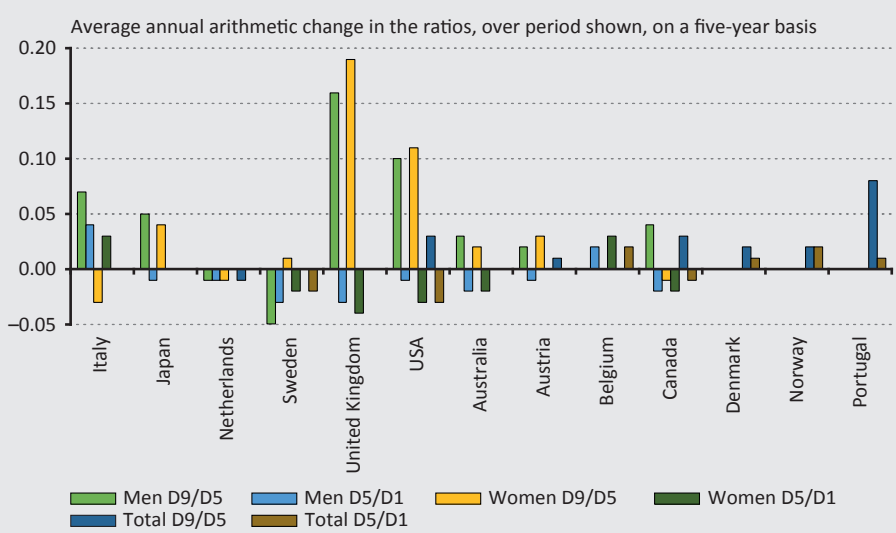
is the top of the inverse U curve (*Tóth and Benkő 2018*). *Tóth and Benkő* (*2018*), on the other hand, believe that lower inequality is preferable in the longer term as it can help improve social cohesion, mobility and the quality parameters of human capital.

Citing Richard Freeman, one of the most articulate contemporary proponents of the "optimal inequality" thesis, *Edsall* (*2014*) writes that the costs of excessive inequality are high: "Inequality that results from monopoly power, rent-seeking or activities with negative externalities that enrich their owners while lowering societal income (think pollution or crime), adversely affect economic performance." High inequality reinforces corruption, and when national income goes mostly to those at the top, there is little left to motivate people lower down. *Stiglitz* (*2015*) argues that much of the inequality at the top cannot be justified as "just deserts" as these individuals are disproportionately those in the financial sector, some of whom made their wealth by market manipulation and similar methods. The inadequacy of the just deserts theory was demonstrated by the 2007 collapse of Wall Street and the subsequent recession. It showed that inequality in income and power can threaten economic stability and concentrate economic power in the hands of the few (*Edsall 2014*).

Conservative economists look at the issue of equality from the opposite vantage point: they want to know when government efforts to redress inequalities and redistribute income worsen conditions by acting as a disincentive to work and productive activity. *Casey Mulligan* (*2012*), one of the leading critics of government intervention, argues that safety net programmes face a well-known equity-efficiency trade-off: providing more resources for the poor can raise their living standards, but it also gives them less incentive to raise their own living standards. Carrying this logic a step further, Mulligan contends that the expansion of the safety net both immediately before and after the financial collapse of 2007–2009 was the major cause of rising unemployment. Some recent analyses dispute the findings of *Mulligan* (*2012*), one of the most important of which, according to *Edsall* (*2014*), is the study by *Ostry et al.* (*2014*). The study found that lower net inequality is robustly correlated with faster and more durable growth, for a given level of redistribution. The IMF economists argue that redistribution appears generally benign in terms of its impact on growth; only in extreme cases is there some evidence that it may have direct negative effects on growth. More broadly, redistribution can also occur when progressive taxes finance public investment, when social insurance spending enhances the welfare of the poor and risk taking, or when higher health and education spending benefits the poor, helping to offset labour and capital market imperfections. In such cases, redistributive policies could increase both equality and growth (*Ostry et al. 2014*).

Freeman (*1994*) argues that due to the significant changes in the wage structure after 1980, the inverse correlation between inequality and economic growth may no longer hold true for advanced industrial countries. This idea is taken up by *Partridge* (*1997*) who claims that greater human and physical capital mobility among advanced economies or among regions within advanced nations may limit the income redistribution capacity of national or subnational governments. This led him to the conclusion that the model developed by *Persson and Tabellini* (*1994*), which shows a negative relationship between income inequality and future economic growth, may not be valid. He used the Gini coefficient to test this assumption. The results indicate that in countries with a higher income inequality at the beginning of the period, subsequent economic growth was actually higher, but in countries where the middle quintile had a higher income share, growth was also faster. This is consistent with what the model of *Persson and Tabellini* (*1994*) suggests – a positive relationship between the relative welfare of the median voter and economic growth – but contradicts the empirical findings of the model. In this context, Partridge's research implies that the generally negative relationship between inequality and future economic growth only applies to developing or newly industrialised nations, but not to advanced nations. According to *OECD* (*1993*) data, income inequality has risen in virtually all advanced economies since 1980, led by the United States and the United Kingdom (*Figure 1*), indicating that their labour markets are developing as they become more skill-intensive. However, this would imply that there is a need to create models that can explain why overall inequality is positively related to subsequent economic growth in advanced economies (*Partridge 1997*).

Figure 1
Trends in earnings dispersion in the 1980s



Source: OECD (1993)

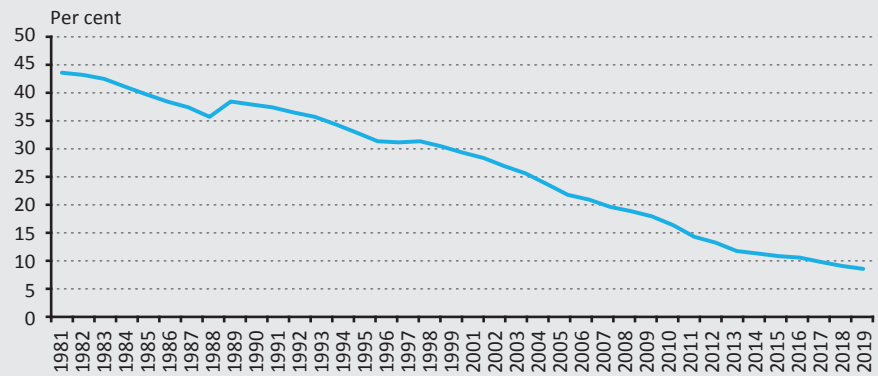
The possible tendency for structural changes during the early stages of rapid economic growth to widen relative income inequalities was noted by *Kuznets* (*1955*). According to *Tendulkar and Jain* (*1995*), two points require emphasis here. First, *Kuznets* (*1955*) treated this as a tendency and not an inevitable consequence; second, he made this observation when conceptualising the growth-inequality relationship in the context of predominantly market-driven growth that had historically taken place in the then developed countries. He attributed this tendency to three factors. One is the rise in intersectoral inequality in product per worker due to the uneven impact of technological changes across sectors and across production units within a given sector; the second is the greater concentration of asset incomes and their higher rewards because of deficiency of capital relative to labour in the early stages of growth; and the third is the predominance of self-employment incomes in the early stages with inherently greater variability than wage and salaried incomes (*Tendulkar and Jain 1995*).

Another equally important aspect of growth and inequality is what *Kuznets* (*1955*) called "income mobility". This refers to shifts in the relative income positions of individuals during the growth process. These shifts may involve various combinations of a change in location (e.g. from rural to urban), a change in occupation (e.g. from craft-based to education-based), a change in industry of attachment (e.g. from agrobased to non-agrobased) as well as a change in employment status (e.g. from self-employed to employee). The phenomenon is brought about by new economic opportunities generated by structural changes during the growth process. The availability of (real) income-enhancing opportunities is governed by improvements in the efficiency of resource utilisation, improved functioning of economic organisation and by a rise in total factor productivity brought about by technological progress. Some sectors and production units affected by the foregoing factors would be expanding rapidly, whereas others may become obsolete, resulting in unemployment or a deterioration in the relative income position of those employed in these lagging sectors and units. Consequently, the growth process may engender income mobility in either direction. However, during the process of rapid economic growth, newly generated opportunities leading to upward income mobility far outweigh those leading to unchanged income position or downward income mobility. The phenomenon of income mobility thus tends to soften the adverse social consequences of widening income inequalities that might be experienced in the growth process (*Tendulkar and Jain 1995*).

4. Comparison of developed and developing countries

The nature of the social inequalities we are still experiencing is determined by historical factors which many countries, such as China and South Korea, have managed to overcome through intensive development built on institutions that are appropriate to the existing economic structure. Absolute poverty has started to decline as per the World Bank criteria, but it is still high (*Figure 2*) and steadily increasing in countries that have not yet completed the second demographic transition. Judging by contemporary discourse, relative poverty creates sharp social contrasts (*Grigoryev and Pavlyushina 2019*).

Figure 2
Absolute poverty headcount ratio between 1981 and 2019, at 2017 purchasing power parity, expressed as a percentage of the world population



Source: World Bank (https://data.worldbank.org/indicator/SI.POV.DDAY, downloaded: 10 June 2023)

Despite significant improvements over the past half century, absolute poverty remains widespread in many lower-middle and low income countries. Calculated at 2011 USD purchasing power parity, in 2015, nearly 750 million people lived on less than USD 1.90 a day, and around 2 billion people lived on USD 3.20 a day (*Todaro and Smith 2020*). According to *Kuznets* (*1955*), one of the reasons for greater inequality in developing countries is that because of the low average income of these countries, significant savings are possible only for those with high incomes, which leads to even greater stratification. Another reason is the low GDP growth rate (hence the low per capita income) in these countries. Kuznets assumes that these countries represent fairly unified population groups, and excludes, for the moment, areas that combine large native populations with small enclaves of non-native, privileged minorities (e.g. Kenya and Rhodesia), where income inequality,

because of the excessively high income shares of the privileged minority, is appreciably wider than in the other developing countries. On this assumption, he infers that in countries with low average income, the secular level of income in the lower brackets could not be below a fairly sizable proportion of average income – otherwise the groups could not survive.

Kuznetz (*1955*) explained that the countries of Latin America, Africa and Asia were underdeveloped because during the last two centuries their rate of economic growth had been far lower than that in the Western World. The underlying shifts in industrial structure, the opportunities for internal mobility and for economic improvement were far more limited than in the developed countries. He thought there was no hope, within the lifetime of a generation, of a significantly perceptible rise in the level of real income. A few decades later, *Rodrik* (*2018*) wrote that not so long ago, economic analysts had been extremely optimistic about the economic growth prospects of the developing world. Emerging markets were expected to maintain their strong performance that characterised the pre-crisis decade, unlike the US and Europe where prospects looked weak. In this case, developing countries could have become the engine of the world economy – some economists, for example, have concluded that the conditions have never been so favourable for broadscale, sustained growth, and they envisioned this growth and development to be led by African and Asian countries. However, these forecasts have now been replaced by what the Economist called the "the great slowdown":[1] Growth in China and India has slackened, Brazil and Turkey are struggling with political problems, and Latin American countries are witnessing the slowest growth in recent times, as Rodrik points out, with inequality rising again since the 2010s according to the *UN* (*2020*) report.

Looking at the impressive pace of growth of China's economy, *Yuan et al.* (*2011*) point out that poverty has declined at an astonishing rate since the 1978 reforms. Rapid economic growth has led to the rapid emergence of an expanding middle class and, more recently, a super-rich class with wealth rivalling that of their counterparts in developed countries. One driver of the expansion of this stratum is human capital formation, with graduates returning from overseas showing significant growth, in particular.

[1] https://www.economist.com/leaders/2012/07/21/the-great-slowdown?utm_medium=cpc.adword.pd&utm_source=google&ppccampaignID=18151738051&ppcadID=&utm_campaign=a.22brand_pmax&utm_content=conversion.direct-response.anonymous&gclsrc=aw.ds&gad_source=1&gclid=Cj0KCQjwhfipBhCqARIsAH9msbm_M9Yruyi3kcPhrx13wvkou6z8DA-_1dfzzwirKZqUBG9H-Z5XvroaAjlLEALw_wcB

According to *Sachs* (*2005*), it is typical that in a fast growing country like China, growth gradually moderates over time, just as it did in Japan in the second half of the 20th century. The fundamental reason is that much of this growth is catching up, i.e. adopting technologies from leading innovative countries. As these technologies come into use, and thus the income gap relative to the leading countries narrows, the scope for "easy" growth through technology imports narrows. This is important because other drivers of middle class expansion are industrialisation and urbanisation. The growth of the tertiary sector depends on urbanisation, but the Chinese government curbs urbanisation through institutional restrictions. As a result, despite the fact that employment in the tertiary sector outstripped employment in the secondary sector in 1995, the services sector lagged behind the country's economic development. The sector could have employed more people and contributed more to GDP if urbanisation had kept pace with the country's economic development (*Yuan et al. 2011*).

It is estimated that China will add an additional 80 million people to the middle and upper classes between 2022 and 2030, which will make up nearly 40 per cent of the total population. But this means new challenges and pressures for the country. Income inequality, regional disparities and rising living costs present obstacles to raising more people to the middle-income bracket, and addressing these issues is becoming a top priority for the government. However, social mobility overall has slowed in recent years following decades of rapid social change. People belonging to low-income groups and high-income groups were more likely to stay in the same profession or class as their parents, further consolidating these two groups' levels of wealth and social positions. According to a survey that examined the relationship between children's and their parents' occupational income between 2010 and 2015, around 47 per cent of sons and 58 per cent of daughters of farmers would also be farmers. Meanwhile, 43.2 per cent of sons and 39.4 per cent of daughters of highly paid employees would remain in the same wealth class as their parents. The reasons for the slowing social mobility are increasing levels of intergenerational transfer of wealth and unequal economic opportunities. In addition, rising costs of living make it harder for poorer families to raise a child, which in turn makes it harder for low-income earners to catch up with higher-income earners. Increasing medical burdens can also be a major factor contributing to low-income groups falling into the poverty trap (*Huld and Interesse 2023*).

5. The impact of industrialisation on inequality

Economic miracles refer to the development experiences of countries that have not just witnessed a sudden burst of economic growth, but have grown quickly and sustainably. With the exception of a few small countries rich in mineral resources, successful economies have boomed thanks to rapid industrialisation. East Asian countries have been remarkably good at reallocating their labour from the countryside to the cities for organised industrial production, as the US and Germany did before (*Rodrik 2018*).

The answer to the question of why the industrial revolution started in Britain is usually that there – and in the countries that followed – wages were high, so mechanisation was profitable, whereas in countries where wages were low there was no interest in mechanisation. However, this is not entirely true because the Netherlands, which also had a high wage level, set out on the path of industrialisation about half a century later, and one only has to think of China to see that low wages do not hinder industrialisation (*Ritter and Trautmann 2020*). Industrialisation enables rapid development because it is relatively easy for poorer countries to copy and adopt foreign models and production technologies (*Rodrik 2018*). *Rodrik*'s (*2018*) research shows that manufacturing is catching up with the technological frontier at a rate of around 3 per cent per year, regardless of policy, institutions and geography. In a country with a dynamic economy with relative freedom of individual opportunity, technological change is rampant and property assets that originated in older industries almost inevitably have a diminishing proportional weight in the total because of the more rapid growth of younger industries. Unless the descendants of a high-income group manage to shift their accumulating assets into new fields and participate with new entrepreneurs in the growing share of the new more profitable industries, the long-range returns on their property holdings are likely to be significantly lower than those of the more recent entrants into the class of substantial asset holders (*Kuznets 1955*).

In the simplest model, the distribution of the income of the total population can be seen as a combination of the distribution of income of the rural and urban population. From what we know about the structure of the income distribution of these two components, it can be concluded that the average per capita income of the rural population is generally lower than that of the urban population, and that the percentage shares of the rural population are somewhat more even, i.e. inequality is less pronounced, within this distribution than those of the urban population – even if we look at annual income; and this difference would probably increase for distributions by world income levels. Consequently, all other things

being equal, an increasing weight of the urban population implies an increasing proportion of the more unequal distribution of the two components. The relative difference in per capita income between rural and urban populations does not necessarily decrease during economic growth. There are indications that this gap is at best stable, but more likely to increase, as the per capita productivity of urban activities is rising faster than that of agriculture. If this is the case, inequality in the overall income distribution should increase. As a result, for example, the differences between large, successful entrepreneurs and Southern farmers in the United States have become sharper. This suggests that countries that are able to successfully shift labour from agriculture to industry will grow faster (*Rodrik 2018*). *Engels*' (*1845*) *State of the Working Class in England in 1844* was an early and famous account of unequal development. Analysing this, *Allen* (*2009*) describes how the industrial revolution led to massive urbanisation and great increases in output. However, while per capita income was rising, real wages remained constant, so the gains from economic development accrued overwhelmingly to property owners. *Allen* (*2009*) termed the period of constant wages in the midst of rising output per worker "Engels' pause". The pause had a progressive side, as the bourgeoisie saved from its growing income and the ensuing investment drove the economy forward. Engels was not alone in his view of British industrialisation. Ricardo, Malthus and Marx all believed that real wages would remain constant during capitalist development. However, they differed in their explanations: Ricardo and Malthus believed that population growth would accelerate in response to any rise in income and ultimately force wages back to subsistence; by contrast, Marx believed that technological progress had a labour saving bias that would eliminate any upward demand pressure on wages even as output per worker surged (*Allen 2009*).

Allen (*2009*) highlights three general findings in his research. First, inequality rose substantially in the first four decades of the 19th century. The share of capital income expanded at the expense of both land and labour income. The average real wage stagnated, while the rate of profit doubled. Second, these trends can be explained without reference to contingent events like the Napoleonic Wars or the settlement of the American West. The main trends can be explained with a simple macroeconomic model. Third, that macro model implies that the explanation of growth cannot be separated from the discussion of inequality since each influenced the other. With these general considerations in mind, we can outline the story of the industrial revolution as follows: the prime mover was technical progress. It was only after 1800 that the revolutionised industries were large enough to affect the national economy. Their impact was reinforced by rising agricultural productivity and the application of further inventions more generally. The adoption of these inventions led to a rise in demand for capital and, concurrently, for cities, housing

and infrastructure as well as for plant and equipment. Consequently, the rate of return rose and pushed up the share of profits in national income. With more income, capitalists saved more, but the capital–labour ratio rose only modestly, the urban environment suffered as cities were built on the cheap and the purchasing power of wages stagnated. Real wages rising in line with the growth of labour productivity was not a viable option since income had to shift in favour of property owners in order for their savings to rise enough to allow the economy to take advantage of the new productivity raising methods. Hence the upward leap in inequality (*Allen 2009*).

According to *Kuznets* (*1955*), the very fact that after a while an increasing proportion of the urban population was "native", i.e., born in cities rather than in the rural areas, and hence more able to take advantage of the possibilities of city life in preparation for the economic struggle, meant a better chance for organisation and adaptation, providing a better basis for securing greater income shares than was possible for the newly "immigrant" population coming from the countryside or from abroad. This can result in greater equality of opportunity as family advantages that result from higher income and wealth are more easily passed on to the next generation (*EC 2017*).

If we look across developing countries, we see a huge gap between the leading and lagging sectors of their economies. This economic dualism has always been present in low income societies. What is new is that the low-output segments of developing economies are not only not declining, they are actually growing. We know that economic development usually takes place when labour flows from low income sectors to modern sectors, such as from agriculture to industry or services. Then the output of the economy as a whole increases, the gap between the traditional and modern forms of economy narrows, and dualism finally discontinues. This process took place in Spain and Portugal after the war, but also later in South Korea, Taiwan and China. The expansion of modern manufacturing led to growth even in countries that produced mainly for domestic markets, as in Turkey, Mexico and Brazil until the 1980s. Today, however, the situation is different. It is true that young people in rural areas are still moving to big cities, but they take up jobs not in factories but in low-productivity services. Industry has recently been replaced by the services sector with the emphasis shifting from tradable to non-tradable activities. Such structural changes are a major impediment to economic development in Latin America, Africa and many Asian countries. Most high-productivity services require a wealth of knowledge and skills that developing countries do not have. It is simple to illustrate: a poor country can easily compete with Sweden in terms of

manufacturing, but it takes a lot for it to catch up with Swedish institutions, and this process can take decades, if not centuries (*Rodrik 2018*).

Rodrik (*2018*) uses the case of India to illustrate what happens when a country relies more heavily on the services sector than on industry in the early stages of economic development. The country is a key player in the IT sector in terms of software and call centres, but the majority of the Indian workforce does not have the knowledge and skills needed to enter this field. In East Asia, on the other hand, unskilled labour has flooded into factories, partly because workers earn several times more than they would in rural areas doing agricultural work. Instead, workers in India have two options: one is to stay on the land, the other is to work on construction sites or engage in non-specialised services. This does not increase productivity.

Rodrik (*2018*) repeatedly stresses that industrialisation is an important step for poor countries towards development in several respects. Some say that the current low-income countries in Africa, Asia and Latin America need to do something similar if they are to achieve rapid and sustainable economic development, but there is no comparison between the world today and the world during the industrial revolution. The combination of globalisation and technological progress has changed the way industries operate, making it very difficult, if not impossible, for developing countries to follow the example of the "Asian Tigers" or the North American and European economies. Industry is increasingly capital and skills-oriented, resulting in a decreasing proportion of the workforce that can move from agriculture to industry (*Rodrik 2018*). *Atkinson* (*2015*) argues that increased inequality is due to the demand for educated workers rising faster than the supply, and that technological progress and globalisation have eliminated jobs for many low-skilled workers.

Rapid global technological progress has reduced the price of manufactured goods relative to services, discouraging developing countries from entering. The peak rates of industrialisation are lower than ever before, and current wages are a fraction of those experienced by previous industrialisers. This means that many (or perhaps most) developing countries are becoming "service economies" without having actually gone through industrialisation – a process *Rodrik* (*2018*) calls "premature deindustrialisation". *Rodrik* (*2016*) found in his research that while early industrialisers were able to reallocate at least 30 per cent of their labour force to industry, later industrialisers were not: The highest rate was 20 per cent in Mexico and even lower, 16 per cent, in Brazil. In India, the share of people working in industry started to fall as it reached 13 per cent.

According to *Kuznets* (*1955*), repetition of past patterns of the then developed countries would, under the markedly different conditions of the developing countries, put a strain on the existing social and economic institutions and eventuate in revolutionary explosions and authoritarian regimes. *Rodrik* (*2018*) believes it is possible that the "Asian Tigers" were the last to experience industrialisation under the conditions we know from history. If this is indeed the case, it is detrimental to economic growth. The gap between earnings and working conditions between bankers and managers, or small-scale industrial or household workers, is significantly larger in developing countries. If they move to the tertiary sector before human capital is accrued and the right institutions are in place, this will greatly exacerbate the problems of inequality and exclusion in the labour market (*Rodrik 2018*).

6. A way out of inequality

There are two major economic theories to underpin our understanding of the evolution of global inequalities in the coming decades. One is that with globalisation, income convergence should intensify, i.e. poor countries' incomes should catch up with those of rich countries, as emerging economies are expected to have higher per capita growth rates than rich countries. This projection is not invalidated by the slowdown in growth in some emerging economies, such as China. However, two reservations have to be taken into account. First, we are talking about a broad pattern which does not mean that all poor countries are involved in catching up. In fact, one of the surprises of the current globalisation process has been the failure of many countries to catch up and the further decline of some economies.[2] The same cannot be ruled out in the future. Second, when we look at the welfare of individuals, it is the income convergence of the most populous countries that matters most. This approach places particular emphasis on how countries such as China, India, Indonesia, Bangladesh and Vietnam continue the process of catching up.

The other important economic theory concerns changes in inequalities within nations characterised by movement along the different stages of the first or second Kuznets wave. Depending on their income level and structural characteristics, countries may go through different Kuznets waves or different stages of the waves. Thus, in China, inequality may start to decline as it slides down the Kuznets wave, while in some very poor countries inequality may increase – they are moving up the first wave. The richest countries, already advanced in the process of the second technological revolution, will continue to move up the upward section of the second Kuznets wave – as expected for the US – or will soon start the downward phase.

[2] For debates and experiences on distribution in the context of globalisation, see *Halmai* (*2023*).

So there are many different experiences, but the most important patterns will be determined by what happens in the US and China (*Milanovic 2016*).

According to *Atkinson* (*2015*), if we want to reduce inequalities, there are steps we can take. The fact that the factors that create inequality include politics and are not just the inevitable result of economic forces means that there are policies that can mitigate the extremes of inequality and improve opportunities for catching up. At a conference on inequalities organised by *Blanchard and Rodrik* (*2021*), it was widely agreed that removing government interventions or stimulating economic growth alone are not enough. Instead, governments should play a stronger direct role in closing lifestyle gaps. Policymakers must make it a priority to move more people out of poverty, strengthen the middle class and curb the excesses at the top. Most of the policies are clear: more support for education; increasing the minimum wage; strengthening the earned-income tax credit; better financial sector regulation (*Stiglitz 2015*). As exemplified by the welfare states built by rich countries in the 20th century, modern redistribution is based on basic social rights: the right to education, health and pensions. The problem of inequality can therefore be solved not by dismantling redistribution, but by improving it through more effective programmes (*Piketty 2014*).

Brazil, torn by even greater inequality than the United States, has introduced similar measures and shown how concerted policies focusing on education and children can bring down inequality within the span of less than two decades (*Stiglitz 2015*). Development of the education and training system has also been a key to economic growth in the newly industrialised countries of Southeast Asia, with Taiwan being a good example according to *Csáki* (*2018*).

The minimum wage is often seen as an important public policy element in reducing poverty and inequality. Raising the minimum wage should in theory increase the incomes of millions of low-paid workers, thereby reducing inequality of income. However, there is disagreement in the literature of the industrialised countries as to whether the increase in the minimum wage has contributed to lessening earnings inequality (*Lin and Yun 2016*). *Lin and Yun* (*2016*) cite the example of China, which has recently demonstrated rapid economic growth and rising inequality of income. Since China promulgated a new minimum wage law in 2004, the rate and frequency of change in the minimum wage has been significant both over time and across jurisdictions. The growing importance and controversial nature of research on the link between the minimum wage and earnings inequalities has sparked heated debates in the country. In the period 2004–2009, the increase in the minimum wage mitigated inequality by reducing the gap between median and bottom decile earnings.

At a conference held at the Peterson Institute for International Economics, there was consensus that taxes should be raised – at least in the US – but whether they should be focused on the revenue or expenditure side, was the subject of debate. Some would finance public spending on the bottom and middle sections of income distribution with broad taxes such as VAT because it is easy to collect. Others, on the other hand, would prefer to address the great inequality caused by the extremely high incomes of the top classes through wealth taxes and progressive income taxes, seeking a rational middle ground between the two (*Blanchard and Rodrik 2021*).

Looking at the US and other developed countries, we see that they are trying to achieve greater equality in very different ways. In Sweden and the other Nordic countries, for example, progressive taxation, redistribution and strong welfare systems propel these countries towards this goal, while in Japan, greater equality is ensured through a smaller difference in pre-tax income between the top and bottom quintiles. In the US, Vermont and New Hampshire are good examples of states that are doing well in addressing health and social issues – the former follows the Swedish example, and the latter adopts the Japanese approach. It seems that no matter what mechanism societies use to move towards greater equality, the point is to get there (*Kerry et al. 2012*).

Blanchard and Rodrik (*2021*) cover a very wide range of policies that tackle inequality, so for an ease of understanding they break them down into two dimensions. First, policies vary depending on the stage of the economy they target. In this dimension, three orientations are distinguished: policies focusing on the pre-production phase, policies focusing on the production phase and policies focusing on the post-production phase. The second dimension shows the part of the income distribution they want to change. Some policies target the lower classes, others seek to increase the income share of the middle class, but there are also policies that reduce the income share of the top classes. Combining the two dimensions yields a 3x3 matrix (*Table 1*).

Table 1
A taxonomy of policies affecting inequality

		At what stage of the economy does the policy intervene?		
		Pre-production	**Production**	**Post-production**
What kind of inequality do we care about?	**Bottom**	Endowment policies (healthcare, education); universal basic income	Minimum wage, job guarantees	Social transfers (e.g. earned income tax credit); full employment macro policies
	Middle	Public spending on higher education	"Good jobs" policies; industrial relations and labour laws; sectoral wage boards; trade agreements; innovation policies; employee ownership	Safety nets; social insurance policies
	Top	Inheritance/estate taxes	Regulations; antitrust laws	Wealth taxes

Source: Own compilation and using data from Blanchard and Rodrik (2021)

Economics provides some guidance on which cells of the table to focus on to effectively address inequality, but it is not sufficient in itself. The solution requires coupling economic analysis with values and normative judgements – or political philosophy – as well as views on the interaction between economics and politics (*Blanchard and Rodrik 2021*).

Opinions on the role of state redistribution differ in the literature. Research by *Ostry et al.* (*2014*) found surprisingly little evidence for the growth-destroying effects of fiscal redistribution at a macroeconomic level. Some mixed evidence suggest that very large redistributions may have direct negative effects on growth duration, such that the overall effect – including the positive effect on growth through lower inequality – may be roughly growth-neutral. But for non-extreme redistributions, there is no evidence of any adverse direct effect. The average redistribution, and the associated reduction in inequality, is thus associated with higher and more durable growth. We need to be mindful about over-interpreting these results, especially for policy purposes. It is hard to go from these sorts of correlations to firm statements about causality. One important positive conclusion from their look at the big picture is that extreme caution about redistribution – and thus inaction – is unlikely to be appropriate in many cases. On average, across countries and over time, the things that governments have typically done to redistribute do not seem to have led to bad growth outcomes, unless they were extreme. And the resulting narrowing of inequality helped support faster and more durable growth, apart from ethical, political or broader social considerations. Even given these results about average effects, it remains important to try to make redistribution as efficient as possible

(*Ostry et al. 2014*). *Partridge* (*1997*) argues that the important policy implications of the impact of inequality on economic growth suggest that a better understanding of this relationship is warranted. Whether there have been recent changes in the relationship between inequality and economic growth in advanced post-industrial economies, and whether the relationship between countries is different from that within countries, deserves further enquiry.

7. Summary

In this essay, I examined the question of whether social inequalities encourage or hinder economic growth. First, I briefly introduced the key concepts and then pointed out the two-way relationship between global inequality and long-term growth and the differences in opinion concerning the subject. This called for an identification of the optimal level of inequality. It can be concluded that there is no consensus among economists in the relevant literature as regards this relation. In my view, although some inequality can act as an incentive and thus be supportive of the economy, it has an overall negative impact on economic growth, especially when coupled with poverty, as it affects human capital in the form of sub-optimal education and health.

In comparing developed and developing countries, I noted that absolute poverty has started to decline as per the World Bank criteria, yet it remains high. In this chapter, I also discussed the growth of the middle class in Chinese society.

By analysing the context of the industrial revolution, I found that although the process of industrialisation played a decisive role in the growth and development of today's developed countries, developing countries will no longer be able to follow suit because of globalisation and the current technological progress. I introduced the concept of "premature deindustrialisation" and pointed out that the dominance of the service sector over industry is checking economic development in many parts of the world as there is a lack of skilled labour.

Finally, because politics itself can contribute to inequality, I reviewed the economic policy measures that can facilitate the mitigation of inequality and promote economic growth. The clear aim is to reduce the income inequality that affects the global economy and many countries around the world, in both developed and developing societies. Thanks to globalisation and digitalisation, in this century, we have access to an unprecedented wealth of information to explore the world, and so perhaps it will be easier for us to recognise what is already obvious to many: that too much inequality is not only harmful to the wellbeing of society but also to economic performance.

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Dualities in the Hungarian Economy – Growth and Prosperity in the 21st Century*

Ágnes Nagy

The decade of the 2010s can be considered the most successful period in Hungary's economic history of the last century, due to the reforms implemented at the beginning of the period. The positive performance was mainly based on quantitative indicators, while qualitative indicators showed a lag as reforms gradually slowed down. Our analysis highlights the dualities in the Hungarian economy that are reflected in the quantitative and qualitative indicators, drawing attention to the need for a complete turnaround in competitiveness to achieve sustainable convergence.

1. Introduction

The decade of the 2010s can be considered the most successful period in Hungary's economic history of the last century, as the reforms that were implemented put the country on a path of balanced convergence. The timing of competitiveness reforms and measures also played a key role, as more than 80 per cent of the reforms were implemented in the first third of the decade. The reforms and targeted measures led to a fiscal turnaround from 2010 and a monetary and growth turnaround from 2013. A number of economic indicators improved, supporting Hungary's competitiveness and rising prosperity. However, the positive quantitative performance is only the surface, as qualitative shortcomings can be identified in several areas of the economy, in deeper dimensions, due to a gradual slowdown in the introduction of measures in an effort to further improve competitiveness from the second half of the decade. In the light of today's major global challenges (e.g. digitalisation, green transition) and the historic scale of recent crises, the need to improve the qualitative factors that contribute to competitiveness and prosperity has become particularly important. A shift towards a knowledge and technology-intensive growth model is needed, for which past achievements and progress in quantitative indicators provide a good basis, but further efforts are necessary. In our analysis, we illustrate the dualities that can be identified in the economy through quantitative-qualitative indicator pairs, drawing attention to the potential for growth, in particular in qualitative factors. A complete competitiveness turnaround is needed to eliminate

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the economic dualities, which will ensure sustainable convergence and rising prosperity in the long term. A full competitiveness turnaround can also help avoid the middle-income trap (*Baksay – Nagy 2022*).

2. Dualities in the real economy

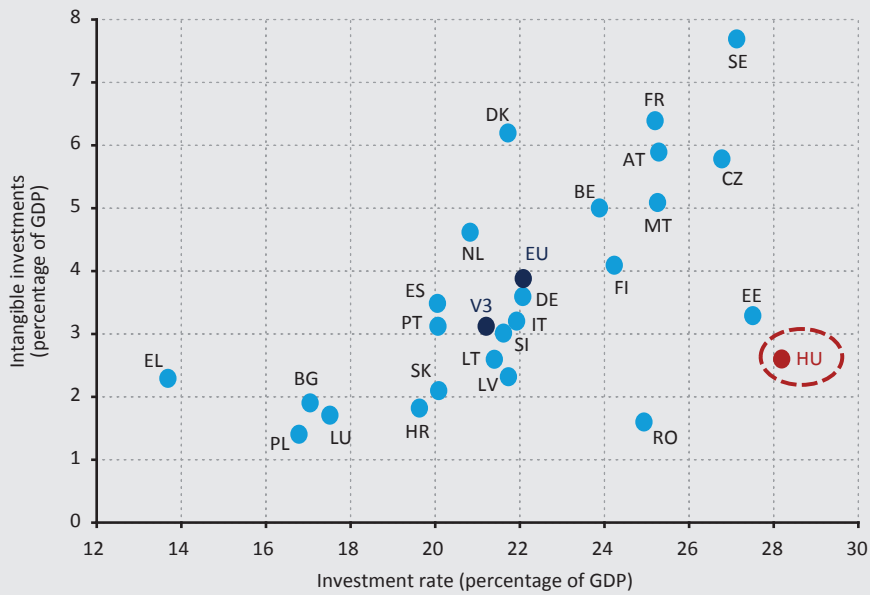
Increasing prosperity is more than economic growth, but without balanced growth and a strong economy, neither increasing prosperity nor ensuring its sustainability can be achieved. In Hungary, the macroeconomic conditions for a competitiveness turnaround were successfully established in the 2010s, and the Hungarian economy embarked on a path of balanced growth and convergence, as evidenced by improvements in a number of quantitative indicators. On the qualitative side, however, there is significant room for growth in value creation, efficiency and innovation that could be leveraged to support sustainable economic convergence.

As a result of fiscal and economic stabilisation after 2010, domestic economic growth has consistently exceeded the EU average since 2013, and thus in terms of GDP per capita, the key indicator of economic development, Hungary has been on a trend to catch up with the EU average over the past decade. Hungary's economic development has risen from 66.1 per cent of the EU average in 2010 (at current prices) to 76.3 per cent in 2022. However, gross national income (GNI) – the actual disposable income of domestic agents – continues to lag behind GDP (*MNB 2023a*). The gap between GNI and GDP was close to 5 per cent of GDP in 2010, decreasing with minor fluctuations to 3.9 per cent in 2022. Thus, the disposable income of the domestic sectors continues to lag behind the income generated in Hungary, mainly as a consequence of the negative capital income balance.

Investment, which underpins production and long-term growth capacity, has expanded significantly in recent years. While the investment-to-GDP ratio was around 20 per cent in the early 2010s, it has been consistently above 25 per cent in recent years, and in 2022 the Hungarian indicator was the highest in the European Union at 28.2 per cent. However, the situation is nuanced by the fact that from 2019 onwards, the rise in the investment rate was mainly driven by a rapid increase in investment prices. Recent economic analyses show that the quality and structure of investment is as important as the quantity, but Hungary's position is unfavourable by EU standards (*Baksay et al. 2022*). The ratio of intangible investment to GDP, which is essential for the digital and technology-driven transition, was only 2.6 per cent in 2022, placing Hungary in the bottom third of the EU ranking. The average for the Visegrad peers was 3.1 per cent, the EU average was 3.9 per cent, while Austria's was 5.9 per cent in 2022 (*Figure 1*). The low level of intellectual capital investment in Hungary compared to developed countries is linked to Hungary's low productivity level also by international standards, and accordingly, looking ahead,

it is essential to increase intellectual capital investment and achieve knowledge-intensive growth (*Csath 2023*).

Figure 1
Investment rate and share of intangible investment in 2022



Note: Data on intangible investment are not available for Cyprus. Ireland is not included due to its outlying value.

Source: Eurostat

In terms of Hungary's economic development, it is positive that Hungary is one of the most open economies in the EU, with exports as a share of GDP at 90 per cent in 2022. The Hungarian indicator is substantially above the EU and V3 averages (56 and 43 per cent, respectively). At the same time, the import content of exported goods is high, which is accompanied by a domestic value added content of only 52 per cent based on data from 2020, the 4th lowest in the EU. The Hungarian ratio is 13 percentage points below the average for the EU and other Visegrad countries (65 per cent). Increasing domestic value added content is key to inclusive economic growth. In addition, increasing the domestic value added ratio reduces the risk of falling into a growth trap and strengthens the competitiveness of the economy (*Csath 2022*).

Hungarian industrial output growth has been the 5th highest in the EU since 2010, helped by high investment rates and FDI inflows over the past decade. In 2022, the output of domestic industry was more than 50 per cent above the 2010 level, while the EU average was 16 per cent. However, as industrial output increased, its energy

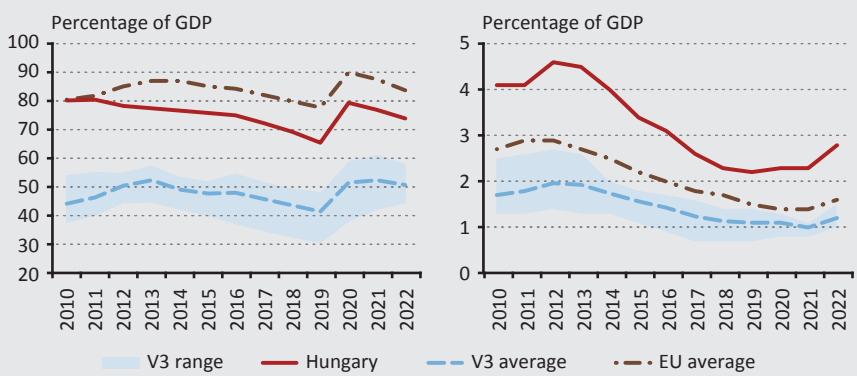
intensity increased by 9 per cent, whereas energy intensity decreased in the vast majority of EU countries. Boosting the energy efficiency of industry would support sustainability while increasing production.

3. Dualities in finance

Fiscal, macroeconomic and financial market balance is essential for sustainable growth and prosperity, as is a stable and efficient financial system that provides adequate financing for economic agents. Over the past decade, the macro-financial balance and the financial system in Hungary have both improved significantly, as evidenced by improvements in a number of indicators, mainly quantitative ones. However, there are qualitative factors that represent efficiency gains, and improvements in these could further strengthen sustainability, both for the public and the private sector.

Thanks to the fiscal turnaround from 2010, the public debt ratio declined steadily from 2011 until the coronavirus outbreak, and has been on a downward path since its rise in 2020. The gross debt-to-GDP ratio fell from 79.3 per cent in 2020 to 73.9 per cent in 2022. However, interest expenditure, the real price of debt, has been rising in recent years: while it averaged 2.3 per cent in 2018–2021, it reached 2.8 per cent of GDP in 2022, above the average of the Visegrad peers and the EU (*Figure 2*). In 2023, gross interest expenditure as a share of GDP is expected to rise further, to 3.8 per cent of GDP, based on the revised 2023 budget estimate.

Figure 2
Evolution of gross public debt (left panel) and gross ESA interest expenditure (right panel) as a share of GDP



Note: The EU average is a weighted arithmetic average. The ESA (European System of Accounts), otherwise known as the accrual methodology, focuses on economic events, as opposed to the cash flow methodology. By ESA interest expenditure we mean the interest obligation arising on the national debt in the given period.

Source: Eurostat

One of the key factors for macro-financial sustainability is household wealth. Household net financial wealth has increased significantly over the past decade: while in 2010 the indicator stood at 70 per cent of GDP, in 2022 it was 105 per cent. Hungarian households have financial wealth well above the average of Visegrad competitors (70 per cent), although the domestic indicator is lower than the EU average (121 per cent). The level and composition of household financial wealth is particularly important in times of crises and shocks, as higher financial wealth – if accumulated across large sections of society and in relatively liquid financial assets – can cushion the impact of crises (*Briglevics – Hegedűs 2023*). However, the positive situation is nuanced by the fact that households have a significant cash position in savings, at 10.3 per cent of GDP based on 2022 data. This makes Hungary the 5th in terms of the highest cash holding rate in the EU ranking, above both the EU and V3 averages (5.9 and 8.7 per cent, respectively). A shift from cash into interest-bearing assets would substantially improve the structure of the economy's financing.

Ensuring stable corporate lending is a key priority for financial deepening and convergence. In recent years, Hungary has seen a significant increase in corporate sector credit growth, above the regional and EU averages, which has been supported by targeted central bank and government lending programmes. Corporate lending remained dynamic during the Covid crisis. In line with international trends, the pace of credit expansion slowed down in 2023 H1, but the Hungarian dynamics remain above the regional and EU averages, with annual growth above 10 per cent (*MNB 2023b*). Despite double-digit growth in recent years, credit penetration remains low. Indeed, the corporate sector credit-to-GDP ratio was 18 per cent in 2022 in Hungary, which is close to the V3 average, but falls far short the EU average of 33.5 per cent, leaving room for prudent credit expansion in the region.

Adequate profitability is equally important for maintaining a strong capital position of the credit institution sector and for implementing efficiency improvements (*MNB 2022*). The profitability of the Hungarian banking system has consistently been at the top of the EU ranking, and in 2022, with an after-tax return on equity of almost 13 per cent, it exceeded the EU average of 10 per cent. However, the cost side of the banking system hides efficiency reserves, as the operating cost-to-assets ratio in Hungary was the highest in the EU, at 2.8 per cent in 2022. This is twice the EU average and represents a constraint on profitability and the pricing of banking products. Deepening financial penetration and the digitalisation of operational processes would help to increase the efficiency of the sector and thus strengthen its growth-supporting role.

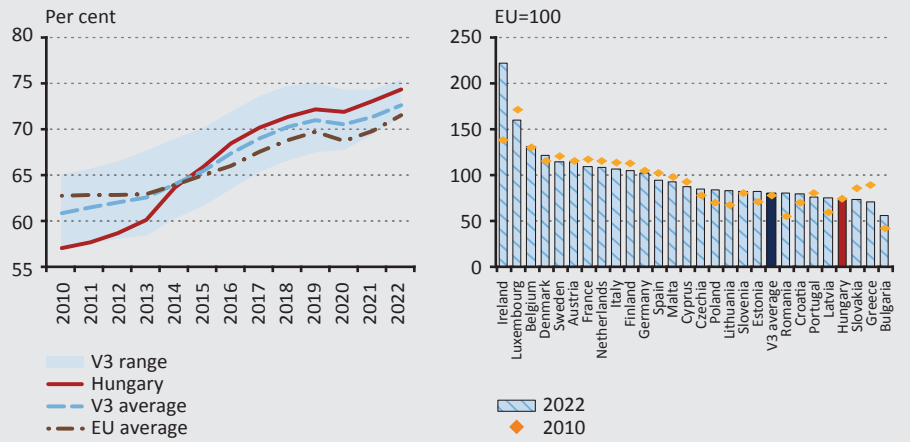
4. Dualities in human capital

The availability of skilled labour is Hungary's most important resource, and a key factor in the transition to an intensive growth model. The quantity of human capital is determined primarily by demographic trends; its quality and productivity are influenced by the effectiveness of the education system, while health conditions have an impact on both the quantitative and qualitative dimensions. The quantity of human capital is increasingly affected by demographic constraints (declining and ageing population), as a result of which the working age population is steadily decreasing. For this reason, it is essential to increase the productivity of the workforce, which will be helped by improving the qualitative factors. In Hungary, progress has been made over the past decade mainly in quantitative indicators of human capital, and a number of qualitative indicators have room for growth, which will become particularly valuable in reaching a path of knowledge- and innovation-driven growth.

The total fertility rate, a key indicator of demographic trends, has risen gradually and substantially over the past decade, from a low of 1.23 in 2011 to 1.52 in 2022, but remains below the 2.1 needed to reproduce the population. At the same time, live births averaged 91,000 per year from 2010 to 2022, still some 20,000 below the target of 110,000. Long-term sustainable economic growth will be difficult to achieve with a declining population (*Sharma 2020*). Thus, a family policy that encourages having children even more effectively is needed to reverse demographic trends.

Many quantitative indicators for the domestic labour market have improved substantially since 2010, and Hungary has approached full employment, supported by a number of measures to increase employment in recent years. The Hungarian employment rate has grown at the 3rd fastest rate in the EU over the last decade, and the coronavirus crisis only temporarily interrupted the upward trend, so that the Hungarian indicator (74.4 per cent in 2022) exceeds both the EU and regional averages. In parallel with the rise in employment, unemployment has also fallen significantly and is currently below 4 per cent. However, despite the favourable headcount figures, Hungarian labour productivity is the 4th lowest in the EU ranking. GDP per person employed increased by 32 per cent between 2010 and 2022, but the Hungarian indicator stagnated as a share of the EU average: 74.3 per cent in 2010 and 73.5 per cent in 2022 compared to the EU average. Productivity developments were also influenced by composition effects (low productivity of new labour market entrants) in the first half of the decade, before growth became more capital intensive from 2017 onwards. The average for the other Visegrad countries was 80.6 per cent of the EU average in 2022. Raising Hungarian labour productivity is also key to wage and prosperity growth (*Figure 3*).

Figure 3
Employment rate (left panel) and labour productivity (right panel)



Note: Employment rate: 15–64 year olds. Labour productivity: GDP per person employed at purchasing power parity.

Source: Eurostat

Nominal average wages have risen significantly since 2010, helped by dynamic economic growth and strong labour demand, as well as targeted wage increases. Nominal average wages grew by an average of almost 8 per cent annually between 2010 and 2022, including an average of around 12 per cent per year since 2017. However, the dynamics of average real wages have diverged from nominal wages and have been slowing down since 2017. Between 2017 and 2022, real wages rose by 6.4 per cent on average. From 2020 onwards, the coronavirus crisis and then the global inflationary wave slowed down real wage growth, which remained positive throughout 2022 (2.5 per cent), but in 2023 H1, real wage growth fell by 8.1 per cent year-on-year, while nominal wages increased by almost 14 per cent.

The quality of education fundamentally determines the quality of human capital and its productivity. International tests measuring the effectiveness of public education show that Hungarian students learn the expected curriculum, but are less able to apply what they learn in real life (*MNB 2022*). However, some students excel in the Student Olympics: for example, in the last decade, Hungarian students have placed 21st on average in the Student Olympics in Mathematics, compared to an EU average of 46th. At the same time, the proportion of 25–34 year olds with a university degree is one of the lowest in Hungary. The indicator has been almost stagnant since 2012, contrary to the increasing trend in the EU, and stood at 32 per cent in 2022, compared to the V3 average of 38 per cent and the EU's 42 per cent. To shift to a knowledge- and technology-driven growth model, it is crucial to

ensure the right number of skilled workers with the right skills and knowledge, and their continuous training and development.

5. Dualities in the green economy

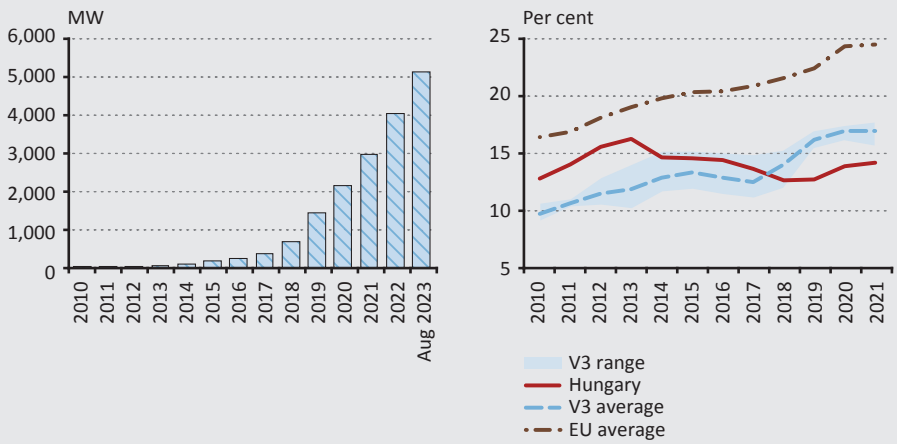
Without environmental sustainability, long-term sustainable growth and increased prosperity cannot be achieved. Today, green and sustainable management is gaining increasing attention, as ensuring the regeneration of resources is the only way to guarantee the prosperity of future generations (*MNB 2021*). Environmental sustainability includes not only the protection of the natural environment, but also efficient energy management, the reduction of emissions from human activities and green financing, among other things. Over the past decade, we have seen several promising developments in Hungary in the field of environmental sustainability, but qualitative progress is still needed in a number of areas to ensure a successful green transition. The MNB is one of the first central banks to support the green transition and has taken meaningful steps to integrate environmental sustainability considerations into the regulatory framework of the banking system, reserve management, monetary policy, collateral management and data disclosure (*Matolcsy 2022*).

One important measure of ecological efficiency, carbon dioxide emissions per unit of output has been on a downward trend in Hungary over the past three decades, as in most EU countries. Since 2010, the indicator has decreased by 30 per cent and is at a more favourable level than the regional and EU averages. As CO_2 emissions have fallen over the past decade, the energy intensity of the economy – a measure that shows the amount of energy required per unit of economic output – has also declined. Hungary's energy intensity (206 kg/thousand euro) is similar to the average of the other Visegrad countries, but still significantly higher than the EU average (117 kg/thousand euro). Lower energy intensity is cheaper for the economy to operate and reduces Hungary's energy dependence, and, while increasing efficiency, provides greener conditions for successful convergence (*MNB 2022*).

Increasing the importance of renewable energy sources can strengthen the sustainability of a country's energy production and reduce the energy dependence of the economy. Since 2010, solar energy in Hungary has seen a positive trend, with more than 5,000 MW of solar capacity added. However, the share of renewable energy sources in final energy consumption remains low. The Hungarian indicator rose in the first half of the 2010s and then fell. Since 2019, the share of renewable sources has been rising again reaching the national target of 13 per cent by 2020. The 14 per cent share of renewable energy in 2021 is lower than the average for the Visegrad countries and the EU (17 and 24 per cent, respectively) (*Figure 4*). By 2030, the Hungarian state wishes to increase the share of renewable energy to 29

per cent, which is significantly lower than the 42.5 per cent target set by the EU. Looking ahead, the expansion of other renewable (wind, hydro, geothermal) and nuclear energy sources, in addition to solar energy, could contribute to achieving this target.

Figure 4
Solar cell capacity in Hungary (left panel) and share of renewable energy sources in final energy consumption (right panel)



Source: Eurostat, MAVIR

Agriculture is of key importance not only for food supply, but also for the environment and sustainability. In Hungary, agriculture has a high importance compared to the EU, and accordingly it is worth building on it. The weight of agriculture has averaged 3.6 per cent of GDP over the last 10 years, the 5th highest in the EU ranking and more than double the EU average (1.7 per cent). However, there is considerable scope for increasing the productivity of the food industry, with the Hungarian indicator being the 2nd lowest in the EU ranking. Compared to the EU average, the productivity of the food industry is 36 per cent, which represents a substantial reserve for efficiency and competitiveness.

As water management becomes increasingly important in the future, there is a major duality. Hungary is in a favourable position in terms of total renewable water resources, but is a water scarce country in terms of internal renewable water resources. Hungary's total per capita renewable water resources are the 7th largest in the EU, but its internal renewable water resources are the 2nd lowest. Efficient use of Hungary's water resources would also contribute to increasing agricultural productivity and responsiveness to climate change.

6. Summary

In the 2010s, Hungary achieved results on a scale of economic history that makes it the most successful decade of the last century. Thanks to the targeted reforms and economic turnarounds of the 2010s, both balance and growth were achieved. Strengthening employment and economic growth was essential to achieve this balance, with structural reforms of the tax system and the budget as the main instruments. From 2013, this was supported by the monetary policy turnaround. The coordinated operation of the two main branches of economic policy has resulted in an innovative, growth-friendly economic policy, which created a long-unprecedented unity of macro-financial balance and economic growth after 2013 (*Matolcsy – Palotai 2018*).

The 2010s saw a trend improvement in a number of economic and social indicators, and Hungary also moved closer to the European Union in terms of economic development. However, the improvements were mainly seen in quantitative indicators, while substantial room for growth can still be identified in a number of key qualitative indicators. Hungary's economic growth has consistently outpaced the EU average since 2013, bringing the country close to the EU average in terms of development, but the real disposable income of domestic agents, GNI, remains below GDP, as in other countries in the region. Investment rates have risen significantly in recent years and are at historic highs, but Hungary ranks in the bottom third of the EU ranking in terms of the share of intangible investment, which is essential for the digital and technology-driven transition. One of the most significant successes of the last decade has been the substantial improvement in many quantitative labour market indicators, bringing the country close to full employment, but Hungary's labour productivity remains one of the lowest in the EU. Corporate lending, which is crucial for financial deepening and convergence, has expanded significantly in recent years, but there remains substantial room for prudent credit expansion as a share of GDP. Thanks to the fiscal turnaround in the early 2010s, fiscal indicators have also improved significantly and the public debt ratio is declining again since its temporary rise in the wake of the Covid crisis, but interest expenditure has risen, with further increases likely to follow. There are also promising developments in the area of environmental sustainability, with a reduction in carbon dioxide emissions per unit of output and a decrease in energy intensity. However, the latter remains significantly above the EU average. In addition, there is still considerable room for, inter alia, expanding renewable energy sources.

Looking forward, qualitative improvements and the elimination of the current economic dualities are essential for knowledge- and innovation-driven growth. For sustainable convergence and growing prosperity, it is not enough to improve real

economic factors: a complete competitiveness turnaround is needed. Significant potential for growth can be identified in the areas of value creation, efficiency and innovation, for which continuous improvement in the qualitative indicators of human capital, such as health conditions, knowledge and skills levels, is essential. At the same time, there is also a need to increase the efficiency of businesses and the state, which can be facilitated by the wider use and strengthening of digitalisation and innovation. Furthermore, sustainable growth and increased prosperity cannot be achieved without taking environmental concerns into account, ensuring the efficient use and recycling of resources and the preservation of natural environment.

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The Role of Ethical Principles in the Economy*

István Kőrösi

Katalin Botos:
Világvallások és a gazdaság
(World Religions and the Economy)
Kairosz Kiadó, Budapest, 2023, 135 pages
ISBN: 978-963-514-171-5

Professor Katalin Botos has an extremely rich body of work. She is the author of nearly twenty books and more than 380 scientific publications. Besides her work in science management and as the founder and head of doctoral schools, she was actively engaged in the field of economic and financial policy as minister without portfolio and as chair of the Banking Supervisory Authority. Her academic contribution is also extensive on an international scale. Her research and teaching activities have enriched university education at Corvinus University and its predecessors, as well as at the University of Szeged and the Pázmány Péter Catholic University. Her educational pursuits are wide-ranging and diverse. She also hosts an economic analysis show on the radio.

Her interesting new book published this year explores the economic teachings of world religions and their role in the functioning of the economy. In this review, I present her book, focusing on the role of moral principles and values in the functioning of the economy.

Botos' volume of studies consists of five parts. In her introduction, she points out that the economic teachings of world religions have one thing in common: they all reject purely profit-oriented economic behaviour. The first part is entitled "*The economic teachings of world religions and the global market economy"*. An important claim here is that today "*the high costs of redistribution put entrepreneurs in Western capitalist societies at a competitive disadvantage relative to markets where community values and the solidarity based on them are more esteemed"* (p. 11). One intriguing question is whether and how the socio-economic teachings of

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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world religions play a role in the economic success of certain groups of countries, and whether they contribute to economic development.

Long-term historical development has many lessons to teach us. Angus Maddison analysed in detail the population and growth trends in the world economy and the evolution of welfare in each group of countries. Maddison divided the world into Western (A) and Eastern (B) groups of countries. The West included Western Europe, North America, Australia and Japan. Group B comprised Asia (excluding Japan), the Asian successor states of the former Soviet Union, Eastern and Central Europe, Africa and Latin America. Botos points out – correctly, in my opinion – that such a division of West and East is a simplification. Given their potentials, China and India have been, and still are, the historically dominant countries in shaping the position and average development level of the East. Furthermore, for centuries, the nomadic Tatar and Mongol Empire in Central Asia had the greatest economic and commercial influence due to its territorial expanse, but it was precisely because of its nomadic nature that it was unstable and changed rapidly. In his analysis, Maddison shows that 2000 years ago, average per capita income was similar in the two groups of countries; in 1000, it was lower in the Western group than in the Asian group; and then in the second millennium, the Western countries developed at a faster pace. There are two main phases in the second millennium. In 1820, the Western group of countries had twice the income per capita of the Eastern group. After 1820, with the spread of capitalism, the development of the West accelerated, and by 1998 the income gap had grown sevenfold in favour of the West.

Botos provides a convincing analysis of the qualities and factors that determined the development of European and Asian civilisations. The emergence of Europe's technical and technological dominance cannot be explained by geography, as these conditions existed previously (although it is true that the climate changed significantly from time to time). One should consider the economic and social organisation, the role of rationality and the rational structure of economic models to identify the foundation of and key to the rise of civilisations. The driving forces in the modern world are the rapid and efficient introduction of technical innovations, the regular reinvestment of surplus income and the motivation of management and employees. The author correctly highlights that Christianity "*makes reason and logic the basis of faith"* (p. 17). She cites Samuel Gregg's statement in saying that *"If we accept that logic and reason contribute to the development of science, we can say that Christian religion has contributed much to the accumulation of knowledge, which is the most important factor in economic growth"* (p. 18). As early as in the Roman Empire, patient and elderly care was already in the focus of Christians. In addition to its moral and social significance, this furthered the growth of the Christian population. Appreciation and respect of intellect became the basis of culture and the accumulation of knowledge. The scientific achievements of antiquity were preserved, transmitted and advanced by Christianity.

According to American professor Deepak Lal, a distinction must be made between people's material and cosmological beliefs. The first relates to the ways of making a living, while the second shows how we should live. Christianity responds to both, proclaiming the fundamental value of the person and creating a new institutional framework for socio-economic activities. The institutional and legal environment is very important for the accumulation of material and intellectual capital. Botos is right in pointing out that "*the decisive factor is the human knowledge factor; therefore, I believe it is appropriate to look for the driving force of development in an ideology that rests on intellect*. *Without human capital, without the accumulation of knowledge, there can be no technological revolution, as the concentration of material wealth in itself will not engender a capitalist mode of production*..." (p. 23). Some of the world religions are closer to a communitarian ideology, others to an individualist ideology. Chinese, Japanese and Korean values and the Hindu religion are also fundamentally communal in nature, but at the same time, they build on individual responsibility. Civilisations built on monotheism are essentially individualistic in nature, as they emphasise the role, the responsibility of the individual, individuality, and the importance of the actions of the individual.

The section "*The impact of religions on the economy"* looks into the role that qualities, responses to challenges, and the erudition and attitudes of the population play in underpinning economic performance. Favourable natural conditions not only do not guarantee success, they often make societies feel too comfortable and lead to inefficient performance and lagging behind. Changing seasons and the challenges posed by harsher natural and climatic conditions demand better performance and may require greater efforts, greater achievements and progress, but only if society can respond to these challenges by mobilising its labour, intellectual and material endeavours to a greater extent (cf. the rise of Scandinavia and Switzerland). And this depends on the culture. That is why these countries are more developed than those around the Equator. Good values and their pursuit, conscientious value-creating work, an attitude to social coexistence and adherence to the rules are the key to a well-functioning society. Botos presents a comprehensive study of the World Value System, which covers 66 countries focusing on six areas. It examines the impact of religion on the following areas: cooperation between people; the attitude of members of society towards women, the state and the government; legislation; the fair functioning of the market economy; and frugality. Trust and tolerance were highlighted in the analysis of cooperation between people. In the case of legislation, the extent to which citizens abide by the rules and comply with the law was surveyed. For the market, the acceptance of income differences is justified by the incentive to do better. The study found that religious people tend to have traits that favour the market economy and its institutions, have more trust in each other and the government, and are more law-abiding.

The third part of the book compares Christian social teaching with economic reality. The starting point for evaluating economics is that economics is not a natural science. "*There are mathematisable facts, but decisions are made by people and do not only have economic but also social consequences*. *Moreover, a large part of economic decisions are not made by market entrepreneurs, but by political bodies which take into account a number of individual aspects in addition to economic benefit"* (p. 53). From the second half of the 19th century onwards, the Catholic Church has been seeking a comprehensive response to the fundamental problems of the functioning of capitalism. In 1891, Pope Leo XIII published his encyclical on the economy, *Rerum Novarum* (*"Of New Things"*), which has since been followed by a series of encyclicals on the same subject. Their guiding principle is that the economy is to serve the people, and not the other way round. In its social teaching, the Church combines the requirement of economic efficiency and justice.

Botos quotes and analyses the writings of Pope John Paul II, who criticised multinational and transnational corporations as exploiters in host countries, and also noted that capital only considers the economic function of labour, often ignoring social aspects and the development of the individual. The primacy of labour over capital is indisputable. In job creation, the state has an important duty in encouraging employment growth, ensuring adequate conditions for education and training, and promoting the public training of a quality workforce. International capital flows have further strengthened the differentiating forces that have widened international economic disparities. There are structural problems in the world that can only be solved by human behaviour that is based on solidarity and cooperation on a global scale. In his encyclical *Centesimus Annus* (CA) published in 1991, Pope John Paul II explained in detail the problems of the regime change that took place in Central and Eastern Europe, pointing out that *"the costs of transformation were as great as the damage caused by the World War or the burden of reconstruction"* (CA, 28, cited in Botos, p. 65). Also fundamental is the idea that "*A person who is concerned solely or primarily with possessing and enjoying [...] cannot be free"* (CA, 41, quoted in Botos, p. 67).

Botos also provides a comprehensive overview of human ecology. The first and fundamental structure of human ecology is the family because it is the scene of the qualitative reproduction of life. Education must go hand in hand with raising children to make them develop into mature, responsible, cooperative and creative individuals. This requires healthy families, and that these families be protected and supported. Ensuring fair wages and decent working conditions, and reconciling the interests of employers and workers are extremely important aspects. Inspired by Naughton, Botos presents the importance of love graphically. The nurse who cares for the patient with love and humanity is not paid for love but for the administration of medicines and the nursing activity. Money can't buy love. At the same time, the desire to love and be loved is present in people.

Christian ethics of economy provide an important guidance of values for sustainable development. In societies of plenty, values have become distorted, as we spend far less than necessary on basic health care, education and clean drinking water. Ecological pressures are increasing, marked by the ever-faster depletion of natural resources and the enormous pollution of the environment. This puts sustainable development at risk. The only solution is an eco-social market economy that meets the needs of the present generation in a way that satisfies the needs of the future generation. The future depends not only on science, but also on moral conduct. Botos makes it clear that the achievements of modern technology and the information society must be coupled with a morality that treats our planet with the care of a good steward. It also highlights the important role of the local division of labour. That "*local division of labour can bring about a much more favourable situation of competitiveness*. *If family services are more valued and appreciated as they should be, we can solve many problems without money. This means lower costs, but not necessarily a worse quality of life"* (p. 77). As a child, a sick person, a person in need of care, an elderly person, you are part of relationships in which assistance and morality play a fundamental role. This train of thought in the book concludes with the idea that "*Without more cooperation, without greater solidarity, we will be losing out in the global race"* (p. 77).

The fourth part is a joint study by Katalin Botos and József Botos: *"Relationships between the economic teachings of the world religions, the global market economy and charity"*. I find this part particularly interesting in this outstanding work. It focuses on three main aspects: how the values of different religions relate to profit orientation, knowledge economy and charity. Thinking through the values reflected in the economic teachings of the different world religions is an interesting exercise. The book summarises these very well. I will briefly summarise a few important and interesting points here.

Buddhism is about not letting our desires control our lives. One should not get rich through immoral means. Hinduism is not opposed to economic empowerment and prosperity. However, the rigid caste system limits mobility and thus the freedom of economy. Confucianism is the dominant religion in China, but it is also prominent in Korea, Japan and Southeast Asia. It sets high moral standards for the individual (discipline, loyalty, trustworthiness, reciprocity). It stresses the importance of self-control over human passions. It also emphasises the individual's social obligations and respect for tradition. Confucianism is economically progressive, because it promotes self-reliance and entrepreneurship. Mencius, the famous teacher, condemned profit seeking as a threat to the harmony of the state, which is the highest ideal of Confucianism. *"One's act should neither be motivated by what profits him or her nor be motivated by what profits one's family or even one's state"* (quoted in Botos, p. 86). In modern Confucian thinking, the purpose of business

is to improve people's living conditions, but this activity also generates profit as a by-product. Profit is therefore a result, but not a fundamental motivating factor. They seek to bring capitalism into line with Confucianism and develop a new motivational force on this basis.

Monotheistic religions have their roots in the Old Testament, the Bible. According to Jonathan Sachs, the biggest change in the history of human development is the realisation that you can do something to shape your own destiny. The core of Jewish socio-economic teaching is that people are responsible for their actions. Our task is to do our utmost to preserve human dignity and to pass on a better world to future generations. Jewish teaching places great emphasis on cooperation and the family, the synagogue and schools are its most important institutions. The economy is largely dependent on the accumulated intellectual capital. This enables creativity which is the basis of business success. However, an important part of Jewish social teaching is distributive justice. Jewish teaching makes charity mandatory. Under Mosaic Law, a person enslaved because of indebtedness had to be freed in the seventh year. If someone was forced to sell their ancestors' land or to give it to a creditor in exchange for debt, it had to be returned to the original owner in the year of Jubilee, when the "trumpet is blown", i.e. after 50 years. This regulation had the aim to protect the ownership of agricultural land. Urban properties could be permanently alienated. The humane treatment of widows and orphans was also regulated by law.

Christianity is based on the fundamental commandment of love. Christianity emphasises human equality, human dignity, and links faith and reason, which clearly had and still has a role to play in the foundation and acceleration of economic development. The economy rests on the core pillars of the dignity of individual and private property. Without these, we could not be good enough stewards of the world entrusted to us. However, there is also a place and role for the appropriate forms of community ownership (public, church, municipal, foundation, non-profit, etc.). We must manage the Earth's natural resources responsibly, and the best way forward in economics is to apply the principle of maximum cooperativity. A spontaneous economic system does not create social justice; this is the task and the requirement of the rule of law. In today's world, the power of the state is often smaller than that of a single multinational corporation, so we need global cooperation, international agreements and well-functioning organisations.

Islam also sees the individual as the cornerstone of society and underlines that people are personally responsible for their actions. Islam sees the world as a network of connections. Islam accepts the existence of individual interests and market mechanisms, but it does not advocate the exclusivity of the market. It emphasises the role of justice in development. It considers interest to be usury and rejects it, as it is against fixed and guaranteed capital income. However, it is still

possible to acquire interest income by means of a sale and purchase transaction where the lender joins in the real economic investment and the benefits are shared.

Successful economies in Asia rely heavily on the solidarity of small communities and the family, and solve many social problems within this framework. The overly individualistic Western world, on the other hand, buys for money, and either makes the state pay for it or pays out of pocket, but in both cases, the increase in taxes and spending damages its international competitiveness. Therefore, by strengthening morality and solidarity, competitiveness also increases. Without relieving the state of the responsibility for the rational operation of large distribution systems, the circles of human solidarity and the networks of human relations must be rebuilt and strengthened. I think it is an astute approach and a clear conclusion that "*Modern charity means that not all services are measured in money*. *Interestingly, however, it will have benefits for society, even monetary ones, as the economy becomes more competitive, by harnessing the so-called social capital"* (p. 100)

The final, fifth part is entitled "*Cooperation and competitiveness"*. The relationship between competition and cooperation is always important in the functioning of the economy. Competition has been present in the economy all along. At best, sellers compete for buyers in the market. Competition is inherent to capitalism. Today, there is increasingly fierce competition not only for markets but also for the resources needed for production. In modern production, the division of labour plays an ever greater role, so collaboration is another key process. Botos makes the important point that "*Economic cooperation (however) requires a solid moral basis, since the transaction costs of business would greatly increase if all contracts could only be enforced through legal means"* (p. 107).

Networking is becoming more and more important in the global economy. This generates social capital, which is one of the foundations of the current success of the Asians. The author illustrates how Japan combines intragroup cooperation in school and sport with an intergroup competitive spirit. Subsidiarity must be the basis for the economy and the organisation of society, but at the same time, greater solidarity is needed by linking the individual and the common good. Botos has also clearly stated that "*competition should not be achieved at the expense of nature"*. *We cannot neglect the interests of future generations, meaning that intergenerational solidarity is required. This has ecological, legal, economic, political and cultural aspects"* (p. 132).

Professor Botos' book is a deep and thought-provoking work of great value. It offers a fundamentally new approach in that it interconnects the merits and the usefulness of the ethical principles, moral values and the corresponding behaviour and actions that originate in the teachings of world religions for the economy and society. It proves that value-based, ethical behaviour is also a key to success in the race between the countries. Her book enriches every reader.

Report on Some of the Sessions of the Hungarian Economic Association Congress*

Ferenc Tóth – Benjámin Nagy – Gábor Szarka – Lilla Bánkuty-Balogh

On 21–22 September 2023, the 61st Annual Congress of the Hungarian Economic Association (HEA) was held in Eger, Hungary. This is the largest annual conference of the Hungarian economics community with one of the most significant traditions. At the opening plenary session, György Matolcsy, Governor of the Magyar Nemzeti Bank (MNB, the central bank of Hungary), Mihály Varga, Minister of Finance, and Péter Ákos Bod, university lecturer, Professor Emeritus of Corvinus University, Vice President of HEA, held a roundtable discussion on economic policy moderated by Gyula Pleschinger, President of HEA and member of the Monetary Council of the MNB. Following this, László Windisch, President of the State Audit Office of Hungary and member of the Board of the Sustainability Section of HEA, gave a presentation.[1] In this report, we give an account of the bank chiefs' roundtable discussions and the sessions on monetary policy, sustainability and competitiveness issues as well as the need to measure sustainable development.

Roundtable discussion of bank leaders

At one of the most prominent and well-attended sessions, the *Roundtable discussion of bank leaders*, *Pál Péter Kolozsi*, Director of the MNB's Monetary Policy Instruments, Foreign Exchange Reserve and Risk Management, associate professor at the MNB Knowledge Centre for Sustainable Finance, John von Neumann University, and President of the HEA Finance Section, gave the welcome speech. The roundtable discussion was moderated by *Barnabás Virág*, Deputy Governor of the MNB and member of the Board of the HEA's Competitiveness Section, with senior executives of Hungarian commercial banks. The participants included *Éva Hegedüs*, President and CEO of GRÁNIT Bank Zrt., Secretary General of the HEA, *Ádám Egerszegi*, Deputy General Manager of MBH Bank Nyrt., *Radován Jelasity*, CEO of ERSTE Bank Hungary Zrt. and President of the Hungarian Banking Association,

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[1] Available on HEA's YouTube page: https://www.youtube.com/watch?v=GNWCywpUu74

Pál Simák, Chairman and CEO of CIB Bank Zrt. and *László Wolf*, Deputy CEO of OTP Bank Nyrt., Vice-President of the HEA.

Barnabás Virág gave an overview from the macro side in his presentation entitled *Banking System 2023: after the storm, before the calm?* He highlighted that the global economy was facing serious real economic challenges. The inflationary pressures that have been unprecedented for 50 years and a high interest rate environment that has been unexperienced for two decades at the global level is putting the financial system to a severe test. An important question is whether recent American and European banking market events were harbingers of further systemic risks or merely isolated events caused by a changed environment. Regulatory efforts have been successful and, as a result, the capitalisation of the European banking system is now much more robust than in 2008, and banks are operating in a much safer manner. As deposit-side interest rate transmission is weak, increased net interest income has been a key factor in the growth in profitability of EU banks, which are increasingly being subjected to special taxes to help restore the fiscal balances of more and more countries. As the economic cycle is losing steam, the main risks to the EU banking system are from the real estate market, which is highly overvalued, and from profitability. The big question is whether these developments will have consequences for the balance sheet of the banking system. The resilience and capital position of the Hungarian banking system remains strong, with ample liquidity, but factors such as high inflation, low growth, the declining deposit portfolio, slowing lending dynamics, real estate market risks and, consequently, the sustainability of profitability pose a major risk. However, the return on equity within the sector improved materially in 2023.

The Deputy Governor of the MNB noted that the credit institutions sector had achieved a net profit after tax of HUF 675 billion in 2023 H1, according to individual (non-consolidated) data. This was the highest half-year result since the turn of the millennium. The main source of this was the increase in net interest income received from the MNB, which amounted to HUF 627 billion. Retail deposits decreased by HUF 821 billion between December 2022 and June 2023, but this was amply offset by the liquidity effect of the interest payments by the central bank. The repricing of retail time deposits was significantly below the rise in short-term interbank yields, with strong interest rate transmission only seen for corporate deposits. The lending capacity of the banking system was historically high, but was constrained by a lack of demand. The slowdown in corporate loan growth was a common phenomenon in the EU, with the uncertain economic environment discouraging lending. Corporate demand for foreign currency and short-term loans had been buoyant over the past year, with foreign currency loans requiring close attention. New household lending had halved. At the same time, credit risks had not materialised so far, helped by a stable labour market. The Hungarian banking system had made significant progress in the field of digitalisation.

The first question on the *functioning of the markets and the banking system* was how much more turbulence was expected. Bank executives pointed out that lending had also fallen radically at the international level, e.g. mortgage applications in the USA were at their lowest level since 1990 and retail lending in the euro area was at its lowest level since 2015. This was likely to improve next year. The biggest challenges were confidence, and how the interest rate environment, the war and the green transition would develop going forward.

As we heard, the *European banking system* was in better shape, both compared to the USA and to the situation in 2008, and banks had performed well in stress tests. One reason for this may be that the European Banking Authority was more rigorous and consistent than the US system. On the risk front, the problem of Italian government bonds had emerged. Retail lending was also expected to recover soon, thanks to a stable labour market.

The *profitability* of EU banks may remain high in 2024, as it had this year, since European interest rates might be even higher on average next year than this year. However, this might be significantly affected if further countries introduce bank taxes.

Several factors were behind the significant *deposit outflows*: in the past, sharply falling real wages, and nowadays the draining effect of the government securities market. Statistics showed that the real assets of the public in the banking system were declining and that deposit outflows were not only going into government securities but also partly into investment units as well, and thus overall there was a significant restructuring from liquid assets to investments. In addition, there was a clear reduction in the savings portfolio for a significant part of the population. Alongside the shift towards government securities, there was also increasing demand for foreign currency deposits.

The decline in *corporate credit demand* was much smaller for large companies than for small firms, because while large firms export abroad, small firms tended to produce for the domestic market, where there had been a significant drop-off in demand. According to banking sector representatives, there was a lack of subsidised and targeted investment loans. Improving business productivity and competitiveness would be very important. At present, companies preferred to take out working capital loans and were replacing their existing more expensive loans. Green lending had an important role to play in the green transition, but this was not a task for banks only, support from policy and demand was also required. The vast majority of green lending was concentrated in three sectors: transport, energy and property development.

Barnabas Virág concluded by saying that the banking system would hopefully be able to handle the uncertainties ahead well, and the next congress could be about how to lend more efficiently, improve productivity and accelerate the energy transition in a growth phase.

Session of the Monetary Policy section

The session of the Monetary Policy section focused on the search for a new equilibrium and the impact of the high inflation environment on monetary policy. The session was opened by *Ádám Banai*, Executive Director responsible for the Magyar Nemzeti Bank's Monetary Policy Instruments, Financial Stability and Foreign Reserve Management and Co-Chair of the Monetary Policy Section of the HEA. *M. Zoltán Jakab*, Senior Economist at the IMF and member of the Board of the Monetary Policy Section of the HEA, highlighted the challenges in the current economic environment and economic policy in his opening speech: the coronavirus pandemic had caused both demand and supply shocks globally, and energy shocks not only threatened security of supply but may become permanently embedded in inflation expectations; coordination with fiscal policies was essential for the effectiveness of monetary policies, and a number of factors were pushing towards a change in the equilibrium real interest rate.

Előd Takáts, Chairman of the Monetary Policy Section of the HEA and advisor to the Deputy Chief Executive Officer of the Bank for International Settlements (BIS), presented the liquidity risks arising from the operation of central clearing houses in the context of extreme price volatility in a turbulent market environment. Following the 2008 crisis, the clearing of derivatives transactions, which had previously been concluded on a bilateral basis, was shifted to central clearing houses to increase market transparency and mitigate risks. In the course of its operations, the central clearing house joined the parties that previously transacted directly, depositing liquidity with the clearing house and keeping it available on an ongoing basis in the form of margin to ensure that the given derivative transaction could be closed without expected loss in the event of default by any party, thereby eliminating counterparty risk. However, the amount of liquidity required to be held with the clearing house varied according to market conditions and the value of the given derivative transaction. This meant that counterparty risk was transformed into liquidity risk: in the event of extreme market price changes, the contracting parties would have to transfer large amounts of margin, which could consume large amounts of liquidity. In extreme cases, this withdrawal of liquidity could also jeopardise the proper functioning of institutions. Similar developments had taken place in relation to European gas futures deals in recent years. The military conflict in Ukraine, the EU sanctions policy and other energy market developments could lead to extreme increases in energy prices, even within a single day, which

imposed significantly increased margin requirements on market participants holding derivative positions. In the current period of ample liquidity, thanks also to the central bank's handling of the coronavirus crisis, this risk had not materialised significantly and had not caused markets to malfunction, but *Takáts* stressed that, in parallel with the normalisation of monetary policies, greater attention should be paid to the liquidity risks arising from the operation of systemically important central clearing houses.

Piroska Mohácsi Nagy, Visiting Professor at the London School of Economics and Political Science (LSE), former Head of Department and Advisor to the International Monetary Fund, compared the communication between central banks in global dominant and emerging markets. In terms of transparency in central bank communication, emerging market central banks had made significant progress over the last two and a half decades, approaching the Federal Reserve (Fed), the European Central Bank (ECB) and the Bank of England. Moreover, in terms of comprehensibility, their communications were, until the coronavirus pandemic, more transparent than those of the advanced central banks, given the level of education required to understand their publications. A *sentiment analysis* of central bank communications shows that in the years following the 2008 financial crisis and the European debt crisis, and during the coronavirus pandemic, monetary policy communications from both advanced and emerging markets moved in synchronicity, conveying easing messages. However, in 2021–2023, emerging market central banks, including the MNB, started to communicate tightening messages earlier than advanced market ones in response to the unfolding global inflation. A thematic decomposition of communications showed that the Fed, in line with its dual mandate, often included labour market factors alongside inflation, which likely reduced the clarity of its communications when inflation was rising rapidly. Importantly, it had also made quantitative tightening a dominant theme. By contrast, inflation had typically been the focus of the ECB's communication, and the technique of *forward guidance* was actively used until 2022. The tone and themes of the communications of regional central banks were closer to those of the ECB, with the difference that they adopted a more flexible form of forward guidance, with less commitment and thus the possibility of a more data-driven approach. With the exception of Poland, the central banks in the region were rightly still communicating a tightening policy as inflation remained high. Due to the smaller size of their economies, the openness of their financial markets and hence their vulnerability to rapid capital flows, as a special point, the communication of emerging market central banks also emphasised messages about exchange rates. *Mohácsi Nagy* stressed that central bank communication had a particularly important role to play, especially in the rapidly changing economic environment that had characterised recent years. She pointed out that there was room for improvement in the communication of both developed and emerging market central

banks, in particular by improving transparency through the communication of fiscal policy coordination and the economic policy mix.

The roundtable discussion following the presentations, moderated by *Ádám Banai*, was joined by *Zsolt Kuti*, Executive Director of the Magyar Nemzeti Bank, responsible for Monetary Policy, Financial Analysis and Statistics. Participants agreed that if a liquidity problem arose in a market stress situation arising from the operation of the central clearing house that jeopardised the efficiency of monetary transmission or financial stability, the central bank should intervene in accordance with its legal mandate. However, the form of central bank intervention was questionable and it was particularly important that it take place within appropriate controls and to the extent necessary. Participants also underlined that the role of central bank communication had increased in recent years. On the one hand, with the acceleration of information flows and financial market movements, central banks needed to convey their messages more effectively and in a shorter time frame to market participants, who were able to respond in increasingly quickly by shifting large amounts of liquidity. This also implied that central bank messages need to be more carefully formulated, as correcting a communication error could have significant costs in fast-moving financial markets that could respond instantaneously. On the other hand, broad and transparent communication was also particularly important for democratic accountability in turbulent times, when central banks needed to provide citizens with non-professional financial knowledge with an understandable account of macroeconomic and inflationary processes and developments in monetary policy.

Session of the Sustainability and Competitiveness Section

At the session of the Sustainability and Competitiveness section, after three presentations, the invited speakers discussed the domestic and international situation of green financing as well as the challenges and tasks for companies from the ESG side and the green transition in a roundtable discussion.

At the full-house event, *Richárd Végh*, CEO of the Budapest Stock Exchange and President of the HEA Sustainability Section, welcomed the participants. This was followed by the opening presentation of *Csaba Kandrács*, Deputy Governor of the MNB, responsible for the supervision of financial institutions and consumer protection, and member of the HEA Sustainability Section's Board of Directors, with the title *The State of Green Finance in Hungary*. He started his presentation by outlining the complex impact caused by the appearance of mankind on the planet's climate. The environmental impacts of climate change had a significant impact on the economy and the financial system, which was a challenge for central banks, including the MNB, to address. The MNB was the first central bank to receive a green

mandate. Sustainability was a key priority for the MNB, not only for the stability of the financial system and the impact on the real economy, but also for price stability, which was why in 2019, the MNB had launched its own green programme built on three pillars: measures to address the financial system (mapping environmental risks, developing a green financing environment, improving the resilience of the financial system), and developing relations (education-research, international professional relations), as well as greening the MNB's own operations (making them more sustainable, reporting). The actions of the central bank regarding the financial system were very significant, with the promotion of green lending resulting in green bond holdings reaching HUF 83 billion in 2023 Q2, green corporate loans reaching HUF 459 billion and green housing loans reaching HUF 112 billion. In addition to green lending incentives, the MNB was also working on the development of an ESG[2] methodology for corporate lending and had launched a two-year research and methodology programme with the OECD and the European Commission to assess and address the financial risks of biodiversity loss. Consequently, it could be said that the MNB's green activities were unique in the region.

This was followed by a presentation by *Richárd Végh*, who presented the capital market aspects of sustainability. The main message of his presentation was that sustainability was a competitiveness issue for companies all over the world, not only for large corporations but also for small and medium-sized enterprises. Sustainability had been a high priority for the capital markets for a very long time, as the ESG methodology was first adopted in the field of stock market investing. Companies were expected to operate sustainably by consumers, regulators and investors. Consumers' attitudes were increasingly ESG-conscious, both in terms of yield expectations and engagement, which had a positive impact on corporate operations. On the regulatory side, the European Union had also made sustainable development a priority, which it wished to attain inter alia through emission quotas and their regulation to reduce the carbon footprint (ETS,[3] CBAM[4]). In addition to direct carbon footprint emissions, it also sought to standardise the definition (taxonomy) and the different reporting principles associated with it (CSRD,[5] SFDR[6]). Companies were also increasingly coming forward with science-based issuance

[2] ESG: ESG stands for environmental, social and governance, and aims to monitor the non-financial risks inherent in the day-to-day operations of companies

[3] ETS: Emissions Trading System of the European Union. Under the ETS, allowances, or emission rights, are created for greenhouse gas emission quotas that participating companies or organisations can buy, sell or exchange.

[4] CBAM: Carbon Border Adjustment Mechanism, a mechanism to compensate for the carbon intensity of imported goods ("carbon duty"), aims to make the comparability of carbon emissions between European companies and their competitors that import from countries with less stringent environmental regulations and higher greenhouse gas emissions fairer and more balanced.

[5] CSRD: Corporate Sustainability Reporting Directive. It aims to tighten and standardise corporate sustainability reporting obligations in the European Union.

[6] SFDR: Sustainable Finance Disclosure Regulation. The SFDR aims to promote transparency and comparability of sustainability information in the financial sector and empowers customers to make informed decisions about sustainable investments.

targets (SBTI[7]), and the number of such companies was growing rapidly on the capital markets of developed countries as well. On the investor side, 45 per cent of net asset value in Europe was already held in so-called Article 8 SFDR funds, which were considered sustainable, but the penetration of these funds in Hungary was still very low, at only 2 per cent. The Budapest Stock Exchange supported the competitiveness of Hungarian companies in the context of sustainability through a number of instruments (EU funds, education, training, consultancy, investor outreach) and as a listed issuer it was at the forefront of these initiatives (Xtend platform, ESG guide, BSE Sustainability Report, Green Platform).

In his closing presentation, Government Commissioner *László György* presented the Harmonic Growth Index (HGI) developed by the Makronóm Institute. The HNI was a composite indicator that measured all dimensions of sustainable growth at the macro level, in 6 pillars and 32 hard indicators. By applying these variables, the Index was able to make the sustainable growth of each country comparable on a factual basis according to the ESG criteria framework. The six pillars of sustainable growth were economic, financial, environmental, social, and demographic sustainability, and that it should be work-based and knowledge-based. In terms of socially unsustainable growth, *György* mentioned the example of the United States of America, where GDP grew dynamically between 1980 and 2017, but the income of the bottom half of the population had not grown at all and infrastructure had not developed at the same rate. In terms of demographically unsustainable growth, he mentioned South Korea, where dynamic economic growth had been accompanied by a radical decline in fertility. The comprehensive analysis was the result of around two years of work by the Makronóm Institute and covered the period between 2005 and 2019, including 87 countries. Based on these indicators, we can say that Hungary's development over this period had been balanced and sustainable (significant real wage growth, infrastructure development, balanced budget), and by 2019 it was ranked 29th in the overall HGI ranking, and first in the HGI ranking of developing countries.

The panel discussion following the presentations was moderated by *István Máté-Tóth*, Deputy CEO of the Budapest Stock Exchange. The panellists were *Csaba Lentner*, professor at the National University of Public Service, *Orsolya Oszabó*, consultant at Egon Zehnder Budapest, *Sujit Chaudhuri*, associate professor, board member of the Sustainability Section of the HEA, and *Sándor Vízkeleti*, CEO of Amundi Alapkezelő Zrt., president of the Association of Hungarian Investment Fund and Asset Management Companies (BAMOSZ), board member of the Sustainability Section of the HEA.

[7] SBTI: Science-Based Targets Initiative is a global initiative to help companies and organisations develop and achieve science-based climate targets. The principles of SBTI allow companies to set targets that are consistent with scientifically accepted guidelines for mitigating global warming.

The panel discussion explored the opportunities and risks of ESG from a corporate perspective. *Orsolya Oszabó* drew the audience's attention to the fact that the "S" of the ESG objectives, i.e. the social objectives, were still difficult to quantify, but more and more guidelines and regulations were emerging from the EU. She cited the 2002 initiative to require 40 per cent of board members of public companies to be from the under-represented sex from 2026. The first companies to adapt would gain a competitive advantage. *Sujit Chaudhuri* highlighted that ESG and sustainability had not yet been present in education, while it was a cardinal goal in employment, among other areas. Regarding the sustainability challenges, *Csaba Lentner* highlighted the intensive energy consumption of Hungarian households, a situation that had not improved in recent years. The spread of green credits and bonds could significantly improve energy use, but access to them was still very limited (ease of access, administration). *Sándor Vízkeleti* highlighted the domestic lag in corporate governance as a competitiveness risk.

In addressing the tasks and challenges ahead, *Orsolya Oszabó* stressed the importance of long-term preparation (e.g. bringing up internationally competitive Hungarian female leaders in the last 10–15 years). *Sujit Chaudhuri* pointed out the double standards used by companies in developed countries (different transparency in the home and target countries) and the discrepancy between the return on investment in sustainability (4–7 years) and the actual predictable time horizon (3 years). *Csaba Lentner* stressed the importance of applying accounting principles that ensure transparency. *László György* stressed the importance of meritocracy as opposed to political fads, and *Sándor Vízkeleti* also highlighted the importance of long-term, intentional development work (citing the example of Norway in bringing up capable female leaders).

Concluding the panel discussion and the session, *István Máté-Tóth* underlined that there were clear positive aspects of ESG and sustainability regulation, but there were also controversial points. However, regardless of we think about the details of the rules, they will affect a significant part of domestic companies, and so it was important to support their preparation to successfully meet the new requirements.

Sustainable GDP – the need to measure sustainable development

The session entitled *Sustainable GDP – the need to measure sustainable development* was chaired by *Gergely Baksay*, Executive Director of the MNB, Chairman of the Competitiveness Section of the HEA, who is also one of the editors of the MNB's handbook *Sustainable GDP – Global Discussion Paper* which is currently under publication. In his introductory presentation, Gergely Baksay said that competitiveness was a recurring theme in the opening plenary presentations, which highlighted the importance of measuring quality as well as quantity in

economic performance. The question arose: how could GDP be measured in a new way, what were the limitations of this index, and what new ways of measuring economic performance in the 21st century could be used to reflect sustainability? The discussion paper aimed to apply the same approach to measuring economic performance as the publication entitled *New Sustainable Economics* published by the MNB in 2022, according to which the purpose of economic life was sustainable growth and well-being. *Baksay* pointed out that GDP was not intended to measure these factors by definition, but it was also not necessarily an accurate indicator for measuring certain dimensions of economic performance. Developed in the 1930s by Russian-American Nobel Prize-winning economist Simon Kuznets, it was one of the most influential statistical indicators in history, but it was born in the era of industrial mass production and was best suited to measure it. GDP alone was no longer precise enough to assess the performance of digital services, the sharing economy, the platform economy, the distribution of income, household work, voluntary work and the social utility of activities in general. Finally, it did not measure at all "soft" factors such as the state of our environment, our physical and mental health, self-actualisation, the degree of freedom or even happiness, which were important determinants of human well-being. The stated aim of this research and discussion paper was to help develop a measurement methodology that moved from measuring material wealth and prosperity to a comprehensive measure of sustainability and well-being. The authors of this publication would like to introduce an alternative economic measure called *Sustainable GDP* (*sGDP*), which takes into account economic, financial, social and environmental sustainability, in addition to the level of development.

Later in the session, the five invited authors of the discussion paper presented their research in detail. University professor *Magdolna Csath*, Vice President of the Innovation Section of the HEA, spoke about the shortcomings of GDP as a measure of economic performance. She pointed out that GDP was essentially a "flow" index, relying on process indicators such as physical capital investment or consumption, and did not address the "stock" effects of growth on national assets such as the value of natural or human capital. This was particularly important in the sense that GDP consequently prefers a short-term perspective and even positively values overconsumption. Magdolna Csath also highlighted problems related to measuring the performance of the digital economy, such as transfer pricing of value-adding activities in global value chains or the failure to take into account the social value creation of the sharing economy.

Eszter Baranyai and *Lilla Bánkuty-Balogh,* Master Lecturers at the MNB Institute of the John von Neumann University, examined the impact of factors other than GDP on well-being. Among their findings was that economic development and life satisfaction do not show a direct correlation, which made it necessary to investigate

the factors of subjective well-being not covered by GDP. Factors influencing well-being were examined along the lines of external (e.g. physical environment, institutions, community life) and individual factors (e.g. personal attributes, health, values and attitudes), and their measurability and relevance for economic policy were discussed.

Gábor Bartus, Secretary of the National Council for Sustainable Development, spoke about the definition of sustainability as a concept and its measurement limitations. He stressed that there is no universally accepted standard for assessing sustainability, as it always depended on context (place and time). He then gave examples of current methods of measuring sustainability, such as resource/capital/asset inventories, composite indicators and modified GDP indicators, and pointed out that the economy actually developed at a different pace when qualitative changes in resources were taken into account.

Pál Bóday, Presidential Advisor of the Hungarian Central Statistical Office (HCSO), presented how the HCSO integrated the indicators of the UN Sustainable Development Goals (UN SDGs) in practice to measure certain aspects of sustainability, under the theme of sustainability and economic growth. He provided insights into factors that were complementary to the national accounts system and were measured by the Environmental-Economic Satellite Accounts, such as resource productivity, greenhouse gas intensity or the evolution of environmental taxes.

After the presentations, the audience had the opportunity to ask questions, and *Gergely Baksay* formulated some closing words. In his summary, he noted that the sGDP project did not aim to change GDP as a measure, as throughout history several indicators had been used in parallel to measure the economic situation and development. For example, the amount of royal wealth accumulated or the unemployment rate. Nowadays, it was mainly economic growth and inflation that were monitored, and the role of inequality as an indicator was also growing. The aim of the sGDP project was that, in five to ten years, the indicators used at the economists' annual meetings and beyond would include whether sustainability had improved, deteriorated or stagnated over time, and that this could be expressed in a single indicator that could be referred to in a standardised way.

Report on the Third International Conference "Digital Transformation and Sustainability in Global Financial Economics"*

Tim A. Herberger – Michael Kuttner

On September 18 and 19, the 3rd conference, "Digital Transformation and Sustainability in Global Financial Economics," took place at the Salzburg University of Applied Sciences, Austria. This year's motto was "Opportunities and challenges for a sustainable and digital future." Originally, the conference was initiated by Tim A. Herberger (Chair of Business Administration esp. Entrepreneurship, Finance and Digitalization, Andrássy University in Budapest, Hungary). For the first time, the event was organised in cooperation with Michael Kuttner (Professor of Accounting & Financial Management, Department Business & Tourism, Salzburg University of Applied Sciences, Austria). About 50 experts (mainly from Austria, Hungary and Germany) presented and discussed the latest findings on digitalisation and sustainability. A total of 17 research projects on this topic were presented in both German and English. Each presentation was followed by a co-presentation, which kept the conference lively and open for discussion and constructive feedback. The conference featured a wide variety of topics, which will be presented in detail in the following sections.

1. Initial situation

Digital Transformation has permeated every aspect of our lives, and its importance is now impossible to ignore, particularly with the advent of the Covid-19 pandemic. Similarly, the ongoing endeavours toward sustainability have garnered increased attention in economics and society.

While there is a growing recognition of the importance of "digital transformation" in our current research landscape, its usage is often ambiguous and lacks a clear-cut definition. This absence of standardised terminology complicates interdisciplinary comprehension, obscuring the relationships between these terms. Nevertheless, their significance remains evident. The situation is similar concerning the term

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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sustainability, where other terms such as socially responsible investments (SRI) and corporate social responsibility (CSR) are partly synonymous and partly subsets of the overarching concept of sustainability (*Herberger – Dötsch 2021*; *Kuttner et al. 2021*).

Given these problems in defining the buzzwords "digital transformation" and "sustainability," as well as the global challenges against the background of the VUCA[1] framework (*Barber 1992*), we aim to offer a solution strategy. This strategy is based on our conference, "Digital Transformation and Sustainability in Global Financial Economics," where we discuss concrete economic problems and formulate case-related answers based on scientific research. Hence, we adopt *Johansen's* (2012) approach, effectively addressing volatility through a clear vision, gaining understanding in the face of uncertainty, managing complexity with a focus on clarity in our actions and responding to ambiguity with agility.

The conference, which has become a regular annual event and took place at Andrássy University in Budapest in previous years, was held for the first time at the University of Applied Sciences Salzburg. Once again, we presented a multi-layered and informative programme, demonstrating to everyone that risk management has evolved into uncertainty management in financial decision-making.

2. Summary of the presentations of the 1st day of the conference

The 1st conference day was opened by *Yanik Bröhl*, who presented results from a research project with *Arnd Wiedemann* (both University of Siegen, Germany) on the success factors for risk governance of sustainability. Identifying success factors is based on a comprehensive literature review of relevant scientific studies on implementing sustainable management systems in the corporate context. In total, six success factors were identified (e.g. the establishment of sustainability in corporate management and strategy, influence of stakeholders on sustainable corporate management, sustainable partnerships and cooperations). According to the presenter, the success factors, as well as the development of a suitable conceptual framework to manage these factors, are the prerequisite for management and can thus serve as a foundation for transforming a company to improve its sustainable success. Accordingly, by taking sustainability risks and stakeholder interests into account, companies can assume responsibility towards society and contribute to sustainable development.

[1] VUCA stands for volatility, uncertainty, complexity and ambiguity.

The second presentation by *Patrick Hilpert* and *Manuela Ender* (both IU International University of Applied Sciences, Germany) is based on an examination of the influence of the updated auditing standard IDW PS 340 in the context of the audit of the early risk detection system on the external risk reporting of German companies. Based on an empirical content analysis in combination with a scoring model, the 2020 and 2021 risk reports of a sample of DAX 40 (German blue-chip shares' index) companies are evaluated. In doing so, an individually-created mapping specifies the influence of the main changes in IDW PS 340 on the risk reporting requirements of the German accounting standards DRS 20. By using the compliance grades as research results, it becomes clear that the tightening of the internal audit of the risk management system also influences risk reporting. Core elements of the updated auditing standard, such as the specification of risk-bearing capacity or risk aggregation, are more strongly considered in risk reporting in the year of first-time application of the auditing standard than in the previous year. Nevertheless, an optimisation of DRS 20 regarding the updated elements of IDW PS 340 is recommended to increase the reporting quality and informative value for users of financial statements.

Renate Hörzing provided insights into the status of the research project "Impact of Sustainability Reporting on Risk Management", conceptualised with *Michael Kuttner* (both Salzburg University of Applied Sciences, Austria). The research project aims to identify the aspects of sustainability reporting that influence the integration of sustainability risks into risk management. A quantitative research design is used to answer the research question. The sample for the survey includes listed companies in Austria or Germany that prepare sustainability reports according to the Global Reporting Initiative (GRI) guidelines. For example, the variables of organisational integration, reporting experience, reporting quality and stakeholder engagement are investigated. Although the results of the study are not yet available, it is expected that the intensive examination of sustainability in the context of sustainability reporting will support companies in identifying sustainability risks, that the increased involvement of stakeholders will enable companies to address the relevant sustainability risks in risk management in a more targeted manner and that sustainability risks will not be viewed in isolation but rather holistically. Integrating sustainability risks into risk management is crucial to meet stakeholder expectations and regulatory requirements.

Laura Wolfschluckner presented results on the development of a process structure for effective reporting according to the Corporate Sustainability Reporting Directive (CSRD), which originates from a research project with *Christa Hangl* and *Nicole Scheidleder* (all University of Applied Sciences Upper Austria, Austria). The CSRD introduced binding reporting standards at the EU level for the first time. To support

companies in fulfilling the requirements, the authors have created a process structure that deals with the concept of reporting and the collection of content-related topics and key figures for the sustainability report. The process structure and associated processes are intended to improve the internal process for preparing the report to meet the new requirements of the directive. The transparency created concerning data availability, tools used and interfaces required within the company should help ensure that the content-related topics and key figures are available on time. During the process, responsibilities are defined, and the controlled processes for collecting qualitative and quantitative content are made available. With the help of the insights gained, optimisation potentials are identified from the process structure, as well as from the detailed process of the environment decision.

Alina Alexenko presented results from a joint study with *Tim A. Herberger* (both Andrássy University Budapest, Hungary). The authors examine whether and how accurately narrative framing is used to describe financial ratios by companies listed in the Financial Times Stock Exchange (FTSE) 100 Index. The analysis results show that companies emphasise desirable developments, especially in the voluntary part of reporting – the shareholder letter. By using a "biased tone," companies try to hide undesirable business developments. Results show that the modality words communicating lower materiality were used more often to describe undesirable business developments than neutral and positive ones. Moreover, the positive business developments were intensively emphasised with positive and attention-focusing (higher materiality communicating) modality words. The regulatory effort to improve the use of language in reporting is thus justified.

The next presentation by *Marcel Tyrell* comes from a project with *Carina Stanjeck* (both University Witten/Herdecke, Germany) and analyses the capital market performance of listed companies during the Ukraine war. The authors examine which types of corporate structure are present in portfolios with high environmental social governance (ESG) scores and in portfolios with low ESG scores. For this purpose, the Fama and French five-factor model and the Carhart four-factor model are used. These models typically have a high explanatory power for shares due to the structural factors included. The results show strong differences in the individual values of the coefficients of the structural factors for portfolios with high and low ESG scores. This allows conclusions to be drawn about the structure of the companies in the portfolios. Portfolios with high ESG scores have more large, undervalued and low-yielding companies that maintain a conservative investment culture and whose shares have a low preliminary return (momentum factor), compared to portfolios with low ESG scores. All regression models of the portfolios with higher ESG scores had a higher explanatory power for returns than those with

low ESG scores. Multifactor models can be better applied to portfolios with high ESG scores during the Ukraine war.

Cornelia Huis presented the results of a study on circular business models of banks, which originated from a cooperation project of the Paris Lodron University Salzburg (*Cornelia Huis*, *Christine Vallaster*, *Claudia B. Wöhle*) and the Salzburg University of Applied Sciences (*Eva Lienbacher*). The authors examine how circular economy business models can be applied within Central European banks and how the strategy and the product portfolio support this change. Initial results show that only a few banks have a circular business model, align their product portfolio with ESG criteria and integrate circular business models. Finally, possibilities to integrate circular business models in the financial sector were discussed.

Laura Schwab and *Martina Sageder* (both Salzburg University of Applied Sciences, Austria) presented results on the acceptance, opportunities and risks regarding the application of FinTech in small and medium-sized enterprises (SMEs). The study results show that FinTechs are already being used in all of the SMEs surveyed, although the potential extent of use is not being fully exploited due to the lack of digitalisation. Reasons for the acceptance of FinTech are a highly perceptible benefit and user-friendliness. Interfaces to existing systems are highly relevant. The automation of standard processes and the associated speed and lower susceptibility to errors are perceived as an opportunity. In addition, the exchange of data with business partners and the good availability of data for evaluations is seen as an advantage. Risks include data privacy and security aspects, such as the risk of cyber-attacks. The high level of investment required for digital innovations is perceived as an obstacle.

Harun Pačić (University of Applied Sciences BFI Vienna, Austria) spoke about the intersection of digitalisation, sustainability and labour law in human resource management. In detail, the results were based on three legal acts from the European Union: the directive on transparent and predictable working conditions in the European Union, the directive on the protection of persons who report breaches of Union law (whistleblowing directive) and the CSRD. From a legal point of view, labour law is the basis and framework for shaping the employment relationship. However, from a human resource perspective, labour law does not drive digital transformation or sustainable development, even though they are in an interdependence with the law. The view of working conditions, however, is shaped by human resources management throughout the value chain.

In the next presentation, *Christian Weiß* and *Katja Wiedemann* (both Salzburg University of Applied Sciences, Austria) addressed the question of how social sustainability is presented in the CSR reports of Austrian companies and how social

sustainability can be supported by human resource development. The authors are just at the beginning of the research project and showed a first literature review and explained the planned methodological approach.

The presentations of the first day were concluded by *Alexander Bull* (IU International University of Applied Sciences, Germany), who spoke about the relevance of social sustainability in the context of project management. Findings are based on an explorative survey on social sustainability in project management, which was conducted among professional project managers in the fourth quarter of 2022 in Germany. The results show that project managers in both the private and professional spheres face increasingly extensive requirements and challenges. These requirements and challenges are mostly met based on the existing experience and know-how of the project managers. A healthy work-life balance is essential for successful project management to cope with the requirements and challenges.

3. Summary panel discussion

The 1st day of the conference concluded with a panel discussion on "Opportunities for a sustainable and digital future." During the evening event, experts from business practice and science discussed current and exciting issues relating to sustainability and digitalisation. Participants included *Andreas Schmelzer* (Head of Digital Transformation & Services, Porsche Holding GmbH), *Ulrike Regner* (Head of Sustainability Management, Raiffeisenverband Salzburg), *Lukas Haigermoser* (Managing Director, zobl.bauer. Salzburg), *Erich Stadlberger* (Head of Private Banking & Asset Management, Oberbank AG), *Christine Vallaster* (Professor of Marketing, Paris Lodron University Salzburg) and *Tim A. Herberger*. *Tim A. Herberger* moderated the panel discussion. In addition to the conference participants, about 120 other guests (mostly students) attended the evening event.

After introducing the experts, the session delved into the digitalisation and transformation of entrepreneurial processes and entire economic systems, exploring the associated opportunities and challenges. These encompassed the utilisation of robotic process automation, artificial intelligence, (digital) competency requirements in the future labour market and financing considerations for fundamental transformation processes. Moreover, sustainability within corporate processes and pursuing sustainable business systems were focal points. The discussion encompassed various aspects, including demonstrating sustainability levels through certifications, providing support mechanisms for companies in their transition towards greater sustainability and garnering political support for establishing sustainable business systems. The discussion also touched upon the legal mechanisms to address societal misconduct, including issues such as

"greenwashing." Additionally, there was a focus on integrating digitalisation and sustainability, including concepts like "twin transformation". Special attention was given to the challenges of pursuing transformation when resources are limited. Finally, the session concluded by addressing questions from the audience.

4. Summary of the presentations of the 2nd day of the conference

On the second day, *Jona Stinner* (University Witten/Herdecke, Germany) started the lecture series with the results of a joint project with *Andreas Park* (University of Toronto, Canada). The authors examine the effectiveness of liquidity mining programmes in decentralised lending protocols within the blockchain ecosystem. Specifically, the research investigates whether these programmes attract meaningful (and permanent) liquidity, whether the liquidity is real or "phantom," and whether the liquidity creates externalities for other platform users. The results show that liquidity reduction programmes attract deposits and increase platform activity, while the end of a programme leads to outflows of funds and increased lending rates. Increased borrowing raises lending rates, raising concerns that yield aggregators may represent a negative externality. However, the authors conclude that yield aggregators add value to the bottom line because their presence leads to lower total interest payments.

The next presentation by *Maria Skalaban* focused on the impact of digitalisation on households' financial behaviour and stemmed from a research project with *Tatiana Nikitina* (both St. Petersburg State University of Economics, Russia). The findings are based on a survey among students in Russia and Germany about the use of digital financial products and services. The results make it clear that in Germany and Russia, digitalisation of the financial sector is at a high level and is viewed positively by respondents. Promising areas of digitalisation of the banking sector in Germany include simplifying and accelerating money transfers and developing ecosystems that enable customers to access various non-financial services. This will lead to an expansion of the functionality of the mobile banking application. Among the promising areas of digitalisation of the banking sector in Russia is using digital technologies to encourage investment behaviour among the population. This may include automated investment portfolio management based on data analytics and robo-advising. In addition, banks could provide more detailed information about financial products and financial education articles in their mobile apps. Financial institutions in both countries should pay attention to cybersecurity, as this risk is the respondents' biggest concern related to digitalisation.

Maria Cenger, *Christine Mitter* and *Julia Riepl* (all Salzburg University of Applied Sciences, Austria) presented findings from their literature review about microcredits in emerging markets. The research aims to identify the impacts of microcredits on firms and borrowers in emerging markets. In total, 44 papers on different impacts of microcredits (e.g. performance, investment, growth, start-ups, health/nutrition, subjective well-being) were identified. The authors presented research gaps and deduced future research opportunities from the findings. For instance, future studies could investigate whether the results can be attributed to microcredits or whether other factors also play a role.

Afterwards, the results of a study of sustainability and resilience in family businesses were presented by *Thomas R. Mörth* and *Michael Kuttner* (both Salzburg University of Applied Sciences, Austria). Based on an exploratory, qualitative study, the authors show that the long-term orientation of family businesses promotes both sustainability and resilience by creating the potential for success through investments in the future. Sustainable, high-quality products target economic success and strengthen the regular customer base. Trusting, personal and long-term relationships with internal and external stakeholders are the basis for successful cooperation and long-term orientation. Emotional attachment to the family business influences the family business's strategic and long-term investments and development. Gut feeling, experience and intuition are essential in decision-making within family businesses. Due to their special characteristics, family businesses are predestined to harmonise economic, ecological and social sustainability and to create differentiating competitive advantages.

Finally, *Jörg Müller* (Technical University of Chemnitz, Germany) offered critical insights on artificial intelligence in university business education. Using text generators based on artificial intelligence (especially ChatGPT) in university teaching is controversial. The discourse to date has focused on admissibility. This study investigates the extent to which artificial intelligence-based text generators provide error-free answers. The results show that the use of text generators based on artificial intelligence often does not lead to an improvement in efficiency for students and/or teachers. In many cases, artificial intelligence supports but cannot fully solve problems due to the lack of "depth" of penetration. A profound reflection cannot be expected from such systems, which should also be made clear to the students.

5. Concluding remarks

To conclude, the two days in Salzburg were characterised by an intensive discourse around digitalisation and sustainability in a global financial economy. The large number of submissions, the heterogeneity of the contributions and the great interest in the conference reflect the relevance of the topics. The valuable feedback of the co-presentations, which experienced scientists held, included the possibility of further developing research projects. Besides the scientific exchange, there was also enough time for networking among the participants, some of whom already knew each other from the previous two conferences at Andrássy University Budapest.

Finally, we would like to thank all participants and especially the speakers. They have contributed significantly to the success of the conference. A conference anthology (*Herberger 2023*) on our conference in 2022 was published in German in the fourth quarter of 2023, containing a large number of the papers presented at Andrássy University in Budapest on 1 December 2022 ("Digital Transformation and Sustainability in the Financial World. Current Issues and Perspectives in the Context of Financial Risk Management"). A corresponding anthology is also planned for this year's conference, which will probably be published in summer 2024 and will also include many of the papers presented. The future of the conference is also secured, with the next event expected to take place in September 2024 in Munich. We will publish a call for papers in early 2024.

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Report on the Fifth Green Finance Conference of the Magyar Nemzeti Bank*

Donát Kim – Balázs Lóránt – Bálint Várgedő

On 12 and 13 October 2023, the Magyar Nemzeti Bank (central bank of Hungary, MNB) held its fifth Green Finance Conference at the Buda Centre of MNB. Unlike previous years, this year's conference was a two-day event. The first day was a public event, thematically related to energy efficiency and Hungary's opportunities for action. On the second day, participants were invited to attend the conference on "Sustainability Trends and Dilemmas in Economics". The organisers aimed to reach out to university professors, PhD students and the research network working on sustainable finance and economics in Hungary.

Energy Efficiency Day

The event opened with a welcome speech by *Csaba Kandrács*, Deputy Governor of the Magyar Nemzeti Bank. The first presenter was *Jan Rosenow*, Director of European Programmes of the Regulatory Assistance Project, who as an online speaker presented the global challenges of energy efficiency and highlighted the importance of electrification, which could reduce global final energy consumption by up to 40 per cent.

The second speaker of the conference, *Ksenia Petrichenko*, Energy Efficiency Policy Analyst at the International Energy Agency (IEA), conveyed that global carbon emissions had continued to rise in 2022, while demand for energy sources was expected to reach its peak in this decade. She mentioned the unexpected shocks to the energy sector and the risks and uncertainties associated with the winter of 2023/24. She then turned to the importance of energy efficiency in terms of demand reduction and energy security, which additionally indicated strong demand for labour. She presented the IEA's projections for 2030 and 2050, which suggested a higher penetration of solar energy in the energy mix.

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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The third speaker at the event was *Claudia Canevari*, Head of the Energy Efficiency Unit of the European Commission, who spoke about the EU's energy efficiency policy and the "Fit for 55" package. She presented the EU's plans and programmes for energy efficiency and gave an overview of the main challenges of energy efficiency. Among the challenges, she mentioned the financing gap between the need for investment and (public) financing, and the lack of awareness and data.

The fourth speaker, physicist and political scientist *Stefan Thomas*, began his presentation by pointing out that energy efficiency contributes to reducing costs and emissions, and thus to the productivity of companies. Just as the previous speakers, he presented the EU's objectives and the renewal rates in the EU, with a special focus on Hungary. He then presented Germany's targets and energy efficiency efforts.

The last speaker in the morning session was *Vlasios Oikonomou*, economist at the Institute for European Energy and Climate Policy. His presentation focused on energy poverty in Hungary. He stressed that energy poverty in Hungary mainly affected rural areas, where the floor space of real estates is larger. The main sufferers were elderly people living alone, single parents, large families and the unemployed, and he recommended in particular the provision of energy efficiency subsidies. These should, he said, help low-income households most and the EU standards should take better account of the energy behaviour of such households.

The morning programme ended with the presentation of the Green Finance Awards. The winner of the Green Bank Award was UniCredit Bank Hungary Zrt., while the Green Insurance and Pension Fund Award 2023 was presented to Aranykor Országos Nyugdíjpénztár pension fund. The Green Investment Fund Manager Award went to Amundi Befektetési Alapkezelő Zrt.

The afternoon session was in Hungarian and commenced with a discussion between *Csaba Kandrács*, Deputy Governor of the MNB, and *Péter Kaderják*, Head of the Zero Carbon Centre (ZKK) at the Budapest University of Technology and Economics. Projects between the MNB and ZKK, the impact of the energy crisis on MNB mandates and energy vulnerability were the topics discussed.

The discussion was followed by a presentation by *Daniella Deli*, Deputy State Secretary for Climate Policy at the Ministry of Energy. She gave a detailed presentation of the European Union's objectives and the Hungarian strategy, and Hungary's objectives in terms of energy efficiency, also highlighting the role of renewable energies in the sustainability transition.

The last speaker of the day was *Károly Szita*, who as the Mayor of Kaposvár leads the Association of Cities with County Rights. He gave a new perspective, from the standpoint of local governments, on what they think needs to be done in energy

policy. The three main pillars were security of supply, predictable and reliable prices and the protection of the natural environment. He also highlighted the fact that the cities in the association had individually prepared greenhouse gas inventories.

The day concluded with two panel discussions. The first focused on the challenges and opportunities in the field of corporate energy efficiency and was attended by *Csaba Attila Kiss*, CEO of MVM ESCO Zrt., *Tamás Mészáros*, Director of the Corporate Business Unit of CIB Bank, *Zoltán Nagy*, President of the Industrial Energy Consumers Forum, and *Dávid Kiss*, Head of Energy Efficiency at MOL Group. The discussion was moderated by an experienced energy expert, *Csaba Nemes*, formerly Head of the Department of Sustainable Development at the Hungarian Energy and Public Utility Regulatory Authority. The participants first gave an assessment of the energy situation of industry in Hungary and that of Hungarian companies in general. They underlined the negative legacy of socialism and the impact of the Covid outbreak on the energy sector. The problems with the Energy Efficiency Obligation (EEO) scheme were detailed. Mention was also made of the high cost of financing, which hinders energy investment. In addition, due to the unfavourable financing possibilities, many are waiting it out and hoping for potential public subsidies. The role of ESCOs (Energy Services Companies) was also mentioned, where it was stressed that ESCOs are not expensive, as the price includes considerable professional service. The panel members agreed that the most important issues are financing and expanding knowledge and brainpower.

The final panel discussion of the first day concentrated on opportunities for energy efficiency in residential buildings. The panellists were *Áron Horváth*, Executive Director of the Hungarian Energy Efficiency Institute, *Pál Kiss*, President of the Hungarian Heat Pump Association, *Levente Suba*, Head of Sustainability at K&H Bank, and *Tamás Csoknyai*, Head of the Department of Building Services at the Budapest University of Technology and Economics. The discussion was moderated by *Zsombor Barta*, Ambassador and former President of the Hungarian Green Building Council. The participants agreed that the Hungarian housing stock was extremely outdated. Due to the very low renewal rate of the building stock, it was not enough to just build new buildings; it was necessary to improve the energy efficiency of the existing stock, one of the most important elements of which was insulation. In connection with heat pumps, *Pál Kiss* pointed out that the wait for state subsidies was an obstacle to growth in the heat pump market. *Tamás Csoknyai* noted that there was sufficient data available on residential buildings, but poor and insufficient data on non-residential buildings, which would require a more serious survey of their energy features. He also mentioned that Hungary was not only lagging behind Western and Scandinavian countries in terms of the energy efficiency of buildings, but also Slovakia and the Czech Republic, for example, although energy consumption could be halved by thermal insulation. The reason for falling behind

was that the reductions in utility costs had not provided an incentive for energy improvements. *Tamás Csoknyai* also explained that after the reductions in utility costs, the willingness to renovate was highest in the case of detached houses built before 1990, as the heat losses suffered by these houses were so high that it was worth investing in improvements. At the same time, only a limited range of people were able to renovate, and energy poverty was a characteristic of most villages. *Levente Suba* presented the most important details of the EU taxonomy on green loans.

Sustainability trends and dilemmas in economics

The second day of the conference was opened by *Csaba Kandrács*. After welcoming the guests, he noted that, as part of the scientific conference, the MNB wished to provide a bridge between stakeholders, to present the views of experts with different backgrounds and with extensive experience, and to facilitate knowledge sharing, networking and cooperation, which was of key importance in all fields of science, including economics.

The day started with a session named after the eminent scientist Lajos Lóczy, with the first block focusing on the relationship between business models and the circular economy. *Eszter Tóth*, Chief Financial Officer of MOHU MOL Hulladékgazdálkodási Zrt. (MOL Waste Management), gave a presentation on the new waste management model in Hungary. She highlighted the new elements of the 35-year concession system won by MOL Nyrt., including producer responsibility, mandatory return and the new separate household waste stream collection system. She stressed that these would help meet the main expectations of EU waste management: reducing landfilled waste to below 10 per cent and increasing the proportion of recycled waste to over 65 per cent. She also presented the figures for municipal solid waste under concession, which was expected to reach between 4 and 4.5 million tonnes per year. MOHU would be collecting and pre-treat this waste and then transferring it for recovery or disposal. She identified the challenge of accessing waste management data, which required the creation of an IT system capable of ensuring the separation of total costs for different material streams. The new system would provide the basic data for the tariff calculation procedure of the Hungarian Energy Authority, which would be used for establishing the tariffs set in the different subsystems. At the end of her presentation, she explained that MOL intended to invest HUF 185 billion in the next few years to meet EU waste management targets.

The second speaker on the topic of circular economy was *József Benedek* from Babeș-Bolyai University, who gave a presentation on measuring and monitoring sustainability. He started his speech by introducing the topic of sustainable development, highlighting the 17 Sustainable Development Goals (SDGs) adopted

by the United Nations in 2015 as an important milestone in the process. He stressed the multidimensional nature of the topic, as it encompassed several economic, social and environmental aspects. He also underlined the importance of data collection and processing in measuring the goals, especially in respect of environmental dimensions, which were also relevant for risk assessment in the financial and banking sector. His presentation focused on a measurement methodology that he and his co-authors had implemented in Romania. The analysis used a comprehensive set of 90 indicators to measure and localise the 17 SDGs. The data sources included a number of public statistics, information from different ministries, as well as unique and innovative sources such as Earth Observations and Geographical Information Systems. He also pointed out the importance and challenges of applying the methodology in practice. Finally, he presented the results of the measurement process, revealing the spatial distribution of the SDG index in Romania. He stressed that the sustainability index produced generally had low values, especially in the less economically developed regions. One of the reasons for this was that the index included a number of indicators strongly linked to economic development. He concluded his presentation by outlining how this integrated methodology was being tested and applied to promote sustainable development efforts.

The second block of the Lajos Lóczy session was entitled "Energy Efficiency Research: from Data to Policy Measures". In this session, researchers aimed to answer the question of how raw data could be used to produce results in this topic that could be used by policymakers. The first speaker, *Gyula Gróf* (Centre for Energy Research), professor emeritus, pointed out in his presentation how energy efficiency investments typically fell short of preliminary calculations, known as the energy savings gap. Among other things, the reasons for this included an initial lack of information on the building to be renovated, the lack of comfort (i.e. heating savings from cost reduction), technical challenges in renovation and the changed forms of behaviour after renovation. Failure typically ensued from ignoring adaptation from human behaviour change. Energy efficiency decision makers needed to address these impacts to achieve the expected results. He stressed that if programmes were based on measured data, there was less chance of meeting energy efficiency and climate protection targets.

The next presentation was given by *Judit Gáborné Székely*, Head of the Housing Statistics Department of the Hungarian Central Statistical Office, with the title "The Energetic Condition of the Hungarian Housing Stock", based on the study "Estimating the Energy Demand of the Residential Real Estate Stock in Hungary Based on Energy Performance Certificate Data", which was published in the September 2023 issue of the Financial and Economic Review, co-authored by Bene et al[2]. The aim of the

[2] https://doi.org/10.33893/FER.22.3.123

research was to estimate the specific primary energy demand of the 2020 housing stock by region and to determine the upper 15-per cent threshold. The method used both linear regression and random forest model estimation, with machine learning achieving better predictions. The research estimated the upper 15 per cent of the domestic housing stock threshold to be 223 KWh/m^2/year for single-family homes and 133 KWh/m^2/year for condominiums, based on specific primary energy demand. It must be noted that the majority of buildings do not reach energy class FF, i.e. the average energy efficiency level. The calculated values showed significant regional variation, and the energy efficiency of detached houses was found to be significantly worse than that of condominiums.

This was followed by a panel discussion, in which *Gyula Gróf* and *Judit Gáborné Székely* were joined by *Gábor Szarvas*, President of the Hungary Green Building Council (HuGBC) as a panellist, and *Donát Kim*, Head of Division at the Sustainable Finance Department of the MNB, as the moderator. According to the estimate presented in the contribution by *Gáborné Székely*, there were approximately 1.2 million properties in Hungary with poor or sub-standard energy efficiency, worth less than HUF 10 million. As market-based renovation was unlikely for these properties, *Donát Kim* inquired about the possible solutions to this problem to open the topic. *Gábor Szarvas* pointed out that the renewal rate was indeed a fraction of what was necessary, and that consequently, in addition to financial resources, public information and expert and contractor capacities were essential. *Gáborné Székely* complemented the above with the findings of a 2015 housing survey conducted by the Central Statistical Office, which showed that in the case of detached houses, it is common that the funds for renovation were available, but the owners were waiting, for example, because they expected a tender process for funding, and condominiums could not organise the renovation themselves. Citing Western European examples, *Gyula Gróf* noted that when several buildings in close proximity to each other were renovated, this led to the renovation of other buildings in their vicinity.

In response to the moderator's question about the blind spots in Hungarian energy know-how and possible new research directions, *Gyula Gróf* – who cited the cooperation with colleagues from the central bank as a positive example, where economists, sociologists and engineers are able to work together – emphasised that one of the foundations of successful cooperation was finding a common language. It would be important to understand the reasons of energy over- and under-consumption and the incentives that prompt owners to start an energy renovation. *Gáborné Székely* considered it a fascinating research question how family types and family structures affect renovation. She gave the example that before retirement it was common for owners to use their advance savings for energy renovation, and this was more common in families with a direct heir. *Gábor Szarvas* concluded by

highlighting the need for energy efficiency assessments of commercial properties besides residential properties, and the improvement of appraisal models by giving greater weight to the energy efficiency of the building.

In conclusion of the Lajos Lóczy session, MNB Deputy Governor *Csaba Kandrács* presented the Green Financial Science Awards founded by the MNB. The 2023 Green Finance Science Talent Award was awarded to *Emilia Németh-Durkó*, an assistant lecturer at Corvinus University of Budapest, who published several highly cited papers on the topic. The winners of the Green Finance Science Research Initiative competition were *Edit Lippai-Makra* and *Regina Bodó*, members of the research team at the University of Szeged, for their research project "The Impact of the European Union's Sustainable Finance Action Plan on the Sustainability Disclosures of Hungarian Banks'. The 2nd place went to the University of Pécs and the 3rd place to the research team of the Corvinus University of Budapest.

During the lunch break of the conference, participants had the opportunity to view the selected works from the poster submissions received for the conference. The exhibited posters were related to the broader issue of sustainability, including climate attitudes, sustainable transport and the clothing industry, as well as to issues related to the impact of other green policy measures. The audience also had the opportunity to discuss the research topics and findings with the authors of the papers.

After the lunch break of the conference, *Pál Péter Kolozsi*, Director of the MNB, gave a presentation in connection with the joint research project of the central bank and the MNB-Institute of the John von Neumann University. He started his presentation by saying that there was a basic consensus among central banks on the prudential aspects of climate risks, but that the integration of a green approach into monetary policy was still a matter of divisive debate. Thus, understanding how the greening of monetary policy impacts faith in the central bank was a key issue. This was why they had launched a project, a representative survey on public perception, to assess this faith in line with international research. Their results showed that respondents perceive climate change as a real threat, with a majority fearing its adverse effects, but also that there was a chance of slowing down the process of climate change. The responses also show that there was a need for institutions and political actors to take responsibility. The presentation also highlighted that the majority of people felt that it was important for the central bank to take up a role in the fight against climate change and that targeted and direct measures were more likely to have a positive impact on trust.

The conference then continued with a session entitled "Between Disciplines: the Relationship between Biodiversity and the Economy", with *Katalin Sipos*, Director of WWF Hungary, as the first speaker. In her presentation, she explained that

the loss of biodiversity also had repercussions for the economy, primarily via the reduction of available natural resources and degradation of ecosystem services – the endowments that nature provided for people. She explained that for many years the Risk Report of the World Economic Forum had identified biodiversity loss as one of the 10 most likely and most serious risks. She noted that by restoring natural habitats, we could reconnect ecosystem services that enhance environmental security and climate resilience and facilitate the regeneration of natural resources. These were so-called nature-based solutions. With regard to the financial and economic sectors, she underlined, among others, the need to improve the understanding and assessment of nature-related economic risks and science-based objectives. Finally, she drew attention to the need for the active contribution of the academic sector.

The second speaker of the block was *György Szabó*, Rector of the University of Nyíregyháza. According to Szabó, in recent decades, the study of the effects of climate change had forced an increasing number of specialist areas to apply their tools and methodologies to the study of risks related to climate change and sustainability. The rapid development of remote sensing and earth observation tools and processing methods had led to the development of widely applicable models and results on global climate change. He stressed the importance of measurability in the context of biodiversity-related financial risks. At the end of his presentation, he outlined the most important bio- and geodiversity data systems and the projects launched in Hungary to develop national-level maps. Among the latter, the Landscape Ecological Vegetation Database & Map of Hungary (MÉTA), the NÖSZTÉP Ecosystem Base Map online map service and the National Geospatial Base Map (NTA) were worth mentioning.

The third and final speaker of the biodiversity block was *Eszter Kelemen*, senior researcher at the Environmental Social Science Research Group (ESSRG). At the beginning of her presentation, she introduced the way economic science thinks about nature. She then presented the report issued by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on the values of and appreciation of nature. According to the report, the value of nature was usually expressed in terms of a single metric, such as how many protected species it was home to. However, these value indicators could only provide a fraction of the information about nature-specific – instrumental, relational and intrinsic – values that were deep-rooted in societal values and worldviews. The analysis also showed that in the vast majority of cases, evaluation results were not directly fed into decision-making.

The conference ended with a panel discussion moderated by MNB director *Péter Kolozsi*, entitled “Challenges and opportunities of new issues from an editorial perspective”. The first topic was the relationship of the scientific community and

journals with new sustainability and green issues. *Péter Halmai*, a full member of the Hungarian Academy of Sciences, highlighted the economic interest in new topics, but noted that neoclassical approaches had difficulties in exploring issues beyond their established methods. He cited Dasgupta's report as a good example, which attempted to integrate environmental considerations into neoclassical growth accounting. He also noted that it was important to analyse social and economic sustainability, as these could have implications for environmental sustainability. *Tamás Halm*, editor-in-chief of Közgazdasági Szemle (Economic Review – monthly of the Hungarian Academy of Sciences), identified growth, networks, simulations and machine learning as the most frequently discussed topics, which had recently been expanded to include industry 4.0, pension sustainability and healthcare. Also noteworthy were the papers in the journal on energy sustainability and the impact of battery factories. *Endre Morvay*, editor-in-charge of Hitelintézeti Szemle/Financial and Economic Review, spoke about the evolving discourse on the implications of the green transition for monetary policy and supervisory tasks, including the thematic journal issue on sustainable finance.

On the issue of interdisciplinarity and sustainability, *Péter Halmai* said that caution should be exercised in the case of initiatives labelled as exclusively "multidisciplinary", which did not meet the requirements of the individual disciplines. On the issue of local journals and international rankings, *Endre Morvay* pointed out that universities were under great pressure to publish in internationally ranked journals, which created competition. He explained the challenge of meeting the criteria, e.g. the Web of Science criteria, for inclusion in international rankings. *Tamás Halm* acknowledged that Hungarian-language journals found it difficult to advance in international rankings, while *Péter Halmai* concluded by underlining the importance of preserving the Hungarian language through Hungarian scientific journals. Overall, the debate touched on the complexity of adapting economic thinking to new sustainability challenges and the transformation of scientific publishing at both the national and international levels. In his closing speech, *Norbert Holczinger*, Head of the Sustainable Finance Department of the MNB, drew attention to the importance of cooperation.

INSTRUCTION FOR AUTHORS

Manuscripts should be submitted in accordance with the following rules:

- The length of the manuscripts should be limited to 40,000 characters (including spaces) but a ± 50 per cent deviation is accepted. Manuscripts should be written in Hungarian and/or English.
- The unnumbered footnote of the author's name contains his/her position, the institution the author works at, his/her email address and any other relevant information and acknowledgment regarding the article.
- Papers always begin with an abstract which should not exceed 800–1,000 characters. In the abstract a brief summary is to be given in which the main hypotheses and points are highlighted.
- Journal of Economic Literature (JEL) classification numbers and keywords should be given (three at least).
- Manuscripts should be written in clear, concise and grammatically correct Hungarian and/or English. Chapters and subchapters should be bold.
- Manuscripts should contain the list of references with the first and surname of the authors (in case of non-Hungarians the initials of the first name is required), the year of publication, the exact title of the book, the publisher, the place of publication. In case of papers, the exact title of the journal, the year, the volume, and the pages should be indicated. References in the text should contain the surname and the year. When citing the exact page should be indicated.
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- Equations should be aligned to the right and should be numbered continuously in parenthesis. (Chapters and subchapters should not contain restarted the numbering.)
- Manuscripts are to be sent to the Editorial Office only. Papers are peer-reviewed by two independent and anonymous reviewers.
- Manuscripts should be sent as attachment by email in MS Word file. Figures should be sent in MS Excel file both in Hungarian and English.
- In case of further questions related to the manuscript visit the following website: *https://en-hitelintezetiszemle.mnb.hu/authors-guide*

Thank you!

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